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Perspectives and Challenges of Hydrogen Storage by Metal-Organic Frameworks

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Abstract:
A potential solution to develop clean and low-carbon future, replacing fossil fuels with zero-carbon energy systems, such as hydrogen energy systems which uses sunlight, wind, geothermal & heat. Mostly these sources are environmentally favorable, but they are not supplemental enough on their own. It is strongly believed that as alternative renewable energy source, hydrogen energy can help to address the growing demand for energy and slow down global climate because it is environmentally clean, abundant in nature and shows higher gravimetric energy capacity compare to other energy sources.
Although the field of high surface area materials is considered very mature, the need for improved materials for alternative energy applications remains challenging. Currently zeolites, metal oxides, and activated carbons dominates the market, but more advanced materials required for a variety of applications.
Metal organic frameworks (MOFs) are a relatively new class of nanoporous materials that show promise for several energy and chemical engineering applications. At this point Metal-organic frameworks (MOFs), are currently emerging as ideal candidates for hydrogen storage due to their goal directed structures, high thermal stabilities, adjustable chemical functionalities and ultrahigh surface areas. They are basically built with rigid organic legends linked to metal or metal containing clusters.
In this review, a brief summary of the current status of porous MOFs for hydrogen storage, its perspectives and challenges for future energy sources, storage and other gas separation applications were studied.

Key Words: Metal organic framework, Hydrogen, Porosity, Energy storage, Physisorption

1. Introduction:

With the continuous growth of economies and increasing demand for replacing fossil fuels, clean energy has become one of the main challenge. Hydrogen is an ideal clean energy carrier because of its abundant availability, clean burning qualities, and its potential for domestic production from e.g. renewably produced electricity and water. Moreover, its high energy density (at STP, hydrogen is a gas with density of 0.089 gm/lit.), which is nearly triple that of gasoline per unit mass, makes it an attractive energy carrier. However, the extremely low volumetric storage density of hydrogen presents a barrier that limits its practical usage as a fuel for vehicles [1, 2].
For board use, hydrogen can be compressed to very high pressures or stored cryogenically. The storage of hydrogen in liquid or gaseous form is an important safety concerns for board transport applications. Therefore, it is desirable to design safe, light-weight and low-cost materials that can reversibly and rapidly store hydrogen near ambient conditions at a density equal to or greater than that of liquid hydrogen. Table- 1 shows the properties of hydrogen compared with those of some common fuels [3]:

Properties	Hydrogen	Petroleum (Gasoline)	Methane	Methanol
Boiling point (^{0}K)	20.3	350–400	111.7	337
Liquid density at B.P. (kg/m^3)	70.8	~ 700	425	797
Gas density at STP (kg/m^3)	0.08	~ 4.7	0.66	---
Vaporization heat (kJ/kg)	444	~ 300	577	1168
Combustion heat (MJ/ kg)	120	44.5	50.0	20.1
Combustion heat (liquid fuel) (MJ/ m$^{3)}$	8960	31170	21250	16020
Ignition temperature (in Air) (^{0}K)	858	495	807	658

Table- 1: Properties of hydrogen compared with those of some common fuels

Metal-organic frameworks (MOFs) can store nano scaled objects and make them available for various applications. For this reason, they are of particular interest in many research areas, including materials science, biology, and medicine. MOFs are highly ordered molecular systems, consisting of metal nodes and organic rods. The pores in these frameworks are freely accessible. MOFs are used in powder form to store hydrogen and other small molecules, such as carbon dioxide or methane. Metal organic frameworks (MOFs) are a unique class of crystalline porous solids that have been studied extensively for a number of applications, including gas storage, gas separation, heterogeneous catalysis, and so on. Generally, metal-organic frameworks are constructed by assembling metal atoms or small metal-containing clusters, referred to as the secondary building unit or SBU, with multi dentate organic legends via coordination bonds [1, 4, 5, 6].

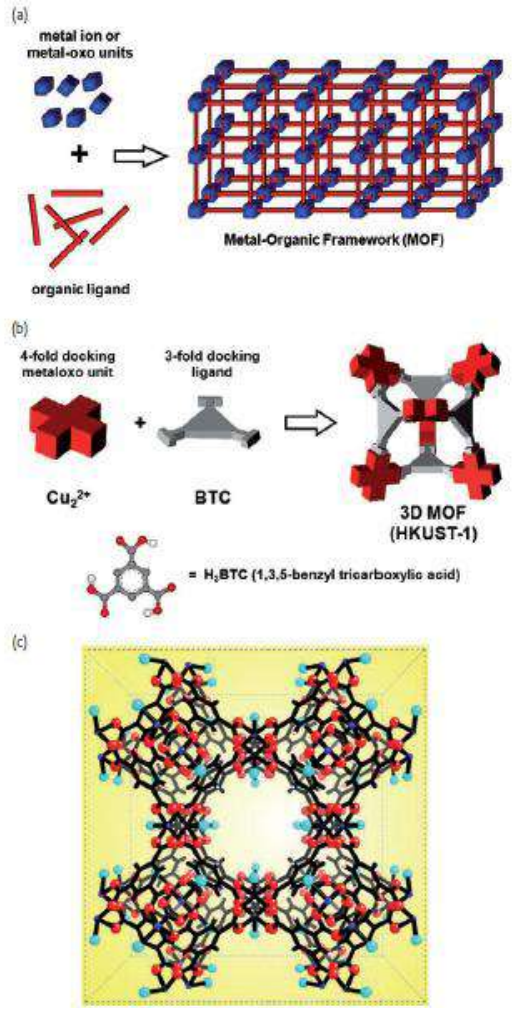
2. Fundamental study of hydrogen storage by physisorption

Besides metal hydrides, highly porous solids that can retain hydrogen by physical adsorption (Physisorption) are under active research as hydrogen storage materials. Since physisorption is a non-activated process, fast kinetics of adsorption and desorption, low heat of adsorption and being completely reversible. These are the main favorable characteristics of physical adsorbents. The major drawback is that physisorption is brought about by (weak) Vander Waals forces comprising dispersion, orientation and induction energy. In the absence of relatively strong polarizing centers, interaction between the adsorbent and the non-polar hydrogen molecules relies on dispersion forces, which are weak; typically of the order of 3-6 kJ /mol. Hence, significant hydrogen adsorption often takes place only at a cryogenic temperature [3, 7, 8].

Outstanding surface area and pore volume confers considerable potential to MOFs as prospective materials for hydrogen storage. And, in contrast to activated carbons, metal-organic frameworks have well-defined crystal structures; which results in a system of pores of uniform size (about 0.5 to 2 nm in diameter) for each particular material [3,9].

3. Synthesis of MOFs:

Different types of synthesis methods were applied in the literature for MOF materials. Among them are classical hydro (Solvo) thermal synthesis, microwave method, electrochemical synthesis, diffusion method, and ultrasonic method [9].
MOFs are synthesized under Solvo-or hydrothermal conditions in the presence of a base. The formation of MOFs is schematically shown in Fig 1 [a] and in more detail for the example of the MOF HKUST-1, in Fig. [b]. The fig. (c) shows the unit cell of the HKUST-1 MOF. The sizes of the largest pores in this particular MOF are 1.2 nm. Many MOFs are prepared in pure N,N-diethylformamide (DEF) or N,N-dimethylformamide (DMF), which are well known to undergo decomposition at elevated temperatures to slowly generate an amine base that deprotonates the organic functionalities of the linker and generates the metal-organic clusters [8,9,10].



Ref. [11]: Hartmut Gliemann et.al., Materials Today,Vol.15(3), March 2012
(Blue: copper; Red: oxygen; Black: carbon; Light blue: Oxygen of the associated water).

Figure-1: Synthesis scheme MOF
a)The scheme of the formation of a three-dimensional connection of a metal-oxo unit with organic legends to a MOF. b) Formation of the MOF HKUST-1 as an example c) The structure of a unit cell of HKUST-1.

The reactions are carried out either in glass in glass jars (1-10 g) sealed with Teflon lined caps to prevent solvent escape and corrosion of the caps. The reaction solutions are then heated to 50-250 ºC & crystalline materials are thus formed. Subsequently, the solvent is removed from the crystals. The crystals are submerged in a variety of low boiling, non- or weakly coordinating solvents (such as $CHCl_3$, CH_2Cl_2, methanol, ether) to extract DEF, DMF, and water from the pores of the material. Finally, the crystals are filtered from the solution and dried under vacuum at elevated temperature to completely evacuate the pores. Once the MOF is evacuated, it is likely to become air and moisture-sensitive, i.e. it may decompose or re-hydrate irreversibly in air. Some tips for maximizing the surface area of a MOF include using fresh DEF or DMF (which tend to degrade over time or upon exposure to air), filtration and sonication of the reaction mixture prior to heating, degassing of the reaction solvent with N_2, and certainly the proper activation (evacuation) procedure described above. Each of these steps can reduce crystal defects and enhance the surface area of the material [12,13,14].

The most important analytical techniques used in the characterization of new materials include surface area analysis by gas sorption, X-ray diffraction (XRD powder or single crystal), elemental microanalysis, IR, and thermo-gravimetric analysis (TGA) [8, 15].

4. Porosity of MOFs:

The porosity of MOFs is greater than that of any other porous material, double the record for porous carbon. The surface area of MOF-5 was initially reported at 2,900 m^2/g , but now MOF-5 can be activated to obtain 3,800 m^2/g. In such a material, 60% is open space, into which gases and organic molecules can be introduced [16].

Unlike other porous materials, MOFs have pores without walls; they are made entirely of struts and intersections. They are open scaffolds, where the struts or the intersections are sites for gas molecules to enter. That is the reason they have very high surface area, and this is the optimal way to create high surface area materials. MOF-177 had a surface area of 5500 m^2/g [16] by evacuating the pores completely. The surface areas of Zeolite is approximately 500 m^2/g, mesoporous materials of 1,000 m^2/g, and porous carbon, which is amorphous with 1,500 m^2/g surface area (2,000 m^2/g with some expensive processing). Now, using simple chemistry, we can obtain 5,500 m^2/g. MOFs can be shaped for various applications, including catalysis and gas separation [1, 9, 16, 17].

5. Hydrogen storage in porous MOFs:

Hydrogen storage is of great interest because hydrogen as a possible substitute for fossil fuels for zero-emission energy technology [16]. There are currently several storage systems for hydrogen including liquid or high-pressure H_2 gas like reversible metal hydrides, chemical hydrides, and porous adsorbents. The table-2 shows the few of them with their benefits and barriers for hydrogen storage. However, up to date none is capable of satisfying the criteria of size, recharge, kinetics, cost, and safety required for use in transportation.

H_2 storage Technology	**Benefits**	**Barriers**
Liquids Tanks	Well understood technology Good storage density possible	Very low temperature require super insulation; Cost can be high; Some hydrogen is lost through evaporation; Energy intensity of liquid hydrogen production; Energy stored still not comparable to liquid fossil fuels.
Compressed Gas Cylinders	Well understood up to pressure of 200 bar ;Generally available Can be low cost	Only relatively small amounts of H_2 are stored at 200 bar; Fuel and storage energy densities at high pressure (700 bar) are comparable to liquid hydrogen but still lower than gasoline and diesel; High pressure storage still under development.
Metal hydrides	Technology available; Solid-state storage; made into different shapes; Thermal effects can be used in subsystems; Very safe	Heavy; Can degrade with time; Currently expensive; Filling requires cooling circuit.
Carbon structures	May allow high storage density; Light & cheap	Not fully understood or developed

Table: 2- Benefits and barriers of hydrogen storage

Hydrogen storage is a problem that has been a focus of scientific research for decades. Each of these methods has its advantages and disadvantages, but all on-board storage technologies have to meet the requirements like safety, performance, cost, and technical adaptation for the infrastructure, scalability small and large vehicles [18].

The variety of methods have been investigated, although, none of these have accomplished the required performance level so far. Current methods for hydrogen storage can be broadly separated into: mechanical storage (storage in a tank of compressed gas or liquid hydrogen); Physisorption [19] (storage in a solid material) includes, Graphene and other carbon structures, metals and metallic nano-crystals and composites, metal-organic frameworks, zeolites; hydrogen: storage in solid or liquid material of chemically bound hydrogen that is released on decomposition, includes, light metal hydrides (alkaline hydrides), boro-hydrides, amines and imides [19,20].

Metal organic frameworks (MOFs) are a new class of porous materials with low density and high surface area. They are crystalline, infinite networks assembled by linking metal ions with various organic linkers through strong bonds. More recently, it was realized that some of them could be promising candidates for hydrogen storage. Table-2 shows the relevant data of some of the selected MOF at different pressure, surface area and H_2 uptake capacities of MOFs [3, 20].

Material	**Surface Area (m^2/gm)**	**Pore volume (cm^3/gm)**	**H_2 uptake capacity (wt%)**		**ΔH^0 (kJ/ mol)**
			77^0K	**298^0K**	
$Cu^2(*L^2)(H_2O)_2$	2247	1.08	6.1 (20 bar)	--	--
HKUST-1	2175	0.75	3.6 (10 bar)	0.35 (65 bar)	6.8
IRMOF-11	2180	--	3.5 (34 bar)	--	--
IRMOF-20	4580	--	6.7 (70 bar)	--	--
MIL-100	2800	1.0	3.28 (26 bar)	0.15 (73 bar)	6.3
MOF-5	4170	--	5.2 (48bar)	0.45(60 bar)	4.8
MOF-74	1132	0.39	2.3(26 bar)	--	8.3
MOF-177	5640	--	7.5(70 bar)	--	--
ZIF-8	1810	0.66	3.1 (55 BAR)	--	--

($*L_2$ = Terphenyl-tetracarboxylate).
Table-3 : Relevant data for some selected MOFs

6. Hydrogen- towards a sustainable energy future:

A major challenge facing our planet today related to the problem of anthropogenic driven climate change and the need of future energy. The technology of hydrogen energy will contribute significantly to a reduction in environmental impact, enhanced energy security and diversity and the creation of new energy industries [21]. However, the transition from a carbon-based (fossil fuel) energy system to a hydrogen-based economy involves significant scientific, technological and socioeconomic barriers to the implementation of hydrogen as the clean energy technologies [16,18, 22] of the future. Global drivers for sustainable energy vision of our future need to:

i) Reduce CO_2 emissions and improve air quality.
ii) Ensure security of energy supply.
iii) Create a new industrial and technological energy base, crucial for our economic prosperity.

7. Applications:

i) The vision of an integrated energy system of the future would combine large and small fuel cells for domestic and decentralized heat and electricity power generation with local hydrogen supply networks that would also be used to fuel conventional (internal combustion) or fuel-cell vehicles.
ii) Unlike coal, gas or oil, hydrogen is not a primary energy source. Its role more closely to that of electricity as an 'energy carrier', which first is produced using energy from another source and then transported for future use, where its stored chemical energy can be utilized. Hydrogen can be stored as a fuel and utilized in transportation and distributed heat and power generation using fuel cells, internal combustion engines or turbines, and, importantly, a hydrogen fuel cell produces only water and no CO_2 [2,16,23].
iii) Hydrogen can also be used as storage medium for electricity generated from intermittent, renewable resources such as solar, wind, wave and tidal power. It therefore provides the solution to one of the major issues of sustainable energy, namely the vexing problem of intermittency of supply. As long as the hydrogen is produced from non-fossil-fuel feed stock, it is a genuinely green fuel. Moreover, locally produced hydrogen allows the introduction of renewable energy to the transport sector, provides potentially large economic and energy security advantages and the benefits of an infrastructure based on distributed generation. It is this key element of the energy storage capacity of hydrogen that provides the link between sustainable energy technologies and a sustainable energy economy, generally placed under the umbrella term of 'hydrogen economy'[16].

8. Challenges:

In order to achieve the hydrogen economy, there are some obstacles that need to be overcome to make hydrogen a viable energy carrier. They are characterized by four main aspects of hydrogen use and some of these will be addressed here [18]:

i) **Production:** Since hydrogen needs to be produced, ideally from water, it is necessary to develop production methods that would consume the least amount of energy and provide ability to produce hydrogen renewably on a large scale.

ii) **Storage:** Fuel needs to be easily stored for use and transport, where one of the main requirements is that it is readily available, which requires not just short charge/discharge times, but also excellent control of charge/discharge process coupled with sufficient energy and gravimetric/volumetric density.

iii) **Power generation:** Once hydrogen is ready to be consumed, it is necessary to do so in the most effective way: the power generation system that uses hydrogen needs to be both efficient and, for mobile application, light weight.

iv) **Safety:** Hydrogen use and storage comes with some risks (flammability) which necessitate certain precautions and safety measures; another aspect related to this is environmental impact of the hydrogen cycle, which depends on the methods used to produce, store and use it.

Since hydrogen is thought to be a renewable fuel for the future, it is only appropriate that, when we consider all the challenges associated with its production, storage and use, we keep in mind that when we consider proposed systems, efficiency is only one of the factors that will determine the success of these systems. Other important aspects are production cost, durability, stability of

operation and safety, and these can, more than efficiency, determine the success or failure of any of the proposed solutions for a part of the hydrogen cycle.

For practical applications of hydrogen storage, the storage material should be rechargeable. H_2O is very difficult to be fully removed from commercial hydrogen sources. For practical applications, it is not economical to use super-high purity hydrogen for transportation because of the additional cost for purifying hydrogen. Thus, the H_2O adsorption characteristics and the structure stability upon H_2O adsorption are very important issues for a promising hydrogen storage material for practical applications. This is even more problematic for MOFs because MOFs decompose easily at elevated temperatures, indicating the instability of this type of material [14, 23]

9. Conclusion:

As a new class of functional materials, porous MOFs have exhibited great potential for energy-relatedapplications, ranging from gas storage to catalysis and from gas separation to fuel cell. Many MOFs can be synthesized easily and quickly at low cost; moreover, variations of MOF compositions and structures, including high aspect ratio MOFs, may be practically unlimited and the organic linkages provide a useful platform for chemistries that may improve adhesion to polymer matrices.

In the current state-of-the-art in hydrogen storage, no single technology satisfies all of the criteria required by manufacturers and end-users, and a large number of obstacles have to be overcome. At the present time, there are three major technological barriers that must be overcome for a transition from a carbon-based (fossil fuel) energy system to a hydrogen-based economy. i) First, the cost of efficient and sustainable hydrogen production and delivery must be significantly reduced. ii) Second, new generations of hydrogen storage systems for both vehicular and stationary applications must be developed. iii) Finally, the cost of fuel-cell [18] and other hydrogen-based systems must be reduced. Storage and transport of hydrogen constitutes a key enabling technology for the advent of a hydrogen-based energy transition. Main research trends on hydrogen storage materials, including metal hydrides, porous adsorbents and hydrogen clathrates, were reviewed with a focus on recent developments. There is a plenty of scope of this present work. It is of paramount importance to actually find the surface area, pore volume and pore size distribution of all the synthesized products. Additionally, newer mechanisms are required to be invented to improve the thermal and chemical stability of synthesized materials.

10. References:

[1]. Shengqian Ma, Hong-Cai Zhou," Gas storage in porous metal–organic frameworks for clean energy applications", Chem. Commun.,Vol. 46, 44–53, 2010.
[2]. Shengqian Ma, Le Meng, "Energy-related applications of functional porous metal–organic frameworks", Pure Appl. Chem., Vol. 83, (1), 167–188, 2011.
[3]. Annemieke W. C. Vanden Berg, Carlos Otero Arean, "Materials for hydrogen storage: Current research trends and perspectives", Chem. Commun., 668–681,2008.
[4]. Jie Yang, "Hydrogen storage in Metal Organic Frameworks" Thesis-Master of Science in Chemistry, Xiaan Normal University, Xi'an, China, 2012.
[5]. Jesse L.C. Rowsell, Omar M. Yaghi, "Review :Metal–organic frameworks: A new class of porous materials", Microporous and Mesoporous Materials, 73, 03–14, 2004.
[6]. Ryan Adams, Cantwell Carson, Jason Ward, Rina Tannenbaum, William Koros, "Metal organic framework mixed matrix membranes for gas separations" Microporous and Mesoporous Materials, xxx–xxx, 2010.
[7]. Michael Hirscher, Barbara Panella, Barbara Schmitz, "Metal-organic frameworks for hydrogen storage", Microporous and Mesoporous Materials, 129, 335–339, 2010.
[8]. Yingwei Li, Ralph T. Yang, "Hydrogen Storage in Metal-Organic and Covalent-Organic Frameworks by Spillover", AIChE Journal, (January), Vol. 54, No. 1, 269-279, 2008.
[9]. Duncan W. Bruce, Dermot O. Hare, Richard I. Walton, "Porous Materials", 1st Edn. John Wiley & Sons, Ltd, 01-67, 2011.
[10]. Martin Schroder, "Functional Metal-Organic Frameworks: Gas Storage, Separation and Catalysis" Springer Publications, New York, ISSN- 0340-1022, 2010.
[11]. Hartmut Gliemann, Christof Woll, "Epitaxially Grown Metal- Organic Framework", Materials Today, Vol. 15 (3), 110-116, 2012.
[12]. S. Keskin, D. Sholl, "Selecting metal organic frameworks as enabling materials in mixed matrix membranes for high efficiency natural gas purification, Energy Env. Sci., Vol.3, 343–351, 2010.
[13]. Stephen R. Caskey, Adam J. Matzger, "Selected Applications of Metal-Organic Frameworks in Sustainable Energy Technologies", Material Matters-Alternative Energy Photovoltaic, Ionic Liquids, and MOFs, Vol. 4 (4), 111-113, 2009.
[14]. David J. Tranchemontagne, Joseph R. Hunt, Omar M. Yaghi, "Room temperature synthesis of metal-organic frameworks: MOF-5, MOF-74, MOF-177, MOF-199, and IRMOF-0, Tetrahedron, (64), 8553–8557, 2008.
[15]. Z. Ozturk, D. A. Kose, A. Asan, B. Ozturk, "A Kind of Energy Storage Technology: Metal Organic Frameworks", International Journal of Renewable Energy Research, Vol.2, (1), 44-46, 2012.
[16]. Omar M. Yaghi, Qiaowei Li, "Reticular Chemistry and Metal-Organic Frameworks for Clean Energy", Materials Research Society(MRS) Bulletin, Vol. 34, (Sept), 682-690, 2009.
[17]. Juergen Caro, "Are MOF membranes better in gas separation than those made of zeolites?" Current Opinion in Chemical Engineering, 01, 77–83, 2011.

[18]. P.P. Edwards, V.L. Kuznetsov, W.I.F. David, N.P. Brandon, "Hydrogen and fuel cells: Towards a sustainable energy future", Energy Policy, 36, 4356-4362, 2008.

[19]. Dipendu Saha, Shuguang Deng, Zhiguan Yang, "Hydrogen adsorption on metal-organic framework (MOF-5) synthesized by DMF approach" J Porous Mater, Springer Publication, DOI 10.1007/S10934-007-9178-3.

[20]. David J. Collins, Hong-Cai Zhou,"Hydrogen storage in metal–organic frameworks", J. Mater. Chem., 17, 3154-3160, 2007.

[21]. Ioannis Hadjipaschalis, Andreas Poullikkas, Venizelos Efthimiou, "Overview of current and future energy storage technologies for electric power applications", Renewable and Sustainable Energy Reviews, 13, 1513-1522, 2009.

[22]. Jun Yang, Andrea Sudik, Christopher Wolverton, Donald J. Siegel," Critical Review: High capacity hydrogen storage materials: attributes for automotive applications and techniques for materials discovery", Chem. Soc. Rev., 39, 656-675, 2010.

[23]. Bilge Yilmaz, Natalia Trukhan, Ulrich Muller, "Industrial Outlook on Zeolites and Metal Organic Frameworks", Chin. J. Catalysis, 33, 3-10, 2012.

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"Online Off-Site Condition Monitoring Of Three Phase Induction Motor by Using GSM Technology"

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***Abstract*— This paper describes online off-site condition monitoring of three phase induction motor by using GSM technology. In this approach, a microcontroller based hardware unit has been developed to continuously monitoring and measure the stator current of the motors. In a motor monitoring system the motor is connected with one microcontroller based hardware unit, which is also connected to Global System for Mobile Communication (GSM) modem. The preliminary level of fault or abnormality in operation of motor is diagnosed by the Fast Furrier Transform in MATLAB and the fault details are reported to the assigned operator through an SMS service. In extreme case, the provision of motor is shut down by a return SMS is also provided. A lab model is set up and is working satisfactorily.**

Keywords*— *GSM Modem, Moto Fault, Motor current Monitoring, SMS Service.

I. INTRODUCTION

Condition monitoring of induction motor have a challenging task for engineers in industries. There are many conditions monitoring methods including vibration monitoring, thermal monitoring, chemical monitoring all these monitoring methods required expensive sensors or specialized tools whereas online off-site condition monitoring of induction motor using GSM does not required additional sensors. This also contains AVR controller which generates controlled signals which is transmitted to server also makes use of mobile frequency band provides complete automation. It monitored stator fault, rotor fault, bearing fault by using microcontroller which communicates with GSM and GSM send message to the user. Condition monitoring of induction motor is a process that may be used to great advantage in agricultural field as well as in the industrial application. Motor current acts as an excellent transducer for detecting fault in the motor. Spectrum analysis of the motor's current and voltage signals can hence detect various faults without disturbing its operation. Current signature analysis involves the measurement of electric current around any one phase either through clamp on meters or through CT's. This current is then transformed into its frequency spectra and analyzed for detection of fault .

The proposed work for project aims is to detect the rotor fault by online off site condition monitoring of induction motor using GSM technology by developing working model of system.

II. INDUCTION MOTOR FAULT

Induction machine failure surveys have found the most common failure mechanisms in induction machines are stator related faults, rotor related faults, bearing related faults and other faults.

Stator fault: - Almost 38% of induction machine failures fall stator fault. The three phase stator winding consists of coils of insulated copper wire placed in stator slots. Stator winding faults are caused by insulation failure between two adjacent turns in a coil. This is called a turn-to-turn fault.

Rotor fault: - Rotor faults account about 10% of total induction machine failures. The failure mechanism is a breakage or cracking of the rotor bars which can be due to thermal or mechanical cycling of the rotor during operation. This type of fault creates the twice slip frequency sidebands in the stator current spectrum around the supply frequency signal.

Bearing fault: - Almost 40% of induction machine failures because of bearing fault. The majority of induction motor use ball or rolling elements bearings and these are one of the common causes of failure. Bearings consist of an inner and outer ring with a set of rolling elements placed in raceways rotating inside these rings. Faults in the inner raceway, outer raceway or rolling elements will produce unique frequency components in stator current signals

Other fault:-Almost 12% of induction motor fails because of other faults like eccentricity faults etc.

III. METHODOLOGY FOLLOWED

The proposed work aims is to detect the rotor fault by online off site condition monitoring of induction motor using GSM technology by developing working model of system. There are several techniques that can be used for detecting faults in induction motors.

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The MCSA (Motor Current Signal Analysis) is a non-invasive, on-line monitoring technique for diagnosing problems in induction motors. This method is based on the spectral decomposition of the steady state stator current which can be acquired with simple measurement equipment and under normal operation of the machine. MCSA can diagnose failures such as broken rotor bars, shorted turns, bearing damage and air gap eccentricity. In the MCSA method, the current frequency spectrum is obtained and specific frequency components are analyzed. These frequencies are related to well-known machine faults. Therefore, after processing the stator current, it is possible to infer about the machine's condition an accurate comprehension of the influence of each variable is desired for the correct interpretation of the data acquired.

In this work the frequency spectrum is obtained using the FFT. For the cases where the data acquisition is done for a complete number of cycles of the frequency component being studied, obtaining its amplitude and frequency is relatively straight forward. However, this is rarely the case, leading to cases where certain frequency components mask others of interest. This is commonly known as leakage. Another fact which must be taken into account is that the motor's load conditions are not always the same; this alters the fault signature characteristics as well. The main objective of the technique described in this paper, is to identify the frequency components associated with the types of failures previously mentioned, independently from the motors' operating conditions and data acquisition, and monitor them in order to determine the condition of the machine. To avoid the masking effect, the signal is multiplied by a function (also known as window) to reduce the discontinuity. Both the description of different windows and their results are not analyzed instead it focuses on the acquisition of the current's frequency components' amplitudes, of those components which are induced by each failure. When the number of samples is sufficiently high (tests have been done using sampling rates of 5 kHz, 2 kHz and 1 kHz during a sampling time of 8 s and 10 s), the values of the discrete Fourier series converge to those of the continuing Fourier series.

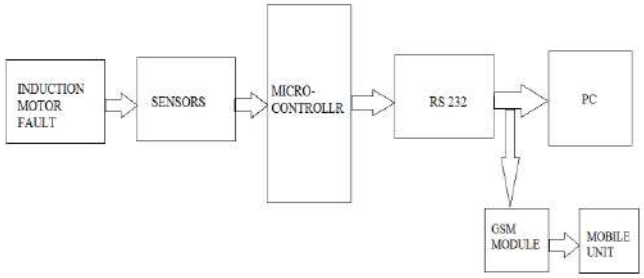

Fig1: Block diagram of general approach

Different type of sensor can be used to sense the characteristic signals resulting from fault.

Various signal processing techniques are applied to these sensor signals to extract particular fault. fig 1 shows block diagram of general approach. Current transformer will sense the current from one phase of stator winding which is given to microcontroller for analysis purpose then signal is given through RS 232 to the GSM module as well as computer where the fault is analyzed in MATLAB through FFT. This GSM modem is a highly flexible plug and easy integration to RS232. GSM modems can be a quick and efficient way to get started with SMS, because a special subscription to an SMS service provider is not required. The mobile operator charges for this message sending and receiving as if it was performed directly on a mobile phone. In most parts of the world, GSM modems are a cost effective solution for receiving SMS messages, because the sender is paying for the message delivery.

IV. System Description

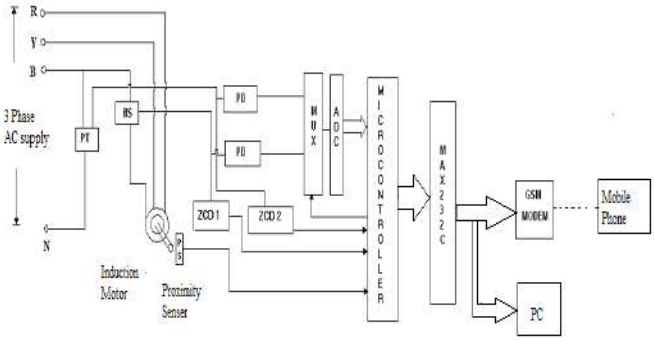

Fig 2: Schematic diagram of a Method

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The developed GSM based remote fault monitoring system consists of four main blocks viz. microcontroller based hardware unit, GSM modem, pc with MATLAB, mobile unit. Induction motor is associated with dedicated hardware unit for data acquisition to measure the stator current parameter the fault condition is detected by DHU and generate message and send to pre-assigned as a text SMS through the GSM modem. DHU passed same signal to computer through RS232, where the fault signal is analyzed by MATLAB.

DHU, the microcontroller is interfaced with, current transformer (CT) or hall sensor (HS), through proper hardware circuitry in order to measure the applied voltage, fault current and speed of the motor. The fault or abnormal conditions are also classified into different levels of priorities. Depending upon the priority of the type of abnormal conditions the DHU decides its corrective action. In case of highest priority abnormal conditions the machine will be isolated from supply.

V. Interfacing Of GSM Modem With DHU

A GSM modem is specialized type of modem, GSM accepts SIM card, and operate over a subscription to a mobile operator, like mobile phone from mobile operator perspective GSM modem tools like a mobile phone.GSM also pioneered low-cost implementation of the short message service (SMS), also called text messaging, which has since been supported on other mobile phone standard as well GSM modems are most frequently used for sending and receiving SMS message. A GSM modem exposes interface that allow application such as SMS to send and receive message over modem interface. During the process witch faults occur can be displayed on the screen of mobile with the help of communication done between microcontroller and GSM, because of TXD of microcontroller is connected to RXD of GSM and RXD of microcontroller is connected to TXD of GSM. To perform these tasks GSM modem must support extended AT command extended this AT command set for sending/receiving SMS message. GSM modem can be quick and efficient way to get started with SMS because special subscriptions to SMS service provider is not required. GSM modem is cost efficient solution for receiving SMS message because the sender is paying for the message.

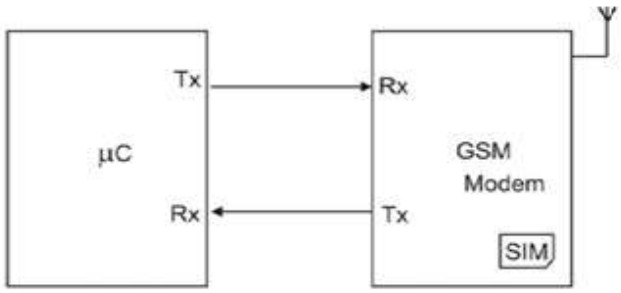

Fig 3: Schematic diagram of GSM interfacing

The GSM modem is built with a COM port with RS232 protocol based interfacing facility. First the microcontroller has to send "AT" command word. A response "ok" is returned from GSM modem. The microcontroller sends another query like by sending "AT+CPIN?" to get the PIN (Personal Identification Number).If the SIM card is ready the response "+CPIN: READY" is returned. After this, step by step AT commands are to be sent for the required SMS services.

VI. Conclusion

The approach discussed in the paper has achieved the target to remotely monitoring the three phase induction motor using the GSM based system satisfying user needs and requirements. GSM technology capable solution has proved to be controlled remotely, provide industrial security and has achieved the target to control different induction motor remotely using the SMS-based system satisfying user needs and requirements GSM technology capable solution has proved to be controlled remotely, provide industrial security and is cost-effective as compared to the previously existing systems. It have more advantages as compared to the other monitoring method .Here motor monitored through GSM modem from remote place as result manpower as well as time requirement will be less. This offers major benefit to both customer and companies in terms of efficiency, reliability, and cost saving and motor is fully protected. A methodology based on MCSA is presented for monitoring and diagnosing faults in induction motors. This method is able to ascertain the exact value of both magnitude and frequency of the signal's components, regardless of the sampling time. Therefore, studies of the faults' growth tendencies are very easier.

REFERENCES

[1] "Induction Motors' Faults Detection and Localization Using Stator Current Advanced Signal Processing Techniques" Mohamed El Hachemi Benbouzid, Member, IEEE, Michelle Vieira, and C´eline Theys.

[2] "An Unsupervised, on line system for Induction Motor Fault Detection Using Stator Current Monitoring" Randy R. Schoen, Member, IEEE, Brian K. Lin, Student Member, IEEE, Thomas G. Habetler, Senior Member, IEEE, Jay H. Schlag, and Samir Farag, Member, IEEE.

[3] "Detection of Broken Rotor Bars in Induction Motors Using Wavelet Analysis"H Douglas', P. Pillay , A Ziarani, Clarkson University, on leave from the Department of Electrical Engineering University of Cape Town**,** Rondebosch 7701 South Africa.

[4] **"**On-Line Current-Based Condition Monitoring and Fault Diagnosis of Three-Phase Induction Motor" Prof.Dr. K. S. Krikor Ali H.Numan. M.Sc.

[5] **"**Multiple Signature Processing-Based Fault Detection Schemes for Broken Rotor Bar in Induction Motors" Bulent Ayhan, Student Member, IEEE, Mo-Yuen Chow, Senior Member, IEEE, and Myung-Hyun Song, Member, IEEE.

[6] "Condition based reporting of multi-machine monitoring system using GSM". Jinia Datta(Das), Soumyajit Datta, Sumana Chowdhuri and Jitendranath Bera International Journal of Scientific and Research Publications, Volume 2, Issue 6, June 2012 1 ISSN 2250-3153

[7] "Faults Detection and Remote Monitoring System for Induction Motors using MCSA Technique" José Ignacio Terra, Marcelo Castelli, Juan Pablo Fossati.

ASIC Design of Reversible Multiplier Circuit

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***Abstract*—Reversible logic is very much in demand for the future computing technologies as they are known to produce low power dissipation having its applications in Low Power CMOS, Quantum Computing, Nanotechnology, and Optical Computing. Adders and multipliers are fundamental building blocks in many computational units. In this paper we have presented and implemented reversible Wallace signed multiplier circuit in ASIC through modified Baugh-Wooley approach using standard reversible logic gates/cells, based on complementary pass-transistor logic and have been validated with simulations, a layout vs. schematic check, and a design rule check. It is proved that the proposed multiplier is better and optimized, compared to its existing counterparts with respect to the number of gates, constant inputs, garbage outputs, hardware complexity, and number of transistors required. It has also been shown in Cadence's tools that the reversible multiplier outperform the irreversible multiplier in terms of power dissipation.**

Keywords: - Reversible logic, Low Power CMOS, Wallace signed multiplier, Baugh-Wooley approach, standard reversible logic cells.

1. INTRODUCTION

Power dissipation and therewith heat generation is a serious problem for today's computer chips. The 30-year-long trend in microelectronics has been to increase both speed and density by scaling of device components. During this trend higher level of integration and new fabrication processes reduced the heat generation in the last decade. A more fundamental reason for power dissipation arises from the observations made by Landauer already in 1961 [1]. Landauer proved that using conventional logic, gate operations always lead to energy dissipation regardless of the underlying technology. More precisely, exactly *kTln2* Joule of energy is dissipated for each "lost" bit of information during an irreversible operation. This phenomenon can be attributed to the fact that erasing a bit amounts to ignoring its present contents, which may in fact be unknown and resetting it to some standardized state (usually 0). This means that the system moves from a random state to an ordered state thus bringing down the entropy of the system. But according to second law of thermodynamics entropy of a system cannot decrease and hence heat is dissipated into the surrounding environment [2].

In contrast, Bennett [3] showed that energy dissipation can be reduced or even eliminated if computation becomes information-lossless. This does not hold for irreversible (conventional) circuits. But, reversible circuits, i.e. circuits where all operations are performed in an invertible manner, satisfy this criterion. Moreover, as also shown by Bennett, zero power dissipation on circuits will only be possible if the respective computation is made reversible.

As a consequence, Landauer [1] (and later Bennett [3], Fredkin [4], Toffoli [5]) suggested the use of reversible circuits. These circuits have an equal number of input and output signals, whereby each input assignment maps to a unique output assignment. Since reversible circuits are by definition information-lossless, power dissipation resulting from Landauer's principle, as described above, can be decreased or even eliminated.

In the computational units, multiplication is one of the useful operations. Therefore, developing a signed multiplier circuit is necessary. In this paper, we have proposed Wallace reversible signed multiplier circuit by Toffoli gate (TG) [5], Peres gate (PG) [6], and Haghparast-Navi gate (HNG) [7, 8]. We implemented basic standard reversible cells in Cadence tool and used them in the design of Wallace reversible signed multiplier.

The paper is organized as follows. Section 2 presents an overview of reversible logic and multiplier circuits. In Section 3 we introduced design of reversible and irreversible Wallace sign multiplier circuit. Section 4 described the CMOS implementation of reversible and irreversible circuits. Furthermore, we have analyzed and evaluated the proposed reversible signed multiplier circuit in Section 5, Section 6 suggest some future extensions and Section 7 concludes the paper.

2. BASIC CONCEPTS

A. Reversible logic

Quantum gates which are represented by unitary matrices have potentials to implement reversible logic circuits. Each Quantum gate represents a valid Quantum operation, which must be unitary and hence must be reversible. That is Quantum gates are reversible, unlike many classical logic gates. Reversible logic gate/circuit can be defined as follows:

Definition 1: For an n input, m output logic gate, if there is a one-to-one correspondence between its inputs and outputs, and then this logic gate is reversible.
Definition 2: A gate is reversible if and only if the (Boolean) function is bijective i.e. a gate is reversible if it maps each input vector into a unique output vector and vice versa.

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Definition 3: A garbage bit (G) is an additional output, that are not used or unwanted, that makes an n-input m-output function reversible.
Definition 4: Number of ancillary inputs called as ancilla, which are constant inputs, which are used to maintain the reversibility of the circuit.
Definition 5: Quantum cost (QC) of a gate is the number of elementary quantum operations that are used to implement the complete functionality. All elementary 1 x 1 and 2 x 2 qubit gates have quantum cost of 1
Definition 6: Flexibility refers to the universality of a reversible logic gate in realizing more functions.
Definition 7: Hardware Complexity refers to the total number of logic operation in a circuit. Means the total number of EXOR (represented by α), AND (represented by β), and NOT (represented by d) operation in a circuit.
Definition 8: Delay for reversible circuits is the maximum number of gates in a path from any input line to any output line. This definition is based on two assumptions 1) each gate performs computation in one unit time, and 2) all inputs to the circuit are available before the computation begins.

Feynman gate (FG) and Toffoli gate (TG), are universal reversible gate. FG shown in Fig.1 has QC equals 1 and hardware complexity is 1α. TG shown in Fig. 2 has QC equals 5 and hardware complexity is 1α + 1β. Figure 3 shows Peres gate (PG) which has QC equals 4 and hardware complexity is 2α + 1β, and Fig. 4 shows Haghparast-Navi gate (HNG) which has QC equals 6 and hardware complexity is 5α + 2β.

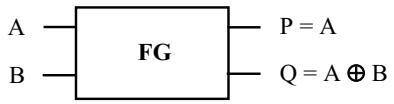

Fig.1. Feynman Gate

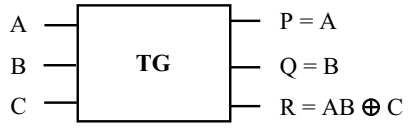

Fig.2. Toffoli Gate

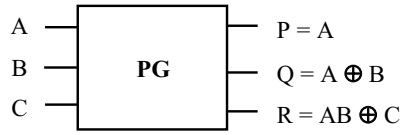

Fig.3. Peres Gate

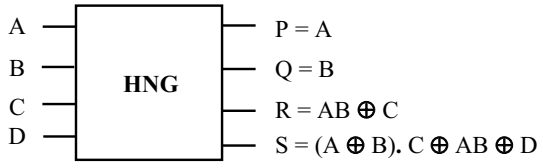

Fig.4. Haghparast Navi Gate

B. Reversible multiplier

Multiplier circuits are divided into two categories: unsigned and signed. Several approaches have been presented to multiply the signed numbers, such as 2's complement, Baugh-Wooley, and modified Baugh-Wooley methods [9]. In modified Baugh-Wooley method, the number quantity is considered as 2's complement. Figure 5 shows how the multiplication operation takes place, which need 17 AND gates and 8 NAND gates to produce a signed multiplier.

Many reversible unsigned multiplier circuits have been designed so far [7, 10-17]. In 2005 Thapliyal and Srinivas [18] was presented a 4 x 4 reversible signed multiplier circuit first time. In 2010, Zhou et al. [19] designed another 5 x 5 reversible signed multiplier circuit. In 2011, Ehsan Akbar, Haghparast, and Navi [20] designed fast 5 x 5 reversible Wallace sign multiplier circuit.

3. Design of Irreversible And Reversible Wallace Sign Multiplier

To compute product of two signed numbers we have used modified Baugh-Wooley approach [21]. Both irreversible and reversible multiplier design is divided into two parts: partial product generation circuit and then multi-operand addition circuit.

A. Design of irreversible multiplier

First to compute partial product, we used 17 ANDs and 8 NANDs employing the procedure given in Fig. 5. After generating partial products, next step is a multi-operand addition. We should add the bits of each column given in Fig. 5. To add these bits, we need FA and HA. We have to add these bits in the way that our circuit will give the best results. Figure 6 shows the way of adding these bits in our proposed circuit. The Wallace approach has been used to construct a circuit with less delay. To minimize delay in our proposed circuit, P_9 is computed by inverting carry output from earlier FA (FA13). The resulting circuit for multi-operand addition needs one 1-NOT gate, 4-HA and 16-FA.

B. Design of reversible multiplier

First to compute partial product, we used 25 TG gates to create 17 ANDs and 8 NANDs as shown in Fig. 7, employing the procedure given in Fig. 5. To generate partial product, we not only tried to use less number of gates, garbage outputs, and constant inputs but also we minimized number of transistors required. The number of garbage outputs in this circuit is 10 and the constant inputs are 25.

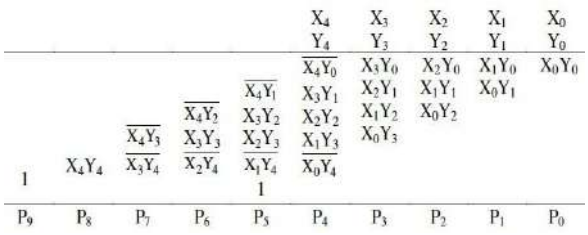

Fig.5. Modified Baugh-Wooley 5 x 5 Signed Multiplier

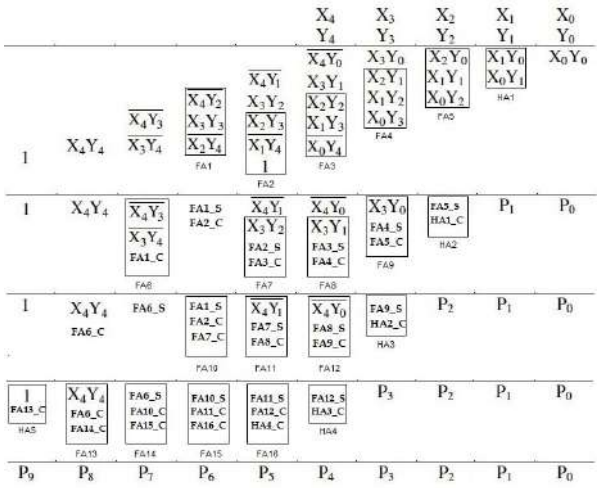

Fig.6. Multiplication by Wallace approach in the proposed circuit

Next step is a multi-operand addition. After generating partial products, we should add the bits of each column given in Fig. 5. To add these bits, we need FA and HA. We have to add these bits in the way that our circuit will give the best results, so that circuit will have minimum quantum cost, number of garbage outputs and constant inputs. Figure 6 shows the way of adding these bits in our proposed circuit. The Wallace approach has been used to construct a circuit with less delay. In our proposed circuit, the PG has been used for HA

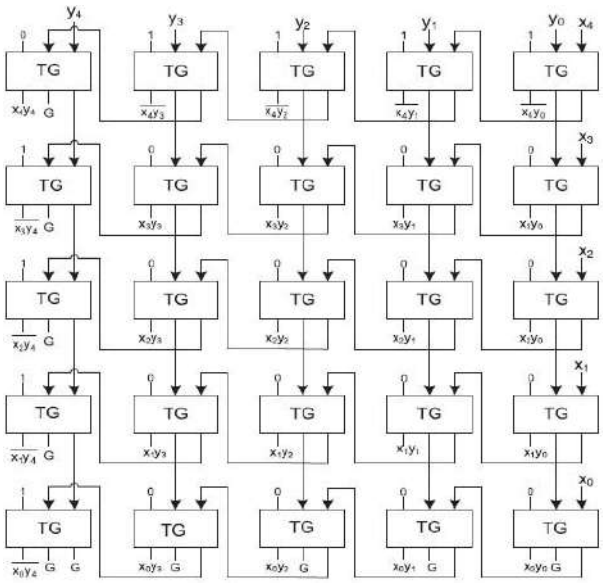

Fig.7. Partial Product Generation by Toffoli Gates

and the HNG has been used for FA. To minimize delay in our proposed circuit, P_9 is carry out of earlier FA (HNG), if and only if we put 1 instead of 0 as HNG's fourth input in pre-last column.

The resulting circuit for multi-operand addition is shown in Fig. 8, which needs 4 PG and 16 HNG. The number of garbage outputs in this circuit is 36 and the constant inputs are 21.

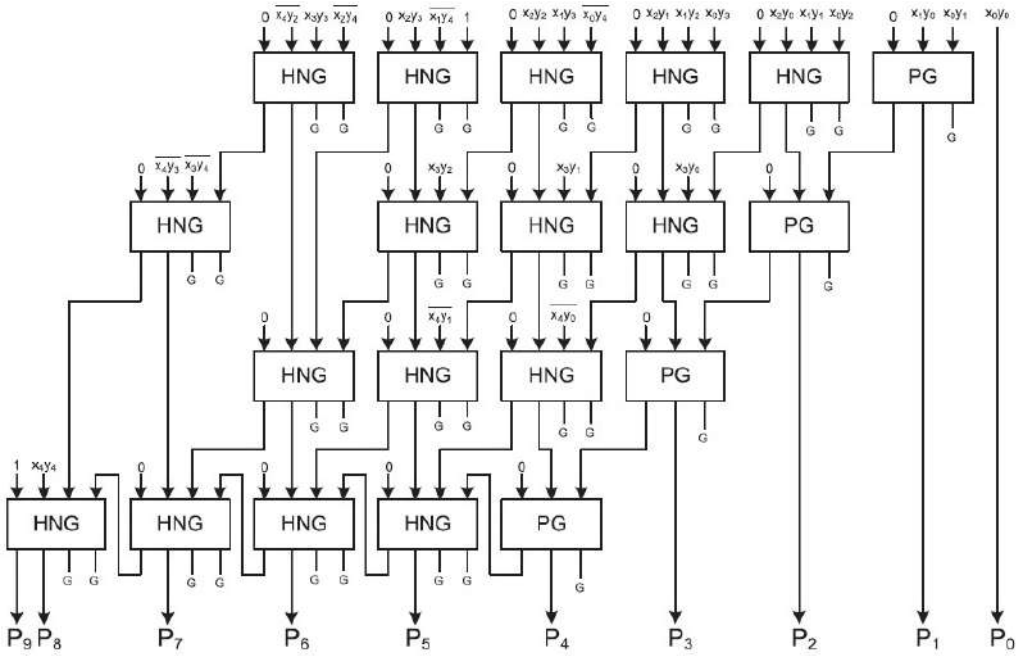

Fig.8. Multi-Operand Addition by Peres and Haghparast-Navi gates

4. Semi-Custom ASIC Design of Irreversible And Reversible Wallace Sign Multiplier

Semi-custom ASIC design is carried out using Cadence tool. To implement irreversible multiplier, structural verilog code is written for the circuit shown in Fig. 6. Then by using digital design flow from Cadence which uses Cadence Encounter RTL Compiler, Encounter RTL-to-GDSII System, Virtuoso Schematic and Layout Editor tools, we implemented irreversible multiplier, schematic and Layout is shown in Fig. 9 and Fig. 10.

To implement reversible multiplier, we have first designed basic standard cells/gates for reversible logic, which includes TG and FG. PG and HNG are designed using TG and FG. Finally reversible multiplier schematic and layout is implemented for the circuit shown in Fig. 7 and Fig. 8 using Virtuoso Schematic and Layout Editor as shown in Fig. 11 and Fig. 12.

For both irreversible and reversible multiplier, Schematic were validated by electrical simulations using Spectre , Layout has been successfully validated by the DRC and LVS check has successfully validated the functionality with respect to the schematic. For simulation of schematic and analog_extracted view we written Digital Vector file which generates stimuli and performs vector check according to digital vectors using Virtuoso UltraSim Simulator, which is used in Virtuoso Spectre Mode. Finally the post extraction simulation is carried out for both the circuits and calculated power dissipation values as shown in Fig. 13 and Fig. 14 for irreversible multiplier and Fig. 15 and Fig. 16 for reversible multiplier.

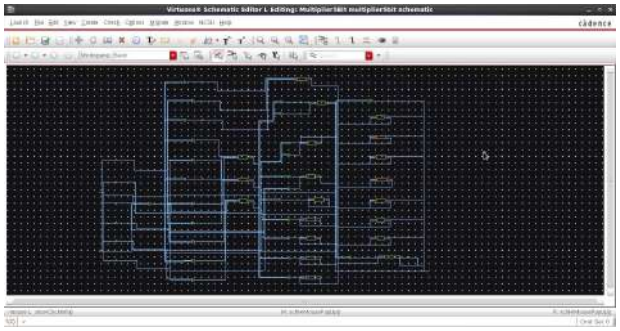

Fig.9. Schematic for Irreversible Multiplier

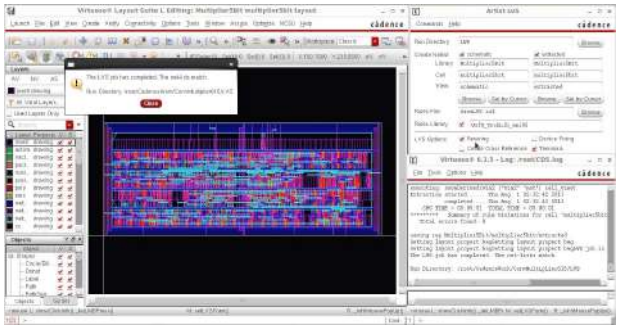

Fig.10. Layout and LVS match for Irreversible Multiplier

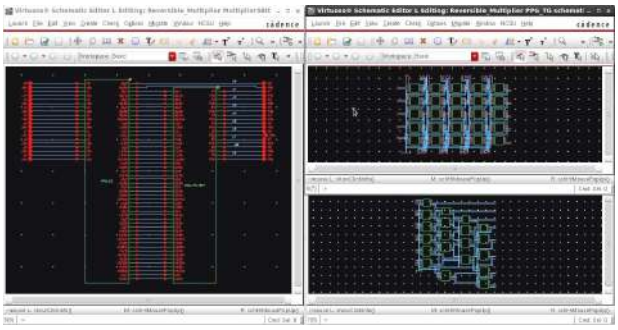

Fig.11. Schematic for Reversible Multiplier

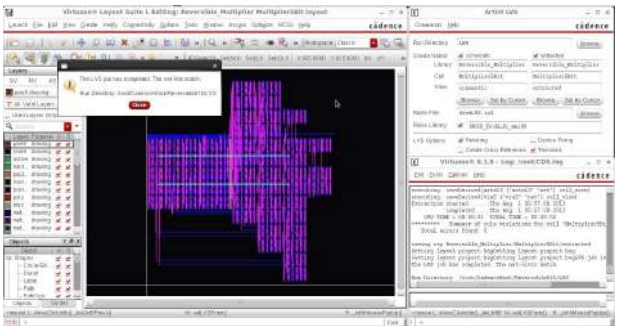

Fig.12. Layout and LVS match for Reversible Multiplier

Fig.13. Post Extraction Simulation waveform and digital vector file for Irreversible Multiplier

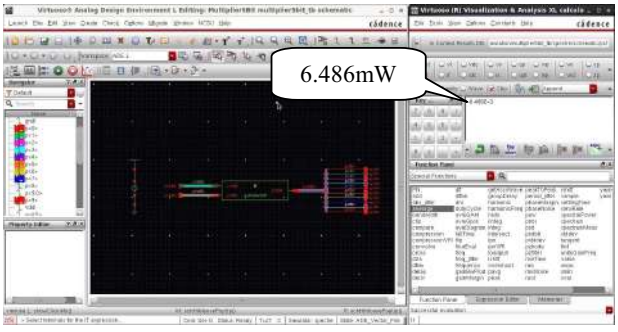

Fig.14. Power dissipation after post extraction simulation for Irreversible Multiplier

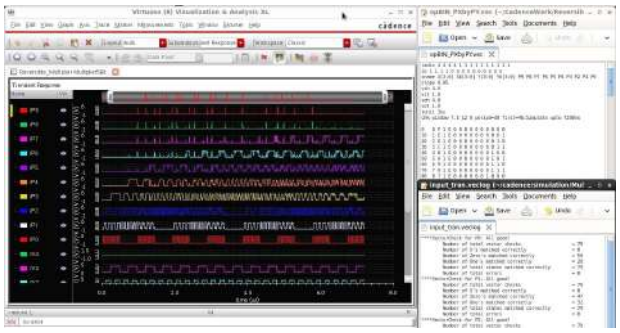

Fig.15. Post Extraction Simulation waveform and digital vector file for Reversible Multiplier

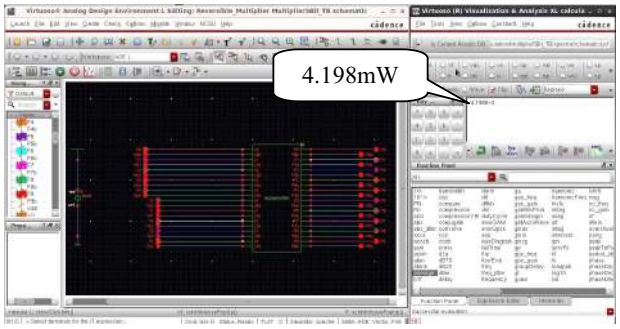

Fig.16. Power dissipation after post extraction simulation for Reversible Multiplier

5. Evaluation Of Reversible Signed Multiplier

Table 1 and 2 show comparison of proposed reversible multiplier with the existing reversible multiplier presented in [18, 19, 20].

It must be noted that the multiplier presented in [18] is a 4 x 4 reversible signed multiplier, where as those proposed by us and that given in [19, 20] are 5 x 5 reversible signed multiplier. Table 1 shows the comparison between the reversible partial product generation circuits of the proposed design and the existing design in [19, 20]. Table 2 shows the comparison between the reversible multi-operand addition circuits of the proposed design and the existing design in [18, 19, 20]. Table 3 shows sum of partial product generation and multi-operand addition circuit. It shows comparative result of different reversible signed multiplier circuits, whereas proposed circuit is implemented in semi-custom ASIC. Finally Table 4 shows Comparative results of irreversible and reversible signed multiplier circuit. It shows that reversible multiplier outperform the irreversible multiplier in terms of power dissipation.

6. Future Work

The proposed reversible multiplier placement and routing can be carried out by tool like Cadence Encounter. Always we think of optimization as reducing the number of gates, or the circuit delays, but in this case it would also allow us to improve the placement and routing of cells. Number of required transistor can further be decreased in the implementation of multi-operand addition.

Table 1. Comparative results of partial product generation circuit

Method	No. of gates	No. of garbage outputs	No. of constant inputs	Hardware Complexity	Quantum cost	Transistor required
Proposed	25	10	25	25α + 25β	125	400
[20]	25	10	25	34α + 25β	116	472*
[19]	25 + 20	30	25 + 20	45α + 25β	145	Not known

Table 2. Comparative results of multi-operand addition circuit

Method	No. of gates	No. of garbage outputs	No. of constant inputs	Hardware Complexity	Quantum cost	Transistor required
Proposed (5 x 5)	20	36	21	88α + 36β	112	864+
[20] (5 x 5)	20	36	21	88α + 36β	112	864
[19] (5 x 5)	20	40	25	160α + 80β + 61d	Not known	Not known
[18] (4 x 4)	13	39	18	Not known	Not known	Not known

Table 3. Comparative results of different reversible signed multiplier circuits

Method	No. of gates	No. of garbage outputs	No. of constant inputs	Hardware Complexity	Quantum cost	Transistor required
Proposed (5 x 5)	45	46	46	113α + 61β	237	1264
[20] (5 x 5)	45	46	46	122α + 61β	228	1336*
[19] (5 x 5)	65	70	70	205α + 105β + 61d	Not known	Not known

* If we use our proposed reversible standard cells for TG, PG and HNG

\+ Can further be reduced to 736, if we use FA design proposed in [22, 18]

Table 4. Comparative results of proposed reversible and irreversible signed multiplier circuits

Multiplier Design Method	Process Technology	Power Dissipation	Transistor required	Place and Routing	Total Area
Irreversible	AMI06 (C5N 0.5µ) CMOS Process Technology	6.486 mw	810	By Tool	389 µm X 156 µm, with power ring
Reversible	AMI06 (C5N 0.5µ) CMOS Process Technology	4.198 mw	1264	Manual	650µm X 807µm without power ring

7. CONCLUSION

In this paper we presented and successfully implemented Wallace reversible signed multiplier circuit in Semi-custom ASIC using Cadence tools. The standard reversible cells were implemented in 0.6µm CMOS using complementary pass-transistor logic. These cells are prototype cells and knowledge for future improvements.

It is proved that not only the proposed multiplier is better and optimized, compared to its existing counterparts with respect to the number of gates, constant inputs, garbage outputs, hardware complexity, and number of transistors required, but also reversible logic design results in low power dissipation over irreversible logic design.

REFERENCES

[1] R. Landauer, "Irreversibility and heat generation in the computing process," Reprinted from IBM Journal of Research and Development, Vol.-5, Issue-3, 1961, pp.183-191.

[2] Avinash G. Keskar, Vishal R. Satpute, "Design of Eight Bit Novel Reversible Arithmetic and Logic Unit,"4th IEEE International Conference on Emerging Trends in Engineering and Technology (ICETET), 2011, pp.227-232.

[3] C. H. Bennett, "Logical reversibility of computation," IBM Journal of Research and Development, Vol.-17, Issue-6, Nov-1973, pp. 525-532.

[4] E. F. Fredkin and T. Toffoli, "Conservative logic," International Journal of Theoretical Physics, vol. 21, no. 3/4, 1982, pp. 219-253.

[5] T. Toffoli, "Reversible computing," in Automata, Languages and Programming, W. de Bakker and J. van Leeuwen, Eds. Springer, 1980, p. 632, technical Memo MIT/LCS/TM-151, MIT Lab. for Computer Science.

[6] A. Peres, "Reversible logic and quantum computers", Phys. Rev. A, 32, 1985, pp.3266-3275.

[7] M. Haghparast, Somayyeh Jafarali Jassbi, K. Navi and Omid Hashemipour, "Design of a Novel Reversible Multiplier Circuit Using HNG Gate in Nanotechnology," World Applied Sciences Journal 3 (6), 2008, pp.974-978.

[8] M. Haghparast, K. Navi, "A Novel Reversible BCD Adder for Nanotechnology Based Systems," American Journal of Applied Sciences 5 (3), 2008, pp.282-288.

[9] Neil Weste, Kamran Eshraghin, "Principles of CMOS VLSI Design", Second Edition, 2002.

[10] Himanshu Thapliyal and M.B Srinivas, "Novel Reversible Multiplier Architecture Using Reversible TSG Gate," IEEE International Conference on Computer Systems and Applications, 2006, pp.100-103.

[11] Rangaraju H G, Aakash Babu Suresh, Muralidhara K N, "Design and Optimization of Reversible Multiplier Circuit," International Journal of Computer Applications, Vol.-52, No.-10, 2012, pp.44-50.

[12] M. S. Islam, M. M. Rahman, Z. Begum and M. Z. Hafiz, "Low Cost Quantum Realization of Reversible Multiplier Circuit," Information Technology Journal 8(2), 2009, pp.208-213.

[13] Md. Belayet Ali, Hosna Ara Rahman and Md. Mizanur Rahman, "Design of a High Performance Reversible Multiplier," IJCSI International Journal of Computer Science Issues, Vol.-8, Issue-6, No.-1, 2011, pp.134-141.

[14] Masoumeh Shams, Majid Haghparast and Keivan Navi, "Novel Reversible Multiplier Circuit in Nanotechnology," World Applied Sciences Journal 3 (5), 2008, pp.806-810.

[15] Fateme Naderpour, Abbas Vafaei "Reversible Multipliers: Decreasing the Depth of the Circuit," 5th IEEE International Conference on Electrical and Computer Engineering (ICECE), 2008, pp.306-310.

[16] Mariam Zomorodi Moghadam, Keivan Navi, "Ultra-area-efficient reversible multiplier," Microelectronics Journal 43, 2012, pp.377-385.

[17] H. R. Bhagyalakshmi, M. K. Venkatesha, "An Improved Design of A Multiplier Using Reversible Logic Gates," International Journal of Engineering Science and Technology, Vol. 2(8), 2010, pp.3838-3845.

[18] H. Thapliyal, M.B. Srinivas, "Novel design and reversible logic synthesis of multiplexer based full adder and multipliers", 48th IEEE MIDWEST Symposium on Circuits and Systems (MWSCAS 2005), Cincinnati, Ohio, USA, August 7–10, 2005, pp.1593-1596.

[19] Rigui Zhou, Yang Shi, Huian Wang, Jian Cao, "Transistor realization of reversible ''ZS'' series gates and reversible array multiplier," Microelectronics Journal 42, 2011, pp.305-315.

[20] Ehsan Pour Ali Akbar, Majid Haghparast, Keivan Navi, "Novel design of a fast reversible Wallace sign multiplier circuit in nanotechnology" Microelectronics Journal 42, 2011, pp.973-981.

[21] Ch.R. Baugh, B.A. Wooley, "A two's complement parallel array multiplication algorithm",IEEE Transactions on Computers C-22, 1973,12.

[22] Yvan Van Rentergem and Alexis De Vos, "Optimal Design of A Reversible Full Adder," International Journal of Unconventional Computing, Vol.-1, 2005, pp.339-355.

Printed Circular Monopole Antenna for UWB Applications

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ABSTRACT
Antenna is very essential component in wireless communication system. Since need of compact devices is increasing day by day, antenna plays very important role in developments of such devices. Printed antennas are known as microstrip antennas which are low profile & having more advantages over the conventional antennas. Though this antenna provides compactness but they have narrow bandwidth. Hence these antennas can be used for high frequencies by using feeding techniques. There is a growing demand for small and low cost UWB antennas that can provide satisfactory performances in both frequency domain and time domain.[15],[16] Printed monopole antennas have large attention among all the printed antennas. This paper consists of mathematical analysis & partial implementation of circular monopole antenna which is basically microstrip antenna with partial ground plane & rectangular microstrip feed line. The simulation is done by using IE3D for Ultra Wide Band applications.

Keywords
Printed Antenna or Microstrip Antenna (MSA), Printed Monopole Antenna, UWB.

1. INTRODUCTION
A band of 3.1GHz to 10.6 GHz is covered by the Ultra Wide Bane which is allotted by Federal Communication Commission (FCC). Demand of UWB antennas is increasing since there is rapid growth in the Ultra Wide Band communication. Ultra wide band systems have some fundamental differences from conventional narrow band systems as it has larger bandwidth which offers specific advantages with respect to signal robustness, information content and/or implementation simplicity.[1]

An antenna is a very essential element in UWB system because it acts as a band pass filters to reshape the pulse spectra. So antennas should be carefully designed to avoid unnecessary distortions. Designing of an antenna is one of the most important challenges for the designers.

Printed antenna has features like low profile, small size, low weight and hence exploited for the compact applications such as mobile phones, other personal communication devices which becoming smaller and low weight day by day. The telemetry and communications antennas on missiles need to be thin and conformal and are often MSAs. Radar altimeters use small arrays of microstrip radiators. Other aircraft-related applications include antennas for telephone and satellite communications. Microstrip arrays have been used for satellite imaging systems. Patch antennas have been used on communication links between ships or buoys and satellites. Smart weapon systems use MSAs because of their thin profile. Pagers, the global system for mobile communication (GSM), and the global positioning system (GPS) are major users of MSAs[11].

Printed Monopole antenna offers large bandwidth & hence they have large attention among the all type of Printed Antennas recently. Microstrip antenna consists of radiating patch printed on grounded low loss substrate.[15] The printed antenna can be of various shapes but rectangular and circular shapes are mostly used. .Several UWB printed monopole antennas with various shapes have been used in simple and hybrid forms. These antennas feature controllable bandwidth, good radiation properties, low profile and simple structure.[2]

There is great demand for UWB antennas that offer miniaturized planar structure, so the vertical disc monopole is still not suitable for integration with a PCB. This drawback limits its practical application. For this reason, a printed structure of the UWB disc monopole is well desired, which consist on printed radiator disc on substrate. Printed CDM antennas can be fed simple microstrip line, coplanar waveguide (CPW), or slotted structures.[8]

In this paper design of circular monopole antenna is implemented for UWB applications, which consists of ground plane which is etched one & simple rectangular microstrip feed line is used. All the simulations & results are obtained by using IE3D software.

2. GEOMETRY

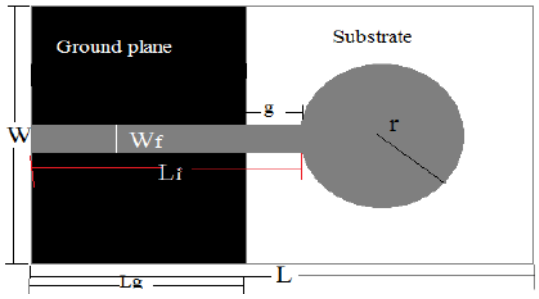


Fig1: Geometry of Printed Circular Monopole Antenna

A circular disc monopole antenna is a planner structure. It consists of a circular patch having radius ‘r’ and rectangular microstrip feed line both are printed on dielectric substrate. All the parameters are as follow In figure 1,

L & W denotes the length and width of substrate.

Wf= width of the microstrip feed line .

Lf =length of microstrip feed line.

Lg&Wg are the length and width of the partial conducting ground plane respectively.

g = gap between circular disk and ground plane.

εr = the dielectric constant for the substrate.

h = the height or thickness of the substrate

3. DESIGNS OFDIFFERENT CIRC-ULAR MONOPOLE ANTENNA FOR UWB APPLICATIONS

By introducing simple microstrip transitions between the 50Ω feed line and the printed circular discs, the impedance BW of the planar monopole can be extended beyond 30 GHz. Design C is basic circular monopole antenna having 50Ωmicrostrip feed line. Design A & Design B are formed by just introducing dual & single microstrip line transitions respectively [1].

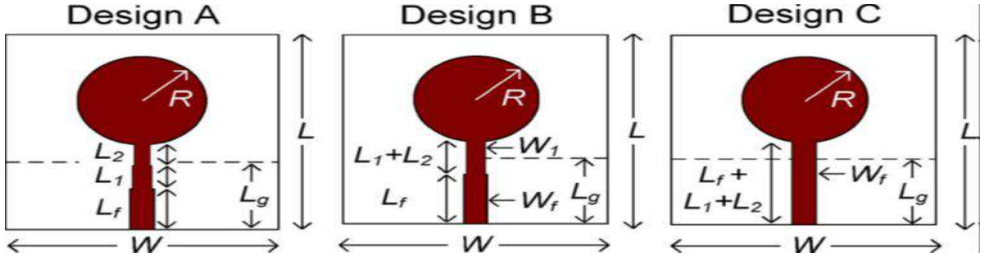


Fig 2:Different 3 designs of circular monopole antennas [1]

4. MATHEMATICAL ANALYSIS OF DESIGN- A

4.1. Center Frequency:

It can be given by,

$$F_C = \frac{F_h + F_l}{2} = \frac{10.6 + 3.1}{2} = 6.85GHz$$

4.2 Dielectric Constant (ε_r) and (ε_e):

For the antenna to be design have FR4 substrate & for this substrate "r=4.4Also thickness of substrate used is h=o.83

Effective Dielectric Constant is given by,

$$\epsilon_e = \frac{\epsilon_r + 1}{2} * (1 + 0.3h) = 2.75$$

4.3 Effective Radius(a_e) and Radius (a):

$$a_e = \frac{8.791}{F_c\sqrt{\epsilon_e}} = 0.78cm = 7.8mm$$

$$a_e = a + h$$

$$a = a_e - h = 0.7cm = 7mm$$

4.4 Width of Ground Plane(W_g):

$$W_g = \frac{1.38 * c}{F_c * \sqrt{\epsilon_e}} = 0.036m = 36cm$$

4.5 Length of Ground Plane(L_g)

$$L_g = \frac{0.36 * c}{F_c * \sqrt{\epsilon_e}} = 0.0095m = 9.5mm$$

4.6 Width of Feed Line(W_f):

$$\lambda_g = \frac{c}{F_c * \sqrt{\epsilon_r}} = 0.02cm = 2mm$$

$$W_f = \frac{\lambda_g}{2} = 1mm$$

$$let\ W_f = 1.8mm$$

4.7 Length of Feed Line(L_f)

$$L_f \gg W_f = 7mm$$

4.8. Width of First Feed Line(W_1) and Width of Second Feed Line(W_2):

$$W_f = W_1 + W_2(approximately)$$

$$W_1 > W_2$$

$$let\ W_2 = 0.8mm\ , then\ W_1 = 1mm$$

4.9 Lenght of First Feed Line(L1) and Length of Second Feed Line(L2):

$$L_f = L_1 + L_2(approximately)$$

$$L_1 < L_2$$

$$let\ L_2 = 4mm\ , then\ L_1 = 3mm$$

5. SIMULATIONS AND RESULTS

All the parameters are summarized in following table. By using IE3D simulator all the 3 designs are made & simulated. As all the designs have FR4 substrate & partial ground plane. The thickness of metal is 0.002. The following graphs show the simulated results for design A.

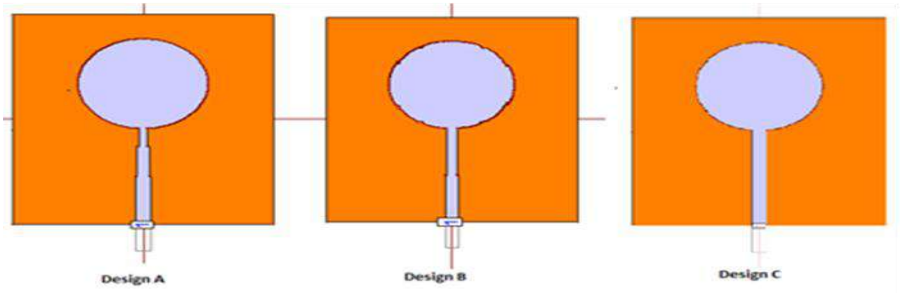


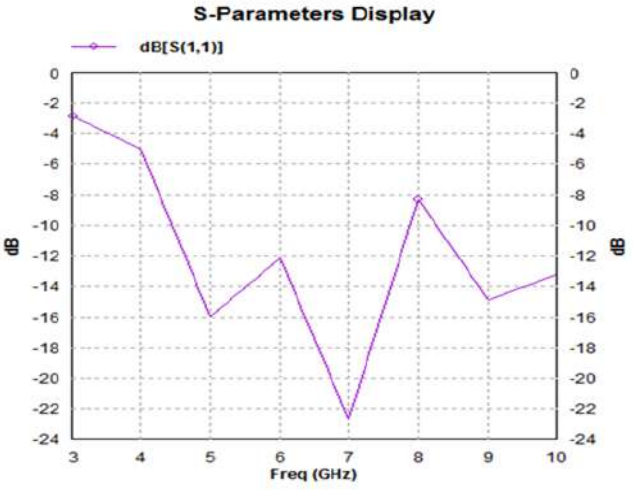
Fig 3: 3 Designs by using IE3D simulator

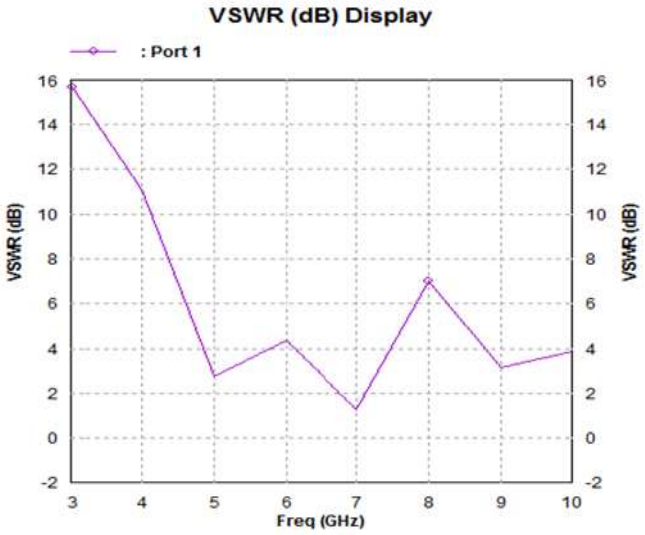
Table 1: Summary of Analysis

Parameter	Designed Value (in mm)	Selected Value (in mm)
Width of substrate(W)	30	30
Length of substrate(L)	35	35
Width of feed line (WF)	1	1.8
Length of feed line(LF)	8	8
Width of first microstrip feed line(W1)	1	1.4
Length of first microstrip line(L1)	4	5
Width of second microstrip feed line(W2)	0.8	1
Length of second microstrip feed line(L2)	3	3
Width of partial ground plane(Wg)	36	30
length of partial ground plane (Lg)	9.5	15.7
Radius of Printed Disk (a)	7	7.5
Substrate thickness (h)	0.83	0.83

S-parameters describe the input-output relationship between ports (or terminals) in an electrical system. In practice, the most commonly quoted parameter in regards to antennas is S11. S11 represents how much power is reflected from the antenna, and hence is known as the reflection coefficient (sometimes written as gamma: or return loss. If S11=0 dB,then all the power is reflected from the antenna and nothing is radiated. accepted power is either radiated or absorbed as losses within the antenna. Since antennas are typically designed to be low loss, ideally the majority of the power delivered to the antenna is radiated.

VSWR stands for Voltage Standing Wave Ratio, and is also referred to as Standing Wave Ratio (SWR). VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna. The VSWR is always a real and positive number for antennas. The smaller the VSWR is,





the better the antenna is matched to the transmission line and the more power is delivered to the antenna. The minimum VSWR is 1.0. In this case, no power is reflected from the antenna, which is ideal.

The S-parameter results are shown in above figure (4) which shows that S11 parameters are below -10 dBs for 4.5 GHz to 7.9GHz & 8.2GHz to 10.6GHz frequency bands. Also VSWR graph gives has value near to 2dB for same frequency bands, but not for the complete UWB band. It was observed that results of S-parameter for Design B & C are poor than that of design-A

6. CONCLUSION

As this paper is based on partial implementation all the designs having results but not for the complete band. By using optimization process results can be improved for complete UWB frequencies. While doing optimization width & lengths of single & dual lines will get varied since those are introduced to provide large bandwidth. The dimensions of 50 Ω feed line will be kept constant.

7. ACKNOWLEDGMENTS

I take this opportunity to express my heartfelt gratitude towards the Department of E\& TC RCPIT, Shirpur that gave me an opportunity for presentation of my seminar in their esteemed organization. It is a privilege for me to have been associated with Prof P. J.Deore, my guide during project work. It is with great pleasure that I express my deep sense of gratitude to him for his valuable guidance, constant encouragement and patience throughout this work. I express my gratitude to Prof Dr P. J. Deore [Vice Principal \&HOD of E\& TC Dept.](RCPIT, Shirpur) \& Prof. J. B. Jadhav (RCPIT, Shirpur) their constant encouragement, co-operation and support. I also take the opportunity to thank P.G.coordinatorProf.S. A. More for his support and guidance throughout the project work.

8. REFERENCES

[1] Sarra Mohamed Nabil Srifi, Symon K. Podilchak ,Mohamed Essaaidi, Compact Disc Monopole Antennas for Current and Future Ultra wideband (UWB) Applications IEEE Transaction On Antennas and Propagation, VOL. 59, NO. 12, DECEMBER,2011

[2] RahaEshtiaghi, JavadNourinia, And ChangizGhobadi, Electro magnetically Coupled Band Notched Elliptical

Monopole Antenna For UWB Applications, IEEE Transactions On Antennas And Propagation, Vol. 58, No. 4, April 2010.

[3] Bharat BhushanAgrawal, PriyadarshiSuraj, Vibha Rani Gupta, Printed Monopole Antenna for UWB Application, International Journal of Microwave AND Optical Technology,Vol.5 No.4 July 2010

[4] M. Sun, Y. P. Zhang, and Y. Lu, miniaturization of planar monopole antenna for ultrawide band radios IEEE Trans. Antennas Propag., vol.58, no. 7, pp. 2420, Jul. 2010.

[5] R. Zaker and A. Abdipour, Avery compact ultrawide band printed omnidirectional monopole antenna IEEE Antennas Wireless Propag. Lett., vol. 9, pp. 471473, 2010.

[6] J.Liang, L.Guo, C.C.Chiau, X.Chen, and C.G.Parini,Study of CPW fed circular disc monopole antenna for ultra wideband applications IEEE Proc. Microw.AntennasPropag., pp.520,Dec.2005.

[7] Taeyoung Yang, Seong-YoupSuh, Randall Nealy, William A. Davis, and Warren L. Stutzman, Compact Antennas For UWB Applications,wcsp:eng:usf:edu=UWB Testbed Docs

[8] Mohamed Nabil Srifi, Ultra-Wideband Printed Antennas Design,Ultra Wideband Communications: Novel Trends Antennas and Propagation ,www.intechopen.com

[9] K.FrancisJacob , Printed Monopole Antenna For Ultra Wide Band (UWB)Applications Thesis, Cochin University, June 2008.

[10] Jianxin Liang, Antenna Study and Design for Ultra Wideband Communication Applications, Thesis,University of London,United Kingdom ,July 2006

[11] Girish Kumar, K.P.Ray, Broadband MicrostripAntenna,Artech House Boston,London, 2003

[12] DebatoshGuha, YahirAntar,Microstrip and Printed Antennas,John Wiley and Sons Ltd.,First Edition,2011.

[13] Rodney B. Waterhouse ,Microstrip Patch Antenna, John Wiley and SonsLtd.,First Edition,2011

[14] R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon,Microstrip Antenna Design Handbook ,Norwood, MA: Artech House, Inc., 2001.

[15] http://shodhganga.inflibnet.ac.in/bitstream/10603/8001/10/10_chapter%201.pdf

[16] http://iisrt.com/wp-content/uploads/2014/08/IISRT-3-Design-of-Rectangular-Patch-Antenna-Array-using-Advanced-Design-Methodology.pdf

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Printed Monopole Antenna for UWB Applications

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Abstract

Antenna is very essential component in wireless communication system. Since need of compactdevices is increasing day by day, antenna plays very important role in developments of such devices. Printed antennas are known as microstrip antennas which are low profile & having more advantages over the conventional antennas. Though this antenna provides compactness but they have narrow bandwidth. Hence these antennas can be used for high frequencies by using feeding techniques.There is a growing demand for small and low cost UWB antennas that can provide satisfactory performances inboth frequency domain and time domain.Printed monopole antennas have large attention among all the printed antennas.This paper consists of mathematical analysis &partial implementation of circular monopole antenna which is basically microstrip antenna with partial ground plane & rectangular microstrip feed line. The simulation is done by using IE3D for Ultra Wide Band applications.

Keywords: Printed antenna, Printed monopole antenna, UWB.

1. Introduction

A band of 3.1GHz to 10.6 GHz is covered by the Ultra Wide Bane which is allotted by Federal Communication Commission (FCC). Demand of UWB antennas is increasing since there is rapid growth in the Ultra Wide Band communication. Ultra wide band systems have some fundamental differences from conventional narrow band systems as it has larger bandwidth which offers specific advantages with respect to signal robustness, information content and/or implementation simplicity.[1]

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There is great demand for UWB antennas that offer miniaturized planar structure,so the vertical disc monopole is still not suitable for integration with a PCB.This drawback limits its practical application. For this reason, a printed structureof the UWB disc monopole is well desired, which consist on printed radiator disc on substrate. Printed CDM antennas can be fed simple microstrip line, coplanarwaveguide (CPW), or slotted structures.[8]

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In this paper design of circular monopole antenna is implemented for UWB applications, which consists of ground plane which is etched one & simple rectangular microstrip feed line is used. All the simulations & results are obtained by using IE3D software.

2. Geometry of Printed Circular Monopole Antenna:

A circular disc monopole antenna is a planner structure. It consists of a circular patch having radius 'r' and rectangular microstrip feed line both are printed on dielectric substrate.

In figure 1,

L & W denotes the length and width of substrate.

W_f= width of the microstrip feed line .

L_f=length of microstrip feed line.

L_g& W_g are the length and width of the partial conducting ground plane respectively.

g = gap between circular disk and ground plane.

ε_r = the dielectric constant for the substrate.

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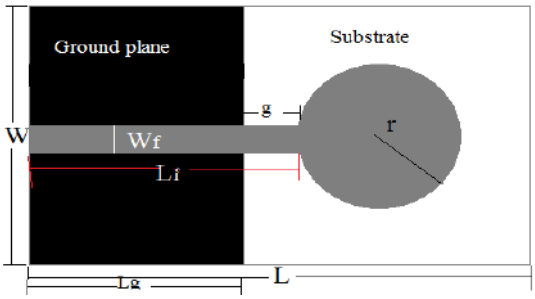

Fig1: Geometry of Printed Circular Monopole Antenna

3. Designs of Circular Monopole Antenna for UWB Applications:

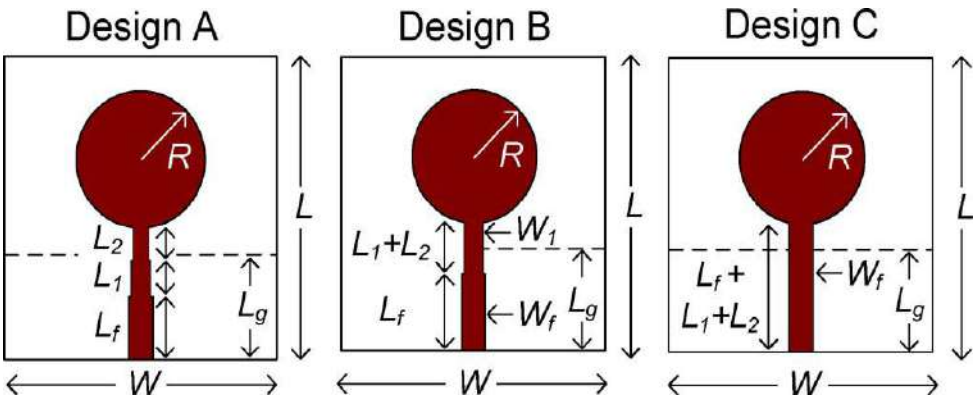

Fig 2: Different 3 designs of circular monopole antennas [1]

By introducing simple microstrip transitions between the 50Ωfeed line and the printed circular discs, the impedance BWof the planar monopole can be extended beyond 30 GHz.Design C is basic circular monopole antenna having 50Ωmicrostrip feed line. Design A & Design B are formed by just introducing dual & single microstrip line transitions respectively[1].

4. Mathematical Analysis of Design A:

4.1. *Center Frequency:*
It can be given by,

$$F_C = \frac{F_h + F_l}{2} = \frac{10.6 + 3.1}{2} = 6.85GHz$$

4.2 *Dielectric Constant (ϵ_r) &(ϵ_e):*
For the antenna to be design have FR4 substrate &for this substrate "r=4.4Also thickness of substrate used is h=o.83
Effective Dielectric Constant is given by,

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$$a_e = \frac{8.791}{F_c\sqrt{\epsilon_e}} = 0.78cm = 7.8mm$$

$$a_e = a + h$$

$$a = a_e - h = 0.7cm = 7mm$$

4.4 *Width of ground plane(W_g):*

$$W_g = \frac{1.38 * c}{F_c * \sqrt{\epsilon_e}} = 0.036m = 36cm$$

4.5 *Length of ground plane(L_g)*

$$L_g = \frac{0.36 * c}{F_c * \sqrt{\epsilon_e}} = 0.0095m = 9.5mm$$

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$$let\ W_f = 1.8mm$$

4.7 *Length of feed line(L_f)*

$$L_f \gg W_f = 7mm$$

4.8. *Width of First feed line(W_1)& Width of second feed line(W_2)*

$$W_f = W_1 + W_2(approximately)$$

$$W_1 > W_2$$

$$let\ W_2 = 0.8mm\ , then\ W_1 = 1mm$$

4.9 *Lenght of first feed line(L1)& Length of second feed line(L2)*
from fig(2),

$$L_f = L_1 + L_2(approximately)$$

$$L_1 < L_2$$

$$let\ L_2 = 4mm\ , then\ L_1 = 3mm$$

5. Simulations & Results:

By using IE3D simulator all the 3 designs are made & simulated.As all the designs have FR4 substrate & partial ground plane. The thickness of metal is 0.002 & all the parameters are summarized in following table.

Parameter	Designed Value (in mm)	Selected Value (in mm)
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Substrate thickness (h)	0.83	0.83

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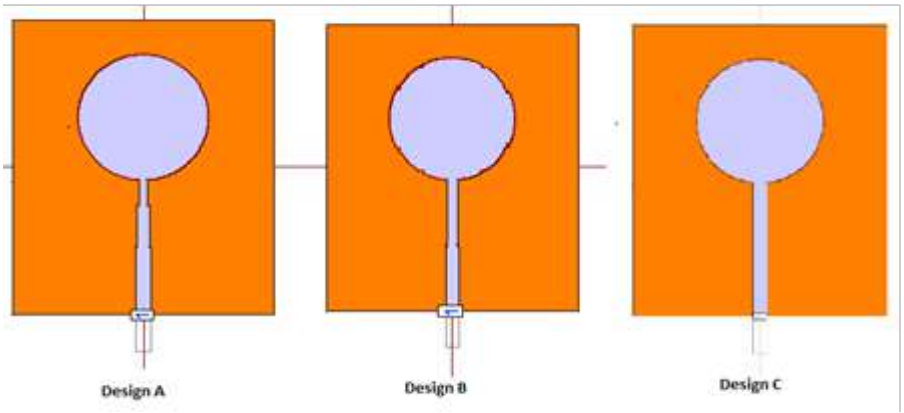
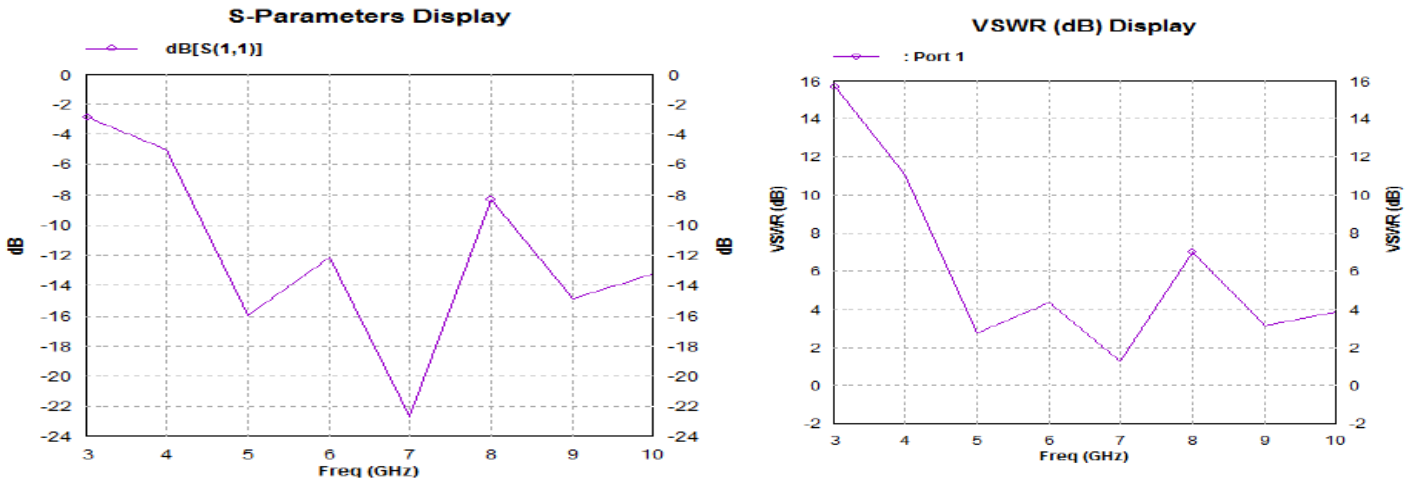


Fig(3): 3 Designs by using IE3D simulator



Fig(4): S parameter Graph & VSWR Graph for Design A

The S-parameter results are shown in above figure (4) which shows that S_{11} parameters are below -10 dBs for 4.5GHz to7.9GHz & 8.2GHz to 10.6GHz frequency bands. Also VSWR graph gives has value near to 2dB for same frequency bands, but not for the complete UWB band. It was observed that results of S-parameter for Design B & C are poor than that of design A.

6. Conclusion:

As this paper is on partial implementation, all the designs having results but not for the complete band. By using optimization process results can be improved for complete UWB frequencies. While doing optimization width & lengths of single & dual lines will get varied since those are introduced to provide large bandwidth. The dimensions of 50$\boldsymbol{\Omega}$feed line will be kept constant.

References

1. SarraMohamed Nabil Srifi, Symon K. Podilchak ,Mohamed Essaaidi, Compact Disc Monopole Antennas for Current and Future Ultrawideband (UWB) Applications IEEE Transaction On Antennas and Propagation, VOL. 59, NO. 12, DECEMBER,2011
2. RahaEshtiaghi, JavadNourinia, And ChangizGhobadi, Electro magnetically Coupled Band Notched Elliptical Monopole Antenna For UWB Applications,IEEE Transactions On Antennas And Propagation, Vol. 58, No. 4, April 2010.
3. Bharat BhushanAgrawal, PriyadarshiSuraj, Vibha Rani Gupta, Printed Monopole Antenna for UWB Application, International Journal of MicrowaveAND Optical Technology,Vol.5 No.4 July 2010
4. M. Sun, Y. P. Zhang, and Y. Lu, miniaturization of planar monopole antenna for ultrawideband radios IEEE Trans. Antennas Propag., vol.58, no. 7, pp. 2420,Jul. 2010.
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6. J.Liang, L.Guo, C.C.Chiau, X.Chen, and C.G.Parini,Study of CPW fed circular disc monopole antenna for ultrawideband applications IEEE Proc. Microw.Antennas Propag., pp.520,Dec.2005.
7. Taeyoung Yang, Seong-YoupSuh, Randall Nealy, William A. Davis, and Warren L. Stutzman, Compact Antennas For UWBApplications,wcsp:eng:usf:edu=UWB Testbed Docs
8. Mohamed Nabil Srifi, Ultra-Wideband Printed Antennas Design,Ultra Wideband Communications: Novel Trends Antennas and Propagation ,www.intechopen.com
9. K.FrancisJacob , Printed Monopole Antenna For Ultra Wide Band (UWB)Applications Thesis, Cochin University, June 2008.
10. Jianxin Liang, Antenna Study and Design for Ultra Wideband Communication Applications,Thesis,University of London,United Kingdom ,July 2006
11. Girish Kumar, K.P.Ray, Broadband MicrostripAntenna,Artech House Boston,London, 2003
12. DebatoshGuha, YahirAntar,Microstrip and Printed Antennas,John Wiley and Sons Ltd.,First Edition,2011.
13. Rodney B. Waterhouse ,Microstrip Patch Antenna,John Wiley and SonsLtd.,First Edition,2011
14. R. Garg, P. Bhartia, I. Bahl, and A. Ittipiboon,Microstrip Antenna Design Handbook ,Norwood, MA: Artech House, Inc., 2001.

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25.Title: 'Women Entrepreneurs: Challenges and Responsibilities'

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Abstract: Women are now more cognizant about their existence, roles and rights. They want new challenges and opportunities for self-fulfillment. They want to prove their mettle in innovative and competitive jobs. Women entrepreneurs are coordinating the business management of the enterprise along with risk taking, controlling the enterprise, innovation, motivation and other related activities. Although we found many women entrepreneurs successfully performing various functions of enterprising, they are also confronted with many challenges in their career. Most of the women entrepreneurs lack the management inputs as well as technical education. Still women are now transforming their social roles from being passive to active participants in the economic mainstream.

Keywords: administration, coordination, employment, enterprise, innovation, training.

26.Title: A Comparative Analysis on Travel & Tourism Industry

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Abstract: Tourism in India is the largest service industry, with a contribution of 6.23% to the national GDP and 8.78% of the total employment in India. In 2010, total Foreign Tourist Arrivals (FTA) in India were 5.78 million and India generated about 200 billion US dollars in 2008 and that is expected

Overview on Evaluation of Excess Thermodynamic properties

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Abstract

In recent years, the excess thermodynamic properties have attracted considerable attention. Despite their interest and importance, the physicochemical properties and the detailed knowledge of the thermodynamic behavior of pure substances and mixtures have not been studied systematically. In this context, a systematic investigation of the thermodynamic and thermo physical properties is an important issue. The addition of oxygenated compounds to gasoline as additives instead of lead reduces the emissions of hazardous compounds mainly carbon monoxide. Ethers have been suggested as gasoline additives. In this context the use of ethers as gasoline blending agents, requires the thermodynamic properties of mixtures involving hydrocarbons and ethers. The main purpose of the present study is to identify the experimental method and unknown excess molar enthalpy (or heat of mixing) for several binary and ternary mixtures.

Keywords: Excess enthalpy; Oxygenated compounds; Calorimeter

1. Introduction

The thermodynamic properties of liquid mixtures provide important information for good design of industrial process, to improve the understanding of the molecular interactions existing in the liquid mixtures, and to test the predictive capability of the chemical models. The physical properties such as density, Viscosity, refractive index, and heat of mixing of mixtures over the whole composition range are useful for a full understanding of their thermodynamic and transport properties, as well as for practical chemical engineering purposes.

Excess enthalpies of binary system have been investigated extensively. Due to the difficulties involved in the experimental measurements and the increasing time consumption with each additional component of a multi component mixture, experimental investigations of the excess enthalpies of multi component systems have been very limited. It is, therefore, highly desirable to develop suitable methods capable of predicting excess enthalpies of multi component system from binary data.

A lot of research work has been done on various excess thermodynamic properties like excess molar volume, excess viscosity, excess molar enthalpy, excess Gibbs free energy, excess surface tension etc. The heat of mixing is an important property in many chemical separation processes, such as absorption, distillation and extraction. Enthalpy of mixing is a fundamental thermodynamic property of liquid mixtures.

Excess enthalpy data for the mixtures composed of organic compounds are important both in theory and practice. Researches on these thermodynamic properties not only provide reliable data and empirical rules for science and technology, but also enhance the understanding of the behavior of liquid mixtures.

2. Excess properties of Oxygenated components

It is well known that as a result of changes in economic and environmental requirements, alternative transportation fuels have begun to attract increasing attention. A portion of regular gasoline currently available in the market can be replaced by alternatives, such as alcohols or ethers. Among them are ethanol, propanol and methyl tert-butyl ether (MTBE), etc., which may be obtained from processes other than petroleum refining and used to increase the gasoline's octane number. The alternative fuel helps to reduce our dependence on crude oil supply and to meet clean air standards.

It was known long time ago that the interactions among unlike molecules are critical for determining EOM and other excess properties. Yet, it is one of the most difficult properties to be predicted accurately and conveniently. Because of its importance, prediction of EOM has drawn considerable attention for several decades.

The use of oxygenated compounds, such as ethers and alcohols, as gasoline-blending agents has been proposed to reduce emissions of new reformulated gasoline. (Ether + alcohol + alkane) are of interest as model mixtures for gasoline in which the alcohol and the ether act as non-polluting, high octane number blending agents [1].

Several oxygenated compounds are added to gasoline to enhance the octane number and to reduce air pollution. For proper design of synthesis and separation processes of these reformulated gasolines, which contain ethers and alcohols, the phase behavior and thermodynamic properties of the fluid mix··es need to be known[2,3].

The thermodynamic properties of the mixtures containing hydrocarbon and ether are of considerable interest in view of the fact that ethers are used as oxygenating agents in gasoline blending technology. Oxygenated gasolines not only reduce the emission of green- house gases but also increase the anti-knocking properties of the automotive fuels. In this connection, the use of ethers as gasoline blending agents has gained considerable interests [4]. The thermo- dynamic properties of the mixtures involving gasoline-component hydrocarbons and ethers are therefore of practical importance. Earlier studies of the excess enthalpies for

the (ether + n-alkane) systems include that made by Wang et al. [5] for the (dipropyl ether + n-hexane) system at (T = 298.15 K) and that reported by Marsh et al. [6] for the (dibutyl ether + n-hexane) system at {T = 298.15 and 308.15) K}.

Before the Clean Air Act Amendments of 1990, organo-metal (e.g. tetra-ethyl lead, tetra-methyl lead, methyl cyclopentadienyl manganese tricarbonyl, etc.) and aromatics (e.g. benzene, toluene, xylenes, ethyl-benzene, etc.) were frequently used as octane enhancers for automobiles and vehicles. From the recent increasing concerns about the environmental problems and health risks for human, however, oxygenated organic compounds such as light alcohols and aliphatic branched ethers are being considered and/or mandated for addition to gasoline because of their expected air pollution-reducing capabilities. Methyl tert-butyl ether (MTBE) is one of the oxygenated additives into gasoline to reduce the polluting component in exhaust gases like CO, NOx, unburned hydrocarbons, polynuclear aromatics. The economic advantages of the MTBE manufacturing process include lower investment [7], operating costs, and energy consumption, besides its noteworthy octane properties. Therefore, the blending characteristics of MTBE additive in a new gasoline formulation have been investigated extensively [4,8]. The MTBE mixtures with lower alcohols have outstanding properties such as miscibility in gasoline, storage stability, and potential compatibilities with the emission restriction by the clean air legislation.

3. Methods for measuring the excess enthalpy

A calorimeter is a device for measuring the heat effects, which arises from the physical or chemical processes upon mixing of two or more components. Various types of calorimeters have been developed based on different modes of operation for measuring heats of mixing during the last several decades. Excess Enthalpy (H^E) were last reviewed by McGlashan in 1961.[9] Since that review the most widely used calorimeters have been modifications of that described by Larkin and McGlashan.[10] Recently a number of stepwise dilution calorimeters, based on the original design of Savini et al.,[11] have been described. [12-14] With this technique only two runs are required to cover the whole composition range, as each run can give values of H^E, for more than half the volume fraction range. These calorimeters have a higher precision than previous calorimeters and they have the added advantage that a large number of results can be obtained quickly. Flow calorimetric techniques have been developed in recent years to give a precision equal to that of the Larkin and McGlashan type calorimeter [15]. The main disadvantage of a majority of flow calorimeters is that large quantities of pure liquids are required, some requiring up to 300cm^3 of each component for a few measurements. The method has however served to confirm results obtained by other methods [16-17].

To obtain precise values it is necessary to measure H^E, directly using either an adiabatic or isothermal calorimeter. Until recently, most measurements have been made with adiabatic calorimeters.

3.1 Adiabatic Calorimeters

In an adiabatic experiment, the two liquids are mixed in a vessel which is thermally isolated from its surroundings. If H^E is positive (endothermic) then there will be a lowering of the temperature. In practice, electrical energy is usually supplied to the calorimeter partially to nullify the temperature drop. If H^E is negative (exothermic) then the temperature of the calorimeter rises on mixing. A second experiment is necessary to determine the amount of energy required to produce the same temperature rise. Alternatively two identical calorimeters can be used [18]. A known amount of electrical energy is added to the second calorimeter in such a way that the temperature difference between the two calorimeters is minimized. The two main requirements of mixing calorimeters are: (a) the absence of a vapor space and (b) some means to allow for the volume change which occurs on mixing. McGlashan [9] has reviewed the published mixing calorimeters prior to 1961. All the calorimeters reviewed were of the adiabatic type. One which has been widely used and meets the above requirements is the calorimeter described by Larkin and McGlashan [10].

3.2 Isothermal Calorimeters

Malcolm and Rowlinson [19,20] described an isothermal apparatus based on the Bunsen calorimeter. The mixing vessel is surrounded completely by a vessel containing a liquid, part of which is frozen to give a mantle around the inner walls. Any energy released or absorbed during the mixing process causes melting or freezing of the mantle and the volume change that accompanies the process is measured by the movement of the liquid or mercury in a capillary tube. Bunsen calorimeters can be used to measure energy changes for slow processes. A major disadvantage is that measurements can only be made at the melting temperature of the calorimeter fluid. Recently Davies and Pritchard have discussed in detail the stability and accuracy of Bunsen-type calorimeters. An alternative is the isothermal dilution calorimeter. For an endothermic system, one component is slowly injected into the second component with the simultaneous addition of electrical energy sufficient to maintain the calorimeter isothermal. The addition is discontinued at any desired composition and the excess enthalpy determined from the initial amount of substance of component B in the vessel, the amount of substance of component A injected, and the electrical energy added to maintain isothermal conditions. The apparatus is normally designed so that the entire composition range can be covered in two experimental runs. For exothermic systems it is possible to add electrical energy continuously to raise the temperature of the calorimeter a few tenths of a kelvin above the thermostat temperature. On injection of liquid, the addition of electrical energy is discontinued in such a way as to keep the calorimeter

isothermal. Operating the calorimeter in this mode requires a blank run to determine the energy required to raise the temperature of the injected liquid to that of the calorimeter. Alternatively, a thermoelectric cooling device can be inserted directly into the calorimeter or connected to the calorimeter by a defined heat-leak path. Energy is removed from the calorimeter at a constant rate and the calorimeter is maintained isothermal, at the thermostat temperature, by the continuous addition of electrical energy.

An apparatus suitable for endothermic systems was first described by Van Ness and co-workers [21] in 1961. Several other calorimeters based on that original design have been reported in the literature. [11-14][22-25] A number of other isothermal dilution calorimeters which contain a vapour space [22,26] have been described. Mrazek and Van Ness [21] used a new isothermal calorimeter with no vapor space, for measuring excess enthalpies of alcohol-aromatic binaries at 25^0 C, 35^0 C and 45^0 C. This calorimeter has been widely used either in the original or modified form. The calorimeter consisted of an unsilvered 150 cc flask fitted with a plug held in a fixed position. The plug had four openings for leads of the heater, feed tube, leads of the thermistor and air vent. Small indentations had been provided at the bottom of the mixing vessel as well as in the plug to support the stirrer. A rotating magnet below the apparatus actuated the stirrer. One of the pure components was taken in the flask and the second component was added from the bulb over mercury. The amount of second component used in the experiment was determined from the weight of the mercury required to displace the liquid from the bulb. Savini, et al., [11], Winterhalter and Van Ness [12], Tanaka, et al., [23] used an isothermal displacement calorimeter similar to the one described by Mrazek and Van Ness [21]. The mixing vessel consisted of a 130 cc silvered Dewar flask and the lid of the vessel (flanged type, polished and flat) fitted to the vessel by means of bolts to give a tight seal. The lid had provisions for the introduction of a feed tube, thermistor, heater and cooling assembly. The stirrer was fixed with the help of a frame inside the vessel. The stirrer was rotated by an external magnet and with a constant speed motor. Tanaka, et al., [23] measured excess enthalpy values of mixtures formed by benzene, cyclohexane, n-hexane and dichloromethane at 25^0 C. This calorimeter was used for both endothermic and exothermic enthalpy of mixing.

3.3 Flow Calorimeters

A flow calorimeter is one of the best choices in determining the heat of mixing for most liquid system. In a flow calorimeter the two liquids are injected into a mixing chamber at a steady and known rate. For an endothermic system the power P in the heater is adjusted so that the temperature of the mixed liquid is restored to that of the unmixed liquid. Flow calorimeters: Continuous flow calorimeters have been used for rapid determination of excess enthalpy data. The advantages of flow calorimeters are: 1. Ease of operation (with ± 5% accuracy), and 2. adoptability for high-pressure operation. The main disadvantages are: 1. Large quantities of pure substances are required which becomes costly, and 2. at low concentrations the precision of measurements is low.

Wormald [27] has recently constructed a flow calorimeter which appears to give a reproducibility of better than 0.2%. The commercial LKB isothermal flow calorimeter which was initially designed for aqueous systems has been modified for non-aqueous systems by various workers. Gustin and Renon [28] used 10 cm^3 precision pumps which could be adjusted for flow rates from 0.01 to 0.4 $cm^3\ min^{-1}$ with an accuracy of 0.2%. They found it necessary to degass the solvent to prevent bubble growth in the mixing cell. For the test system benzene + carbon tetrachloride their results appear accurate to about 1 J mol^{-1}. Harsted and Thomsen [17] determined a calibration constant for their LKB calorimeter by using various results determined by Marsh and co-workers. They estimated that their modified flow calorimeter was accurate to about 2 $Jmol^{-1}$. Goodwin and Newsham [29] have described a flow calorimeter for use with alcohol + water systems. Picker et al.[30] have described an interesting calorimeter. By reducing the time taken to reach a steady state in a flow calorimeter to less than 1 min and by continuously varying the flow rates of the two liquids they managed to obtain the complete excess enthalpy curve in less than 1 h.

Monk and Wadso [31] described a prototype of a flow reaction microcalorimeter (LKB 10700-1) for determining the heat of dilution of aqueous electrolyte. Later Tanaka et al.[32] depicted the potential application of the flow microcalorimeter (LKB 10700-1) to non-electrolyte solutions. In the same paper they presented a modification of the flow microcalorimeter (LKB 10700-1) to measure the heat of mixing of hydrocarbons.

4. CONCLUSION

Recently, increasing the environmental problems and health risks for human, however, oxygenated organic compounds such as light alcohols and aliphatic branched ethers are being considered and/or mandated for addition to gasoline because of their expected air pollution-reducing capabilities. Marsh et al. [4] reviewed several thermo physical properties (excess enthalpy, excess volume, and vapor-liquid equilibria) of binary and ternary mixtures containing oxygenates (gasoline additives) and hydrocarbons. This review presents that there are still significant number of systems for which thermodynamic property measurement are insufficient. However, the selection of calorimeter is dependent on the research requirements. For precise measurements, the requirements are: there must be *no* vapour space - if this requirement is not adhered to, errors may arise due to evaporation or condensation of the components onto the walls of the mixing vessel - resulting in a heat effect and uncertainties of the composition of the mixture. The liquids must be adequately mixed in the reaction vessel - and the composition of this mixture must be accurately known.

References:

[1] B.Elvers, Handbook of fuels: Energy sources for Transportation, Wiley-VCH, Weinbeium,Germany,2008.
[2] F. Aguilar, F.E.M. Alaoui, C. AlonsoTristán, J.J. Segovia, M.A. Villama˜nán, E.A. Montero,J. Chem. Eng. Data 54 (2009) 1672–1679.
[3] F. Aguilar, F.E.M. Alaoui, J.J. Segovia,M.A. Villama˜nán, E.A. Montero, Fluid Phase Equilib. 284 (2009) 106–113.
[4] K.N. Marsh, P. Niamskul, J. Gmehling, R. Bolts, Fluid Phase Equilib. 156 (1999) 207–227.
[5] L. Wang, G.C. Benson, B.C.-Y. Lu, J.Chem. Thermodyn. 20 (1988) 975–979.
[6] K.N. Marsh, J.B. Ott, M.J. Costgan, J. Chem. Thermodyn. 12 (1980) 857–862.
[7] E.J. Chang, Prep. Pap.-Am. Chem. Soc., Div. Fuel Chem. 39 (1994) 330–336.
[8] H.L. Brockwell, P.R. Sarathy, R. Trotta, Hydrocarbon Processing 9 (1991) 133–141.
[9] M. L. McGlashan, in 'Experimental Thermochemistry', Vol. 11, Ch. 15, Heats of Mixing, ed. H. A.Skinner, Interscience, London, 1967.
[10] J. A. Larkin and M. L. McGlashan, J. Chem. SOC., 1961, 3425.
[11] C. G. Savini, D. R. Winterhalter, L. H. Kovach, and H. C. Van Ness, J. Chem. and Eng. Data, 1966, 11, 40.
[12] D. R. Winterhalter and H. C. Van Ness, J. Chem. and Eng. Dara, 1966, 11, 189.
[13] R. H. Stokes, K. N. Marsh, and R. P. Tomlins, J. Chem. Thermodynamics, 1969, I, 211.
[14] B. Murakami and G. C. Benson, J. Chem. Thermodynamics, 1969, 1, 559.
[15] M. L. McGlashan and H. F. Stoeckli, J. Chem. Thermodynamics, 1969, 1, 589.
[16] J. M. Sturtevant and P. A. Lyons, J. Chem. Thermodynamics, 1969, 1, 201.
[17] B. S. Harsted and E. S. Thomsen, J. Chem. Thermodynamics, 1974,6, 549.
[18] D. A. Armitage and K. W. Morcom, Trans. Faraday Soc., 1969, 65, 688.
[19] G. N. Malcolm and J. S. Rowlinson, Trans. Faraday Soc., 1957,53, 921.
[20] R. W. Kershaw and G. N. Malcolm, Trans. Faraday Soc., 1968,64, 323.
[21] R. V. Mrazek and H. C. Van Ness, Amer. Inst. Chem. Engineers J., 1961,7, 190.
[22] R. S. Ramalho and M. Ruel, Canad. J. Chem. Eng., 1968, 46, 456.
[23] R. Tanaka, S. Murakami, and R. Fujishiro, Bull. Chem. SOC. Japan, 1972, 45, 2107.
[24] M. B. Ewing, K. N. Marsh, R. H. Stokes, and C. W. Tuxford, J. Chem. Thermodynamics, 1970, 2, 751.
[25] J. J. Christensen, J. W. Gardner, D. J. Eatough, R. M. Izatt, P. J. Watts, and R. M. Hart, Rev. Sci. Instr., 1973, 44, 481.
[26] E. Kauer, D. Kirchner, D. Haupt, and H. J. Bittrich, Z. phys. Chem. (Leipzig), 1972, 250,153.
[27] K. Elliot and C. J. Wormald, J. Chem. Thermodynamics, 1976, 8, 881.
[28] J. L. Gustin and H. Renon, J. Chem. and Eng. Data, 1973,18, 164.
[29] S. R. Goodwin and D. M. T. Newsham, J. Chem. Thermodynamics, 1971,3, 325.
[30] P. Picker, J. Jolicourr, and J. E. Desnoyers, J. Chem. Thermodynamics, 1969, 1, 469.
[31] Wadso, I. Design and Testing of Micro Reaction Calorimeter. Acta chemica Scandinavica, 1968, 22, 927-937.
[32] Tanaka, R.; D'Arcy, P. J.; Benson, G. C. Application of a Flow Microcalorimeter to Determine the Excess Enthalpies of Binary Mixtures of Non-electrolytes. Thermochim. Acta, 1975, 11, 163-175.

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Experimental Investigation of Excess molar enthalpies of binary mixtures formed by cyclohexane with (benzene or toluene or methanol)

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Abstract
The experimental excess enthalpy data are useful in the design of separation equipments. From the various designs available for the experimental determination of enthalpy of mixing, the apparatus was selected, modified and constructed. The apparatus of enthalpy of mixing was tested with a known system and the data obtained was in very good agreement with literature values. The excess molar enthalpies are reported for three binary systems formed by mixing cyclohexane with +benzene, + toluene, methanol have been measured at *T* 298.15 K and 308.15 K using an isothermal calorimeter. The experimental results are correlated with polynomial equations.

Keywords: Excess molar enthalpies; isothermal calorimeter; cyclohexane

Introduction
This work continues our studies about the excess thermodynamic properties for binary mixtures. Excess enthalpy data for the mixtures composed of organic compounds are essential both in theory and practice. Researches on these thermodynamic properties are useful in the design of separation and it provides full understanding of the liquid mixture behaviour. Heat of mixing of mixtures over the whole composition range are useful for a full understanding of their thermodynamic and transport properties, as well as for practical chemical engineering purposes. Enthalpy effects on mixing of liquids are quite large and of considerable importance especially for the design of absorption and distillation columns [1].

Experimental
Van Ness and co-workers (1961) described an apparatus suitable for endothermic systems [2]. A number of other calorimeters based on that original design have been reported in the literature [3-6]. Isothermal dilution calorimeters which contain a vapour space have been described [2,7,8] used a new isothermal calorimeter with no vapor space. [7] used an isothermal displacement calorimeter similar to the one described by Mrazek and Van Ness [2]. In the present work a static type calorimeter incorporating the design features of [1,7,9-11] was designed and used to measure enthalpy of mixing at 298.15 K and 308.15 K.

The products used in the present work were purified by the methods suggested by Riddick, J.A and Weissberger, A. [12-13]. The purity was checked by specific gravity, refractive index and vapor phase chromatography.

An Isothermal calorimeter was used to measure excess molar enthalpies H_m^E at 298.15 ± 0.003K and 308.15 K. Details of the equipment and its operating procedure for binary system have been described previously [1]. Over most of the mole-fraction range, the errors of the excess molar enthalpies are estimated to be less than 0.5%.

The calorimeter is immersed in the constant temperature water bath. The liquids whose enthalpy of mixing is to be determined are taken in jacketed burettes. Long stemmed thermometers of range -10 to 110^0C with 0.1^0C accuracy are used to measure the temperatures of the liquids in the jacketed burettes.

The temperature of the water bath is maintained at the desired value at which the enthalpy of mixing is to be measured. When the temperature of the liquids in both burettes equals that of the constant temperature bath, T_0, a known amount of liquid (1) from one of the burettes is run down into the calorimeter. Stirring is started and continued till the end of the experiment.

Then, from the second burette, a known amount of liquid (2) is run down into calorimeter so that the total volume of both liquids is 270 ml. The temperature T_1 in the calorimeter is registered by means of transducer AD590. The liquid in the calorimeter is allowed to cool to the original temperature T_0, .and the heater is switched on and heating is continued till the liquid attains the temperature T_1. The current through the heater, the potential drop across it and the heating time of the mixture are all recorded. Finally, the liquids are emptied from the calorimeter.

The same procedure is repeated for different volume ratios of the two liquids, always keeping the total volume of 270 ml.

Results and discussion
Excess molar enthalpies H_m^E for three binary system cyclohexane (1) + benzene (2), cyclohexane (1) + toluene (2), cyclohexane (1) + methanol (2) have been measured at *T*

298.15 K and 308.15 K using an isothermal calorimeter. Since there was no appreciable change in the enthalpy of mixing values beyond 308.15 K. Also the liquids start vaporizing at higher temperatures. The experimental results of binary excess enthalpies are listed in table 1 at T 298.15 K and table 2 at T 308.15 K and shown in Figures 1-3. The experimental excess enthalpy depends on composition of the binary system were fitted to the Redlich-Kister polynomial by the method of un weighted least-squares.

Table 1 Experimental excess molar enthalpies $H^E_{m,12}$ (J mol^{-1}) at 298.15K for the binary mixtures cyclohexane (1) + benzene (2), cyclohexane (1) + toluene (2), cyclohexane (1) + methanol (2)

x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$
x_1 (C_6H_{12}) + (1-x_1) C_6H_6					
0.05	165.25	0.4	703.47	0.75	547.46
0.1	283.48	0.45	726.57	0.8	467.81
0.15	357.93	0.505	742.28	0.85	394.23
0.2	437.73	0.55	754.67	0.9	297.64
0.25	538.12	0.6	723.15	0.95	167.62
0.3	623.34	0.65	694.23		
0.35	668.36	0.7	634.61		
x_1 (C_6H_{12}) + (1- x_1) CH_3OH					
0.05	173.64	0.4	437.73	0.75	475.64
0.1	286.34	0.45	442.56	0.8	457.84
0.15	367.45	0.505	453.78	0.85	436.25
0.2	393.78	0.55	448.73	0.9	346.25
0.25	408.67	0.6	464.67	0.95	273.45
0.3	423.17	0.65	473.56	0.975	183.64
0.35	428.97	0.7	498.13		
x_1 (C_6H_{12}) + (1- x_1) $C_6H_5CH_3$					
0.05	37.86	0.4	145.67	0.75	108.96
0.1	53.67	0.45	147.35	0.8	93.67
0.15	71.62	0.505	152.72	0.85	80.42
0.2	98.56	0.55	150.68	0.9	63.46
0.25	115.67	0.6	139.67	0.95	46.32
0.3	123.61	0.65	125.53	0.975	36.28
0.35	138.23	0.7	116.2		

$$H^E_{m,12}/\,J\,mol^{-1} = \sum_{k=1}^{n} h_k\,(1-2x_1)^{k-1} \qquad (1)$$

The coefficient h_k of Eq. (1) and the standard deviation *σ of Eq. (2)* calculated for the three constituent binary mixtures are tabulated in Table 3.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}\left(H^E_{exp\,,i} - H^E_{cal\,,i}\right)^2}{n}} \qquad (2)$$

Table 2 Experimental excess molar enthalpies $H^E_{m,12}$ (J mol^{-1}) at 308.15K for the binary mixtures cyclohexane (1) + benzene (2), cyclohexane (1) + toluene (2), cyclohexane (1) + methanol (2)

x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$
x_1 (C_6H_{12}) + (1- x_1) C_6H_6					
0.05	165.25	0.4	686.16	0.75	537.62
0.1	283.48	0.45	703.45	0.8	448.61
0.15	357.93	0.505	723.64	0.85	394.23
0.2	437.73	0.55	743.81	0.9	297.64
0.25	538.12	0.6	707.12	0.95	167.62
0.3	623.34	0.65	683.42		
0.35	668.36	0.7	621.57		
x_1 (C_6H_{12}) + (1- x_1) CH_3OH					
0.05	162.14	0.4	411.23	0.75	447.84
0.1	220.54	0.45	418.24	0.8	426.51
0.15	343.16	0.505	425.42	0.85	407.56
0.2	373.96	0.55	431.12	0.9	283.86
0.25	371.14	0.6	440.37	0.95	218.94
0.3	387.46	0.65	450.46	0.975	143.84
0.35	401.35	0.7	464.25		
x_1 (C_6H_{12}) + (1- x_1) $C_6H_5CH_3$					
0.05	36.43	0.4	128.76	0.75	94.35
0.1	51.36	0.45	135.42	0.8	81.46
0.15	68.12	0.505	142.34	0.85	67.32
0.2	84.65	0.55	131.64	0.9	48.34
0.25	96.78	0.6	123.43	0.95	34.62
0.3	106.45	0.65	114.42	0.975	30.46
0.35	118.56	0.7	105.34		

Conclusion

The experimental determination of excess molar enthalpy values for three binary at 298.15K and 308.15K has been performed by means of isothermal calorimeter. The heats of mixing values for binary systems studied are endothermic in nature and over the most of the composition range, the errors of the excess molar enthalpies 5 %.

Acknowledgement

We are deeply indebted to the Siddaganga Institute of Technology – Tumkur - Karnataka, India, and SVIT, Chincholi, Nashik for support to this research project.

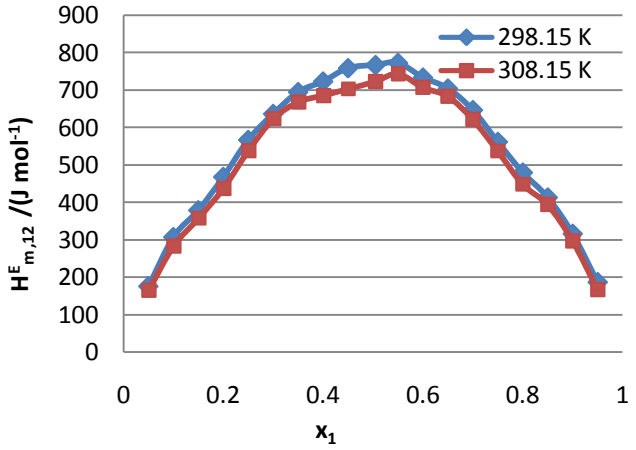

Figure 1: Enthalpy of mixing for cyclohexane (1) - Benzene (2) system

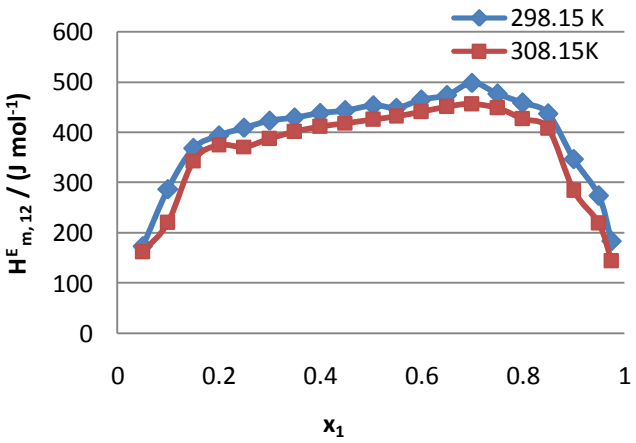

Figure 2: Enthalpy of mixing for cyclohexane (1) - Toluene (2) system.

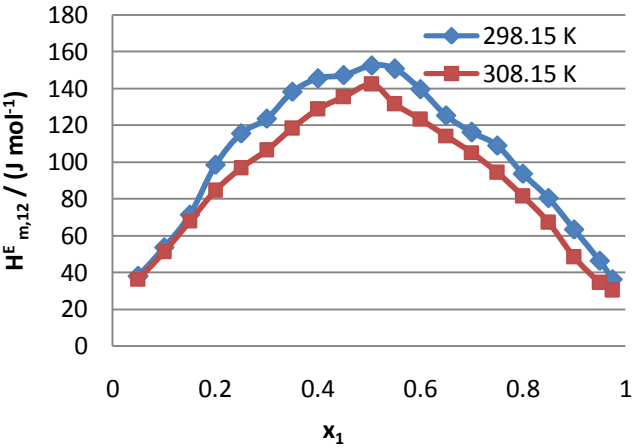

Figure 3: Enthalpy of mixing for cyclohexane (1) – methanol (2) system.

Table 3 Parameters h_k and standard deviations σ for the representation of $H^E_{m,12}$ at 298.15K and 308.15 K by Eq. (1)

T /K	System (1+2)	h_1	h_2	h_3	h_4	h_5	σ /J mol^{-1}
298.15	(Cyclohexane + benzene)	3105.219	-39.0518	-965.185	-107.845	2205.068	0.34
308.15	(Cyclohexane + benzene)	3015.72	-149.056	-869.524	55.07913	1684.273	0.54
298.15	(Cyclohexane +Toluene)	1812.289	-210.699	1655.016	-595.166	2120.399	0.48
308.15	(Cyclohexane +Toluene)	1699.904	-305.24	1852.081	-258.249	801.9138	0.52
298.15	(Cyclohexane + methanol)	585.0825	104.7014	84.06362	-297.084		0.211
308.15	(Cyclohexane + methanol)	524.325	38.20897	27.25812	-76.2953		0.21

References

[1] K. L. Shivabasappa, P. Nirguna Babu and Y. Jagannadha Rao, Braz. J.of Chem. Eng., 25, 167, 2008.
[2] R. V. Mrazek and H. C. Van Ness, Amer. Inst. Chem. Engineers J. 7, 190, 1961.
[3] D. R. Winterhalter and H. C. Van Ness, J. Chem. and Eng. Dara, 11, 189, 1966.
[4] C. G. Savini, D. R. Winterhalter, L. H. Kovach, and H. C. Van Ness, J. Chem. and Eng. Data, 11, 40, 1966.
[5] R. H. Stokes, K. N. Marsh, and R. P. Tomlins, J. Chem. Thermodynamics, I, 211, 1969.
[6] B. Murakami and G. C. Benson, J. Chem. Thermodynamics, 1, 559, 1969.
[7] R. Tanaka, S. Murakami, and R. Fujishiro, Bull. Chem. SOC. Japan, 45, 2107, 1972.
[8] J. J. Christensen, J. W. Gardner, D. J. Eatough, R. M. Izatt, P. J. Watts, and R. M. Hart, Rev. Sci. Instr, 44, 481, 1973.

[9] Patel, H.R., Ph.D. Thesis, Department of Chemical Engineering, Indian Institute of Science, Bangalore, India, 1974.
[10] Rao Y.J., and Viswanath D.S, J.Chem .Eng. Data, 18, 49, 1973.
[11] Nirguna Babu. P, Ph.D. Thesis, Department of Chemical Engineering, Siddaganga Institute of Technology, Tumkur – 572103 – India, 2003.
[12] Riddick, J.A., Bunger, W. S., Techniques of Chemistry, Organic Solvents, Vol. II, 3e, Wiley-Interscience, NY, 1970.
[13] Weissberger, A., Editor, Techniques of Organic Chemistry, Vol I, Interscience, NY, 1949.

ADVANCEMENT AND PROSPECTIVES OF MOF AND ZIF AS FILLER IN MIXED MATRIX MEMBRANE FOR CO_2/N_2 SEPARATION - A REVIEW

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ABSTRACT

To control the rising level of atmospheric carbon dioxide is a major issue and the challenge due to rapid population, industrialization and growing demand for energy. To meet the current demand of energy, 80 % of energy is produced by combustion of fossil fuels. Various methods and technologies have been developed for carbon capture, storage and reducing the harmful emission of CO_2, but still it is a critical issue for the development of energy efficient CO_2 separation. Although membrane based separation has been considered as capable technology, apart from established materials and techniques, the investigation of advanced polymers, filler's with high performance and low cost, capable at severe conditions are vital and significant. The MOF's and ZIF's are an emerging class of nanoporous crystalline materials offers an exciting enormous prospect as filler particles in polymeric matrices. The objective of this review was to overview the different types of MOF and ZIF materials used as a filler, selection criteria, current status and development, parameters of separation, scalable fabrication at lower cost and enhance selectivity characteristics with those of inorganic materials. The most emphasis was towards CO_2 /N_2 separation in view of direct significance to the post combustion of fossil fuels to the gas separation. Also, the purpose of the study was to investigate and assess the future prospects and challenges of post combustion separation to achieve high selectivity and permeability at low concentration, low pressure and large volume of CO_2 in presence of other contaminants.

KEYWORDS: *Filler, Mixed Matrix Membrane (MMM), Metal Organic Framework (MOF), Post Combustion, Permeability, Zeolitic Imidazolate Framework (ZIF)*

I. INTRODUCTION

Energy efficient and environmental friendly separation and purification processes have become a prime importance in dealing with the global pollution issues associated to CO_2 emissions during the combustion and natural gas purification [1]. Nowadays the

coal fired power plants alone emit billion tons of CO_2 per year and next 20 to 30 years, fossil fuels will remain an important source of the world's energy. So reduction of CO_2 emission is extremely important to balance the environment [2], [3].

The traditional methods of separation like amine based chemical solvents and sorbents, polymeric membrane separation [1], [4] shows some limitations like a high energy requirement, cost of operations, operating conditions, stability etc. [1]. The applications of polymeric membranes in gas separation [5] continue to grow, but there are apparent limitations to the membrane performance.

Pre-combustion, Post- combustion and Oxy-combustion are the three technological pathways can be usually followed for CO_2 capture and separation [6]. Among all, post combustion CO_2 capture and separation as shown in figure 1 has the better near term potential for significantly reducing CO_2 emission, because it can be affordable and retrofit to existing coal fired power plants with few modifications [2], [3] & [6]. It is primarily applicable to conventional coal fired, oil fired or gas fired power plants. In the coal fired power plant, fuel is burned with air to produce steam, which drives a turbine to produce electricity. During combustion, a flue gas stream mostly consists of nitrogen, moisture, and CO_2 [2] [3], [6]. The typical flue gas composition of a coal fired power plant is shown in Table 1.

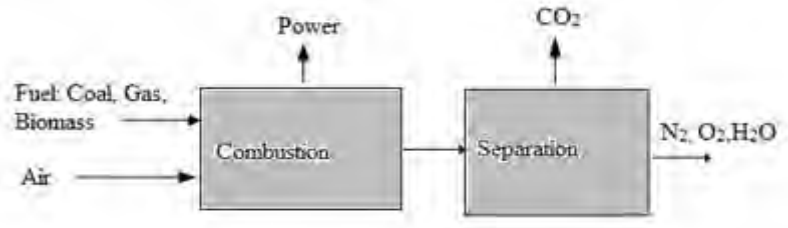

Figure 1: Post combustion CO_2 separation

- **KEY CHALLENGES OF POST COMBUSTION SEPARATION**

The key challenges of post combustion capture and separation of CO_2 have focused and studied for the suitability of MOF and ZIF based MMM [3], [7] & [8] are as follows: i) to separate and capture CO_2 at low pressure (atm.) of flue gas, ii) gas is at a low concentration (15% CO_2), iii) required to handle high volume of gas iv) difficult to create a driving force for separation v) difficult to meet both high recovery rate and purity vi) interference of other gases vii) modifications in multiple stages and recycle streams. These issues create demand for new membrane materials that must withstand at these severe operating conditions of post combustion operation [2].

The mixed matrix membrane based technology is highly useful, compact, energy efficient, cost effective, easy to scale-up and can be able to solve all issues up to some extent with few limitations.

Table1: Approximate flue gas composition

Gas	Concentration (Vol. %)
N_2	73-77
CO_2	15-16
H_2O	5-7
O_2	3-4
SO_2	800 ppm
SO_3	10 ppm
NO_x	500 ppm
HCl	100 ppm
CO	20 ppm
HC	10 ppm
Hg	1ppb

- **BACKGROUND OF MMM TECHNOLOGY**

Over the last three decades, various porous solid nano materials have been invented and found to have a large number of applications in the field of adsorption, separation and purification as well as catalyst [9], [10]. Blending between the inorganic fillers like carbon nano tubes, zeolite, metal oxides, silica and silica nano particles, MOF, ZIF with glassy and rubbery polymers to prepare a mixed matrix or hybrid membrane [9] , [11] has been worked out successfully.

Despite of several advantages of inorganic material, MMM performance is still below the expectations, due to membrane defects, uniform dispersion and processing problems [12]. Major technical barrier is the preparation of well dispersed and wetted additives at high loading. There is prime importance to study the material selection of organic and inorganic phases, and its preparation techniques [13].

Many MOF's & ZIF's can be synthesized easily, quickly at low cost. By varying the MOF and ZIF compositions [14], many structures with organic linkages improve the adhesion. [11] [15]. Due to their diverse framework structures and functional properties [16] they are used in the various fields.

By tuning of the pores of these materials, controlling the size, shape and structures during its synthesis, create the material in such a way that, its affinity and kinetic diameter [4] , [17] as shown in table 2 must match with the specific gas molecules, as a result permeability and selectivity of MMM are expected to enhance [6]. MMM could combine the molecular sieving effect of MOF and process ability of the base polymers. Therefore, they could be readily scale-up for industrial applications using the established fabrication techniques for polymer membranes [6], [18].

This study was undertaken to look forward the opportunities to overcome the tradeoff of polymeric membrane, to enhance the permeability and selectivity, to bridge the gap between the inorganic and polymeric membrane, filler loading limitations, future opportunities of newly developed fillers i.e. MOF and ZIF for membrane preparation [18]. Various factors like size and shape, dimensions of the particles, wetting nature of particles, surface area, filler concentration, selective separation, matrix-particle interaction, defect free fabrication strategies and material selection criteria must be considered to improve the transport characteristics [6] , [18].

The variety of membrane methods like polymeric, ceramic, facilitated transport, selective & mixed matrix membrane [4] and technologies such as absorption, cryogenic, adsorption etc. have developed for CO_2 separation [2] , [8] but still it is a critical issue of energy efficient CO_2 separation. The most emphasis is towards CO_2/N_2 separation [2], [7] & [19] in view of direct significance to the post combustion. The purpose of the study was to investigate and assess the progress and challenges of post combustion by MMM at low concentration, low pressure and large volume of CO_2 in presence of other contaminants.

II. FUNDAMENTALS OF MOF/ZIF BASED MMM

Mixed matrix or hybrid membrane consists of a combination of two or more chemically different materials with a distinct interface between them. The continuous phase is a polymer matrix and other most important constituent is the reinforcement in the form of fine nanoparticles, which is added to the matrix to improve or alter the matrix properties. The use of two materials with different flux and selectivity provides the possibility to better design of gas separation membrane [12]. Mixed matrix membranes as shown in Figure 3 incorporate impermeable or permeable molecular

sieving filler materials (inorganic additives) like MOF and ZIF into an efficient polymer matrix [9], [15] & [17].

Table 2: Gas molecule with kinetic diameter of flue gas

Gas Molecule	H_2	N_2	O_2	CO	NO	H_2O	H_2S	CO_2	NO_2	CH_4
Kinetic Diameter (A^0)	2.89	3.64	3.467	3.76	3.49	2.65	3.60	3.3	--	3.758

- **ADVANCEMENT OF FILLER MATERIALS**

The filler materials offer higher selectivity and the polymer matrix characteristics, which will improve the desired process ability, required to manufacture membranes. The research is going on new combination of polymer and molecular sieve [20], also by introducing new approach to maximize the MMM performance and properties [6] [15]. The typical materials with different pore sizes [20], [21] are given in the table 3.

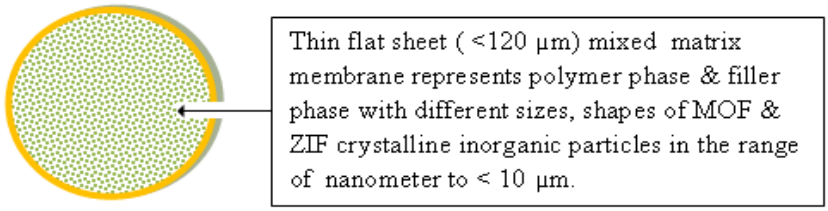

Figure 2: Schematic representation of mixed matrix membrane

- **FABRICATION OF MOF/ ZIF BASED MMM**

Fabrication of defect free MMM is done by blending of inorganic particles in a polymer matrix similar to the ordinary polymeric membrane by the phase inversion method. Preparation of a homogeneous solution of polymer and particles by three different ways: i) either disperse synthesized MOF/ ZIF particles into the solvents and after stirring, add in the polymer, ii) initially polymer is dissolved in the solvent and after stirring, add the MOF/ZIF particle in the solution and iii) particles are dispersed into the solvent and stirred**,** then dissolve polymer in the solvent separately and then particle suspension can be added in the polymeric solution [22].

Table 3: The typical materials with different pore sizes

Zeolite		Meso-porous materials		MOF's & ZIF's	
Particles	Pore size (°A)	Particles	Pore size (°A)	Particles	Pore size (°A)
Silicalite-1	5.2–5.8	Activated carbon	20–30	Cu-TPA	5.2
ZSM-5	5.1–5.6	TiO_2	37.1	$Cu_3(BTC)_2$	5 x 9
Zeolite-13X	7.3	Meso-porous ZSM-5	27	MOF-177	7.1–7.6
SAPO-34	3.8	MCM-41, 48	>25	ZIF-7	3
Zeolite-A	3.2- 4.3	MgO	30	ZIF-8	3.4
--	--	SBA-11, 12, 15	>20	MOF-5	8.3
--	--	--	--	MIL-100	5.5 x 8.6
--	--	--	--	Cu-BPY-HFS	8
--	--	--	--	MIL-96	2.5–3.5

To overcome the drawbacks like cracks, voids, retention of surface area etc. can be improved by the material properties, dispersion without aggregation, surface chemistry [19].

The major technical barrier for MOF based MMM is the well dispersed and wetted additives at high loading. The following strategies have been developed for zeolite based membrane, also can be applicable to MOF/ZIF based MMM membrane [22], [23].

- **Particle size**: Mostly affect the dispersion and wetting. Less than 100 nm particle size is preferred for the best suspension in the blend and is less likely to settle during casting of the membrane.
- **Particle Shape:** Also affect the dispersion, polymer-particle interactions and surface area of the membrane. The spherical nanoparticles would have least contact area between the particles, which might help to prevent the agglomeration.
- **Pre-coating of the crystal:** It helps for dispersion of MOF/ZIF particle and promotes better interaction between the polymer and MOF/ZIF particles.
- **Particle loading:** For more effective dispersion and membrane thickness, there should be potential in varying the percentage of loading of MOF/ZIF. It also affects the membrane strength and durability in the severe environment.

- **SELECTION CRITERIA OF POLYMERS FOR MOF/ZIF BASED MMM**

If the pure polymer membrane has a high selectivity for CO_2, but low permeability, adding a MOF can enhance the membrane permeability slightly with little change in the membrane's selectivity. The results from the literature are shown in table 4 shows that, the polymer like Matrimid, pairing with a highly selective MOF/ZIF can produce a MMM with attractive characteristics of CO_2/N_2 separation [2], [24].

But, still a question remains, that, what is a best suitable combination of MOF/ZIF with polymer to achieve higher selectivity and permeability? What to do, if the polymer that is very permeable but has less selectivity? The strategies developed in this regard have been considering a series of polymers that lie along the Robeson's upper bound curve either for the single gas components or gas pairs like CO_2/ CH_4 [8] or CO_2/N_2 [7], [25]. To sum up, there are a wide range of polymers and MOF/ZIF are available, there is a need to identify well defined strategies to face the challenge to adding appropriate filler in a polymer that can yield large performance enhancement [2], [6] & [26].

III. SYNTHESIS TECHNOLOGY

The MOF crystalline particles [10] can be produced by the two major components, mainly a metal ions (or clusters of metal ions) and an organic molecule as a linker with suitable solvents as shown below.

Metal Ions + Organic Linkers = MOF

The organic linkers are the groups that donate multiple lone pairs of electrons to the metal ions, while the metal ions are made up of vacant orbital shells that can accept these electrons to form a MOF. The MOF's are well defined, adjustable, highly porous with spatial confinement, crystalline, sensitive to air, resistance to structural collapse upon heating [10]. Due to their high surface area (BET surface area is > 1000 $m^2 g^{-1}$), low design cost, light weight, it is suitable for gas storage and separation, catalysis, as a gas adsorbent and purification [26] etc. Two methods of synthesis are generally adopted, one conventional synthesis that is Solvo-thermal and other unconventional, that is grinding a mixture of organic linker and metal salt in the absence of solvent [6], [12].

Table 4: CO_2/N_2 gas separation performance of selected MOF as a filler for MMM

MOF and Polymer	MOF loading	Testing Conditions	Gas Permeability CO_2 (*Barrers or GPU)	CO_2/N_2 selectivity
$Mn(HCO_2)_2$/ PSF	10 wt. %	--	--	25.5
HKUST-1/PSF	5 wt. %	---	6-8	25
HKUST-1/PI	30 wt. %	--	--	27
HKUST-1/Polyimide	--	25^0C, 2 bar	88 GPU	9
HKUST-1/PI-PSF (3:1)	30 wt. %	--	--	23
ZIF-90/ 6FDA-DAM		25^0C, 2 bar	600-800	22
CuTPA/PVAc	15 (w:w)	--	--	35
ZIF-8/Pebax-2533 (Dual Layer)	10	--	--	31.4
	15	--	--	30.3
	35	--	--	32.3
ZIF-8/ Matrimid	10	--	--	21.6
	20	--	--	19
	30	--	--	17.1
	--	35^0C, 2.7 bar	9-24	23-33
Cu(BDC)/PVAc	--	35^0C,4.5 bar	3.3	35
HKUST-1/PDMS	--	---	3000	9
$CuSiF_6(bpy)_2$/Matrimid	--	35^0C, 2 bar	8-15	30-33
MOF-5/Matrimid	--	35^0C, 2 bar	11-20	35-40
HKUST-1/ Matrimid	--	35^0C, 10 bar	12-18 GPU	23-27

**1 Barrer = 3.348 x 10^{-16} mol. m/ (m^2.s.pa) and GPU (Gas Permeation Unit, 10^{-6} cm^3 (STP)/ (cm^2.s.cmHg)*

IV. CHALLENGES AND ISSUES MOF/ZIF IN MMM

There are several challenges and issues still remain and must be essential to study in detail with practical applications at the real severe conditions. The performance of MOF/ZIF based membrane based on the several major issues and challenges [6], [11] & [12] with some useful remarks shown in table 5.

- **PROGRESS AND PROSPECTS OF MOF/ ZIF BASED MMM FOR POST COMBUSTION**

Membranes for CO_2 separation have various advantages like easy to operate and design, no chemical reactions and moving parts, compact, with relatively low energy requirement. However, a few issues and technology challenges still remain, including need to handle CO_2 at low partial pressure, membrane performance and its life, scale-up on large volumes etc. [3]. Especially, for post combustion capture, advanced membrane research target include potential to retrofit with the existing coal fired plants, the design and synthesis of new materials that have high selectivity of CO_2/ N_2 and permeability with tunable pore size and distribution without degradation of gas permeability with the presence of other constituents at severe conditions and at less operating energy [2], [7] & [19].

Both polymeric and inorganic membranes have an enormous potential for use in the all three combustion processes for the CO_2 capture [5]. The burning of coal in air generates flue gas with a relatively low CO_2 and bulk of N_2, released at a total pressure of 1 bar and in method of Post-combustion, the membrane may be operated in the temperature range of 50-150^0C, at the temperature of desulfurizer [27]. This range of temperature is suitable range for CO_2/N_2 separation by membrane [25]. CO_2 permeability, selectivity, chemical and mechanical stability, membrane cost, material, fabrication methods are the other main considerations for the selecting an appropriate type of membrane. [5], [28]. During CO_2 separation, the primary need is

to find more chemically and thermally robust materials capable of withstanding the high level of moisture present, impurity components (O_2, CO, SO_x, NO_x) in the flue gas streams and also tuning the temperature required for regeneration.

Table 5: Issues and challenges with useful remarks

Issues and Challenges				
Plasticization	Interfacial defects	Agglomeration	Poor polymer and sieve contact	Particle size and its distribution
Use cross linking agents and addition of plasticers to the polymeric solution.	Use polymer with low glass transition temperature (tg), surface modification of particle using coupling agents.	Can be controlled by sonication of solution, use of more Viscous slurries.	Use of sizing agents, improve adhesion and minimize aggregation at high particle loading by priming and sizing.	Use nano and submicron size particle for the good interface area and enhance polymer- filler interface contact.

V. CONCLUSION

The key challenges of post combustion CO_2 separation by MMM such as the flue gas is at low pressure (1 bar), low concentration (15%) of CO_2, to treat large volumes of gas, to reduce the energy penalty, stability against CO_2 plasticization, compatibility between fillers and matrix with good thermal and chemical stability etc. are still remaining. Another aspect may be considered is the influence of feed exposure on the separation of CO_2/N_2. Different feed exposure exerts internal and external stresses on the fibers and compressing the fibers. Since permeability is the ratio of permeability and skin thickness, thinner skin gives rise to higher permeability. Mixed gas permeation characterization shows that, testing temperature [7] played an important role in the separation of CO_2/ N_2 [25]. Despite the progress made with traditional materials for membrane, above mentioned challenges must defeat in the near future to achieve realistic CO_2/N_2 selectivity and permeability. Due to the inventiveness of this field of research, there are certain limited numbers of MOF/ZIF based MMM membrane specifically studied for the CO_2/N_2 separation and look forward the bright potential in the use of post combustion.

REFERENCES

[1] Hongqun Yang, Zhenghe Xu, Maohong Fan, R. Gupta, R. B. Slimane, A. E. Bland, Ian Wright, 2008, *"Progress in carbon dioxide separation and capture: A review",* Journal of Environmental Sciences, 20, 14-27.

[2] Jian-Rong Li, Yuguang Ma, M. Colin Mc Carthy, J. Sculley, Jiamei Yu, Hae-Kwon Jeong, P.B. Balbuena, Hong-Cai Zhou, 2011, *"Review - Carbon dioxide capture-related gas adsorption and separation in metal-organic frameworks",* Coordination Chem. Rev., 255, 1791–1823.

[3] P. S. Sai Prasad, K. V. Raghavan, 2012, *"Techno- economic aspects of the post-combustion CO_2 capture processes",* Indian Journal of Chemistry, 51 (A), 1201-1213.

[4] C. A. Scholes, S. E. Kentish, G. W. Stevens, 2008, *"Carbon dioxide separation through polymeric membrane systems for flue gas applications",* Recent Patents on Chemical Engineering, 1, 52-66.

[5] S. Wang, Xiao Chun Han, 2012, *"Application of polymeric membrane in CO_2 capture from post combustion",* Advances in chemical engineering and science, 2, 336-341.

[6] K. Sumida, D. L. Rogow, J. A. Mason, T. M. McDonald, E. D. Bloch, Zoey R. Herm, Tae-Hyun Bae, Jeffrey R. Long, 2012, *"Carbon dioxide capture in metal organic frameworks",* Chem. Rev., 112, 724-781.

[7] Lu Liu, E. S. Sanders, J. R. Johnson, O. Karvan, S. Kulkarni, D. J. Hasse, W. J. Koros, 2013, *"Influence of membrane skin morphology on CO_2/N_2 separation at sub-ambient temperatures",* Jr. of Mem.Sci., 446, 433-439.

[8] Y. Zhang, J. S., S. Liu, Rong Wang, 2013, *"Current status and development of membranes for CO_2/CH_4 separation: A review",* Int. Jr. of Green. Gas Cont.12, 84-107.

[9] Jianwen Jiang, 2014, *"Molecular simulations in metal–organic frameworks for diverse potential applications",* Mol. Simul., 40, (7-9), 516–536.

[10] S. Qiu, G. Zhu, 2009, *"Review- Molecular engineering for synthesizing novel structures of metal-organic frameworks with multifunctional properties",* Coord. Chem. Rev., 253, 2891-2911.

[11] Wun-gwi Kim, Sankar Nair, 2013*, "Membranes from nanoporous 1D and 2D materials: A review of opportunities, developments, and challenges",* Chem. Eng. Sci. 104, 908-924.

[12] S. Keskin, D. S. Sholl, 2010*, "Selecting metal organic frameworks as enabling materials in mixed matrix membranes for high efficiency natural gas purification",* Energy Env. Sci., 3, 343–351.

[13] O. Bakhtiari, N. Sadeghi, 2014, *"The formed voids around the filler particles impact on the mixed matrix membranes gas permabilities",* Int. Jr. Che. Eng. Appl, 5 (2), 198-203.

[14] K.S. Park, Zheng Ni, J.Y. Choi, R. H. Fernando J. H.K. Chae, M. O Keeffe, O. M. Yaghi, 2006, *"Exceptional chemical and thermal stability of zeolitic imidazolate frameworks",* PNAS, 103 (27), 10186–10191.

[15] Anja Car, Chrtomir Stropnik, Klaus-Viktor Peinemann, 2006*, "Hybrid membrane materials with different metal- organic frameworks (MOF's) for gas separation",* Desalination, 200, 424–426.

[16] Jeong Yong Lee, Jing Li, Jacek Jagiello, 2005, *"Gas sorption properties of microporous metal organic frameworks",* Jour. of Solid State Chemistry, 178, 2527–2532.

[17] Vajiheh Nafisi, May-Britt Hagg, 2014, *"Development of dual layer of ZIF-8/PEBAX-2533 mixed matrix membrane for CO_2 capture",* Jour. of Membrane Sci., 459, 244-255.

[18] John P. Ferraris, Inga H. Musselman, Kenneth J. Balkus Jr., 2012, *"Mixed matrix membranes based on metal organic frameworks",* Adv. Mat. for Membrane Prep., 83-93.

[19] Tae-Hyun Bae, Jeffrey R. Long, 2013, *"CO_2/N_2 separations with mixed-matrix membranes containing Mg_2 (dobdc) nanocrystals",* Energy Environ. Sci., 6, 3565–3569.

[20] Harold B., Tanh Jeazet, Claudia S. Christoph Janiak, 2012, *"Metal–organic frameworks in mixed-matrix membranes for gas separation",* Dalton Trans., 41, 14003-14027.

[21] T. H. Bae, .Qiu, W. J. Koros, C. W. Jones, S. Nair, 2010, *"A high performance gas separation membrane containing sub micrometer-sized metal-organic framework crystals",* Angew. Chem. Int. Ed., 49, 9863- 9866.

[22] Edson V. Perez, K. J. Balkus Jr., John P. Ferraris, Inga H. Musselman, 2009*, "Mixed-matrix membranes for gas separations using metal-organic frameworks",* Polymer Preprints, 50 (2), 771-772.

[23] T. Singh, D. Kang, S. Nair, 2013, *"Rigorous calculations of permeation in mixed-matrix membranes: Evaluation of interfacial equilibrium effects and permeability-based models",* Jour. of Mem. Sci. 448, 160–169.

[24] Bei Liu, B. Smit, 2010, *"Molecular simulation studies of separation of CO_2 /N_2, CO_2/CH_4 and CH_4 /N_2 by ZIFs",* J. Phys. Chem. (C), 114, 8515-8522.

[25] Ying Dai, J. R. Johnson, Oguz Karvan, D. S. Sholl, W.J. Koros, "Ultem /ZIF-8 mixed matrix hollow fiber membranes for CO_2/N_2 separations", Journal of Membrane Science, 401- 402, 76– 82.

[26] J. Thompson, K. Chapman, W. Koros, S. Nair, 2012, *"Sonication-induced Ostwald ripening of ZIF-8 nanoparticles & formation of ZIF-8/polymer composite membranes",* Micro. and Meso. Mat. 158, 2012, 292–299.

[27] S. Xiang, Yabing He, Z. Zhang, Hui Wu, W. Zhou, R. Krishna, Banglin Chen, 2012, *"Microporous metal-organic framework with potential for carbon dioxide capture at ambient conditions",* Nat. Comm., 3(954), 1-9.

[28] Seda Keskin, Timothy M. van Heest, David S. Sholl, 2010, *"Can metal-organic framework materials play a useful role in large-scale carbon dioxide separations?"* Chem. Sus. Chem., 3, 879-891.

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QosBased Service Populating For Cloud Based Mobile Apps

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Abstract. Popularity of mobile devices network technologies increases day by day. Mobile devices always maintain network connectivity by different network providers. So if user moves around then they can access cloud services without any disadvantages. In current model when user moves from one geographical area to another he will keep accessing services from previous cloud over a long distance. It results in more congestion on network. This will degrades the QoS and QoE of services in cloud. There is the need of different approach which maintains resources by improving QoS and QoE of mobile services. This framework tells that the services run on public cloud are able to populate to other cloud in different location. This paper proves that if we add resource pool for every cloud then it is responsible for removing ambiguity which occurs at the time of migrating services. It also find out how the number of clients can influence the decision making at service delivery layer.

Index Terms: cloud computing, QoS, QoE, service population.

1. Introduction

Cloud computing becomes popular now a days because of its simple nature. It offers various computingand storage services over a internet. Cloud serviceproviders rent data centers hardware and software to deliverstorage and computing services through the internet.Internet users can access services from cloud. Insteadof their own devices cloud users can store theirdata on cloud. They can run their applications on cloudplatform without full installation of software.Cloud service providers provide various cloud servicesand resources as user requirement and they charged themaccordingly. Cloud computing increases its popularitybecause of its simple nature. Amazon EC2 and ApplelsiCloud are very popular cloud based products[2]. Thosevendors create their own cloud services and offer themto client for business and individual uses. They createcloud services as requirements come from market and eachhave different than others.Mobile computing also becomes more popular due tosmartphones and tablet pcs. Laptops and desktops arecannot be easily operate due to its size and form. Soit increases the demand of less weighted mobiledevices than laptops and desktops. But these devicescannot have some hardware resources which is used toperform some critical task. At that situation there is theneed to access those devices remotely through networkfor storage and

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processing. This feature is provided bycloud computing. It provides center based resources andthose devices require decenter based pool of resources.It creates traffic congestion problem on internet due touser mobility and high bandwidth services. It affects QoSand QoE factors in mobile services. This paper consistsof framework which overcomes the problem by servicepopulating technique

2. Literature Survey

A previous project invents a reshaping of the physical footprintof virtual machines within a cloud [3]. It invents a concept towards the lower operational costs for cloudproviders and improvement of hosted application performanceby taking into account affinities and conflictsbetween replaced virtual machines. It is achieve by mappingvirtual machine footprints. After comparing if similaritiesfound in memory footprint the virtual machines are migrated to the same memory location and content based memory sharing also deployed to get consolidation[4]-[6].The basic thing is to build control systemfor cloud which perform footprint reshaping to achievehigher level objectives like low power consumption, highreliability and better performance. It then reduces thecost for cloud providers and creates low cost cloud servicesfor user.

Media Edge Cloud (MEC) architecture improvesthe performance of cloud technology. This architecturealso improves QoS and QoE for multimedia applications.To achieve those cloudlets of servers running at edge ofbigger cloud. So it handles the request closer to thecloud thus it reduces the latency. If requests needs furtherprocessing then requests are sent to the inner clouddue to that the cloudlets are reserved for QoS based multimedia applications[7]. Using that concept the physicalmachines closer to the clouds outer boundary will used to handle QoS sensitive services. As these machines locatedon outer boundary of cloud the data has to travel less distance within the cloud before sending to the client.It improves QoE for client and reduces network congestionof cloud. All these researches aims only to improvethe cloud performance, no one can think about the usermobility. Providing media services to mobile client's becomespopular in future. As per that concept mobilityand multimedia contents becomes more popular and highbandwidth data streams will have to travel more distance and reach moving target can create a problem in future.Cloud providers may need to create more clouds to handlethe load and reduces the congestion.In cloud computing client get services by contactinga physical resources directly and then ask about theservice. Clients need to connect to the cloud then theycan accesses the services from the cloud. But in thisapproach client need to know the name of the physicalresource which offers the services to the client, so it creates the problem of redundancy. Some organizations solve thisproblem by running multiple servers and by using DNS,for load balancing and fail over [7]. This approach needsmore cost which is not affordable for small entities whichoffers a service at lower layer.The ability for clients torequest services directly from the network instead of askingfor physical resources that offers those services[1]. Itopens a doors for future development. Client request aservice ID and network infrastructure which is used tofind whether the actual service is running and then connectit to the client. This approach is able to running aservice in multiple locations and directly client requeststo the appropriate instance depending on their locationand network status.

3. Programmers Design

A.System Model

QoS aware service delivery model is necessary to deliver the services. The network infrastructure is used to decide the network status between the client andservice. Service providers provide services with bestQoS and QoE parameters to their clients. In this modelclient of cloud services will remain connect to the samecloud without thinking about its physical location andnetwork status. If the network condition satisfactoryand there

is no redundant path the service will be outof reach of network. So providers not able to reachtheir SLA standards and clients not getting the bestQoE at all time. Another thing is that the cloud fromany location has connected to the same cloud to getservices without thinking about the distance of cloudfrom itself. It results in creating more processing loadon cloud which degrades the QoS of services. It is notpossible for cloud providers to build a multiple clouds toprovide services to the different geographical areas. Sothere is the need of new technique for service deliverywhich provides various services to clients with properQoS and QoE parameter, it is also provide better cloudmanagement to the providers, it also reduces the networkcongestion. In this service delivery model we willhave clients who request the services and their requestswill be directed to physical location at which the serviceis running by fulfilling QoS and QoE parameters. In thecase of mobility it is difficult to direct client to a specificinstance of service. We can connect client to the serviceinstance based on their present location and networkconditions, but if client move to another location withdifferent network area then it is difficult to get this. Ifthe user moves far away from the cloud then it createscongestion on network so it impacts on the QoS of allservices on the network. To solve this problem we couldconnect to the client at different instance of service eachtime the QoS parameter degrades, at that time notexpected to create multiple clouds by cloud providers.Single cloud providers may not own multiple clouds at different physical location so it is possiblethat many cloud providers have their cloud far apartor down to regional scale within a country. So we ableto address the issue of service population across thedifferent boundaries of cloud providers. It introduces aconcept where service providers will register their servicesglobally and not bound to specific cloud providers.Services which are globally registered and not boundwith specific cloud providers will free to populate or migrate to different cloud depending on QoS and source of service request parameters. This will only possiblewhen cloud providers open their boundaries, so servicescan move in and out of their cloud. It will changethe model of service providers. Service providers willregister their services with service level agreement whichdefines the expected QoS parameters. Cloud providers provide services with best QoS so that it will populatetheir service and it gives income for them. It is notpossible to any big cloud to take all the services due tothe network congestion problem. So the services maypopulate from bigger cloud to smaller cloud to maintainnetwork congestion free and minimize the distance ofitself from client. After populating services from onecloud to another the receiving cloud can also rejectthe populating service, if it is already under the heavyload. This population of service process is completelytransparent to the user. To achieve all those thingsthere is the need of new service delivery framework andit should be QoS aware and support service population.At the time of migration of any service from one cloudthere may be the chance that another user is accessingthe same service so after migration of service fromcurrent cloud leads to starvation of second client. Soto solve this problem we add separate resource pool toeach cloud which is used to keep references or object ofall populated and non-populated services.Another client can access the populating service withoutany interruption.

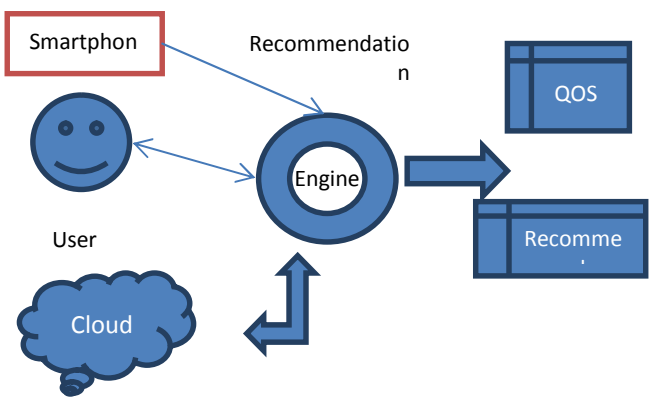

Figure 1: System Model

Above figure shows a system architecture smartphonesand users are the clients who accessed the servicesof cloud. Those are mobile clients so if they move fromone location to another then there is the need to populate the services to another location. So the engine givesthe recommendations depending on the QoS parameters.The another cloud decides whether to +

A. MATHEMATICAL MODEL

We apply set theory to our project. The aim of project is to perform service migration to improve QoS&QoE of a service. Let there are three sets one is Cloud, one is service population and one is QoS . Cloud is union of QoS and population, so we will consider some QoSrequirements and some populating services from set population which are corresponding to each other. We will merge these sets by intersecting them as shown in following fig. Hence we get the solution to our project, by populating some services from one cloud to another with satisfying QoS parameter we can manage the traffic & removes the ambiguity.

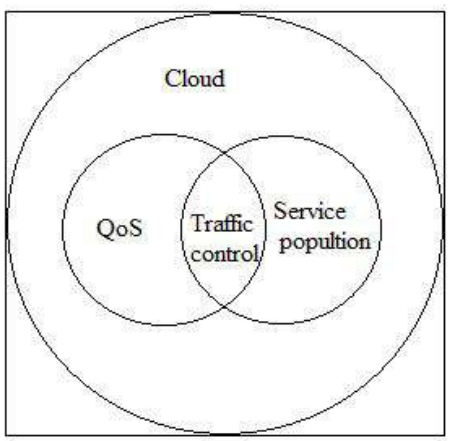

Figure 2: Venn diagram

4. Implementation

The service populating model needs a concept of anopen cloud. The existing closed cloud only runs services controlled by its owner. Open cloud allows services fromthird party providers to populate it. The open cloud islike resource pool so anyone can use these resources torun their services and anyone can provide such resourcepool and accept services from other providers to run onit. So the new framework comes in model. This proposed Framework consists of six layers.

A. Service management layer

It is used to check how services are registered in acloud. Billing information between resources and service providers is processed. It is considered as part of applicationlayer in OSI because it defines the applications andhow they use resources. When service providers wantto publish service they have to define security QoS parameters.It is the requirement to run the service. So todo that each service must have a list of parameters thismust agree with parameters defined by cloud. It is alsoused to migrate the service to find proper clouds

that canaccept the service. At that time if service needs an extraresource, it can be given as per that service providerswill billed.

B. Service Subscription Layer (SSL)
It is used to perform the subscription of clients to the servicethe information which handle the subscription, likeuser IDs, list of services subscribe by individual client.Subscriber is clients who request a service and he willbe charged for subscription. It is used to keep track ofnumber of from which location accessing a service.

C. Service Delivery Layer (SDL)
It delivers services to specific clients. It is responsible for publishing a service from one cloud to another cloud.Finding the appropriate cloud as per the necessary requirements is done and then service is populating to thiscloud.

D. Service Migration Layer (SMiL)
The migration of services between clouds is the responsibility
ofSMiL . To populate a service we have to firstsure that the target cloud can accept the service. So thedecision of whether to move or not to move a serviceis done at SDL. Using that decision SMiL instruct thecloud about which resources need to be allocated.

E. Service connection layer
It handles the client mobility issue and also checks theconnection between client and services.

F. Service network abstraction layer
It provides the abstraction property to simplify the migrationprocess. It acts as interface between service deliveryframework and new technology.

Algorithm:

1. Create and start node.
2. Start QoS manager which checks the QoS of various services.
3. Then next step is user authentication which is used to authenticate the users.
4. Authenticated user is connected to the service.
5. Suppose user access video, video streaming is going on.
6. At the time of streaming system tracks the QoS with the help of QoS manager.
7. QoS manager gives some recommendations those are track by system.
8. On the basis of recommendation system takes migration decision.
9. Service is migrated to another cloud or keeps as it is.
10. If service is migrated to another cloud system will again check the QoS.

5. Result and Discussion

This system is used to migrate the services from one cloud to another as user moves from one geographical area to another. This reduces the congestion on network; also it decreases the load on network. Cloud providers can share the resources which increases the efficiency of cloud services.

6. Conclusion

This paper gives the solution on challenges presented byuser mobility. Previous service delivery model is inefficientto provide future requirements of mobile user. Thecloud technology with proposed model can bring the solutionto proper management of network resources. Thispaper also introduced a technique which reduces the congestionon network, which is generated by streaming video andaudio.

References

[1] Fragkiskos Sardis, GlenfordMapp, Jonathan Loo"On the Investigation of Cloud Based Mobile Media Environment with Service Populating QoS Aware Mechanisms" IEEE trasaction on multimedia, vol.15.
[2] Apple,2012.iCloudFeb15,2012.[Online] Available:http://www.apple.com/icloud.
[3] J.Sonnek and A.Chandra, Virtualputty :Reshaping the physical footprint of virtual machines, in Proc .Workshop on Hot Topics in Cloud Computing (Hot-Cloud09), San Diego, CA, USA, Jun. 2009.
[4] J. Sonnek, J. Greensky, R. Reutiman, and A. Chandra,Starling: Minimizing communication overheadin virtualized computing platforms using decentralizedAfnity-aware migration, in Proc. 39th Int. Conf.on Parallel Processing (ICPP10), San Diego, CA,USA, Sep. 2010.
[5] C. A. Waldspurger, Memory resource management inVMWare ESX server, in Proc. OSDI, 2002.
[6] T.Wood, G. Tarasuk-Levin, P. Shenoy, P. Desnoyers,E. Cecchet, and M. Corner, Memory buddies:Exploiting page sharing for smart colocation in virtualizeddata centers, in 3Proc. 5th ACM Int. Conf.
[7] Virtual Execution Environments, 2009.
[8] W. Zhu, C. Luo, J. Wang, and S. Li, Multimediacloud computing, IEEE Signal Process. Mag., vol.28, no. 3, pp. 5969, May 2011.
[9] J. Postel and J. Reynolds, ISI, RFC 948, A Standard for the Transmission of IP Datagrams Over IEEE 802 Networks, IETF, 1988.
[10] H.Inamura, G Montengero, R Ludwig, A.Gurtov, andF.Khazov, RFC 3481, TCP over Second (2.5 G) andThird (3 G) Generation Wireless Networks, IETF,2003.
[11] Amazon, 2012, EC2, Feb. 28, 2012. [Online]. Available:http://aws. ama- zon.com/ec2/. Microsoft, 2011CloudComputing, Feb.28, 2012.
[12] [Online].Available: http://www.microsoft.com/enus/cloud/default.aspx?fbid
[13] D.Gupta,S.LeeM.Vrable, S.Savage, A.C.Snoeren,G.Varghese, G.M.Voelker,andA.Vahdat ,Dierenceengine: Harnessing memory redundancy invirtual machines, in Proc. OSDI, 2008.
[14] T. Brisko, RFC 1794, DNS Support for Load Balancing,IETF, 1995.
[15] D. N. Thakker, Prefetching and clustering techniquesfor network based storage, Ph.D. dissertation,Sch. Eng. Inf. Sci., Middlesex Univ., London, U.K.,2010.
[16] Microsoft 2011, cloud computing, Feb.28;2012. [online].Available:http://www.mocrosoft,com/en-us/cloud/default.aspx?fbid=uzSXFYwh_d4.
[17] ETSI, 2011, Mobile Technologies GSM, Feb.15,2012.[online].Available:http://www.etsi.org/website/Technologies/gsm.aspx.

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Front End and Back End Database Protection in Multitier Web Application

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Abstract. Web applications are known common for different organization due to their use of accessing information and operation without knowing time restriction and geographical restriction. Now a day, for a better performance web application are made or built in multi-tier architecture. Generally there are different tier available like data tier, web tier and client tier. The web browser contains in client tier while web server and web resource contain in web tier architecture. Data base contains in data tier. Currently there exist Intrusion Detection System (IDS) only for either web server or database server. There is not possible to provide end to end security to entire web server and database server simultaneously. In current paper we implement the mechanism which provides protection for database server as well as web server in multitier application by using java in front end and SQL server in back end side.

Keywords: Pattern Mapping, container architecture, pattern mapping, container ID.

1. Introduction

1.1Overview.

Now a day's many domains like banking, traveling and social networking which are not come to existence without use of web services. These web services mainly use two types of logic front end web server (eg.http server) and back end server like database server or file server. These web services always targeted by attackers as popularity of these web services increased rapidly in personal and co-operate work. [1] Currently available Intrusion Detection System (IDS) generally test the network packet separately either for web server or either for database system but not both. There is very less analysis has been done for how to protect the multi-tier web architecture. Back end database server in multi-tier architecture is protected by firewall while web server accessing remotely in internet. Therefore back end system is protected from direct remote attack but it is not protected by that web request when it is susceptible and used for means to exploit back end. For monitoring of network infrastructure intrusion detection system is mainly used [2].

1.2 About Multitier Web Application.

In classic three tier architecture model we can't say about which transaction request is corresponds to which client request since communication in between database server and web server is not known [1][18].

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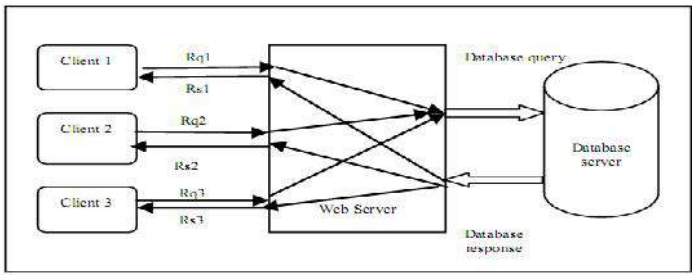

Fig 1: Classical Architecture of Three Tier System

1.3 Case Study on Type of Attacks.

1.3.1. Privilege Escalation Attack [1] [7].
Consider that a website which is used by both type of users i.e. regular user and administrator user. Now regular user will trigger web request to web server with regular or normal user level request, while administrator will trigger admin level request to web server. Let's consider any opponent or attacker log on as normal user on web server and modified his detail and try to fetch the administrator data by triggering admin level queries. In this case web server intrusion detection system or database intrusion detection system will not able to identify such kind of attack because both queries are allowable. But this kind of attack can easily detect by our mapping model as database query does not match any corresponding request.

1.3.2. Injection Attack.
This kind of attack is very intellectual type of attack. Have opponent or attacker only use existing expose vulnerabilities in web server. Here the data or content of string which contains some type of goal and request the web server for controlling goal to attack on database server. This kind of attack changes the SQL query structure.

1.3.3 Hijack Future Session Attack.
This is an attack which is generally take place at the web server side. Opponent or attacker first take the control over the server and then hijack the all allowable user session for attacking purpose. This can also be described as man in the middle attack because attacker can be listening sent spoofed replied or other user request can be dropped. DOS (denial of services) or replay attack is also come in this category. Figure shows that if web server gets hijacked then the web server does not generate the any database query for normal user request. In classical three tier model web server intrusion detection system or database detection system cannot detect such kind of attack. Our container architecture model can be detecting such kind of attack because each user request is divided into different individual container and attacker or opponent cannot see other user container [1].

1.3.4 Direct Database Attack.
In this case of attack, attacker avoid the all type of firewall or web server and connect direct to back end database. Opponent can be submitting his queries directly without any web request send through web server. Since there is no any web request seen, web server intrusion detection system cannot detect such kind of attack. Same time at the database side intrusion detection system detect the queries which is from the set of permissible queries submitted by attacker. So database side IDS also not give any alert about attack.

This kind of attack can be identified by our model since we not found any matching request for corresponding database queries figure shows how attacker can submit the database query by avoiding the web server.

2. Literature Survey

To solve the problem processing in very high speed vendors find solution that install host based IDS , so that

data can be analyses in real time. Such type of IDS are tip wrapper, tripwire and free tool snort [8]. Snort is lightweight intrusion detection system with different platform. This system can be used in network based as well as host based but when it was released in 22 December 1998, it was only Unix based and limited capability. In June 2000 Michael Davis make it for windows for first time. An intrusion detection system [7] uses temporary information for detecting attack or intrusion, but in our double ground system it is not related to time basis since these time basis event, If happen concurrently then it will feel correlated event thought they are separate. Double guard uses contained ID each event or request. There is no problem whether they happen concurrently or separately. Database should be protected with higher level protection because it contains very valuable information. Therefore so many researches has take place a database like [9] [10] [11]. This intrusion detection system like green SQL [4] act as reverse proxy to connection for database. Web application first connected to the database firewall, not directly connects to database server. Then web query is tagged for intrusion system explained in [12] compose for web intrusion detection system for receive more accurate result or detection. But in this case also we found some normal attack which are look like normal traffic but cannot detect in both web and database intrusion detection system. If attack is correlated then also no alert is generated by them. Previous some intrusion detection system require the source code or executable [13][14][15] or some requires[16][17] track information flow to detect intrusion. But in our approach there is container based web server architecture in which each request is separated in different session for detection of intrusion in information flow from web server to database server. This approach also is not requires to analyze the source code of application logic.

3. System Container Architecture

Container architecture is very useful for detecting intrusion in both side i.e. web server side and database server side. Container architecture is more useful to detect both category and intrusion like behavioral intrusion detection system and signature based intrusion system. We can also call it as hybrid category of intrusion detection system.

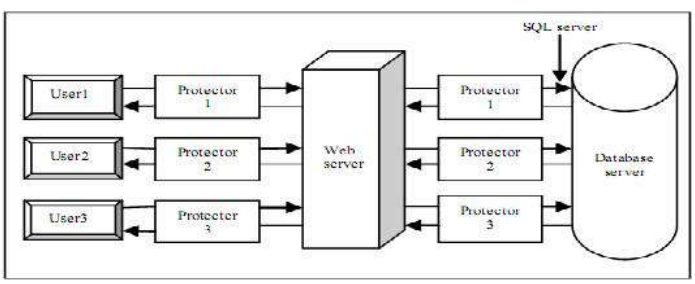

Fig 2: Container Architecture

In this architecture we creates normality model which divide each user request to different session which include web request(http request) and database query(SQL query). For this purpose a lightweight virtualization technique is used for assigning each user's session in new container. We are assigning container identification number to each user request with its subsequent database queries.

3.1 Pattern Mapping Approach in Container [1].

3.1.1 Deterministic Mapping.

This is perfect match pattern. If web request Rm and SQL queries set Qn and then Rm->Qn ($Qn \neq \phi$)or ($Rm \neq \phi$) for testing phase with Rm if Qn is absent then it will be indicate possible intrusion. (See Figure. 3)

3.1.2 Empty Query Set.

In some cases web request is present but it not causes to generate any new query e.g. If any web request which want to fetch an image GIF file from same server, then mapping relation is not made. In that case

(Rm->ϕ) we can take this type of web request in EQS (empty query set). (See Figure. 3)

3.1.3 No Matched Request.
Some time web server itself submit some queries periodically to database server for some type of scheduled task like taking of backup. Here no any web request is generated by any user or client. Such types of queries are kept in NMR (no match request). (See Figure. 3)

3.1.4 Non Deterministic Mapping.
In some cases web request may be the cause to produce different SQL query set. Have Rm->Qi

(Qi={Qn,Qp,Qq…..}). This is possible in blogs for forum site i.e. dynamic web site. (See Figure. 3)

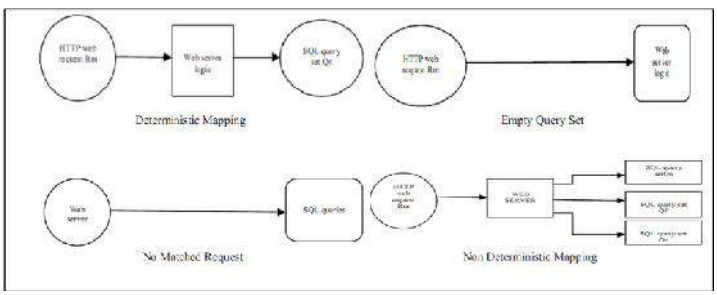

Fig 3: Mapping Pattern

3.2 Work Breakdown Structure.
We are implementing the following part of our implementation.

1) Control on user
2) Monitoring on user session
3) Monitoring on query
4) Matching web server query with database queries

Showing attack (mismatch web server and database queries).

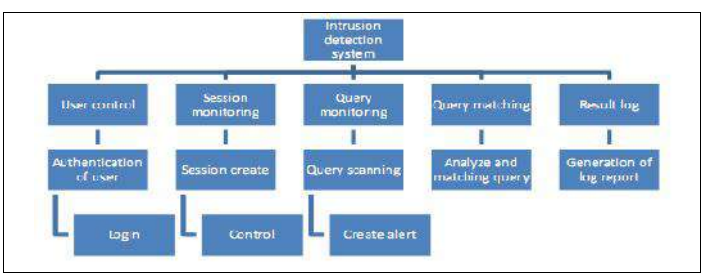

Fig 4: Work Break down Structure

1) Control on user:

Input: - user will do registration and get login name and password.
Output: - user logged or login unsuccessful. Algorithm step:-

1) new user will do registration
2) User get login name with password.
3) User will enter into system

4) User will start his session.

5) After completion of work user will log out from system This part of implementation describes the how security will manage the entire system so that only authorized user will get access after entering login name and password. When he will login successfully alert message will show that he login successfully or next page is opened automatically.

2) Monitoring on user session:-

Input: - web server query (http query) and database query (SQL query).
Output: - give session identification no to each web request and query.

Algorithm Step:

1) 1For every different session traffic Tdo
2) Get different HTTP request 'r' and database query 'q' in this session.
3) for each various 'r' do.
4) If 'r' is a file request which is static files then.
5) Add 'r' in the empty query set (EQS)
6) Else
7) If 'r' absent in set required query set (REQ) then
8) Add 'r' in the set REQ
9) Assign the session ID 'i' into set ARrand put 'r' as key
10) for each different 'q' do
11) If 'q' is not SQL then
12) Add 'q' into SQL
13) Assign the session ID 'i' into set AQq with 'q' as key.

This part of algorithm explain the unique identification no is assigned to each HTTP request and corresponding SQL query. If that HTTP query for any data file, which is static then that mean that requested contain is present in web server. Then 'r' is added to EQS (empty Query set). There is no ID given for such query. If'r' is not available in REQ that means that query new arrived and added in REQ (request query set) ARr. Likewise for each SQL query if q is not available in SQL query then it added in SQL set AQq.

3) Monitoring on query (query processing watching):
Input: -Front end query (HTTP query) 'r' and back end query (SQL query) 'q'.

Output: - insertion of queries into query s

Algorithm Step:

1) For every different session traffic Tdo
2) Get separate front end(HTTP) request 'r' and separate databasequery 'q' in that container
3) to every 'r' do
4) If 'r' is a file request which is static files then
5) Else.
6) Assign 'r'to setempty query set (EQS)
7) If 'r' absent in Required Query Set (REQ) then
8) Assign 'r' in the Required Query Set (REQ)
9) for every separate 'q' do
10) If 'q' is absent in set SQL then
11) Add 'q' into SQL

It is algorithm for adding various requests into different proper set of query. If any HTTP request is for static file then it means that requested contain should be available web server itself.
Then 'r' should be added in the empty query set (EQS). If 'r' is not in REQ means that query is newly arrive

into system then
'r' is added into REQ.
Same likewise 'q' is not in SQL query set then it is added in

SQL.

4) Query Matching:

Input: - set ARr and AQq and if't' is cordiality.
Output: - HTTP query comparing torelated SQL query.

Algorithm Step:

1) To every separate front end HTTP request 'r' in REQ do
2) To eachdatabase query 'q' in SQL do
3) Compare set of ARr with set of AQq
4) If ARris equal toAQq with set ofAQq
5) If when cardinality (ARr>t)andARr = AQqthen
6) If getting a deterministic mapping 'r' to 'q'
7) Assign 'q' to set MSr or 'r' 8. Mark 'q' in SQLset
8) Else
9) Need more training session
10) Return false
11) for every database query 'q' in SQL do
12) If 'q' is not marked then
13) Add 'q' in the No Matched Request (NMR) set.
14) For every front end HTTP request in REQ do
15) If 'r' has non deterministic mapping model then
16) put 'r' in the set Empty Query Set (EQS)
17) Return True

User will request to web server in HTTP request then SQL query will produce due to it. This algorithm matches the HTTP query with corresponding SQL query. Output of session monitoring and query monitoring is used here. HTTP query its ID is stored in set of AQq set and SQL query with ID is placed in AQq set. Now if both match to each other and cardinality of ARr is more than 1 then deterministic mapping relation will be found 'q' is placed in matched query set. After if any query from set of q is not marked then that q is placed in NMR (no match request). Likewise for each HTTP request 'r' has no deterministic matching found then placed that

'r' to EQS (empty query set).

5) Showing Attack Log:
Input: - HTTP request 'r' and SQL query 'q'.

Output: - showing attack.

Algorithm Step:

1. If the rule for tends to deterministic mapping r -> Q ($P \neq \phi$) we will test whether Q is a subset of query, if it is subset of query then it is valid, and we will mark queries in Q. otherwise we will considered something going to be wrong and session will considered as suspicious
2. If rules is empty query set r-> ϕ, then request should be normal but not do any database queries and no any attack will be reported.
3. For remaining unmarked queries we have to check that whether these database queries are present in

No Match Request (NMR) pattern.R->Q (r=ϕ) (Q≠ϕ)

4. Now remanning web request database queries are abnormal and should be mark as suspicious.

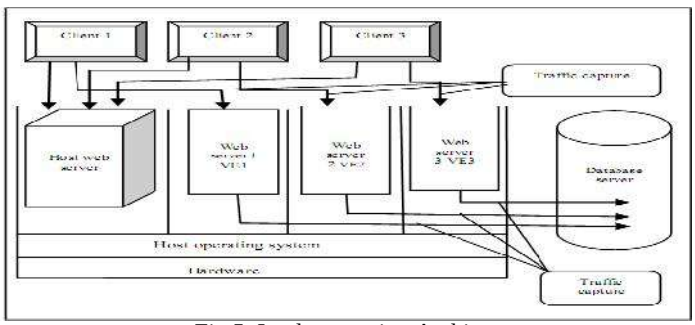

Fig 5: Implementation Architecture

4. Experimental Results

The main goal of this paper is to compare and prevent the intrusion in multitier web application of the user session, in front end (http web request) and back end database (SQL query) One of the important thing in the security is the to detect attack while web server is continuously attacked by the attacker. Here we test the approach by continuously attacking the web server. For this purpose we have consider pool of 10 attacks are performed by each user. Five user continuously attack the web server and each attack 10 times on the web server i.e. In each pool among the four attack, each attack is performed on ten(10) times . We can capture these attacks in following number of times.

4.1 Data sets.

User ID	Privilege Escalation Attack	SQL Injection Attack	Hijack Future Session Attack	Direct Database Attack
1	6	7	8	7
2	9	7	7	8
3	8	8	9	7
4	7	8	5	6
5	7	6	7	6

Fig 6.User to Data Relation

4.2 Results.

The algorithms are implemented in Java. For test we used Pentium IV (CPU 2.50 GHZ and 4 GB RAM) and oracle database by considering the maximum of 10 iterations and 05 independent test runs.

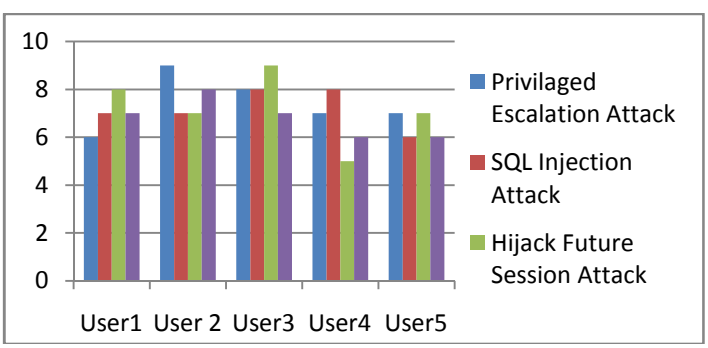

Fig 7: User Vs Attack

5. Future Scope

To make system more efficient and effective, some modification in the system is possible. System can be installed on wide range of operating system and platform. For converting the English sentences into SQL queries we can apply Natural Language Processing (NLP) in query processing.

6. Conclusion

Our model is for intrusion detection system which builds a normality model for three- tier web application. this approach form container based architecture where it will accept multiple input and produced alert if applied input is suspicious .there is lightweight virtualization technique is used to assigning the session ID for separate container. This separate container is nothing but an isolated virtual computing environment for each web request and web query. With the help of this environment we can detect the attack such as Privilege Escalation Attack, Direct Database Attack, Hijack Future Session Attack and SQL Injection Attack. We can also generate log report of these attacks and block such type of virtual environment and session ID.

References

[1] MexiengLe,AngelosStavrou,brentByungHoonKang,"Double guard detecting Intrusions In Multitier Web Applications",IEEE Transaction on dependable and secure computing,vol,9,no.4,july/august 2012.

[2] F. Valeur, G. Vigna, C. Kru¨ gel, and R.A. Kemmerer, "A Comprehensive Approach to Intrusion Detection Alert Correlation," IEEE Trans. Dependable and Secure Computing, vol. 1, no. 3, pp. 146-169, July-Sept. 2004.

[3] Shyam A.Gade,Prof.M.B.Vaidya,"Front End and Back End Database Protection From Intruders in Distributed Web Application".,IJETAE,vol 3,2013.

[4] Gerf,http:/www.hpl.hp.com/research/linux/httperf/2011.

[5] Joomlacms, http://www.joomla.org/, 2011.

[6] A. Seleznyov and S. Puuronen, "Anomaly Intrusion DetectionSystems: Handling Temporal Relations between Events," Proc.Int'lSymp. Recent Advances in Intrusion Detection (RAID '99), 1999.

[7] M. Roesch, "Snort, Intrusion Detection System," http://www.snort.org, 2011.

[8] S.Y. Lee, W.L. Low, and P.Y. Wong, "Learning Fingerprints for a Database Intrusion Detection System," ESORICS: Proc. European Symp. Research in Computer Security, 2002.

[9] S.Y. Lee, W.L. Low, and P.Y. Wong, "Learning Fingerprints for a Database Intrusion Detection System," ESORICS: Proc. European Symp. Research in Computer Security, 2002.

[10] Y. Hu and B. Panda, "A Data Mining Approach for DatabaseIntrusion Detection," Proc. ACM Symp. Applied Computing (SAC),H. Haddad, A. Omicini, R.L.Wainwright, and L.M. Liebrock, eds.,2004.

[11] A. Srivastava, S. Sural, and A.K. Majumdar, "Database Intrusion Detection Using Weighted Sequence Mining," J. Computers, vol. 1,no. 4, pp. 8-17, 2006.

[12] G. Vigna, F. Valeur, D. Balzarotti,W.K. Robertson, C. Kruegel, and E.

[13] Kirda, "Reducing Errors in the Anomaly-Based Detection ofWeb-Based Attacks through the Combined Analysis of Web Requests and SQL Queries," J. Computer Security, vol. 17, no. 3, pp. 305-329, 2009.

[14] D. Wagner and D. Dean, "Intrusion Detection via Static Analysis,"Proc. Symp. Security and Privacy (SSP '01), May 2001.

[15] M. Christodorescu and S. Jha, "Static Analysis of Executables to Detect Malicious Patterns," Proc. Conf. USENIX Security Symp.,2003.

[16] V. Felmetsger, L. Cavedon, C. Kruegel, and G. Vigna, "Toward Automated

[17] Detection of Logic Vulnerabilities in Web Applica-tions," Proc. USENIX Security Symp., 2010.

[18] R. Sekar, "An Efficient Black-Box Technique for Defeating Web Application Attacks," Proc. Network and Distributed System Security Symp.(NDSS),2009

[19] G.E. Suh, J.W. Lee, D. Zhang, and S. Devadas, "Secure Program Execution via Dynamic Information Flow Tracking," ACM SIGPLAN Notices, vol. 39,no.11,pp.85-96,Nov.2004.

[20] Manoj E.Patil,RakeshD.More,"Survey of Intrusion Detection System in Multi-tier Web Application".,IJETAE,vol.2,2012.

Wireless sensor network for physician to monitor effectively health parameter of a patient

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***Abstract*— Now days due to increasing age population, health cost, and mobile life. Thus present a type of sensor network architecture for Health Care Monitoring. This network named Health Care Monitoring Net. This network isolated wireless sensor networks (WSNs) into internet. Node of each WSN composed of health care sensors and RF transreceiver which send data to back end sever. Sensors can choose in the range of WSNs, while RF transreceiver is implemented as a coordinator which manages WSN other than forwards data. The sensing data of each patient are stored in back-end server with each having its own ID. The data analysis, database inquiry, data manning and the system management are processed on the web page of server. A test bed is constructed with wearable sensor and RF transmitter. This paper provides less cost, continuous health monitoring to patients and its relative. We implement a system for wireless health monitoring by using Wireless Sensor Network (WSN).It is useful to associate relative of patient and doctors for continuous health monitoring of patient. In this paper we review the objectives, status, advantages and design of current health monitoring. This paper provides new ideas for low-cost, implementation of WSNs for a good quality of medical health care monitoring.**

Keywords— Health Care; Wireless Sensor Network; GSM

I. INTRODUCTION

A Health Care Monitoring network named HCMNet for pervasive, adaptive healthcare in communities where residents or patients have diverse health care demands. HCMNet is a distributed system which combines mobile ad-hoc WSNs with conventional internet, and integrates embedded devices, back-end server, online analysis, and user interfaces. Service oriented Architecture (SOA) Technology is utilized to program the software that administrates the distributed system. The software service modules and their integration in SOA are introduced in another paper. This paper focuses on the design and implementation of HCMNet. HCMNet have several benefits: flexible monitoring, mobility, cost effective and improving services quality.[2] The advantages of a WSN are numerous for smart health- care, as it provides the following important properties:

Portability Unobtrusiveness. WSN operate with minimal patient input and send data through wireless communication to sever. They may be placed on the body of patient. WSN are not noticeable which helps to patient acceptance and minimizes errors with WSN.

Easy to implement and scalability. WSN can be implementing with less cost and complexity compared to wired networks. Current health monitoring structure implemented with a WSN network instead of wired installations which is expensive and complex. WSN are placed on patient body and turned on, calibrating automatically and self-organizing.

Real-time and accurate measurement and continuous. Physical data of patient can be monitor continuously & allowing real-time response for emergency or healthcare workers. The data collected from a patient is stored RAM of microcontroller and send to sever and which help for maintain patient history. WSN will monitor data continuously sensors still on though power management and on demand activation.

Reconfiguration and self-organization. WSN are flexible installation adding and removing sensors easily done in the network. Each WSN can use for another patient with only removing of sensor from network. All sensors in network are self-organize to form routing paths.

II. ARCHITECTURE OF HEALTH MONITORING

Architecture of health monitoring shown in fig 1 which consist of two different node with sensing parameter such as BP & heart rate monitor, ECG, temperature, SPO2 sensor

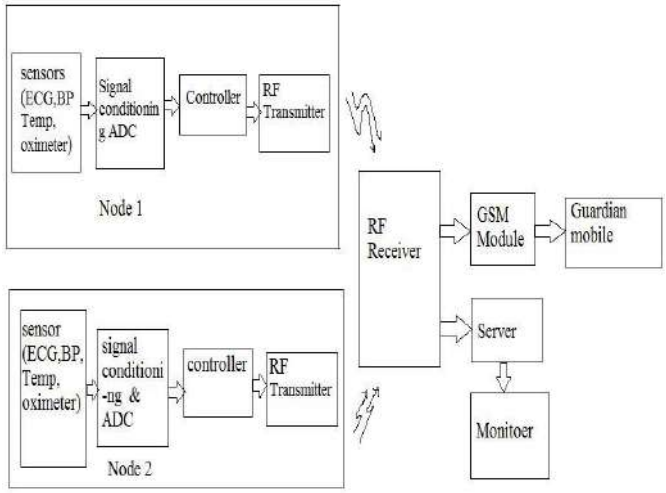

Fig1. Architecture of health monitoring using WSN

Wireless sensor network

ECG Sensor: ECG sensor used to monitor appearance of waves and sprockets, duration of waves, sprockets, segments and intervals, amplitude of waves and sprockets, Rhythm of heart cycles, Un/presence of waves or sprockets View plot or process ECG signals from output of sensor.[6]Two thumbs hold on the board and start

getting output in pulse output. The optocupler used to isolate ECG signal from sensor get clean ECG signal.[5]

SPO2 Sensor: SPO2 sensor used to monitor Pulse Oximeter, Heart Rate Meter, Plethysmograph used for such parameter measurement.LED and LDR combination is used for obtained the Heart Beat signal. Blood flow though hands interrupts the Light reaching the LDR and this signal is converted into digital by ACD which then read by microcontroller these RF signal is transmitted by RF transmitter.[5]

BP sensor**:** BP sensor used to measure the blood pressure which is pressure on wall of arteries when heart contract and relax. The systolic is high blood pressure on wall of arteries when heart is contract and diastolic is low blood pressure when heart is relax. [5]Use the correct cuff size for accurate reading. The Wireless Blood Pressure Monitor includes a

Medium cuff. If cuff size is too large ***G*** then output is lower than the correct blood pressure and if cuff size is too small then output is higher than the correct blood pressure**.**

Temperature sensor: **I**n critical condition of patient to measure temperature of patient temperature sensor required [5]

Signal conditioning & ADC: All sensor collect data from patient body data is in analog form and very small in strength so that there is need to signal conditioning block that used amplifier and filter that remove the noise added in signal.[5] These signal converted into digital form by high precision analog to digital converter which has minimum 8 simultaneous channel. We cannot used the ADC in microcontrollers because all signal from patient body area very small strength thus high precisions is required.[5]

Microcontroller: The data from ADC is sent to microcontroller for process. The amplified and conditioned Heart Rate signal is fed to input port of the microcontroller. The microcontroller reads the BP, ECG, heart rate and temperature sample stored in the RAM of the through the ADC. It is then converted and stored in the memory as two 8-bit unsigned integers (0-255).[5]The microcontroller constructs the SMS messages and packs the data samples after completion of signals acquisition, then communicates with the mobile phone using at-commands on its GSM modem port to send the message(s).

CC2500 RF Module

CC2500 RF Module is a transreceiver module which provides RF communication at 2.4 GHz. CC2500 RF Module used to transmit and receive data at 9600 baud rates. This module not required extra hardware and no extra coding to. This module provides simply direct replacement for serial communication. The mode of operation of this module is Half Duplex mode. The low noise amplifier (LNA) used to amplify received RF signal and down-converted to the intermediate frequency. I/Q signals are converted into digital by analog to digital converter. The transmitter is operated on principle synthesis of the RF frequency.

sever:

The back-end server is programmed as a web server which delivers a webpage when requested by a web browser. Both the data collected by sensors and the software of the system administration, data processing and analyzing, are stored on the server. Administrator can manage the whole system by accessing the web page on server. Back-end users, such as doctors, health care advisors or relatives of patients can also inquire the health care monitoring data on the web page [3]

Back End Computer and human interface

Two sensor nodes connected to the backend computer for continuously data mining and data archiving of patient. Patient's relatives and doctors are interface with the network using PCs. The PCs are used for data management and configuration depending on health monitoring for patient. There should be minimum interactions supported with body sensors and control unit. These health monitoring may provide memory for patient history, alerts, and emergency communication channel. Real-time interfaces provided by PDAs and PCs. Backend computer useful for doctor understood condition of patient in emergency

E. GSM module (SIM900)

The SIM900 is a complete Quad-band GSM/GPRS solution in a SM module which can be embedded in the customer applications. SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor with low power consumption. SIM900 can fit in small space requirements such as M2M application due to its slim and compact demand of design. GSM module is designed by SIMCom use for global market. SIM900 is quad-band GSM/GPRS module that operates on frequency GSM 850MHz. SIM900 small size and meet all requirements of user's.

III. CONCLUSION

This paper kind of network architecture named Health monitoring network which integrates WSNs into internet. Each WSN is organized as a mobile ad-hoc network with one allocated mesh router connecting with internet. The healthcare data collected by sensor node are all transmitted to mesh router, then forwarded to back-end web server through internet. The whole network administration including working mode setting for sensor node, sensing data managing and analyzing are processed on back-end server. A test bed is constructed to test the performance of Health Care Monitoring Net, where sensor node measures blood pressure, ECG, heart rate, temperature parameter of a patient. In project the measuring cycle can be flexibly set on the various requirements of patients

REFERENCES

D. Mahesh Kumar Department of Electronics, PSG College of Arts and Science, Coimbatore - 641014. dmaheshkumar@rediffmail.com Int. J.

Advanced Networking and Applications Healthcare Monitoring System Using Wireless Sensor Network ,1497 Volume:04 Issue:01 Pages:1497-1500 (2012) ISSN : 0975-0290

G. Virone, A. Wood, L. Selavo, Q. Cao, L. Fang, T. Doan, Z. He, R. Stoleru, S. Lin, and J.A. StankovicDepartment of Computer Science, University of Virginia , An Advanced Wireless Sensor Network for Health Monitoring (2011)

Fangling PU1 School of Electronic Information Wuhan University Wuhan, P.R.China Chao LI2, Tingting GAO 3, Jiao PAN 4, Jiaping LI 5 School of Electronic Information Wuhan University Wuhan ,Design

Alexandros Pantelopoulos and Nikolaos G. Bourbakis, Fellow, IEEE A Survey on Wearable Sensor-Based Systems for Health Monitoring and Prognosis(2010)

IEEE TRANSACTIONS on Systems, Man, And Cybernetics—Part C: Applications And Reviews, VOL. 40, NO. 1, JANUARY 2010

singh1, Sr. Asst. Prof. Ravi Mishra2 1(ME II Year VLSI Design, Department Of EC, SSCET, Gunwani, Bhilai Nagar (C.G), India) 2(Sr. Asst. Prof. Department Of EEE, SSCET, Gunwani, Bhilai Nagar (C.G), India) Microcontroller Based Wireless Temperature And Heart Beat Read-Out Nisha (2008)

Ćirković, Predrag; Aleksić, Anđa Processing of Medical Signals (ECG) in Wireless Sensor Networks (2007)

Jochen Fingberg, Marit Hansen et al., ―Integrating Data Custodians in eHealth Grids – Security and Privacy Aspects‖, NEC Lab Report,

2006.

Aleksandar Milenkovic´ *, Chris Otto, Emil Jovanov Electrical and Computer Engineering Department, The University of Alabama in Huntsville, 301 Sparkman Drive, Huntsville, AL 35899, USA Wireless sensor networks for personal health monitoring: Issues and an implementation (2006)

WHO: ―Connecting for health global vision, local insight report for the world summit on the information society‖ (WHO 2005).

T. Hodgson, L. Cai, ―Medical care expenditures for hypertension, its complications, and its comorbidities,‖ Medical Care, vol. 39, no. 6, pp.

599-615, June, 2001.

C. E. Perkins, E. M. Royer, ―Ad-hoc on-demand distance vector routing,‖ Second IEEE Workshop on Mobile Computing System and Applications, 1999, proceedings. WMCSA’99, pp.90-100, Feb. 1999.

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Light Sensor Based Information Transmission System

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Abstract : *Light reach nearly universally so communication can also go along with light freely. Light Fidelity is a branch of wireless communication which is a rising technology. By using visible light as transmission medium, Li-Fi provides wireless communication. I propose using common and cheap fluorescent lamps to transmit information for navigation, because using fluorescent lamps to provide light is so popular, widespread, and cost-effective in existing buildings. In this paper I have described a novel light-sensor-based information transmission system. In a novel manner, fluorescent light is used as the medium to transmit information, which is encoded by using a pulse width modulation technique. The user will receive the information which is encoded in light through a photo detector, after a data stream of information is received and processed, it will be fed into the computer through the serial port for further processing. The proposed system can be used in indoor supervision and navigation applications*.

Keywords - *Arduino Compatible Development Board, Electronic Ballast, Fluorescent Light, Photo receiver, Wearable Computer*.

I. Introduction

Li-Fi basically known as light fidelity is an outcome of twenty first century. The basic principle behind this technology is that the data can be transmitted through fluorescent light whose intensity varies even faster than the human eye. The advantageous thing is the wireless communication which decreases the cost enormously. Li Fi offers a far more secure form of data transfer because it can only be intercepted by those within a line of sight of the light source. Visible Light Communications is a very generic term that suggests any form of data communications via visible, primarily white light. Data Transfer in Visible Light Communication the basis of Light Fidelity is on the thought of using light for transmitting the data in place of Radio waves. Although any light source can be used as transmitter but some of them have practical priorities based on their operational properties. Fluorescent light is a key component in data transfer in this paper, will be equipped with transceivers which will receive as well as transmit the data. As light can be switched on and off much faster than we perceive and this on-off motion can be used to represent binary digits 0s and 1s. Such a sequence of light variation will enable for data. The signal send by transmitter is to be converted into the data. For this reason receivers are to be used. For serving the purpose of receivers to convert the light into electric pulses photodiodes are used. These photodiodes demodulates the received signals into actual data. It could transform wearable computer or laptop. In this paper Free Arduino USB which is a Arduino compatible board is used, which is compatible with all Arduino development tools, softwares, codes etc. It contains everything that is required for programming a microcontroller and omits all extra features to keep it simple and cost effective.

Light fidelity is the upcoming and on growing technology acting as competent for various other developing and already invented technologies. Since light is the most important source for transmission in this technology. This paper based on light fidelity concept. The aim of this paper is to design a highly secure information transmission system based on a light sensor; fluorescent lamp is used as a transmitting device.

II. Block Diagram

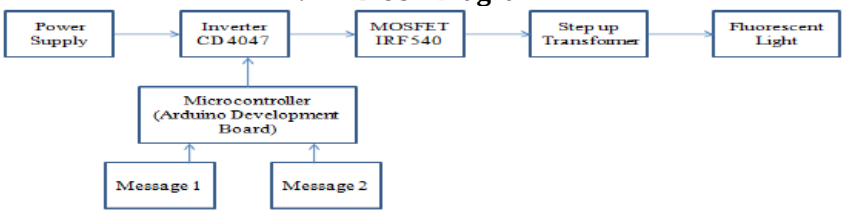

Fig 1. Transmitter

In this section, we will outline the hardware system used for data transmission using fluorescent lamp. The whole system is divided into two parts: the transmitter and the receiver. The transmitter sends out messages encoded by the fluorescent light whose flicking is imperceptible to human vision, while the receiver detects the light using a photo detector. In the transmitter section, information can be encoded into the light through arc frequency variation. Here, I use a fluorescent lamp for our system since, first, it is highly used everywhere like buildings,malls,schools,colleges etc. and, second, there is no need to design a expensive circuit for controlling the arc frequency of the lamp, and by simple modifications on the current widely cheap and available circuit, we can furnish our goal. The lighting of the fluorescent lamp is due to the arc current running through the lamp. When the amplitude and frequency of the arc current is appropriate, the light will light up. Amplitude and frequency are the two key factors for the light output. Therefore, changing the frequency of the arc current may encode all the information into the fluorescent light. If the modulation frequencies are very high then the information will be transmitted without flickering due to the characteristic of human vision. Therefore, we can simply transmit digital data through the light.

2.1Inverter Circuit (using IC CD4047)

In the inverter circuit there are three parts: Oscillator, Integrated Circuit (CD 4047), MOSFET. According to RC variation CD 4047 integrated circuit gives variable input to the MOSFET.MOSFETs operate in push pull configuration.IRF 640 MOSFETs are used in this circuit

2.1.1 Features

- Low power consumption: special CMOS oscillator configuration.
- A stable (free-running) operation.
- True and complemented outputs.
- Only one external R and C required.

2.2 MOSFET (IRF 540)

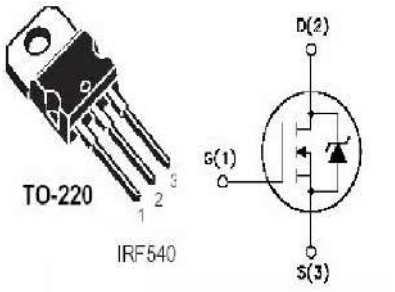

Fig. 2: MOSFET (IRF 540)

2.2.1. Features

- Advanced Process Technology.
- Dynamic dv/dt Rating.
- Fast Switching.
- Fully Avalanche Rated.
- Ease of Paralleling.
- Simple Drive Requirements

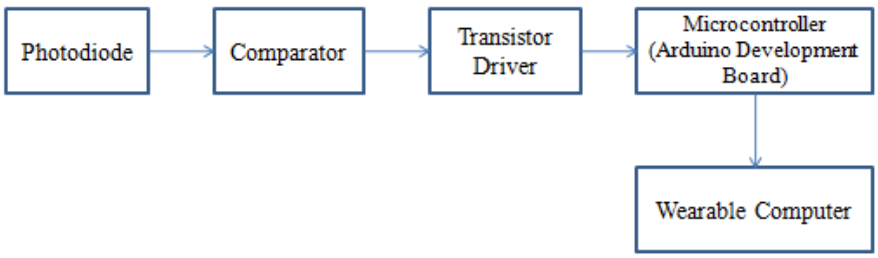

Fig 2: Receiver

The receiver detects the fluorescent light and transforms the signals to the comparator that can be sent to the user's mobile wearable device through microcontroller (Arduino Compatible Development Board). The photo detector will detects light levels and its resistance changes based on the amount of light it picks up. The photo detector detecting the fluorescent light processes the data that are eventually fed into the computer. When light is exposed to bright light, a photo resistor's resistance drops drastically. Voltage divider of a photo resistor and a fixed resistor, in which the voltage divided up among the two components, will change due to ambient lighting. In darkness, the photo resistor will have a very high resistance and more voltage. Is allocated with components with an upper resistance value. So, when this voltage divider is connected to a comparator, the voltage divider will create a very high voltage. When the photo resistor is exposed to bright light, will have a low resistance. So, less voltage will fall across it. So when it is captivated up to a comparator, the circuit of voltage divider will produce a voltage less than the reference voltage. Output of a photo transistor is given to the IC pin number 3 which is a non inverting input and reference voltage is given to the inverting pin number 2.We get the output from the comparator at pin number 6 and it is given to the base of a BC 547 transistor which acts as a inverting switch, output of it is given to the microcontroller (Arduino Compatible Development Board) and get display on the screen

2.3 Arduino Compatible Development Board

Fig 3: Arduino Development Board

Arduino is an open source embedded development stage consisting of an easy development board based on Atmels AVR microcontroller and an easy to use development condition for writing, compiling and uploading codes to the board. Freeduino USB is a Arduino well-suited board, which is compatible with all Arduino development tools, softwares, codes etc. Freeduino USB comes with only the bare essentials present on an Arduino board that is required for getting started. It contains everything which is required for programming a microcontroller and omits all extra features to keep it simple and cost effective. Arduino is an open source development platform, which means all the designs are available for free.

2.3.1 Features Arduino Compatible Development Board

- The board is built on a high quality FR-4(1.6 mm) board with a green solder mask and a clear and legible white legend
- Compatible with all Arduino development tools, hardware, etc. and can be used as a direct cost effective replacement for the official Arduino
- Completely open source, hence easy to understand, work with and modify as per individual requirements
- Can be powered through USB or through an external power input(7 - 15 V DC)
- Power Status LED(Green) along with a general purpose LED connected to Pin 13
- Onboard quartz crystal 16 MHz oscillator circuit
- A right angled reset switch which can be used even when a shield is plugged onto the board

- All IO pins are brought out to female header pins, for easy plugging of wires and prototyping
- Every IO pin has an empty parallel next to each which can be used for easy expansion by soldering in required connectors or wires from external circuits

2.4 Atmels AVR Microcontroller

The AVR is a modified Harvard architecture 8-bit RISC single chip microcontroller which was developed by Atmel. The AVR was one of the first microcontroller families to use on-chip ash Memory for program storage, as opposed to one-time programmable ROM, EPROM, or EEPROM used by other microcontrollers at the time. The AVR is a modified Harvard architecture machine where program and data are stored in separate physical memory systems that appear in different address spaces, but having the ability to read data items from program memory using Special instructions. ATMega8- 8 bit AVR Microcontroller with 8k Bytes In-System Programmable Flash.

2.4.1 Features

- High-performance, Low-power AVR 8-bit Microcontroller.
- Advanced RISC Architecture.
- Nonvolatile Program and Data Memories.
- 8k Bytes of In-System Self-Programmable Flash.
- 512K Bytes EEPROM.
- Programming Lock for Software Security.
- 1K Byte Internal SRAM.
- 3.5-5V for ATmega8.

III. Conclusion

Light Sensor Based Information transmission System is a highly secure information transmission system. This system can be used in aircraft, similarly in medical devices and in hospitals, so it can be easily used in such places where Bluetooth, infrared, Wi-Fi and internet are not allowed. So, it will be most helpful transferring medium for us. The use of a conventional fluorescent light as a data transmission medium also has a cost advantage in eliminating the need to wire large numbers of receiving devices. So, in the data transmission system using a fluorescent lamp, a highly secure coding technique is used that is Manchester coding. Therefore this system is highly secure system. This can be used in military applications, Hospitals, industrial area. Freeduino USB is used in this project which is an Arduino compatible board and is compatible with all Arduino development tools, softwares, codes etc. Freeduino USB can be programmed directly through a USB connection to a PC through the Arduino IDE, which is a simple and easy to use program development environment. It contains everything that is required for programming a microcontroller and omits all extra features to keep it simple and cost effective.

References

[1]. Adrian David Cheok and Li Yue. "a Novel light-sensor-based information transmission system for indoor positioning and navigation". IEEE transactions on instrumentation and measurement, 60(1), january 2011.
[2]. Josef Shwartz Frank Deicke. "li-fi a new paradigm in wireless communication". EFY, 2012.
[3]. V.Roja M.Mounika N.Navyatha, T.M.Prathyusha. “Li-fi (light fidelity)”. International Journal of Scientific and Engineering Research,, 4, 2013.
[4]. Ruchi Garg. "li-fi data on light instead of online". Anveshanam a National Journal of Computer Science and Applications, 1, 2013.

A COMPARATIVE STUDY OF REGENERATIVE CHATTER AND CHATTER FREE ZONE USING SLD

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Abstract- Advanced production technology involves high speed milling, use of newer materials and machines. However, machine tool chatter due to self-excited vibration is always a hidden cause that controls the quality of the surface generated in machining. Occurrence of chatter, not only reduces tool life but causes a poor surface finish. The parametric conditions that provide chatter-free machining can be obtained from the stability lobe diagram.

Key words—chatter, vibration, stability lobe diagram.

I. INTRODUCTION

Advanced manufacturing technology requires high speed machining for achieving higher productivity. When high speed machining is combined with newer 'difficult-to-machine' materials, then there could be difficulties with cutting tool life and hence, the productivity. At the same time, when high speed machining is performed on thinner or slender work surfaces, the deflection of tool and work surfaces would lead to mechanical vibrations due to lack of stiffness. Normally, aerospace structural components are carved out of monolithic block involving huge, in excess of 90% of material removal. Many of the structural elements on these components are very thin in size and have complex to free form shapes.

A significant amount of research has been done by various investigators in these fields to detect, identify, avoid or suppress chatter. Guillem. [1] classified the current methods to ensure stable cutting by stability lobe diagram as out-of-process and in-process also, by system behaviour modification as passive and active changes. In 1907, Taylor stated that chatter is the "most obscure and delicate of all problems facing the machinist". Detection of chatter and thereby creating stability lobe diagram helps to calculate the optimum depths of cut and corresponding spindle speeds both analytically and experimentally [2]. Guillem. [3] performed experiments on inclined plane of workpiece to generate stability lobe diagram, first by operator using the sound emission analysis, second by computer application and finally compared both the results. Songlin Ding.[4] presented online chatter detection system based on analysis of cutting force signature and transformed it into frequency domain by applying Fast Fourier Transform (FFT). Armando. [5] also used the time and frequency domain of cutting force signature to study the influence of tool entering angle on the stability of the process. The selection of various cutting parameters on difficult to machine materials and their influence on tool wear, surface integrity and MRR is described with various experiments [6]. Fang. [7] made a comparative study of cutting forces on Titanium and Inconel alloys with extensive experiments based on various levels of cutting parameters like cutting speed, feed rates etc. Toh [8] analysed machining vibration by the use of cutting force signatures obtained on various cutter path orientation on rough and finish milling based on new and worn cutters. The occurrence of chatter is highly associated with the workpiece interaction, flank face wear of cutter and imposed cutting conditions.

II. LITERATURE SURVEY

i. Vibration Analysis In Machining

It is observed that out of all the factors which produce vibration in machining, chatter is most obscure and needed to be handle carefully as it has a huge impact on material removal rate and surface finish. The whole idea of vibration analysis is detection, identifying, avoiding, preventing, reducing or suppression of chatter, enormous amount of research has been done on the same. Various approach towards the can be again classified as below:

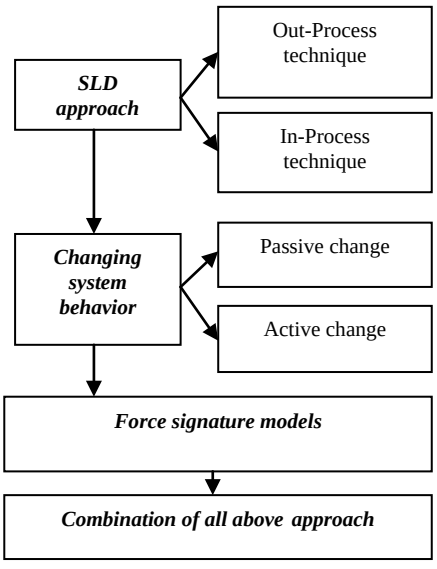

Fig:-Classification of literature research for stable machining techniques.

ii. Out- Process Technique

Out-process technique is the method of predicting the optimum cutting parameter in the stability region without changing the characteristics of the machine tool system composed of machine tool structure, tool, tool holder, drives, etc.
It is very important to note that in this process technique, the stability lobe diagram calculation is done before the actual manufacturing process starts and selection of desired parameter from SLD is done before the process starts [3] [9].

iii. In-Process Technique

It is the technique that involves the detection of chatter during the machining process and from there allowing the cutting parameters to change if required in order to migrate the process from unstable to stable zone. This technique requires skilled operator for monitoring the process and utilizing the modern equipments like microphone, sensors in order to get the chatter online and to make suitable adjustment to suppress it [4].

iv. Passive Change In System Behaviour

It is the technique that focuses on enlargement of stable zone in stability lobe diagram or by modifying the system behaviour. Passive technique is based on improving the design of the machine tool by carefully analysing the problem of vibration and acting against it. It also involves the usage of some extra devices that can absorb energy or disrupt the regenerative effect [10] [11].

v. Active Change In System Behaviour

Active chatter avoidance technique for chatter reduction and suppression are differentiated from the passive methods by their ability to monitor the dynamic state of the machine tool system, detection of a certain occurrence and actively executing those decisions that change the system to a more adequate situation [12].

vi. Force Signature Models

In this dynamometer is used to measure the cutting force coefficients in any cutting tests in most severe direction in terms of damping and force signature is captured by any data acquisition system. Further FFT analysis of force signature is done to analyze the system vibration effects [8] [13].

vii. Combination Approach

There are many approaches that make the use of two or more above mention techniques to analyze the chatter [14] [5].

viii. Sensors In Chatter Detection

It is observed form previous literature that in order to achieve highly efficient machining, unwanted phenomena called chatter must be detected, suppressed or eliminated. Out of all these, chatter detection is the most vital part and it can be achieved by using various signals from the machining process by the use of various sensors. Based on the process and response of particular operation sensor must be selected. Selection of sensors is also very important task as efficiency of detection of chatter depends on the effectiveness of the response signal from sensors. Several researchers have used various kind of sensors based on their application.

Process	**Physical Quantity**	**Sensor**	**Signal Processing**	**Chatter Identification Criteria**
Milling	Sound emission	Microphone	Power Spectral Density (PSD)	Energy threshold exceeded
Turning	Tool vibrations	Accelerometer	Cross coherence function between accelerations	Coherence function close to one at a certain frequency
Milling	Tool vibrations	Laser displacement sensor	Tool trajectory in time domain	Qualitative analysis
Milling	Spindle housing vibrations	Eddy current probes	Vibration and force signals trajectories in time and frequency domain (PSD)	Qualitative analysis
	Cutting forces	Plate dynamometer under the workpiece		
Turning	Cutting forces	Plate dynamometer under the workpiece	Coarse-grained entropy rate—CER of the force signals	CER below a threshold
Milling	Sound emission	Microphone	OPRS of the audio signal	OPRS variance above a limit
Milling	Workpiece vibrations	Eddy current probes	OPRS, PS, PSD of tool trajectory	High OPRS variance, chaotic PS
Milling	Cutting forces	Plate dynamometer under the workpiece	FFT of cutting force signals	Anomalous distribution of spectral peaks
Milling	Tool vibrations	Laser displacement sensor	OPRS, PS, PSD of tool trajectory	High OPRS variance, chaotic PS, anomalous distribution of spectral peaks
Milling	Sound emission	Microphone	PSD of audio signal	Energy threshold exceeded

Table:- Summary of chatter identification system research [8], [9]

III. METHODOLOGY

The work related with issue of chatter formation, detection and suppression was limited for end milling of thin structures and for hard to machine material irrespective of its wide usage in current industries.

The methodology adopted for the stability analysis is as shown in fig.

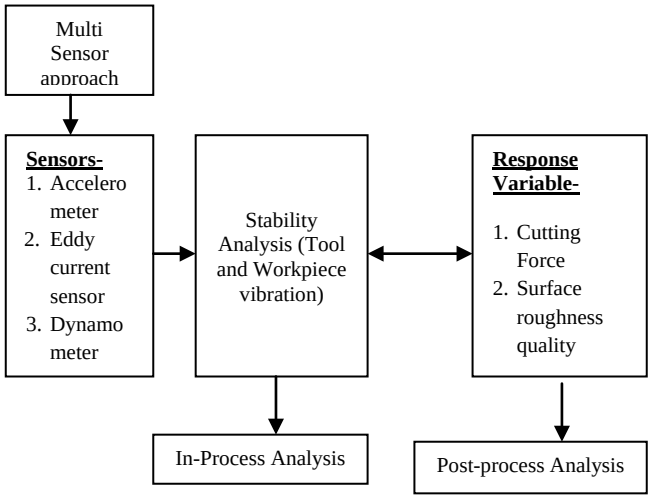

Fig.:- Methodology adopted for the stability analysis.

To correlate the in-process stability analysis parameters such as data obtained from various vibration sensors viz. a) Accelerometer b) Eddy current sensors c) Dynamometer, with the post process response variables viz. a) Cutting forces b) Surface quality.

The above work also serves some other objectives, which are as follows,

- To investigate the stiffness of the system formed by the machine-tool, tool holder, collet and cutting tool.
- To investigate cutting forces induced vibrations in the system and consequent effects on dimensional accuracy of feature machined and the quality of machined surfaces.
- To investigate the effect of cutting speed and tool – workpiece deflections on the stability of machining process.
- To investigate the compatibility of multi sensor system with the available milling machine and data acquisition system.

IV. SCOPE OF WORK

The parametric study on high-speed milling, in order to enhance the material removal rate, has been investigated extensively over past few decades. Nevertheless, analysis of machining stability brought on by vibration effects due to cutting process requires a deeper understanding to further aid the analysis. However, very few researchers have been addressed the issue of chatter occurrence in milling of thin structures irrespective of its wide use in the current industries. On this regard, the initial study is done to understand the process behind stability analysis and its impact on milling of thin structures. Under this initial work, experiments will be performed in order to decide the range of parameters, which significantly influence the stability of the machining process in milling of thin metal or alloy plates. The results obtained from the preliminary experiments will be used to decide the range of machining parameters and to decide the frequency range for accelerometers, eddy current sensors, data acquisition system etc. in order to design the experiments for successive chatter analysis.

The Present experimental work detects the chatter in high speed milling process with the use of multi-sensor system and correlated with the surface quality obtained and workpiece acceleration when chatter occurs. Chatter is an unwanted phenomena which restricts the material removal rate and impacts the surface quality. In this chatter boundaries occurred during machining is obtained, from that stable and unstable zone of machining is obtained to get the experimental stability diagram.

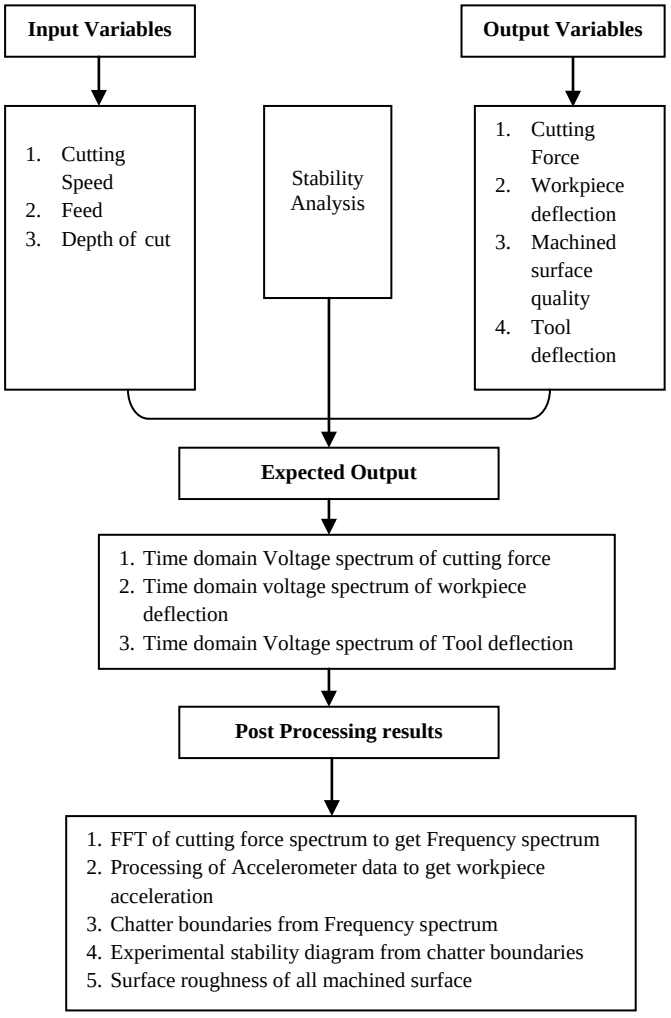

Fig:- Proposed theme of work.

V. PROPOSED EXPERIMENTAL SETUP

For experimental study, different types of sensors can be selected based on their usability for chatter detection during machining process. The proposed experimental setup along with data acquisition system is as shown in Fig. The cutting force dynamometer mounted on the milling machine bed. Then various chatter detection sensors placed on locations, where a lot of vibrations are expected during machining on the milling machine. The most vibration prone area would be tip of the cutting tool, however, it is impossible to attach a contact type sensor to detect the cutting tool vibration due to continuous rotations of the cutting tool during machining. Therefore, place a non-contact type eddy current sensor near the tool holder. Similarly, a contact type accelerometer can be used to detect the workpiece deflection in radial direction. The accelerometers and eddy current sensors are connected to specifically designed individual power source from where, an output is connected to data acquisition block. All the data must be simultaneously collected in one computer system from each individual sensor during the machining process. The data collection must be started before the beginning of milling process to avoid the time lag in the sensor.

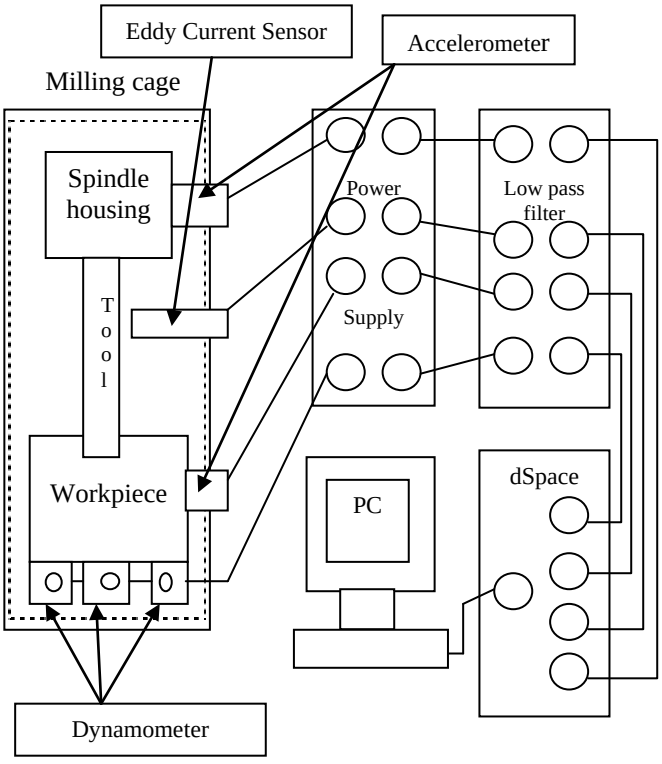

Fig:- Proposed schematic of experimental setup

VI. PROPOSED EXPERIMENTAL PROCEDURE

I. Mounting of Sensors

The accelerometer attached to the workpiece surface as well as tool holder casing and a non-contact type sensor near the tool holder system. The non-contact type eddy current sensor was properly mounted in such a way that it is perfectly rigid and perpendicular to the tool holder surface.

II. Sensors and data acquisition system

Suitable sensors are to be selected as per the requirement. Dynamometer can be mounted on the bed of milling machine below the workpiece surface to measure cutting tool forces in X-Y-Z directions. Eddy current non-contact type sensor can be mounted near a tool holder to capture the tool deflection. The contact type accelerometers can be mounted on the workpiece and the tool holder casing for capturing their deflections while machining. All the three sensors (dynamometer, accelerometer, eddy current sensor) are connected with some suitable input-output block. Further, a data acquisition system is connected to acquire the voltage data generated from various sensors. Suitable software can be used to acquire the entire signals simultaneously within the time domain.

III. Post Processing

After collecting all the data from various sensors during machining process, the data can be filtered using low pass filter in the Origin software to avoid the excess noise other than machining vibrations.

VII. CONCLUSION

The conclusion drawn from whole study has been put in below section.

- The cutting force data can be analyzed using FFT and the chatter frequencies can be distinguished from tool path and spindle frequencies. Further, chatter boundaries can be defined for each combination of process parameters selected for study. Thereby, the final stability analysis of milling process can be carried out.

- Multi sensor approach can be used, in which sensors like accelerometer, eddy current deflection sensor and dynamometer is used to give the output simultaneously while machining. The data obtained is post processed and analyzed to get the stability diagram.

- The detail analysis of formation of chatter and its transition from no-chatter to chatter can be done with the help of chatter boundary plot.

- The safer machining zone based on parametric selection is obtained experimentally.

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REFERENCES

1. Guillem Quintana, Joaquim Ciurana, Chatter in machining processes: A review, International Journal of Machine Tools & Manufacture 51 (2011) 363–376.
2. Junsuke Fujiwara, Takaaki Arimoto, Kazuya Tanaka, High Speed Milling of Titanium Alloy, Advanced Materials Research Vol. 325 (2011) 387-392.
3. Guillem Quintana, Joaquim Ciurana , Daniel Teixidor. A new experimental methodology for identification of stability lobes diagram in milling operations, International Journal of Machine Tools & Manufacture 48 (2008) 1637–1645.
4. Songlin Ding, R. Izamshah R.A, John Mo, Yongwei Zhu, Chatter Detection in High Speed Machining of Titanium Alloys, Key Engineering Materials Vol. 458 (2011) 289-294.
5. Armando, ItaloSetteAntonialli, AnselmoEduardoDiniz, RobsonPederiva, Vibration analysis of cutting force in titanium alloy milling, International, Journal of Machine Tools & Manufacture 50 (2010) 65–74.
6. D. Dudzinski, A. Devillez, A. Moufki, D. Larrouque're, V. Zerrpiki, J. Vigneau, A Review of developments towards dry and high speed machining of Inconel 718 alloy, International Journal Of Machine tools & Manufacture 44 (2004) 439-456.
7. N. Fang, Q. Wu, Acomparitive study of the cutting forces in high speed machining of Ti-6Al-4V and Inconel 718 with a round cutting edge tool, Journal of Materials Processing Technology 209 (2009) 4385-4389.
8. C.K. Toh, Vibration analysis in high speed rough and finish milling hardened steel, Journal of Sound and Vibration 278 (2004) 101-115.
9. Neil D. Sims, Phillip V. Bayly, Keith A. Young, Piezoelectric sensors and actuators for milling tool stability lobes, Journal of Sound and Vibration 281 (2005) 743-762.
10. Panling Huang, Jianfeng Li, Jie Sun, Maojie Ge, Milling force vibration analysis in high-speed-milling titanium alloy using variable pitch angle mill, International Journal of Advance Manufacturing Technology (2012) 58:153-160.
11. Ahmad R. Yusoff, Sam Turner, Chris M. Taylor, Neil D. Sims, The role of tool geometry in process damped milling, International Journal of Advance Manufacturing Technology (2010) 50:883-895.
12. C. Brecher, D. Manoharan, U. Ladra, H.G. Kopken, Chatter suppression with active worpiece holder, Production Engineering Research and Development (2010) 4:239-245.
13. Min Wan, Yi-Ting Wang, Wei-Hong Zhang, Yun Yang, Jian-Wei Dang, Prediction of chatter stability for multiple-delay milling system under different cutting force models, International Journal of Machine Tools & Manufacture 51 (2011) 281-295.
14. C.M. Lee, S.W. Kim, Y.H. Lee, D.W. Lee, The optimal orientation in ball end milling of cantilever-shaped thin plate, Journal of Materials Processing Technology 153-154 (2004) 900-906.

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ROLE OF E- MARKETING STRATEGY IN SMEs

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ABSTRACT

Today e-marketing communications are moving toward interactions between individual recipients and consumers rather than being directed from a marketing organization to masses of consumers. Several attempts have been made through the fields of technology and marketing to overcome the anonymousness of the computer user's interests and preferences to move toward a direct behavioral approach to e-marketing more specifically, identifying the users on the internet, collecting profiles of their interests and delivering advertisements that appeal to their specific preferences. From a marketing perspective, we are at a pioneering stage in understanding how these work. The elements of this infrastructure are technological, commercial, political, and social.The social networking that allows the quick and easy dissemination of information and mis-information is in part a product of changes in online communication channels, but these communication channels are in part enabled by such social networking. This paper reviews the current approaches to Internet behavioral marketing and its shortcomings as well as bio-metrics and its potential for more effective Internet marketing. This article suggests an infrastructure that could be useful in studying how e-marketing communication channels are emerging and how they might evolve in the future.

Keywords: E- marketing , Integrated Marketing Communication, Social Networking, Internet.

INTRODUCTION

We have seen an emergence of new ways that marketing promotions can launched and new ways that marketing attacks can be initiated. Our current concepts and models in the marketing discipline were formulated around promotional media, modes of service delivery, ethical considerations, and such that were common before the Internet existed. Our thoughts on integrated marketing communications (IMC) and corporate reputation management are based on tactics such as traditional press releases to paper news media, whether that be to promote a new product or to react to a negative event such as an oil spill. a marketing standpoint, usernames and passwords, in addition to other tracking devices such as cookies, smart cards, tokens, credit cards and digital certificates are useful approaches for gathering information concerning general tastes and preferences from the general public; however, there are limitations to this technology concerning e-marketing. The market for technology used to track and capture individuals' interests in order to market to their tastes, often referred to as behaviorally targeted advertising, is growing. Internet marketing in particular is evolving into more personalized advertisement approaches for strategic placements of advertisements to appeal to users' preferences. One such method that has the potential to both eliminate the frustration of usernames/passwords for users and give marketers a better picture of user's tastes and preferences is the biometric identification hardware/software. Our hope is that this model can help us in the future to better understand how emerging communication channels are enabled and manipulated.

INTERNET TRACKING AND SOCIAL NETWORKING

The objective is the effective placement of advertisements to attract consumers to products for which they have a strong potential to purchase. However, this form of Internet tracking has several shortcomings. First of all, cookies identify the computer but not necessarily the user .Since several users may access the same computer, Internet site owners may obtain only those mouse clicks specific to a computer, not to a specific user. With the indefinite accessibility of public computers with internet

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access available in libraries, schools and other public venues, the information received from cookies can only yield a generally broad measurement of likes and dislikes as opposed to information specific to an individual. On the other hand, having to keep track of multiple username and passwords for an indefinite number of websites, in addition to keeping them both accessible and private, can be rather frustrating for the user. Also usernames and passwords can be passed to others; this can create discrepancies in the data gathered by marketers. Other forms of security measures such as smart cards, tokens, credit cards and digital certificates require physical possession and have the same drawbacks as cookies and usernames/passwords since someone other than the actual owner may be tracked. Tracking cookies, usernames/pass words, smart cards, tokens, credit cards and digital certificates are all useful for marketing purposes. However they all fall short in their abilities to track specific user's individual tastes and preferences for individual target marketing. A social networking website is defined here as "one that allows internet users the ability to add user-generated content such as: comments, feedback, ratings, or their own dedicated pages". Social networking websites also allow anonymous attacks on the character of named persons or organizations.

INTEGRATED MARKETING COMMUNICATION

The concept of integrated marketing communications, or IMC, is relatively new. The general idea with a lack of any standard is that there are a wide array of methods, media, and channels for communicating with those outside of an organization, and that an organization needs to coordinate and centralize these activities over the long term in order to be effective. Although IMC is a term that is now common in marketing management textbooks, it is a concept that still lacks a commonly. The adoption of new methods of communication – My Space, Face book, You Tube, Epinions, personal blogs and websites, online message boards, and such – have enabled marketers to reach new markets in ways that are very different from traditional advertising channels. These sorts of communication channels have also enabled competitors and detractors to launch attacks that simply aren't possible through traditional marketing channels Interest in this article is in suggesting the components that enable newer forms of online communication. In order to do this, we need to look at the concept of diffusion of innovations. Everett Rogers, perhaps the most well-known person associated with this concept, defines the diffusion process as an innovation which is communicated through certain channels over time among members of a social system . To understand how marketing communications happen on the Internet, we have to expand on the idea of a social communication network by looking at factors that enable that social network to exist in the first place. It is hoped that the exploratory studies such as this would provide the researchers with added incentives to conduct further investigations. After all, one needs to accept that fact that while the e- marketing strategy is a popular one, it is still far from perfect. The stage is set for information technology experts to integrate biometrics into their websites to give marketers the edge to collect relevant data on Internet users and market to those users' specific tastes and preferences. Gaining greater exposure to online e-marketing communication channels can require little more than acquiring physical resources The remainder of the article focuses on the infrastructures that would app ear to enable the diffusion of online communication channels. The hope is that we can gain a better understanding of how to manage an organization's integrated marketing communications (IMC) by understanding what can be enabled by these basic infrastructures rather than by sorting through every month's new online marketing tactic or by thumbing through a marketing management textbook that is based on traditional media and traditional ways of thinking. Additionally, there absolutely must be the technological infrastructure on which such new social systems ride. Before the Internet, servers, networking protocols, Web browsers ,user-friendly applications, and such, the communication channels that are discussed herein were not available

E- MARKETING

Marketing attacks aimed at online communications are typically discussed with a focus on the core/technological infrastructure. Technological infrastructure refers to the interconnected computers, servers, routers, switches, and cables that make the Internet work. Exploits of an online networking system are often made with the intention of gaining access to internal information through system probes and scans, root and account compromise, packet sniffing, and malicious programs. Exploits can also be made, however, with the intention to disrupt or harm an organization's marketing efforts. That is, in order for spaces such as Face book, Epinions, there has to be some sort of commercial role for these. Without some sort of financial incentive, nobody would

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offer hosting services for personal websites at prices that individual hobbyists are willing to bear .Without some sort of commercial and/or competitive incentive, nobody would have enough motivation to run an extensive social networking system of the sort that is required to maintain applications such as Facebook.

CONCLUSION

In order for a marketer to understand how these media or tactics might change, evolve, or become useful, concern for changes in these infrastructures is more important than simply looking at the media or tactics themselves. Although new social media have become available in recent years, the continuance of these media in current forms and the diffusion of these into common use by an entire society is not guaranteed. In many instances of applications that have been evolving, we are still at a pioneering stage such that there are many negative or ethically-questionable uses being made. The present article has proposed that the evolution of social media and communication channels for marketing uses depends on a set of underlying infrastructures technological infrastructure, a commercial infrastructure, a political/regulatory infrastructure, and a social infrastructure

REFERENCES

1. Klaassen, Abbey (2007), Behavioral Targeting: The New Killer App for Research, Advertising Age, 78
2. Koltzsch, Gregor (2007), – Market Segments and Journal of Business Economics Krebsbach, Karen (2004),
3. Researcher Hacks Microsoft Fingerprint Reader, PC World Online, (March 6).Pons, Al
4. Marketing: Targeting the Online Consumer, Communications of the Turle,Marcus(2007).

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Review of energy and economic assessment of membrane distillation

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Abstract – *Membrane distillation (MD) is a recent and unique separation technology. It has been known since last 50 years, but it is not implemented due to high energy consumption and lower flux as compared to an existing accepted reverse osmosis (RO) process. Hence this paper presents the review of the energy requirement and economical assessment of MD for the water purification process. The comparison of the energy requirement and cost of MD and RO process was presented. Our assessment has found that the MD process has an economically favored than RO when using the low-grade waste heat energy or the proper heat recovery system is installed. Multi-effect membrane distillation is a viable process found by a cost-effectively.*

Keywords*: Energy requirement; Economics; Membrane distillation; Cost of MD; Water purification*

I. Introduction

Membrane distillation (MD) is relatively new and innovative membrane technology known since last 50 years. It has been widely studied for the various processes such as desalination of seawater or brackish water, concentration of solutions, removal of volatile organic compounds, removal of heavy metals and toxic elements from water and other separation and purification processes [1-4]. MD is a thermally driven separation process and it is economical in terms of energy, since low grade-waste heat energy for the process can be used because it has an advantage of performing at moderate temperature and pressure [5,6]. The working principle of MD is based on the vapor pressure difference between the two sides of hydrophobic membrane means the feed side and the permeate side. The vapor evolved from the feed solution passes through the pores of the membrane and is collected as the condensate. This depends on different MD configuration which are direct contact membrane distillation (DCMD), vacuum membrane distillation (VMD), air gap membrane distillation (AGMD) and sweep gas membrane distillation (SGMD); which have been well described in the literature [7-9]. In the literature many studies are found in the performance of the MD mainly on the membrane properties, operating conditions and module design [10-24].

The advantage of MD is that evaporation and condensation surfaces are tightly packed and therefore result in compact equipment leading to a good relation between output and capital cost. Reduced use of chemicals, filters and consumables implies low running cost. In many situations, the energy is available at minimal cost, so the MD will not be as costly as typical desalination and water treatment processes, which are more energy intensive [25,26]. Despite an attractive advantages of MD over other water purification technologies such as reverse osmosis (RO), till it has been not significantly implemented due to high energy consumption and lower flux as compared to RO process.

The MD process proved in its technical feasibility for the water purification, desalination and other separation processes. But in terms of economical feasibility, advance research is needed for optimizing the parameters by using low grade waste heat energy, solar energy and suitable heat recovery system which should minimize the MD cost.

Many researchers reported in their studies on the MD mainly investigate the temperature polarization phenomena, heat efficiency or heat transfer [27].

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Only few studies are found on the energy requirement for the MD process [3,28-30]. High energy consumption is the limitation of MD to the industrial implementation or commercialization in the industry. Hence there is need to optimize the process in order to maximize the permeate flux and minimize the energy requirement or reduce the temperature polarization phenomena. It is possible by carefully designed and optimized the MD membrane module configuration [37,38].

II. Energy Requirement to MD

The energy for the MD plants is generally supplied in the form of either thermal or electricity. Thermal energy is required to hating the feed and electrical energy required to run the circulation pump, vacuum pumps or compressors. The thermal energy requirement for MD process is more than the electrical energy, i.e. around 90% of the total energy. It can be accessed by using low grade waste heat. As compared to the most popular water treatment, RO process required only the electrical energy and which is more expensive than the waste heat. [39].

Table I.Comparisons Between Md And Ro Process In Terms Ofnergy Requirement

Parameter	MD	RO	Ref.
Energy	Thermal and electrical	Only electrical	[4]
Forms of energy	Low grade/ waste heat sources and some electrical energy for pumping	Electrical energy derived from fossil fuels or renewable sources	[4]
Thermal energy (kWh/m^3)	100	0	[40-42]
Electrical energy (kWh/m^3)	2	3.5	[40, 43]

Hence Table 1 presented the comparison of the MD process with RO in terms of energy required for water treatment.

Temperature is one of the operating variables that affect not only the MD process, but also energy efficiency significantly. Permeate flux increases with the temperature of the feed due to the exponential increase in the vapor pressure with temperature [44,45]. The thermal energy efficiency can be improved by increasing the driving force on the membrane. Also, this improvement can be achieved by reducing the permeate temperature. The thermal efficiency, enhanced by about 12% by the increase in the feed temperature from 40 ^{0}C to 80 ^{0}C [46]. And at cost feed temperature thermal efficiency raised from 8% to 14% by slightly decreasing the permeate temperature [47,48].

Low operating temperature of feed enables the utilization of waste heat as a preferable energy source. The possibility of utilization of alternative energy sources such as solar, wave or geothermal energy is particularly attractive [49]. Since the MD process does not require high quality steam or hot feed solutions in the temperature range of 80-120 ^{0}C. MD process has the potential to compete with RO provided a suitable membrane is employed in the lower temperature range. VMD can compete with RO at lower temperature at 25 ^{0}C but lower flux than that of RO [30]. Also MD is not inhibited by high solute concentration which is a big drawback for the RO process. The total energy consumption in the AGMD for desalination using hydrophobic ceramic membranes, is 4 times less (1 kWh/m^3) required to obtain a permeate flux 5 L/m^2h as compared to the RO [50].

Since last two years, MD has emerged with numerous commercially oriented devices especially in MD modules or high efficiency system such as vacuum multi-effect membrane distillation (V-MEMD) successfully developed by the Memsys (Germany). The V-MEMD technology combines the advantages of multi-effect and vacuum to achieve highly efficient heat recovery [51]. The MD process

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with either external or internal heat recovery has the characteristics of multi-effect operation. Hence the term MEMD is used to describe an MD process with latent heat recovery and with a performance ratio (PR) of much more than one [52].

III. Economic Analysis in MD

Maximum permeate flux is the main criteria for the MD process. Optimization of the process should also involve the economic value and the heat used. The economic value varies with the type of energy source [53]. MD processes effectively an operating at low temperature; hence it is possible to utilize low grade waste heat which is generally available in the industry. Also in the MD process, thermal energy can be recovered by using the proper heat recovery system. Hence the plant can be competing with the existing RO plant by reasonably. The cost comparison of the MD process with RO plant based on the type of energy available is shown in the Fig.1. It shows that RO plant is the most cost effective process when no waste heat energy is used. However, there is a cost saving in the thermal energy which is used in the MD process when the MD process is driven by a waste heat sources. The cost of MD is reduced from 2.2 $/m^3 to 0.57 $/m^3 water produced for the plant capacity of 30000 m^3/day, while it was 0.8 $/m3 water produced by the RO plant [39].

Memstill technology is developed for the desalination of sea water uses residual heat, a source of energy that is widely available in industrial countries. This process is driven by minor temperature difference, so little energy is required. Meidersma et al. [54] reported the comparative analysis between the MD and RO for the seawater desalination in terms of energy and the investment cost of the Memstill technology. In this process the heat is supplied in cogeneration with electricity. The estimated total cost of the process was 0.17 $/m^3 while it was 0.35 $/m^3 water produced for RO. So, the cost of MD plant can be minimized by using lower grade-waste heat and installation proper heat recovery system. Hence the economic modernization of the traditional MD process is needed for the commercialization of the process industry.

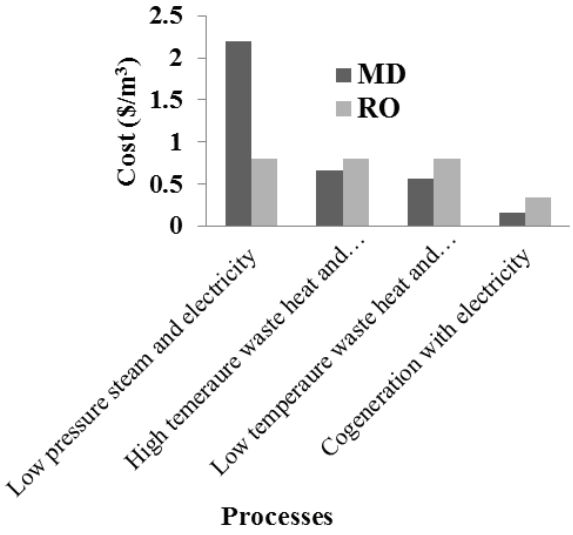

fig.1. Cost comparisons between MD and RO plant based on the type of energy [39]

Conclusion

MD has significant advantages over other processes, including operating at low temperature and the ability to run at low pressure than RO. This process uses energy sources such as waste heat or solar heat. This review covered and discussed the energy requirement and economical assessment of both MD and RO processes. The MD unit is said to be performing better if high flux is obtained at minimal energy consumption. Hence optimizing the process by increasing the flux, decreasing energy consumption and providing long term performance will make the process a viable alternative for many applications.

References

[1] A. Criscuoli, M.C. Carnevale, E. Drioli, Evaluation of energy requirements in membrane distillation, Chem. Eng. Processing 47 (2008) 1098-1105.

[2] K.W. Lawson, D.R. Lloyd, Membrane distillation, J. Membr. Sci. 124 (1997) 1-25.

ISBN 978-81-9297-9-1

[3] A.M. Alklaibi, N. Lior, Membrane – distillation: status and potential, Desalination 171 (2004) 111-131.

[4] S. Yarlagadda, L.M. Camacho, V.G. Gude, Z. Wei, S. Deng, Membrane distillation for desalination and other separations, Recent Patents on Chem. Eng. 2 (2009) 128-158.

[5] G.A. Mannella, La Carrubba, V. Brucato, Charecterization of hydrophobic polymeric membranes for membrane distillation process, Int. J. Material Forming 3 (1), (2010) 563-566.

[6] N.N. Li, A.G. Fane, W.S. Ho, T. Matsuura, Advanced membrane technology and applications, John Wiley and Sons, Inc., Hoboken, New Jersey (Eds.) (2008).

[7] A. Alkhudhiri, N. Darwish, N. Hilal, Membrane distillation: A comprehensive review, Desalination 287 (2012) 2-18.

[8] Water desalination report Vol. 45(2), Global Water Intelligence (2009).

[9] J. Zhang, N. Dow, M. Duke, E. Ostarcevic, J. D. Li, S. Gray, Identification of material and physical features of membrane distillation membranes for high performance desalination, J. Membrane Sci. 349 (2010) 295-303.

[10] B.L. Pangarkar, P.V. Thorat, S.B. Parjane, R.M. Abhang, Performance evaluation of vacuum membrane distillation for desalination by using flat sheet membrane, Desalination and Water Treatment 21 (2010) 328-334.

[11] B. L. Pangarkar, M.G. Sane, S.B. Parjane, M. Guddad, Vacuum membrane distillation for desalination of ground water by using flat sheet membrane, Int. J. of Chem. Biolo. Engg. 4(1), (2011) 13-18.

[12] B.L. Pangarkar, M.G. Sane, Performance of air gap membrane distillation for desalination of ground water and seawater, Int. J. Eng. Natural Sci. 4(3), (2010) 150-154.

[13] T. Mohammadi, M.A. Safavi, Application of Taguchi method in optimization of desalination by vacuum membrane distillation, Desalination 249 (2009) 83-89.

[14] J.P. Mericq, S. Laborie, C. Cabasuud, Vacuum membrane distillation for an integrated seawater desalination process, Desalination and water treatment 9 (2009) 293-302.

[15] M. Safavi, T. Mohammadi, High –salinity water desalination using VMD, Chem. Eng. J. 149 (2009) 191-195.

[16] Y. Yun, R. Ma, W. Zhang, A.G. Fane, Jiding Li, Direct contact membrane distillation mechanism for high concentration NaCl solutions, Desalination 188 (2006) 251-262.

[17] M. Khayet, M.P. Godini, J.I. Mengual, Theoretical and experimental studies on desalination using the sweeping gas membrane distillation method, Desalination 157 (2003) 297-305.

[18] A. Alkhudhiri, N.Darwish, N. Hilal, Treatment of saline solutions using air gap membrane distillation: Experimental study, Desalination 323 (2013) 2–7

[19] A.R. Kurdian, M. Bahreini, G.H. Montazeri, S. Sadeghi, Modeling of direct contact membrane distillation process: Flux prediction of sodium sulfate and sodium chloride solutions, Desalination 323 (2013) 75–82

[20] L. Martinez, J.M. Rodriguez-Maroto, Effects of membrane and module design improvements on flux in direct contact membrane distillation, Desalination 205(2007)97-103.

[21] M. Khayet, A.O. Imdakm, T. Matsuura, Monte Carlo simulation and experimental heat and mass transfer in direct contact membrane distillation, Inter. J. Heat and Mass Tranfer. 53 (2010) 1249-1259.

[22] M. Mtheswaran, T. O. Kwon, J. W. Kim, S. Moon, Factors affecting flux and water separation performance in air gap membrane distillation, J. Ind. Eng. Chem. 13(6) (2007) 965-970.

[23] L. Cheng, P. Wu, C. Kong, J. Chen, Spatial variations of DCMD performance for desalination through countercurrent hollow fiber module, Desalination 234 (2008) 323-334.

[24] D. Winter, J. Koschikowski, M. Wieghaus, Desalination using membrane distillation: Experimental studies on full scale spiral wound modules, J. Membr. Sci. 375 (2011) 104–112.

[25] R. Bhaksr, Solar powered membrane distillation and reverse osmosis process, Int. J. Latest Res. In Sci. & Tech. 3(1) (2014) 75-78.

[26] B.L. Pangarkar, M.G. Sane, M. Guddad, Reverse osmosis and membrane distillation for desalination of ground water: A review, ISRN Material Science (2011) 1-9.

[27] Y. Xu, B.K. Zhu, Y.Y. Xu, Pilot test of vacuum membrane distillation for seawater desalination on a ship, Desalination 189 (2006) 165-169.

[28] M.S. El-Bourawi, Z. Ding, R. Ma, M. Khayet, A framework for better understanding membrane distillation separation process, J. Membrane Sci. 285 (2006) 4-29.

[29] P. J. Foster, A. Burgoyne, M.M. Vahdati, Improved process topology for membrane distillation, Sep. Purif. Technol. 21 (2001) 205-217.

[30] C. Cabassud, D. Wirth, Membrane distillation for water desalination: how to chose an appropriate membrane? Desalination 157 (2003) 307-314.

[37] V.A. Bui, L.T.T. Vu, M.H. Nguyen, Simulation and optimization of direct contact membrane distillation for energy efficiency, Desalination 259 (2010) 29-37.

[38] A. Criscuoli, M. C. Carnevale, E. Drioli, Energy requirements in membrane distillation: evaluation and optimization, Desalination 200 (2006) 586-587.

[39] U.K. Kesieme, N.Milne, H. Aral, C.Y. Cheng, M. Duke, Economic analysis of desalination technologies in the context of carbon pricing and opportunities for membrane distillation, Desalination 323 (2013) 66-74.

[40] T. Mezher, H. Fath, Z. Abbas, A. Khaled, Techno-economic assessment and environmental impacts of desalination technologies, Desalination 266 (2011) 263-273.

ISBN 978-81-9297-9-1

[41] J.B. Galvez, Seawater desalination by innovative solar powered membrane distillation system, MEDESOL project no. 036986 (2012).

[42] M. Khayet, T. Matsuura, Membrane distillation, 1st Edition, Principles and application (2011): Elsevier.

[43] H. Ettouney, Visual basic computer package for thermal and membrane desalination processes, Desalination 165 (2004) 393-408.

[44] J. Phattaranawik, R. Jiraratananon, A.G. Fane, Heat transport and membrane distillation coefficients in direct contact membrane distillation, J. Membr. Sci. 212 (2003) 177–193.

[45] M. Qtaishat, T. Matsuura, B. Kruczek, M. Khayet, Heat and mass transfer analysis in direct contact membrane distillation, Desalination 219 (2008) 272-292.

[46] A.M. Alklaibi, N. Lior, Transport analysis of air gap membrane distillation, 25(2005) 239-253.

[47] P.A. Hogan, A.G. Sudjito, G.L. Morrison, Desalination by solar heated membrane distillation, Desalination 81 (1991) 81–90.

[48] V. Calabro, E. Drioli, F. Matera, Membrane distillation in the textile wastewater treatment, Desalination, 83 (1991) 209–224.

[49] M. Tomaszewska, Membrane distillation – examples of applications in technology and environmental protection, Polish J. Environ. Studies, 9(1) (2000) 27-36.

[50] L. Gazagnes, S. Cerneaux, M. Persin, E. Prouzet, Desalination of sodium chloride solutions and seawater with hydrophobic ceramic membranes, Desalination 217 (2007) 260-266.

[51] K. Zhao, W.Heinzel, M.Wenzel, S. Buttner, F. Bollen et al., Experimental study of the memsys vacuum-multi-effect membrane distillation (V-MEMD) module, Desalination 323 (2013) 150-160.

[52] R. Liu, Y. Qin, X. Li, L. Liu, Concentrating aqueous hydrochloric acid by multiple-effect membrane distillation, Frontiers of Chemical Science and Engineering 6(3) (2012) 311-321.

[53] F.A. Banat, J. Simondal, Desalination by membrane distillation: parametric study, Separ. Sci. Techno. 33 (1993) 210-206.

[54] G. Meindersma, G. Gujit, A. de Haan, Desalination and water recycling by air gap membrane distillation, Desalination 187 (2006) 291-301.

Performance Studies of ZIF-8/PES Asymmetric Mixed Matrix Membrane for Permeation of CO_2/CH_4

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Abstract — *Mixed matrix membranes with moderate filler loading have been shown to improve the properties of pure polymers for many gas separations. Nano-size fillers mixed uniformly into polymer matrix would overcome the challenges of developing MMM by carefully dispersion in polymer matrix, high interfacial contact of polymer-filler even at low filler loading. The synthesized ZIF-8 in the earlier work was used as filler for MMM preparation. Its XRD pattern revealed that it was successfully synthesized. Asymmetric neat Polyethersulfone (PES) membrane and PES/Zeolitic Imidazolate Framework-8 (PES/ZIF-8) based mixed matrix membrane was prepared using solvent-evaporation method. The prepared membrane was coated with 2 wt% of polydimethylsiloxane (PDMS) in n-hexane with moderate heat treatment and used for permeation of CO_2/CH_4. The gas permabilities of CO_2 and CH_4 by the PES/ZIF-8 MMM were increasing with increasing ZIF-8 loading at 3 bars. The incorporation of ZIF-8 at low loadings (□ 30 w/w %) improved the performances of the membrane. While the addition of 10 w/w % ZIF-8 into polymer increased the permeability approximately twice for CO_2 and CH_4 while the ideal selectivities for CO_2/CH_4 gas pair showed a slight loss (~14 to 17%). The increase in the permabilities was about 3 to 4 times, while the loss in selectivities for CO_2/CH_4 gas pair was about approximately 16 % compared to results of pure PES membrane. For the higher ZIF-8 loadings (≥ 30 w/w %), the permabilities are increasing, but the ideal selectivities started to reduce very rapidly. Since the most realistic increase in permabilities was observed in CH_4 but the selectivity decreases. As a result, using nano ZIF-8 as filler into PES matrix has revealed competent membrane for CO_2/CH_4 separation at moderate loading.*

Keywords — *Mixed Matrix Membrane (MMM), Polyether sulfone (PES), Zeolitic Imidazole Framework (ZIF-8), Gas separation, Permeability, Selectivity.*

I. INTRODUCTION

Gas separation membranes have found many applications such as hydrogen, oxygen–nitrogen separation, vapor–vapor separation, and dehydration of air and natural gas separation such as carbon dioxide separation and dew point adjustment etc [1]. Due to low capital cost, modest energy requirement and ease to fabricate, research on polymeric membrane has expand much attention in the last two decades. Polymeric membranes provide many advantages and its performance is studied by Robeson's trade-off curve shows relation between selectivity and permeability [1].

Inorganic fillers such as carbon molecular sieve, various zeolite, carbon nanotube, activated carbon etc. posses separation properties surpass Robeson's trade-off limit, were initially embedded into polymer. Still inorganic fillers shows poor interaction with polymer matrix and often lead to defective membrane. Developing defect-free mixed matrix membranes remains major challenge [2] [3]. Membrane can be defected through particle agglomeration, un-selective voids formation, filler pore blockages and sieve-in-cage morphology affect its effectiveness. The Metal organic frameworks (MOFs) as potential filler due to organic linkers present in the structure have good interaction with polymer. Besides, MOFs consist of large surface area, high adsorption capacity, ease of modifications and high affinity towards certain gas, gives good potential for MOFs to be used as filler [4] [5].

Among MOFs, zeolitic imidazole framework-8 (ZIF-8) is one of the most investigated MOFs [6],[7],[8] and it has porous crystalline structure with M-Im-M angle (M= metal) near to 145°, coincident with the Si–O–Si angle found in many zeolites [7],[8],[9]. ZIF-8 has sodalite (SOD) topology with a pore size of 0.34 nm [6], [10], [8]. It has large pores of 11.6 A^0 which is two times larger than SOD zeolites. The pores are accessible through small channels (3.4 A^0). It exhibits thermal stability up 400^0C and it has a BET surface area around 1300 to 1600 m^2/g or even more [6], [10], [11], [8]. ZIF-8 shows good chemical stability against polar and

TABLE 1
TEXTURAL PROPERTIES OF THE ZIF-8

MOF Type	Pore topology	Pore diameter (nm)	BET Surface area m^2/gm	Approximate Particle size (nm)
ZIF-8	Cage/ Window	1.16 /0.34	1214	170

TABLE 2
GENERAL PROPERTIES OF GASES CO_2, N_2 AND CH_4

Gas	Molecular Mass (g/mol)	Critical Temperature (^0K)	Kinetic Diameter (nm)
CO_2	44	304	0.33
N_2	28	126	0.36
CH_4	16	190	0.38

non-polar solvents [9], reorientation of its structure at high pressure and mechanical strength. Above table-1 shows the textural properties of the ZIF-8 [11], [12],[8].

Another important concern about MMM is the amount of filler loading. The particle size of filler material is also an important factor in determining the gas transport properties of the mixed matrix membrane. High filler loading would provide higher penetrant-filler interaction with increase separation properties, but leads to particles agglomeration, directly reflect on membrane production cost and deteriorating its performance. In contrast, incorporating small amount of filler give irrelevant improvement on membrane separation properties, but highly unlikely for particles to agglomerate. Lowest filler loading with considerable improvement of membrane performance would be the ideal MMM [13] [5].

CO_2 has a smaller kinetic diameter 0.33 nm compared to CH_4 gas, and much upper critical temperature compared to N_2 and CH_4 as shown in above table-2. The lesser kinetic diameter and prominent critical temperature (higher condensability) of CO_2 support in higher diffusion rate and solubility coefficients and hence higher permeability compared to N_2 and CH_4.

Polyethersulfone (PES) was used for membrane preparation which is a commercial polymer provided by Solvay. It is commercially attractive due to its high chemical resistance, thermal degradation and stability to oxygen. The glass transition temperature (Tg) and weight average molecular weight of the polymer (PES) are 220^0C and 53,000, respectively [14].

Its gas transport properties lie near the upper bound line on the middle region of Robeson's plot for attractive gas pairs like CO_2/CH_4, H_2/CH_4. Dimethylformamide (DMF) was used as solvent due to its strong dissolving power for many components. It has the chemical formula of C_3H_3ON, and boiling point of 153^0C [15].

In order to develop high performance MMM at low to moderate filler loading, nano filler with good polymer-filler interaction is necessary. Thus, this study intend to utilize synthesized nano sized ZIF-8 as a filler to prepare mixed matrix membrane and study the influence of ZIF-8 loading on performance of gas separation. Typically the a lot of research focused on development of ZIF-8-MMM dense membrane, but the purpose of this study was to preparation of asymmetric MMM using solvent evaporation method at varied filler percentage loading of ZIF-8 to analyse the performance of CO_2/CH_4 separation.

II. EXPERIMENTAL

A. Materials: Zinc nitrate hexahydrate [$Zn(NO_3)_2.6H_2O$], methanol were obtained from Fisher Scientific and 2-methylimidazole [$C_4H_6N_2$] was obtained from Sigma-Aldrich (India). Polyethersulfone (PES) [Radel A-100 grade] provided by Solvay. Polydimethylsiloxane (PDMS) was obtained from Sigma Aldrich and n-hexane and Dimethyl formamide (DMF) were purchased from Merk. Deionized water was obtained from Thomas Baker. All chemicals were used as received without any further purification.

B. *ZIF-8 Synthesis:* The ZIF-8 crystals were synthesized [16] [17] by the room temperature synthesis method [9] with some modifications with the help of methanol and de-ionized water. In this method a solution of 3 gm of [$Zn(NO_3)_2.6H_2O$] added in 100 ml of methanol and other solution of 6.6 gm of 2-methylimidazole added in 100 ml of methanol were prepared and then mixed with each other under vigorous stirring for one hour at room temperature. After stirring, the resulting ZIF-8 crystals were separated by centrifugation at around 10000 rpm for 10-12 minutes, followed by washing with methanol two to three times and dried under vacuum at 45^0C for four to five hours and stored dry for further analysis and use. Similarly, ZIF-8 synthesized by via de-ionized water with accurate proportion of Zinc Nitrate Hexahydrate (1.17gm) and 2-methylimidazol (22.7gm) was dissolved in 88ml de-ionized water. Synthesis methodology applied for ZIF-8 crystals is previously studied in our work [13].

C. **Membrane Preparation Methodology:** The morphology and the transport properties of mixed matrix membranes are strongly related to the types of polymer, solvent, filler material and the additives used in fabrication [18]. Solvent-evaporation method was used for preparation of the membranes. PES and ZIF-8 were dried at 80^0C and 180^0C overnight before using in the membrane synthesis. Two different types of membranes were prepared in this study, pure PES, PES/ZIF-8 with different ZIF-8. PES concentration in DMF, 20 w/v %, was kept constant for all membranes.

Asymmetric flat sheet neat membrane was prepared by casting solution consisted of Polyethersulfone (PES)

and DMF. Overnight dried PES was added into the solvent DMF step by step in order to prevent a sudden increase in the viscosity of solution and ease of stirring. Then, the solution was stirred for overnight by a magnetic stirrer. Casting process was performed by hand-casting at ambient atmosphere. Asymmetric flat sheet MMM was prepared by overnight dried ZIF-8 was dispersed in the solvent DMF in three or four steps according to the amount of ZIF-8. Between each two steps, the solution was ultrasonicated for 20 to 30 min in order to ease the dispersion and minimize the agglomeration of ZIF-8 particles in the solution. After completing the ZIF-8 addition, PES was primed by adding 15 wt % of the total amount so as to increase the compatibility between ZIF-8 and PES and the solution was stirred for overnight by a magnetic stirrer. Then, remaining amount of PES was added to the solution in three or four steps with 20 to 30 minute ultrasonication in between the steps and again the solution was stirred for overnight. While the PES concentration was kept constant, the ZIF-8 contents in the membranes were varied between 10- 30 w/w % and the compositions of prepared membranes [19] [20] [21]. After that, membranes were dip-coated for 10 to 12 minutes in 2wt% PDMS in n-hexane to seal possible pinhole on membrane surface. Then, membrane undergoes "curing" at 50°C overnight.

III. THEORY

Gas permeation tests were performed with a designed membrane permeation cell by using carbon dioxide (CO_2), and methane (CH_4). Circular membrane discs with an effective permeation area of 7.069 cm^2 were used. Feed pressure was maintained at 3 bar while permeate side was opened to atmosphere. Permeability 'P' of 1 barrer corresponding to 10^{-10} related to cubic centimetres per second (volume at STP) was calculated by using following equation:

$$\text{Pemeability (Pi)} = \frac{\text{Gas flow rate (Vi)} \times \text{Membrane thickness (l)}}{\text{Area (A)} \times \text{Pressure drop } (\Delta p)} \quad --(1)$$

Where 'i' represent the gas component i, Vi is gas volume permeated through the membrane (cm^3, STP), 'A' the effective membrane area (cm^2), 't' is the time of permeation (s) and 'Δp' is the transmembrane pressure drop (cmHg) [10]. The unit of permeability usually is Barrer, where,

$$\text{Barrer} = 1 \times 10^{-10} \frac{cm^3\ (STP)\ cm}{cm^2\ s\ cmHg} \quad --(2)$$

Selectivity was obtained using Equation (2):

$$\propto_{i/j} = \frac{(y_i/y_j)\text{permeate}}{(x_i/x_j)\text{feed}} \quad --(2)$$

Where, x_i and y_i are mole fractions of component 'i' in the gas mixture in the feed and permeate sides respectively.

IV. RESULTS AND DISCUSSION

The X -Ray Diffractometer (XRD) [9], [19] were used to confirm the phase purity of ZIF-8 and results found in our earlier literature [13]. XRD is a non destructive analysis to measure wavelength of sample and to identify structure. The XRD will release X-rays to the sample and the X-Rays diffracted at different angles and intensity by CuKa irradiation with a wavelength (λ) 1.54 A^0 at room temperature. The schematic graphical representation of synthesized ZIF-8 crystalline powder by room temperature synthesis method and synthesis procedure of ZIF-8 crystals [15] by using de-ionized water and by using methanol has been studied in our earlier work [13].

The single gas permeability's of pure PES and PES/ZIF-8 MMM are presented together in figure-1 and shows that, the single gas permeability of the PES/ZIF-8 MMMs are increasing with increasing ZIF-8 loadings. Especially, with the addition of 30 w/w % and higher ZIF-8 nano-crystals, the raise in the permeability was very strong and the highest increase was in the permeability of CH_4. In literature, there are similar increasing permeability trends with increasing loadings of nano-size filler materials. However, for the higher percentage of ZIF-8 nano-crystals, the gas permeability's were reduced. This trend was claimed as the result of reduction in the amount of polymer for gas transport, increase in the diffusion path length for the gas penetrants, and reducing free volume in the membrane due to increasing density. The increase observed in the permeability values with increasing ZIF-8 loading may be due to the enhanced free volume and ZIF-8 –polymer interfaces that the gas molecules can cross through the membrane.

The selectivity's of the PES/ZIF-8 MMM for CO_2/CH_4 gas pair are represented in table-3. The incorporation of ZIF-8 at low loadings (□ 30 w/w %) improved the performance of the membranes. By the addition of 10 w/w % ZIF-8 into polymer, increased the permeability performance about two times for gases CO_2 and CH_4, while the ideal selectivity for CO_2/CH_4 gas pair showed a slight loss (~14 to 17%). The increase in the permeability's was about 3 to 4 times while the loss in selectivity's for CO_2/CH_4, gas pairs was about approximately 16 % compared to results of pure PES membrane.

For the higher ZIF-8 loadings (≥ 30 w/w %), while the permeability's are increasing, the ideal selectivity's started to reduce very rapidly. Since the most sensible increase in permeability's were observed in CH_4 but the selectivity decreased CO_2/CH_4 for all membranes. In general the ideal selectivity's are improved with the addition of filler into glassy polymers up to 25% and 30% loadings [22].

TABLE 3
PERMEABILITY AND SELECTIVITY OF NEAT PES AND PES/ZIF-8 AT 10, 20, 30 % LOADING PERCENTAGE

Membrane Type	Permeability (Barrer)		Selectivity CO_2 / CH_4
	CO_2	CH_4 x10	
Neat PES	4.4	2.4	35.6
10% ZIF-8	8.6	3.2	30.8
20% ZIF-8	14.7	6.6	29.6
30% ZIF-8	23.8	16.8	23.3

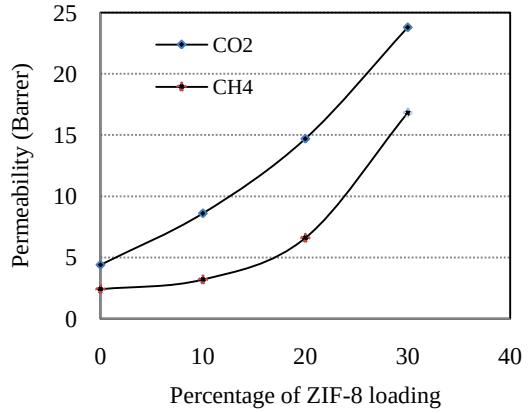

Fig.1. Effect of percentage ZIF-8 loading on single gas Permabilities of PES–ZIF-8 MMM at 3 bar 30^0C

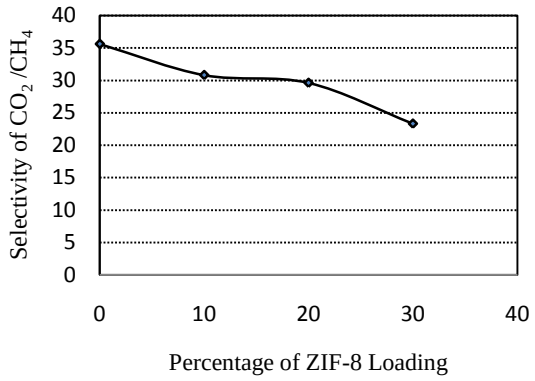

Fig.2. Effect of percentage ZIF-8 loading on selectivity CO_2/CH_4 of PES–ZIF-8 MMM at 3 bar 30^0C.

V. CONCLUSION

The incorporation of synthesized ZIF-8 crystals into continuous PES matrix resulted in high performance gas separation membranes at good dispersion of fillers and high improvement of permabilities with considerable ideal selectivity. The permeability of gases increased with ZIF-8 loading, while the ideal selectivity showed a slight decrease compared to neat PES membrane. The addition of 20 to 25 w/w % ZIF-8 was selected as optimum filler loading for membrane formulation considering the permeation performances at 3 bar pressure. For all types of membranes used, the feed pressure is the other important parameter appreciably affected the separation performances for gas pair. Thus, the MMM prepared with moderate nano-filler loading shows that there will be great potential to be further improvement and various applications in the gas and vapour separation.

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REFERENCES

[1] R.W. Baker, "Membrane Technology and Applications", 2nd ed., John Wiley & Sons, 2006.

[2] Guangxi Dong, Hongyu Li, and Vicki Chen, "Challenges and Opportunities for Mixed Matrix Membranes for Gas Separation," Journal of Materials Chemistry-A, vol. 1, pp. 4610-4630, Jan. 2013, doi: 10.1039/c3ta00927k.

[3] Vajiheh Nafisi, and May-Britt Hagg, "Development of Dual Layer of ZIF-8/ PEBAX-2533 Mixed Matrix Membrane for CO_2 Capture," Journal of Membrane Science, vol. 459, pp. 244-255, Feb. 2014.

[4] Zee Ying Yeo, Pei Yee Tan, Siang-Piao Chai, Peng Wei Zhu, and Abdul Rahman Mohamed,"Continuous Polycrystalline ZIF-8 Membrane Supported on CO_2 -Selective Mixed Matrix Supports for CO_2/CH_4 Separation," RSC Adv., vol. 4, pp. 52461–52466, Oct. 2014, doi: 10.1039/c4ra09547b.

[5] P.S. Goh, A.F. Ismail, S.M. Sanip, B.C. Ng, and M. Aziz, "Review-Recent Advances of Inorganic Fillers in Mixed Matrix Membrane for Gas Separation," Separation and Purification Tech., vol. 81, pp. 243-264, Aug. 2011.

[6] Jianfeng Yao and Huanting Wang, "Zeolitic Imidazolate Framework Composite Membranes and Thin Films: Synthesis and Applications," Chem. Soc. Rev., vol. 43, pp. 4470-4493, March 2014.

[7] Ying Dai, J.R. Johnson, Oguz Karvan, David S.Sholl, and W.J. Koros, "Ultem/ Zif-8 Mixed Matrix Hollow Fiber Membranes for Co_2/N_2 Separations,"Journal of Membrane Science, vol 401-402, pp. 76-82, 2012.

[8] Omid Bakhtiari, Samira Mosleh, Tayebeh Khosravi and Toraj Mohammadi, "Preparation, Characterization and Gas Permeation of Polyimide Mixed Matrix Membranes," Jour. Membrane Science and Technology, vol. 1 no. 1, pp. 1-8, 2011, doi:10.4172/2155-9589.1000101.

[9] Kyo Sung Park, Zheng Ni, Adrien P. Cote, Jae Yong Choi, Rudan Huang, Fernando J. Uribe-Romo, Hee K. Chae, Michael O Keeffe, and Omar M. Yaghi, "Exceptional Chemical and Thermal Stability of Zeolitic Imidazolate Frameworks," PNAS, vol. 103, no.27, 10186–10191, 2006, doi/10.1073/ pnas.0602439103.

[10] Harold B. Tanh Jeazet, Claudia Staudt, and Christoph Janiak, "Metal–Organic Frameworks in Mixed-Matrix Membranes for Gas Separation," Dalton Trans, vol. 41, pp. 14003-14027, 2012, doi: 10.1039/c2dt31550e.

[11] John P. Ferraris, Inga H. Musselman, and Kenneth J. Balkus Jr., "Mixed Matrix Membranes Based on Metal Organic Frameworks," Advanced Materials for Membrane Preparation, Bentham Science Publishers, pp. 83-93, 2012.

[12] Binling Chen, Zhuxian Yang, Yanqiu Zhu, and Yongde Xia, "Zeolitic Imidazolate Framework Materials: Recent Progress in Synthesis and Applications," J. Mater. Chem. A, vol. 2, pp. 16811–16831, 2014, doi: 10.1039/c4ta02984d.

[13] R.M. Abhang, K.S. Wani, V.S. Patil, "Synthesis and Characterization of ZIF-8 Filler for Preparation of Mixed Matrix Membrane" International Journal of Scientific & Engineering Research, Vol.6,(8), ISSN 2229-5518, 2015.

[14] Helen Julian, I.G. Wenten, "Polysulfone membrane for CO_2/CH_4 separation: State of the art", IOSR Journal of Engineering ", Vol.2 (3), pp. 484-495, 2012.
[15] Asim Mushtaq, Hilmi Bin Mukhtar, and Azmi Mohd Shariff," Blending Behavior of Polymeric Materials and Amines in Different Solvents" International Journal of Chemical Engineering and Applications, Vol. 5, No. 2, 2014.
[16] Qilei Song, S.K. Nataraj, Mina V. Roussenova, Jin Chong Tan, David J. Hughes, Wei LI, Pierre Bourgoin, M. Ashraf Alam, Anthony K. Cheetham, Shaheen A. Al-Muhtaseb, and Easan Sivaniah, "Zeolitic Imidazolate Framework (ZIF-8) based Polymer Nanocomposite Membranes for Gas Separation," Energy Environ. Sci., vol. 5, pp. 8359- 8369, 2012.
[17] Anh Phan, Christian J. Doonan, Fernando J. Uribe-Rromo, Carolyn B. Knobler, Michael O'Keeffe, and Omar M. Yaghi, "Synthesis, Structure, and Carbon Dioxide Capture Properties of Zeolitic Imidazolate Frameworks," Accounts of Chemical Research, vol. 43 no. 1, pp. 58-67, 2010.
[18] Iqbal Ahmed, Zainal Abidin Mohd Yusof, M.D.H, Beg, "Fabrication of Polymer Based Mix Matrix Membrane - A Short Review", International Journal of Basic & Applied Sciences IJBAS-IJENS, Vol.10 (2), pp 14-19, 2010.
[19] Joshua A. Thompson, Karena W. Chapman, William J. Koros, Christopher W. Jones, and Sankar Nair, "Sonication – Indusced Ostwald Ripening of ZIF-8 Nanoparticles and Formation of ZIF-8/ Polymer Composite Membranes," Microporus and mesoporous Materials, vol. 158, pp. 292-299, 2012.
[20] M.A. Aroon, A.F. Ismail, T. Matsuura, and M.M. Montazer-Rahmati, "Performance Studies of Mixed Matrix Membranes for Gas Separation: A Review," Separation and Purification Technology, vol. 75, pp. 229–242, 2010.
[21] R.M. Abhang, K.S. Wani, V.S. Patil, "Advancement and Prospective of MOF and ZIF as Filler In Mixed Matrix Membrane For CO_2/N_2 Separation - A Review" Cyber Times International Journal of Technology & Management Vol. 7 (2), 2014.
[22] Anja Car, Chrtomir Stropnik, Klaus- Viktor Peinemann, "Hybrid membrane material with different metal- organic framework (MOFs) for gas separation", desalination, Vol. 200, Pp 424-426, 2006.

Solar Photocatalytic Process for Treatment of Textile Industrial Wastewater

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Abstract *— The worst impact of rapid development in dyes and textile industries in the recent decades has resulted in the accumulation of large quantities of recalcitrant pollutants into our water cycle. Traditionally physicochemical and biological methods used for wastewater treatment have inherent limitations in their applicability, effectiveness and cost. The combination of photo catalytic process using both homogeneous and heterogeneous catalysts like Fenton's process and TiO_2 and its modified forms respectively, with biological treatment for the degradation of organic pollutants can provide a viable alternative for the detoxification and recycling of industrial wastewater. In this study, treated the textile effluent using catalyst namely TiO_2 under the sunlight. It reduces the COD and color of the effluent very sharply. The reaction conditions were optimized such as the catalyst concentration at 0.8 gm/l, pH of the effluent at 5.5 and the rate of degradation at 1ml oxidant per 200ml effluent sample.*

Keywords — *Photocatalytic, Watewater, Textile effluent, TiO_2, COD*

I. INTRODUCTION

Textile mills are major consumers of water and consequently one of the largest groups of industries causing intense water pollution. Around 10 kg and more than 10,000 different synthetic dyes and pigments are produced annually worldwide and used extensively in dyeing and printing industries. Textile processing employs a variety of chemicals, depending on the nature of the raw material and products. It estimates that about 10 % of the chemicals are lost in industrial wastewater [1]. The wastewater generated by the different production steps (i.e. Sizing of fibers, scouring, desizing, bleaching, washing, mercerization, dyeing and finishing) has a high pH and temperature. It also contains a high concentration of organic matter, non-biodegradable matter, toxic substances, detergents and soaps, oil and grease, sulfide, sodas, and alkalinity. In addition, the high salt conditions of the reactive dye baths result in high-salt wastewater, which further exacerbates both their treatment and disposal. The fate of these chemicals varies, ranging from 100% retention on the fabric to 100% discharge with the effluent. As a result, textile industry is confronted with the challenge of both color removal (for aesthetic reasons) and effluent salt content reduction. In addition, reactive dyes are highly water-soluble and non-degradable under the typical aerobic conditions found in the conventional biological treatment system.

More worrying is the fact that current legislation only governs the amount of biochemical oxides in, and the level of alkalinity and acidity of industrial effluents, but not the dye concentration. If polluted fluids are discharged directly into the aquatic environment, their toxicity will be absorbed by aquatic creatures and will eventually find its way through the food chain into human beings.

In general, the current practice in textile mills is to discharge the wastewater into the local environment without any treatment. This wastewater causes serious impacts on natural water bodies and land in the surrounding area. High values of COD and BOD, presence of particulate matter and sediments, and oil and grease in the effluents causes depletion of dissolved oxygen, which has an adverse effect on the marine ecological system. Effluent from mills also contains chemicals; effluents are dark in color, which increases the turbidity of the water body. This in turn hampers the photosynthesis process, causing alteration in the habitat. Besides, the improper handling of hazardous chemical content in textile water has some serious impacts on the health and safety of workers. Contact with chemical puts them the high-risk bracket for contracting skin diseases like chemical burns, irritation, ulcers, etc. and even leads to respiratory problems [2].

Several studies focused on the decolonization of industrial wastewater using different methods of treatments; however, most of these methods have difficulty in practical uses. In recent studies, different systems were used, such as, ozonation [3,4], H_2O_2/UV [5-7], photocatalysis [8,9], photo-Fenton [10,11], electrocoagulation [12], sonolysis [13], gamma–radiolysis [14], biological [15,16] and combined anaerobic–photocatalytic treatment [17].

To overcome the shortcomings in the existing treatment techniques, research and development in innovative technologies during the last decade have

shown that advanced oxidation processes (AOP's) that are combination of powerful oxidizing agents like UV light, UV/TiO_2, O_3 /UV, H_2O_2 to mention a few are highly promising for the remediation of complex organic compounds which are present in contaminated water /effluent systems without generating any sludge or solid material of hazardous character [18].

Among heterogeneous AOP's, Titanium dioxide (TiO_2) – mediated photocatalytic oxidation appears to be a promising alternative, since the optical absorption of TiO_2 is in the near UV –A region and is the major advantage of the photocatalytic method over the UV-C has driven AOP's that require light of shorter wavelengths and hence cannot make use of solar irradiation. The photocatalytic detoxification has been discussed as an alternative method for cleanup of polluted water in the scientific literature since 1976 [19].

The photocatalysis implies the combination of photochemistry with a catalyst. Both radiation and catalyst are necessary to achieve or to accelerate a chemical reaction. Heterogeneous photocatalysis employs semiconductors as catalysts. Besides catalyst and a proper radiation no additional chemicals or expensive processes are necessary. The biggest problem of the photocatalysis nowadays is the low quantum efficiency of generation of reactive species, capable of oxidation or reduction of organic molecules. New development in the research field of photocatalysis might improve this to the degree that photocatalysis will be soon economically acceptable for specific applications.

II. SELECTION OF TiO_2 CATALYST

Titanium dioxide (TiO_2) is a biologically and chemically inert, photostable, largely available and inexpensive, what are its additional advantages in comparison to the other photocatalysts. Some advantages of TiO_2 photocatalysis over the other AOP's could be summarized like (i) Low cost and high chemical stability of TiO_2. (ii) It needs only O_2 and UV photons for the activation. Also the solar energy could be used as a source of UV photons. (iii) It can be applied to the systems with very low concentrations of highly toxic pollutants. (iv) Ions, generally present in water, do not decrease its activity considerably. (v) Total mineralization for many organic compounds could be achieved. (vi) Other decontamination methods could be efficiently combined with TiO_2 photocatalysis thus increasing its efficiency. (vii) TiO_2 photocatalysis works at room temperature, therefore no additional input of thermal energy is necessary.

III. MATERIALS AND METHOD

A. *Materials*

The actual wastewater sample was collected from the equalization tank of Raymond textile industry located at the Jalgaon city of the Maharashtra (India). The photocatalyst used in all the experiments was anatase form of titanium dioxide powder (the BET surface area is 50 ± 15 m^2g^{-1} with an average particle size is 30 nm). Hydrogen peroxide was used as an oxidant. Hydrochloric acid (HCl) and sodium hydroxide (NaOH) was used to adjust the pH. All chemicals are purchased from the Jalgon city.

B. *Methods*

The wastewater characterization was done in environmental laboratory of the Jalgon city. The wastewater sample was highly concentrated. Hence, the sample was diluted in the ratio of 1:1 by using distilled water. The initial pH of the sample was adjusted by using HCl and NaOH solution. The sample was treated in a natural sunlight, as shown in Fig.1. The outside temperature was measured by using a thermometer. Samples were withdrawn after every one hour and filtered. COD of the samples were measured in the environmental laboratory. The results were then optimized variation of oxidant addition, pH adjustments, catalyst loading. The tests were repeated for getting the reproducibility of results.

Fig. 1. Photocatalytic treatment of wastewater in sunlight

IV. RESULT AND DISCUSSIONS

A. *Wastewater characteristics*

Raw wastewater was collected directly from the equalization tank of the Raymond textile Industry. The analyses were done in the environmental laboratory and those shown in Table 1. The sample was found with highly concentrated on the TS, TSS and TDS. So some pre-treatment is required, so as to safely discharge the water.

B. *Effect of_Catalyst (TiO_2) concentration on the reduction of COD*

Catalyst (TiO_2) concentration was varied from 2.0 g/l to 10 g/l (i.e. 0.2% to 1.0%) during reactions in sunlight. It was observed that the rate increases with an increase in catalyst concentration and becomes constant above a certain level. The reasons for this decrease in degradation rate are as: (i) Aggregation of TiO_2 particles at high concentrations causing a decrease in the number of surface active sites, and (ii) Increase in opacity and light scattering of TiO_2 particles at high concentration leading to decrease in the passage of irradiation through the sample.

Table 1.
Characteristics of the raw wastewater sample of Raymond textile mill

Sr. No	Parameter	Prevailing Range(mg/l)
1.	COD	240 – 250
2.	TS	681600
3.	TDS	297600
4.	TSS	384000
5.	COLOUR	Light pink
6.	pH	9.54 – 10
7.	Temperature	34^0 c

As the concentration of the catalyst is increased, the number of photons absorbed and the number of pollutant molecules absorbed are increased owing to an increase in the number of TiO_2 particles. The density of particles in the area illumination also increases and so the rate is enhanced. Above a certain level, the substrate molecules available are not sufficient for adsorption by the increased number of TiO_2 particles. Hence the additional catalyst amount is not involved in the catalytic activity and the rate does not increase with an increase in the amount of catalyst beyond a certain limit. Surface active sites also decrease due to aggregations of TiO_2 particles at high concentrations. This observation is in agreement with the observations reported in literature and an amount of 3.0 mg/l has been taken for the subsequent experiments for studying the effect of oxidant addition and pH of the solution.

Fig.2 shows the effect of catalyst concentration on the COD reduction. It was observed that the COD continuously decreases from 240 to 20 mg/L on increasing the catalyst concentration from 0.2 g/l to 1.0 g/l. An optimum of catalyst concentration has to be taken when the decrease in COD level is to be within acceptable limits. Use of higher concentration of catalyst will increase the cost of the process and decrease the permeability of sunlight.

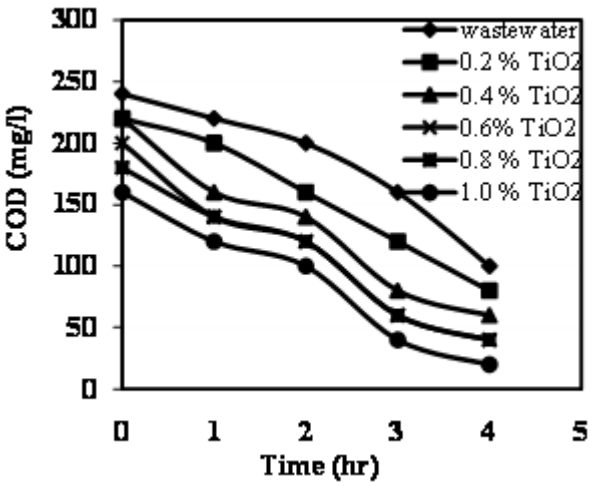

Fig. 2. Effect of catalyst concentration on the COD reduction

C. ***Effect of operating pH***

The wastewater from textile industries usually has a high pH value (nearly 10). Further, the generation of hydroxyl radicals (AOP's) is also a function of pH. Thus pH plays an important role both in the characteristics of textile wastes and the generation of hydroxyl radicals. Hence, attempts have been made to study the influence of pH in the degradation of dye in the range 3 - 10.

The pH of the solution significantly affects TiO_2 activity, including the charge on the particles, the size of the aggregates it forms and the positions of the conductance and valence bands.In our experiments, maximum degradation was observed at pH nearly 6. As shown in fig.3. Other pH values also responded to good degradation rates, but the final pH after photocatalytic treatment which was the deciding factor for determining the optimum pH, which was found to be in the range of 6.0-7.0. So it is clear that an optimum pH should be at 6.0, because maximum degradation was achieved at this pH and final pH gets to be 7.0, which was suitable for the biological process.

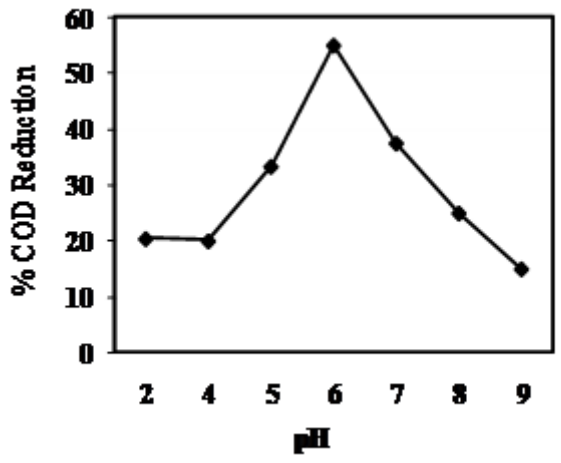

Fig. 3. Effect of pH on the % degradation of the effluent (0.4% catalyst loading)

D. *Effects of Oxidant addition*

One possible way to increase the reaction rate would be to increase the concentration of OH radicals because these species are widely considered to be promoters of photocatalytic degradation. The addition of hydrogen peroxide to the heterogeneous system increases the concentration of OH radical, since it inhibits the electron-hole recombination, according to the following equation:

$$TiO_2 (e^-) + H_2O_2 \longrightarrow TiO_2 + OH^- + OH^\bullet \quad (1)$$

Hydrogen peroxide is considered to have two functions in the process of photocatalytic degradation. It accepts a photo generated electron from a conduction band and thus promotes the charge separation, and it also forms OH radical, according to Eq. (1). However, at high concentration of H_2O_2, it also acts as a scavenger as shown in the following equations.

$$H_2O_2 + OH^\bullet \longrightarrow HO_2^\bullet + H_2O \quad (2)$$

$$HO_2^\bullet + OH^\bullet \longrightarrow H_2O + O_2 \quad (3)$$

In the experiments, the hydrogen peroxide concentrations were varied from 1.0 to 5.0 ml per 1000ml of the effluent. The best results were found, when oxidant addition came out to 1ml/200ml of effluent and has been taken as the optimum amount required for maximum effective degradation of pollutants.

E. *Color Removal*

Color is usually the first contaminant to be recognized in wastewater. Many azo dyes, constituting the largest dye group, may be decomposed into potential carcinogenic amines under anaerobic conditions in the environment. Color removal from wastewater is often more important than the removal of soluble colorless organic substances, a major fraction of which contribute to the COD and BOD besides disturbing the ecological system of the receiving waters. The traditional techniques used for color removal are activated carbon (charcoal), filtration and coagulation. Each method has a few advantages and disadvantages. For example, the use of charcoal is technically easy, but has high waste disposal cost. Although filtration potentially provides pure water as the final product, it is possible for low molar mass dyes to pass through the filter system. Coagulation using alums, ferric salts or limes is a low cost process, but all these methods have a major disadvantage of simply transferring the pollutants to another phase rather than destroying them. Biological treatment is a proven technology and cost effective, however, it has been reported that the majority of dyes is only adsorbed on the sludge and not degraded.

F. *Reuse of TiO_2*

The catalyst's lifetime is an important parameter of the photocatalytic process, due to the fact that its use for a longer period of time leads to a significant cost reduction of the treatment. For this reason, the photocatalytic experiment was repeated 3 times with the same amount of TiO2 P-25 as catalyst. The quantity of the catalyst was reduced day by day, but only in a very small percentage (1% of the initial quantity was lost). No more catalyst was added. Catalyst recycling depends upon the following factors: 1. Fouling of catalyst, 2. Nature of pollutants, 3. Reaction conditions, 4. Activation, etc.

V. CONCLUSIONS

In this study, we treated the textile effluent using catalyst namely Titanium dioxide under the sunlight. The Titanium Dioxide reduces the COD of the wastewater to a very approachable and also it retains the properties of water and the color reduction was also very sharp. During photocatalytic pretreatment, reaction conditions were optimized for getting the economical benefits of the process. Catalyst concentration was optimized at 0.8 gm/l, pH of the effluent was optimized in 5.5 and the rate of degradation was enhanced by optimizing 1ml oxidant per 200ml effluent sample.

The chemical process could be used as pretreatment in order to1 increase the biodegradability of the wastewater or as a post-treatment to remove the non-biodegradable compounds. The solution resulting from the photo treatment stage is considered to be biologically compatible after the elimination of: the initial biorecalcitrant and/or toxic compounds, the inhibitory and/or non-biodegradable intermediates, and any chemical reagent (H_2O_2, O_3….).

These requirements, together with information concerning the evolution of toxicity and biodegradability of the pretreated solution, allow the determination of optimal operational conditions, which corresponds to the best cost-efficiency compromise. Finally, this strategy could be used as a useful guide, as it proposes an easy way to determine the most feasible methods for any industrial wastewater treatment.

This photocatalytic method is quite easy and cheap for the treatment of wastewater as the main energy for the treatment is available free of the cost. It is easy to setup in the industry as the cost of setup is much lower than the other methods.

The only disadvantage of this process was found that the total solids, total dissolved solids and total suspended solids increases by a considerable amount.

REFERENCES

[1] L. Young, J. Yu, Ligninase catalysed decolourization of synthetic dyes, Water Res., 31, (1997) 1187-1193.

[2] F. H. Hussein, T.A. Abass, Photocatalytic treatment of textile industrial wastewater, Int. J. Chem. Sci. 8(3) (2010) 1353-1364
[3] M. J. Farre, M. I. Franch, S. Malato, J. A. Ayllon, J. Peral, X. Domenech, Degradation of some biorecalcitrant pesticides by homogeneous and heterogeneous photocatalytic ozonation, Chemosphere, 58 (2005) 1127-1138.
[4] H. N. Liu, G. T. Li, J. H. Qu and H. J. Li, Degradation of azo dye Acid Orange in water by Fe0/granular activated carbon system in the presence of Ultrasound, J. Hazard. Mater., 144 (2007) 180-189.
[5] A. Aleboyeh, Y. Moussa and H. Aleboyeh, Kinetics of oxidative decolourisation of Acid Orange 7 in water by ultraviolet radiation in the presence of hydrogen peroxidePurif. Technol., 43 (2005) 143-149.
[6] P. Baldrian, V. Merhautova, J. Gabriel, F. Nerud, P. Stopka, M. Hruby and M.J. Benes, Decolorization of synthetic dyes by hydrogen peroxide with heterogeneous catalysis by mixed iron oxides, Appl. Catal. B Environ., 66 (2006) 258-263.
[7] Amin Heba, Ashraf Amer, Anwer El Fecky and Ibrahim Ibrahim, Treatment of textile wastewater using H_2O_2/UV system, Physicochemical Problems of Mineral Processing, 42 (2008) 17-25.
[8] D. F. Ollis, Photocatalytic purification and remediation of contaminated air and water," Comptes Rendus de l'Academie des Sciences - Series IIC: Chemistry, 3(6), (2000) 405–411.
[9] Abbas J. Attia, Salih H. Kadhim and Falah H. Hussein, Photocatalytic Degradation of Textile Dyeing Wastewater Using Titanium Dioxide and Zinc Oxide, E-J. Chem., 5 (2008) 219-226.
[10] K. Barbusiński, The Modified Fenton Process for Decolorization of Dye Wastewater, Polish J. Environ. Stud., 14 (2005) 281-286.
[11] K. Barbusiński and K. FilIpek, Use of Fenton's Reagent for Removal of Pesticides from Industrial Wastewater, Polish J. Environ. Stud., 10 (4), (2001) 207-215.
[12] Hao-Jan Hsing, Pen-Chi Chiang, E. E. Chang and Mei-Yin Chen, The decolorization and mineralization of Acid Orange 6 azo dye in aqueous solution by advanced oxidation processes: A comparative study, J. Hazard. Mater.,141 (2007) 8-16.
[13] C. Minero, P. Pellizzari, V. Maurino, E. Pelizzetti and D. Vione, Enhancement ofdye sonochemical degradation by some inorganic anions present in naturalwaters, Appl. Catal. B – Environ., 77 (2008) 308-316.
[14] J. A. LaVerne, K. Enomoto and M. S. Araos, Radical yields in the radiolysis of cyclic Compounds, Radiat. Phys. Chem., 76 (2007) 1272-1274.
[15] A. B. Dos Santos, I. A. E. Bisschops, F. J. Cervantes and J. B. Van Lier, The transformation and toxicity of anthraquinone dyes during thermophilic (55 ºC) and mesophilic (30 ºC) anaerobic treatments, J. Biotechnol., 115 (2005) 345-353.
[16] Y. H. Lee, R. D. Matthews and S. G. Pavlostathis, Biological decolorization of reactive anthraquinone and phthalocyanine dyes under various oxidation-reduction conditions, Water Environ. Res., 78 (2006) 156-169.
[17] F. Harrelkas, A. Paulo, M. M. Alves C, L. El Khadir, O. Zahraa, M. N. Pons and F. P. Van Der Zee, Photocatalytic and combined anaerobic–photocatalytic treatment of textile dyes, Chemosphere, 72 (2008) 1816-1822.
[18] Mukherjee P.S., Ray A.K., Major challenges in the design of a large-scale photocatalytic reactor for water treatment. Chemical Engineering and Technology, 22 (1999) 253-260.
[19] Hardin, I.R., et.al., (2000), Textile Chemist and Colorist and American Dyestuff Reporter, 32 (11), (2000) 38-42.

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Fluoride Removal from Water Using Selected Processes.

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Abstract– *Contents of fluoride in water is raising many environmental and human health issues. The dental and skeletal fluorosis issues are quite common. As per World Health Organisation the permissible limit of fluoride content is 1.5 ppm. The technologies which are available for fluoride removal are limited, they have their own advantages and disadvantages. In adsorption processes, the low cost adsorbents are not giving fluoride removal, with the desired optimum conditions especially pH of the water. In case of precipitation methods the water is contaminated with the precipitating material. The coagulation or electrocoagulation and reverse osmosis materials shows feasibility of the fluoride removal.*

Keyword: *Fluoride, adsorption, precipitation, reverse osmosis, coagulation.*

I. Introduction

High concentrations of fluoride, in drinking water result in dental, skeletal fluorosis, and several neurological damages [1]-[2]. Fluoride is a normal constituent of natural water samples. Its concentration, though, varies significantly depending on the water source. Although both geological and manmade sources contribute to the occurrence of fluoride in water, the major contribution comes from geological resources. The presence of naturally occurring fluorides or added fluoridated salts in drinking water allows its easy entrance in the body via the gastrointestinal tract [3]-[4]. Fluorides are found in the waste discharges from process streams in a number of industries. Significant amounts of fluoride come from the following industries: semiconductor, photovoltaic, glass manufacturers, electroplating, steel and aluminum, pesticides and fertilizer. The fluoride concentration in untreated effluent can vary over a large range, and the allowable level for discharge depends on the place of disposal [5].

II. Methods available for fluoride removal

Fluoride Removal by Adsorption

A wide variety of adsorbents and their modifications have been tested for the removal of fluoride from water. These include activated carbons , activated alumina , bauxite , hematite , polymeric resins , activated rice husk , brick powd, pumice stone, red soil, charcoal, brick, fly ash, serpentine , seed extracts of Moringa oleifera , granular ceramics , chitin, chitosan and alginate , modified ferric oxide/hydroxide , hydroxyapatite (HAP) , zirconium and cerium modified materials, titanium-derived adsorbent , schwertmannite , modified cellulose, clays , zeolite and magnesium-modified sorbent [6]. The removal of fluoride was attempted using natural materials such as red soil, charcoal, brick, fly-ash and serpentine. Each material was set up in a column for a known volume and the defluoridation capacities of these materials were studied with respect to time. According to the maximum defluoridation capacity these materials were added proportionately to the vertical column. Ten mg-l -1of fluoride was passed through the column and the variation of fluoride removal for a known rate of flow was studied.

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Acknowledgement based Security for Manets Against DDOS attacks

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Abstract : *Wireless MANET Mobile AD-HOC Network is an emerging technology and have great strength to be applied in critical situations such as military applications, battlefields commercial and most important and critical applications. Every node in MANET has its own routing capability and free to move in any direction as it does not have centralized infrastructure. However, the open medium and wide distribution of nodes in MANET faces security. Chances of attack on MANET increases as wireless sensor nodes are in unattended environment; there are many types of attacks for example wormhole denial of service, black hole etc.; the DDOS is one of them. DDOS affects network by increasing routing load, end to end delay, packet drop and many other parameters. So it is very important to design and develop effective intrusion-detection system to protect MANET from DDOS attacks. In this paper, we discuss DDOS attack on MANET, and propose and implement a enhanced intrusion-detection system to detect DDOS type of attack and provide security against it using hybrid cryptology for acknowledged packets.*

Keywords :*Acknowledgment (ACK), Mobile Ad hoc Network (MANET), Distributed Denial of Service (DDOS).*

1. INTRODUCTION

Mobile nodes which communicate with each other without centralized infrastructure is Mobile Adhoc Network MANET. Communication between each node is bidirectional however these nodes cannot communicate with each other if distance between them is beyond the range; So Manet is divided in two types of network single hop and multihop to relay data transmission. In a single-hop network, all nodes within the same radio range communicate directly with each other and in multi hop nodes depend on other intermediate nodes to transmit if the destination node is out of their radio range due to this it is vulnerable to attacks. So traditional based IDS are no more feasible .So secure intrusion detection system is to be build for MANET. One of the most powerful attack is DDOS where huge amount of packets are sent to target all over the network this uses large amount of bandwidth thereby dropping important packets to reach the target and as MANET is used in military applications it is important to build the secure IDS for MANET.

2. BACKGROUND

IDS in MANETs

In this section we describe three approaches of IDS based on acknowledgement and also discuss some possible types of attack on MANET. Three existing approaches are: Watchdog [4], TWOACK [2], Adaptive Acknowledgment (AACK) [5], and EAACK [1]

1) Watchdog*:* Marti et al. [4] proposed a scheme named Watchdog. Watchdog serves as IDS for Manets by detecting malicious node that misbehaves in the network. It detects malicious node by listening to the next hop in transmission, if watchdog finds that next node fails to transmit the packet within period of time then it increases the its failure counter and if it reaches its threshold then it reports the node as malicious. Advantages has made watchdog popular but has disadvantages too. It fails to detect malicious behavior with following:

1) Ambiguous collisions; 2) receiver collisions; 3) limited transmission power; 4) false misbehavior report;5) collusion; and 6) partial dropping.

2) TWOACK: TWOACK proposed by Liu et al. [3] is one of the most important approaches among them. It detects the misbehaving by acknowledgement from every three consecutive nodes from source to destination; each node has to send the acknowledgement upon retrival of packet to the node two hops away down the route. If packet is not received in predefined time then both nodes are reported as malicious. It works on DSR .Twoack solves the problems such as receiver collision and limited power transmission but increases the unwanted network overhead by acknowledge process required by the packets in transmission.

3) AACK*:* Based on TWOACK, Sheltami et al. [5] proposed a new scheme called AACK. AACK reduces network overhead faced by twoack.In this a packet is send from the source node and all intermediate nodes forwards the packet to the destination node, as the packet reaches the destination node has to send the acknowledgement packet to the source node on the same route in reverse order, if this packet is not received the acknowledgement in predefined time then source nodes shifts to twoack node this reduces the network overhead but still fails to detect malicious node due to false report and forged acknowledgement packet.
4) EAACK: It handles three weakness of watchdog such as false misbehavior, limited transmission power, and receiver collision, N. Kang et. al.[1] proposed a system called Enhanced Adaptive Acknowledgement(EAACK) it consist of three parts as.
A. Acknowledgement mode: It is basically the end-to end acknowledgement in predefined time else switches to S-ack mode.
B.Secure-Acknowledgement mode: This part is basically to determine misbehaving nodes in the route. Every two consecutive nodes should send acknowledgement to source node in reverse path,so misbehaving node will be detected if acknowledgement not received in predefined time and then shifts to MRA –mode. to confirm misbehavior report.
C. Misbehavior reporting acknowledgement mode: This is designed to detect whether the destination node has received the missing packet through different route. to detect the misbehaving node with presence of false misbehavior report because this report can be generated by malicious attacker to report innocent nodes as malicious. this attack can be harm for entire network. If reported packet was received, if already received then it concludes that this is a false misbehavior report and whoever has generated this report is declared as malicious. Otherwise report is trusted.
EAACK fails to detect is source get attacked and also increases the overhead and time required to deliver the packet.
5) TYPES OF ATTACK:
a. Denial of service: it completely disrupts the routing information by creating the bogus route information thereby disrupting the the establishment of routes and to use resources of the participating nodes and consumes batteries by keeping the nodes engage in finding the routes which leads to overflow of the routing table.[7]
b. Distributed denial of service: In denial of service only one node participates in the attack whereas in DDOS many nodes participate in the attack thereby disrupting routing information. All nodes at a time attack on victim node by sending huge amount of packets which will consume bandwidth and victim will not be able to receive important packet [7].

3. PROBLEM DEFINITION

Three weakness of watchdog such as false misbehavior, limited transmission power, and receiver collision along with to detect if source gets attacked and to reduce overhead and increase packet delivery ratio are handled by our [proposed system. The three problems in detail:
1. Receiver collisions: for example node A sends packet 1 to node B it overhears that whether node B has forwarded the packet to node C at the same time node X is sending packet 2 to node C, node A overhears that node B has successfully forwarded the packet to node C but failed to notice that node C has not received the packet 1 due to collision between node 1and node 2.
2. Limited Transmission power: In order to preserve own transmission power node B limits its power such that it is strong enough to be overhear by node A but not strong enough to be received by node C
3. A False Misbehavior Report: node A successfully overhears that node B has forwarded packet to node C, still node A reports as node B misbehaving.
So in our propose IDS we use improved EAACK with additional node as IDS node which will routing protocol [9].As the system is completely based on acknowledgement packets it needs security so we extend the research by adding hybrid cryptography by using algorithms such as AES and Blowfish during packet transmission to ensure integrity and authenticity of all acknowledgement packets.

4. SCHEME DESCRIPTION

In this section, we describe our proposed scheme in detail each node in the network is bidirectional. Additionally one node is set as attack node and one node source node as IDS node. Hybrid cryptography (AES and blowfish algorithm) is used to prevent acknowledgement packets from attacks. Our system Improved

EAACK consists of major parts of EAACK which are already discussed. and additional part such as attack node, IDS node. To detect DDOS attack.

1. Attack node

In this we create one node as attacker node whose parameters are set such as scan time, scan port, infection rate, attacker node then sends probing packet to all other nodes .Any weak node in the radio range then agrees for communication with attacker node when that probing packet is received by the node is infected then this infected nodes launch DDOS attack and infect next node so on in that case overall network is infected.

2. IDS NODE

In this one node is set as IDS node that watches all the nodes in the range for abnormal behavior in the network. That node creates the normal profile which contains information such as packet type (TCP, UDP, CBR), time of packet (sent, received) and threshold value.

3. Acknowledgement mode

It is basically the end-to end acknowledgement .In this S node sends out the packet to the destination node if all the nodes in the path are cooperative then node D.Successfully receives the packet, then node D has to send the acknowledgement to the node S along the same path in reverse order in predefined threshold time. If node S receives the packet in the time defined then the packet transmission from node S to node D was successful else it switches to S-ACK mode.

4. Secure-Acknowledgement mode

This part is basically to determine misbehaving nodes in the route. IDS node here compares the normal profile with each new trace value, then to find the attacker scheme proposed by Liu *et al.* [3] is applied every third consecutive node needs to send S-ACK acknowledgement packet to the first node, if first node does not receive this packet in the predefined time then both nodes are declared as misbehaving nodes. Then are scheme moves to MRA mode to confirm misbehavior report.

5. Misbehavior reporting acknowledgement mode

This is designed to detect whether the destination node has received the missing packet through different route. It solves the weakness of watchdog when it fails to detect the misbehaving node with presence of false misbehavior report because this report can be generated by malicious attacker to report innocent nodes as malicious. This attack can be harm for entire network. To start MRA mode the source node searches for alternative route and sends packet to destination node by diverting the misbehavior reporter node. When destination receives MRA packet taking the help of ids node it compares if reported packet was received, if already received then it concludes that this is a false misbehavior report and whoever has generated this report is declared as malicious. Otherwise report is trusted.

In our proposed system as the IDS node is introduced which maintains the profile along with the information of affected node .So when in MRA mode it is searching for alternate path it will select the path comparing it with profile & log as it will not select the affected node in it will increase the throughput of the system and by acknowledgement we will get sure that the packet has reached the destination.

```
Algorithm
Create node =ids;
If ((node in radio range) && (next hop! =Null)
{
Capture load (all_node)
Create normal_profile (rreq, rrep, tsend, trecv, tdrop)
{pkt_type; //  TCP, CBR, UDP
Time;
Tsend, trecv, tdrop, rrep, rreq
}
Threshold_parameter ()
If((load<=max_limit)&& (new_profile<=max_threshold) &&(new_profile>=min_threshold))
{
Not DDOS attack;
```

```
        Shift to ACK mode()//send acknowledgement to the source node
        }
        Else {
        Attack in network;
        Find_attack_info (); // by IDS Node
        Shift to S-ack mode()
    }
      Else {
        "Node out of range or destination unreachable"
        Find_attack_info ()
        {
        Compare normal_profile into each trace value
        If (normal_profile! = new trace_value)
        {
        S-ack mode generates Node misbehavior Report
         shift to MRA ();
        }
```

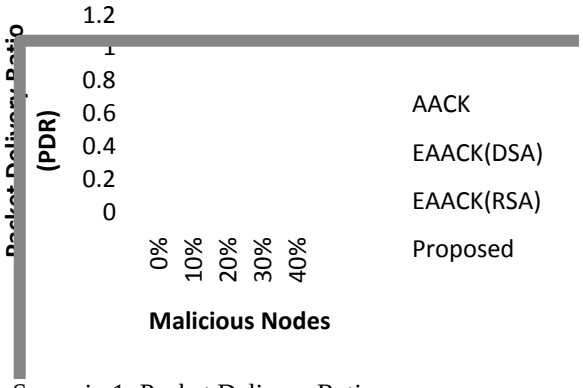
As in our proposed system we rely on acknowledgement packets to detect misbehaving in the network; we need to secure acknowledgement packets to maintain integrity so hybrid cryptography a combination of AES and Blow fish is used for encryption and decryption to safeguard the data. Blowfish t uses symmetric block cipher variable key length from 32 bits to 448 bits for securing data it uses Feistel Network iterating simple encryption function 16 times with block size 64 bits. AES with block size of 128 bits 196 bits and 256 bits works on substitution principle and encrypts data in one pass. The plaintext is the input to blowfish then output cipher text of blowfish is the input to AES and the output of AES is the double encrypted cipher text which is the strongest cipher text we receive .This provides high security as we need that to use in applications such as military.

5. RESULT

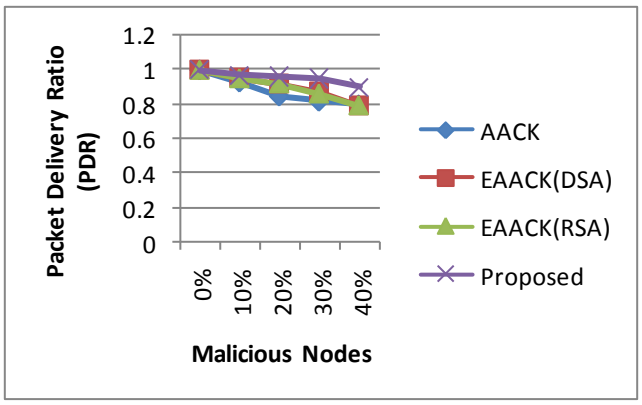
We implemented the system in real time to compare the performances one of the parameter performance parameter PDR was used.Packet Delivery ratio(PDR): defines the ratio of number of packets received by the destination to the number of packets sent by source node.

The graph shows the results with three scenarios:

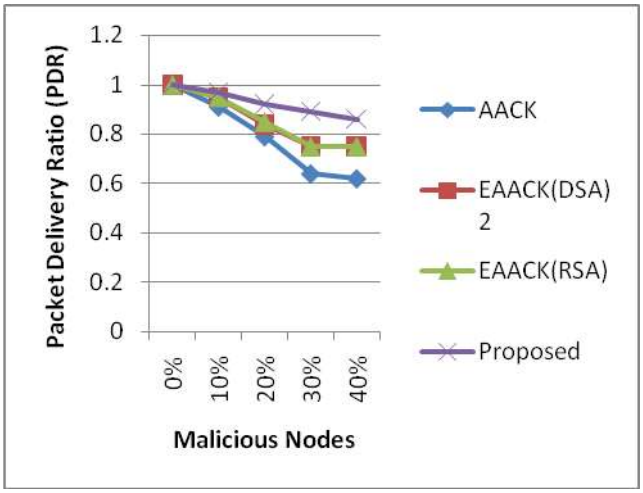
1. Scenario1: Malicious nodes drop all the packets that pass through the network. Table shows that EAACK's performance drops due to MRA but proposed system increases it as it receives MRA acknowledgement fast.
2. Scenario2:In this we set all the malicious node to sent false misbehavior report in this our proposed system works more than 90% due to MRA mode with IDS node as it finds the alternate route faster. To detect misbehavior node.
3. Scenario3: In this we set malicious node with ability to forged acknowledgement packets. In this our system shows the improved results.



Scenario 1: Packet Delivery Ratio



Scenario 2: Packet Delivery Ratio



Scenario 3: Packet Delivery Ratio

6. CONCLUSION

With our proposed system it not only helps us to detect the DDOS type attacks but also increases the PDR as shown in our results as DDOS attack is the dangerous and it affects network load. This type of attack also ditrupts the routing information but as we maintain the IDS Node with profile by comparing we get the results fast as to which node is affected or may be affected and find the alternate route faster. Hydrid

crytopgraphy (AES & Blowfish) provides double encryption nad is faster.. In future we can use the system with other protocols to find the different types of attacks.

REFERENCES

[1] Elhadi M. Shakshuki, Senior Member, IEEE, Nan Kang, and Tarek R. Sheltami, Member, IEEE "EAACK—A Secure Intrusion-Detection System for MANETs" IEEE Transactions on Industrail Electronics, VOL. 60, NO. 3, March 2013
[2] K. Liu, J. Deng, P. K. Varshney, and K. Balakrishnan, "An acknowledgment-based approach for the detection of routing misbehaviourin MANETs," IEEE Trans. Mobile Comput., vol. 6, no. 5,pp. 536–550, May 2007.
[3] S. Marti, T. J. Giuli, K. Lai, and M. Baker, "Mitigating routing misbehaviourin mobile ad hoc networks," in Proc. 6th Annu. Int. Conf. MobileComput. Netw., Boston, MA, 2000, pp. 255–265.
[4] T. Sheltami, A. Al-Roubaiey, E. Shakshuki, and A. Mahmoud, "Videotransmission enhancement in presence ofmisbehaving nodes inMANETs,"Int. J. Multimedia Syst., vol. 15, no. 5, pp. 273–282, Oct. 2009.[26]
[5] K. Al Agha, M.-H. Bertin, T. Dang, A. Guitton, P. Minet, T. Val, and J.-B. Viollet, "Which wireless technology for industrial wireless sensor networks? The development of OCARI technol," IEEE Trans. Ind. Electron., vol. 56, no. 10, pp. 4266–4278, Oct. 2009.
[6] Prajeet Sharma, Niresh Sharma, Rajdeep Singh" A Secure Intrusion detection system against DDOS attack in Wireless Mobile Ad-hoc Network" International Journal of Computer Applications (0975 – 8887) Volume 41– No.21, March 2012
[7] A.Anna lakshmi and Dr.K.R.Valluvan " A Survey of Algorithms for Defending MANETs against the DDoS Attacks;" Volume 2, Issue 9, September 2012 ISSN: 2277 128X
[8] G. Jayakumar and G. Gopinath, "*Ad hoc* mobile wireless networks routing protocol—A review," *J. Comput. Sci.*, vol. 3, no. 8, pp. 574 582,2007
[9] N. Kang, E. Shakshuki, and T. Sheltami, "Detecting misbehaving nodes in MANETs," in *Proc. 12th Int. Conf. iiWAS*, Paris, France, Nov. 8–10,2010, pp. 216–222.
[10] N. Kang, E. Shakshuki, and T. Sheltami, "Detecting forged Acknowledgements in MANETs," in *Proc. IEEE 25th Int. Conf. AINA*, Biopolis, Singapore, Mar. 22–25, 2011, pp. 488–494.

PI Self Tuning Control system For UPFC Application

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ABSTRACT

A new add- on self tuning control scheme to supplement its conventional PI control system in damping high frequency inter area power oscillations is proposed in this paper. Inter-area oscillations having frequency(0.1 to 0.8 Hz) are often observed because of disturbances such as faults, line outages and sudden load changes causes power systems interconnected through weak tie lines. Power System stabilizers (PSS) that are invented are suitable for damping local area(intra-area) oscillations. Unified Power Flow Controller is a member of the FACTS family. UPFC can control both transmitted real and reactive power independently, at the receiving ends and sending end of the transmission line. The UPFC is an advanced power systems device capable of providing simultaneous control of voltage magnitude and active and reactive power flows in an adaptive fashion. Artificial Neural networks and fuzzy logics require either offline training or inference rules which are ineffective for damping oscillations in a dynamic power system. To overcome these problems it is proposed to supplement the PI controller with an (Self Tuning) ST feedback loop comprised of an identifier and a Pole Shifting (PS) control algorithm.

Keywords

Adaptive control, flexible AC transmission systems (FACTS), power systems control, self-tuning (ST) control

1. INTRODUCTION

An ever-increasing demand in electricity accompanied with restricted building of new transmission facilities has caused today's interconnected power systems to be overloaded. as a consequence, high frequency (0.1 to 0.8 Hz) inter-area oscillations are often observed when power systems interconnected through weak tie lines are withstand disturbances such as faults, line outages and sudden load changes. Previously, power system stabilizers (PSS) installed at generator locations were common damp such system oscillations. However, PSSs are localized stabilizers and hence best suited for damping local oscillatory modes in the power system. The advancements in high-power semiconductors leds to the advent of flexible AC transmission systems (FACTS) technology.UPFC Is a device capable of controlling the active and reactive power flows in a transmission line by controlling appropriately its series and shunt parameters[4]. In addition to being appropriate controlling line power flows, the UPFC can also damp out power oscillations [1]. A majority of these control systems has employed conventional-PI (or lead-lag) controllers as feedback controllers, providing satisfactory damping performance around a specific operating point.

The proposed self-tuning (ST) controller in this paper differs from the ANN and Fuzzy Logic control approaches [2][3]. Unlike ANNs, it does not require offline training nor is dependent on inference rules, which are essential for fuzzy approaches. It instead addresses these deficiencies by exploiting the principles of indirect adaptive control theory. Indirect adaptive control principle consists of an identifier and controller. The identifier peeve an estimated plant model of a power system; an auto-regressive moving average (ARMA) model. It identifies the ARMA parameters online and uses parameter estimates to adaptively tune the corresponding control parameters thereby yielding a satisfactory control performance. The adaptive identifier and controller described works well for large disturbances as well. The performance of the proposed ST control scheme depends on accurate determination of the ARMA parameters[5]-[7]. It was previously reported that an RLS identifier primarily of the estimation process gives poor estimation results due to large initial transients present in the system. In this paper, a simple third-order ARMA model is proposed to represent the dynamic oscillations in the power system and it has been found to be sufficient to represent the high frequency power

oscillations in the power system. This is because a third-order model has three poles: a pair of complex poles and a real pole. The complex poles represent the oscillatory behavior of the power oscillations and could be used to damp the overshoot using the PS controller; whereas the real root represents the decaying either the oscillatory response and perhaps controlled with the PS controller to achieve the desired steady-state response.

2. UPFC CONTROL SYSTEM

The unified power flow controller (UPFC) is one of the most widely used FACTs controllers and its main function is to control the voltage, phase angle and impedance of the power system thereby modulating the line reactance and controlling the power flow in the transmission line. The basic components of the UPFC are two voltage source inverters (VSIs) connected by a common dc storage capacitor which is connected to the power system through a coupling transformers. One (VSIs) is connected in shunt to the transmission system through a shunt transformer, while the other (VSIs) is connected in series to the transmission line through a series transformer. Three phase system voltage of controllable magnitude and phase angle (Vc) are inserted in series with the line to control active and reactive power flows in the transmission line. So, this inverter will exchange active and reactive power within the line. The shunt inverter is operated in such a way as to demand this dc terminal power (positive or negative) from the line keeping the voltage across the storage capacitor (Vdc) constant.

There are several possibilities of operating configurations by combing two or more converter blocks with flexibility. Among them, there is a novel operating configuration, namely the Generalized Unified Power Flow Controller (GUPFC) which is significantly extended to control power flows of multiline or a sub-network preferably control power flow of single line by a Unified Power Flow Controller (UPFC) or Static Synchronous Series Compensator (SSSC).

The UPFC consists of two branches. The series branch consists of a voltage source converter which injects a voltage in series through a transformer. Since the series branch of the UPFC can inject a voltage with variable magnitude and phase angle it can exchange real power with the transmission line. The energy storing capacity of this dc capacitor is generally small. Therefore, active power drawn by the shunt converter should be equal to the active power generated by the series converter. The reactive power in the shunt or series converter can be chosen independently, giving greater flexibility to the power flow control. The coupling transformer is used to connect the device to the system. Figure 1 shows the schematic diagram of the three phase UPFC connected to the transmission line.

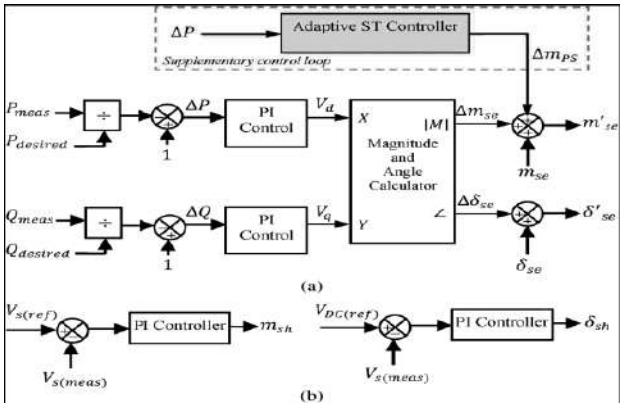


Fig 1: Overall UPFC control system for a damping application. (a) Series VSC control system; (b) Shunt VSC control system.

3. SELF-TUNING (ST) CONTROLLER

Self-tuning control schemes are useful for systems with unknown or slowly time-varying parameters and represent a class of advanced control algorithms[8]-[10] .The principle of adaptive control is based on self-tuning control as shown in Fig. 2 In this approach, first, the power system including the UPFC is represented by a suitable fixed-order mathematical (ARMA) model. The main aim of the adaptive control approach is to solve the control problem in cases where the characteristics of a controlled system are unknown or time variable. The basic principle of the adaptive control system is to change the controller characteristics on base of the characteristics of control process[12]. Selftuning controllers use the combination of the recursive process identification on base of a selected model process and the controller synthesis based on knowledge of parameter estimates of controlled process.Next, an identifier is used to determine the parameters of the ARMA model. Finally, the updated parameters that track the system operating conditions are used all pole-shift controller to compute the necessary control. The computation of the updated parameters and control is done on-line every sampling period.

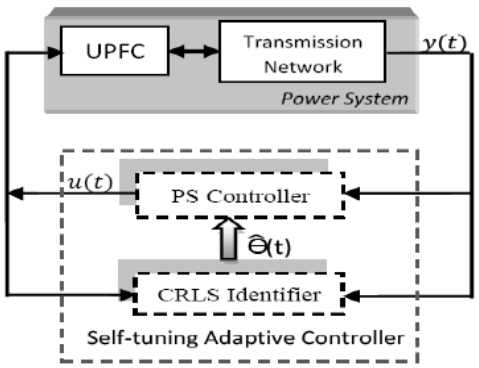


Fig 2: Self-Tuning(ST) controlIer

4 .CRLS IDENTIFIER

The procedure of system identification is based on parameter estimates that should, ideally, identically represent the plant's behavior even during disturbances. This is made possible by recursively calculating the plant parameters at a pre-defined sampling rate. A commonly used technique of achieving a continuous closed-loop tracking of the system's behavior is the recursive least squares parameter identification method. Additionally, to enhance the ability of the identifier to track actual system conditions and to avoid the parameter burst-out, a forgetting factor is used to discount the importance of the older data [7]. Further, to correctly estimate the system parameters during large disturbance such as three-phase faults, a constrained-RLS approach is used that provides a smooth parameter variation. It prevents a noisy controller output during initial swings following a disturbance. The CRLS identification algorithm approximates the dynamics of the power system accompanied by a UPFC through a discrete ARMA model given by:

$$A(z^{-1})y(t) = B(z^{-1})u(t) + e(t) \quad (1)$$

where $y(t)$,$u(t)$ and $e(t)$ are the system output, input and noise terms respectively. (z^{-1}), (z^{-1}) and (z^{-1}) are the polynomials expressed in terms of the backward shift operator z^{-1} and are defined as:

$$A(z^{-1}) = 1+a_1z^{-1} + a_2z^{-2} + \ldots a_{na}z^{-na}$$

$$B(z^{-1}) = b_1z^{-1} + b_2z^{-2} + \ldots b_{nb}z^{-nb} \quad (2)$$

n_a and n_b are the orders of the polynomials $A(z-1)$ and $B(z-1)$ respectively. Re-writing Equation (1) in the following form suitable for identification

$$y(t) = \hat{\theta}^T(t)\,\phi(t) + e(t) \quad (3)$$

where $\theta(t) = [a_1\ a_2\ a_3 \ldots a_{na}\ b_1\ b_2\ b_3 \ldots b_{nb}]^T$ is the system parameter vector, $\phi^T(t) = -y(t-1)\ -y(t-2) \ldots -y(t-n_a)\ u(t-1) \ldots u(t-n_b)]$ is the sampled input/output measurement data vector and $e(t)$ is the measurement white noise. Then, the CRLS algorithm that includes a variable forgetting factor, $\rho(t)$ and the tracking constraint term, $\beta(t)$given in (4) can be used to identify the system parameter vector $\hat{\theta}^T(t)$.

$$\hat{\theta}^T(t+1) = \hat{\theta}^T(t) + K(t)[y(t) - \hat{\theta}^T(t)\,\phi(t)]]\beta(t)$$

$$K(t) = \frac{P(t)\,\phi(t)}{P(t) + \phi^T(t)P(t)\,\phi(t)} \quad (4)$$

$$P(t+1) = \frac{1}{\rho(t)}\,[P(t) - KT(t)P(t)]\,\phi(t)]$$

$$\rho(t) = \rho0\rho(t-1) + (1-\rho0);$$

where $\rho0$ is a positive value between 0 and 1, $P\,t$ is the error covariance matrix and $K\,t$ is the modifying gain matrix. $\beta\,t$ is calculated at each sampling interval as:

$$\beta(t)=1.0 \text{ if } \frac{N_2}{N_1} \le \beta_0 \quad (5)$$

$$=1.0\ \frac{\beta_0}{N_2} \text{ if } \frac{N2}{N1} > \beta_0$$

where $N_1 = \| \hat{\theta}(t) \|_2$

$N_2 = \| \phi(t)] + K(t)\,[y(t) - \hat{\theta}T\,(t)\,\phi(t)] \|_2$

$\| \cdot \|_2$ is the norm of the corresponding vector, and $\beta0$ is a positive constant to determine the updating rate of the identified parameters.

5. POLE SHIFT(PS) CONTROL

The concept of the PS control is based on the Minimum Variance (MV) control and the Pole Assignment (PA) control[11]. Similar to the PA controller, the PS controller emphasizes on the closed-loop stability by self-searching a single pole shifting factor, α obtained by minimization of a suitable performance index at each sampling instant. The performance index is based on the minimum variance criterion. Also, to ensure closed-loop stability at all times, the closed-loop poles are restricted to lie within the unit circle in the z-domain. The closed loop system configuration with the PS controller in the feedback loop is shown in Fig. 5.

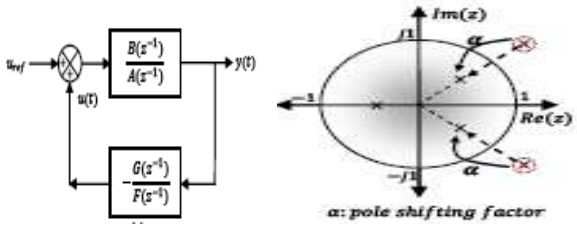


Fig:3 Closed-loop system configuration

The PS controller assumes the feedback loop of the form:

$$\frac{u(t)}{y(t)} = \frac{G(z^{-1})}{F(Z^{-1})} \quad (6)$$

where,

$$F(z^{-1}) = 1+f_1z^{-1} + f_2z^{-2} + \ldots f_{nf}\,z^{-nf}$$

$$G(z^{-1}) = g_0 + g_1z^{-1} + g_2z^{-2} + \ldots g_{ng}\,z^{-ng}$$

and $n_f=n_b-1$, $n_g=n_a-1$. From (1) and (6) and from above Figure , the characteristic equation of the closed loop control is:

$$T(z^{-1}) = A(z^{-1})F(z^{-1}) + B(z^{-1})G(z^{-1}). \quad (7)$$

The PS algorithm shifts the open-loop poles by the same factor, α and the closed-loop characteristic polynomial takes the following form:

$$T(z^{-1}) = A(z^{-1})F(z^{-1}) + B(z^{-1})G(z^{-1}) = A(\alpha z-1). \quad (8)$$

In the PS algorithm, α, a scalar, is the only parameter to be determined and its value reflects the stability of the closed-loop system [9]. Re-arranging (6) in matrix form gives:

$$\begin{bmatrix} 1 & 0 & . & 0 & b_1 & 0 & . & 0 \\ a_1 & 1 & . & 0 & b_2 & b_1 & . & 0 \\ . & a_1 & . & . & . & b_2 & . & . \\ a_{n_a} & a_{n_a-1} & . & 1 & b_{n_b} & b_{n_b-1} & . & b_1 \\ 0 & a_{n_a} & . & a_1 & 0 & b_{n_b} & . & b_2 \\ 0 & 0 & . & a_2 & 0 & 0 & . & b_3 \\ . & . & . & . & . & . & . & . \\ 0 & 0 & . & a_{n_a} & 0 & 0 & . & b_{n_b} \end{bmatrix} \begin{bmatrix} f_1 \\ . \\ . \\ f_{n_f} \\ g_0 \\ . \\ . \\ g_{n_g} \end{bmatrix} = \begin{bmatrix} (a-1)a_1 \\ (a^2-1)a_2 \\ . \\ . \\ (a^{n_a}-1)a_{n_a} \\ 0 \\ . \\ 0 \end{bmatrix}$$

Or,

$$M\omega\cdot(\alpha) = L(\alpha) \qquad (9)$$

where the elements of matrix M are the parameters ai ,$\{bi\}$ that are identified by the identifier every sampling period[11]. If the value of pole shift factor, α, is known, (9) can be solved for the control parameters fi and $\{gi\}$ following which control output, (t) can be obtained using (6). Since the essence of pole shift algorithm is based on α, for optimum performance, it is desirable to obtain the value of α online and at each sampling instant. Pole shift factor, α is selected so as to optimize certain performance index, J $(t+1,t)$. Here, α is calculated iteratively to minimize the one time-step ahead prediction error in (t), i.e.

$$\text{Min } J(t+1, \alpha t) = E\,[\hat{y}(t+1) - yr(t+1)]^2 \qquad (10)$$

where E is the expectation operator, y $(t+1)$ is predicted output and y_r $(t+1)$ is the reference value. The predicted output y $(t+1)$ can be calculated as

$$\hat{y}(t+1) = X^T(t)\mu + b_1\,[u(t, \alpha t)] \qquad (11)$$

where,

$$X(t) = [-u(t-1).. - u(t-n_f) - y(t) - y(t-1)..- y(t-n_g]^T$$

$$\beta = [-b_2\text{-}b_3\ldots\text{-}b_{nb}\, a_1 a_2\ldots a_{na}]^2$$

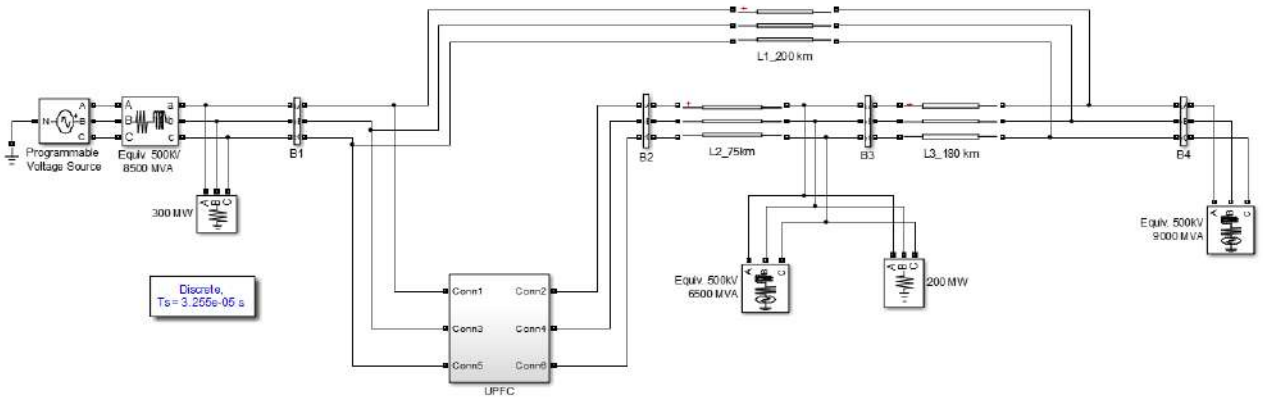
The minimization function in (10) is a constrained optimization routine subjected to a *stability* constraint and a *control* constraint. The *stability* constraint defines the range of αt to be within $(-1/\lambda,1/\lambda)$, where λ represents the absolute value of the largest root of the characteristic equation $T(z^{-1})$. Further, the *control* constraint emphasizes on the control signal to lie within the controllable range, $(u_{min,max})$, where $umin$ and $umax$ are the minimum and maximum control signal boundaries respectively. For the UPFC application, this controllable range is decided by the minimum and maximum series voltage injection available by the series-VSC which in turn depends on the compensation range provided by the series VSC.

6. CONCLUSIONS

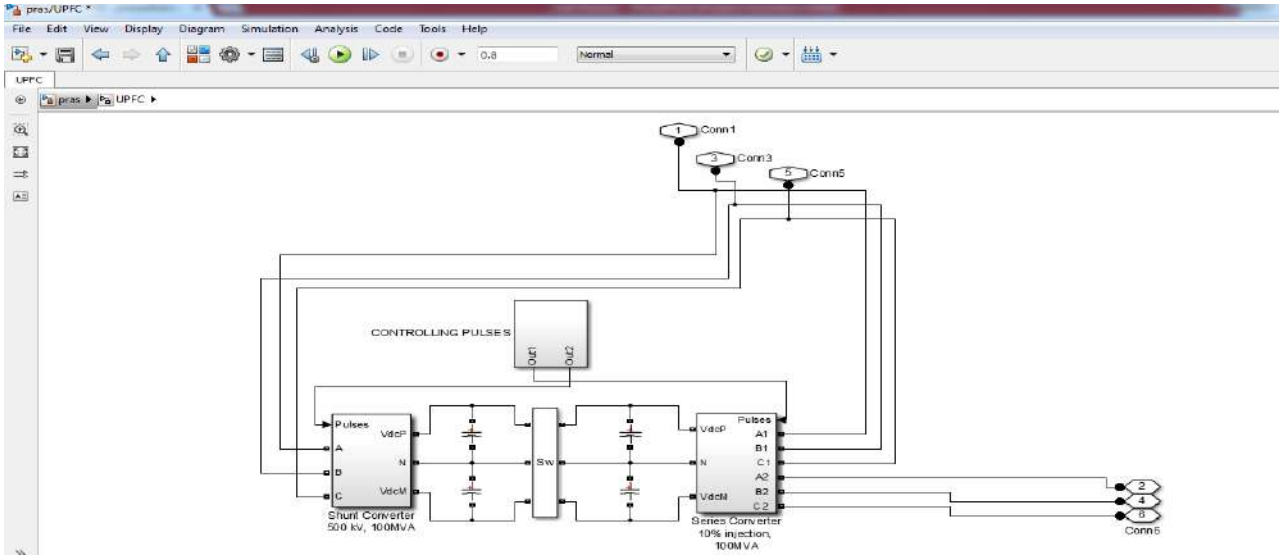
The paper proposed the use of an adaptive supplementary controller in assisting the PI-controlled UPFC control system to damp power oscillations. In addition, the constrained recursive least squares (CRLS) identification method proved beneficial by avoiding large identified parameter variations during large system disturbances. The adaptive control scheme is discussed in detail and its favorable influence on damping oscillations is shown through electromagnetic time domain simulation analyses. The PS algorithm is self-tuned online by a single parameter to obtain an improved damping response and hence can be easily implemented in real time. The results clearly showed that adding the supplementary pole-shift control greatly enhanced the damping of inter-area power oscillation while being robust to fault types and operating conditions.

7. SIMULATION RESULTS

Adding self tuning in PI UPFC is to test the damping enhancement capacity of ST Controller.



(a)



(b)

Fig: 4(a) Power system with UPFC (b)Detail controlling parameter of UPFC

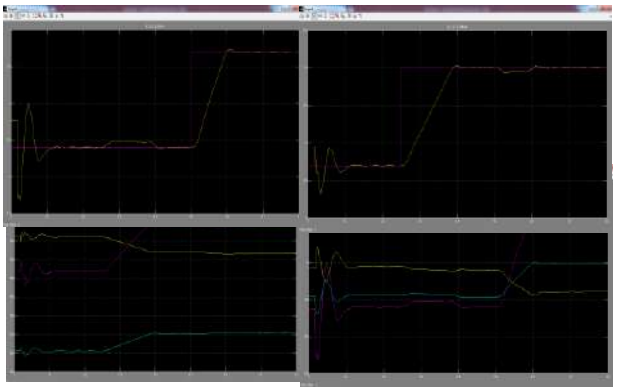


Fig: 5 Response of q(mvar),p(mw), v_{dc}, v_{ref}

VIII.APPENDIX

The UPFC parameters and the conventional PI controller gains and time constants are given below:

TABLE 1: UPFC DESIGN PARAMETERS

UPFC compensation	20% of X_{7-8}
C_{UPFC}	$15mF$
$V_{7(ref)}$	$1\ p.u.$
$V_{DC(ref)}$	$42.4\ kV$
m_{sh}	0.94
δ_{sh}	3.08°
m_{se}	0.52
δ_{se}	104°

TABLE:2 OFF-NOMINAL PI PARAMETERS

$P_{7-8} = 400MW$	$K_p = 0.02$ $T_i = 0.63$

REFERENCES

[1] N.G.Hingoaaniand L.Gyugyi, undersanding FACTS: Concepts and Technology of Flexible AC Transmission Systems. New York, NY, USA: IEEE Press, 2000, pp. 315–319.

[2] W. Qiao and R. G. Harley, "Indirect adaptive external neuro-control for a series capacitive reactance compensator based on a voltage source PWMconverter in damping power oscillations," *IEEE Trans. Ind. Electron.*, vol. 54, no. 1, pp. 77–85, Feb. 2007.

[3]X. Duan, H. Deng, and H. Li, "A saturation-based tuning method for fuzzy PID controller," *IEEE Trans. Ind. Electron.*, vol. 60, no. 11, pp. 5177–5185, Nov. 2013.

[4] D. Murali Dr. M. Rajaram N. Reka Comparison of FACTS Devices for Power System Stability Enhancement *International Journal of Computer Applications (0975 – 8887) Volume 8– No.4, October 2010*

[5] G. P. Chen, O. P. Malik, G. S. Hope, Y. H. Qin, and G. Y. Xu, "An adaptive power system stabilizer based on the self-optimizing pole shift control strategy," *IEEE Trans. Energy Convers.*, vol. 8, no. 4, pp. 639–645, Dec. 1993.

[6] R. Gokaraju and O. P. Malik, "Radial basis function identifier and poleshifting controller for power system stabilizer application," *IEEE Trans. Energy Convers.*, vol. 19, no. 4, pp. 663–670, Dec. 2004.

[7] A. Domahidi, B. Chaudhuri, P. Korba, R. Majumder, and T. C. Green, "Self-tuning flexible ac transmission system controllers for power oscillation damping: A case study in real time," IET Gener. Transm. Distrib., vol. 3, no. 12, pp. 1079–1089, Dec. 2009.

[8] T. Yamamoto and S.L. ShahDesign and experimental evaluation of a multivariable self-tuning PID controller

[9]A° stro¨m, K.J.: 'Theory and applications of adaptive control - A survey', Automatica, 1983, 19, (5), pp. 471–486

[10] Clarke, D.W., and Gawthrop, P.J.: 'Self-tuning control', Proc. Inst. Electr. Eng., 1979, 126D, (6), pp. 633–640

[11] Control System for a UPFC ApplicationIEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 61, NO. 5, MAY 2014

[12] Vladimír Bobál, Petr Chalupa, Petr DostálUSAGE OF SELF-TUNING CONTROLLERS SIMULINK LIBRARY FOR REAL-TIME CONTROL.

Mathematical Modeling for Solar PV Module

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Abstract—**The two inherent problems in solar technology is low conversion and next one is the presence of highly non-linear I-V characteristics. Therefore the aim of this paper is to increase the efficiency and power output of the system and to reduce external power consumption. So to increase the efficiency it is desire to extract the maximum power from PV module.**

***IndexTerms*—SPVM, PV Module,**

I INTRODUCTION

The growing demand for electricity and the recent environmental threats such as global warming has led to need for new source of energy that is cheaper and clean with less carbon emission. The increasing prices of oil and decreasing level of oil has made solar energy most suitable as energy source. Among all renewable energy resources PV energy has drawn attention due clean, need little maintenance and having no noise. Earth receives 174 pet watts of incoming solar radiation at the upper atmosphere. The total solar energy absorbed by earth's atmosphere, ocean and land masses is 3,850,000EJ per year. Solar energy is used in many applications such as solar heater, solar cooker, crop drying etc. the solar energy is harvest by human since ancient times. To harvest solar energy, the most common way is to use the PV panel which will receive photon energy from sun and convert it into electricity.

The photovoltaic effect was first demonstrated by Edmond Becquerel. The PV system has two main drawbacks high capital cost and low efficiency. The conversion efficiency drops by about 0.38 % per ◦C increase in panel temperature [2]. Energy produced by PV module is dependent on environmental condition such as temperature and solar insolation [6]. For given solar insolation and temperature there is only one maximum peak point (MPP) at which PV module delivers the maximum power. Hence, in order to extract maximum power and to increase the utilization efficiency of the module it is necessary to operate it at MPP [1]. To achieve this, there are different methods to extract maximum power has developed such as perturb and observe (P&O) and incremental conductance. P&O is the simple and cost of implementation is low but they are not accurate enough [5], while the incremental conductance algorithm has high complexity but it can track the rapidly changing environmental condition with high accuracy.

II SIMULINK MODEL PV ARRAY

Solar cell is basically a p-n junction fabricated in a thin wafer or layer of semiconductor. The electromagnetic radiation of solar energy can be directly converted to electricity through photovoltaic effect. Due to the low voltage generated in a PV cell (around 0.5V), several PV cells are connected in series (for high voltage) and in parallel (for high current) to form a PV module for desired output. Performance evaluation shows a solar panel can generate output power above 60% of its rated value for only six hours of a day from 9.00 am to 3.00 pm [3].

An ideal cell is modeled by a current source in parallel with a diode. However no solar cell is ideal and thereby shunt and series resistances are added to the model as shown in the PV cell diagram above. R_S is the intrinsic series resistance whose value is very small. R_P is the equivalent shunt resistance which has a very high value. Energy available from the solar cells is not in uniform manner, it randomly varies according to environmental conditions like temperature, intensity of radiation and partial shading effects [5].

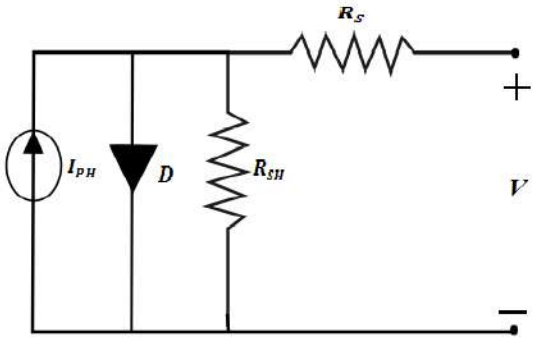

Figure 1: Equivalent model of solar cell

Applying Kirchoff's law to the node where I_{ph}, diode, R_p and R_s meet, we get

$$(I_{PH} - I_d - I)R_{SH} = V + IR_S$$

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But

$$I_d = I_0\left(e^{\frac{V+IR_S}{\frac{nkT}{q}}} - 1\right)$$

Replacing I_d we obtain

$$I = I_{PH} - I_0\left(e^{\frac{V+IR_S}{\frac{nkT}{q}}} - 1\right) - \frac{V + IR_S}{R_{SH}}$$

Where,
I_{PH}-Light-generated current or photocurrent,
I_0-cell saturation of dark current,
Electron charge q = 1.6 ×10-19C
Boltzmann's constant k= 1.38 ×10−23J/K,
T-cell's working temperature,
A -is an ideal factor,
R_{SH}- is a shunt resistance, and
R_S-is a series resistance.

A PV array is a group of several PV modules which are electrically connected in series and parallel circuits to generate the required current and voltage. The equivalent circuit for the solar module arranged in NP parallel and NS series is shown in Fig.

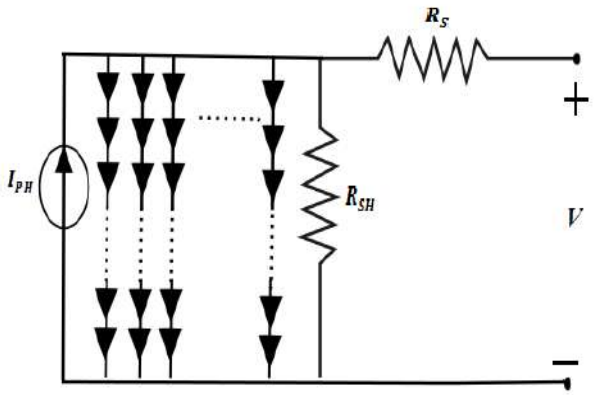

Figure 2: Equivalent circuit for the solar module.

The terminal equation for the current and voltage of the array is given by:-

$$I = N_P I_{PH} - N_P I_S\left[e^{\frac{q\left(\frac{V}{N_S}+IR_S\right)}{\frac{N_P}{KT_CA}}} - 1\right] - \frac{\frac{N_P V}{N_S} + IR_S}{R_{SH}}$$

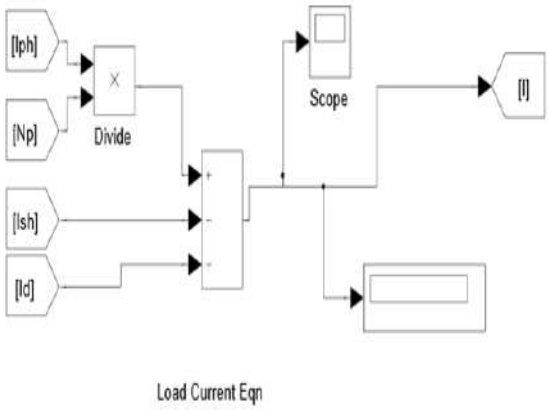

Figure 3: Simulink model for load current equation.

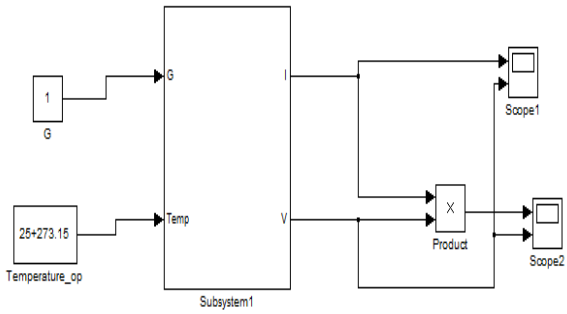

Figure 4: Simulink model of PV array module.

III SIMULATION RESULTS OF PV ARRAY

Effect of temperature on IV and PV characteristics:
Since increase in temperature increases reverse saturation, the total output current and hence, the output power decreases. The conversion efficiency drops by about 0.38 % per ◦C increase in panel temperature [2]

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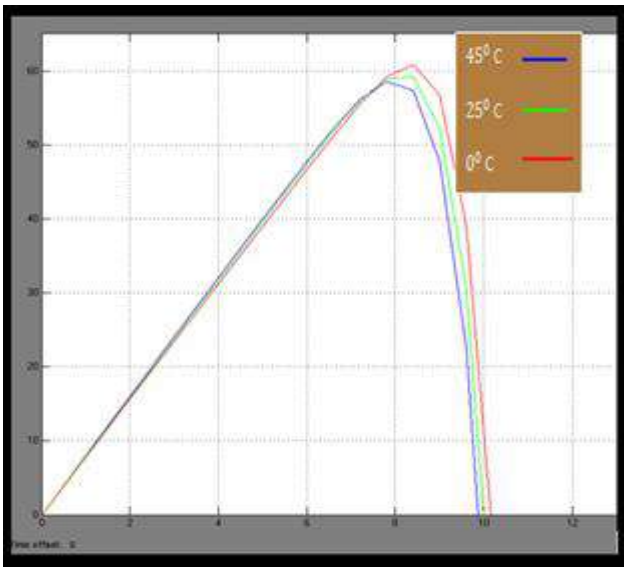

Figure 5: Effect of temperature on P-V curve at insolation $1w/m^2$.

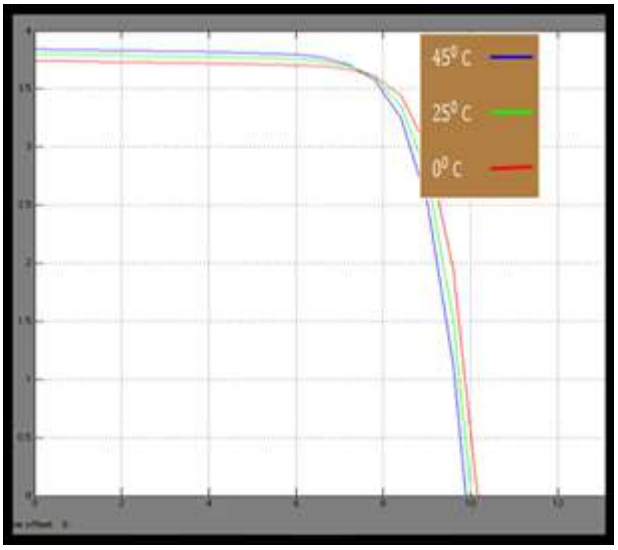

Figure 6: Effect of temperature on I-V curve at insolation $1w/m^2$.

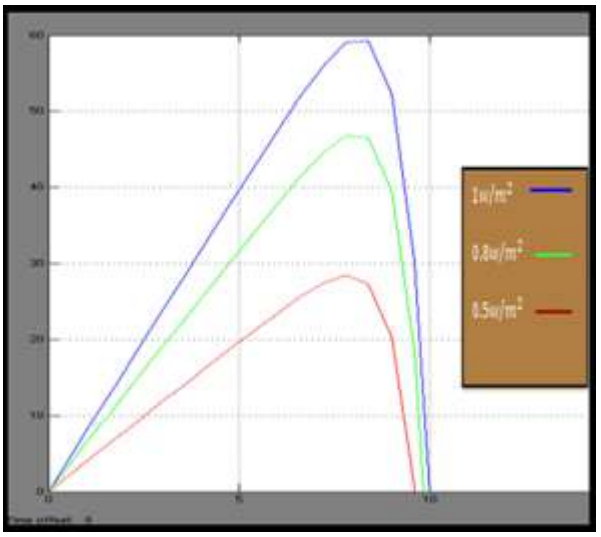

Figure 7: Effect of solar insolation on P-V curve at temperature25^0.

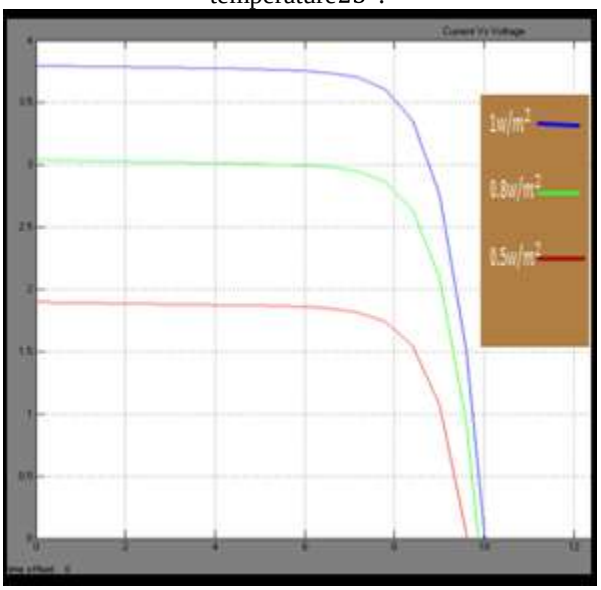

Figure 8: Effect of solar insolation on I-V curve at temperature25^0.

Conclusion

We have done the simulation of solar panel and observe that the characteristics of solar panel are non-linear. Effect of solar insolation on IV and PV characteristics the output current and the power increases with the increase of irradiance. This is due to the fact that increase in irradiance increases the light-generated photo current

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REFERENCES

[1]Manoj Patil, "Design and Simulation of Perturb and Observe Maximum Power Point Tracking Using MATLAB/Simulink,"2015 International Conference on Industrial Instrumentation and Control, May 28-30, 2015 IEEE.

[2] Wim J.C. Melis, "Increasing Solar Panel Efficiency in a Sustainable Manner,"IEEE ENERGYCON 2014, May 2014 , Dubrovnik, Croatia.2

[3] Al JumlatAhmed,"Performance Evaluation of Solar Panel and Proposed New Algorithm of Solar Tracking System,"2nd International Conference on Green Energy and Technology, September 2014 IEEE.

[4] RokeyaJahanMukti, "Designing an Efficient Photovoltaic System with Maximum Power Point Tracking Technique by Comparing Different Converter Topologies," 17th International Conference on Computer and Information Technology,2014 IEEE.

[5] Alex Joseph and Kamala J, "PV Array Characteristics Analysis Under Partial Shading & Modeling of P&O MPPT Applied Boost Convertor Using Matlab/Simulink," 2013 IEEE.

[6] Jaypalsinh Chauhan, "Comparison of MPPT Algorithms for DC-DC Converters Based Photovoltaic Systems,"2013 IEEE.

[7] B. M Hasaneen, "Design and Simulation of dc/dc boost converter,"2008 IEEE.

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Appliances monitoring and dynamic controlling of power

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Abstract- Energy crisis in the country is great bottleneck. There is huge demand of energy all over the globe. We lose so much energy, particularly in the old system. Energy issues and technology change have played crucial roles in energy saving. Electrical appliances used in the past consume most of the power[1-5] and even though todays most of the electrical appliances are having inbuilt features for power management. These appliances are used everywhere in the offices and home. These appliances are computers, computer peripherals such as monitors, printers. But all the time these will never get shutdown. But they goes into sleep mode or idle mode, but still they consume energy. This is avoided in the proposed system, where these appliances are made OFF. These are made ON as on when required by giving trigger when we work on it. This embedded system saves 10% overall power consumed in a year.

Keywords- Standby Power, Energy Saving, appliances, dynamic Controlling. Dynamic energy management system (DEMS)

I. INTRODUCTION

Many small businesses are connected through the technology. The energy use of small office equipments in the small business may account 18% of overall energy bills.[6-8] One can stop paying such increased in the bill and spend the same amount in business. Business will grow. Simple change to the way one use office equipments and monitors these office equipments through the system will definitely increase energy saving. There is huge demand of such system which can save energy as well as optimum use of office equipments[14-16]. Office electrical equipments in which computer peripherals such as monitor, printer plays important role energy consumption. There are different ways to control it. 1) One can turn off monitor if you are not using it for more than 30 minutes. 2) Switch of all the equipments after office hours and weekends. These equipments should be off and ensure it should not be in sleep mode. 3) One can install timer equipmentss to turn off the office equipmentss. Computer equipmentss contribution in standby and sleep mode contributes lots of energy. There is more than 40% to 90% of the total energy waste from computer peripherals standby mode. [9-13]

These ways stated above can result it into significant cost saving:

1) Energy consumption
2) Maintenance cost
3) Replacement costs,
4) Operating life of equipmentss and,
5) Running cost

This paper is structured in six section, section-I gives introduction, section-II gives methodology, proposed system is given in the section-III, section IV shows implementation of system, section V gives software implementation and section VI draws conclusion.

II. METHODOLOGY

In this project a circuit is designed and implemented into any electrical appliances to reduce this standby power. The paper deals with a printer, which consume standby power of 90W is reduced where a low standby power achieved. The printer power consumption is monitored and it is connected to the analog input of the microcontroller. In this simulation we connected the Trim pot for adjusting the current input to the microcontroller. Current consumption go below 90W the microcontroller turns off the relay. Then the printer power shuts off.

The door switch output signal is connected to the input of the MCU. If the door is opened, the MCU wakes up from its sleep mode and turns on the relay. So the printer power switched on, thus enabling the printer and allowing the user to set the control panel. The keypad output is also connected to the input of the MCU. If the keypad is pressed, the printer power is switched on. This variation in its operating mode is indicated by the LED design circuit. Its power consumption and the implement results are compared and explained. The circuit designed for low standby power consumption can be implemented in any of the future electrical appliances due to its low cost simple design and its flexibility.

III. PROPOSED SYSTEM

Block diagram of proposed system is shown in figure 1. This is divided into four parts.

a. Microcontroller.
b. Power sensing circuit.
c. Appliances Triggering unit.
d. Appliances under control.

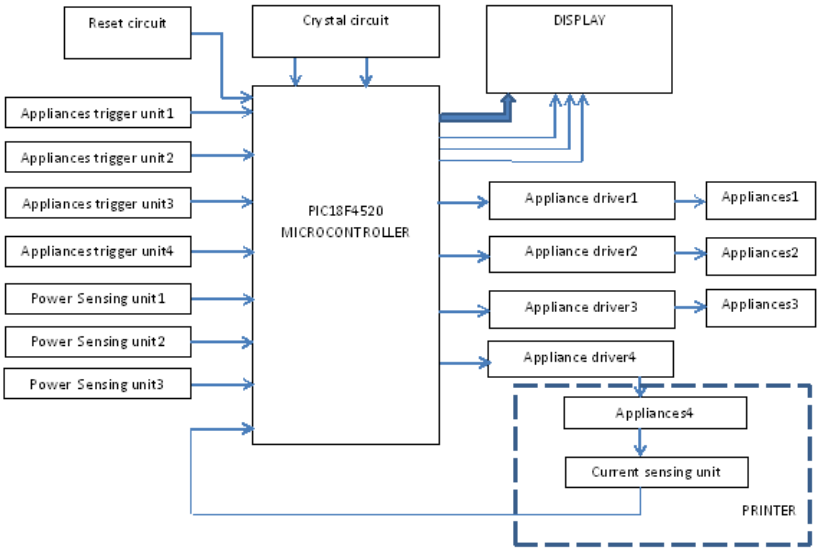

Figure 1. Proposed system of energy saving

a. Microcontroller.

It is heart of the system. This is a microcontroller which takes decision based on the inputs of appliances. It gives trigger to appliances for making ON/OFF.

b. Power sensing circuit.

This unit consists of signal conditioning circuit which will sense the current and voltage of the appliance [7]. There are different currents in the different mode of appliance. Different modes are a) Idle mode b) Power down mode c) Shut down mode.

c. Appliances Triggering unit.

This unit consists of a circuit which will sense the appliance whenever it is operated by a user. Even though this appliance is in any mode Idle mode, Power down mode, Shut down mode. This will give signal to microcontroller and these appliances will immediately come in the operating mode where it will activate all its functions

d. Appliances under control.

There are different appliances which are need to control such as computer peripherals like printers, scanner. Workgroup printer draws 800w during printing and 90w during standby mode. Mid-workgroup printer is about 500-800W in use and 80W during standby mode. Most of this is heating up the fuser. To save energy it is best to turn off the printer when not being used. In ideal mode current is very small, this current is sense [17] by signal conditioning circuit which is given to PIC18F4520 through internal ADC. PIC microcontrollers will tale decision based on the amount of current.

IV. HARDWARE IMPLEMENTATION

Implementation of the system is shown in figure 2 below.

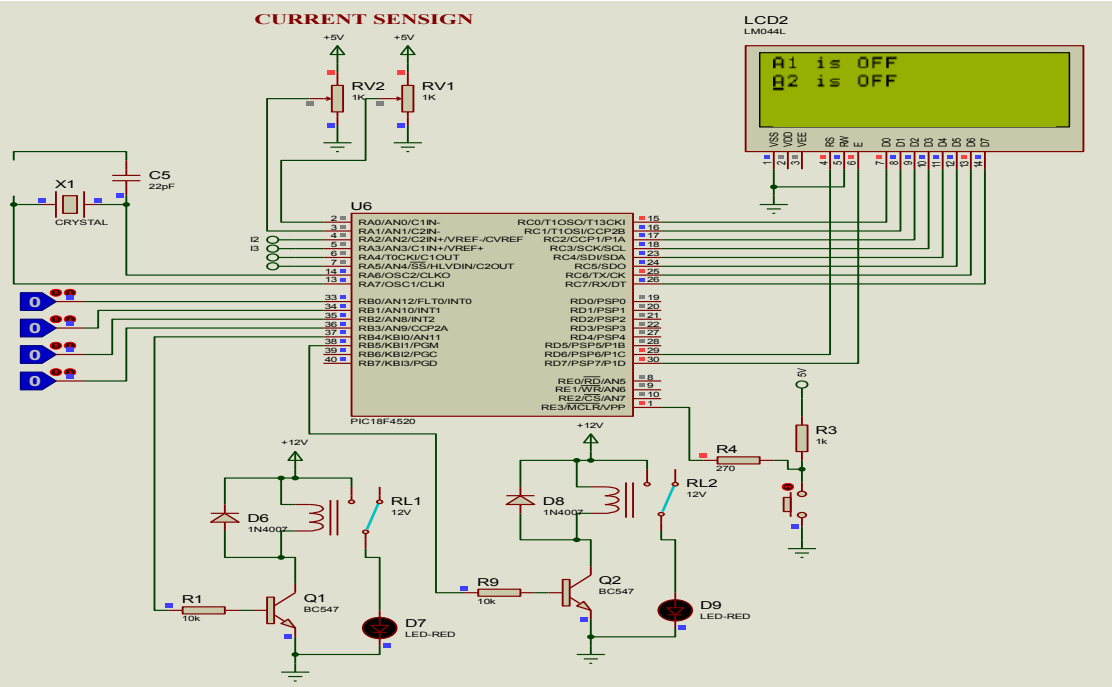

Figure 2. System Circuit diagram

Pin out of the circuit design is as given as below

1. LCD INTERFACING
    a. LCD data PORTC
    b. LCD RS RD6
    c. LCD EN RD7
2. Appliances triggering
    a. PORT B0-B3
3. Appliances ON/OFF
    a. PORT B4-B7
4. Current sensing
5. ADC input ANALOG A0-A4

Pin out which is assigned with PIC18F4520 is shown in figure 3.
Appliances current are measured at analog channel, if current is less than the standby, it gives signal to relay driver circuit. Relay driver circuit will switch off the Appliances. If the user wants to use appliances, he will touch the keypad of the appliances which will give trigger automatically to the microcontroller which in turns ON the Relay and appliances get activated. This will go on continuing till the current of the appliances go down to level of standby current.

A. Microcontroller.

Power Management Features of PIC18F4520:

- Run: CPU on, Peripherals on
- Idle: CPU off, Peripherals on
- Sleep: CPU off, Peripherals off
- Ultra Low 50nA Input Leakage
- Run mode Currents Down to 11 µA Typical
- Idle mode Currents Down to 2.5 µA Typical
- Sleep mode Current Down to 100 nA Typical
- Timer1 Oscillator: 900 nA, 32 kHz, 2V
- Watchdog Timer: 1.4 µA, 2V Typical
- Two-Speed Oscillator Start-up

Features of PIC18F4520 shows that it is low power microcontroller. Design of PIC18F4520 is shown in fig 3. Capacitor selection is values are shown in Table I.

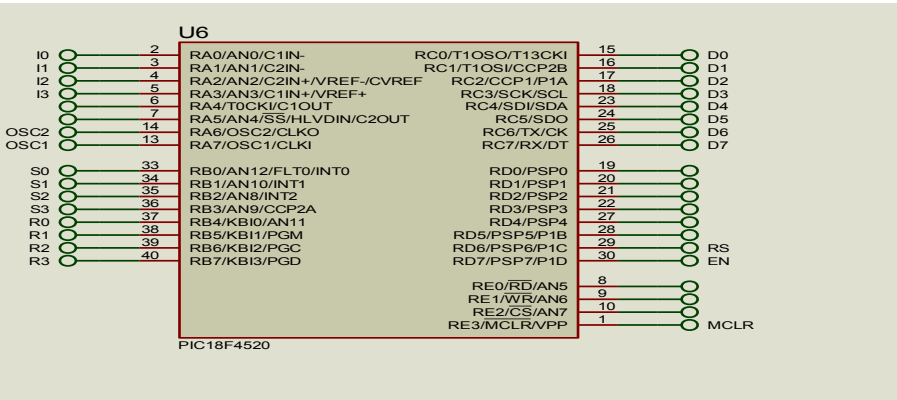

Figure 3. Microcontroller pin out diagram

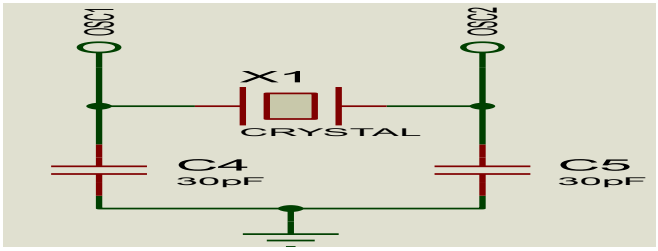

Figure 4. Crystal circuit design

Table 1. typical capacitor values used in crystal

Mode	Freq	OSC1	OSC2
XT	3.58 MHz	15 pF	15 pF
	4.19 MHz	15 pF	15 pF
	4 MHz	30 pF	30 pF
	4 MHz	50 pF	50 pF

Appliances ON/OFF status is shown in fig. 5

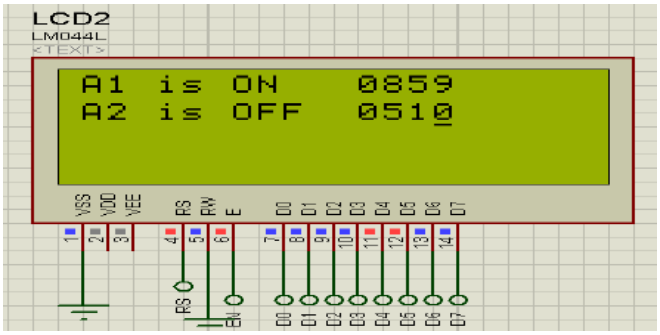

Figure 5. LCD display interface with microcontroller

B. Current sensing circuit

Here we have made attempt to show through simulated sensor. A variable register is used in the input of ADC channel. It reads the change n current. When the change in current go below specified limt. It switch off the appliances.

C. Appliances Triggering unit.

This unit consist of trigger circuit which gives trigger whenever the keyboard or panel of the printer is touch or open, the input singal generated and is given to PIC microcontroller which in turns make the device ON.

D. Appliances under control.

A Relay driver circuit is designed as a switch which is controlled by transistor. As soon as signal is given by controller to this unit, it activates appliances. Figure 6 shows the appliances ON/OFF controller.

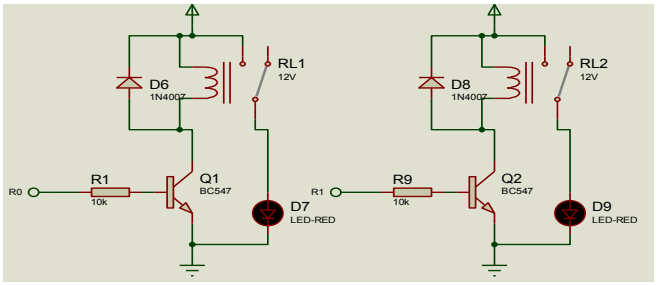

Figure 6. Appliances ON/OFF controller

V. SOFTWARE IMPLEMENTATION

MPLAB IDE: is software program that runs on windows to develop applications for microchip microcontrollers and digital controllers. It provide a development environment for your embedded system design.

Compiler: MPLAB compilers produces highly optimize code it supports all the microchip devices.

Algorithms:

1. It check appliances trigger or not
2. Check current is more than standby current
3. If trigger receives, it will make appliances ON.
4. Continuously monitoring the current till it is more than standby current.
5. If current go below standby it will OFF the Appliances. Go in step 1.

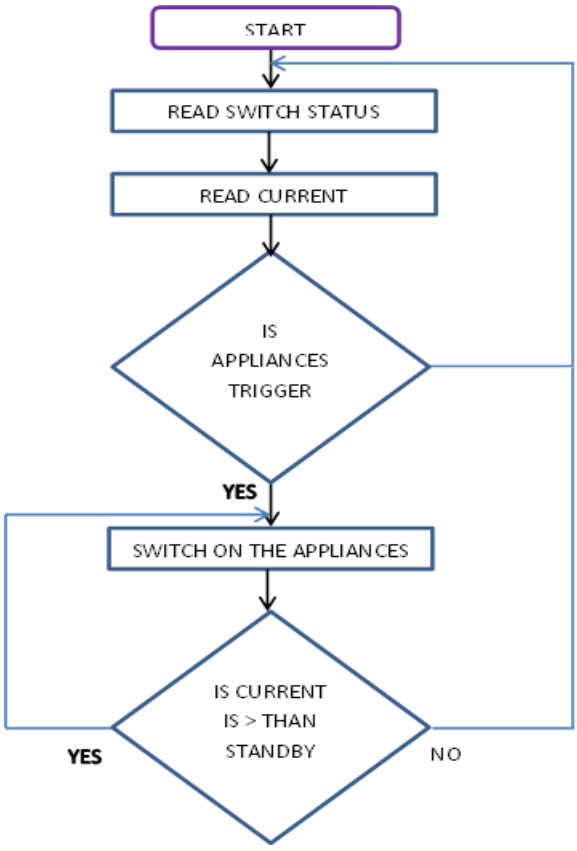

Figure 7. Flow chart of the program

VI. CONCLUSION

This paper proposes a new system design which remarkably reduces the standby power of printer used in offices and home specially laser printer. It also monitors all the equipments in the home/offices. This also reduces continuous monitoring of human which is quite tedious and also costly. These are made on as on when required by giving trigger when we work on it. This embedded system saves 10% overall power consumed in a year.

REFERENCES

[1] U.S. Department of Energy, "Energy Saver Booklet: Tips on Saving Energy & Money at Home," May. 2009.
[2] Ying-Wen Bai, and Yi-Te Ku, "Automatic room light intensity detection and control using a microprocessor and light sensors," IEEE Trans.Consumer Electron., vol.54, no.3, pp.1173-1176, August 2008
[3] Ying-Wen Bai, Zi-Li Xie, and Zong-Han Li, "Design and implementation of a home embedded surveillance system with ultra-low alert power,"IEEE Trans. Consumer Electron., vol.57, no.1, pp.153- 159, February 2011.
[4] Suk Lee, Kyoung Nam Ha, and Kyung Chang Lee, "A pyroelectric infrared sensor-based indoor location-aware system for the smart home,"IEEE Trans. Consumer Electron., vol.52, no.4, pp.1311-1317, Nov. 2006**.**
[5] Sunghoi Parka, Myeong-in Choia, Byeongkwan Kanga, Sehyun Parka, "Design and Implementation of Smart Energy Management System for Reducing Power Consumption using ZigBee Wireless Communication Module", page no 662-668 Elsevier 2013
[6] Prof. Lalit Kumar Wadhwa1, Hemangi Vinchurkar2, Mugdha V. Patil3, "Design and Implementation of Zero Standby Power System Using PIR Luminaire, IJAREEIE Vol. 3, Issue 7, July 2014" 10580-10587.
[7] S. Philomina, "Sophisticated Home Appliance Control System Using Embedded Linux",Middle-East Journal of Scientific Research 20 (12): 1873-1878, 2014.
[8] Shun-Chieh Lin, Huan-Wen Tsai, Yi-Lin Chiang and Tsung-Lin Tsai,"Design and Implementation of an Adaptive Control Mechanism for Standby Power Detection and Saving",International Conference on Affective Computing and Intelligent Interaction Lecture Notes in Information Technology, 295-303 Vol.10 ICACII2012.
[9] Jiin-Hwa Yang, Hui-Li Weng, Wen-Sen Tseng, and Heng-Fa Teng,"Implementation of Power Reduction in the Homes of Older People", International Conference on Gerontic Technology and Service Management, University of Technology, Nantou, Taiwan Apripage no. 1-4, 2010
[10] Cheng-Hung Tasi, Ying-Wen BaiChun-An Chu, Chih-Yu Chung and Ming-Bo Lin,"Design and Implementation of a Socket with Ultra-Low Standby Power", IEEE 1216-1221, 2011
[11] Niks?a Skeledz?ija, Josip C´ esic´, Edin Koc?o, Vladimir Bachler, Hrvoje Nikola Vuc?emilo, Hrvoje Dz?apo, "Smart Home Automation System for Energy Efficient Housing", MIPRO 2014, pp 161-171, 26-30 May 2014
[12] Laxmi Soni1, Sarika K. Thorat2 And Sandeep Chawda3,"PC Controlled Home Appliances",Int. Journal of Engineering Research and Applications,ISSN : 2248-9622, Vol. 4, Issue 5(Version 1), pp.51-53,May 2014,
[13] Swapnil Pujari Amol Jirage M. R. Madki,Optimization for Standby Power Reduction Control Mechanism using Bluetooth,International Conference in Recent Trends in Information Technology and Computer Science (ICRTITCS - 2012) Proceedings published in International Journal of Computer Applications® (IJCA) (0975 – 8887) pp 11-14, 2012
[14] Kyoung-Mi Im, Jae-Hyun Lim," An Intelligent Standby Power Control System Design based on User Location and Appliance Usage Pattern in Smart Home", Journal of Convergence Information Technology(JCIT), pp 1231-1241, Volume8, Number8, April 2013
[15] Poshavoni Vikas Yadav, Prof. N Umaheshwar Rao, "Standby Power Management of Microwave-Oven", International Journal of Science, Engineering and Technology Research, ISSN: 2278 – 7798 Volume 3, Issue 9, September 2014
[16] Inderpreet Kaur, "Microcontroller Based Home Automation System With Security", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 1, No. 6, December 2010.
[17] Wei-Ting Cho1, Chin-Feng Lai2, Yueh-Min Huang3, Wei-Tsong Lee4 and Sing-Wei Huang5,"Home Energy Management System for Interconnecting and Sensing of Electric Appliances",KSII TRANSACTIONS ON INTERNET AND INFORMATION SYSTEMS VOL. 5, NO. 7, July 2011

Simulation of DC-DC Boost Converter for SPVM

Ulhas Patil, and Dr.Mahesh Kolte

***Abstract*—**The design and implementation of high performance closed loop Boost converter for solar system [5]. The closed loop boost converter is used to convert a low level DC input voltage from solar PV module to a high level dc voltage required for the load. To regulate the output of the converter, closed loop PID controller is designed and simulated. The performance of the boost converter can be improved by the design of PID PWM controller. The PWM signal controls the switching of MOSFET [3]. Thus by switching of MOSFET it would try to keep output as constant. Initially the boost converter, PWM and PID controller are designed and simulated. The simulation studies are carried out in MATLAB

***Keywords*—** Solar Photovoltaic (SPV), PWM, boost converter, PID, MOSFET.

I. Introduction

THE renewable energy sources play an important role in electricity generation. People are finding the benefits of having their own renewable energy system more attractive than they ever had before. Specially, energy from the sun is the best option for electricity generation as it is available everywhere and is free to harness. The merit of solar PV system is ease of installation and integration when compared to others. On an average the sunshine hour in India is about 6hrs annually also the sun shine shines in India for about 9 months in a year. Electricity from the sun can be generated through the solar photovoltaic modules (SPV). The SPV comes in various power output to meet the load. However, the output power of a PV panel is largely determined by the solar irradiation and the temperature of the panel [6]. At a certain weather condition, the output power of a PV panel depends on the terminal voltage of the system. To maximize the power output of the PV system, a high efficiency [7], low-cost DC/DC converter with a voltage feedback signal [6] is commonly employed to control the terminal voltage of the PV system at optimal values in various solar radiation conditions.

II. Proposed System

It consists of a PV panel, dc-dc boost converter and load. The proposed standalone PV controller implementation takes into account mathematical model of each component as well as actual component specification. The dc–dc converter is the front-end component connected between the PV array and the load.

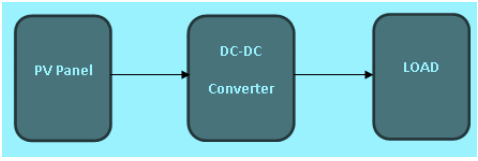

Fig.1.Proposed system of DC-DC Boost Converter for solar system

The PV array which is used & it is made up of mono-crystalline. Mono-crystalline solar panels are made from a large crystal of silicon. These types of solar panels are the most efficient as in absorbing sunlight and converting it into electricity; however they are the most expensive. They do somewhat better in lower light conditions than the other types of solar panels. It has two layer one is very thick and another is very thin. The array used here contains thick n layer. An array contains 36 cells and each cell can produce maximum of 0.5 volts thus maximum of 18 volts can be extracted from a PV panel. The output of the array varies from 12 to 18 volts for different values of load.

The dc-dc boost converters are used to convert the unregulated dc input to a controlled dc output at a desired voltage level [5]. They generally perform the conversion by applying a dc voltage across an inductor or transformer for a period of time (usually in the 20 kHz to 5 MHz range) [5] which causes current to flow through it and store energy magnetically, then switching this voltage off and causing the stored energy to be transferred to the voltage output in a controlled manner. The output voltage is regulated by adjusting the ratio of ON-OFF time. This is achieved using *switched-mode*, or *chopper*, circuits whose elements dissipate negligible power. *Pulse-width modulation* (PWM) [3] allows control and regulation of the total output voltage. It is considered as the heart of the power supply, thus it will affect the overall performance of the power supply system. The ideal converter exhibits 100% efficiency; in practice, efficiencies of 70% to 95% are typically obtained [7].

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III. MODES OF OPERATION

Among the dc-dc power converters, boost converter topology is used to step-up the input voltage. Depending upon the conversion ratio, the output voltage is either equal to the input or higher than the input. Fig.2 shows the circuit for a boost converter.

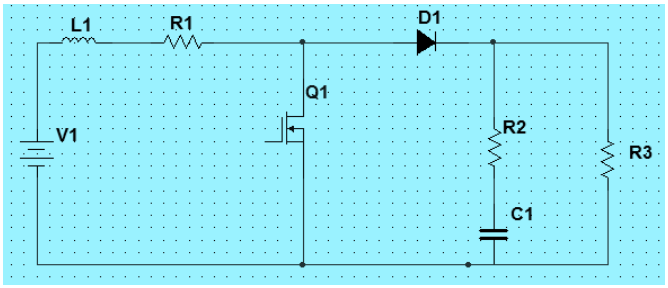
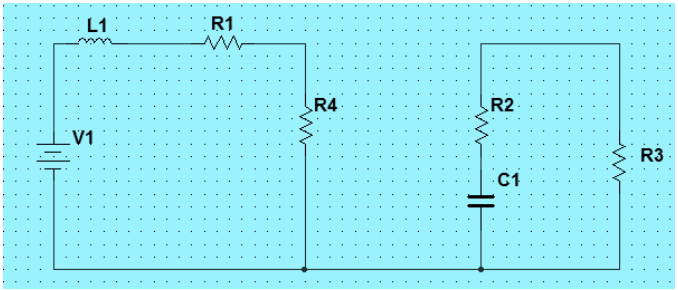


Fig. 2: Boost converter circuit



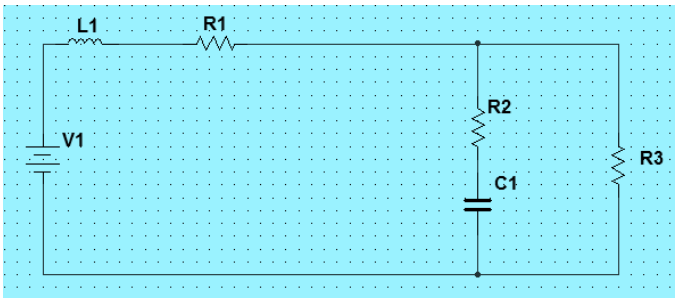


Fig.3: Top – MOS switch ON (diode in reverse bias)
Bottom – MOS switch OFF (diode conducting)

The following assumptions while analyzing fig.3 circuit:

- The converter operates in steady state
- Inductor current is always positive meaning that the converter operates in continuous conduction mode (CCM) [1]
- Circuit when the MOS switch Q1 is ON, is shown in fig. 3 (top). Application of Kirchhoff's voltage and current laws yields following equations:

Thus for closed switch time inductor gets charged [1] and capacitor is delivering the required power to the load, and for the opened switch time inductor will discharge supplying the full power to load and charging capacitor simultaneously.

Assuming that the inductor current rises linearly from I_{min} to I_{max} in time $t_1(T_{on})$ [8], [9]

$$Vin = L(\frac{I_{max}-I_{min}}{t_1}) \quad (1)$$

$$t_1 = L(\frac{I_{max}-I_{min}}{V_{in}}) \quad (2)$$

and inductor current falls linearly from *Imax* to *Imin* in time $t_2(T_{off})$,

$$V_{in} - V_o = -L(\frac{I_{max}-I_{min}}{t_2}) \quad (3)$$

$$t_2 = -L(\frac{I_{max}-I_{min}}{V_{in}-V_o}) \quad (4)$$

The switching frequency can be found from

$$f = \frac{1}{T} = t_1 + t_2 \quad (5)$$

and this gives peak to peak ripple

$$\Delta I = I_{max} - I_{min} \quad (6)$$

$$\Delta I = \frac{V_{in}}{fL} \quad (7)$$

When the MOSFET is on, the capacitor supplies the load current for t=t_1.the average capacitor current during time $t_1$is $I_C=I_0$ and peak to peak ripple voltage of the capacitor is

$$\Delta V_c = V_c - V_0 \quad (8)$$

$$V_c = \frac{I_0(V_c-V_{in})}{f\times V_0} \quad 9)$$

Condition for continuous inductor current and capacitor voltage: I_L is the average inductor current, the inductor ripple current $\Delta I = 2I_L$

$$\Delta I = 2I_L = \frac{2V_{in}}{(1-k)R} \quad (10)$$

which gives the critical value of the inductor L as

$$L = \frac{k(1-k)\times R}{2f} \quad (11)$$

and the average capacitor voltage V_c, the capacitor ripple voltage$\Delta V_{c=}2V_0$,which gives the critical value of the capacitor C_c.

A boost converter can step up the output voltage without a transformer [2]. Due to single MOSFET, it has a high efficiency. The input current is continuous [1] shown in fig.4. However, a high peak current has to flow through the power MOSFET. The output voltage is very sensitive to changes in duty cycle k and might be difficult to stabilize the regulator. The average output current is less than the average inductor current by a factor of (1-k), and a much higher RMS current would flow through the filter capacitor.

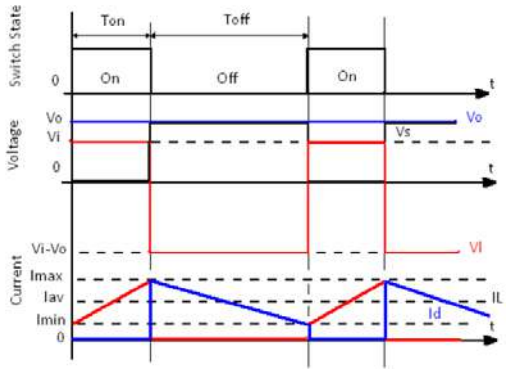


Fig.4. CCM operation of DC-DC converter

IV. DESIGN APPROACH

A. *Load Requirement*

The load is a simple resistive having a resistance of 120 Ω. Based on this load requirement the other parameters would be calculated and the specifications are tabulated in the following table I.

TABLE I
SYSTEM SPECIFICATION

Parameter	Values	Unit
Input Voltage	10-18 V	volts
Output Voltage	24	volts
Output Current	0.204A	ampere
Duty Cycle	0.53	

The duty cycle can be found using the following relation [6].

$$K = \frac{V_0 - V_{in}}{V_0} \tag{12}$$

The value of inductor is determined by using equation

$$L_c = \frac{k(1-k)R}{2f} \tag{13}$$

The value of capacitor is determined from the equation

$$C = \frac{k}{2fR} \tag{14}$$

B. *PID Controller*

The feedback loop of proposed converter is shown in fig.5 and is implemented in the simulation using PID control method. The PID feedback control method adds positive corrections, removing the error from a system's controllable variables. PID control method consists of three actions. The proportional action involves multiplying the error with a negative constant (proportional gain) and adding the product to the controlled quantity. The principle of proportional action requires that the amount of change in the manipulated variable vary directly with the size of the error that is the proportional gain dictates the sensitivity of the correction action. The integral action involves integrating the error over a period of time and then multiplies with a negative constant (integral gain) and adding the product to the controlled quantity. Therefore, this action averages the measured error over a period of time to find the process output's average error from the desired value. Integral action brings the controlled variable back to the set point in the presence of a sustained upset or disturbance that is integral action acts to eliminate steady state error. The derivative action improves stability of the system and enables increase in gain and decrease in integral time constant, which increases speed of the controller response.

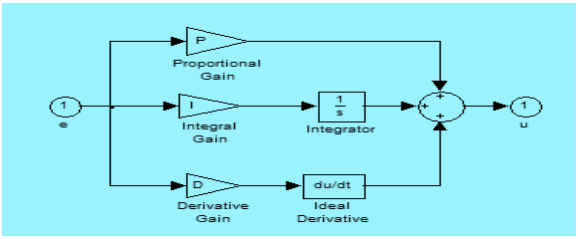


Fig.5. PID Control Scheme

C. *Design of PWM Generator*

The converter operates in continuous conduction mode [5], [1], [6] with the control switch and constant frequency pulse width modulation. The duty cycle of the pulse width modulated signal produced by MATLAB. The isolated boost converter can converter low input voltage to high output voltage. The simulation of boost dc-dc converter control scheme was implemented on MATLAB 2012b version simulation tool and found that scheme is better than the conventional scheme. It deals with PID controller is proposed the open loop does not maintain the constant voltage with the variation of input. The closed loop system is maintained constant voltage with the variation of input voltage. The circuit model of the closed loop system is shown in Figure.7. The output voltage is sensed and it is compared with the reference voltage. The error is applied to a PID controller. The output of PID controller is used to generate proper pulses to drive the MOSFET in the output rectifier. A controlled converter is recommended to get constant voltage across the load. The response of closed loop system is shown in figure 10 & 11, from this figure, it can be seen that the output voltage increases, oscillates and reduces to the set value of 24V. From the output it can be seen that the output voltage increases. There is a steady state error in the output of open loop system. The output voltage is sensed and it is compared with the reference voltage. The error signal is given to the comparator through PID controller. The output pulses of PWM [3] generation system shown in fig.6 and are given to the MOSFET. The pulses of PWM generator is shown in fig. 8. The response of closed loop system is as shown in figure 10 & from the response it can be seen that the output voltage reduces and settles at the set value. The steady state error becomes negligible.

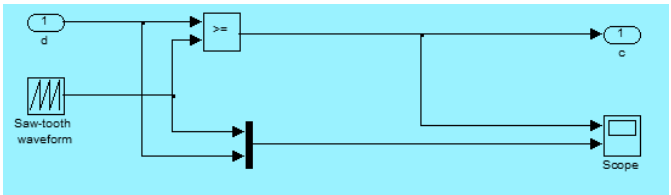


Fig.6. PWM Pulse Generator

V. EXPERIMENTAL SETUP

Simulation of Experimental Setup

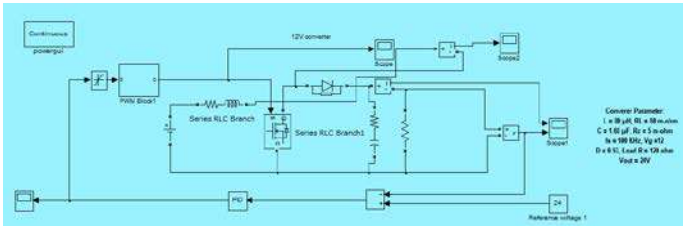


Fig.7. DC/DC Boost converter with lighting load

A DC/DC closed loop boost converter with resistive load is designed in MATLAB and simulation characteristics are verified. The input is taken from solar panel which is equivalently represented as dc power supply in the diagram. The output of the solar panel can vary from 10 to 18 volts. So in order to regulate the output voltage for the variation in input a closed loop voltage feedback technique is used. In which a PID controller is used to regulate the output voltage. This voltage is then multiplies with the gain block the input by a constant value $Y=K\times U$ and compared with a fixed reference voltage.

B. Analysis of Circuit and Results

Analysis of the circuit is carried out based on the following assumptions. The circuit is ideal. It means when the switch is ON, the drop across it is zero and the current through it is zero when it is open. The diode has zero voltages drop in the conducting state and zero current in the reverse-bias mode. The time delays in switching on and off the switch and the diode are assumed to be negligible. The inductor and the capacitor are assumed to be loss less. The responses in the circuit are periodic. It means especially that the inductor current is periodic. Its value at the start and end of a switching cycle is the same. The net increase in inductor current over a cycle is zero. If it is non-zero, it would mean that the average inductor current should either be gradually increasing or decreasing and then the inductor current is in a transient state and has not become periodic. The voltage across the inductor and linear variation of current through inductor are shown in figure 9.

The complete closed loop boost converter with resistive load is developed using MATLAB simulation software. The experimental setup consisting of input from solar PV module, closed loop dc/dc converter and load is tested in MATLAB. The observed results in simulation are shown. The expected output is 24 volts.

VI. CONCLUSION

A low cost high performance DC-DC boost converter has been proposed. The proposed system used solar PV as the input and resistive load as the output which conserves the power. The complete system has been designed and simulated in MATLAB which resulted in an efficiency of 90-95%.

VII. SIMULATION RESULTS

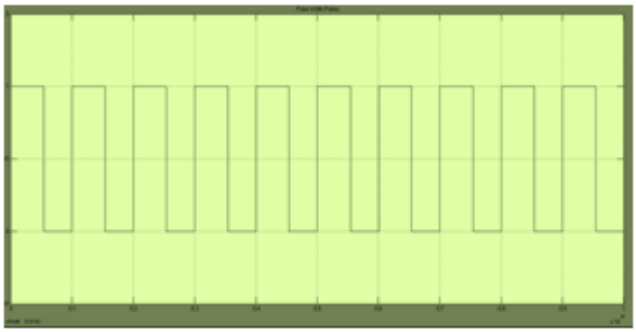


Fig.8. PWM Waveform

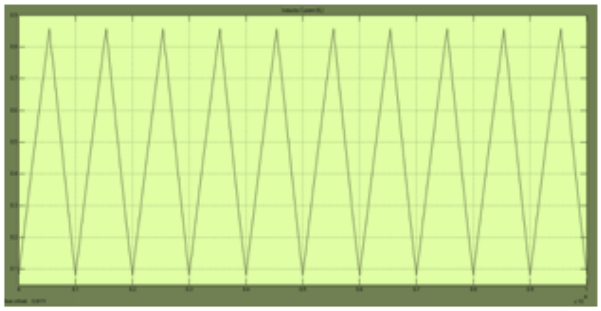


Fig.9 Inductor Current

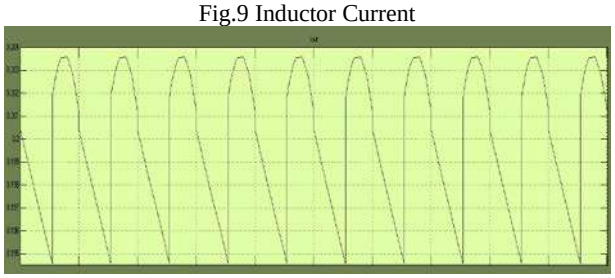


Fig.10 Load Current (Output Current)

Fig.11 Load Voltage (Output Voltage)

REFERENCES

[1] Shih-Ming Chen, Tsorng-Juu Liang, Lung-Sheng Yang and JiannFuh Chen ,"A Cascaded High Step-Up DC–DC Converter With Single Switch for Microsource Applications", IEEE Transactions On Power Electronics, Vol. 26, No. 4, April 2011, pp.1146-1153. http://dx.doi.org/10.1109/TPEL.2010.2090362

[2] Lung-Sheng Yang, Tsorng-Juu Liang, and andJiann-Fuh Chen, "Transformer less DC–DC Converters With High Step-Up Voltage Gain", *IEEE Transactions Industrial Electronics*, Vol. *56, No. 8, August 2009*, pp.3144-3152. http://dx.doi.org/10.1109/TIE.2009.2022512

[3] Yohan Park, Byoungkil Jung, and Sewan Choi, "Nonisolated ZVZCS Resonant PWM DC–DC Converter for High Step-Up and High-Power Applications", IEEE Transactions On Power Electronics, Vol. 27, No. 8,August 2012,pp. 3568-3575. http://dx.doi.org/10.1109/TPEL.2012.2187342

[4] S. Masri and P. W. Chan, "Design and development of a dc-dc Boost converter with constant output voltage", IEEE, International conference on Intelligent and Advanced systems (ICIAS), June 2010. http://dx.doi.org/10.1109/icias.2010.5716257

[5] Abdul Fatah Mat Said., "DC-DC Boost Converter Design for Solar Electric System", International conference on Instrumentation, Control and Automation, October 20-22 (ICA 2009) Bandung.

[6] SyafrudinMasri and Pui-Weng Chan, "Development of a Microcontroller-Based Boost Converter for Photovoltaic System", European Journal of Scientific Research. ISSN 1450-216XVol.41No.1,pp.38-47. http://www.eurojournals.com/ejsr.htm

[7] Diary R. Sulaiman, Hilmi F. Amin, and Ismail K. Said., "Design of High Efficiency DC-DC Converter for Photovoltaic Solar Home applications", Journal of Energy and Power engineering, 2009.

[8] Muhammad H. Rashid, Power Electronics Circuits, Devices, And Applications, 3rd edition, University of West Florida, Pearson Prentice Hall, 2003.

[9] Ned Mohan, Tore M. Undeland, and Williams P. Robbins, Power Electronics: Converters, Applications, and Design, 3rd ed., John Wiley &Sons: USA, 2003. P. Sathya et al. / International Journal of Engineering and Technology (IJET) ISSN.

PVT Analysis of 8 Bit SOI Based RCA Adder with Conventional MOSFET at 32 Nanometer Regime

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Abstract :

Adders are digital components which are widely in the digital integrated circuit design and are the important part of all digital applications like Digital Signal Processing (DSP), microprocessor applications. As the technology is scaling down, researchers are trying to design adders which are either high speed, low power consumption, less area. In this paper, the design of Ripple Carry Adder are discussed using two different devices and are compared on the basis of their performance parameters such as area, delay and energy delay product at 32nm technology node. PVT analysis is done on both devices. SOI device based RCA adder is faster than the bulk based MOSFET RCA adder. All the work has been carried out in Hspice software.

Keywords: Enerrgy Delay Product (EDP); Field Effect Transistor; Ripple Carry Adder; SOI;

I. INTRODUCTION

Semiconductor technology is scaling down. This lead to optimization area and due reduce gate length, at the same time it gives better. CMOS technology scaling down improves the speed of circuits but increased the power dissipation [1-3]. It is observed that there is a huge power required to bridge the gap between the high performance chip and low power systems [4]. To satisfy the Ultra low power requirement of these applications. It is necessary to investigate new type of devices. Arithmetic unit are the essential building blocks of digital systems those are Processors, controllers Digital Processor (DSP), and other data processing units. Adders become a carping hardware unit for the effective implementation of arithmetic unit. In many arithmetic applications and many other kinds of applications, adders are not only useful in the arithmetic logic unit, but also in used other parts of processor [5]. FDSOI offers many benefits over conventional MOSFET. FDSOI strongly reduces the random dopant fluctuation, this drastically cutting threshold voltage of transistor. FDSOI is intrinsically low leakage and have good control on short channel effect [6]. FDSOI transistor offers good analog behavior.

In this paper, the performance parameters of delay, average power, PDP and EDP are compared at different technology node[5].
This paper is organized as below. Section II introduces 8 bit ripple carry analysis. Section III shows simulation results. Section IV draws conclusion.

Working of SOI Device

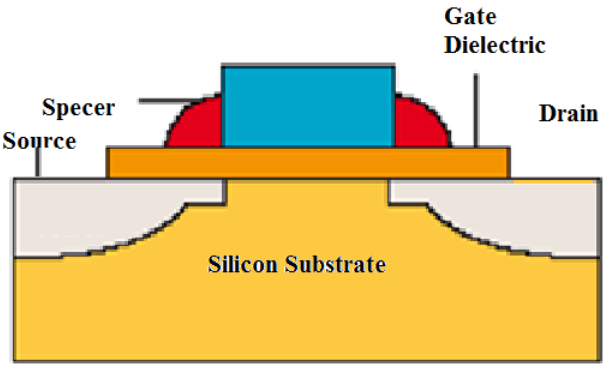

Fig.1: Traditional n-channel MOSFET

A traditional n-channel MOSFET is shown in fig.1 .The traditional MOSFET consists of heavily doped n-type poly silicon gate electrode, a highly doped n-type source as well as drain, a p-type substrate, and a silicon dioxide or oxy nitride gate dielectric, where as fig. 2 A silicon-on-insulator (SOI) MOSFET is same as that of the traditional MOSFET except the active silicon is on a thick layer of silicon dioxide. The electrical isolation of the silicon of SOI decreases parasitic junction capacitance and increases device performance. SOI -- silicon on insulator, refers to placing a thin layer of silicon on top of an insulator such as SiO2.

The devices will be built on top of the thin layer of silicon. The basic idea of SOI is to the parasitic capacitance and hence faster switching speed. Every time a transistor is turned on, it must first charge all of its internal (parasitic) capacitance before it can begin to conduct.

The time it takes to charge up and discharge (turn off) the parasitic capacitance is much longer than the actual turn on and off of the transistor. If the parasitic capacitance can be reduced, the transistor can be switched faster — performance. One of the major source of parasitic

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capacitance is from the source and drain to substrate junctions.. SOI can decrease the capacitance at the source and drain junctions significantly by eliminating the depletion regions extending into the substrate. Silicon-on-insulator CMOS offers a 20–35% performance gain over bulk CMOS. As the technology moves to the 0.13-µm generation, SOI is being used by more companies, and its application is spreading to lower-end microprocessors and SRAMs. Some of the recent applications of SOI in high-end microprocessors and its upcoming uses in low-power, radio-frequency (rf) CMOS, embedded DRAM (EDRAM), and the integration of vertical SiGe bipolar devices on SOI are described.

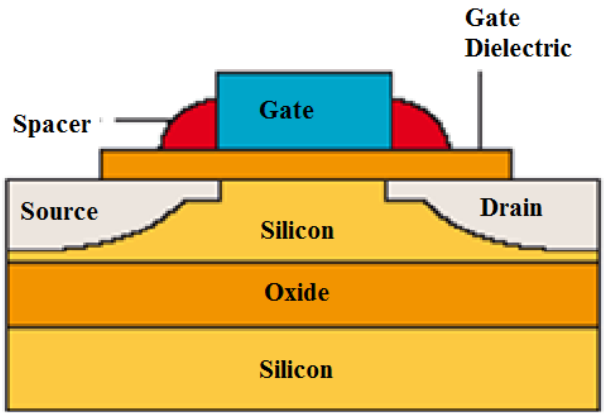

Fig. 2: Silicon-On-Insulator (SOI) MOSFET

II 8-BIT RIPPLE CARRY ADDER ANALYSIS

Addition is the most frequently used arithmetic operation and is often the speed-limiting element of arithmetic logic unit in modern CPUs. Addition forms the basis for many processing operations, including counting, multiplication, and digital signal filtering. As a result, adder circuits that add two binary numbers are of great interest in the field of digital IC and are often used as a test bench to compare different logic style [7-10].

The gate delay can easily calculated looking into the level of the full adder circuit. Every full adder requires three levels of logic. In a 8-bit ripple-carry adder, there are 8 full adders, so the critical path [11] delay is equal to 3 for first adder, 7 multiplied by 2 for propagation of carry in later adders gives total 17 gate delays. The equation for the critical path delay for a carry-ripple adder n-bits is

$$T_{CRA}(\mathrm{n}) = T_{HA} + (\mathrm{n}-1)\bullet \mathrm{T}_C + T_S$$
$$= T_{FA} + (\mathrm{n}-1)\bullet \mathrm{T}_C$$
$$= 6D + (\mathrm{n}-1)2\,\mathrm{D}$$
$$= (\mathrm{n}+2)\bullet 2\,\mathrm{D}$$

Table:1 Full adder truth table

A	B	C_{IN}	F	C_{OUT}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Table 1 is the truth table of a full adder. A and B are the adder inputs, C_{IN} is the carry input, F is the sum output, and C_{OUT} is the carry output. Based on this truth table.

To construct a 8-bit adder, 8 Full Adder units can be cascaded in series, connecting C_{out} of a Full Adder cell to the next stage Full Adder Cin input[12]. This configuration is known as ripple-carry adder, here the carry bit get “ripples" from one stage to the other [13][11][14]. A block diagram of a 8-bit ripple carry adder (RCA) is shown in Figure 3.

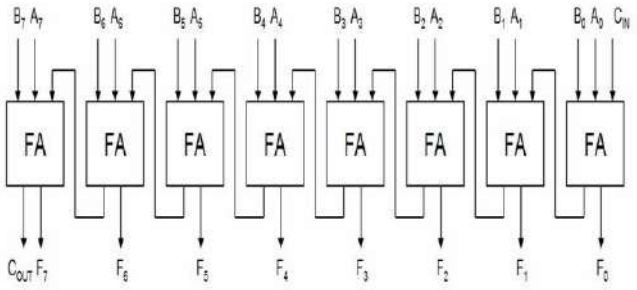

Fig. 3: 8-bit Ripple Carry Adder

For a RCA, the worst case delay is the propagation of carry signal from the least significant carry bit (Ci) to the most significant carry bit. Furthermore, an additional stage is required to produce the sum[15] based on this carry signal. In the case of RCA, the delay is then proportional to number of bits[9-11] [16-18].

III. SIMULATION RESULTS

RCA adder is implemented using FDSOI DEVICE and conventional MOSFET at 32 nm. A bulk transistor having gate length 32nm, threshold voltage 0.5088 for NMOS and gate length 32nm, threshold voltage -0.450 for PMOS, where as FDSOI device with bisimsoi3.2 model card parameters has been considered. All these parameter has been taken from predictive technology model. Different comparison of delay, power, EDP has been done in this paper.

Figure 4 shows comparison of Delay as function of supply voltage. It is observed that for FDSOI device gives better delay as compared to bulk MOSFET at 32 nm.

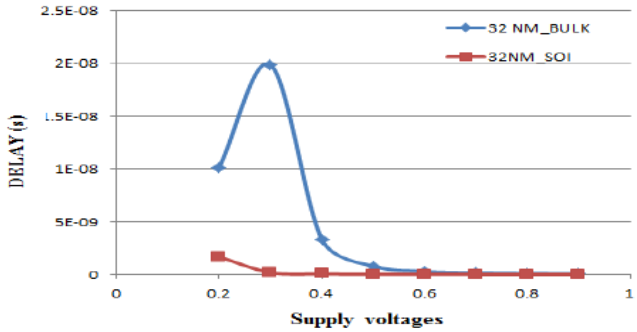

Fig. 4: Comparison of Delay as function of supply voltage

Figure 5 shows comparison of Power as function of supply voltage. It is observed SOI device based RCA consume more power than bulk MOSFET. Power increases with increase in supply voltage.

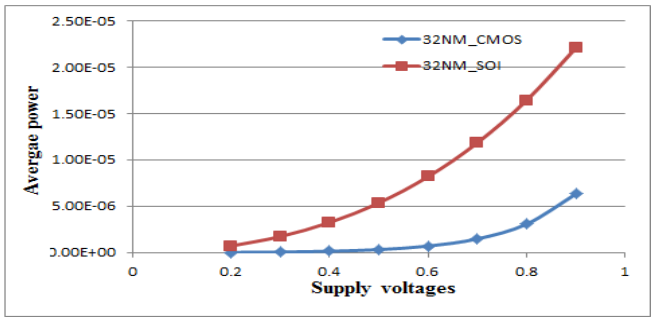

Fig. 5: Comparison of power as function of supply voltage

Figure 6 shows comparison of Energy Delay Product versus change in supply voltage. It is observed SOI device based RCA is faster than bulk MOSFET

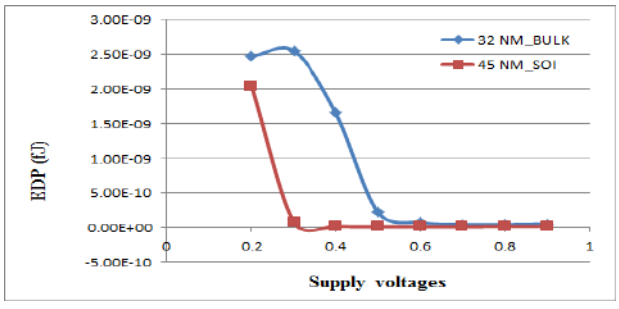

Fig. 6 comparison of EDP as function of supply voltage

Figure 7 shows comparison of Delay versus change in temperature. It is observed SOI device based RCA is faster than bulk MOSFET.

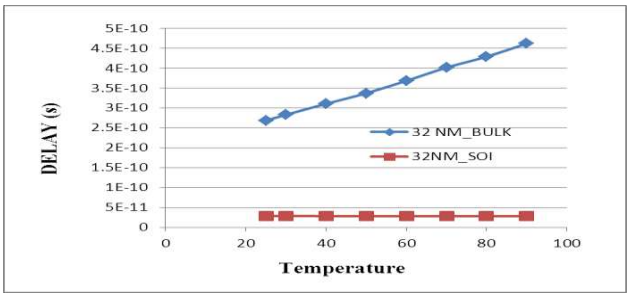

Fig. 7: Comparison of delay as a function of temperature

Figure 8 shows comparison of average power as function of temperature. It is observed SOI device based RCA is adder, power increase exponentially than bulk MOSFET. at the different room temperature over range of 25^0 C to 100^0 C.

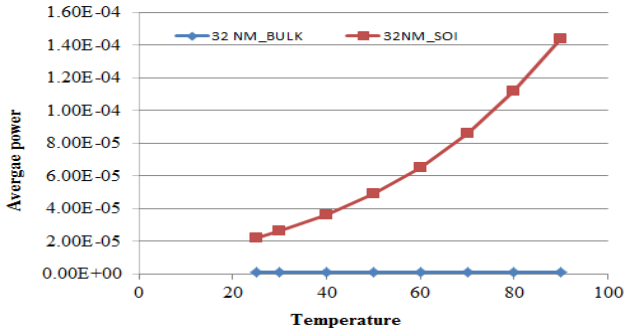

Fig. 8: Comparison of average power as function of temperature

Figure 9 shows comparison of Energy Delay Product as function of temperature. it is observed that SOI based RCA adder is good than the bulk based RCA adder at 32nm at the different room temperature over range of 25^0 C to 100^0 C.

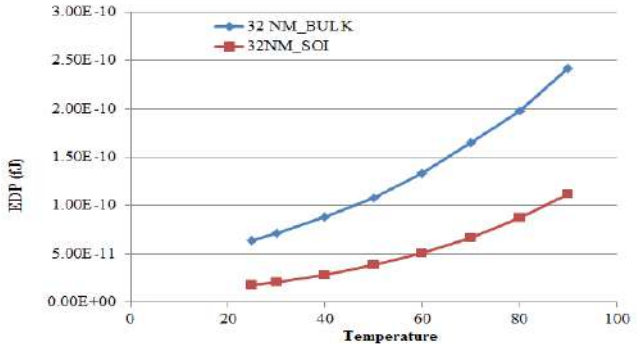

Fig. 9: Energy Delay product vs temperature

Figure 10 shows comparison of Delay as function of gate length. it is observed that SOI based RCA adder is good than the bulk based RCA adder at 32nm over 10 percent vriation in gate length.

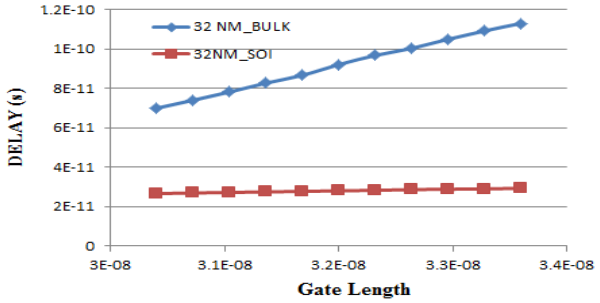

Fig. 10: Delay vs gate length

Figure 11 shows comparison of average Power as function of gate length. it is observed that SOI based RCA adder is good than the bulk based RCA adder at 32nm over 10 percent vriation in gate length.

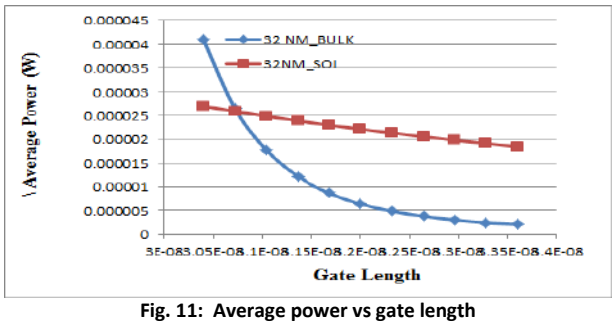

Fig. 11: Average power vs gate length

Figure 12 shows comparison of EDP as function of gate length. it is observed that SOI based RCA adder is good than the bulk based RCA adder at 32nm over 10 percent vriation in gate length.

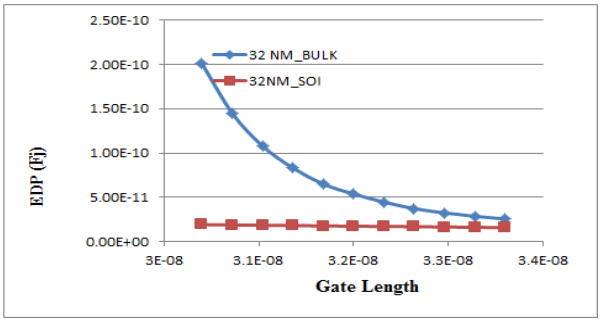

Fig. 12: EDP vs gate length

IV. CONCLUSION

In this paper, we have implemented Ripple carry adder in two different devices at 32nm technology node. Differetnt performance parameters delay, average power and energy delay product are compared. It is observed that FDSOI device based RCA adder gives better delay but consume more power and over all EDP is very good as compared to bulk MOSFET at 32 nm. All the work has been carried out in Hspice software.

REFERENCES

[1] N.S. Kim, K.Flautner, D. Blaauw, and T. Mudge, "Circuit and micro archirectural techniques for reducing cache leakage power," IEEE Transactions on Very Large Scale Integration (VLSI) System, Vol. 12.No.2, pp. 167-187, 2004.

[2] J.M. Rabaey, A.P. Chandrakasan, and B. Nikolic, Digital Integrated Circuits- A Design Perspective, 2nd Edition, Prentice Hall, New Jersey,USA, 2003.

[3] A. Wang, B.H. Calhoun, A.P. Chandrakasan, Sub-Threshold Design for Ultra Low-Power Systems, first ed., Springer, New York, 2006.

[4] Performance S.S. Chopade, S.D. Pable, Dinesh V Padole,"Analysis of CNFET based Interconnect Drivers for Sub-threshold Circuits", International Journal of Computer Applications,Volume 60– No.4, December 2012

[5] Jasmine Saini,Somya Agarwal, Aditi Kansal,"Performance, Analysis and Comparison of Digital Adders"International Conference on Advances in Computer Engineering and Applications (ICACEA)

[6] S. S. Chopade, D. V. Padole, "Design of Double Gate MOSFET and FDSOI using high k material for Nano scaled Circuits" IEEE international conference 978-1-4799-4075-2/14/$31.00 © 2014

[7] Rahul Parhi,Chris H. Kim,Keshab K. Parhi,"Fault-Tolerant Ripple-Carry Binary Adder using Partial Triple Modular Redundancy (PTMR)",978-1-4799-8391-9/15/$31.00 ©2015 IEEE

[8] Behnam Amelifard,Farzan Fallah,Massoud Pedram,"Closing the Gap between Carry Select Adder and Ripple Carry Adder: A New Class of Low-power High-performance Adders",Proceedings of the Sixth International Symposium on Quality Electronic Design (ISQED'05) 0-7695-2301-3/05 $ 20.00 IEEE

[9] Mark S. K. Lau, Keck Voon Ling, Yun Chung Chu, and Arun Bhanu,"Modeling of Probabilistic Ripple-Carry Adders",2010 Fifth IEEE International Symposium on Electronic Design, Test & Applications,978-0-7695-3978-2/10 $26.00 © 2010 IEEE DOI 10.1109/DELTA.2010.14

[10] Ali Asghar Vatanjou, Trond Ytterdal, and Snorre Aunet,"Energy Efficient Sub/Near-Threshold Ripple-Carry Adder in Standard 65 nm CMOS,978-1-4673-7495-8/15/$31.00 ©2015 IEEE

[11] T.-Y. Chang and M.-J. Hsiao,"Carry-select adder using single ripple-carry adder", ELECTRONICS LETTERS 29th October 1998 Vol. 34 No. 22

[12] S. Usha, T. Ravi,"Desing of 4 bit ripple Carry adder using Hybrid 9T Full adder",International conference on circuit, Power and computing Technology [ICCPCT],978-1-4799-7075-9/15/$31.00©2015 IEEE

[13] Tania Sultana,Rajon Bardhan,"A Compact Design of n-Bit Ripple Carry Adder Circuit using QCA Architecture",978-1-4799-8679-8/15/$31.00 copyright 2015 IEEE ICIS 2015, June 28-July 1 2015, Las Vegas, USA\

[14] Shamim Akhter, Saurabh Chaturvedi, Kilari Pardhasardi,"CMOS Implementation of Efficient 16-Bit Square Root Carry-Select Adder",978-1-4799-5991-4/15/$31.00 ©2015 IEEE

[15] Arun, Manoj Kumar,"Design of Low Power Split Path Data Driven Dynamic Ripple Carry Adders",978-93-80544-12-0/14/$31.00 c 2014 IEEE

[16] Mohammad Fawaz Nader Kobrosli Jessica Rizakallah Mohammad Mansour Ali Chehab Ayman Kayssi Hazem Hajj,"Energy Minimization Feedback Loop for Ripple Carry Adders",978-1-4244-8274-0/10/$26.00 ©2010 IEEE

[17] Luis A. Montalvo, Keshab K. Parhi, and Janardhan H.,"ESTIMATION OF AVERAGE ENERGY BASED ON AVERAGE LENGTH CARRY CHAINS",7803-3134-619$65 .0001 996 IEEE

[18] Chih-Jen Fang Chung-Hsun Huang Jinn-Shyan Wang Ching-Wei Yeh,"Fast and Compact Dynamic Ripple Carry Adder Design",0-7803-7363-4/02 2002 IEEE

ANALYSIS OF 8 BIT RCA ADDER AT DIFFERENT NANOMETER REGIME

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***Abstract* -Adders are digital components which are widely in the digital integrated circuit design and are the important part of all digital applications like Digital Signal Processing (DSP), microprocessor applications. As the technology is scaling down, researchers are trying to design adders which are either high speed, low power consumption, less area. In this paper, the design of Ripple Carry Adder are discussed and are compared on the basis of their performance parameters such as area, delay and power distribution at 32nm and 45nm technology node has been compared. It is observed that the 32nm technology node even in all the parameters like delay area average power, power delay product, energy delay product gives better results. All the work has been carried out in Hspice software.**

Keywords: Power Delay Product (PDP);Ripple Carry Adder; Field Effect Transistor;; Enerrgy Delay Product(EDP)

I. INTRODUCTION

Semiconductor technology is scaling down. This lead to optimization area and due reduce gate length, at the same time it gives better. CMOS technology scaling down improves the speed of circuits but increased the power dissipation [1-3]. It is observed from figure 1 that there is a huge power required to bridge the gap between the high performance chip and low power systems[18]. To satisfy the Ultra low power requirement of these applications, it is quite necessary to work the circuit below sub threshold region [4]. Subthreshold operating region is very good for low power demand of devices, however, speed of Ultra Low Power circuit is very low. As the delay increased when operating supply goes below threshold voltage. Arithmetic unit are the essential building blocks of digital systems those are Processors, controllers Digital Processor (DSP), and other data processing units. Adders become a carping hardware unit for the effective implementation of arithmetic unit. In many arithmetic applications and many other kinds of applications, adders are not only useful in the arithmetic logic unit, but also in used other parts of processor[16]. Addition operation can also be used in one's ,two's complement operations, encoding, decoding and so on. The addition operations will result in sum value and carry value

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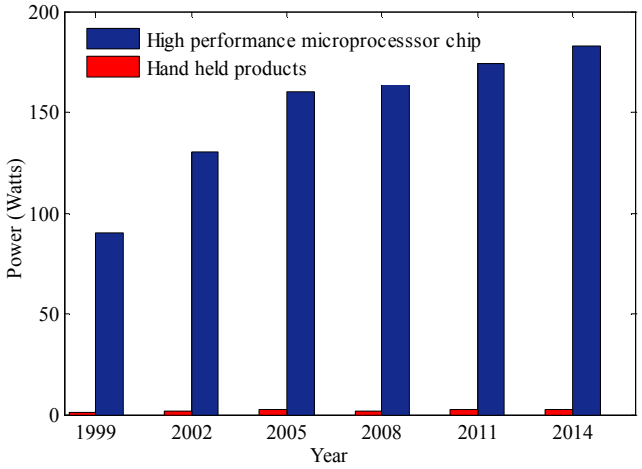

Figure 1. Power requirements of microprocessor chip and portable products as per ITRS [17-19].

. In this paper, the performance parameters of delay, average power, PDP and EDP are compared at different technology node[16].
This paper is organized as below. Section II introduces 8 bit ripple carry analysis. Section III shows simulation results. Section IV draws conclusion.

II. 8-BIT RIPPLE CARRY ADDER ANALYSIS

Addition is the most frequently used arithmetic operation and is often the speed-limiting element of arithmetic logic unit in modern CPUs. Addition forms the basis for many processing operations, including counting, multiplication, and digital signal filtering. As a result, adder circuits that add two binary numbers are of great interest in the field of digital IC and are often used as a test bench to compare different logic style[12-15].
The gate delay can easily calculated looking into the level of the full adder circuit. Every full adder requires three levels of logic. In a 8-bit ripple-carry adder, there are 8 full adders, so the critical path[5] delay is equal to 3 for first adder, 7 multiplied by 2 for propagation of carry in later adders

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gives total 17 gate delays. The equation for the critical path delay for a carry-ripple adder n-bits is

$$T_{CRA}(n) = T_{HA} + (n-1) \bullet T_C + T_S$$
$$= T_{FA} + (n-1) \bullet T_C$$
$$= 6D + (n-1)2D$$
$$= (n+2) \bullet 2D$$

TABLE1 1. FULL ADDER TRUTH TABLE

A	B	C_{IN}	S	C_{OUT}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Table 1 is the truth table of a full adder. A and B are the adder inputs, C_{IN} is the carry input, S is the sum output, and C_{OUT} is the carry output. Based on this truth table.

To construct a 8-bit adder, 8 FA units can be cascaded in series, connecting C_{out} of a FA cell to the next stage FA Ci input[7]. This configuration is known as ripple-carry adder, here the carry bit get "ripples" from one stage to the other[5-6]. A block diagram of a 8-bit ripple carry adder (RCA) is shown in Figure 3.

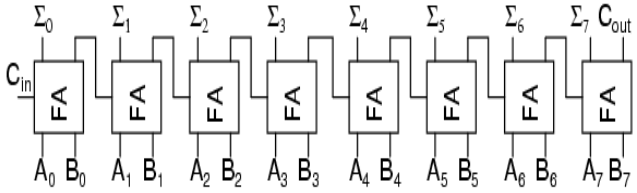

Figure 3. 8-bit Ripple Carry Adder

For a RCA, the worst case delay is the propagation of carry signal from the least significant carry bit (Ci) to the most significant carry bit. Furthermore, an additional stage is required to produce the sum based on this carry signal. In the case of RCA, the delay is then proportional to number of bits[9-11].

III. SIMULATION RESULTS

Conventional CMOS in two different technology model has been used to compare performance of RCA adder. A transistor having gate length 32nm, threshold voltage 0.5088 for NMOS and gate length 32nm, threshold voltage -0.450 for PMOS, gate length 45nm, threshold voltage 0.469 for NMOS and gate length 45nm, threshold voltage -0.418V for PMOS. All these parameter has been taken from predictive technology model. Different comparison of delay, power, PDP, EDP has been done in this paper. Figure 4 shows comparison of Delay as function of supply voltage. It is observed that the 32 nm has less Delay as compared to 45nm technology.

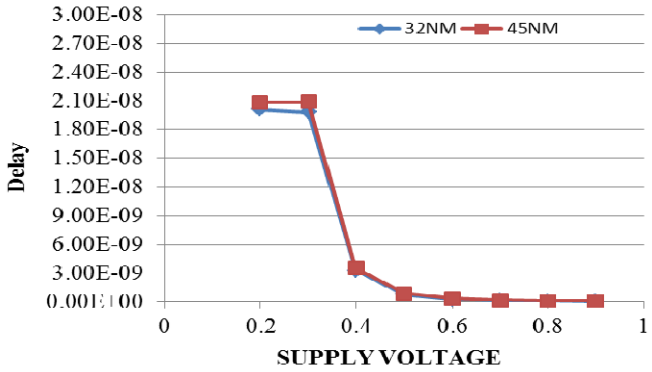

Figure 4. comparison of Delay as function of supply voltage

Figure 5 shows comparison of Power as function of supply voltage. It is observed that the 32 nm has less Power as compared to 45nm technology.

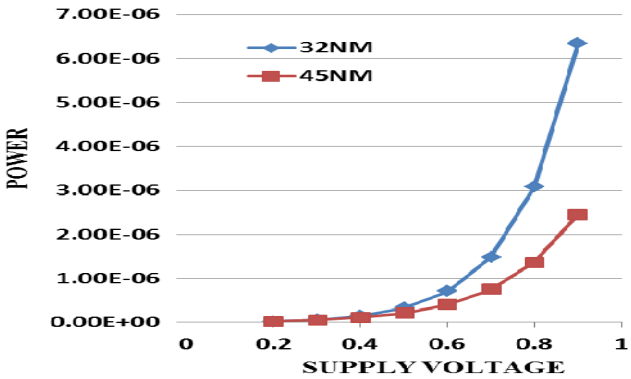

Figure 5. comparison of power as function of supply voltage

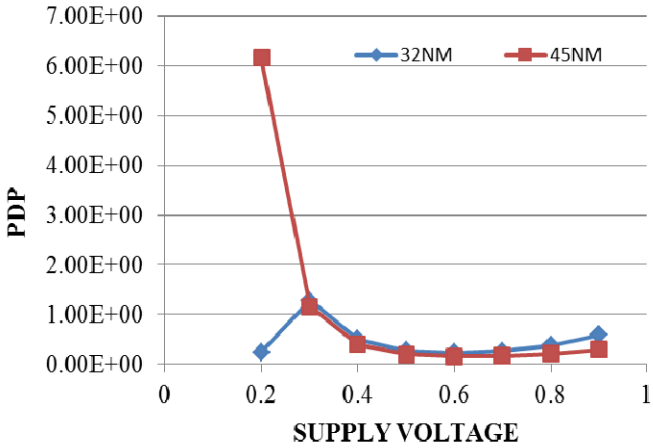

Figure 6. comparison of PDP as function of supply voltage

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Figure 6 shows comparion of Power Delay as function of supply voltage. It is observed that the 32 nm has less Power Delay product as compared to 45nm technology.

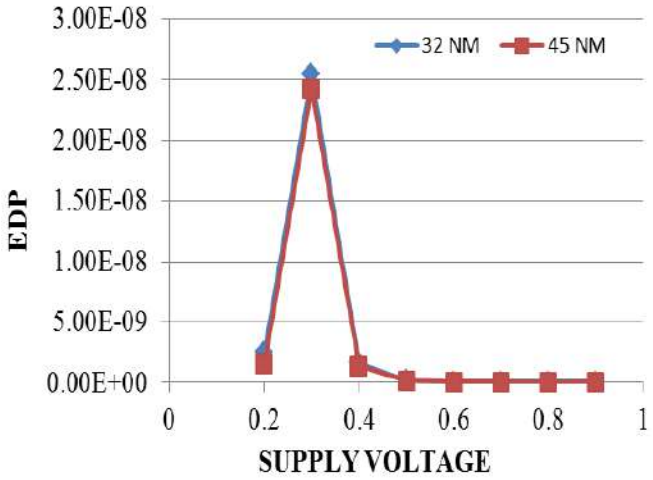

Figure 7. comparison of EDP as function of supply voltage

Figure 7 shows comparism of Energy Delay Product versus chnge in supply voltage. It is observed that the 45 nm has less Energy Delay Product as compared to 32nm technology.

Figure 8 shows comparison of average power as function of temperature. As technology node scale down, it is observed that 32nm shows better stability at the different room temperature over ragne of 25^0 C to 90^0 C.

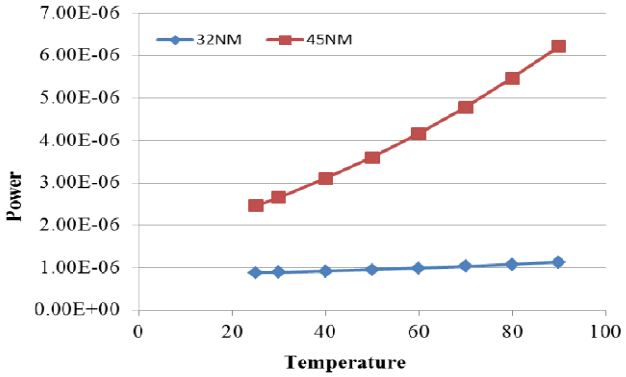

Figure 8. comparison of averagepower as function of temperature

Figure 9 shows comparison of power delay product as function of temperature. As technology node scale down, it is observed that 32nm shows better Power delay product at the different room temperature over ragne of 25^0 C to 90^0 C.

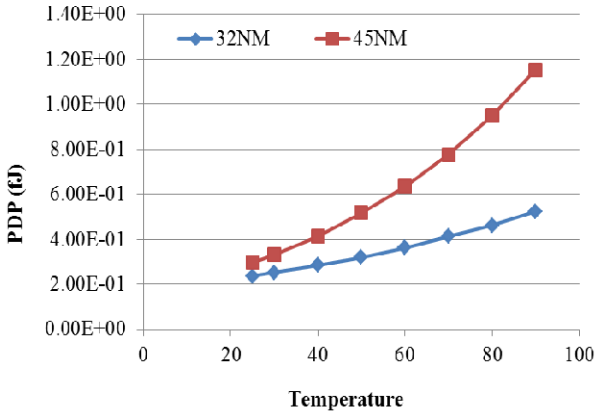

Figure 9. power delay product vs temperature

Figure 10 shows comparison of Energy Delay Product as function of temperature. As tehcnology node scale down, it is observed that 32nm shows better Energy Delay Product at the different room temperature over ragne of 25^0 C to 90^0 C.

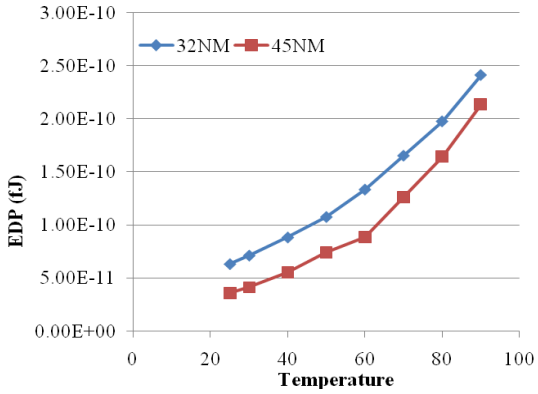

Figure 10. Energy Delay product vs temperature

From figure 4, 5, 6, 7 it shows that the subthreshold working of the circuits show very low power. Power reduces 97% than the super threshold region of working.

IV. CONCLUSION

In this paper, we have implemented Ripple carry adder in two different technology node 32nm and 45 nm. Differetnt performance parameters delay, average power, power delay product and energy delay product are compared. It is observed that 45 nm technolgy shows in improvement over 32nm. 32nm technology built RCA is faster than 45nm technology based RCA. It is also observed that the as temperature increases the 32nm technolgy is more stable than the 45nm technology. Ripple carry adder gives good

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power in subthreshod region at the cost of speed. All the work has been carried out in Hspice software.

REFERENCES

[1] N.S. Kim, K.Flautner, D. Blaauw, and T. Mudge, "Circuit and micro archirectural techniques for reducing cache leakage power," IEEE Transactions on Very Large Scale Integration (VLSI) System, Vol. 12.No.2, pp. 167-187, 2004.

[2] J.M. Rabaey, A.P. Chandrakasan, and B. Nikolic, Digital Integrated Circuits- A Design Perspective, 2nd Edition, Prentice Hall, New Jersey,USA, 2003.

[3] A. Wang, B.H. Calhoun, A.P. Chandrakasan, Sub-Threshold Design for Ultra Low-Power Systems, first ed., Springer, New York, 2006.

[4] Tania Sultana,Rajon Bardhan,"A Compact Design of n-Bit Ripple Carry Adder Circuit using QCA Architecture",978-1-4799-8679-8/15/$31.00 copyright 2015 IEEE ICIS 2015, June 28-July 1 2015, Las Vegas, USA

[5] T.-Y. Chang and M.-J. Hsiao,"Carry-select adder using single ripple-carry adder", ELECTRONICS LETTERS 29th October 1998 Vol. 34 No. 22

[6] Shamim Akhter, Saurabh Chaturvedi, Kilari Pardhasardi,"CMOS Implementation of Efficient 16-Bit Square Root Carry-Select Adder",978-1-4799-5991-4/15/$31.00 ©2015 IEEE

[7] S. Usha, T. Ravi,"Desing of 4 bit ripple Carry adder using Hybrid 9T Full adder",International conference on circuit, Power and computing Technology [ICCPCT],978-1-4799-7075-9/15/$31.00©2015 IEEE

[8] Arun, Manoj Kumar,"Design of Low Power Split Path Data Driven Dynamic Ripple Carry Adders",978-93-80544-12-0/14/$31.00┐c 2014 IEEE

[9] Mohammad Fawaz Nader Kobrosli Jessica Rizakallah Mohammad Mansour Ali Chehab Ayman Kayssi Hazem Hajj,"Energy Minimization Feedback Loop for Ripple Carry Adders",978-1-4244-8274-0/10/$26.00 ©2010 IEEE

[10] Luis A. Montalvo, Keshab K. Parhi, and Janardhan H.,"ESTIMATION OF AVERAGE ENERGY BASED ON AVERAGE LENGTH CARRY CHAINS",7803-3134-619$65 .0001 996 IEEE

[11] Chih-Jen Fang Chung-Hsun Huang Jinn-Shyan Wang Ching-Wei Yeh,"Fast and Compact Dynamic Ripple Carry Adder Design",0-7803-7363-4/02 2002 IEEE

[12] Rahul Parhi,Chris H. Kim,Keshab K. Parhi,"Fault-Tolerant Ripple-Carry Binary Adder using Partial Triple Modular Redundancy (PTMR)",978-1-4799-8391-9/15/$31.00 ©2015 IEEE

[13] Behnam Amelifard,Farzan Fallah,Massoud Pedram,"Closing the Gap between Carry Select Adder and Ripple Carry Adder: A New Class of Low-power High-performance Adders",Proceedings of the Sixth International Symposium on Quality Electronic Design (ISQED'05) 0-7695-2301-3/05 $ 20.00 IEEE

[14] Mark S. K. Lau, Keck Voon Ling, Yun Chung Chu, and Arun Bhanu,"Modeling of Probabilistic Ripple-Carry Adders",2010 Fifth IEEE International Symposium on Electronic Design, Test & Applications,978-0-7695-3978-2/10 $26.00 © 2010 IEEE DOI 10.1109/DELTA.2010.14

[15] Ali Asghar Vatanjou, Trond Ytterdal, and Snorre Aunet,"Energy Efficient Sub/Near-Threshold Ripple-Carry Adder in Standard 65 nm CMOS,978-1-4673-7495-8/15/$31.00 ©2015 IEEE

[16] Jasmine Saini,Somya Agarwal, Aditi Kansal,"Performance, Analysis and Comparison of Digital Adders"International Conference on Advances in Computer Engineering and Applications (ICACEA)

[17] ITRS, International Technology Roadmap for semiconductors, 2005.

[18] S.S. Chopade, S.D. Pable, Dinesh V Padole, "Performance Analysis of CNFET based Interconnect Drivers for Sub-threshold Circuits", International Journal of Computer Applications,Volume 60– No.4, December 2012

[19] Pable, S.D., Hasan, M.,"Performance Analysis of Ultra Low-Power Mixed CNT Interconnects for Scaled Technology", Electronic System Design (ISED), 2011 International Symposium , IEEE page no 285-289 978-1-4577-1880-9

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ANALYSIS OF 8 BIT RCA ADDER AT DIFFERENT NANOMETER REGIME

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***Abstract* -Adders are digital components which are widely in the digital integrated circuit design and are the important part of all digital applications like Digital Signal Processing (DSP), microprocessor applications. As the technology is scaling down, researchers are trying to design adders which are either high speed, low power consumption, less area. In this paper, the design of Ripple Carry Adder are discussed and are compared on the basis of their performance parameters such as area, delay and power distribution at 32nm and 45nm technology node has been compared. It is observed that the 32nm technology node even in all the parameters like delay area average power, power delay product, energy delay product gives better results. All the work has been carried out in Hspice software.**

Keywords: Power Delay Product (PDP);Ripple Carry Adder; Field Effect Transistor;; Enerrgy Delay Product(EDP)

I. INTRODUCTION

Semiconductor technology is scaling down. This lead to optimization area and due reduce gate length, at the same time it gives better. CMOS technology scaling down improves the speed of circuits but increased the power dissipation [1-3]. It is observed from figure 1 that there is a huge power required to bridge the gap between the high performance chip and low power systems[18]. To satisfy the Ultra low power requirement of these applications, it is quite necessary to work the circuit below sub threshold region [4]. Subthreshold operating region is very good for low power demand of devices, however, speed of Ultra Low Power circuit is very low. As the delay increased when operating supply goes below threshold voltage. Arithmetic unit are the essential building blocks of digital systems those are Processors, controllers Digital Processor (DSP), and other data processing units. Adders become a carping hardware unit for the effective implementation of arithmetic unit. In many arithmetic applications and many other kinds of applications, adders are not only useful in the arithmetic logic unit, but also in used other parts of processor[16]. Addition operation can also be used in one's ,two's complement operations, encoding, decoding and so on. The addition operations will result in sum value and carry value

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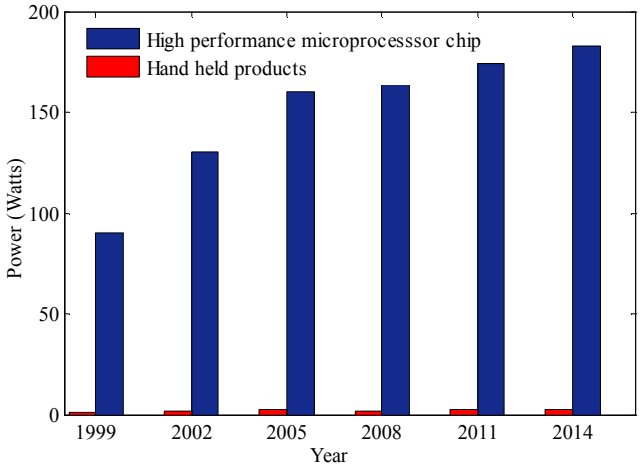

Figure 1. Power requirements of microprocessor chip and portable products as per ITRS [17-19].

. In this paper, the performance parameters of delay, average power, PDP and EDP are compared at different technology node[16].
This paper is organized as below. Section II introduces 8 bit ripple carry analysis. Section III shows simulation results. Section IV draws conclusion.

II. 8-BIT RIPPLE CARRY ADDER ANALYSIS

Addition is the most frequently used arithmetic operation and is often the speed-limiting element of arithmetic logic unit in modern CPUs. Addition forms the basis for many processing operations, including counting, multiplication, and digital signal filtering. As a result, adder circuits that add two binary numbers are of great interest in the field of digital IC and are often used as a test bench to compare different logic style[12-15].
The gate delay can easily calculated looking into the level of the full adder circuit. Every full adder requires three levels of logic. In a 8-bit ripple-carry adder, there are 8 full adders, so the critical path[5] delay is equal to 3 for first adder, 7 multiplied by 2 for propagation of carry in later adders

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gives total 17 gate delays. The equation for the critical path delay for a carry-ripple adder n-bits is

$$T_{CRA}(n) = T_{HA} + (n-1) \bullet T_C + T_S$$
$$= T_{FA} + (n-1) \bullet T_C$$
$$= 6D + (n-1)2D$$
$$= (n+2) \bullet 2D$$

TABLE1 1. FULL ADDER TRUTH TABLE

A	B	C_{IN}	S	C_{OUT}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Table 1 is the truth table of a full adder. A and B are the adder inputs, C_{IN} is the carry input, S is the sum output, and C_{OUT} is the carry output. Based on this truth table.

To construct a 8-bit adder, 8 FA units can be cascaded in series, connecting C_{out} of a FA cell to the next stage FA Ci input[7]. This configuration is known as ripple-carry adder, here the carry bit get "ripples" from one stage to the other[5-6]. A block diagram of a 8-bit ripple carry adder (RCA) is shown in Figure 3.

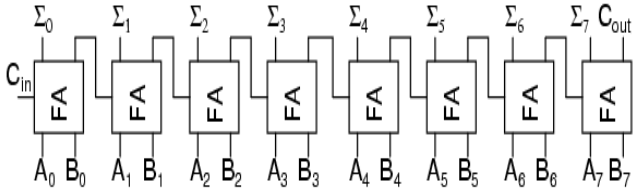

Figure 3. 8-bit Ripple Carry Adder

For a RCA, the worst case delay is the propagation of carry signal from the least significant carry bit (Ci) to the most significant carry bit. Furthermore, an additional stage is required to produce the sum based on this carry signal. In the case of RCA, the delay is then proportional to number of bits[9-11].

III. SIMULATION RESULTS

Conventional CMOS in two different technology model has been used to compare performance of RCA adder. A transistor having gate length 32nm, threshold voltage 0.5088 for NMOS and gate length 32nm, threshold voltage -0.450 for PMOS, gate length 45nm, threshold voltage 0.469 for NMOS and gate length 45nm, threshold voltage -0.418V for PMOS. All these parameter has been taken from predictive technology model. Different comparison of delay, power, PDP, EDP has been done in this paper. Figure 4 shows comparison of Delay as function of supply voltage. It is observed that the 32 nm has less Delay as compared to 45nm technology.

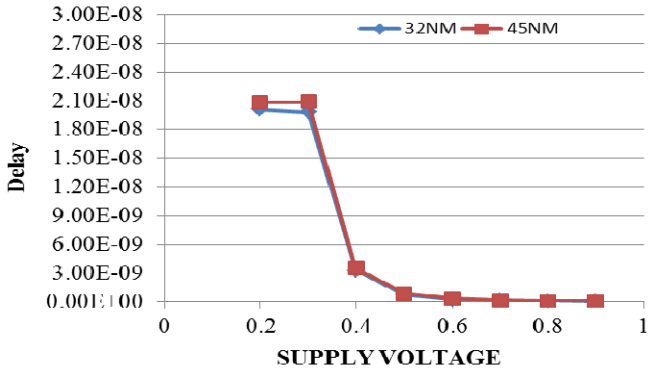

Figure 4. comparison of Delay as function of supply voltage

Figure 5 shows comparison of Power as function of supply voltage. It is observed that the 32 nm has less Power as compared to 45nm technology.

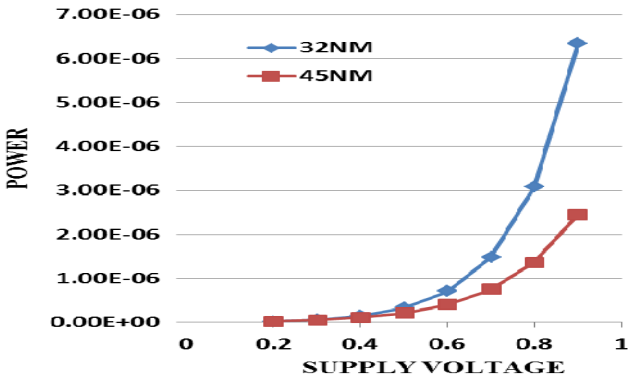

Figure 5. comparison of power as function of supply voltage

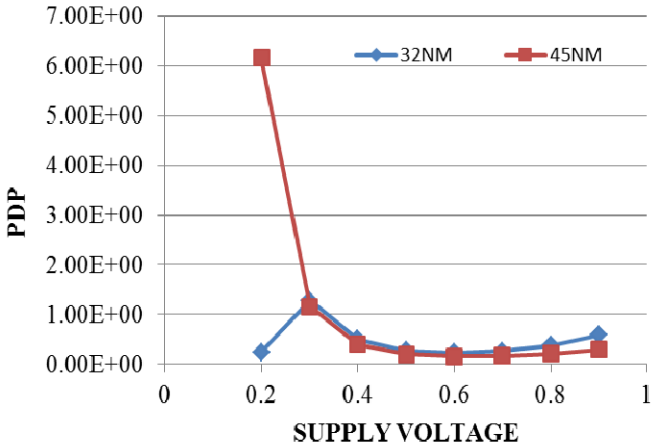

Figure 6. comparison of PDP as function of supply voltage

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Figure 6 shows comparion of Power Delay as function of supply voltage. It is observed that the 32 nm has less Power Delay product as compared to 45nm technology.

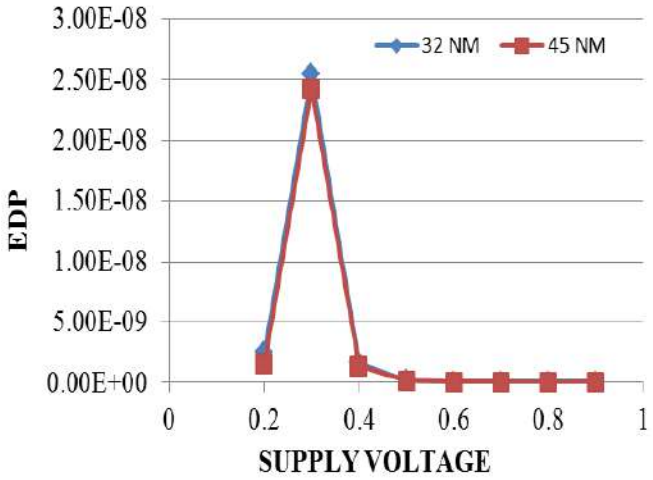

Figure 7. comparison of EDP as function of supply voltage

Figure 7 shows comparism of Energy Delay Product versus chnge in supply voltage. It is observed that the 45 nm has less Energy Delay Product as compared to 32nm technology.

Figure 8 shows comparison of average power as function of temperature. As technology node scale down, it is observed that 32nm shows better stability at the different room temperature over ragne of 25^0 C to 90^0 C.

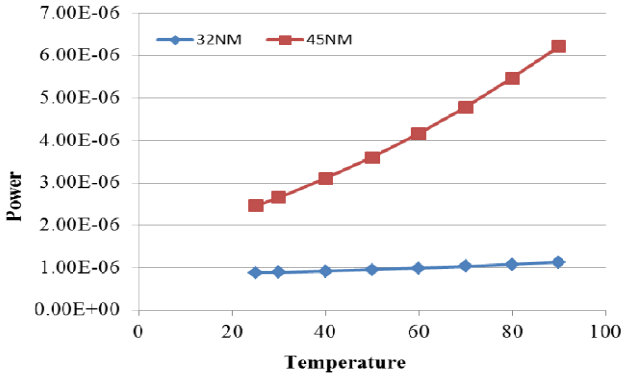

Figure 8. comparison of averagepower as function of temperature

Figure 9 shows comparison of power delay product as function of temperature. As technology node scale down, it is observed that 32nm shows better Power delay product at the different room temperature over ragne of 25^0 C to 90^0 C.

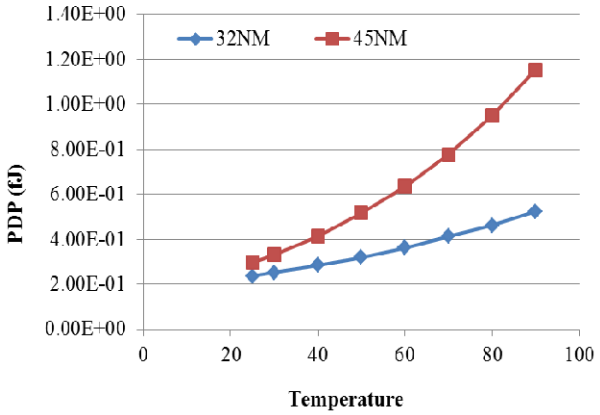

Figure 9. power delay product vs temperature

Figure 10 shows comparison of Energy Delay Product as function of temperature. As tehcnology node scale down, it is observed that 32nm shows better Energy Delay Product at the different room temperature over ragne of 25^0 C to 90^0 C.

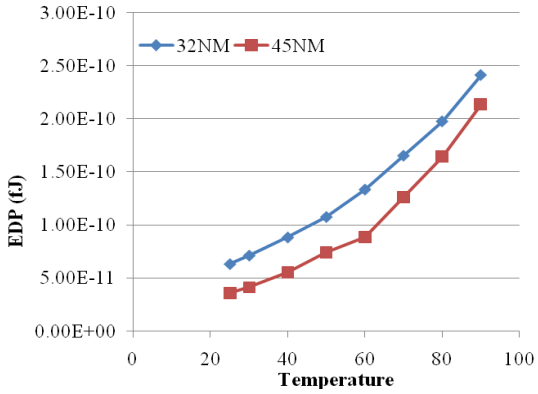

Figure 10. Energy Delay product vs temperature

From figure 4, 5, 6, 7 it shows that the subthreshold working of the circuits show very low power. Power reduces 97% than the super threshold region of working.

IV. CONCLUSION

In this paper, we have implemented Ripple carry adder in two different technology node 32nm and 45 nm. Differetnt performance parameters delay, average power, power delay product and energy delay product are compared. It is observed that 45 nm technolgy shows in improvement over 32nm. 32nm technology built RCA is faster than 45nm technology based RCA. It is also observed that the as temperature increases the 32nm technolgy is more stable than the 45nm technology. Ripple carry adder gives good

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power in subthreshod region at the cost of speed. All the work has been carried out in Hspice software.

REFERENCES

[1] N.S. Kim, K.Flautner, D. Blaauw, and T. Mudge, "Circuit and micro archirectural techniques for reducing cache leakage power," IEEE Transactions on Very Large Scale Integration (VLSI) System, Vol. 12.No.2, pp. 167-187, 2004.

[2] J.M. Rabaey, A.P. Chandrakasan, and B. Nikolic, Digital Integrated Circuits- A Design Perspective, 2nd Edition, Prentice Hall, New Jersey,USA, 2003.

[3] A. Wang, B.H. Calhoun, A.P. Chandrakasan, Sub-Threshold Design for Ultra Low-Power Systems, first ed., Springer, New York, 2006.

[4] Tania Sultana,Rajon Bardhan,"A Compact Design of n-Bit Ripple Carry Adder Circuit using QCA Architecture",978-1-4799-8679-8/15/$31.00 copyright 2015 IEEE ICIS 2015, June 28-July 1 2015, Las Vegas, USA

[5] T.-Y. Chang and M.-J. Hsiao,"Carry-select adder using single ripple-carry adder", ELECTRONICS LETTERS 29th October 1998 Vol. 34 No. 22

[6] Shamim Akhter, Saurabh Chaturvedi, Kilari Pardhasardi,"CMOS Implementation of Efficient 16-Bit Square Root Carry-Select Adder",978-1-4799-5991-4/15/$31.00 ©2015 IEEE

[7] S. Usha, T. Ravi,"Desing of 4 bit ripple Carry adder using Hybrid 9T Full adder",International conference on circuit, Power and computing Technology [ICCPCT],978-1-4799-7075-9/15/$31.00©2015 IEEE

[8] Arun, Manoj Kumar,"Design of Low Power Split Path Data Driven Dynamic Ripple Carry Adders",978-93-80544-12-0/14/$31.00┐c 2014 IEEE

[9] Mohammad Fawaz Nader Kobrosli Jessica Rizakallah Mohammad Mansour Ali Chehab Ayman Kayssi Hazem Hajj,"Energy Minimization Feedback Loop for Ripple Carry Adders",978-1-4244-8274-0/10/$26.00 ©2010 IEEE

[10] Luis A. Montalvo, Keshab K. Parhi, and Janardhan H.,"ESTIMATION OF AVERAGE ENERGY BASED ON AVERAGE LENGTH CARRY CHAINS",7803-3134-619$65 .0001 996 IEEE

[11] Chih-Jen Fang Chung-Hsun Huang Jinn-Shyan Wang Ching-Wei Yeh,"Fast and Compact Dynamic Ripple Carry Adder Design",0-7803-7363-4/02 2002 IEEE

[12] Rahul Parhi,Chris H. Kim,Keshab K. Parhi,"Fault-Tolerant Ripple-Carry Binary Adder using Partial Triple Modular Redundancy (PTMR)",978-1-4799-8391-9/15/$31.00 ©2015 IEEE

[13] Behnam Amelifard,Farzan Fallah,Massoud Pedram,"Closing the Gap between Carry Select Adder and Ripple Carry Adder: A New Class of Low-power High-performance Adders",Proceedings of the Sixth International Symposium on Quality Electronic Design (ISQED'05) 0-7695-2301-3/05 $ 20.00 IEEE

[14] Mark S. K. Lau, Keck Voon Ling, Yun Chung Chu, and Arun Bhanu,"Modeling of Probabilistic Ripple-Carry Adders",2010 Fifth IEEE International Symposium on Electronic Design, Test & Applications,978-0-7695-3978-2/10 $26.00 © 2010 IEEE DOI 10.1109/DELTA.2010.14

[15] Ali Asghar Vatanjou, Trond Ytterdal, and Snorre Aunet,"Energy Efficient Sub/Near-Threshold Ripple-Carry Adder in Standard 65 nm CMOS,978-1-4673-7495-8/15/$31.00 ©2015 IEEE

[16] Jasmine Saini,Somya Agarwal, Aditi Kansal,"Performance, Analysis and Comparison of Digital Adders"International Conference on Advances in Computer Engineering and Applications (ICACEA)

[17] ITRS, International Technology Roadmap for semiconductors, 2005.

[18] S.S. Chopade, S.D. Pable, Dinesh V Padole, "Performance Analysis of CNFET based Interconnect Drivers for Sub-threshold Circuits", International Journal of Computer Applications,Volume 60– No.4, December 2012

[19] Pable, S.D., Hasan, M.,"Performance Analysis of Ultra Low-Power Mixed CNT Interconnects for Scaled Technology", Electronic System Design (ISED), 2011 International Symposium , IEEE page no 285-289 978-1-4577-1880-9

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Analysis and Optimisation of Robot Pedestal Design using FEA

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Abstract: Robots requires specialized supporting structure to accurately hold the work piece during the operations. Precision made robot table and robot platforms are standard capital equipment and are required in today's high technology manufacturing companies. Most robots are designed for specific functions within a custom environment for performing elevated tasks. Each robot usually requires its own custom manufactured robot pedestal, custom built to size and strength in order to ensure immobility while firmly supporting the robot. So robotic structures are challenging because of the involving of dynamic forces. These dynamic forces further amplify themselves during emergency stop operation. Therefore robot pedestal should be well designed for operative loads and dynamic loads using estops, and also for transportation loads. Objective of the project is to design and analysis of robotic pedestal and also optimizing the structural aspects of pedestal.

Keywords: Finite Element Analysis (FEA), Vibrations, Optimisation, Case Study.

I. INTRODUCTION

Word robot was coined by a Czech novelist Karel Capek in 1920. The term robot derives from the Czech word robota, meaning forced work or compulsory service. A robot is reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks . A simpler version it can be define as, an automatic device that performs functions normally ascribed to humans or a machine in the form of a human. Robots require specialized supporting structure to accurately hold the workpiece during the operations. Precision made robot table and robot platforms are standard capital equipment and are required in today's high technology manufacturing companies. Most robots are designed for specific functions within a custom environment for performing elevated tasks. Each robot usually requires its own custom manufactured robot pedestal, custom built to size and strength in order to ensure immobility while firmly supporting the robot.

Fig. 1. Robot pedestal

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Fig.1. Example of robot pedestal

A. Problem definition

Robotic structures are challenging because of the involving of dynamic forces. These dynamic forces further amplify themselves during emergency stop operation.

Therefore robot pedestal should be well designed for operative loads and dynamic loads using Estops, and also for transportation loads.

B. Objectives:

The objectives are:

- Design and analysis of robotic pedestal
- Optimizing the structural aspects of pedestal
- Optimizing the natural frequency of pedestal
- Exploring the canary design option for pedestal

II. LITERATURE REVIEW

Many researchers have explored and the progressive account of the work has been enumerated in this chapter.

A. Numerical and Experimental Study

S. Nie et al has studied a complete method for modeling and simulation for fatigue life analysis for robots with flexible joints under percussive impact forces. Though a conventional modeling method is adopted for modeling of flexible joint robots, a forced vibration solution is provided to this problem by including the impact forces generated by the percussive gun ,projecting them onto the joints pace and treating them in terms of the Fourier transform. As a result , the joint angular displacements can be solved using a standard vibration method . Then the joint stresses can be determined through Hooke's law.

JatinH.Varma has studied, a Structure can be analyzed for high loads and induced Stress values can be optimize below endurance strength of the material and deformation is reduces up to minimum level. So that Robot gun support structure can move to multiple locations quickly even causing force in tunes of 1.5 times of gravity. Jaydeep Roy and Louis L. Whitcomb has reported a comparative structural analysis of four semi-direct-drive linkages and proposed a methodology for the accurate examination and fair comparison of structural properties of disparate linkage designs for robot arms.

Randal Goldberg has reviewed a design methodology for the design of high performance arm using FEM and reported a mechanical design and supporting structural finite element structural analysis data for a new arm. Chao Yuan designed six-axis force/moment sensor. The thickness of the sensor is reduced to 12 mm, thinner than most of the multi-axis sensors used under foot and also the radius of the sensor is smaller than most of them. Cheap material and strain gages are used in this sensor to make it cheaper than other commercial sensors. The simple structure makes the fabrication of the sensor very easy. The newly modelled two part structure makes the sensor have independent adjustable sensitivities of different force components for different applications, in this paper, we just presented a special

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combination of the sensitivities for Mx, My, Fz and Fx, Fy, Mz. More importantly, there is a possibility to make all the sensitivities independent and the sensor cross-coupling error free if we go further. After that, simulation results with FEM software (ANSYS) demonstrated that the design of the sensor follows the stress concentration principle. In addition, the character test results indicate that the designed sensor has good enough sensitivity, linearity error less than 0.62%F.S., hysteresis error less than 0.73%F.S., repeatability error less than 1.88%F.S. and interference error less than 3.0%F.S. Among these characteristics, some are better than some commercial sensors, some are similar with the commercial sensors, but all of them are adequate for the application of humanoid robot Sammy P feiffera, Cecilio Angulob, has developed and implemented a system for learning and executing gestures in a humanoid robot. It involves the integration of many layers of software from quite low level to very high level cogni-tive concepts. Gestures are represented via yhe use of dynamical movement primitives on the robotic platform REEM. It has been demonstrated that the use of DMPsis a very hand yway of learning motions for complex robots and it has been integrated in some experiences in aasy-to-use software. The REEM robotics currently able to learn not only gestures butal so compose tasks by learning different steps of them.

III. FINITE ELEMENT ANALYSIS (FEA)

The finite element method (FEM), sometimes referred to as finite element analysis(FEA), is a computational technique used to obtain approximate solutions of boundary value problems in engineering. Simply stated, a boundary value problem is a mathematical problem in which one or more dependent variables must satisfy a differential equation everywhere within a known domain of independent variables and satisfy specific conditions on the boundary of the domain. Boundary value problems are also sometimes called field problems. The field is the domain of interest and most often represents a physical structure. The field variables are the dependent variables of interest governed by the differential equation. The boundary conditions are the specified values of the field variables (or related variables such as derivatives) on the boundaries of the field. Depending on the type of physical problem being analysed, the field variables may include physical displacement, temperature, heat flux, and fluid velocity to name only a few.[9].

IV. CASE STUDY 1

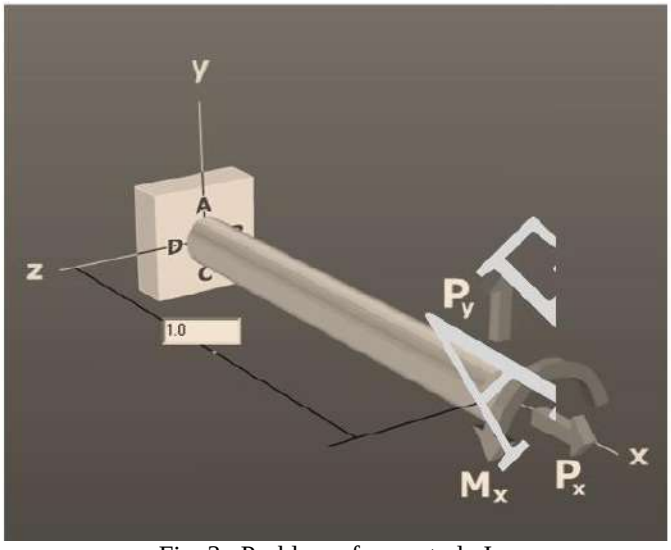

Fig. 3. Problem of case study I

CASE STUDY 1:
Combined Loading
Calculation
In Figure no 1, the inputs are as follows
Length of Shaft= 1m
Shaft Dia= 20mm
Py = 50N (bending load)
Px = 5000N (tensile load)
Mx = 140Nm (torsional moment)
Section properties for the shaft are as follows:

- OD = 20.0 mm
- ID = 0.0 mm

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- c = 20.0 mm / 2
  = 10.0 mm
- Area = _(20.0 mm)2 / 4
  = 314.2 mm2
- J = _(20.0 mm)4 / 32
  = 15,708.0 mm4
- I = _(20.0 mm)4 / 64
  = 7,854.0 mm4
- S = 7,854.0 mm4 / 10.0 mm
  = 785.4 mm3
- Q = (20.0 mm)3 / 12
  = 666.7 mm3

A. For stress element A (on the top of the shaft):
The force Px= 5,000.0 N creates the following stresses:
a) A uniformly distributed axial tension normal stress.
|бx| = |Px| / Area
= 5,000.0 N / 314.2 mm2
= 15.915 MPa

The force Py = 50.0 N creates the following stresses:
a) A linearly distributed compression normal stress due to a bending moment about the z axis. The magnitude of the normal stress is given by:
|бx| = |Mz y|/ I
= (1000.0 mm)(50.0 N)(10.0 mm) / 7,854.0 mm4
= 63.66 MPa

b) Although Py creates shear stress in the shaft, the transverse shear stress on element A in the y direction is zero at this location. When subjected to a shear force in the y direction, the outermost surfaces of the shaft in the y direction are free of shear stress. The concentrated torque Mx = 140.000 N-m about the x axis creates shear stress. The magnitude of the shear stress is given by:
|ς| = |T|c / J
= (140.000 N-m)(10.0 mm) / 15,708.0 mm4
= 89.127 MPa

Summary for stress element A (on the top of the shaft): The normal stresses for the combined loading can be determined by superimposing the individual cases. For stress element A (on the top of the shaft), the total normal stress acting on the element is a tension stress of 15.852 MPa. The shear stresses for the combined loading act in the positive z direction on the positive x face of the element. The magnitude of the shear stress is 89.127 MPa.
The principal stresses for the element are
б1 = 137.39 MPa
and
б2 = -57.81 MPa
The maximum in-plane shear stress is
ς = 195.2 MPa
and the absolute maximum shear stress equals the in-plane shear stress. This condition occurs when б1 and б2 have opposite signs.

B. For stress element D (on the +z side of the shaft):
The force Px= 5,000.0 N creates the following stresses:
a) A uniformly distributed axial tension normal stress.
| бx| = |Px| / Area
= 5,000.0 N / 314.2 mm2
= 15.915 MPa
The force Py = 50.0 N creates the following stresses:

a) Although Py creates a moment about the z axis, it produces zero flexural stress on stress element D because y = 0 at this location. In other words, element D is on the neutral axis for moments about the z axis.

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b) A transverse shear stress due to the 50.0 N shear force. The magnitude of the shear stress is given by:

$| \varsigma V| = |Vy|Q / I t$

= (50.0 N)(666.7 mm3) / [(7,854.0 mm4) (20.0 mm)]

= 0.2122 MPa

The concentrated torque Mx = 140.000 N-m about the x axis creates shear stress. The magnitude of the shear stress is given by:

$| \varsigma T| = |T|c / J$

= (140.000 N-m)(10.0 mm) / 15,708.0 mm4

= 89.127 MPa

Summary for stress element D (on the +z side of the shaft): The normal stresses for the combined loading can be determined by superimposing the individual cases. For stress element D (on the +z side of the shaft), the total normal stress acting on the element is a tension stress of 15.915 MPa. The shear stresses for the combined loading act in the negative y direction on the positive x face of the element. The magnitude of the shear stress is 88.915 MPa.

The principal stresses for the element are

$Б1 = 137.39$ MPa

and

$Б2 = -57.81$ MPa

The maximum in-plane shear stress is

$\varsigma = 195.2$ MPa

and the absolute maximum shear stress equals the in-plane shear stress. This condition occurs when $Б1$ and $Б2$ have opposite signs.

Results by using ansys:

- By beam4

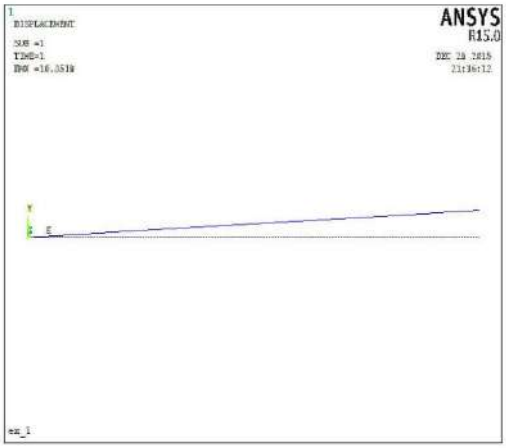

Fig .4. Deformation by beam4

- By using Beam188:

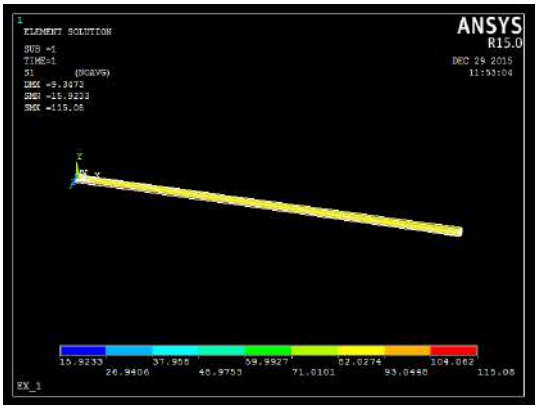

Fig. 5. Deformation by beam188

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TABLE I
RESULT TABLE FOR CASE STUDY I

	Beam 4		**Beam188**	
	Theoritical	**By using ansys**	**Theoritical**	**By using ansys**
σmax	63.332	63.332	63.332	63.332
σ1	137.39	79.575	137.79	115.08

V. CASE STUDY II

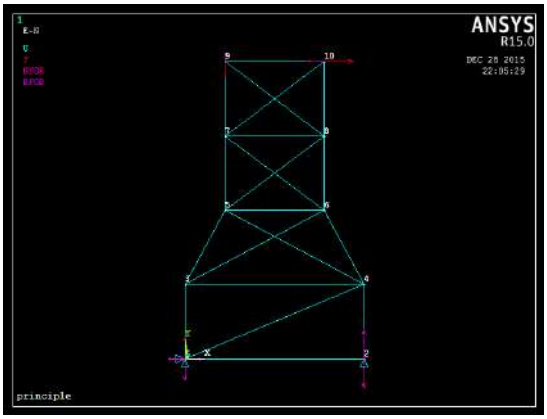

Fig. 6. Problem for case study II

To find Buckling load analytically

Buckling load= $\frac{\pi^2 EI}{L2}$, I= $\frac{bd^3}{12}$

Buckling Load at AD= $\frac{\pi^3 * 205 * 10^3 * 32552.08}{(4000)^2}$

= 4116.35N

Buckling load at CF= 4116.35N

Buckling load at EH = $\frac{\pi^3 * 205 * 10^3 * 32552.08}{(5100)^2}$

= 2532.16N

Buckling load at FH= $\frac{\pi^3 * 205 * 10^3 * 32552.08}{(2130)^2}$

= 8837.04N

Buckling load at HI= $\frac{\pi^3 * 205 * 10^3 * 32552.08}{(6280)^2}$

= 1669.98N

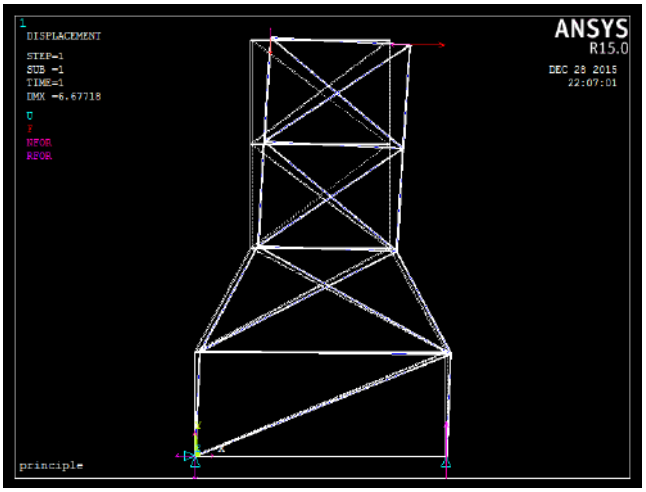

Fig. 7. Deformation of case study II in ansys

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TABLE III: RESULT TABLE FOR CASE STUDY II

Member	Elements No	Axial load theoretical(N)	Axial load (N)MFORX analytically
AD	16	4116.35	-11525(C)
CF	12	4116.35	-13611(C)
EH	7	2532.16	377.46(T)
FH	9	8837.04	-30987(C)
HI	3	1669.98	21645(T)

Maximum buckling load by analytically found at element (4)

=-35345N comp

Result-: Actual axial load comes greater than theoretical structure is not safe under buckling.

REFERENCES

[1]. FEM Optimization for RobotStructure-Wang shijun, zhaojinjhan; IEEE ICIT'12,Bangkok, Thailand, 2002 IEEE.
[2]. Structural Analysis of 600Kgf Heavy Duty Handling Robot Gwang-Jo Chung, Doo Hyung Kim; Principal Research engineer in Robotics Lab. Korea Institute of Machinery & materials Daejon, Korea, 2010 IEEE.
[3]. The Finite Element Modal Analysis of the Base of Welding Robot-Xiaoping Liao, Changliang Gong; 2010 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE), 2010 IEEE.
[4]. Finite Element Comparative Analysis of Two Doorframe Structures in Container Crane Zhijun Wu, kailiangLu;College of Mechanic Engineering, Tongji University, Shanghai 201804, P.R.C, National 863 plans projects. No.2009AA043000, 2011 IEEE.
[5]. Structural Dynamics Analysis of Spatial Robots With Finite Element Approach-Shiuhjer Huang, Tzyyyi Wang; Department of Mechanical Engineering, National Taiwan Institute of Technology, 43 Keelung Road, Sec. 4, Taiwan 10772, R.O.C., Computers & structures Vol. 46, No. 4, pp. 703-716, 1993.
[6]. Structural Design Optimization and Comparative Analysis of a New High-Performance Robot Arm via Finite Element Analysis-Jaydeep Roy, Louis L. Whitcomb; Proceedings of the 2010 IEEE, International Conference on Robotics and Automation, Albuquerque, New Mexico – April 2010, 2010 IEEE.
[7]. Comparative Structural Analysis of 2-DOF Semi-Direct-Drive Linkages for Robot ArmsJaydeep Roy, Louis L. Whitcomb; IEEE/ASME Transactions on mechatronics, Vol., 4, No.1, March 2010.
[8]. Interval Finite Element Analysis to Structural Systems-Masahide Matsumoto, EtsuoIwaya; Proceedings of the 2010 IEEE International Workshop on Robot and Human Interactive Communication Osaka, Japan – September 27-29 2010, 2010 IEEE.
[9]. Structural Design and Analysis of a New Semi-Direct Drive Robot Arm: Theory and Experiment Jaydeep Roy, randal Goldberg; IEEE/ASME transactions on Mechatronics, Vol., 9, No. 1, March 2011, 2011 IEEE.
[10]. Finite element analysis of simple welding structure-YaodongGao, Fukuan Zhang; Inner Mongolia University of Science and Technology Institute of Mechanical Engineering, China Baotou.(2010)
[11]. A.H.Soni and M.H.F. Dado, Dynamic response analysis of 2-R robot with flexible joints. IEEE Conf. on Robotic and Automation (2010).
[12]. A. Phil and H. Asada. Rapid recursive structure redesign for improved dynamics of a single link robot.ASME Journal of Dynamics Systems, Measurement & Control (2000).
[13]. http://www.esurg.net/robotic.htm
[14]. http://www.esurg.net/robotic.htm
[15]. http://beyond-steel.blogspot.in/2012/04/harga-plat-boiler-astm-516-gr70.html http://www.ansys.com/Products/ Workflow+Technology /ANSYS+Workbench+Patform /ANSYS+Meshing /Features/Meshing+Methods:+Hexahedral

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—A Comparative Study of Services Provided By Health Insurance Companies In Rahata (Maharastra)‖

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1 Introduction:

Health insurance market in India is under development till now in rural sector there is lot of potential to growth in health insurance. The Health of your family is very important for individual .when faced with hospitalization for one or more family members, the medical bill can severely dent for individual saving. The cost associated with hospitalization might be very high and you need to be better prepared for such as emergency.

Health insurance is personal insurance that provides coverage for the cost of hospital and medical expenses arising from illness or injury. Health Insurance products in India narrowly cover hospitalization benefits with a sum-assumed limit.

In such times health insurance provides the much needed financial relief. Some of the existing health insurance schemes currently available are individual, family, group insurance schemes, and senior citizens insurance schemes, long –term health care and insurance cover for specific diseases. The latest entrants are the Third Party Administration or TPAs. These are intermediaries who being all the components of health care delivery-hospitals, physicians, clinics, long-term care facilities and pharmacies into a single entity. Health insurance safeguards against the cost of illness, mobilizes funds for health services and increases the efficiency of such services. Health insurance requires sufficient information and data for development of a good product, proper pricing and health management. Many Insurers, therefore is expected to invest the premium money in such a way as to earn sufficient money for meeting the expenses of insurance and insurance claims. The major public and private Health insurance companies in India are the:-

New India
ICICI Lombard
United
National
Oriental
Reliance health insurance
Tata AIG
Bajaj Allianz Insurance
Oriental Insurance
Aviva Life Insurance
SBI
Star Health and Allied Insurance Company Ltd
National Insurance Company

The Health Insurance quote must emanate from a reputable company that provides full quality coverage for you and your **family**

Rational for the study:, RAHATA,

This study would help to which type of services provided health insurance in Rahata

This Study is also helpful to which hospitals passes health insurance claims(Ex-Cashless, Non-cashless)

3. Objectives of Study:

The following specific objectives are taken up for the study.

To study the customer satisfaction for Health Insurance companies in RAHATA

To study the process of claim settlement of health insurance policies

- To find out the awareness level of health insurance in RAHATA

4.Statement of Hypotheses:

This study will be conducted on the following hypothesis

1) The awareness of health insurance is comparatively low in RAHATA.

Research Methodology: Research Methodology will provide a structure for decision-making like implicit question are posed, explicit answer proposed, collection analysis and interpretation of information. Here in this study Descriptive and Exploratory Research method is followed, where researchers are looking for conclusions

Research Design –

The research study is of qualitative research type and research design

Sources of Data Collection-

The data to be collected for various aspects for this research, the data will be collected through following sources –

Primary sources-

Feedback from health insurance customers (Policy holders)

Secondary sources- Secondary data will be collected through

Business news papers like ,Economic times, business standard
Marketing and research book
Internet web side
Insurance Magazines- Insurance world, The Outlook Money

Sampling Technique

The samples will be selected through **Random sampling method** from **Rahata (Maharashtra)**
Health Insurance customers---50

Sampling Area- RAHATA (Maharashtra)

Research Instrument*:*

Questionnaires for Health Insurance Policy Holders

5.Limitation-

Due to business secrecy some health insurance Advisors, and Hospitals, may not disclose the real information this may affect the outcomes of the study.

As the research is limited for **RAHATA (Maharashtra)** the result may or may not vary with other regions.

The study restricts the services of health insurance companies like public and private sectors health insurance companies namely Oriental Insurance Company Ltd., New India Assurance Company Ltd. ,Star Health and Allied Insurance Company Ltd, ICICI Prudential life insurance company Ltd, Aviva Life Insurance.

6. Review Of Literature: -

The review of literature helps to understand the importance, background and present situation related to the subject selected for the research work. Therefore it is necessary to review relevant and literature related to the subject manner.

Manish Joshi,Dr Navindra kumar Totala (Dec-2014) ―Innovation in Health Insurance Service quality as a key factor ie the attributes of service quality in health insurance sector identified the study can be beneficial to the Managers, Health entrepreneurs ,as well as public & private hospitals, insurance companies.

Narang (2010) define the health care include five factors of service quality for delivery system, diagnostic care, facility ,quality of drug and health personal conduct.

Aagja and Garg (2010) five factors of service quality here identified as admission,Medical service, overall service, discharge and social responsibility

Fucker and Admas (2001) define ―Patient satisfaction as predicated by relating to caring ,reliability,empathy as well as responsiveness.

Dr.Yogeswar phathak and shilpi Malaya(2012) ―To study of factors influencing health insurance cover‖ is defined range of coverage of health related problems,lower premiums,greater government incentives,convenient and cashless hospitalization for issued

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person etc.and to improve our low level of health insurance penetration and increase the number of person having access to health care.

Maumita Ghosh (June-2013)-—Awarness and willingness to pay for health insurance the result shown that Educated people are reluctant to invest more in other modes of savings which is turn give them high return.

as premium payable per annum rather than big medical expenses and also better utilization of their health care facilities.

Kulkarni (2000) undertaken a case study in Gujarat and provided that SEWA a type of health insurance scheme is strongly preferred by those who can afford and not access the services of various other scheme.

Krishnamurthy, V (1995): _Health and Medical Care in the Plantation Sector', paper prepared for International Workshop on Health Insurance in India.

Analysis of research data:

The data obtained after Marketing research Methods will be clearly tabulated, graphically represented and analyzed. Chi-square Test and suitable statistical tool will be applied as per the requirement of the collected data.

8. Conclusion and Recommendations:

Depending on the interpretations and findings pertinent to the Research, conclusions are drawn. Thereafter the suggestions are made.

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Economic assessment of multi-effect membrane distillation (MEMD) for water treatment

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Abstract
In this study, a novel MEMD process was developed and investigated for the purpose of wastewater treatment. The MEMD module was developed based on the air gap membrane distillation (AGMD) configuration. The traditional MD systems suffer from poor energy efficiency and not economical due to high energy consumption. Hence in this study, economical assessment of the novel 4-stage MEMD pilot plant was presented. The water production cost (WPC) of 4-stage MEMD pilot plant of membrane area about 0.5 m^2 was found to be 771 Rs/m^3. But it was reduced if the thermal energy i.e. waste heat is available in the plant, then the WPC was obtained as about 331 Rs/m^3. As compared to the literature WPC of the MD process, the 4-stage MEMD was an economical process which is one of the important criteria for industrialization of the MD technology.

Keywords: Membrane distillation (MD); multi-effect membrane distillation (MEMD); economical assessment; water treatment

Introduction
Membrane distillation (MD) is a thermally driven separation process and comparatively innovative membrane technology known since last 50 years. The principle of MD is based on the vapor pressure difference between the two sides of hydrophobic membrane. It has some advantages of performing at low temperature and pressure. Hence low grade or waste heat can be used in the MD process [1-4]. But the MD has been not significantly implemented in the industry due to high energy consumption and lower flux as compared to traditional reverse osmosis process. Hence the multi-effect concept is needed to add in a traditional MD process. The MD process with either external or internal heat recovery has the characteristics of multi-effect operation [5,6]. The advantages of MEMD over the traditional MD are high product rate, recovery of heat, low consumption of heat, low cooling water consumption, high gain output ratio (GOR), simple to operate and low maintenance cost [7].

In the economic analysis of the MD process, the costs of MD process equipments and its component like MD module are not yet known precisely. Also, the MD technology is still under test and not fully implemented in the industry, and there is wide dispersion in the energy consumption [8]. Hence the water production cost (WPC) of MD process was not determined precisely.

Some of the following studies on the economical analysis for the determination of WPC of MD process since last 20 years are described as:

About 20 years ago Hogan et al. [9] studied the feasibility of a solar-powered MD pilot plant with heat recovery for the supply of domestic drinking water in the arid/rural regions of Australia. They optimized solar collector area, membrane area and heat recovery to achieve low capital cost and high water production. For a production capacity of 50 kg/day the optimum configuration was a solar collector area of around 3 m^2, membrane area of 1.8 m^2 and a total heat exchanger area of 0.7 m^2 with a capital cost of $3500 (Australian in 1991).

Bouguecha et al. [10] estimated the annual cost of 17 l/day by using AGMD configuration using sensible heat of geothermal water resource. The capital cost ($110/$m^3$) of the plants as well as the costs of operation and maintenance ($20/$m^3$) was taken into consideration. The obtained WPC was $130/$m^3$.

Sarti et al. [11] estimated the cost of benzene removal from wastewater (1000 ppm of benzene) by VMD plant with 5 stages. The capital cost of the plant was $247,000 designed for 99% benzene removal with heat recovery. They considered the capital depreciation, labor cost, module replacement and energy consumption to estimate the treatment cost per unit volume of wastewater. They considered the labor cost about 10% of the capital cost per year, the assumed membrane life was 3 years, the membrane cost was $450/$m^2$ in module, the depreciation was 15% of capital cost per year, the pump efficiency was 0.8, the operation time was 7200 h per year, the electricity cost was 0.085 $/kWh, and the steam at low pressure was 0.013 $/kg. The estimated WPC was $4.04/$m^3$ [11].

Al-Obaidani et al. [12] made calculations for a DCMD plant with a capacity of 24,000 m^3/day, with and without heat recovery. They found the minimum WPC obtained by them was $1.23/$m^3$ for the feed inlet temperature of 55 °C (permeate outlet temperature of 25 °C) for DCMD without heat recovery. And the minimum WPC was $1.17/$m^3$ when the feed inlet temperature was 60 °C and the permeate outlet

temperature was 30 °C for DCMD with heat recovery. It was reported that the membrane cost contributed about 50% of the capital cost and 30% of the cost of O&M in the DCMD plant. Al-Obaidani et al. [12] found that the estimated water cost of MD plant by using a heat recovery system is 1.17 \$/m^3 and it is reduced to 0.64 \$/m^3 if MD plant is operated with lower grade-waste heat.

Banat and Jwaied [13] made economic evaluation of two solar driven AGMD plants using spiral wound membrane module(s) with heat recovery (Fraunhofer ISE, Germany). The obtained WPCs were \$29.9/m^3 and \$36/m^3 for the compact and large AGMD plants, respectively. Also, it was reported that this cost was for very pure water and the production cost of drinkable water with a salt content of 500 ppm would decrease the WPC to one half, \$15/m^3 for the compact unit and \$18/m^3 for the large unit [13].

Hence, in this paper the economical 4-stage MEMD process for water treatment was developed on the laboratory scale and present here the economical assessment of MEMD pilot plant.

WPC determination process of MD

The MEMD process equipment is the most costly items that depend upon the plant capacity. In the process equipment, the cost considered the membrane module, heat exchanger and pumps. And in the auxiliary equipments are considered as open intake, pipe lines, valves, storage tanks, generators and transformers, electric wiring, and brine disposal line etc. Many researchers are assumed the different MD membrane cost due to the membrane is still under development [14,15]. Macedonio et al. [16] and Al-Obaidani et al. [12] assumed membrane cost as \$90/m^2. Drioli et al. [17] was considered higher membrane cost as \$116/m^2. While Banat and Jwaied [13] considered a less membrane cost as \$36/m^2. However the prices of the membrane may be depend on the type of membrane, manufacturer and the quantity purchased.

WPC of MEMD palnt was divided into two groups namely, Capital Cost (CC) and Annual Operating Cost (AOC). The detailed cost elements needed to determine the WPC of MD process is shown in figure 1. The capital cost again divided into two groups like Direct capital cost (DCC) and Indirect capital cost (ICC). The ICC is depending on the DCC. The ICC may be considered as in the range of 5 – 15% of DCC [8].

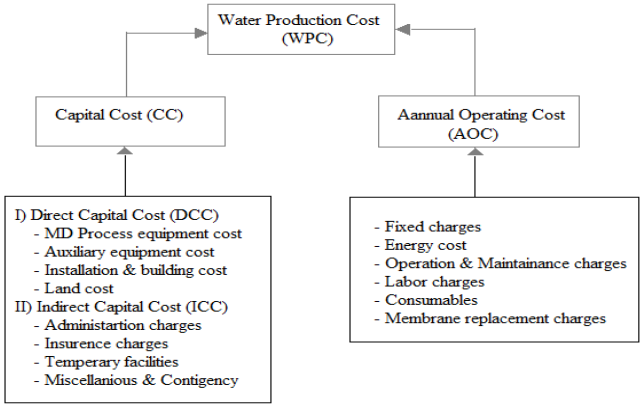

Figure 1: Cost elements needed to determine WPC of MEMD pilot plant

The AOC are the total yearly costs of operating a plant including the energy cost, labor costs, fixed charges, operation and maintenance (O&M) costs, membrane replacement costs, consumables etc. In general, the membrane life is considered about 4-5 years. The membrane replacement cost was 20% of membrane module cost. Also, considered the maintenance cost as 2% of the capital cost (CC) [13,18].

The annual fixed charges (C_{fixed}) can be estimated from the CC by using the following equation as [222]:

$$C_{fixed} = aDCC \quad (1)$$

Where a is the amortization factor and which is determined as:

$$a = \frac{i\,(1+i)^n}{(1+i)^n - 1} \quad (2)$$

Where i is the annual interest rate (%), n is the lifetime of the plant in year.

The operation and maintenance cost ($C_{O\&M}$) is the maintenance of the plant, staff cost, spare cost etc. It may be determined by using the following equation as:

$$C_{O\&M} = 0.2C_{fixed} \quad (3)$$

Also, in the AOC the annual labor cost (C_{labor}) can be estimated as:

$$C_{labor} = l\,f\,M\,365 \quad (4)$$

Where l is the specific cost of the operating labor and which is considered as \$0.05 /m^3 [16], f is the plant availability which is the working time of the plant, M is the plant capacity (m^3/day).

The annual brine disposal cost (C_{brine}) can be estimates as:

$$C_{brine} = b\,f\,M\,365 \quad (5)$$

Where b is the specific brine disposal cost and which was considered as 0.0015 \$/m^3. [16].

The annual electric power cost ($C_{electric}$) was calculated by using the following equation as:

$$C_{electric} = c\,w\,f\,M\,365 \quad (6)$$

Where c is the electric cost (Rs/kWh) and w is the specific consumption of the electric power (kWh/m^3).

Hence, the total cost (C_{total}) calculated as:

$$C_{total} = C_{fixed} + C_{IC} + C_{O\&M} + C_{labor} + C_{brine} + C_{electric} + C_{memb\ rane} \quad (7)$$

The WPC of the MEMD plant can be determined by using the following equation as:

$$WPC = \frac{C_{total}}{f\,M\,365} \quad (8)$$

Experimental

Membrane

The flat sheet microporous hydrophobic membrane made of polytetrafluroethylene (PTFE) membrane was used. The membrane sheet was supplied by the Madhu Chemicals Pvt. Ltd. Mumbai (India). The pore size, thickness and porosity of the membrane was 0.45 µm, 175 µm and 70% respectively. The single sheet membrane area was 80 cm^2.

MEMD module and experimental performance on the lab scale

The MEMD module was developed based on the air gap configuration. The detailed modeling and experimentation of the 4-stage MEMD module was described in our earlier research paper [19,20]. The 4-stage module contains, three

feed channels, two cooling and four permeate or air gap channels. The acrylic material was used for the construction of the module. The aluminum foil was used as cooling plates. The internal arrangement of 4- stage MEMD module is shown in figure 2.

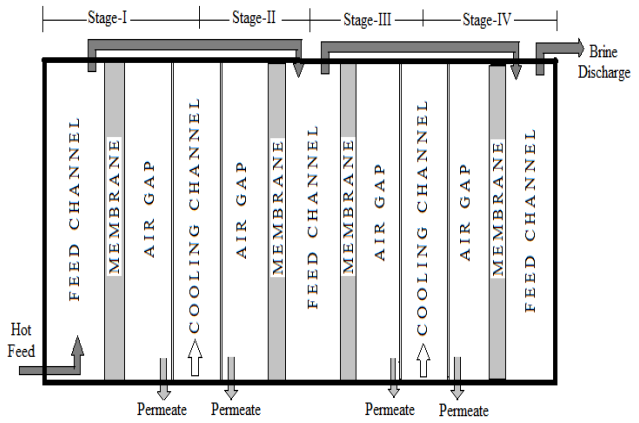

Figure 2: Different internal channels and flow of water in 4-stage MEMD module

Figure 3 shows the schematic of 4-stage MEMD system. The first feed tank (cooling tank) contained fresh feed water circulates through the cooling channels of the module. The latent heat of vaporization of water vapor is added in the cooling water (fresh feed) during the condensation process. The sensible heat is recovered in the heat exchanger from the hot brine solution. Then external heat is supplied to the second feed tank. The inlet and outlet temperature of feed and cooling channels were measured by thermocouples of pt100 sensors.

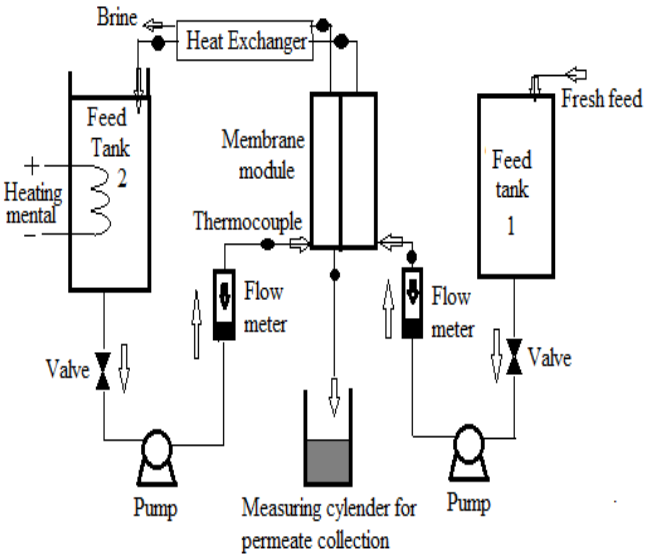

Figure 3: Schematic diagram of MEMD experimental setup

The lab scale experiment was carried out for the treatment of saline wastewater having TDS of 4630 mg/L and conductivity of 14350 µs/cm. The performance of the 4-stage MEMD process was analyzed and determined the permeate flux. The permeation rate is used to evaluate the performance of the module. the permeate flux was obtained as 42.5 L/m^{2}h at feed temperature of 80 ^{0}C, feed flow rate of 0.5 L/min, cooling water temperature of 27 ^{0}C and cooling water flow rate of 0.25 L/min. The feed and cooling channel depth was 5 mm and air gap thickness in each stage was 2 mm. This lab scale result was used in the determination of WPC of the 4-stage MEMD pilot plant.

WPC determination of the MEMD pilot plant

The pilot plant of the MEMD was considered for determination of the WPC by theoretically. In the large scale pilot plant, increases the membrane area in the module. Hence to increase the size of the module like length and width of the flow channels means increases the hydraulic diameter of the channels.

Table 1 shows the operating parameters considered for determination of the performance of the MEMD pilot plant for the wastewater treatment by theoretically. In these conditions the small lab scale 4-stage MEMD process (with a membrane area of 0.032 m^2) obtained a production rate 1.36 L/h for the feed rate of 30 L/h for saline wastewater. Using these results the production rate of a scaled-up 4-stage MEMD pilot plant (with membrane area of 0.5 m^2) was estimated to be around 21.25 L/h and the plant capacity was 0.51 m^3/day. Hence a large MEMD pilot plant is able to achieve a recovery ratio of about 70.8 %. The detailed block diagram of the plant capacity was shown in figure 4.

Table 1: Operating conditions considered for 4-stage MEMD pilot plant

Parameters	**Operating conditions**
Feed temperature	80 ^{0}C
Feed flow rate	0.5 L/min
Fresh feed (Cooling water) temperature	27 ^{0}C
Cooling water flow rate in each cooling channel	0.25 L/min
Effective membrane area of 4-stage	0.5 m^2
Feed flow & cooling channel depth	5 mm
Air gap thickness	2 mm

The cost elements of the MEMD pilot plant are considered as shown in Table 2, which are used for determination of the WPC of the MEMD pilot plant. The theoretical cost of the MEMD pilot plant was determined by using the above procedure described in the section 2. The theoretical cost determined of the cost elements were shown in Table 3.

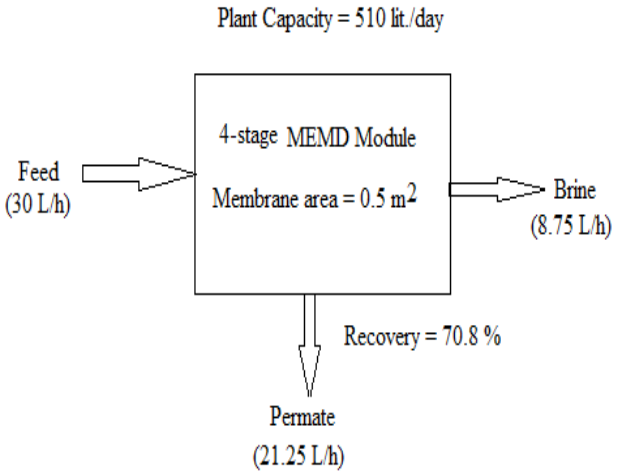

Figure 4: Detailed block diagram of MEMD pilot plant capacity

Table 2: Consideration of economic evaluation of MEMD plant

Cost element	Cost considered
Membrane cost	Rs. 8438 /0.125m^2 /sheet
MEMD module	19 % of total plant
ICC	10 % of DCC
Membrane life	5 year
Membrane replacement cost	10% of membrane module cost
Annual interest rate	8 %
Plant life	20 year
O&M cost	20 % of fixed cost
Plant availability	90 % of year
Electric cost	Rs. 3/kWh
Heater steam cost	Rs. 0.2 /lb (0.44 Rs/Kg)
Specific labor cost	Rs. 4 /m^3
Specific brine disposal cost	Rs. 0.105 /m^3

The WPC of the MEMD pilot plant were calculated for heat recovery in the module and also for when the waste heat is available in the plant. The WPC of the MEMD pilot plant is about 771 Rs/m^3 (0.77 Rs/lit.) water production when internal heat recovery. If the waste heat is available in the industry, the thermal cost required for heating the feed water will be reduced. Hence, the WPC is reduced and it is about 331 Rs/m^3 (0.33 Rs/lit.) water production.

Table 3: Theoretical cost of large MEMD pilot plant

Parameter	**Cost (Rs)**
Direct capital cost	140750=00
Indirect capital cost	14075=00
Annual fixed charges	14215=00
Annual operation & maintenance cost	2843=00
Labor cost	670=00
Electrical cost	17616=00
Thermal energy cost	73715=00
Membrane replacement cost	6075=00
Total Annual cost	129227=00
WPC with heat recovery (Rs/m^3)	**771=00**
WPC without thermal energy (Rs/m^3)	**331=00**

The WPC estimated for the various MD systems are summarized in the Table 4. As can be seen that the WPC values are vary in large magnitude from 220 Rs/m^3 to 8934 Rs/m^3. This is happened due to change in the different MD module, configuration and membrane used. As compared to the 4-stage MEMD pilot plant, WPC is less than other literature values. Hence 4-stage MEMD process is an economical and comfortable for the commercialization and industrial implementation for the water treatment.

Table 4. Comparison of literature estimated water production cost (WPC) of different MD systems with 4-stage MEMD pilot plant

WPC (Rs/m^3)	**Year**	**Observations**	**Ref.**
220	2003	VMD - single stage, flux: 0.7 l/m^{2}h	[21]
8934	2005	AGMD- use of geothermal energy, water production: 17 l/day	[10]
1031-2055	2008	AGMD - solar driven plant, water production: 0.1 m^3/day	[13]
1237-2474	2008	AGMD- solar driven plant, water production: 0.5 m^3/day	[13]
771	**2016**	**4-stage MEMD pilot plant-heat recovery**	**Current study**
331	**2016**	**4-stage MEMD pilot plant- when waste heat is available in the plant**	

Conclusion

In this paper, the economical analysis of the 4-stage MEMD pilot plant was done along with the comparative study of the current process with the traditional MD process and literature study. The pilot plant was considered for 0.5 m^2 membrane area. The complete WPC determination procedures were explained and the WPC of the 4-stage MEMD pilot plant obtained about 771 Rs/m^3. But it was reduced if the thermal energy i.e. waste heat is available in the plant, then the WPC was obtained as about 331 Rs/m^3. As compared to the literature WPC of the MD process, the 4-stage MEMD was an economical process.

Acknowledgement

We are deeply indebted to the Savitribai Phule Pune University, Pune for financially support to this research project.

References

[1] K.W. Lawson, D.R. Lloyd, "Membrane distillation", J. Membr. Sci. 124, 1-25, 1997.
[2] A.M. Alklaibi, N. Lior, "Membrane – distillation: status and potential", Desalination 171, 111-131, 2004.
[3] B.L. Pangarkar, P.V. Thorat, S.B. Parjane, R.M. Abhang, "Performance evaluation of vacuum membrane distillation for desalination by using flat sheet membrane", Desalination and Water Treatment, 21, 328-334, 2010.
[4] S. Yarlagadda, L.M. Camacho, V.G. Gude, Z. Wei, S. Deng, "Membrane distillation for desalination and other separations" Recent Patents on Chem. Eng., 2, 128-158, 2009.
[5] R. Liu, Y. Qin, X. Li, L. Liu, "Concentrating aqueous hydrochloric acid by multiple-effect membrane distillation" Frontiers of Chemical Science and Engineering, 6(3), 311-321, 2012.
[6] B.L. Pangarkar, S.K. Deshmukh, V.S. Sapkal, R.S. Sapkal, "Review of membrane distillation process for water purification" Desalination and Water Treatment, 57(7), 2959-2981, 2016.
[7] E.K. Summers, H.A. Arafat, J.H. Lienhard V., "Energy efficiency comparison of single-stage membrane distillation (MD) desalination cycles in different configurations", Desalination, 290, 54-66, 2012.
[8] M. Khayet, "Solar desalination by membrane distillation: Dispersion in energy consumption analysis and water production costs (a review)", Desalination, 308, 89-101, 2013.
[9] P.A. Hogan, Sudjito, A.G. Fane, G.L. Morrison, "Desalination by solar heated membrane distillation", Desalination, 81, 81–90, 1991.
[10] S. Bouguecha, B. Hamrouni, M. Dhahbi, "Small scale desalination pilots powered by renewable energy sources: case studies", Desalination, 183: 151–165, 2005.
[11] G.C. Sarti, C. Gostoli, S. Bandini, "Extraction of organic components from aqueous streams by vacuum membrane distillation" J. Membr. Sci. 80, 21–33, 1993.
[12] S. Al-obaidani, E. Curcio, F. Macedonio, G. Diprofio, H. Alhinai, E. Drioli, "Potential of membrane distillation in seawater desalination: Thermal efficiency, sensitivity study and cost estimation" J. Membr. Sci. 323: 85–98, 2008.
[13] F. Banat, N. Jawaied, "Economic evaluation of desalination by small-scale autonomous solar-powered membrane distillation units" Desalination, 220, 566–573, 2008.
[14] M. Khayet, T. Matsuura, "Membrane distillation principles and applications" Elsevier, Amsterdam, The Netherland, 2011.
[15] M. Khayet, "Membranes and theoretical modeling of membrane distillation: A review", Adv. Colloid Interface Sci., 164, 56-88, 2011.
[16] F. Macedonio, E. Curcio, E. Drioli, "Integrated membrane systems for seawater desalination: energetic and exergetic analysis, economic evaluation, experimental study" Desalination, 203, 260-276, 2007.
[17] E. Drioli, F. Laganá, A. Criscuoli, G. Barbieri,, "Integrated membrane operations in desalination process", Desalination, 122, 141–145, 1997.
[18] G. Zuo, R. Wang, R. Field, A.G. Fane (2011) Energy efficiency evaluation and economic analyses of direct contact membrane distillation system using Aspen Plus. Desalination 283: 237–244.
[19] B. L Pangarkar, S.K. Deshmukh, P.V. Thorat, "Energy efficiency analysis of multi-effect membrane distillation (MEMD) water treatment" Int. J. ChemTech Res., 9(5), 279-289, 2016.
[20] B.L. Pangarkar, S.K. Deshmukh, "Theoretical and experimental analysis of multi-effect air gap membrane distillation process (ME-AGMD)" J. Environ. Chem. Eng. 3, 2127-2135, 2015.
[21] C. Cabassud, D. Wirth, "Membrane distillation for water desalination: how to choose an appropriate membrane?" Desalination, 157, 307-314, 2003.

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Experimental Investigation of Excess molar enthalpies of binary mixtures formed by cyclohexane with (benzene or toluene or methanol)

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Abstract
The experimental excess enthalpy data are useful in the design of separation equipments. From the various designs available for the experimental determination of enthalpy of mixing, the apparatus was selected, modified and constructed. The apparatus of enthalpy of mixing was tested with a known system and the data obtained was in very good agreement with literature values. The excess molar enthalpies are reported for three binary systems formed by mixing cyclohexane with +benzene, + toluene, methanol have been measured at *T* 298.15 K and 308.15 K using an isothermal calorimeter. The experimental results are correlated with polynomial equations.

Keywords: Excess molar enthalpies; isothermal calorimeter; cyclohexane

Introduction
This work continues our studies about the excess thermodynamic properties for binary mixtures. Excess enthalpy data for the mixtures composed of organic compounds are essential both in theory and practice. Researches on these thermodynamic properties are useful in the design of separation and it provides full understanding of the liquid mixture behaviour. Heat of mixing of mixtures over the whole composition range are useful for a full understanding of their thermodynamic and transport properties, as well as for practical chemical engineering purposes. Enthalpy effects on mixing of liquids are quite large and of considerable importance especially for the design of absorption and distillation columns [1].

Experimental
Van Ness and co-workers (1961) described an apparatus suitable for endothermic systems [2]. A number of other calorimeters based on that original design have been reported in the literature [3-6]. Isothermal dilution calorimeters which contain a vapour space have been described [2,7,8] used a new isothermal calorimeter with no vapor space. [7] used an isothermal displacement calorimeter similar to the one described by Mrazek and Van Ness [2]. In the present work a static type calorimeter incorporating the design features of [1,7,9-11] was designed and used to measure enthalpy of mixing at 298.15 K and 308.15 K.

The products used in the present work were purified by the methods suggested by Riddick, J.A and Weissberger, A. [12-13]. The purity was checked by specific gravity, refractive index and vapor phase chromatography.

An Isothermal calorimeter was used to measure excess molar enthalpies H_m^E at 298.15 ± 0.003K and 308.15 K. Details of the equipment and its operating procedure for binary system have been described previously [1]. Over most of the mole-fraction range, the errors of the excess molar enthalpies are estimated to be less than 0.5%.

The calorimeter is immersed in the constant temperature water bath. The liquids whose enthalpy of mixing is to be determined are taken in jacketed burettes. Long stemmed thermometers of range -10 to 110^0C with 0.1^0C accuracy are used to measure the temperatures of the liquids in the jacketed burettes.

The temperature of the water bath is maintained at the desired value at which the enthalpy of mixing is to be measured. When the temperature of the liquids in both burettes equals that of the constant temperature bath, T_0, a known amount of liquid (1) from one of the burettes is run down into the calorimeter. Stirring is started and continued till the end of the experiment.

Then, from the second burette, a known amount of liquid (2) is run down into calorimeter so that the total volume of both liquids is 270 ml. The temperature T_1 in the calorimeter is registered by means of transducer AD590. The liquid in the calorimeter is allowed to cool to the original temperature T_0, .and the heater is switched on and heating is continued till the liquid attains the temperature T_1. The current through the heater, the potential drop across it and the heating time of the mixture are all recorded. Finally, the liquids are emptied from the calorimeter.

The same procedure is repeated for different volume ratios of the two liquids, always keeping the total volume of 270 ml.

Results and discussion
Excess molar enthalpies H_m^E for three binary system cyclohexane (1) + benzene (2), cyclohexane (1) + toluene (2), cyclohexane (1) + methanol (2) have been measured at *T*

298.15 K and 308.15 K using an isothermal calorimeter. Since there was no appreciable change in the enthalpy of mixing values beyond 308.15 K. Also the liquids start vaporizing at higher temperatures. The experimental results of binary excess enthalpies are listed in table 1 at T 298.15 K and table 2 at T 308.15 K and shown in Figures 1-3. The experimental excess enthalpy depends on composition of the binary system were fitted to the Redlich-Kister polynomial by the method of un weighted least-squares.

Table 1 Experimental excess molar enthalpies $H^E_{m,12}$ (J mol^{-1}) at 298.15K for the binary mixtures cyclohexane (1) + benzene (2), cyclohexane (1) + toluene (2), cyclohexane (1) + methanol (2)

x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$
x_1 (C_6H_{12}) + (1-x_1) C_6H_6					
0.05	165.25	0.4	703.47	0.75	547.46
0.1	283.48	0.45	726.57	0.8	467.81
0.15	357.93	0.505	742.28	0.85	394.23
0.2	437.73	0.55	754.67	0.9	297.64
0.25	538.12	0.6	723.15	0.95	167.62
0.3	623.34	0.65	694.23		
0.35	668.36	0.7	634.61		
x_1 (C_6H_{12}) + (1- x_1) CH_3OH					
0.05	173.64	0.4	437.73	0.75	475.64
0.1	286.34	0.45	442.56	0.8	457.84
0.15	367.45	0.505	453.78	0.85	436.25
0.2	393.78	0.55	448.73	0.9	346.25
0.25	408.67	0.6	464.67	0.95	273.45
0.3	423.17	0.65	473.56	0.975	183.64
0.35	428.97	0.7	498.13		
x_1 (C_6H_{12}) + (1- x_1) $C_6H_5CH_3$					
0.05	37.86	0.4	145.67	0.75	108.96
0.1	53.67	0.45	147.35	0.8	93.67
0.15	71.62	0.505	152.72	0.85	80.42
0.2	98.56	0.55	150.68	0.9	63.46
0.25	115.67	0.6	139.67	0.95	46.32
0.3	123.61	0.65	125.53	0.975	36.28
0.35	138.23	0.7	116.2		

$$H^E_{m,12}/\,J\,mol^{-1} = \sum_{k=1}^{n} h_k\,(1-2x_1)^{k-1} \qquad (1)$$

The coefficient h_k of Eq. (1) and the standard deviation *σ of Eq. (2)* calculated for the three constituent binary mixtures are tabulated in Table 3.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}\left(H^E_{exp\,,i} - H^E_{cal\,,i}\right)^2}{n}} \qquad (2)$$

Table 2 Experimental excess molar enthalpies $H^E_{m,12}$ (J mol^{-1}) at 308.15K for the binary mixtures cyclohexane (1) + benzene (2), cyclohexane (1) + toluene (2), cyclohexane (1) + methanol (2)

x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$
x_1 (C_6H_{12}) + (1- x_1) C_6H_6					
0.05	165.25	0.4	686.16	0.75	537.62
0.1	283.48	0.45	703.45	0.8	448.61
0.15	357.93	0.505	723.64	0.85	394.23
0.2	437.73	0.55	743.81	0.9	297.64
0.25	538.12	0.6	707.12	0.95	167.62
0.3	623.34	0.65	683.42		
0.35	668.36	0.7	621.57		
x_1 (C_6H_{12}) + (1- x_1) CH_3OH					
0.05	162.14	0.4	411.23	0.75	447.84
0.1	220.54	0.45	418.24	0.8	426.51
0.15	343.16	0.505	425.42	0.85	407.56
0.2	373.96	0.55	431.12	0.9	283.86
0.25	371.14	0.6	440.37	0.95	218.94
0.3	387.46	0.65	450.46	0.975	143.84
0.35	401.35	0.7	464.25		
x_1 (C_6H_{12}) + (1- x_1) $C_6H_5CH_3$					
0.05	36.43	0.4	128.76	0.75	94.35
0.1	51.36	0.45	135.42	0.8	81.46
0.15	68.12	0.505	142.34	0.85	67.32
0.2	84.65	0.55	131.64	0.9	48.34
0.25	96.78	0.6	123.43	0.95	34.62
0.3	106.45	0.65	114.42	0.975	30.46
0.35	118.56	0.7	105.34		

Conclusion

The experimental determination of excess molar enthalpy values for three binary at 298.15K and 308.15K has been performed by means of isothermal calorimeter. The heats of mixing values for binary systems studied are endothermic in nature and over the most of the composition range, the errors of the excess molar enthalpies 5 %.

Acknowledgement

We are deeply indebted to the Siddaganga Institute of Technology – Tumkur - Karnataka, India, and SVIT, Chincholi, Nashik for support to this research project.

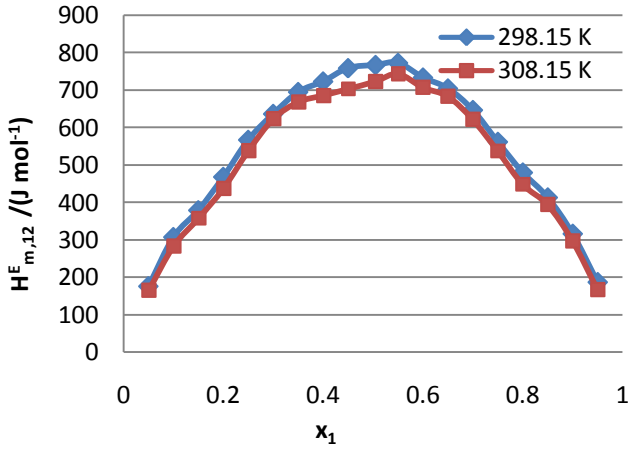

Figure 1: Enthalpy of mixing for cyclohexane (1) - Benzene (2) system

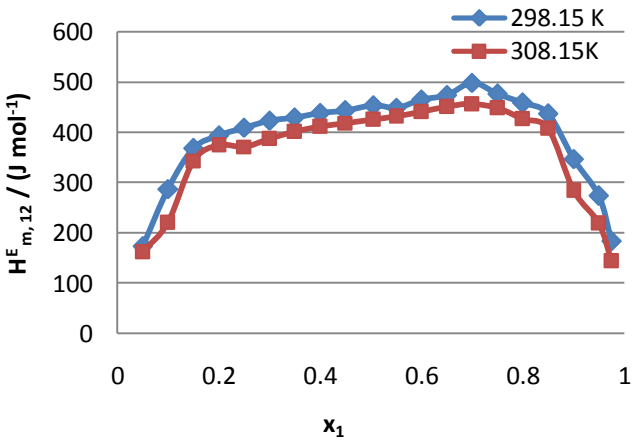

Figure 2: Enthalpy of mixing for cyclohexane (1) - Toluene (2) system.

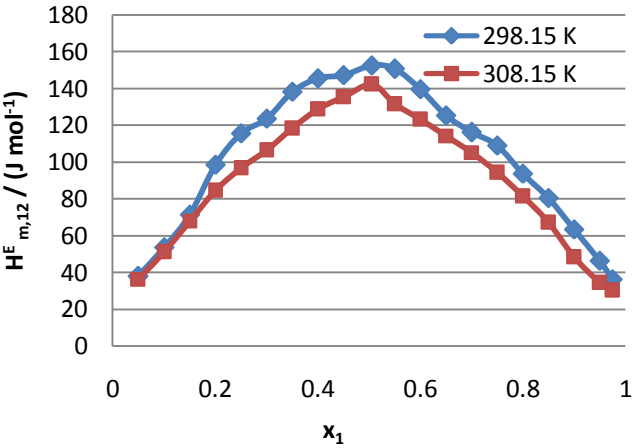

Figure 3: Enthalpy of mixing for cyclohexane (1) – methanol (2) system.

Table 3 Parameters h_k and standard deviations σ for the representation of $H^E_{m,12}$ at 298.15K and 308.15 K by Eq. (1)

T /K	System (1+2)	h_1	h_2	h_3	h_4	h_5	σ /J mol^{-1}
298.15	(Cyclohexane + benzene)	3105.219	-39.0518	-965.185	-107.845	2205.068	0.34
308.15	(Cyclohexane + benzene)	3015.72	-149.056	-869.524	55.07913	1684.273	0.54
298.15	(Cyclohexane +Toluene)	1812.289	-210.699	1655.016	-595.166	2120.399	0.48
308.15	(Cyclohexane +Toluene)	1699.904	-305.24	1852.081	-258.249	801.9138	0.52
298.15	(Cyclohexane + methanol)	585.0825	104.7014	84.06362	-297.084		0.211
308.15	(Cyclohexane + methanol)	524.325	38.20897	27.25812	-76.2953		0.21

References

[1] K. L. Shivabasappa, P. Nirguna Babu and Y. Jagannadha Rao, Braz. J.of Chem. Eng., 25, 167, 2008.
[2] R. V. Mrazek and H. C. Van Ness, Amer. Inst. Chem. Engineers J. 7, 190, 1961.
[3] D. R. Winterhalter and H. C. Van Ness, J. Chem. and Eng. Dara, 11, 189, 1966.
[4] C. G. Savini, D. R. Winterhalter, L. H. Kovach, and H. C. Van Ness, J. Chem. and Eng. Data, 11, 40, 1966.
[5] R. H. Stokes, K. N. Marsh, and R. P. Tomlins, J. Chem. Thermodynamics, I, 211, 1969.
[6] B. Murakami and G. C. Benson, J. Chem. Thermodynamics, 1, 559, 1969.
[7] R. Tanaka, S. Murakami, and R. Fujishiro, Bull. Chem. SOC. Japan, 45, 2107, 1972.
[8] J. J. Christensen, J. W. Gardner, D. J. Eatough, R. M. Izatt, P. J. Watts, and R. M. Hart, Rev. Sci. Instr, 44, 481, 1973.

[9] Patel, H.R., Ph.D. Thesis, Department of Chemical Engineering, Indian Institute of Science, Bangalore, India, 1974.
[10] Rao Y.J., and Viswanath D.S, J.Chem .Eng. Data, 18, 49, 1973.
[11] Nirguna Babu. P, Ph.D. Thesis, Department of Chemical Engineering, Siddaganga Institute of Technology, Tumkur – 572103 – India, 2003.
[12] Riddick, J.A., Bunger, W. S., Techniques of Chemistry, Organic Solvents, Vol. II, 3e, Wiley-Interscience, NY, 1970.
[13] Weissberger, A., Editor, Techniques of Organic Chemistry, Vol I, Interscience, NY, 1949.

Simulation and Validation of Chemical Processes using software

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Abstract

Modeling and Simulation is the market-prominent process. Modeling solution that provides larger economic benefits throughout the process engineering. It brings the supremacy of process simulation and optimization to your desktop, and delivers a unique combination of modeling technology and ease of user friendly approach. Aspen Plus, ChemSepandHYSYS enables chemical processes to come up with new plants and designs to grow market more rapidly and optimize production for greater margins.

Key words- Modeling, simulation, optimization, validation, property method.

I. INTRODUCTION

The use of simulation plays a dynamic role in developing an approach in process design. Using various simulations, the data can be predicted for certain scale up, troubleshooting, design and control and even for scale down process without actually performing the actual experimentation. Usually most of the times the data meet to the required accuracy. It can also be useful in revamping, reprocessing the experimental results.

Chemical Processes explores the effective modeling and simulation approaches for obtaining the solutions of equations. The systematic approach of model development and simulation studies for chemical processes explains the simplification of a complicated process at various levels with the help of a model. Model is a representation of the given system in a mathematical way.

The models introduce and examine various processes which provide examples from a wide range of applications. This includes the simple models based on basic laws viz. Fick's law, models that consist of general equations such as discrete-event models, equations of motion and stochastic models, which comprises of at least one variable as a discrete variable.

II. APPLICATIONS OF DYNAMIC SIMULATION

Plant design:

1. Design and testing of regulatory control systems - selection of control structures, control algorithms, and initial tuning of loops.
2. Design and testing of operating procedures - startup, shut-down, feed stock changeover, etc.
3. Hazard/safety studies - answer important questions raised by HAZOP study.

Plant operation:

1. Dynamic simulation runs in real time and mimics behavior of real plant.
2. Operator interfaces to control system (not simulator) — more realistic.
3. Instructor monitors and creates scenarios (e.g., disturbances, failures).

Chemical Engineering

Innovative Technologies for the Treatment of Industrial Wastewater

A Sustainable Approach

Editors: Shirish Hari Sonawane, PhD
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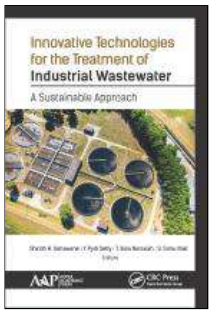

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Notes: 141 b/w illustrations

This book highlights advances in sustainable wastewater treatment technologies, particularly biological wastewater treatment, cavitation-based treatment, hybrid water treatment, membrane technologies, advance oxidation processes, and adsorption. The book focuses on a variety of advanced treatment techniques that are useful for the degradation of organic components, dyes, heavy metals effluent, etc. in wastewater.

Industrial wastewater consists of variety of discharges based on the type of industry, such as the dairy/food industries, which generate more fats and high BOD value with variation in the pH value, while the electroplating industry may expel more inorganic matter and dissolved solids. The oil extraction industries will have more solvents contained in the effluent, and dyes and textiles industry create a higher organic load with high TDS. Hence, every type of manufacturing industry needs a different method for the treatment of its effluents.

Looking at the use of intensified chemical processes in order to make cleaner environment, **Innovative Technologies for the Treatment of Industrial Wastewater** explores the new and innovative methods for pollutant removal that will prove useful for a variety of industries.

Conventional wastewater treatment processes requires more energy and involve expensive equipment, which involves capital and maintenance costs. Sustainable wastewater treatment technologies, however, involve less generation of energy and employ more economically feasible treatment methods, as well as less equipment and maintenance cost, and less energy usage and equipment cost.

This book will be a valuable reference for all types engineers who are working in industry/academics who are looking for innovative and sustainable methods to deal with harmful wastewater effluent.

CONTENTS:

The AAP Blog

August 2018—APP is pleased to announce that **Megh R. Goyal, PE,** has received another accolade for his work. He is the 2018 recipient of the Netafim Award for Advancements in Microirrigation for his work in introducing microirrigation technology in the Caribbean, North and South America, and India through publications, research, and extension activities for scientific and farming fraternity. The award was presented at the International Meeting of Americal Society of Agricultural & Biological Engineers during July 29 - August 1 of 2018 in Detroit, Michigan. Dr. Goyal is the Senior Editor in Chief for Biomedical Engineering and Agricultural Science for Apple Academic Press. Congratulations, Dr. Goyal!

Congratulations to AAP Author K. R. Krishna, PhD, who recently received the Professor Abdul Kalam Gold Medal for the year 2017, which was coordinated by the Global Economic Progress Research Association, New Delhi, India. Professor Kalam was the President of Indian from 2001 to 2006. Professor Kalam, a highly regarded nuclear scientist, also led the Indian Missile Program for more than two decades. The award was given in recognition of Dr. Krishna's contributions to "International Agriculture and Peace."

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"I would like to thank Dr. Mahmood Khan and AAP warmly for offering me the opportunity to publish my book Sustainable Viticulture: The Vines and Wines of Burgundy. I found a lot of pleasure in reflecting on my experience and observations as a viticulturist in Burgundy and other regions of the world. I enjoyed putting in writing thoughts, memories, and ideas I've had for years. I also found pleasure in synthesizing discussions I've had with wine professionals and wine buffs as well as reading notes I regularly jotted down. I can also add that I very much appreciated the friendly and firm support and guidance of the staff of Apple Academic Press." —Claude Chapuis, Associate Professor, School of Wine & Spirits Business, Dijon, France

"I was recently thrilled to flip the pages of my new book, Polymeric Thermosetting Polymers. This book shares a lifetime of lessons from my pioneering efforts in compound custom formulating. That is why I am so very grateful to AAP for making it possible to get this unique book into worldwide circulation. The expert team at AAP made the experience of writing, organizing, and polishing the book quite enjoyable." —Ralph D. Hermansen, Formerly Senior Scientist, Hughes Aircraft Company, El Segundo, California

"Glad to see the final outcome of the book. It was truly wonderful & smooth experience to work with AAP. Definitely, looking forward to more exciting and fruitful association in future." —Arvind K. Birdie, PhD, Associate Professor and Acting Principal, IIMT School of Management (Oxford Brooks University), Gurgaon, India;

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Analysis Of Finger Print Detection Techniques

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Abstract *-Fingerprints are the most widely utilised in establishing bio-metric identity from long time. Fingerprints of a human being do not change during entire life. Fingerprint biometric is less costly as compared to other biometric technique such as face, retina, and DNA. Altered fingerprint detection was as serious problem in existing systems, so we have proposed a system that will eliminate it and detect the altered/tampered fingerprint. Also, fingerprint images get distorted because of variations in skin of finger and impression conditions. So, image enhancement methods are employed before minutiae extraction process. A important step in process of fingerprint matching is to extract minutiae from the input fingerprint images reliably.. We have proposed a system to that will detect the tampered fingerprints and produce the match count.*

Keywords*:fingerprint; ridge pattern; biometric; minutiae; pattern Matching*

1. INTRODUCTION

Fingerprints are today the biometric features most widely used for personal identification. Fingerprint recognition is one of the basic tasks of the Integrated Automated Fingerprint Identification Service (IAFIS) of the most famous police agencies. A fingerprint pattern is characterized by a set of ridgelines that often flow in parallel, but intersect and terminate at some points. The uniqueness of a fingerprint is determined by the local ridge characteristics and their relationships. Most automatic systems for fingerprint comparison are based on minutiae matching.

The verification process either accepts or rejects the user's identity by matching against an existing fingerprint database. In identification, the identity of the user is established using fingerprints. Since accurate matching of fingerprints depends largely on ridge structures, the quality of the fingerprint image is of critical importance. However, in practice, a fingerprint image may not always be well defined due to elements of noise that corrupt the clarity of the ridge structures. This corruption may occur due to variations in skin and impression conditions such as scars, humidity, dirt, and non-uniform contact with the fingerprint capture device.

Fingerprints are more unique than DNA. The identical twins may have same DNA but their fingerprints will still differ. Fingerprints never change with people age also they are inexpensive to collect and analyse, so they are considered as ideal measure for security purpose. Fingerprints are an arrangement of ridges, known as friction ridges

2. FINGERPRINT FEATURES

Fingerprint features can be classified into three classes [1]. Level 1 features show macro details of the ridge flow shape, Level 2 features (minutiae point) are discriminative

enough for recognition, and Level 3 features (pores) complement the uniqueness of Level 2 features.

A. *Global Ridge Pattern*

A fingerprint is a pattern of alternating convex skin called ridges and concave skin called valleys with a spiral-curve-like line shape. There are two types of ridge flows: the pseudo-parallel ridge flows and high-curvature ridge flows which are located around the core point and/or delta point(s). This representation relies on the ridge structure, global landmarks and ridge pattern characteristics.

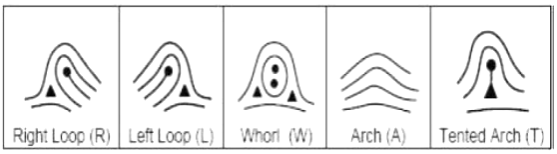

Fig. 1 Global fingerprint ridge patterns

The commonly used global fingerprint features are shown in the figure.

- *Singular points –*

They represent discontinuities in the orientation field. There are two types of singular points. A core is the uppermost of the innermost curving ridge [1], and a delta point is the junction point where three ridge flows meet. They are usually used for fingerprint registration and classification

Fig. 2 Singular points (SPs), where "**O**" and "⊕" denote core and delta, respectively.

- *Ridge orientation map –*

This represents the local direction of the ridge-valley structure. It is commonly utilized for classification, image enhancement and minutia feature verification and filtering.

- *Ridge frequency map –*

It is the reciprocal of the ridge distance in the direction perpendicular to local ridge orientation. It is extensively utilized for contextual filtering of fingerprint images.

B. Local Ridge Pattern

This is the most widely used and studied fingerprint representation. Local ridge details are the discontinuities of local ridge structure referred to as minutiae.

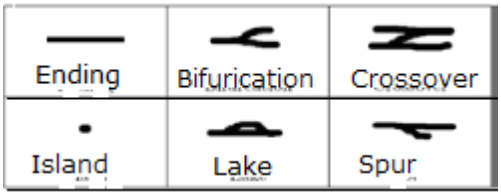

Fig. 3 Some of the common minutiae types

Minutiae are also called "Galton details". They are used by forensic experts to match two fingerprints. There are about 150 different types of minutiae [3] categorized based on their configuration. Among these minutia types, "ridge ending" and "ridge bifurcation" are the most commonly used, since all the other types of minutiae can be seen as combinations of "ridge endings" and "ridge bifurcations".

Some minutiae are shown in fig. 4. The American National Standards Institute-National

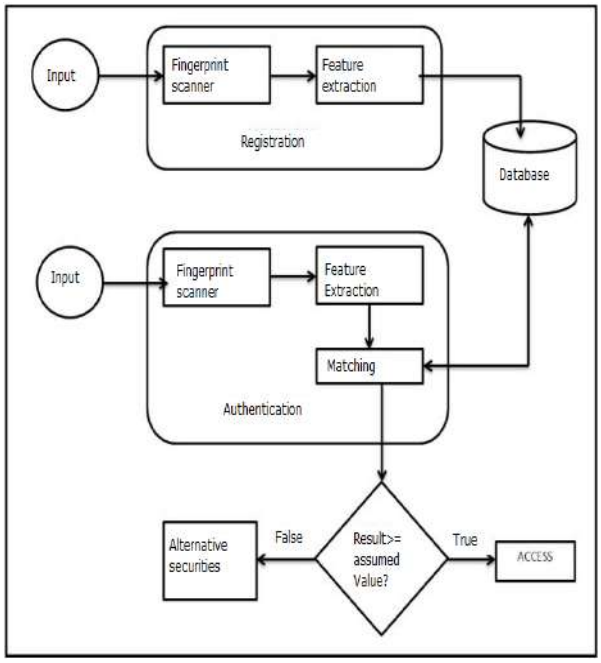

Fig. 4. System Architecture

The above diagram represents the system architecture of our proposed system. In registration phase fingerprint images are scanned and provided as input, while scanning image pre-processing operation are performed. Here a quality is image is captured first and then it is converted in form of template. In feature extraction the images is classified according to different pattern. Minutiae points are determined from the image. The acquired data is stored in database.

In authentication phase the pre-processing operation and feature extraction is once again performed on inputted image. The gain image is searched in the database for its probable match. Depending on the result generated further action is performed. If the result is greater than or equal to the assume value then the user is authenticated else if image is altered then alternative security is provided.

4. CONCLUSIONS

Image quality is related directly to the ultimate performance of automatic fingerprint authentication systems. Good quality fingerprint images need only minor pre-processing and enhancement for accurate feature detection algorithm. This paper reviewed a large number of techniques described in the literature to extract minutiae from fingerprint images.

The approaches are distinguished on the basis of several factors like: the kind of input images they handle i.e. whether binary or gray scale, techniques of binarization and segmentation involved, whether thinning is required or not and the amount of effort required in the post processing stage, if exists. Our proposed system deals with the problems encountered by traditional systems. We use the minutiae based matching algorithm to analyze and detect the altered fingerprint, if we detect the altered fingerprint the user will be blocked. We will provide an alternative security to the user if the match count is less. We are going to minimize the disadvantages of existing system combinations of “ridge endings” and “ridge bifurcations”.

The American National Standards Institute-National Institute of Standard and Technology (ANSI-NIST) proposed a minutiae-based fingerprint representation. It includes minutiae location and orientation [4]. Minutia orientation is defined as the direction of the underlying ridge at the minutia location . Minutiae-based fingerprint representation can also assist privacy issues since one cannot

reconstruct the original image from using only minutiae information. Actually, minutiae are sufficient to establish fingerprint individuality.

A ridge ending minutia: (x, y) are the minutia coordinates; θ is the minutia's orientation; (b) A ridge bifurcation minutia: (x, y) are the minutia coordinates; θ is the minutia's orientation. The minutiae are relatively stable and robust to contrast, image resolutions, and global distortion as compared to other fingerprint representations. However, to extract the minutiae from a poor quality image is not an easy task, although most of the automatic fingerprint recognition systems are designed to use minutiae as the main fingerprint feature for recognition. What is Fingerprint Recognition? The fingerprint recognition [6] problem can be grouped into three sub-domains: fingerprint enrollment, verification and fingerprint identification. In addition, as different from the manual approach for fingerprint recognition by experts, the fingerprint recognition here is referred as AFRS (Automatic Fingerprint Recognition System), which is program-based.

Verification is typically used for positive recognition, where the aim is to prevent multiple people from using the same identity. Fingerprint verification is to verify the authenticity of one person by his fingerprint.

There is one-to-one comparison in this case. In the identification mode, the system recognizes an individual by searching the templates of all the users in the database for a match. Therefore, the system conducts a one to many comparisons to establish an individual's identity. Both verification and identification use certain techniques for fingerprint matching as indicated in the following subsection. 3.1 Techniques for Fingerprint Matching Various fingerprint matching techniques discussed in literature are as follows:

• Minutiae based technique: Most of the finger-scan technologies are based on Minutiae. Minutia based techniques represent the fingerprint by its local features, like terminations and bifurcations [5-6]. Two fingerprints match if their minutiae points match. This approach has been intensively studied, also is the backbone of the current available fingerprint recognition products.

• Pattern Matching or Ridge Feature Based Techniques: Feature extraction and template generation are based on series of ridges as opposed to discrete points which forms the basis of Pattern Matching Techniques. This includes context aware similarity search techniques applicable to all types of content based image retrieval (CBIR) [7].

The advantage of Pattern Matching techniques [8, 9] over Minutiae based techniques is that minutiae points may be affected by wear and tear and the disadvantages are that these are sensitive to proper placement of finger and need large storage for templates.

• Correlation Based Technique [10] : Let I(Δx, Δy, θ) represent a rotation of the input image I by an angle θ around the origin (usually the image center) and shifted by Δx and Δy pixels in directions x and y, respectively. Then the similarity between the two fingerprint images T and I can be measured as :

(1) where CC(T, I) = TTI is the cross-correlation between T and I. The cross-correlation is a well known measure of image similarity. It allows us to find the optimal registration. The direct application rarely leads to acceptable results, mainly due to the following problems: a) Non-linear distortion makes impressions of the same finger significantly different in terms of global structure; the use of local or block-wise correlation techniques can help to deal with this problem. b) Skin condition and finger pressure cause image brightness, contrast, and ridge thickness to vary significantly across different impressions. The use of more sophisticated correlation measures may compensate for these problems. c) The technique is computationally very expensive. Local correlation and correlation in the Fourier domain can improve efficiency.

• Image Based Techniques: Image based techniques try to do matching based on the global features of a whole fingerprint image. It is an advanced and newly emerging method for fingerprint recognition

REFERENCES

[1] Soweon Yoon, Jianjiang Feng, and Anil K. Jain. Altered Fingerprint Analysis and Detection,IEEE Trans.,2012

[2] Unnikrishnan S. Kumar, An Integrated Automated Altered Fingerprint Identification System,IJRCCT,2014

[3] Sonam Shukla, Pradeep Mishra, Increasing the accuracy of an existing fingerprints recognition system using adaptive technique, IJARCSSE, 2012

[4] ChandrakanthBiradar, Vijeth Rao," A challenge to analyze and detect altered human fingerprint",IOSR-JCE, volume 13, Aug. 2013

[5] Abhishek Rawat, A hierarchical fingerprint matching system,2013

[6] Dr. Sunil Kumar Singla, A review of image based fingerprint authentication algorithm, volume 3, issue 6, IJARCSSE, June 2013

[7] Anil Jain, ArunRos, Fingerprint Matching using Minutiae and Texture Features, ICIP,pp.282-285,2001

[8] J.Gu., J.Zhou , C.Yang,Fingerprint Recognition by Combining Global Structure and Local Cues, IEEE Transactions on Image Processing, 2006, vol. 15, no. 7, pp. 1952 – 1964.

[9] Jianjiang Feng, Anil K.Jain and ArunRoss,fingerprint alteration,MSU-CSE-09-30 ,2009

[10]RaviJ,K,B.Raja,VenugopalK.R,Fingerprint Recognition using minutiae score matching,ISSN:0975-5462,2009

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Future Trends in Fiber Optics Communication

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Abstract –*Fiber optic programs are primary telecommunication infrastructure for world-extensive broadband networks. Huge bandwidth sign transmission with low delay is a key requirement in modern-day purposes. Optical fibers provide huge and unsurpassed transmission bandwidth with negligible latency, and are now the transmission medium of choice for lengthy distance and high knowledge fee transmission in telecommunication networks. This paper offers an overview of fiber optic conversation programs including their key technologies, and likewise discusses their technological trend closer to the following generation.*

Keywords*:Bandwidth, Broadband, Fiber optics, Latency, Telecommunication.*

1. INTRODUCTION

The most important using drive at the back of the standard use of fiber optics communication is the high and quickly increasing purchaser and commercial demand for more telecommunication capability and internet offerings, with fiber optic technological know-how capable of supplying the specified information capability (better than each wireless connections and copper cable). Advances in technology have enabled extra knowledge to be conveyed via a single optical fiber over long distances. The transmission ability in optical verbal exchange networks are drastically accelerated utilising wavelength division multiplexing[1].A fascinating characteristic for future optical networks is the capacity to system knowledge entirely within the optical domain for the purpose of amplification, multiplexing, de-multiplexing, switching, filtering, and correlation, in view that optical sign processing is extra effective than electrical signal processingA few new courses of optical communication networks are at the moment emerging [2]. For instance, Code Division multiple entry networks making use of optical signal processing systems have just lately being offered[3] .

Regardless of the related benefits of utilizing optical fiber for communication (comparable to its high reliability over long distances, low attenuation, low interference, excessive safety, very excessive know-how potential, longer lifestyles span and ease of upkeep), research is still ongoing to additional toughen on the reward fiber optics communication approach, and likewise to resolve one of the vital challenges dealing with it. Future optical communiqué systems are expected to be extra powerful than the reward approach. This paper is equipped as follows. Section II describes the elemental concepts of fiber optics verbal exchange. Part III looks at the history and evolution of fiber optics communique whilst section IV offers some envisioned future developments in fiber optics verbal exchange. In part V, we draw the conclusion for the paper.

II. BASIC PRINCIPLES OF FIBER OPTIC COMMUNICATION

Fiber optic verbal exchange is a communiqué technology that makes use of gentle pulses to switch expertise from one factor to another through an optical fiber. The know-how transmitted is essentially digital information generated with the aid of mobile techniques, cable television corporations, and computer programs. An optical fiber is a dielectric cylindrical waveguide comprised of low-loss substances, more commonly silicon dioxide. The core of the waveguide has a refractive index a bit larger than that of the outer medium (cladding), so that gentle pulses is guided along the axis of the fiber through complete interior reflection [4]. Fiber optic verbal exchange systems includes an optical transmitter to transform an electrical sign to an optical sign for transmission by way of the optical fiber, a cable containing a number of bundles of optical fibers, optical amplifiers to lift the vigour of the optical signal, and an optical receiver to reconvert the acquired optical signal back to the usual transmitted electrical sign. Figure 1 gives a simplified description of a basic fiber optic conversation approach.

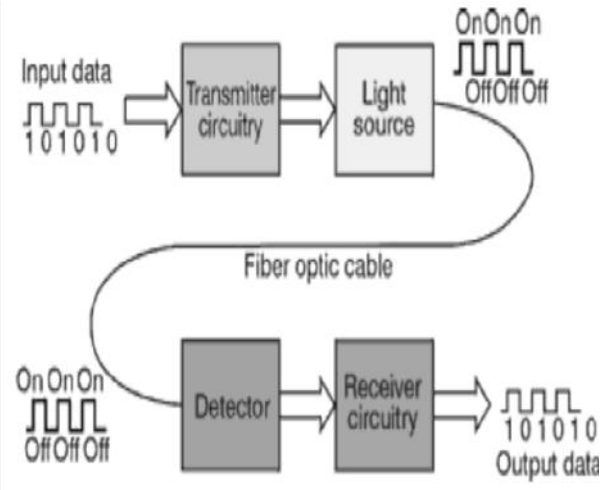

Fig.1. Basic fiber optic communication system [5]

Optical fibers fall into two predominant categories, specifically: step index optical fiber, which include single mode optical fiber and multimode optical fiber, and graded index optical fiber. Single mode step index optical fiber has a core diameter not up to 10 micrometers and most effective makes it possible for one gentle route. Multimode step index optical fiber has a core diameter larger than or equal to 50 micrometers and permits a number of gentle paths, this results in modal dispersion. Graded index optical fibers have their core refractive index regularly slash farther from the centre of the core, this extended refraction on the core centre slows the pace of some gentle rays, thereby enabling all of the gentle rays to reach the receiver at just about the same time, thereby decreasing dispersion. Determine 2 gives a description of the quite a lot of optical fiber modes.

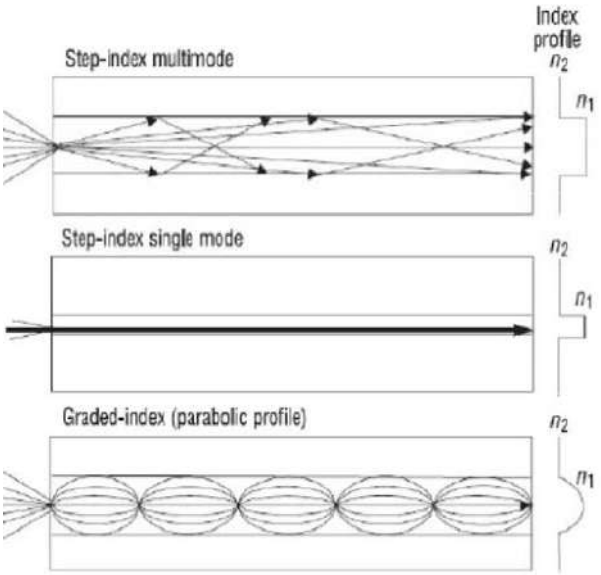

Fig.2. Optical Fiber Modes [6]

III. EVOLUTION OF FIBER OPTICS COMMUNICATION

Optical fiber was first developed in 1970 by Corning Glass Works. At the same time, GaAs semiconductor lasers have been additionally

developed for transmitting light by means of the fiber optic cables. The first iteration fiber optic approach was developed in 1975, it used GaAs semiconductor lasers, operated at a wavelength of 0.8 µm, and bit rate of 45Megabits/2nd with 10Km repeater spacing.

In the early 1980's, the second generation of fiber optic communique was developed, it used InGaAsPsemi conductor lasers and operated at a wavelength of 1.Three µm. Via 1987, these fiber optic techniques had been operating at bit premiums of as much as 1.7 Gigabits/2d on single mode fiber with 50Km repeater spacing.

The 0.33 generation of fiber optic communique working at a wavelength of 1.Fifty five µm was developed in 1990. These programs were working at a little cost of as much as 2.5 Gigabits/second on a single longitudinal mode fiber with 100Km repeater spacing.

The fourth iteration of fiber optic methods made use of optical amplifiers as a alternative for repeaters, and utilized wavelength division multiplexing (WDM) to develop knowledge rates. With the aid of 1996, transmission of over 11,300Km at a data cost of 5Gigabits/second had been confirmed using submarine cables [7].

The fifth generation fiber optic communique programs use the Dense Wave Division Multiplexing (DWDM) to further expand data premiums. Additionally, the idea of optical solitons, which might be pulses that can continue their form via counteracting the side effects of dispersion, can be being explored. Figure three indicates the evolution of fiber optic communication.

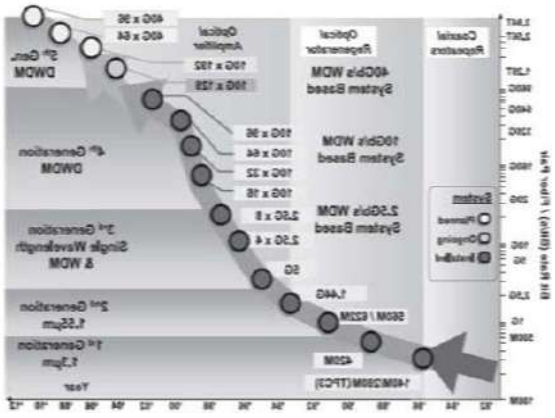

Fig.3. Generations of Fiber Optics Communication [8]

IV. FUTURE TRENDS IN FIBER OPTICSCOMMUNICATION

Fiber optics communique is most likely the future of data communication. The evolution of fiber optic communication has been driven by development in technological know-how and elevated demand for fiber optic communique. It is anticipated to continue into the future, with the progress of recent and more developed communique technological know-how. Beneath are one of the expected future developments in fiber optic conversation.

A. All Optical verbal exchange Networks

An all fiber optic verbal exchange is anticipated that will be thoroughly in the optical area, giving upward thrust to an all optical communication network. In such networks, all signals will be processed in the optical domain, without any type of electrical manipulation. At the moment, processing and switching of indicators take position in the electrical area, optical indicators must first be transformed to electrical signal earlier than they can be processed, and routed to their vacation spot. After the processing and routing, the alerts are then re-converted to optical indicators, which can be transmitted over long distances to their destination.

This optical to electrical conversion, and vice versa, outcome in brought latency on the network and for this reason is a issue to attaining very high data charges.

A different benefit of all optical networks is that there might not be any have to substitute the electronics when information expense increases, seeing that all signal processing and routing happens in the optical area [9]. Nevertheless, before this may end up a reality, difficulties in optical routing, and wavelength switching needs to be solved. Study is presently ongoing to seek out an potent option to these difficulties.

B. Multi – Terabit Optical Networks

Dense Wave Division Multiplexing (DWDM) paves the way in which for multi-terabit transmission. The arena-huge need for improved bandwidth availability has ended in the curiosity in establishing multi-terabit optical networks. Right now, 4 terabit networks utilizing 40Gb/s data rate mixed with one hundred DWDM channels exists. Researchers are looking at attaining even greater bandwidth with 100Gb/s. With the continuous reduction in the fee of fiber optic accessories, the provision of so much bigger bandwidth in the future is viable.

C. Sensible Optical Transmission community

At the moment, ordinary optical networks should not equipped to adapt to the speedy progress of on-line knowledge services due to the unpredictability of dynamic allocation of bandwidth, usual optical networks depend customarily on guide configuration of network connectivity, which is time consuming, and unable to thoroughly adapt to the needs of the state-of-the-art community. Intelligent optical network is a future development in optical community progress [2], and will have the next functions: traffic engineering, dynamic resource route allocation, unique manipulate protocols for community management, scalable signalling capabilities, bandwidth on demand, wavelength apartment, wavelength wholesale, differentiated services for a variety of pleasant of provider phases, etc. It is going to take the time earlier than the shrewd optical community can also be utilized to all levels of the community, it will first be applied in long-haul networks, and step by step be utilized to the community area [10].

D. Ultra – lengthy Haul Optical Transmission

within the area of extremely-lengthy haul optical transmission, the barriers imposed as a result of imperfections within the transmission medium are area for study. Cancellation of dispersion effect has triggered researchers to be taught the advantage benefits of soliton propagation. More working out of the interactions between the electromagnetic light wave and the transmission medium is crucial to proceed in the direction of an infrastructure with essentially the most favorable stipulations for a light pulse to propagate [11].

E. Improvements in Laser science

one more future trend will be the extension of gift semiconductor lasers to a much wider style of lasing wavelengths[12]. Shorter wavelength lasers with very excessive output powers are of curiosity in some high density optical functions. At the moment, laser sources which are spectrally formed via chirp managing to compensate for chromatic dispersion are available. Chirp managing signifies that the laser is managed such that it undergoes a unexpected alternate in its wavelength when firing a pulse, such that the chromatic dispersion experienced by means of the heartbeat is

lowered. There may be ought to enhance devices for use to represent such lasers. Also, single mode tunable lasers are of excellent importance for future coherent optical programs. These tunable lasers lase in a single longitudinal mode that can be tuned to a range of distinct frequencies.

F. Laser Neural network Nodes

The laser neural community is an powerful option for the realization of optical network nodes. A committed hardware configuration working within the optical domain and the use of extremely-rapid photonic sections is predicted to additional enhance the capability and pace of telecommunication networks [12]. As optical networks become extra difficult in the future, the use of optical laser neural nodes may also be an robust answer

G. Polymer Optic Fibers

Polymer optical fibers offer many benefits when in comparison with other knowledge communique options corresponding to copper cables, wi-fi communication programs, and glass fiber. In comparison with glass optical fibers, polymer optical fibers provide an effortless and not more costly processing of optical alerts, and are more bendy for plug interconnections [13]. Using polymer optical fibers because the transmission media for aircrafts is presently beneath study via distinct research and development agencies because of its advantages. The German Aerospace middle have concluded that “using Polymer Optical Fibers multimedia fibers seems to be viable for future aircraft purposes [14]. Additionally, at some point, polymer optical fibers will likely displace copper cables for the last mile connection from the telecommunication organization’s last distribution box and the served end consumer [15]. The longer term Gigabit Polymer Optical Fiber usual can be based on Tomlinson-HarashimaPrecoding,Multilevel PAM Modulation, and Multilevel Coset Coding Modulation.

H. High – Altitude systems

presently, optical inter satellite tv for pc hyperlinks and orbit-to-floor links exists [16], the latter affected by detrimental climate stipulations [17]. Present research explores optical verbal exchange to and from excessive altitude systems. High altitude systems are airships headquartered above the clouds at heights of sixteen to 25Km, where the negative atmospheric have an impact on on a laser beam is much less severe than directly above the ground [18]. As proven in determine 4, optical hyperlinks between high-altitude platforms, satellites and ground stations are anticipated to serve as broadband again-haul verbal exchange channels, if a excessive-altitude platform services as an information relay station

Fig.4. Laser Communication Scenarios from HAPs [4]

I. Enhancements in Optical Transmitter/Receiver science

In fiber optics verbal exchange, it's major to acquire excessive exceptional transmission even for optical alerts with distorted waveform and low sign

to noise ratio in the course of transmission. Research is ongoing to boost optical transceivers adopting new and evolved modulation science, with quality chromatic dispersion and Optical signal to Noise Ratio (OSNR) tolerance, so that they can be compatible for ultra-lengthy haul communique programs. Additionally, better error correction codes, which might be more efficient than the present BCH concatenated codes are anticipated to be available in the nearest future.

J. Development in Optical Amplification science

Erbium Doped Fiber Amplifier (EDFA) is among the valuable technologies used in optical fiber verbal exchange techniques. Someday, higher technologies to enhance EDFA efficiency can be developed. In order to broaden the gain bandwidth of EDFA, better attain equalization science for prime accuracy optical amplification will probably be developed. Additionally, so as to achieve a greater output vigor, and a shrink noise figure, high energy pumping lasers that possess quality optical amplification traits with outputs of greater than +20dBm, and very low noise figure are predicted to exist in the nearest future.

Advancement in community Configuration of Optical Submarine programs with a purpose to improve the pliability of community configuration in optical submarine conversation techniques, it's anticipated that the development of a science for configuring the mesh network shall be a step in the correct course. As proven in figure 5, even as a hoop community joins stations alongside a single ring, a mesh community connects stations directly. At the moment, most enormous scale optical submarine techniques adopt the ring configuration. By way of adopting the optical add/drop multiplexing technology that branches indicators in the wavelength area, it is viable to recognize mesh network configuration that immediately inter-connects the stations. Research is ongoing, and sooner or later such community configuration shall be common.

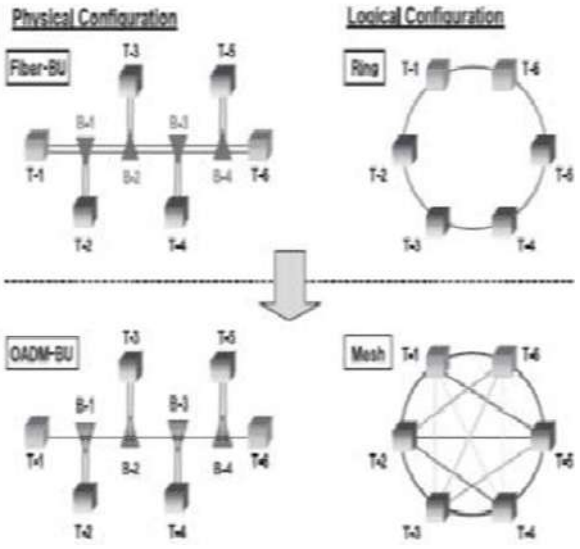

Fig.5. Optical Network Configurations [8]

L. Development in WDM science

study is ongoing on the best way to lengthen the wavelength range over which wave division multiplexing programs can operate. Presently, the wavelength window (C band) degrees from 1.Fifty three-1.57µm. Dry fiber which has a low loss window promises an extension of the variety to 1.30 – 1.65 µm. Additionally, trends in optical filtering technology for wave division multiplexing are expected at some point.

M. Improvements in Glass Fiber Design and aspect Miniaturization at this time, various impurities are introduced or eliminated from the glass fiber to alter its gentle transmitting traits. The outcomes is that the velocity with which gentle passes alongside a tumbler fiber may also be controlled, therefore permitting for the creation of custom-made glass fibers to fulfil the specific site

visitors engineering requirement of a given route. This trend is predicted to continue sooner or later, in order to produce more nontoxic and strong glass fibers. Additionally, the miniaturization of optical fiber conversation components is an additional trend that is certainly to continue sooner or later. switching techniques and more intelligent network architectures that can automatically change dynamically in response to traffic patterns and at the same time be cost efficient. The trend is expected to continue in the future as breakthroughs already attained in the laboratory will be extended to practical deployment thereby leading to a new generation in fiber optics communications.

REFERENCES

[1] M. Noshada, A. Rostami, “FWM minimization in WDM optical communication systems using the asymmetrical dispersion managed fibers”, International Journal for Light and Electron Optics, vol. 123, no. 9, pp. 758– 760, 2012.

[2] X. Wang and K. Kitayama, "Analysis of beat noise in coherent and incoherent time-spreading OCDMA," IEEE/OSA Journal of Lightwave Technology ,vol. 22, no. 10, pp. 2226-2235, 2004.

[3] T. H. Shake, "Confident performance of encoded optical CDMA", IEEE/OSA Journal of Lightwave Technology, vol. 23, pp. 1652- 1663, 2005.

[4] Prachi Sharma et al, “A Review of the Development in the Field of Fiber Optic Communication Systems”, International Journal of Emerging Technology and Advanced Engineering, Vol. 3, no. 5, pp. 113-119, 2013.

[5] G. Keiser, op cit, p 51

[6] Franz Fidler, Markus Knapek, Joachim Horwath, and Walter R.Leeb, “Optical Communications for High-Altitude Platforms”, IEEE Journal of Selected Topics in Quantum Electronics, Vol. 16, no. 5, September/October 2010.

[7] T. Otani, K. Goto, H. Abe, M. Tanaka, H. Yamamoto, and H.Wakabayashi, Electron. Lett.31, 380, 1995.

[8] Ogata Takaaki, “Recent Status and Trends in Optical Submarine Cable Systems”, NEC Technical Journal, Vol. 5 (1), pp. 4-7, 2010.

[9] Colin Yao, “The Future of Fiber Optic Communication”, available at: www.streetdirectory.com, 2013.

[10] “Status of Optical Communication Technology and Future Trends”, available at: www.qqread.net, 2013.

[11] DjanKloe, Henrie Van Den Boom, “Trends in Electro-opticalCommunication Systems, Perspectives on Radio Astronomy: Technologies for Large Antenna Arrays, Proceedings of the Conference held at the ASTRON Institute in Dwingeloo on 12- 14 April 1999. Edited by A. B. Smolders and M. P. Haarlem. Published by ASTRON. ISBN: 90-805434-2-X, 354 pages, 2000., p.2851999.

[12] Pamela L. Derry, Luis Figueroa, Chi Shain Hong, “Semi-Conductor Lasers”, 1991.

[13] U.H.P. Fischer, M.Haupt and M.Janoic, “Optical Transmission Systems Using Polymeric Fibers”, In Tech, available from: http://www.intechopen.com/books, 2011.

[14] Cherian, S., Spangenberg, H. and Caspary, R., “Vistas and Challenges for Polymer Optical

Fiber in Commercial Aircraft, Proceedings of the 19th POF Conference, 2010.

[15] Koonen, A.M.J. et al, "POF Application in Home Systems and Local System", Proceedings of the 14th POF Conference, pp. 165-168, 2005.

[16] T. Jono, Y. Takayama, K. Shiratama, I. Mase, B. Demelenne, Z. Sodnik,A. Bird, M. Toyoshima, H. Kunimori, D. Giggenbach, N. Perlot,M. Knapek, and K. Arai, Overview of the inter-orbit and the orbit to-ground laser communication demonstration by OICETS, SPIE,vol. 6457, pp. 645702-1–645702-10, 2007.

[17] COST297. HAPCOS, "High Altitude Platforms for Communications and Other Services", Available Online at: http://www.hapcos.org, 2010.

[18] L. C. Andrews and R. L. Phillips, Laser Beam Propagation through Random Media, 2nd ed. Bellingham, WA: SPIE, 2005.

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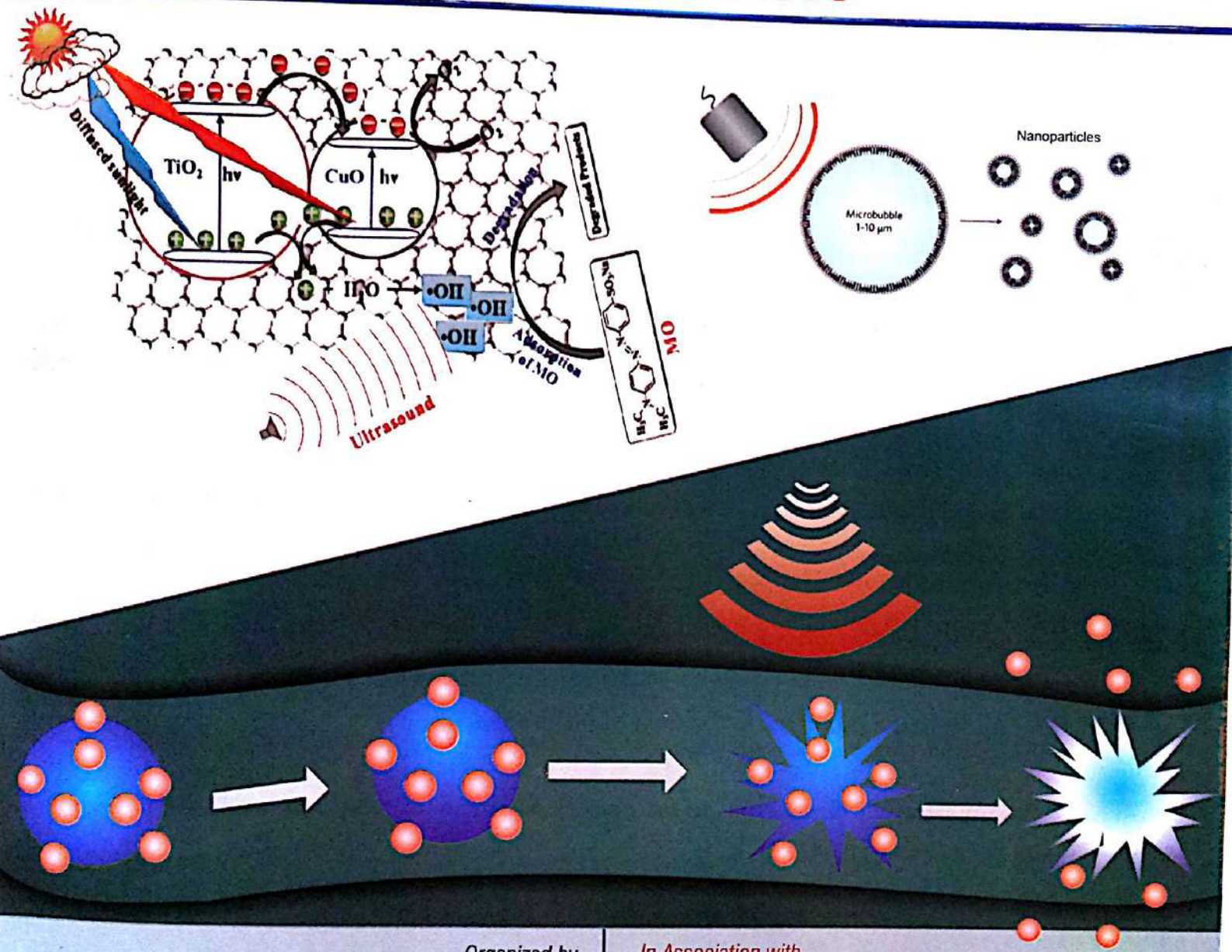

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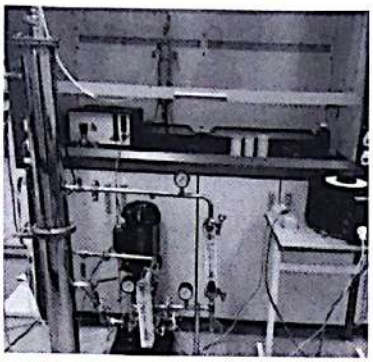

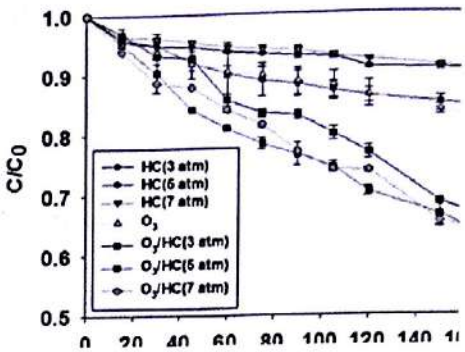

Figure 1 Ozone/hydrodynamic Cavitation Reactor & **Figure 2** Oxidative Removal of Oxalic Acids: HC(3, 5, 7 atm), O_3 and O_3 /HC(3, 5, 7 atm)

References

[1] Cui, M.; Jang, M.; Kang, K.; Kim, D.; Snyder, S. A.; Khim, J. Chemosphere. 2016, 144, 2081-2090.
[2] Dükkancı, M.; Gündüz, G.; Ultrason. Sonochem. 2006, 13(6), 517-522.
[3] Barik, A. J.; Gogate, P. R. Ultrason. Sonochem. 2016. 30, 70-78.

P03

Acoustic cavitation assisted synthesis of ferrous hydrogen phosphate Fe(II)HP nanoparticles for its application in corrosion inhibition of mild steel

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Above study deals with acoustic cavitation assisted synthesis Ferrous hydrogen phosphate nanoparticles Fe(II)HPn of without any further additives . For the synthesis of above nanoparticles Ferrous sulphate and Di-potassium hydrogen phosphate materials were used. Synthesis of Fe(II)HPn was carried out at room temperature (30 °C) and it took 20 min to complete the reaction. Synthesized nanoparticles were characterized using various physical characterizations such as XRD, FT-IR, TEM, UV-Vis and DT/TG analysis. According to XRD results synthesized nanoparticles has 98% crystallanity with crystallite size 5.4 nm. Fe(II)HPn has excellent corrosion inhibiting properties with negligible toxicity than conventional pigments such as lead, cadmium, chromium etc. The anticorrosive performance of above synthesized Fe(II)HPn (At varying concentrations 0-14% W/W (weight of nanomaterial)/(Weight of binding material)) was evaluated using salt Spary Test, Tafel plot test and EIS analysis when applied on Mild steel panels with the help of Epoxy-polyamide as a binding material. Salt spray results shows that Mild steel panels applied with 12% concentration passed more than 740 hours successfully. Also above result was supported by Tafel plot and EIS analysis as well.

P49

Insitu monitoring of geopolymer derived from fly ash and GGBS with nano additive by ultrasonic P-wave and S-wave transmission velocity measurement

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Geopolymer(GP) are inorganic composites, derived from Fly ash, an industrial waste is a best suited alternate green binding material with substantial reducing of CO_2 emission. Blending of GGBS in the FA based GP quickens the hardening properties at ambient temperature and there is a loss in slump with poor workability. The setting property on the casted GP mixes with 0.01%,0.1% and 1.0% of Nano additive were monitored by the Non-destructive ultrasonic waves (NDT). The aim of this study is to evaluate the blended binder material with the Nano additive on the initial and final setting time of mortars and concrete by ASTM C403 standard, ultrasonic transmission velocity measurements of P-Wave and S-waves. Setting process of the blended geopolymer with and without addition of Nano additive have evaluated between Vs and Vp versus time plot by fixing the inflection points. The influence of Nano additive on the blended GP mixes on the microstructural development have been systematical studied by mechanical properties, FTIR and FESEM. Thermal studies (TGA/DTA) on the Nano additive incorporated samples revealed their thermal stability up to 1200 ^{0}C.

Keywords: Geopolymer, Fly ash, GGBS, Shear wave velocity, Setting time.

P50

Ultrasonically synthesized polyhydrogel composite for removal of methylene blue dye from aqueous solution

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In this research work, removals of Methylene Blue (MB) dye from an aqueous solution by using synthesized poly (acrylic acid-acrylamide) hydrogel composite have been tried. The poly (acrylic acid-acrylamide) hydrogel composite was synthesized using polymerization reaction assisted by ultrasound. The synthesized polyhydrogel composite was characterized using Scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD) and Differential thermal/Thermo-gravimetric (DT/TG) analysis. Batch experiments were investigated to evaluate the effect of various operating parameters like pH of the dye solution (range of 2-12), initial dye concentration (range of 20-400 mg/L), operating temperature (range of 15-35 ^{0}C), contact time (range of 0-5

hr) and polyhydrogel composite dose (range of 1-10 g/L) on the extent of removal of Methylene Blue (MB) dye from an aqueous solution. The report shows that quantify results have been obtained by using polyhydrogel composite prepared using ultrasound assisted polymerization reaction. The optimized conditions for the removal of Methylene Blue (MB) dye from aqueous solution were obtained at pH of 8, temperature of 35 °C, contact time of 210 min, polyhydrogel composite dose of 5 g/L. All experiments on the adsorption were studied at these optimized conditions with an initial concentration of dye solution as 20 mg/L and by using 100 mL of this solution. It was observed that percentage removal of Methylene Blue (MB) dye increases with an increase in the contact time with the adsorbent used and the loading of polyhydrogel composite in aqueous solution. The adsorption capacity of polyhydrogel composite for the removal of Methylene Blue (MB) dye from aqueous solution increases with increasing in concentration. The adsorption kinetic and isotherm of Methylene Blue (MB) dye on polyhydrogel composite has been investigated by standard adsorption kinetic and isotherm model under optimized conditions. The obtained results show that the polyhydrogel composite is a promising adsorbent as compared to other commonly used adsorbents. The result found that, the experimental data was well fitted to Pseudo second order kinetic model. Langmuir isotherm model was found to best fit the equilibrium data.

Keywords: Polyhydrogel composites, Methylene Blue dye, adsorption kinetics and isotherms.

P51
Sonophotoelectrochemical analysis: identification of hazardous by products from artificial dyes

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The photosonoelectrochemical analysis of Lawsonia inermis, lawsone and β-Phenylenediamine via Cyclic Voltammetry and Linear Sweep Voltammetry were studied in ethanol. The natural dye lawsonia inermis is electrochemically inactive, lawsone (active component of lawsonia inermis) is electro active and undergoes oxidation producing a cation radical leading to oxidation of hydroxyl group into carbonyl group. In Linear Sweep Voltammetry, lawsone shows hydrogen evolution peak whereas reduction peak is observed for β-Phenylenediamine. To understand the electrochemical reaction mechanism spectroscopic analysis of the dyes under consideration were studied employing UV-Vis, FT-IR, 1H NMR before and after photosonoelectrochemical perturbations. The electronic, FT-IR and 1H NMR spectral analysis identified degradation due to electrochemical reactions occurring in lawsone and β-phenylenediamine, whereas lawsonia inermis (henna) showed degradation of chlorophyll contents and not the dye. The photosonolectrochemical studies in conjunction with the spectral analysis indicated the generation of hazardous by products such as CO_2,C≡N,etc. from lawsone and β-Phenylenediamine, thereby demonstrating the harmfullness in utilizing these dyes over henna for hair colour and tattoo purposes.

Keywords: Lawsonia inermis, lawsone, β -phenylenediamine, cyclic voltametry and Uv-Visible spectrophotometry, FT-IR and 1H NMR spectroscopy.

Performance Studies of ZIF-8/PES Asymmetric Mixed Matrix Membrane for Permeation of CO_2/CH_4

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Abstract — *Mixed matrix membranes with moderate filler loading have been shown to improve the properties of pure polymers for many gas separations. Nano-size fillers mixed uniformly into polymer matrix would overcome the challenges of developing MMM by carefully dispersion in polymer matrix, high interfacial contact of polymer-filler even at low filler loading. The synthesized ZIF-8 in the earlier work was used as filler for MMM preparation. Its XRD pattern revealed that it was successfully synthesized. Asymmetric neat Polyethersulfone (PES) membrane and PES/Zeolitic Imidazolate Framework-8 (PES/ZIF-8) based mixed matrix membrane was prepared using solvent-evaporation method. The prepared membrane was coated with 2 wt% of polydimethylsiloxane (PDMS) in n-hexane with moderate heat treatment and used for permeation of CO_2/CH_4. The gas permabilities of CO_2 and CH_4 by the PES/ZIF-8 MMM were increasing with increasing ZIF-8 loading at 3 bars. The incorporation of ZIF-8 at low loadings (□ 30 w/w %) improved the performances of the membrane. While the addition of 10 w/w % ZIF-8 into polymer increased the permeability approximately twice for CO_2 and CH_4 while the ideal selectivities for CO_2/CH_4 gas pair showed a slight loss (~14 to 17%). The increase in the permabilities was about 3 to 4 times, while the loss in selectivities for CO_2/CH_4 gas pair was about approximately 16 % compared to results of pure PES membrane. For the higher ZIF-8 loadings (≥ 30 w/w %), the permabilities are increasing, but the ideal selectivities started to reduce very rapidly. Since the most realistic increase in permabilities was observed in CH_4 but the selectivity decreases. As a result, using nano ZIF-8 as filler into PES matrix has revealed competent membrane for CO_2/CH_4 separation at moderate loading.*

Keywords — *Mixed Matrix Membrane (MMM), Polyether sulfone (PES), Zeolitic Imidazole Framework (ZIF-8), Gas separation, Permeability, Selectivity.*

I. INTRODUCTION

Gas separation membranes have found many applications such as hydrogen, oxygen–nitrogen separation, vapor–vapor separation, and dehydration of air and natural gas separation such as carbon dioxide separation and dew point adjustment etc [1]. Due to low capital cost, modest energy requirement and ease to fabricate, research on polymeric membrane has expand much attention in the last two decades. Polymeric membranes provide many advantages and its performance is studied by Robeson's trade-off curve shows relation between selectivity and permeability [1].

Inorganic fillers such as carbon molecular sieve, various zeolite, carbon nanotube, activated carbon etc. posses separation properties surpass Robeson's trade-off limit, were initially embedded into polymer. Still inorganic fillers shows poor interaction with polymer matrix and often lead to defective membrane. Developing defect-free mixed matrix membranes remains major challenge [2] [3]. Membrane can be defected through particle agglomeration, un-selective voids formation, filler pore blockages and sieve-in-cage morphology affect its effectiveness. The Metal organic frameworks (MOFs) as potential filler due to organic linkers present in the structure have good interaction with polymer. Besides, MOFs consist of large surface area, high adsorption capacity, ease of modifications and high affinity towards certain gas, gives good potential for MOFs to be used as filler [4] [5].

Among MOFs, zeolitic imidazole framework-8 (ZIF-8) is one of the most investigated MOFs [6],[7],[8] and it has porous crystalline structure with M-Im-M angle (M= metal) near to 145°, coincident with the Si–O–Si angle found in many zeolites [7],[8],[9]. ZIF-8 has sodalite (SOD) topology with a pore size of 0.34 nm [6], [10], [8]. It has large pores of 11.6 A^0 which is two times larger than SOD zeolites. The pores are accessible through small channels (3.4 A^0). It exhibits thermal stability up 400^0C and it has a BET surface area around 1300 to 1600 m^2/g or even more [6], [10], [11], [8]. ZIF-8 shows good chemical stability against polar and

TABLE 1
TEXTURAL PROPERTIES OF THE ZIF-8

MOF Type	Pore topology	Pore diameter (nm)	BET Surface area m^2/gm	Approximate Particle size (nm)
ZIF-8	Cage/ Window	1.16 /0.34	1214	170

TABLE 2
GENERAL PROPERTIES OF GASES CO_2, N_2 AND CH_4

Gas	Molecular Mass (g/mol)	Critical Temperature (^0K)	Kinetic Diameter (nm)
CO_2	44	304	0.33
N_2	28	126	0.36
CH_4	16	190	0.38

non-polar solvents [9], reorientation of its structure at high pressure and mechanical strength. Above table-1 shows the textural properties of the ZIF-8 [11], [12],[8].

Another important concern about MMM is the amount of filler loading. The particle size of filler material is also an important factor in determining the gas transport properties of the mixed matrix membrane. High filler loading would provide higher penetrant-filler interaction with increase separation properties, but leads to particles agglomeration, directly reflect on membrane production cost and deteriorating its performance. In contrast, incorporating small amount of filler give irrelevant improvement on membrane separation properties, but highly unlikely for particles to agglomerate. Lowest filler loading with considerable improvement of membrane performance would be the ideal MMM [13] [5].

CO_2 has a smaller kinetic diameter 0.33 nm compared to CH_4 gas, and much upper critical temperature compared to N_2 and CH_4 as shown in above table-2. The lesser kinetic diameter and prominent critical temperature (higher condensability) of CO_2 support in higher diffusion rate and solubility coefficients and hence higher permeability compared to N_2 and CH_4.

Polyethersulfone (PES) was used for membrane preparation which is a commercial polymer provided by Solvay. It is commercially attractive due to its high chemical resistance, thermal degradation and stability to oxygen. The glass transition temperature (Tg) and weight average molecular weight of the polymer (PES) are 220^0C and 53,000, respectively [14].

Its gas transport properties lie near the upper bound line on the middle region of Robeson's plot for attractive gas pairs like CO_2/CH_4, H_2/CH_4. Dimethylformamide (DMF) was used as solvent due to its strong dissolving power for many components. It has the chemical formula of C_3H_3ON, and boiling point of 153^0C [15].

In order to develop high performance MMM at low to moderate filler loading, nano filler with good polymer-filler interaction is necessary. Thus, this study intend to utilize synthesized nano sized ZIF-8 as a filler to prepare mixed matrix membrane and study the influence of ZIF-8 loading on performance of gas separation. Typically the a lot of research focused on development of ZIF-8-MMM dense membrane, but the purpose of this study was to preparation of asymmetric MMM using solvent evaporation method at varied filler percentage loading of ZIF-8 to analyse the performance of CO_2/CH_4 separation.

II. EXPERIMENTAL

A. Materials: Zinc nitrate hexahydrate [$Zn(NO_3)_2.6H_2O$], methanol were obtained from Fisher Scientific and 2-methylimidazole [$C_4H_6N_2$] was obtained from Sigma-Aldrich (India). Polyethersulfone (PES) [Radel A-100 grade] provided by Solvay. Polydimethylsiloxane (PDMS) was obtained from Sigma Aldrich and n-hexane and Dimethyl formamide (DMF) were purchased from Merk. Deionized water was obtained from Thomas Baker. All chemicals were used as received without any further purification.

B. *ZIF-8 Synthesis:* The ZIF-8 crystals were synthesized [16] [17] by the room temperature synthesis method [9] with some modifications with the help of methanol and de-ionized water. In this method a solution of 3 gm of [$Zn(NO_3)_2.6H_2O$] added in 100 ml of methanol and other solution of 6.6 gm of 2-methylimidazole added in 100 ml of methanol were prepared and then mixed with each other under vigorous stirring for one hour at room temperature. After stirring, the resulting ZIF-8 crystals were separated by centrifugation at around 10000 rpm for 10-12 minutes, followed by washing with methanol two to three times and dried under vacuum at 45^0C for four to five hours and stored dry for further analysis and use. Similarly, ZIF-8 synthesized by via de-ionized water with accurate proportion of Zinc Nitrate Hexahydrate (1.17gm) and 2-methylimidazol (22.7gm) was dissolved in 88ml de-ionized water. Synthesis methodology applied for ZIF-8 crystals is previously studied in our work [13].

C. **Membrane Preparation Methodology:** The morphology and the transport properties of mixed matrix membranes are strongly related to the types of polymer, solvent, filler material and the additives used in fabrication [18]. Solvent-evaporation method was used for preparation of the membranes. PES and ZIF-8 were dried at 80^0C and 180^0C overnight before using in the membrane synthesis. Two different types of membranes were prepared in this study, pure PES, PES/ZIF-8 with different ZIF-8. PES concentration in DMF, 20 w/v %, was kept constant for all membranes.

Asymmetric flat sheet neat membrane was prepared by casting solution consisted of Polyethersulfone (PES)

and DMF. Overnight dried PES was added into the solvent DMF step by step in order to prevent a sudden increase in the viscosity of solution and ease of stirring. Then, the solution was stirred for overnight by a magnetic stirrer. Casting process was performed by hand-casting at ambient atmosphere. Asymmetric flat sheet MMM was prepared by overnight dried ZIF-8 was dispersed in the solvent DMF in three or four steps according to the amount of ZIF-8. Between each two steps, the solution was ultrasonicated for 20 to 30 min in order to ease the dispersion and minimize the agglomeration of ZIF-8 particles in the solution. After completing the ZIF-8 addition, PES was primed by adding 15 wt % of the total amount so as to increase the compatibility between ZIF-8 and PES and the solution was stirred for overnight by a magnetic stirrer. Then, remaining amount of PES was added to the solution in three or four steps with 20 to 30 minute ultrasonication in between the steps and again the solution was stirred for overnight. While the PES concentration was kept constant, the ZIF-8 contents in the membranes were varied between 10- 30 w/w % and the compositions of prepared membranes [19] [20] [21]. After that, membranes were dip-coated for 10 to 12 minutes in 2wt% PDMS in n-hexane to seal possible pinhole on membrane surface. Then, membrane undergoes "curing" at 50°C overnight.

III. THEORY

Gas permeation tests were performed with a designed membrane permeation cell by using carbon dioxide (CO_2), and methane (CH_4). Circular membrane discs with an effective permeation area of 7.069 cm^2 were used. Feed pressure was maintained at 3 bar while permeate side was opened to atmosphere. Permeability 'P' of 1 barrer corresponding to 10^{-10} related to cubic centimetres per second (volume at STP) was calculated by using following equation:

$$\text{Pemeability (Pi)} = \frac{\text{Gas flow rate (Vi)} \times \text{Membrane thickness (l)}}{\text{Area (A)} \times \text{Pressure drop } (\Delta p)} \quad --(1)$$

Where 'i' represent the gas component i, Vi is gas volume permeated through the membrane (cm^3, STP), 'A' the effective membrane area (cm^2), 't' is the time of permeation (s) and 'Δp' is the transmembrane pressure drop (cmHg) [10]. The unit of permeability usually is Barrer, where,

$$\text{Barrer} = 1 \times 10^{-10} \frac{cm^3\ (STP)\ cm}{cm^2\ s\ cmHg} \quad --(2)$$

Selectivity was obtained using Equation (2):

$$\propto_{i/j} = \frac{(y_i/y_j)\text{permeate}}{(x_i/x_j)\text{feed}} \quad --(2)$$

Where, x_i and y_i are mole fractions of component 'i' in the gas mixture in the feed and permeate sides respectively.

IV. RESULTS AND DISCUSSION

The X -Ray Diffractometer (XRD) [9], [19] were used to confirm the phase purity of ZIF-8 and results found in our earlier literature [13]. XRD is a non destructive analysis to measure wavelength of sample and to identify structure. The XRD will release X-rays to the sample and the X-Rays diffracted at different angles and intensity by CuKa irradiation with a wavelength (λ) 1.54 A^0 at room temperature. The schematic graphical representation of synthesized ZIF-8 crystalline powder by room temperature synthesis method and synthesis procedure of ZIF-8 crystals [15] by using de-ionized water and by using methanol has been studied in our earlier work [13].

The single gas permeability's of pure PES and PES/ZIF-8 MMM are presented together in figure-1 and shows that, the single gas permeability of the PES/ZIF-8 MMMs are increasing with increasing ZIF-8 loadings. Especially, with the addition of 30 w/w % and higher ZIF-8 nano-crystals, the raise in the permeability was very strong and the highest increase was in the permeability of CH_4. In literature, there are similar increasing permeability trends with increasing loadings of nano-size filler materials. However, for the higher percentage of ZIF-8 nano-crystals, the gas permeability's were reduced. This trend was claimed as the result of reduction in the amount of polymer for gas transport, increase in the diffusion path length for the gas penetrants, and reducing free volume in the membrane due to increasing density. The increase observed in the permeability values with increasing ZIF-8 loading may be due to the enhanced free volume and ZIF-8 –polymer interfaces that the gas molecules can cross through the membrane.

The selectivity's of the PES/ZIF-8 MMM for CO_2/CH_4 gas pair are represented in table-3. The incorporation of ZIF-8 at low loadings (□ 30 w/w %) improved the performance of the membranes. By the addition of 10 w/w % ZIF-8 into polymer, increased the permeability performance about two times for gases CO_2 and CH_4, while the ideal selectivity for CO_2/CH_4 gas pair showed a slight loss (~14 to 17%). The increase in the permeability's was about 3 to 4 times while the loss in selectivity's for CO_2/CH_4, gas pairs was about approximately 16 % compared to results of pure PES membrane.

For the higher ZIF-8 loadings (≥ 30 w/w %), while the permeability's are increasing, the ideal selectivity's started to reduce very rapidly. Since the most sensible increase in permeability's were observed in CH_4 but the selectivity decreased CO_2/CH_4 for all membranes. In general the ideal selectivity's are improved with the addition of filler into glassy polymers up to 25% and 30% loadings [22].

TABLE 3
PERMEABILITY AND SELECTIVITY OF NEAT PES AND PES/ZIF-8 AT 10, 20, 30 % LOADING PERCENTAGE

Membrane Type	Permeability (Barrer)		Selectivity CO_2 / CH_4
	CO_2	CH_4 x10	
Neat PES	4.4	2.4	35.6
10% ZIF-8	8.6	3.2	30.8
20% ZIF-8	14.7	6.6	29.6
30% ZIF-8	23.8	16.8	23.3

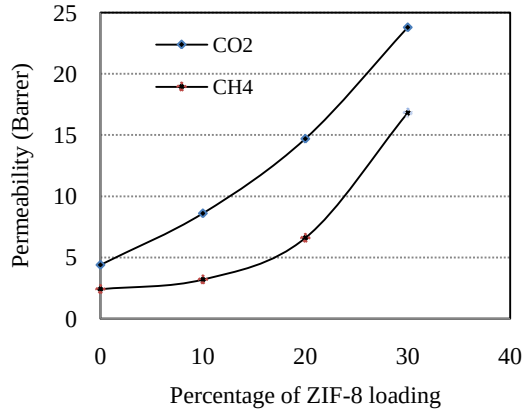

Fig.1. Effect of percentage ZIF-8 loading on single gas Permabilities of PES–ZIF-8 MMM at 3 bar 30^0C

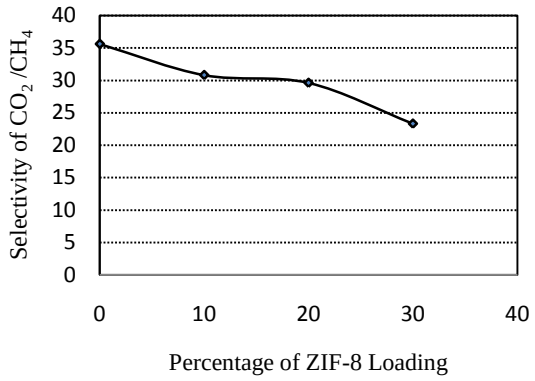

Fig.2. Effect of percentage ZIF-8 loading on selectivity CO_2/CH_4 of PES–ZIF-8 MMM at 3 bar 30^0C.

V. CONCLUSION

The incorporation of synthesized ZIF-8 crystals into continuous PES matrix resulted in high performance gas separation membranes at good dispersion of fillers and high improvement of permabilities with considerable ideal selectivity. The permeability of gases increased with ZIF-8 loading, while the ideal selectivity showed a slight decrease compared to neat PES membrane. The addition of 20 to 25 w/w % ZIF-8 was selected as optimum filler loading for membrane formulation considering the permeation performances at 3 bar pressure. For all types of membranes used, the feed pressure is the other important parameter appreciably affected the separation performances for gas pair. Thus, the MMM prepared with moderate nano-filler loading shows that there will be great potential to be further improvement and various applications in the gas and vapour separation.

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REFERENCES

[1] R.W. Baker, "Membrane Technology and Applications", 2nd ed., John Wiley & Sons, 2006.

[2] Guangxi Dong, Hongyu Li, and Vicki Chen, "Challenges and Opportunities for Mixed Matrix Membranes for Gas Separation," Journal of Materials Chemistry-A, vol. 1, pp. 4610-4630, Jan. 2013, doi: 10.1039/c3ta00927k.

[3] Vajiheh Nafisi, and May-Britt Hagg, "Development of Dual Layer of ZIF-8/ PEBAX-2533 Mixed Matrix Membrane for CO_2 Capture," Journal of Membrane Science, vol. 459, pp. 244-255, Feb. 2014.

[4] Zee Ying Yeo, Pei Yee Tan, Siang-Piao Chai, Peng Wei Zhu, and Abdul Rahman Mohamed,"Continuous Polycrystalline ZIF-8 Membrane Supported on CO_2 -Selective Mixed Matrix Supports for CO_2/CH_4 Separation," RSC Adv., vol. 4, pp. 52461–52466, Oct. 2014, doi: 10.1039/c4ra09547b.

[5] P.S. Goh, A.F. Ismail, S.M. Sanip, B.C. Ng, and M. Aziz, "Review-Recent Advances of Inorganic Fillers in Mixed Matrix Membrane for Gas Separation," Separation and Purification Tech., vol. 81, pp. 243-264, Aug. 2011.

[6] Jianfeng Yao and Huanting Wang, "Zeolitic Imidazolate Framework Composite Membranes and Thin Films: Synthesis and Applications," Chem. Soc. Rev., vol. 43, pp. 4470-4493, March 2014.

[7] Ying Dai, J.R. Johnson, Oguz Karvan, David S.Sholl, and W.J. Koros, "Ultem/ Zif-8 Mixed Matrix Hollow Fiber Membranes for Co_2/N_2 Separations,"Journal of Membrane Science, vol 401-402, pp. 76-82, 2012.

[8] Omid Bakhtiari, Samira Mosleh, Tayebeh Khosravi and Toraj Mohammadi, "Preparation, Characterization and Gas Permeation of Polyimide Mixed Matrix Membranes," Jour. Membrane Science and Technology, vol. 1 no. 1, pp. 1-8, 2011, doi:10.4172/2155-9589.1000101.

[9] Kyo Sung Park, Zheng Ni, Adrien P. Cote, Jae Yong Choi, Rudan Huang, Fernando J. Uribe-Romo, Hee K. Chae, Michael O Keeffe, and Omar M. Yaghi, "Exceptional Chemical and Thermal Stability of Zeolitic Imidazolate Frameworks," PNAS, vol. 103, no.27, 10186–10191, 2006, doi/10.1073/ pnas.0602439103.

[10] Harold B. Tanh Jeazet, Claudia Staudt, and Christoph Janiak, "Metal–Organic Frameworks in Mixed-Matrix Membranes for Gas Separation," Dalton Trans, vol. 41, pp. 14003-14027, 2012, doi: 10.1039/c2dt31550e.

[11] John P. Ferraris, Inga H. Musselman, and Kenneth J. Balkus Jr., "Mixed Matrix Membranes Based on Metal Organic Frameworks," Advanced Materials for Membrane Preparation, Bentham Science Publishers, pp. 83-93, 2012.

[12] Binling Chen, Zhuxian Yang, Yanqiu Zhu, and Yongde Xia, "Zeolitic Imidazolate Framework Materials: Recent Progress in Synthesis and Applications," J. Mater. Chem. A, vol. 2, pp. 16811–16831, 2014, doi: 10.1039/c4ta02984d.

[13] R.M. Abhang, K.S. Wani, V.S. Patil, "Synthesis and Characterization of ZIF-8 Filler for Preparation of Mixed Matrix Membrane" International Journal of Scientific & Engineering Research, Vol.6,(8), ISSN 2229-5518, 2015.

[14] Helen Julian, I.G. Wenten, "Polysulfone membrane for CO_2/CH_4 separation: State of the art", IOSR Journal of Engineering ", Vol.2 (3), pp. 484-495, 2012.
[15] Asim Mushtaq, Hilmi Bin Mukhtar, and Azmi Mohd Shariff," Blending Behavior of Polymeric Materials and Amines in Different Solvents" International Journal of Chemical Engineering and Applications, Vol. 5, No. 2, 2014.
[16] Qilei Song, S.K. Nataraj, Mina V. Roussenova, Jin Chong Tan, David J. Hughes, Wei LI, Pierre Bourgoin, M. Ashraf Alam, Anthony K. Cheetham, Shaheen A. Al-Muhtaseb, and Easan Sivaniah, "Zeolitic Imidazolate Framework (ZIF-8) based Polymer Nanocomposite Membranes for Gas Separation," Energy Environ. Sci., vol. 5, pp. 8359- 8369, 2012.
[17] Anh Phan, Christian J. Doonan, Fernando J. Uribe-Rromo, Carolyn B. Knobler, Michael O'Keeffe, and Omar M. Yaghi, "Synthesis, Structure, and Carbon Dioxide Capture Properties of Zeolitic Imidazolate Frameworks," Accounts of Chemical Research, vol. 43 no. 1, pp. 58-67, 2010.
[18] Iqbal Ahmed, Zainal Abidin Mohd Yusof, M.D.H, Beg, "Fabrication of Polymer Based Mix Matrix Membrane - A Short Review", International Journal of Basic & Applied Sciences IJBAS-IJENS, Vol.10 (2), pp 14-19, 2010.
[19] Joshua A. Thompson, Karena W. Chapman, William J. Koros, Christopher W. Jones, and Sankar Nair, "Sonication – Indusced Ostwald Ripening of ZIF-8 Nanoparticles and Formation of ZIF-8/ Polymer Composite Membranes," Microporus and mesoporous Materials, vol. 158, pp. 292-299, 2012.
[20] M.A. Aroon, A.F. Ismail, T. Matsuura, and M.M. Montazer-Rahmati, "Performance Studies of Mixed Matrix Membranes for Gas Separation: A Review," Separation and Purification Technology, vol. 75, pp. 229–242, 2010.
[21] R.M. Abhang, K.S. Wani, V.S. Patil, "Advancement and Prospective of MOF and ZIF as Filler In Mixed Matrix Membrane For CO_2/N_2 Separation - A Review" Cyber Times International Journal of Technology & Management Vol. 7 (2), 2014.
[22] Anja Car, Chrtomir Stropnik, Klaus- Viktor Peinemann, "Hybrid membrane material with different metal- organic framework (MOFs) for gas separation", desalination, Vol. 200, Pp 424-426, 2006.

Experimental investigation of effect of acid and base catalysts on synthesis of Castor (*Ricinus communis*) oil biodiesel

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Abstract: Due to increase in demand of petroleum products, the prices of petrol and diesel are increasing all over the world. As the available resources of fossil fuel are depleting at faster rate and by 2025 ,the world may face a severe crisis of petroleum fuels, hence an alternative sources of energy to replace fossil fuels are being explored world wide.Biodiesel is one of the promising biofuels and an alternative for fossil fuels as a primary energy source for machineries and vehicles. It is defined as the mono alkyl ester of vegetables oils or animal fats. Due to its technical feasibility and non polluting characteristics, biodiesel is gaining acceptance in steadily growing numbers of countries around the world. Biodiesel is biodegradable, nontoxic, and essentially free of sulfur and aromatics. In this work, experimental investigation has been carried out to produce methyl ester fuels based on non edible oils like castor oil by using different catalysts like NaOH and H_2SO_4.

The parameters such as temperature, residence time has significant effect on yield of biodiesel and physical properties like Viscosity, Specific gravity, Acid value. In this research the effect of acid and base catalysts was studied on yield of biodiesel and physical properties like viscosity, Specific gravity, Acid value

Keywords: Biodiesel, Methyl esters, catalyst

INTRODUCTION

Since human civilization, the most fundamental requirement for human existence is the use of "energy" for various purposes which can easily be facilitated by solar energy, wind energy, hydropower, fossil fuels and so on, but the major source of energy is fossil fuels (petrol, diesel, kerosene, etc) which are mostly used in different sectors. Fossil fuels are vastly used in industrial, agricultural, automobiles, commercial and household purpose. The consumption of fossil fuels has increased to a great level (Rafaat et al. 2008). The total consumption of fossil fuels globally is more than 10 million tons per day.

The concerns over increasing fuel prices and scarcity of supply have promoted interest in the development of alternative source to petroleum fuels. Biodiesel extracted from vegetable oil is one such renewable alternative under consideration nowadays. The production of biodiesel would be cheap as it could be extracted from non-edible oil sources. Biodiesel has been defined as a mono-alkyl ester of vegetable oil or animal fats (Knothe, 2005). These resources of vegetable oil can be re-grown and their supply can be considered infinite as compared to crude oil that is limited. Alternative oilseeds such as Jatropha oil, cottonseed oil, Karanja oil etc, are being investigated as biodiesel feedstocks. Castor (*Ricinus communis L.*) is one of the most promising non-edible oil crops, due to its high annual seed production and yield. Castor can be grown on marginal land and in

semi-arid climate. Still, few studies are available regarding its fuel-related properties in its pure form or as a blend with petrodiesel, many of which are due to its extremely high content of ricinoleic acid.

Biodiesel is produced through a refinery process called transesterification reaction of vegetable oils and animal fat. This process is a reaction of the oil with an alcohol to remove the glycerin, which is a by-product of biodiesel production. In this study, the technical feasibility of Castor oil biodiesel was tested and the specifications in ASTM D6751 which are related to the fatty acid composition of pure castor methyl esters (B100) and its blend with petrodiesel in a 10% vol ratio (B10) were investigated. Distillation temperature and Kinematic viscosity of B100 (397 °C and 15.11 $mm^2 s^{-1}$ respectively) were the only two properties which did not meet the desired standard limits. In contrast, B10 met all the specifications.

Most of the researchers use edible oils such as soybean oil and corn oil to produce biodiesel. But the prices of edible oils keep increasing due to demand for nutritional need. To overcome this issue, castor oil is the best option to make biodiesel because it is easier to plant and costs less than soybean, sunflower or other seeds. Castor oil is a triglyceride of various fatty acids and about 10% glycerine. The fatty acids contains approximately 80–90% ricinoleic acid, 3–6% linoleic acid, 2–4% oleic acid and 1–5% saturated fatty acids (Pazir and Muhammad, 1991).

The catalyst plays an important role in production of biodiesel. Usually in transesterification of oils or fats homogeneous catalysts are used but it causes production of wastewater from washing process of catalyst residues and catalyst cannot be reused. Therefore, the development of heterogeneous solid catalyst has recently gained much attention on view of separation and does not produce soap. The solid catalyst is not dissolved in the reaction and it can be easily separated from products and also can be regenerated and reused and it is environmental friendly.

This research is about the production of biodiesel from castor oil using optimum catalyst concentration to get the maximum yield of biodiesel.

Materials and methods:

Basically there are three basic routes to biodiesel production from oils and fats that is:

(a) Base catalyzed transesterification of the oil,

(b) Direct acid catalyzed transesterification of the oil, and

(c) Conversion of the oil to its fatty acids and then to biodiesel.

Most of the biodiesel produced today is done with the base catalyzed reaction because it is low temperature and pressure; it yields high conversion (98%) with minimal side reactions and reaction time (Anonymous, 2007).

Literature survey on the topic reveals that different studies have been carried out using different alcohols such as methanol, ethanol, propanol, butanol and amyl alcohol for biodiesel synthesis by transesterification reaction. Methanol and ethanol are used most frequently.Ethanol is a favored alcohol in the transesterification process compared to methanol because it is derived from agricultural products and is renewable, however methanol is the most commonly used alcohol because of its low cost and its physical and chemical advantages associated with being polar and the shortest chain alcohol. The reaction time is shorter in the methanolysis because of the physical and chemical properties of methanol.

Castor (Ricinus communis L.) is an important non-edible oilseed crop and is grown especially in arid and semi arid region[6] . It is cultivated around the world because of the commercial importance of its oil. India is the world's largest producer of castor seed and meets most of the global demand for castor oil[5] . India produces 8 to 8.5 lakh tonnes of castor seed annually, and accounting for more than 60% of the entire global production. Because of its limitless industrial applications, castor oil enjoys incredible demand world-wide. The current consumption of castor oil and its derivatives in the domestic market is estimated at about 300,000 tonnes.

Experimental Setup:

Reactor used for carrying out the transesterification reaction, consists of three necked flasks. In assembly of three necked flask central neck is used for stirrer, while other two necks were used for thermometer and condenser as shown in above figure-1. Thermometer was used to record the temperature. The temperature of reaction mixture was maintained constant throughout the complete length of experiment by placing reactor in constant temp bath.

Catalysts used for the production of biodiesel are sulfuric acid and sodium hydroxide. Different runs were carried out for these catalysts by varying the residence time , oil to methanol ratio and reaction temperature.

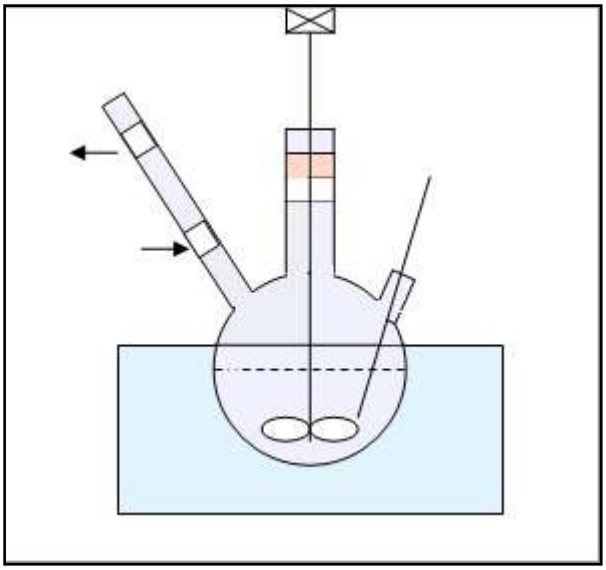


Fig. 1 Biodiesel synthesis-Experimental setup

Effect of residence time:

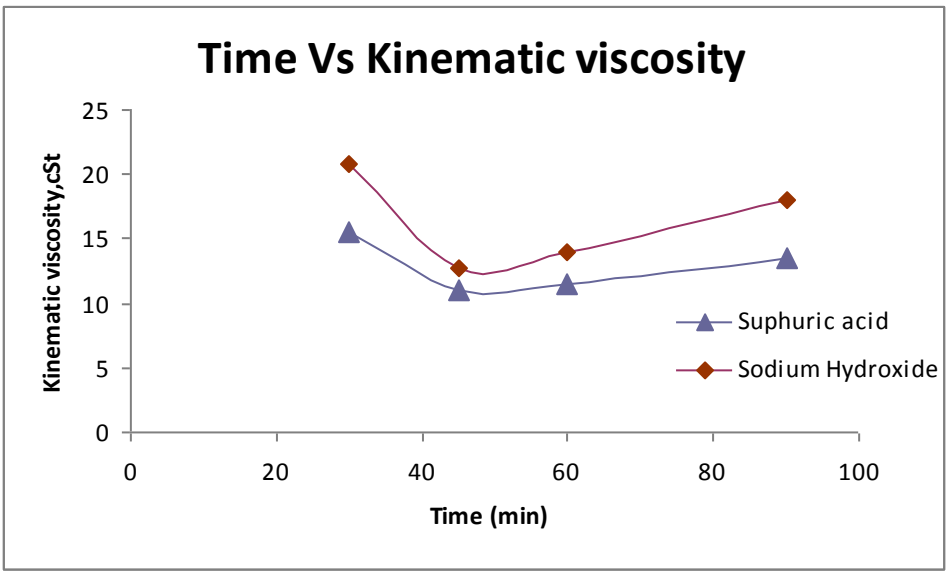
Various runs were carried out for acid and base catalysts in the batch reactor by varying residence time from 30 minute to 90 minutes as shown in the table-1.

Experimental runs were carried out at residence times of 30min,45 min,60min and 90 min. It was found that at the lowest residence time 30 minute the biodiesel viscosity was higher in both the catalysts. As the residence time in the batch reactor was increased further to 45 minute the viscosity decreased from 16.56 to 11.28cSt for sulfuric acid as catalyst. Further increase in residence time to

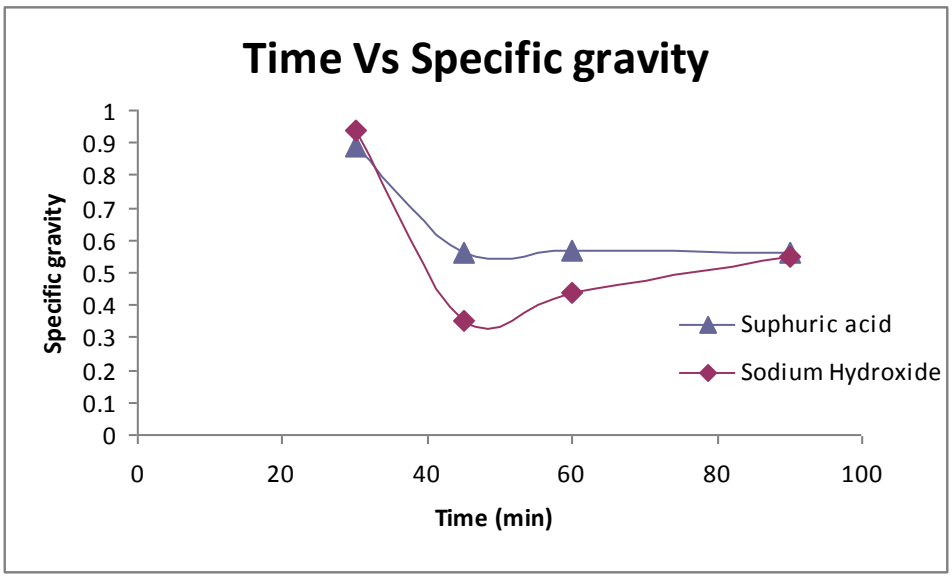
90 minutes the viscosity again increases from 11.28 to 13.93 cSt. Same trend of viscosity was followed by base catalysts i.e sodium hydroxide that is from the above data one may conclude at 45 minutes residence time biodiesel gave lowest viscosity 11.28cSt, 13.10cSt,for sulfuric acid, sodium hydroxide, catalysts respectively. This seems to be the optimum time under the experimental condition studied. Runs for sulfuric acid catalyst are carried out at 55^0C with 3volume% as catalyst concentration. Whereas runs for sodium hydroxide catalysts were carried out at 30^0C with 1wt% of catalyst concentration. The variation of density with residence time appears a follow similar trend as that of viscosity for all the catalysts. That is specific gravity decrease from 0.9108 to 0.9009 as residence time is increased from 30 to 45 minutes, further increase in residence time from 60 to 90 minutes the specific gravity increases 0.9012 to 0.9052 for sulfuric acid as a catalyst. Specific gravity for sodium hydroxide catalyst decrease from 0.9106 to 0.8892 as residence time is increased from 30 to 45 minutes, further increase in residence time from 60to 90 minutes the specific gravity increases 0.9016 to 0.9039. Similar observations were made with regard to acid value at 45 minute residence time in both the catalysts gives lowest acid value.

Table-1 Effect of residence time on parameters such as viscosity, specific gravity and acid value

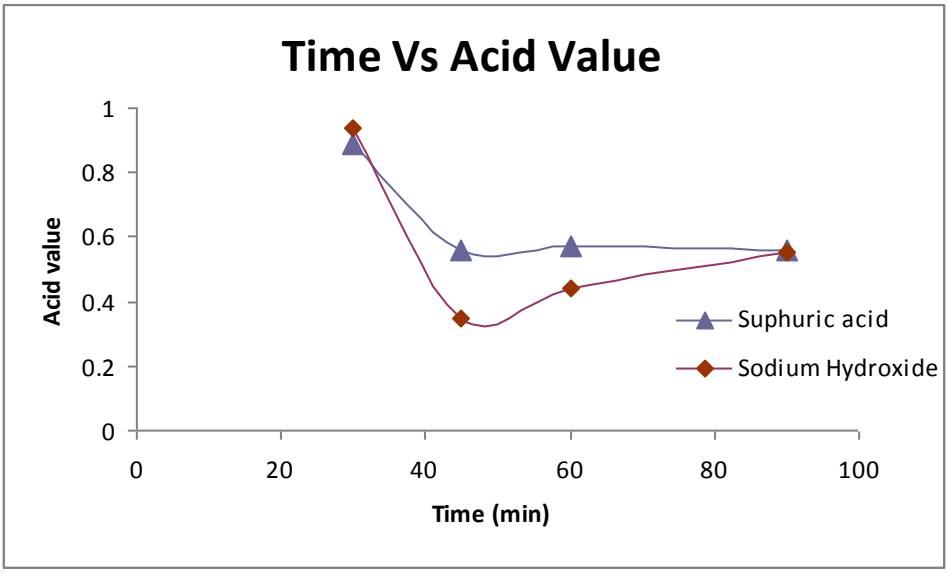
Time of experimental run(min.)	30	45	60	90
Kinematic Viscosity (cSt) for Sulphuric acid as a Catalyst	15.50	11.10	11.44	13.55
Kinematic Viscosity (cSt) for Sodium hydroxide as a Catalyst	20.88	12.80	13.90	18.00
Specific gravity for Sulphuric acid as a Catalyst	0.9018	0.9001	0.9040	0.9022
Specific gravity for Sodium hydroxide as a Catalyst	0.911	0.890	0.9050	0.9048
Acid value for Sulphuric acid as a Catalyst	0.89	0.56	0.57	0.56
Acid value for Sodium hydroxide as a Catalyst	0.94	0.35	0.44	0.55



Graph-1 Variation of Kinematic Viscosity Vs Time



Graph-2 Variation of Specific gravity vs Time



Graph-3 Variation of Acid value vs Time

Oil to methanol mole ratio:

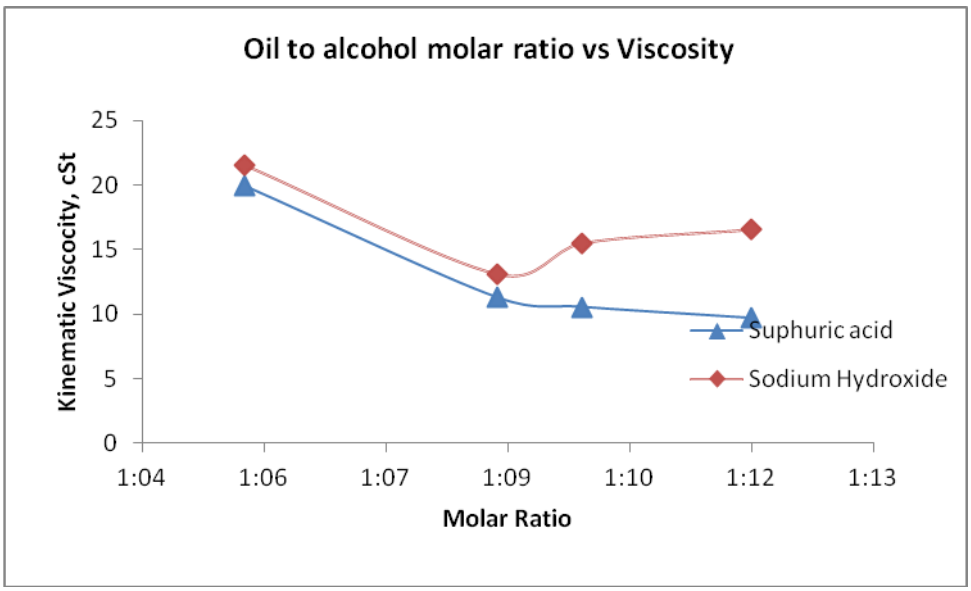
It is observed that for sulfuric acid catalyst with increasing oil to methanol molar ratio from 1:6 to 1:15, biodiesel product viscosity decreases from 19.96 cSt to 6.63cSt. And that for sodium hydroxide catalysts, oil to alcohol ratio is increases 1:6 to 1:9 mole ratios the product viscosity decreased from 15.68 to 13.10 cSt,. Further increase oil to alcohol ratio that is 1:12 two layers are not formed. Probably there may not be any reaction at this higher oil to alcohol ratio in both catalysts. While Sp. gravity for sulfuric acid catalyst decreases from 0.9023 to 0.9006 when oil to methanol molar ratio increases from 1:6 to 1:12 (oil to methanol) and then increases further from 0.9009 to 0.9015 as oil to methanol molar ratio increases to 1:15. Specific gravity for sodium hydroxide also follows a similar change at oil to alcohol ratio 1:9 the specific gravity of biodiesel layer is found to be lowest 0.8892 for sodium hydroxide. From the above discussion it appears oilto alcohol ratio 1:9 and residence time of 45 minutes is optimum the parameters for biodiesel production using sodium hydroxide as catalysts. Whereas 1:10 molar ratio is optimum for biodiesel production using sulfuric acid as a catalyst.

Effect of oil to methanol mole ratio on viscosity, specific gravity, acid vale and sap. Value

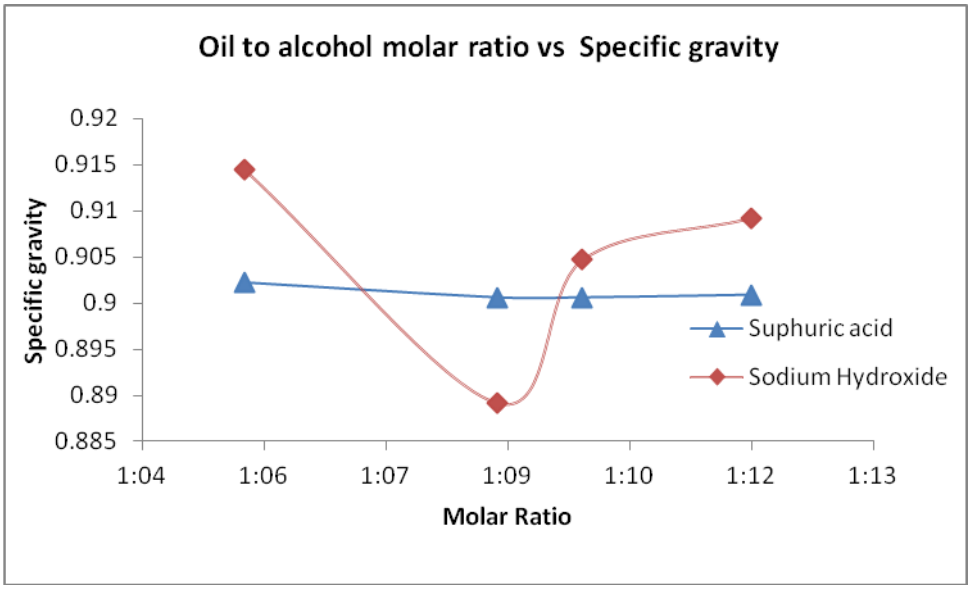
Table-2

Oil to alcohol mole ratio	1:06	1:09	1:10	1:12	1:15
Kinematic viscosity,(Cst)for sulphuric acid as catalyst	19.96	11.28	10.56	9.7	6.63
Kinematic viscosity,(Cst)for sodium hydroxide as catalyst	21.57	13.1	15.51	16.56	Nil

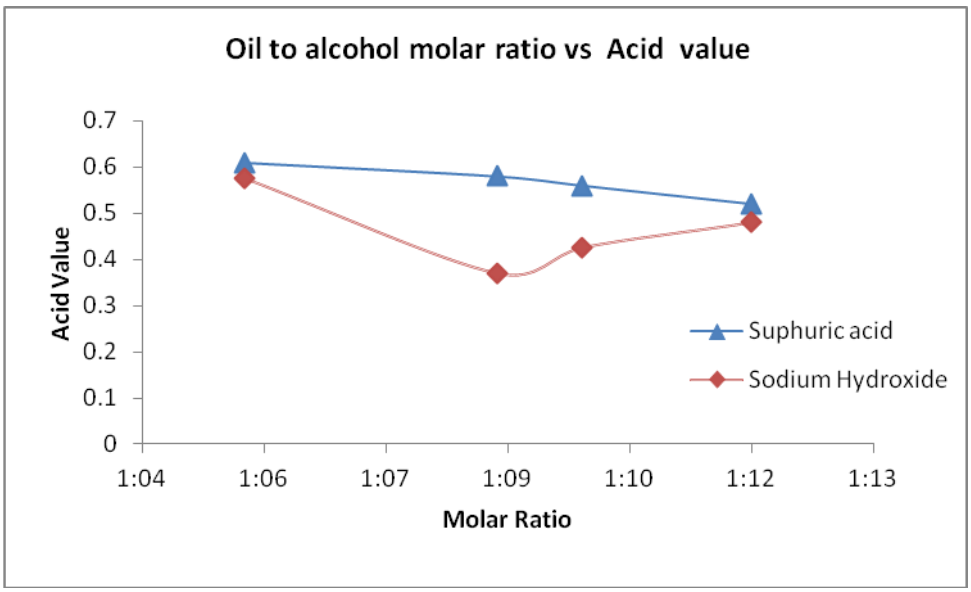
Specific gravity for sulphuric acid as catalyst	0.9023	0.9006	0.9006	0.9009	0.9015
Specific gravity for sodium hydroxide as catalyst	0.9145	0.8892	0.9047	0.9092	Nil
Acid value for sulphuric acid as catalyst	0.61	0.58	0.56	0.52	0.49
Acid value for sodium hydroxide as catalyst	0.576	0.37	0.426	0.48	0.48



Graph-4 Variation of viscosity vs molar ratio



Graph-5 Variation of Specific gravity vs molar ratio



Graph-6 Variation of Acid Value vs molar ratio

Conclusion

Production of biodiesel by transesterification of castor oil has been studied in a batch reactor using different catalysts namely sulfuric acid, sodium hydroxide.

The variables chosen for the study are:

i. Residence time,

ii. Oil to methanol ratio,

iv. Reaction Temperature.

The effects of these variables on the viscosity of biodiesel were studied, since this is one of the important specifications in ASTM standard. Apart from viscosity other properties like sp.gr, acid value, were also determined for the biodiesel product.

The following conclusions were drawn from the study using Sulfuric Acid as catalyst:

As the reaction time increases from 30min to 45 min it was found that viscosity decreased from 16.56cSt to 11.28cSt and, then viscosity increases,further with increasing time. Hence optimum reaction time was found to be 45min.Oil to methanol ratio was varied from 1:6 to 1:18 molar ratio. It was found that viscosity of biodiesel decreases with increasing molar ratio in above range of oil to methanol ratio. At 1:15 oil to methanol ratio biodiesel viscosity was found to be lowest 6.63cSt, whereas according to ASTM specifications the viscosity of the biodiesel should be in the range from 1.9cSt to 6cSt.Thus the viscosity obtained experiments is slightly higher than ASTM range. The reaction temperature in batch reactor was varied from 30-55 ^{o}C keeping other operating conditions constant such as reaction time 45min, cat conc. 3 volume % of H2SO4, and oil to methanol mole ratio 1:9.it was observed that viscosity decreases with increasing temp. The optimum temperature was found to be 55 ^{o}C which gave lowest viscosity of biodiesel as 11.28 cSt. But at 1:15 molar ratio, viscosity was 6.63cSt.

The following conclusions were drawn from the study using Sodium Hydroxide as a catalyst:

As the reaction time increases from 30min to 45 min using sodium hydroxide as a catalyst, it was found that viscosity decreased from 21.57cSt to 13.10cSt and further, viscosity increases with increasing time. Hence optimum reaction time was found to be 45min. Oil to methanol ratio was varied from 1:6 to 1:12 molar ratio for sodium hydroxide as a catalyst. It was found that viscosity decreases in the above range of oil to methanol ratio. At 1:9 oil to methanol ratio biodiesel viscosity was found to be 13.10cSt. The reaction temperature in a batch reactor was varied from 30-50 ^{o}C keeping other operating conditions constant such as reaction time 45 min, cat conc. 1wt% sodium hydroxide and oil to methanol mole ratio 1:9. It was observed that viscosity increases with increasing temp. The optimum temperature was found to be 30 ^{o}C which gave lowest viscosity of biodiesel as 13.10 cSt.

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The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression, “One of us (R.B.G.) thanks . . .” Instead, try

"R.B.G. thanks". Put applicable sponsor acknowledgments here; DO NOT place them on the first page of your paper or as a footnote.

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical statement: The authors declare that they have followed ethical responsibilities

REFERENCES

[1]. The biodiesel hand Book, By Gerhard Knothe, AOCS, Champaign, Illinois, 1, 12-14 (2004)

[2].Carmen Leonor Barajas Forero, Biodiesel from castoroil: a promising fuel for cold weather, clabarajas@bari.ufps.edu.co, (2006)

[3].Perin G., Alvaro G., Westphal E., Vaina L.H., JacobR.G., Lenardao E.J. and D'Oca M.G.M., Transesterificationof castor oil assisted by microwave irradiation, Fuel, 87, 2838-2841 (2008)

[4]. Zieba A., Transesterification of castor oil as a method of biodiesel production, nczieba@cyf-kr.edu.pl (2007)

[5]. Ogunniyi D.S., Castor oil: A vital industrial raw material (2007)

[6]. Report submitted by National Multi-Commodity Exchange Of India Limited (2009)

[7]. Marta M. Conceicao, Roberlucia A. Candeia, FernandoC. Silva, Aline F. Bezerra, Valter J. Fernandes Jr. Antonio G. Souza, Thermoanalytical characterization of castor oil biodiesel, Renewable and sustainable Energy Reviews, 11, 64-975 (2007)

[8].Volkhard Scholz, Jadir Nogueira da Silva, Prospectsand risks of the use of castor oil as fuel, Biomass and Bioenergy, 32, 95-100, (2008)

[9]. Lindon Robert Lee et.al, Biodiesel production fromJatropha oil and its characterization, Res. J. Chem. Sci., 1(1), 81-87 (2011)

[10]. Linus N. Okoro et.al Synthesis, Calorimetric and Viscometric Study of Groundnut oil Biodiesel and Blends, Res. J. Chem. Sci.,1(3), 49-57 (2011)

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Optimization of Distillation Column

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Abstract:The overview of the main advances in distillation column its sequence optimization in zeotropic systems, ranging from systems, using only in conventional columns, each with a condenser and a reboiler, to fully thermally coupled systems with a single reboiler and a single condenser in the entire sequence. We also review the rigorous design of distillation columns, or column sequences. Various optimization tools along with energy aspect are also discussed.

Keywords:distillation, column sequencing, energy, tools

I. INTRODUCTION

The Unit operation Distillation is the most important operation for purification and separation in chemical process industries. In order to get an idea of the importance of distillation. Industrially, vapour and liquid phases are found to coexist most commonly, although liquid-liquid, vapor-solid, and liquid-solid systems are also found. This work deals with vapor and liquid in equilibrium with each other. Equilibrium is a static condition in which no changes occur in the macroscopic properties of a system with time. Vapor–liquid equilibrium (VLE) is a condition in which a liquid and its vapor (gas phase) are in equilibrium with each other, in other words, a condition where the rate of evaporationequals the rate of condensation [1]. Reducing the energy consumption is not as easy as it seems to be. The columns have different configurations with different objectives. [2] The schematic of the process is shown in Figure 1.

II. Optimization Tools

Simulation & control studies are widely in practice for batch and continuous chemical process operations for last two decades[3,4,5].Optimization techniques have been applied to problems of industrial importance ever since the late 1940s. Distillationprocesses are most essential unit operations in chemical engineering. They are of significant importance as separation methods in chemical and petroleum industries. Chemical and petroleum industries hold a significant share in the overall world economy.Distillation processes have huge maintenance and running cost that can be greater than the overall cost of many other processes.Therefore, there should be an effective a reliable control system for efficient and safe operation of a distillation column. Itpresents various challenging control problems. Distillation columns are highly multivariable and shows non-linear behaviour.Therefore, their control is not a trivial task

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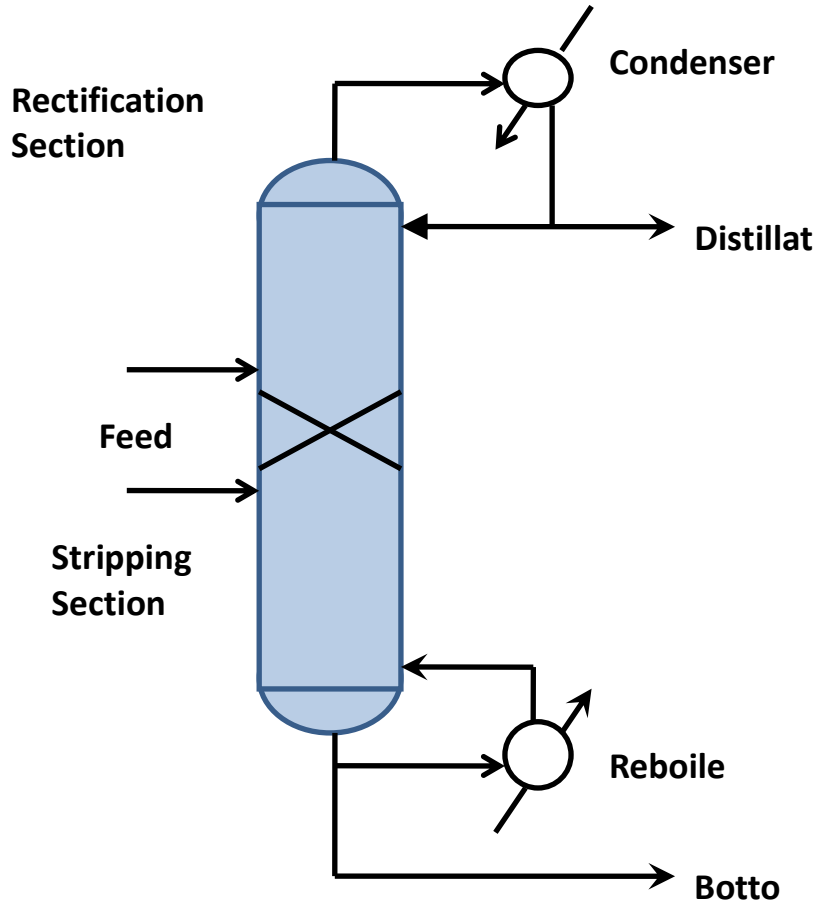

Figure 1: The schematic of the process

A.Mixed-Integer Non Linear Programming (MINLP)

The most common form of MINLP problems is the special case in which 0-1 variables are linear while the continuous variables are nonlinear, a new application of the case-based reasoning method for finding a MINLP model with superstructure and a solution of the corresponding distillation synthesis problem by suggesting an initial point for performing design and optimization of the system. When solving a new problem, the most similar case to the target is found in the case library during the retrieval process in two steps: (i) first, a set of matching

cases is retrieved, using inductive retrieval; (ii) the cases in the retrieved set then are ranked according to their similarity to the target case, using the nearest-neighborhood method.[6]

B.Generalized Disjunctive Programming

An alternative approach for representing discrete – continuous optimization problems is by using models consisting of algebraic constraints, logic disjunctions and logic propositions. This approach not only facilitates the development of the models by making the formulation intuitive, but it also keeps in the model the underlying logic structure of the problem that can be exploited to find the solution more efficiently the synthesis of distillation column configurations to separate non-azeotropic multicomponent mixtures containing *N* components. It is shown that, for sharp separations of an *N*-component mixture, it is possible to develop a superstructure that takes into account all of the possibilities, from thermally linked systems with only one reboiler and one condenser to sequences with only conventional columns [$2(N-1)$ condensers and reboilers]. All of the partially thermally linked superstructures are included. The superstructure is systematically generated using the state task network (STN) formalism, in which only the tasks that can be performed are specified, but not equipment.[7,8].

C.The Rectification Body Method (RBM)

Proposed by Bausa et al [9] for the determination of minimum energy requirements of a specified split. For a given product, branches of the pinch point curves can be found. Rectification bodies can be constructed by joining points on the branches with straight lines. For either section of a column a rectification body can be constructed. The intersection of the rectification bodies of two sections of a column indicates its feasibility. The RBM can be used to calculate the minimum reflux ratio and minimum energy cost and to test the feasibility of a split. Because faces on rectification bodies are linearly approximated by joining branches of pinch point curves using straight lines, this method cannot guarantee accurate results. No information about column design (number of stages and operating reflux ratio) is obtained. The calculation of pinch point curves is, furthermore, computationally intensive [10].

D.Column Sequencing

Multicomponent mixtures are separated using distillation usually in a number of different sequences, which gives the same products but with different energy demand. Multicomponentmixtures are often separated into extrapure products. Column sequencing is a systematic method to find the optimal column sequence based on ease of operation and energy demand. The screening of design substitutes is carried out within a superstructure framework, which allows the breakdown of the separation sequences into unique separation array. The use of the selected array significantly reduces the work. The individual separation tasks are evaluated using shortcut methods. For the application to azeotropic mixtures, the mixture topology is obtained and feasibility checks are performed for every split. In this context, azeotropes are treated as pseudo components [11,12]. The main aim of doing the column sequencing is to isolate the desired product with high purity. This is achieved by using distillation column in series.

E. Heat integration

In the first step, the target is to minimize the total annual cost of sequences by creating heatintegration among columns. To calculate the temperatures and heat flow rates of condensersand reboilers and find the design specifications of columns such as the actual number of trays,reflux ratio, rectify vapor flow, and etc., all the simple sequences are simulated by shortcut and rigorous method of commercial software. In the second step, the target is to find the possible power generation in all the sequences which can be designed and optimized. This investigation is in theory and is just a feasibility study to find the effects of power generation on the energetic efficiency of process and total annual cost [13]

III. CONCLUSION

The optimization of a distillation renders the increase in profitability at maximum possible energy consumption. The initial emphasis of the optimization work was to arrive at operational changes that could be implemented without substantial plant interruptions or modification, using existing piping and equipment. Many different variables were methodically tested to see the effects on throughput. A theoretical approach to optimization has been alsoaccepted, to find ways to increase throughput without forgoing product quality.

REFERENCES

[1] J.M.Smith, H.C.Van Ness andM.M.Abbott (2005), Chemical Engineering Thermodynamics, Tata McGraw Hill Edition, Special Indian Edition, pp.341-343.
[2] E. J.Henley andJ. D.Seader (1981), Equlibrium –Stage Separation Operations in Chemical Engineering, John Wiely and Sons, (Inc. 1981).
[3] W. L. Luyben (2015) Aspen Dynamics simulation of a middle-vessel batch distillation process, Journal of Process Control. 33 pp. 49-59.
[4] W. L. Luyben (2013) Distillation design and control using Aspen simulation: John Wiley & Sons.
[5] V. D., Talnikar and Y. S Mahajan (2014) Recovery of acids from dilutestreams: A review of process technologies, Kor. J. Chem. Eng. 31, pp. 1720–1731.
[6] B. Borchers and J.E. (1994) Mitchell, An improved branch and bound algorithm for mixed integer nonlinear programs. Computers & Operations Research, 21(4): pp. 359-367.
[7] M. Turkayand I.E. Grossmann (1996) Disjunctive programming techniques for the optimization of process systems with discontinuous investment costs multiple size regions. Industrial & Engineering Chemistry Research,. 35(8): pp. 2611-2623.
[8] J.P Ruiz (2012) Generalized Disjunctive Programming: Solution Strategies Algebraic Modeling Systems , J. Kallrath, Editor, Springer Berlin.
[9] J. Bausa, R. von Watzdorf, and W. Marquardt (1998) Shortcut Methods for Nonideal Multicomponent Distillation: 1. Simple Columns. AIChE Journal, 44(10): pp. 2181-2198.

[10] L. Guilian (2004) Shortcut design for columns separating azeotropic mixtures. . Industrial & Engineering Chemistry Research, 43(14): pp. 3908-3923.
[11] A. Harwardt, S. Kossack and W. Marquardt (2008) Optimal column sequencing for multicomponent mixtures, 18th European symposium on computer Aided Process Engineering – ESCAPE -18.
[12] M. Eszter, E. Matild, K. Kornelia, N. Nandor, F. Jeno and B. Katalin (2009) Utilization of electrodialysis for galacturonic acid recovery, Desalination, 241, pp.81-85.
[13] I. E. Grossmann (2002) Review of Nonlinear Mixed-Integer and Disjunctive Programming Techniques. Optimization and Engineering, (3): pp. 227-252.

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Experimental Investigation of Excess molar enthalpies of binary mixtures formed by cyclohexane with (benzene or toluene or methanol)

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Abstract
The experimental excess enthalpy data are useful in the design of separation equipments. From the various designs available for the experimental determination of enthalpy of mixing, the apparatus was selected, modified and constructed. The apparatus of enthalpy of mixing was tested with a known system and the data obtained was in very good agreement with literature values. The excess molar enthalpies are reported for three binary systems formed by mixing cyclohexane with +benzene, + toluene, methanol have been measured at *T* 298.15 K and 308.15 K using an isothermal calorimeter. The experimental results are correlated with polynomial equations.

Keywords: Excess molar enthalpies; isothermal calorimeter; cyclohexane

Introduction
This work continues our studies about the excess thermodynamic properties for binary mixtures. Excess enthalpy data for the mixtures composed of organic compounds are essential both in theory and practice. Researches on these thermodynamic properties are useful in the design of separation and it provides full understanding of the liquid mixture behaviour. Heat of mixing of mixtures over the whole composition range are useful for a full understanding of their thermodynamic and transport properties, as well as for practical chemical engineering purposes. Enthalpy effects on mixing of liquids are quite large and of considerable importance especially for the design of absorption and distillation columns [1].

Experimental
Van Ness and co-workers (1961) described an apparatus suitable for endothermic systems [2]. A number of other calorimeters based on that original design have been reported in the literature [3-6]. Isothermal dilution calorimeters which contain a vapour space have been described [2,7,8] used a new isothermal calorimeter with no vapor space. [7] used an isothermal displacement calorimeter similar to the one described by Mrazek and Van Ness [2]. In the present work a static type calorimeter incorporating the design features of [1,7,9-11] was designed and used to measure enthalpy of mixing at 298.15 K and 308.15 K.

The products used in the present work were purified by the methods suggested by Riddick, J.A and Weissberger, A. [12-13]. The purity was checked by specific gravity, refractive index and vapor phase chromatography.

An Isothermal calorimeter was used to measure excess molar enthalpies H_m^E at 298.15 ± 0.003K and 308.15 K. Details of the equipment and its operating procedure for binary system have been described previously [1]. Over most of the mole-fraction range, the errors of the excess molar enthalpies are estimated to be less than 0.5%.

The calorimeter is immersed in the constant temperature water bath. The liquids whose enthalpy of mixing is to be determined are taken in jacketed burettes. Long stemmed thermometers of range -10 to 110^0C with 0.1^0C accuracy are used to measure the temperatures of the liquids in the jacketed burettes.

The temperature of the water bath is maintained at the desired value at which the enthalpy of mixing is to be measured. When the temperature of the liquids in both burettes equals that of the constant temperature bath, T_0, a known amount of liquid (1) from one of the burettes is run down into the calorimeter. Stirring is started and continued till the end of the experiment.

Then, from the second burette, a known amount of liquid (2) is run down into calorimeter so that the total volume of both liquids is 270 ml. The temperature T_1 in the calorimeter is registered by means of transducer AD590. The liquid in the calorimeter is allowed to cool to the original temperature T_0, .and the heater is switched on and heating is continued till the liquid attains the temperature T_1. The current through the heater, the potential drop across it and the heating time of the mixture are all recorded. Finally, the liquids are emptied from the calorimeter.

The same procedure is repeated for different volume ratios of the two liquids, always keeping the total volume of 270 ml.

Results and discussion
Excess molar enthalpies H_m^E for three binary system cyclohexane (1) + benzene (2), cyclohexane (1) + toluene (2), cyclohexane (1) + methanol (2) have been measured at *T*

298.15 K and 308.15 K using an isothermal calorimeter. Since there was no appreciable change in the enthalpy of mixing values beyond 308.15 K. Also the liquids start vaporizing at higher temperatures. The experimental results of binary excess enthalpies are listed in table 1 at T 298.15 K and table 2 at T 308.15 K and shown in Figures 1-3. The experimental excess enthalpy depends on composition of the binary system were fitted to the Redlich-Kister polynomial by the method of un weighted least-squares.

Table 1 Experimental excess molar enthalpies $H^E_{m,12}$ (J mol^{-1}) at 298.15K for the binary mixtures cyclohexane (1) + benzene (2), cyclohexane (1) + toluene (2), cyclohexane (1) + methanol (2)

x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$
x_1 (C_6H_{12}) + (1-x_1) C_6H_6					
0.05	165.25	0.4	703.47	0.75	547.46
0.1	283.48	0.45	726.57	0.8	467.81
0.15	357.93	0.505	742.28	0.85	394.23
0.2	437.73	0.55	754.67	0.9	297.64
0.25	538.12	0.6	723.15	0.95	167.62
0.3	623.34	0.65	694.23		
0.35	668.36	0.7	634.61		
x_1 (C_6H_{12}) + (1- x_1) CH_3OH					
0.05	173.64	0.4	437.73	0.75	475.64
0.1	286.34	0.45	442.56	0.8	457.84
0.15	367.45	0.505	453.78	0.85	436.25
0.2	393.78	0.55	448.73	0.9	346.25
0.25	408.67	0.6	464.67	0.95	273.45
0.3	423.17	0.65	473.56	0.975	183.64
0.35	428.97	0.7	498.13		
x_1 (C_6H_{12}) + (1- x_1) $C_6H_5CH_3$					
0.05	37.86	0.4	145.67	0.75	108.96
0.1	53.67	0.45	147.35	0.8	93.67
0.15	71.62	0.505	152.72	0.85	80.42
0.2	98.56	0.55	150.68	0.9	63.46
0.25	115.67	0.6	139.67	0.95	46.32
0.3	123.61	0.65	125.53	0.975	36.28
0.35	138.23	0.7	116.2		

$$H^E_{m,12}/\,J\,mol^{-1} = \sum_{k=1}^{n} h_k\,(1-2x_1)^{k-1} \qquad (1)$$

The coefficient h_k of Eq. (1) and the standard deviation *σ of Eq. (2)* calculated for the three constituent binary mixtures are tabulated in Table 3.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}\left(H^E_{exp\,,i} - H^E_{cal\,,i}\right)^2}{n}} \qquad (2)$$

Table 2 Experimental excess molar enthalpies $H^E_{m,12}$ (J mol^{-1}) at 308.15K for the binary mixtures cyclohexane (1) + benzene (2), cyclohexane (1) + toluene (2), cyclohexane (1) + methanol (2)

x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$	x_1	$H^E_{m,12}$
x_1 (C_6H_{12}) + (1- x_1) C_6H_6					
0.05	165.25	0.4	686.16	0.75	537.62
0.1	283.48	0.45	703.45	0.8	448.61
0.15	357.93	0.505	723.64	0.85	394.23
0.2	437.73	0.55	743.81	0.9	297.64
0.25	538.12	0.6	707.12	0.95	167.62
0.3	623.34	0.65	683.42		
0.35	668.36	0.7	621.57		
x_1 (C_6H_{12}) + (1- x_1) CH_3OH					
0.05	162.14	0.4	411.23	0.75	447.84
0.1	220.54	0.45	418.24	0.8	426.51
0.15	343.16	0.505	425.42	0.85	407.56
0.2	373.96	0.55	431.12	0.9	283.86
0.25	371.14	0.6	440.37	0.95	218.94
0.3	387.46	0.65	450.46	0.975	143.84
0.35	401.35	0.7	464.25		
x_1 (C_6H_{12}) + (1- x_1) $C_6H_5CH_3$					
0.05	36.43	0.4	128.76	0.75	94.35
0.1	51.36	0.45	135.42	0.8	81.46
0.15	68.12	0.505	142.34	0.85	67.32
0.2	84.65	0.55	131.64	0.9	48.34
0.25	96.78	0.6	123.43	0.95	34.62
0.3	106.45	0.65	114.42	0.975	30.46
0.35	118.56	0.7	105.34		

Conclusion

The experimental determination of excess molar enthalpy values for three binary at 298.15K and 308.15K has been performed by means of isothermal calorimeter. The heats of mixing values for binary systems studied are endothermic in nature and over the most of the composition range, the errors of the excess molar enthalpies 5 %.

Acknowledgement

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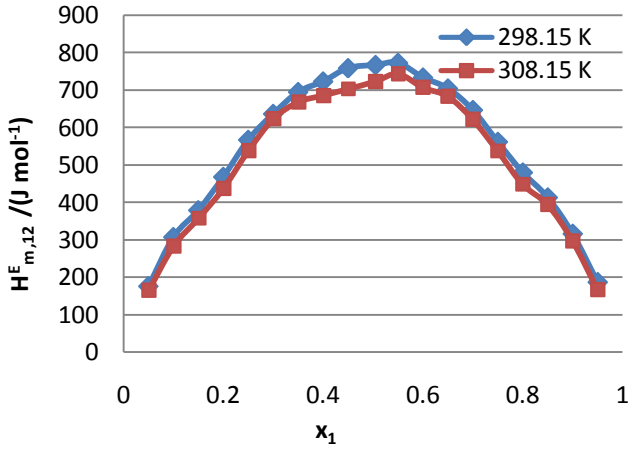

Figure 1: Enthalpy of mixing for cyclohexane (1) - Benzene (2) system

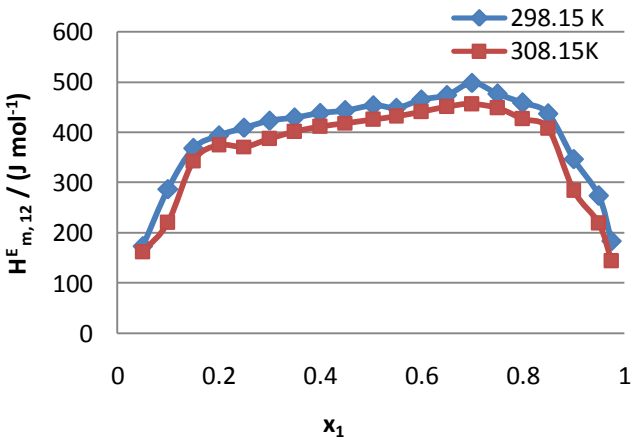

Figure 2: Enthalpy of mixing for cyclohexane (1) - Toluene (2) system.

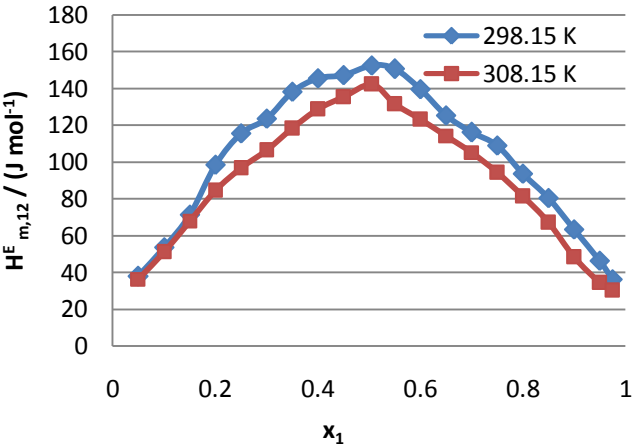

Figure 3: Enthalpy of mixing for cyclohexane (1) – methanol (2) system.

Table 3 Parameters h_k and standard deviations σ for the representation of $H^E_{m,12}$ at 298.15K and 308.15 K by Eq. (1)

T /K	System (1+2)	h_1	h_2	h_3	h_4	h_5	σ /J mol^{-1}
298.15	(Cyclohexane + benzene)	3105.219	-39.0518	-965.185	-107.845	2205.068	0.34
308.15	(Cyclohexane + benzene)	3015.72	-149.056	-869.524	55.07913	1684.273	0.54
298.15	(Cyclohexane +Toluene)	1812.289	-210.699	1655.016	-595.166	2120.399	0.48
308.15	(Cyclohexane +Toluene)	1699.904	-305.24	1852.081	-258.249	801.9138	0.52
298.15	(Cyclohexane + methanol)	585.0825	104.7014	84.06362	-297.084		0.211
308.15	(Cyclohexane + methanol)	524.325	38.20897	27.25812	-76.2953		0.21

References

[1] K. L. Shivabasappa, P. Nirguna Babu and Y. Jagannadha Rao, Braz. J.of Chem. Eng., 25, 167, 2008.
[2] R. V. Mrazek and H. C. Van Ness, Amer. Inst. Chem. Engineers J. 7, 190, 1961.
[3] D. R. Winterhalter and H. C. Van Ness, J. Chem. and Eng. Dara, 11, 189, 1966.
[4] C. G. Savini, D. R. Winterhalter, L. H. Kovach, and H. C. Van Ness, J. Chem. and Eng. Data, 11, 40, 1966.
[5] R. H. Stokes, K. N. Marsh, and R. P. Tomlins, J. Chem. Thermodynamics, I, 211, 1969.
[6] B. Murakami and G. C. Benson, J. Chem. Thermodynamics, 1, 559, 1969.
[7] R. Tanaka, S. Murakami, and R. Fujishiro, Bull. Chem. SOC. Japan, 45, 2107, 1972.
[8] J. J. Christensen, J. W. Gardner, D. J. Eatough, R. M. Izatt, P. J. Watts, and R. M. Hart, Rev. Sci. Instr, 44, 481, 1973.

[9] Patel, H.R., Ph.D. Thesis, Department of Chemical Engineering, Indian Institute of Science, Bangalore, India, 1974.
[10] Rao Y.J., and Viswanath D.S, J.Chem .Eng. Data, 18, 49, 1973.
[11] Nirguna Babu. P, Ph.D. Thesis, Department of Chemical Engineering, Siddaganga Institute of Technology, Tumkur – 572103 – India, 2003.
[12] Riddick, J.A., Bunger, W. S., Techniques of Chemistry, Organic Solvents, Vol. II, 3e, Wiley-Interscience, NY, 1970.
[13] Weissberger, A., Editor, Techniques of Organic Chemistry, Vol I, Interscience, NY, 1949.

Ubiquitous Computing Applications and Projects: A Survey

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Abstract*:* This paper reflects the survey on ubiquitous computing applications and projects. Pervasive computing is as well termed ubiquitous computing. Pervasive gives idea about developing the superiority or inclination to pervade or permeate and ubiquitous involves regularly encountered also actuality existing everywhere at once. UbiCom structure practices collection of interactions. Category of System-Environment Interaction is CCI, CPI and HCI. This paper conveys about initial uses related with ubiquitous computing and timely developments of ubiquitous computing are described.
Keywords: HCI,HHI,CPI, CCI.

INTRODUCTION

This UbiCom structure practices collection of interactions. Category of System-Environment Interaction is CCI, HCI and CPI. Computer-Computer Interaction is commonly referred as C2C or CCI. Interaction among UbiCom systems or devices, or among one UbiCom system and its virtual computer infrastructure that can use SOA, distributed AI and biological systems. Human Computer Interaction i.e. HCI between devices and people. Computer device - Physical world Interaction i.e. CPI e.g., robotics, embedded controllers, sensor nets.

Physical environments generally referred as smart environments act partially as gatherings of smart devices so that CPI concerning smart environments approaches towards CCI. Communications concerning HPI &H2H are frequently intermediated by computer devices. If humans perform mutually using the physical world and the latter is en visionedas a smart environment at that time human smart environment interaction come close to HPI& HCI.

EARLY UBICOM RESEARCH PROJECTS

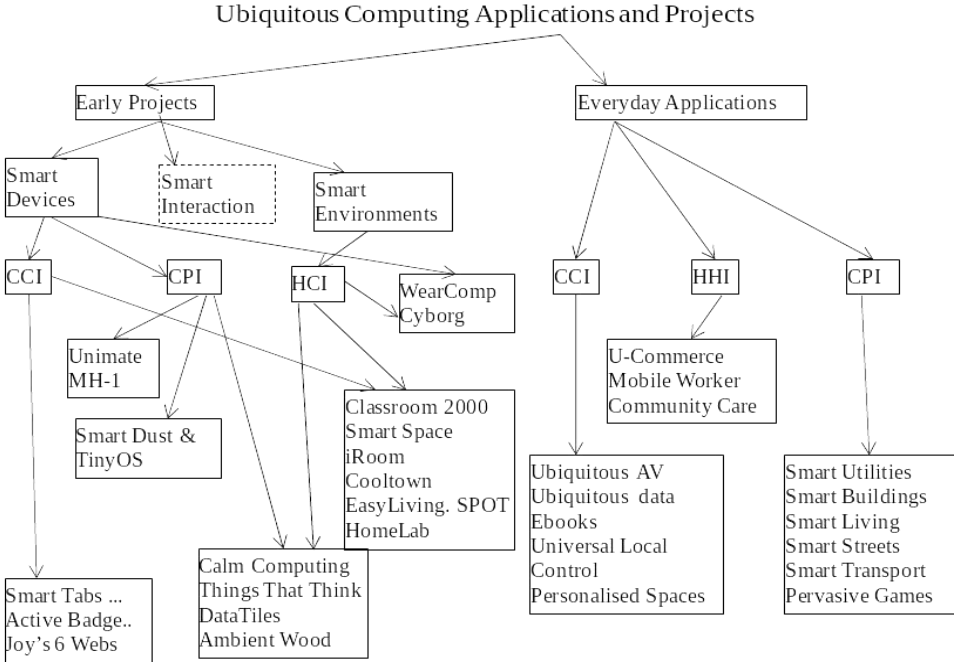

Figure 1.Ubiquitous Computing Applications and Projects.

SMART DEVICES: CCI

1) *Active Badge, Bat and Floor:* Active Badge (forerunner of ParcTab) at Cambridge University / Olivetti. It is 1st context-aware computing application. It designed an aid for a telephone receptionist. Active Device occasionally guides infrared signals to sensors surrounded in rooms all over the building. It has limited Location determination accuracy. Active Bat uses ultrasound. Also it has 3 cm greater accuracy. In this base station used for position determined. Where, Active Floor is used for Identification by person's gait.
2) *PARC Tab, MPad, LiveBoard:* 3 main entangled devices and purposes known as Tabs, Pads, Boards, were advanced at PARC, Palm-sized referred as ParcTab computer,. Smaller computers Book-sized called MPad, Large wall-display program entitled Live Board.

SMART ENVIRONMENTS: CPI AND CCI

1) *ClassRoom 2000*: ClassRoom 2000 is used to capture the live practices of the inhabitants and to deliver that record to users for future access and review.
2) *Smart Space and Meeting Room Projects:* NIST (1998-2003): use of pervasive devices, sensors & networks for context-aware smart meeting rooms that sense ongoing human activities and respond to them Meeting Room design.
3) *Interactive Workspaces Project:* Interactive Workspaces project (Stanford University, 1999) investigated design and of rooms (iRooms) to create applications integrating the use of multiple types of devices of varying form factors. Also advancedseveral interaction configurationsfor acting togetherwith high resolution displays, ZoomScape,FlowMenu, Typed drag and drop support.
4) *Cooltown:* HP Project , 2000-2003, to improvea conceptof UbiCom to sustenancecrucialcharacteristicof Cooltown is that everyphysical and virtual createdresource has a Web presence (URL).
5) *EasyLiving& SPOT:* EasyLiving project (Microsoft, 1997-2003) developed intelligent environments to support dynamic aggregation of diverse I/O devices into a single coherent user experience. SPOT devices (Microsoft, 2003) devisedto listen for digitally encrypteddata such as news stories, weather forecasts, retail directories, traffic updates, and personal messages transferred on frequency sidebands leased from commercial FM radio stations.
6) *Ambient Intelligence(AmI):* It is projectedby Philips in 1990s as a novel modelfor consumer electronics. Key characteristics of AMI systems are user-aware/iHCI, Intelligence, Embedded.

SMART DEVICES: CPI

Unimate and MH-1 Robots*:* Automated machines that just look after one thing remain not robots. Robots have the ability of controlling a range of programmable jobs. 1961, Ernst developed the MH-1. 1st main industrial computer controlled robot, the Unimate designed by Engelberger.

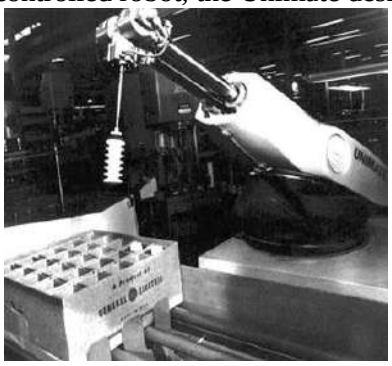

Figure 2. Unimate Robot.

Smart Dust:Micro fabrication and integration of low-cost sensors, actuators and computer controllers, MEMS (Micro Electro-Mechanical Systems). They can be scattered& embedded all overthe digital environment, similarlygeneratinga digital skin that intelligencesphysical & chemicaloccurrences.

Figure 3.Smart Dust(Photo: courtesy of Brett Warneke).

SMART DEVICES: IHCI

1) *Calm Computing*: Calm technologies are said to encalm us as they can authorize our periphery. E.g. "Dangling String".

Figure 4.Example of calm technology- Dangling String

2) *Tangible Bits & Things That Think (TTT):* In 1997, and however to a great extent10 years later, GUI-constructed HCI presented its info as "painted bits" on rectangular displays in the foreground. In compare, Tangible Bits project (led by Ishii, MIT, 1997) intended to modify "painted bits", into "tangible bits" by influencing multiple senses & multimodal human interactions inside the physical *domain*
3) *DataTiles:* DataTiles project (Sony, 2001, led by Rekimoto) focussed on interactive user interfaces that use task specific physical objects as alternatives to conventional HCI. The data Tiles system integrates the benefits of 2 major interaction paradigms: graphical & physical user interfaces.

Figure 5.DataTiles (Photo courtesy of Sony Computer Science Laboratories, Inc.)

4) *WearComp and WearCam:* Mann's experiments with wearable computers started in late 1970s. Main application was recording personal visual memories that could be shared with other via the Internet.

Figure 6.WearComp and WearCam

Later generations three key features.

- Wearable computer was hidden.
- Mediated reality was supported, reality may be diminished.
- Thirdly, Homographic Modeling was support in the display.

5) *Cyborg 1.0 and 2.0:* Entrenched into individual mobile hosts are methods of embedded device. Cyborg 1.0, a *silicon* chip transponder entrenched in a forearm which continued in residence for 9 days. Cyborg 2.0 a novel embeds in his lower arm could transmit signals back and forth amongst the nervous system & PC.

EVERYDAY APPLICATIONS IN THE VIRTUAL, HUMAN AND PHYSICAL WORLD

EVERYWARE UBICOM APPLICATIONS: CCI

Ubiquitous MM Content Access: Multi-media (MM) content via any network & access device. Broadcast MM content, professionally, created by third-parties, copyright, non-interactive, downloaded, read-only content, stored & manipulated in access device.

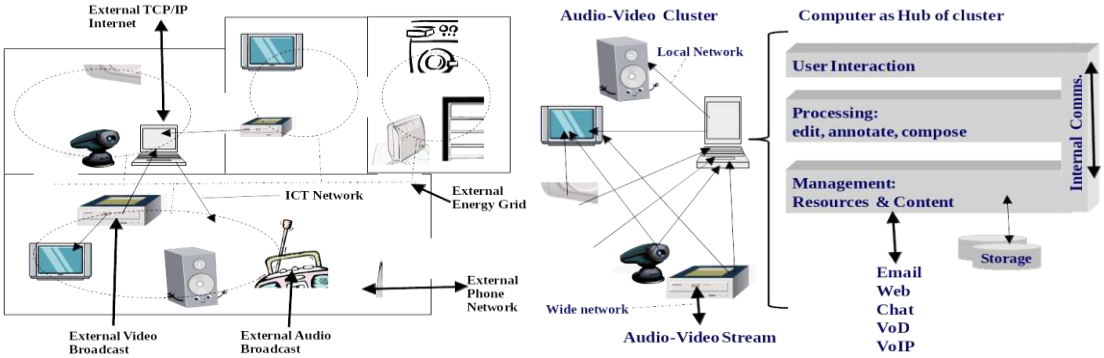

Figure 7. Multi-media (MM) content

Universal Information Access: PC still the dominant information access device. PC agonizes after a number of restrictions related to its paper equivalent. Specialised reading devices: ebooks, epaper. E.g. www.sonystyle.com, www.amazon.com (kindle, USA only when 1st released).

Universal Control of Local Devices: Appliances controlled using Infrared, short-range controller. 1 controller per appliance -> many controllers, discarded each time, appliance is upgraded. Use of mobile phones and PDAs as universal local controllers.

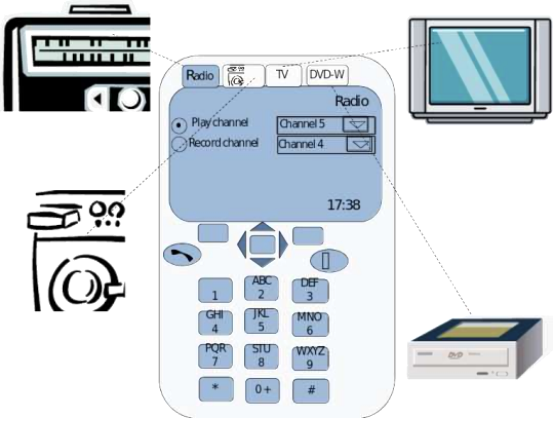

Figure 8. Universal Local Control Devices

User Awareness & Personalisation: Personalisation matterand facilitiesdesigned to individuals constructeddepending onrealizationapproachingtheir preferences andperformance, Benefits. Greateropportuneness, additionalrelatedclarifiedinformation but trade off in contradiction ofa loss in privacy. Users can personify pattern of services, explanationof content. Personal preferencescould track a user around Mobile devices offer an comprehensiblemeans for operators to personify theirenvironments

EVERYWARE UBICOM APPLICATIONS: HHI

M-commerce and U-Commerce:

M-COMMERCE: VARIANT OF E-COMMERCE WITH SERVICES OVER MOBILE-WIRELESS INFRASTRUCTURE. CHARACTERISED BY UNIVERSALITY, UNIQUENESS, UNISON, UBIQUITY.

*Enhancing Productivity of Mobile Humans:*Productivity can suffer from a blockage whenindividuals don't have the correct information where & when they requires it. E.g., Mobile users can access calls, email, diary, calendar and notepads.

Care in the Community: 'Vulnerable' individuals at domesticarea overseenby family, friends and health professionals situatedto a different place. There are two fundamental typesof tacticsin regards of whether the subject unambiguouslyrequestsaimed atassistancefrom others or Whether others can expectas soon asthe subject necessitatesthe help.

EVERYWARE UBICOM APPLICATIONS: (HPI, CPI)

- Physical Environment Awareness
- (Physical) Environment Control
- Smart Utilities
- Smart Buildings and Home Automation
- Smart Living Environments and Smart Furniture
- Smart Street furniture
- Smart Vehicles, Transport and Travel
- Pervasive Games and Social Physical Spaces

CONCLUSION

The technique of the pervasive environs authorizes communication amongst devices every time and in all places, so the systems turn out to be more pervasive in recent world. In this paper we surveyed on ubiquitous computing basicdevelopmentsof smart devices, smart interaction, smart environmentsas well as ubiquitous computing everyday applications.

REFERENCES

Bashir, R.N., Qadri, S., Saleem, R.M., Naeem, M. and Ghafoor, Y. (2014) Human Computer Interaction (HCI) in Ubiquitous Computing. International Journal of Innovation and Applied Studies, 9, 534.

Grudin, J. (2011) A Moving Target: The Evolution of HCI. In: Jacko, J., Ed., The Human-ComputerInteraction Handbook, 3rd Edition, Taylor & Francis, New York.

Stefan Poslad, Ubiquitous Computing, Smart devices, environment and interaction, Wiley.

Jochen Burkhardt, Horst Henn, Stefan Hepper, Klaus Rindtorff, Thomas Schaeck, Pervasive Computing, Pearson, Eighteenth Impression, 2014.

http://people.eng.unimelb.edu.au/vkostakos/courses/ubicomp10S/

http://mpc.ece.utexas.edu/research.html

http://en.wikipedia.org/wiki/Pervasive_Computing

"Development of customer-oriented service: smart shopping carts with automatic billing system through RFID"

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ABSTRACT: These days, great quantity of advancements inside the field of net of things (IoT) era has given manner to new programs and fields. The interfacing with sensors and actuators performs the blended function of environmental sensing, specific computing, and wirelessly communicating gadgets. Closer to the concept of clever mall, the IoT generation embeds networks of sensors and actuators in buildings can efficiently function in facts series and control in order that it is predicted to significantly enhance the excellent of buying carrier.

Index Terms—IoT, Digital India.

I. INTRODUCTION

A system is a manner of working, organizing or doing one or many tasks in keeping with a hard and fast plan, application, or set of policies. A machine is likewise an arrangement in which all its gadgets bring together and work together in step with the plan or program. An embedded device is one which has laptop-hardware with software embedded in it as considered one of its maximum crucial aspect. It's far a dedicated computer-based totally gadget for a utility(s) or product. It may be either an independent gadget or a part of a bigger machine. Internet of factors (IoT) is a domain that represents the next maximum exciting technological revolution for the reason that birth of the internet. IoT will deliver countless opportunities and impact every nook of our planet. with IoT, we are able to construct smart cities where parking area, city noise, visitors congestion, street lights, irrigation, and waste can be monitored in actual time and controlled more efficaciously. We can construct clever houses which are secure and electricity-green. We will build smart environments that routinely screen air and water pollutants and enable early detection of earthquake, wooded area fireplace and many other devastating screw ups.[1] IoT can rework production, making it leaner and smarter. In step with cbs information, we've had almost six hundred bridge failures in the US seeing that 1989. A huge variety of bridges in every state are sincerely a chance to the visiting public. IoT can monitor the vibrations and material situations in bridges (as well as buildings and historic monuments) and provide early caution that might save several human lives.

II. BACKGROUND STUDY

Supermarket is the place in which customers come to purchase their day by day the use of products and pay for that. So there may be need to calculate how many merchandise are bought and to generate the invoice for the client. Cashier's desks are located in a position to sell movement. At

gift, many supermarket chains are trying to further reduce exertions costs through shifting to self-carrier take look at-out machines, in which a unmarried employee can oversee a set of four or five machines at once, assisting multiple customers at a time.

III. PROPOSED MODEL

To make shopping mall more interactive, here we provides 3 modules with deep information and with clear idea. Three modules are:

1. Smart Basket
2. Smart Application
3. Smart Inventory Management

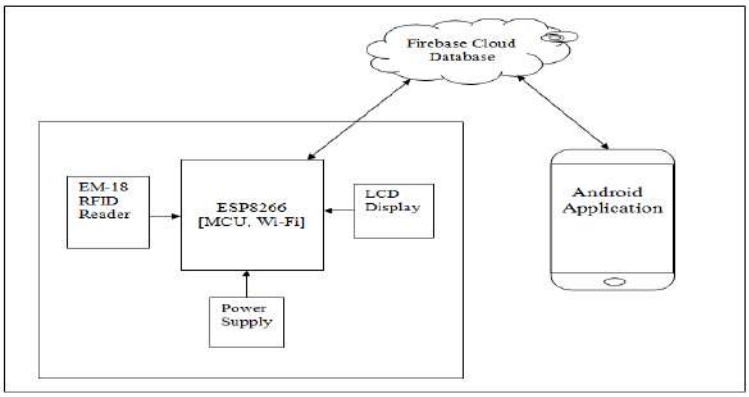

Fig 1.1.Block Diagram of Interactive Intelligent Super Market Framework

1. Smart Basket Module

This paper proposes a reliable and fee effective clever basket with a smart consumer-interactive interfacing scheme. These goals to reduce the man strength and sell the shopping experience for its customers, and for this reason it's miles suitable to be used and included into the IoT network of the clever mall. Within the following, the implementation of the clever basket may be described in element with the resource of vision and Wi-Fi technology to provide the robustness and ease of use from the point of view of the customer.[2] Ultimately, the experiments in a trendy mall could be conducted to present the encouraging results in actual global deployment. [1]

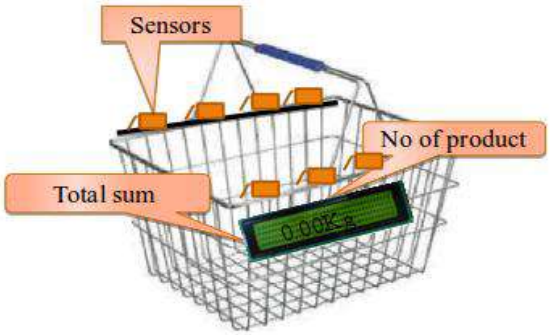

Fig.1.2 Design of a Smart Basket.

Hardware and Design of a basket:

1. MICROCONTROLLER (Wi-Fi module):

The esp8266 wireless module is a self-contained soc with incorporated tcp/ip protocol stack which can provide any microcontroller get entry to on your wireless network. The esp8266 is capable of both web hosting an software or offloading all Wi-Fi networking capabilities from some other utility processor. Each esp8266 module comes pre-programmed with a command set firmware. It helps to 802.eleven a/b/g/n IEEE widespread protocol for Wi-Fi. Esp8266 on-board processing and garage abilities allow it to be included with the sensors and different application specific gadgets thru its gpios with minimal improvement up-the front and minimum loading during runtime.[5] With its excessive degree of on-chip integration, which includes the antenna transfer blain, electricity control converters, it requires minimal outside circuitry, and the whole solution, such as the front-cease module, is designed to occupy minimal pcb region. State-of-the-art machine-stage capabilities consist of fast sleep/wake context switching for energy-efficient VOIP, adaptive radio biasing for low-electricity operation, boost signal processing, and spur cancellation and radio co-existence features for commonplace cell, Bluetooth, ddr, lvds, and liquid crystal display interference mitigation.

Fig. ESP8266 Wi-Fi module

2. RFID READER:

Radio frequency identification (RFID) is a rapidly growing technology that has the potential to make great economic impacts on many industries. While RFID is a relatively old technology, more recent advancements in chip manufacturing technology are making RFID practical for new applications and settings, particularly consumer item level tagging. These advancements have the potential to revolutionize supply-chain management, inventory control, and logistics. At its most basic, RFID systems consist of small transponders, or tags, attached to physical objects. RFID reader used here for scanning each product while putting into the basket. RFID reader can scan a product from far distance also this is the advantage of RFID reader. Another reason of using RFID reader is it can read group of products at a time. RFID reader stores the more information of a product as manufacturing date of a product, Expiring date of a product, Total price of a product etc.[7]

EM-18 RFID Reader module directly connects to any microcontroller UART (Universal Asynchronous Receiver/Transmitter)or through a RS232 converter to PC. It gives UART or Wiegand26 output. This RFID Reader Module works with any 125 KHz RFID tags. It features low cost, low power consumption, small form factor and easy to use.[3]

The module radiates 125 KHz through its coils and when a 125 KHz passive RFID tag is brought into this field it will get energized from this field

Fig 1.3. EM-18 RFID Reader module

3. RFID TAGS:

RFID tags supply whatever they're attached to a unique identity, electronically saved and without problems retrieved. RFID tags may also soon end up the maximum pervasive microchip in records. While wirelessly interrogated by RFID transceivers, or readers, tags respond with a few identifying information that may be associated with arbitrary information. As a result, RFID structures are one kind of automatic identity device, just like optical bar codes. Right here, passive RFID tags are used. a passive tag is an RFID tag that does not include a battery; the electricity is provided by means of the reader. While radio waves from the reader are encountered via a passive RFID tag, the coiled antenna in the tag forms a magnetic area. The tag attracts strength from it, energizing the circuits in the tag. The tag then sends the statistics encoded in the tag's memory.

Fig.1.4 Passive RFID Tags

4. LCD DISPLAY (16*2):

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. This is a 16 character by 2 line display that runs at 3.3V. Utilizes the common ST7066/HD44780 parallel interface. Interface code is widely available for many different controllers and systems. It will need ~11 general I/O pins to interface to this LCD screen. Includes white LED backlight. A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. [9]

Fig.1.5 16*2 LCD Display

2. Central Automated Billing System Module:

The fig. shows the concept of Central Automated Billing System. Since each basket has unique identity number through Wi-Fi module each basket sends its information to the central server. With the help of Firebase cloud storage one central server can handle multiple clients as number of baskets at same time. [1]

Fig. 1.6 Central Automated Billing System

3. Smart Application Module

A cell app improves the revel in of the site visitors of shopping centre or branch shop. Purchasing centres are getting bigger and bigger which makes extra tough for the purchaser to find out the offerings it gives. With a cellular app site visitors may have all the facts of buying centre in their mobile phones. Also, an app is an extremely good device to boom frequency of visits and raise the loyalty thanks to the frenzy notifications. shopping mall ,which as a enterprise retail business, expect an vital part in India's monetary development, there are nonetheless some troubles in its stock administration, grocery store shops, settlement and specific angles, certainly confining the depth of ventures. Basically to keep the time in searching merchandise this utility can be very useful. Whilst you are accomplished with shopping, app will offer one of a kind fee alternative for making price.[7]

Fig.1.7 Design of Mobile App

Purposes of creating app:

- Visible to Customers at All Times: One of the biggest benefits of having a mobile app is that all the information you'd like to provide to your customers including special sales and promotions is right at their fingertips. Through push notifications you're getting even closer to a direct interaction, and can easily remind customers about your products and services whenever it makes sense.

- Create a Direct Marketing Channel: Apps serve many functions: they can provide general info, prices, shopping cart, search features, user accounts, messages, offers, and much more.[8]
- Provide Value to Your Customers: Talking about on-hand information, mobile application supports digitization. The more often you can get customers involved with your app, the sooner they will be inclined to the technology and services.
- Cultivate Customer Loyalty: The most important reason why you should consider building your own mobile app is customer loyalty. With all the noise out there roadside banners, billboards, flashing signs, newspaper ads, flyers, coupons, websites, website banners, and marketing we slowly lose our impact on customers because of the immense amount of advertising surrounding us all. It can be a way of staying closer to your customers, and being just a fingertip away at all times.[6]

Working of Smart Application:

The store works with the android app. With that app, you can enter mall, take the products you want, and go. For the purpose of push the boundaries of computer vision and machine learning to create a store where customers will not have to spend time for searching products here and there and making ease of payment. We will exemplify scenarios to illustrate the functionality and details of our project. First off, we assume that a customer enter the mall. At this time, we conduct him/her to download our application from the server.

We assume that at the first scenario, our customer wants to buy a particular stuff:

Step1: User has to register by filling following fields.
Step2: Login yourself into the system

Step3: You will get an OTP to verify it's you. Enter basket ID to get linked with the basket

Step4: Searching product location.

Step5: Get product and check your item list. It will get updated.
Step6: Make payment by different payment options provided[1]

4. Smart Inventory Management

Inventory control is a field often approximately specifying the shape and placement of stocked items. The concept of inventory, stock has been extended from production structures to service agencies and initiatives, via generalizing the definition to be "all paintings in the manner of production- all paintings this is or has passed off previous to the crowning glory of manufacturing."

in the context of a manufacturing production machine, stock refers to all work that has occurred - raw substances, partially completed merchandise, completed products previous to sale and departure from the producing gadget.[2] The use of RFID generation inside the inventory management, it enabled enterprises to add goods timely , and additionally display the self-existence of perishable commodity, basing on well timed grasping stock data of the commodity and expertise the call for each commodity, in the end reduce stock prices, reduce loss, shop a lot of time and effort for the organizations .stock management entails a retailer in search of to acquire and keep a proper merchandise collection at the same time as ordering, transport, dealing with and associated charges are stored in test. It additionally entails structures and procedures that become aware of inventory necessities, set objectives, offer replenishment techniques, record real and projected inventory popularity and manage all features related to the monitoring and management of fabric.[3]

5. Working of Smart inventory:

The utilization of RFID innovation in the stock administration, empowers undertakings to include products convenient, furthermore screen the self-existence of perishable product, based on opportune getting a handle on stock data of the ware and comprehension the interest for each ware, at last diminish stock expenses, lessen misfortune, save a great deal of time and exertion for the endeavours.

Due to utilizing RFID innovation as a part of store stock administration, suppliers may ace their items deals in a shopping mall and district whenever by the Internet of things and supply products specifically to the shopping mall, in light of the ideal methodology of both sides, and accomplish win-win. Here we assemble stock model to portray it: accepting that one merchant gives a product, in the model considering the circumstance of different stores requesting various item from various sellers[4].

IV. USER INTERACTIVE DESIGN:

All modules and methods of design help to make shopping mall more interactive to customers. Figure 1.10 shows customer oriented interactive shopping mall framework.

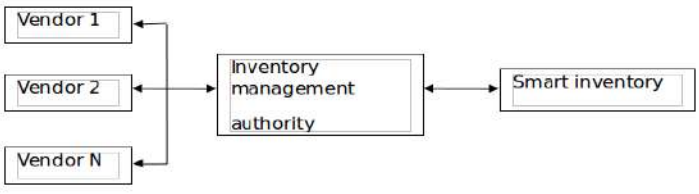

Fig.1.10 working between mall authority and vendors

V. CLOUD DATABASE:

Firebase is a cloud garage provider that we've leveraged a good way to allow our middleware to be decoupled and interface with 3rd party programs. We determined to apply firebase upon an analysis of Google nest's api. They utilized firebase to permit builders to create cellular and web packages that used the facts generated by way of their clever thermostat and smoke detector, while not having to adjust to the unique format of facts they had been generating. All of the data is stored in json format and any modifications in information, displays right now with the aid of appearing sync throughout all the structures & gadgets.Furthermore, on the grounds that firebase enables

customers to feature authentication to their personal firebase, customers can relaxation confident that their statistics is included from malicious attackers.

All Firebase Real-time Database data is stored as JSON objects. You can think of the database as a cloud-hosted JSON tree. Unlike a SQL database, there are no tables or records. When you add data to the JSON tree, it becomes a node in the existing JSON structure with an associated key [5].

Firebase real-time database is a schema less database in which the data is stored in JSON format. Basically the entire database is a big JSON tree with multiple nodes. So when you plan your database, you need to prepare the json structure in way that the data is accessible in easier way by avoiding nesting of child nodes. Firebase provides great support when comes to offline data. It automatically stores the data offline when there is no internet connection.

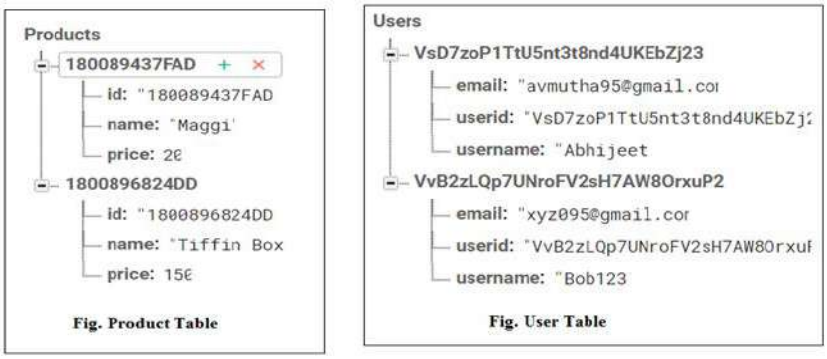

Fig.1.11. Database as a cloud-hosted JSON tree

VI. CONCLUSION

This is supposed to introduce the utility of the internet of factors within the intelligent interactive grocery store framework and customers shopping, to clear up a number of the drawbacks inside the beyond the supermarket. knowing wise interactive control inside the supermarket, at the same time as saving the purchaser a lot of buying time, and from the supply to make sure product fine, speedy and convenient cellular payment feature, absolute confidence make modern life greater convenient. In mild of our estimation, the programmed charging office can avoid line inside the registration procedure so that the higher shopping information for clients can be made. there are some in addition troubles like net of things enterprise specialized benchmarks and conventions are not uniform, protection problems like machine security etc.

REFERENCES:

[1] Mr.P.Chandrasekar and Ms.T.Sangeetha."Smart Shopping Cart with automatic Billing System through RFID and ZigBee,"ICICES, 2014.

[2] Hsin-Han Chiang, Wan-Ting You, Shu-Hsuan Lin, Wei-Chih Shih, Yu-Te Liao, Jin-Shyan Lee, and Yen-Lin Chen. "Development of Smart Shopping Carts with Customer-Oriented Service",International Conference on System Science and Engineering (ICSSE) National ChiNan University, Taiwan, July 7-9, 2016.

[3] NavidRajabi and Amin Hakim,"An Intelligent Interactive Marketing System based-on Internet of things",2nd International Conference on Knoeledge-Based Engineering and Innovation(KBEI),Nov 5-6,2015

[4] LuoZhengshan and Wang Hongchao,"Research on intelligent supermarket architecture based on The Internet of Things technology",8th International Conference on Natural Computation (ICNC 2012)

[5] Joseph Boman,Jonathan Taylor and Anne H. Ngu . "Flexible IoT Middleware for Integration of Things and Applications",10th IEEE International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom 2014)

[6] http://www.androidhive.info/2016/10/android-working-with-firebase-realtime-database/

[7] https://firebase.google.com/docs/database/web/structure-data

[8] Design and implementation of a RFID-based power meter and outage recording systemShun-Yu Chan; Shang-Wen Luan; Jen-Hao Teng; Ming-Chang Tsai

[9] Ultra low-power UWB-RFID system for precise location-aware applications Yuan Zhou; Choi Look Law; Jingjing Xia

I-Home: Intelligent Home Automation Using Data Mining and IoT.

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ABSTRACT: Home automation while playing a vital role in our lives helps us to manage and control the household appliances. Wi-Fi is often used for the remote monitoring and control. Home devices when remotely monitored and controlled via the internet form an important constituent of the IoT. I-Home technology is used for automating the appliances around us for the repairing work. It helps in controlling the appliances and intelligently warns us when it gets faulty. Here, we are integrating the IoT and data mining, with the help of cloud computing we are able to manage, store and process the enormous amounts of data that will be collected from the sensors in real time. This study will enable the people to repair the appliances through a smart click after the alert is generated. It will help us in the detection and repairing of the household appliance by reducing the human intervention.

Keywords: **Arduino, IoT, Relay board, Sensor.**

I. INTRODUCTION

In today's era use of Internet of things widely increase with other technologies like data mining, cloud computing, Artificial intelligence etc. so that it help in different fields like, to control home appliances, in industry for monitoring the different devices and maintaining their record for future prediction, for monitoring and controlling the environmental condition, for smart city, for smart marketing, In educational field for maintaining record, It will also help in home automation for controlling the home appliances etc. The use of Internet of things with other techniques plays very important role in home automation for making intelligent home to maintain living standards, and secure environment. In this paper, paper consist of use of Iot and data mining for intelligent home automation using different sensors like temperature sensor(Tdr), light sensor(Ldr) ,potentiometer(pot) ,vibration sensor etc. for monitoring home appliances. Up till now we can see the use of IoT in home automation for switching on/off the electronic devices if we are outside that is controlling the home appliances from another place, detection of gas and if there is leakage then inform to security. By considering such use of IoT in home appliances we thought about controlling home appliances as well as if there is any problem in appliances then inform to proper technician by considering different parameters like address, working time, day to reduce human intervention then technician will come and check the appliances. So this paper is an idea given which help to choose the proper type of technician by using naïve Bayes algorithm. The following points give the rest of the paper information as follows. Section II includes information about different research activities related to home automation. Section III includes information about proposed system. Section IV gives information about working flow of the project. Section V observations and result of the project and section VI concludes the project and future scope so that we can do further advancement.

II. LITERATURE SURVEY

The literature survey which is presented in this section is the observations and current situation of automation in real life. The authors have taken many efforts to do this literature survey and to design the new architecture diagram based on this survey. The main aim of this survey is to convey the idea of the project to reader and the user. Survey in IOT and data mining domain is very of much difficult and crucial. Thus from this survey some of the paper survey is given in following part. The base paper of this project gives the idea about the use of IEEE 14.5.1 protocol by combing with CPLD architecture for water monitoring system. But this system uses spread sheet for their datasets management. Hence it leads to the improper management of datasets.[2] Another paper is focused on resource constraint node with COAP and ubiquitous ID(UID) architecture. This architecture uses tiny operating system which is not opted for complex operations. The other paper also gives the idea about monitoring the system only and no any controlling part is available.[4] Some of the systems are having lack of security for authenticating devices and users. To support all this paper survey, authors have done application survey too. This application survey includes some of the android application for home automations. One application is that Ardunio Smart Home Automation which controls the devices or appliances which work with wifi network or internet. But the application is leading to repeated crash of the system. The other application which is working only for turn on and off of the devices. It supports to the monitoring the devices only. Also this application does not support outside of the house unless you put quite sometimes into setting up secure port forwarding. The axial control free application controls Z-wave, thermostat means appliances on off condition, seen setup and activation.[5] The other application domestic's home automation light is useful for monitoring purpose only.[1] Thus the authors get to know that there should be the system which will monitor and control the home equipments and appliances. By looking at the existing system and existing applications authors got the idea of making the home automation system. Hence they come up with the problem statement that is to generate a system in IOT that uses data mining concepts to ping the nearest electrician for repairing the faulty electrical equipments. In further section detail explanation of proposed system is given.

Hardware:

1. Transformer:

The main purpose of transformer is to convert AC power of one voltage to AC power of another voltage level without changing the frequency. It is used to transfer electrical energy between two or more circuits through electromagnetic induction.[3]

2. Regulator IC(7805,7812):

Voltage sources in circuits may be have fluctuations so not giving fixed voltage output. Regulator IC for voltage maintains the voltage at constant rate.7805 IC provide +5 volt power supply with heat sink. Output voltage range between 4.8 volt to 5.2 volt. 7812 IC provides +12 volt power supply and the maximum output voltage is 12.48volt.[7]

3. Arduino UNO

Wecan provide power to Arduino UNO from a USB cable coming from your computer or a wall power supply. There are 3ground pins, A0-A5 analog in pin that read the signal from an analog sensor and convert it into a digital value, 0-13 digital pin use for both digital input and output, PWM pins that is pulse width modulation use for simulate analog output denoted by '~',ARFF Stands for Analog Reference sometimes use to set an external reference voltage.[6] Arduinouno can interact

with motors, LEDs, buttons, speakers, GPS units, cameras, the internet, and even with smart-phone or TV.

4. Uln2803 Transistor:

Uln2803 is 8 NPN darling transistor use for interfacing between low logic level digital circuitry and higher voltage/current requirements that is for high-voltage outputs with common-cathode clamp diodes for switching inductive loads.

5. Sensors:

Sensors are the electronic components use to find the changes in the surrounding and give information to the other electronics. Here we are using temperature sensor(TDR) for monitoring the heat, Light sensor(LDR) for monitoring the light and potentiometer(Pot) for checking water tank level.[9]

6. Relay board:

The relay board works on 12V. Board has four relays driven by ULN2803 IC. the input can come directly from microcontroller output working at 3V or 5V to control relays. Each relay can change from different AC or DC high voltage, current loads working at 110V or 220V AC devices like lights, fans, motors and more. LEDs use to indicate status of the relays.

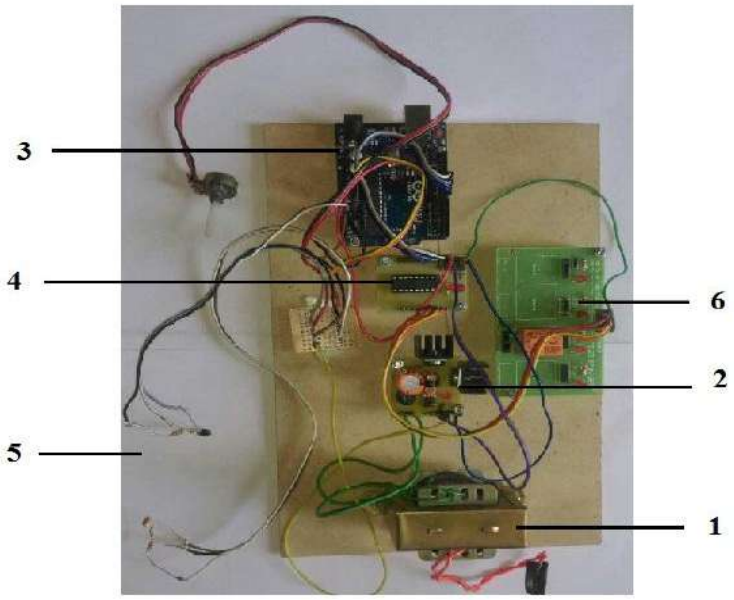

Fig 1.1 Working Model

III. PROPOSED SYSTEM

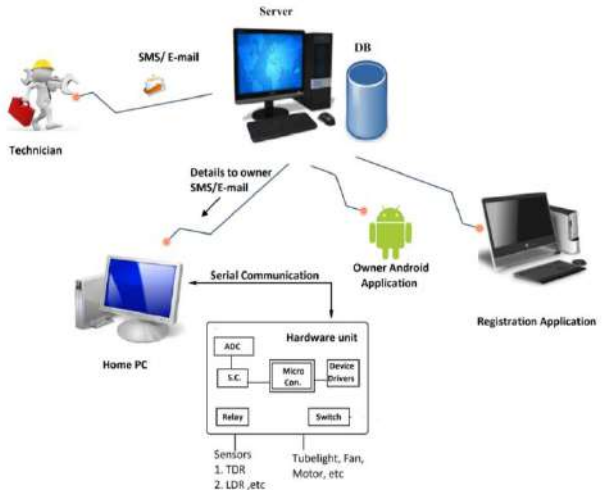

Fig. 1.2 Proposed System Model

The above diagram gives a pictorial view of i-Home. Basically, we are trying to design a system which integrates cloud and database server going hand in hand to fetch the information. This device can be widely used as IoT application to detect the fault in the appliances. We use a hardware unit in which we are going to use a microcontroller chip, a signal conditioner, a relay board, a device driver and ADC. We are going to use sensors i.e. temperature sensor, light sensor, vibration senor on appliances such as tube light, fan, motor, electric geyser. Firstly, the sensors need to be attached to the appliances and they need to be connected to the micro-controller with the help of device drivers.[8] The sensor values will come to the micro-controller and the values will be sent to the signal conditioner which prepares it for the next stage of processing. The sensor values now are with ADC which converts analog value to digital value which is readable by computers. Now the digital value is sent to the Admin PC with the help of serial communication (i.e. MAX-232 cable). Admin PC continuously keeps a check on the working of the sensors as well as monitors the sensors values. The Admin PC is provided with threshold values of the sensor; the task of the Admin PC is to check whether the sensor value exceeds the threshold value and if this is true then it will send the information to the cloud server.[10] The cloud server is used to store all the information about the technicians. We are using a registration application in which the technicians will enter their data with the help of database. We are also storing the information about the super market vendors, technicians etc. We are also keeping a record of the date/time when the technician is available, as well as his area of expertise. So now when the sensor value exceeds the threshold value the Admin PC will notify the cloud server about it. The cloud server will go the database and apply the data mining algorithm (in our case Naïve Bayes) on the dataset i.e. the technician's data. Our parameters for prediction of the technicians are: 1) his present location. 2) His availability of time/date. 3) Cost.[13]

We also provide an application to the user in which he/she has to select the type of technician i.e. Local technician or specific brand's system engineer. After the user selects the type of technician the request goes to the cloud server and the data mining algorithm is applied accordingly. Finally, after

the selection of the technician the cloud server sends message to both technician and owner. After the confirmation of the owner the technician is sent to his/her place. [11]

IV. FLOW CHART

At initial state we do the connection among hardware components with personal computer and then give power supply. After that there will be basic checking of hardware that is to check hardware is working properly or not. If there is no any problem then sensors start sensing the values, here we are using arduino. Then the value which sense from sensor will convert into digital format and converted value will be monitor for 30 seconds with provided upper bound or lower bound of threshold. If the values which obtain from sensor cross the threshold then information goes to server and through server mail goes to owner, then owner have to open their android app for choosing the technician whichever he/she wants from the provided list and that list is obtain from naïve Bayes algorithm. Whenever owner choose technician then mail goes to technician, then technician will come and repair or change the device

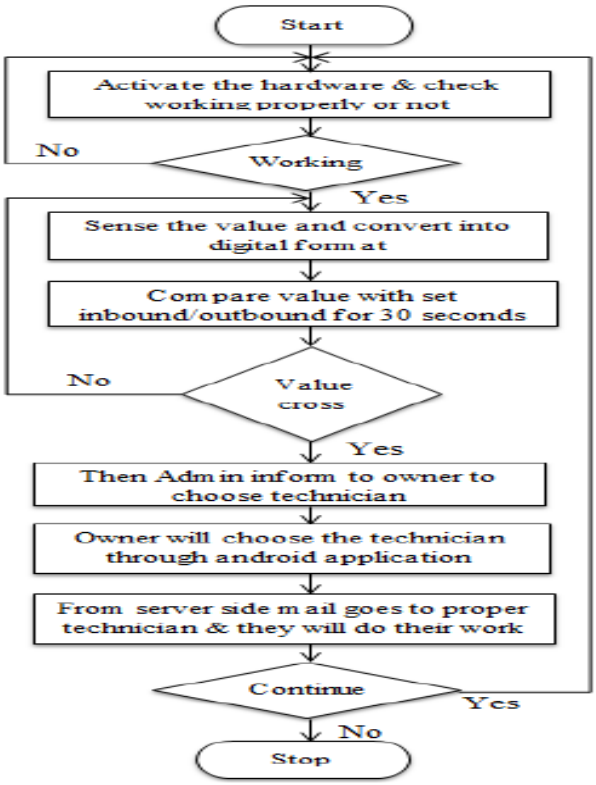

Fig 1.3 Flow Chart

V. EXPERIMENTAL RESULT:-

A simulation of the proposed system is created using Java, Android application and API. This system contains vendor application, admin application and android application. Vendor application gives the facility for vendor registration, technician data update and technician feedback record. The admin is having rights to check the sensor and devices working, sensor settings and monitoring part of devices. Following observation tables gives the brief idea about monitoring of sensor values and device working:

Table 1.4 Experiential Results

Sr. No.	Sensors	Set bound	Bound Limit	Result
1	Temperature(TDR)	Out Bound(60)	>60	Alert will not generate
			<=60	Generate Alert
2	Light(LDR)	In bound(52)	>=52	Generate Alert
			<52	Alert will not generate
3	Potentiometer(Pot)	Out Bound(128)	>128	Alert will not generate
			<=128	Generate Alert

The proposed system monitors each sensor and device for 30 seconds. Admin sets the sensor using Inbound and Outbound values. Based on these values, devices will get monitor. If any sensor value crosses its inbound alert will be generated. Based on the sensor type and technician dataset Naïve Bays algorithm predicts the technician. This predicted answer and other technician list is send to the user or owner using Simple Mail Transfer Protocol (SMTP). User has to select one technician from given options by considering local or company's technician and have to send it to server. Server will send the notification about the appliance failure or faulty devices to technician based on his data set. Thus the proposed system automates the monitoring and selection of technician process if any faulty home appliance or equipment occurs which is the goal of our project.[12]

VI. CONCLUSION

In this chapter, we have introduced the concept of the smart sensor interface. The setup of a cloud based home automation was a proof of the powerful and simple low cost alternative to the available commercial solutions. The key idea of this system is to propose a method that considers a low cost mechanism for integrating IoT with the home monitoring system. The systems that are introduced earlier (eg: Water monitoring system), they just collect the sensor values but they don't put it to use. Our system thus collects the related sensor values, focuses to putting it into some worth by making use of it. The advantages of the proposed system, the feasibility offered to the humans by reducing the human intervention. Another great advantage of the system is that it suggests a low cost option to the user for the repairing of the appliance. Also, the development of the android app, the user is able to select the technician on the basis of the suggestion provided by the Naïve Bayes classifier.

REFERENCES:

1. Qingping Chi, Hairong Yan, Chuan Zhang, Zhibo Pang, and Li Da Xu, Senior Member, "A Reconfigurable Smart Sensor Interface for Industrial WSN in IoT Environment", IEEE transactions on industrial informatics, VOL. 10, pp. 1551-3203, May 2014.
2. Sean Dieter Tebje Kelly, Nagender Kumar Suryadevara, and Subhas Chandra Mukhopadhyay, Fellow," Towards the Implementation of IoT for Environmental Condition Monitoring in Homes" IEEE sensors journal, Vol. 13, October 2013.
3. Takeshi Yashiro, Shinsuke Kobayashi, Noboru Koshizuka, and Ken Sakamura, "An Internet of Things (IoT) Architecture for Embedded Appliances", IEEE R10-HTC2013, Aug. 2013.

4. L. Atzori, A. Iera, and G. Morabito, "The Internet of Things: A survey" Computer Network, vol. 54, pp. 2787–2805, Oct. 2010. [Online] Available:http://dx.doi.org/10.1016/j.comnet.2010.05.010.

5. http://hubpages.com/living/Home-Automation-Sensors

6. Oladayo Bello, Member, IEEE, and SheraliZeadally, Senior Member, "Intelligent Device-to-Device Communication in the Internet of Things", IEEE systems journal,Vol. 10, pp. 1932-8184, 2014.

7. RupaliShanbhag, RadhaShankarmani, "Architecture for Internet of Things to Minimize Human Intervention", International Conference on Advances in Computing, Communications and Informatics, 978-1-4799-8792-4/1, 2015.

8. Himshekhar Das; L. C. Saikia, "GSM enabled smart energy meter and automation of homeappliances"**IEEE Conference** on Energy, Power and Environment: Towards Sustainable Growth (ICEPE), 978-1-4678-6503-1/1, 2015.

9. AbdelhakimAhmim, Tam Le, Esther Ososanya and SasanHaghani, "Design and Implementation of a Home Automation System for Smart Grid Applications", IEEE International Conference on Consumer Electronics (ICCE), 978-1-4673-8364-6/16, 2016.

10. https://en.wikipedia.org/wiki/Naive_Bayes_classifier

11. Kaylee Moser, Jesse Harder, Simon G. M. Koo, "Internet of Things in Home Automation and Energy Efficient Smart Home Technologies", IEEE International Conference on Systems, Man, and Cybernetics, 978-1-4799-3840-7/14, October-2014.

12. J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): A vision, architectural elements, and future directions," Future Gener. Comput. Syst., vol. 29, no. 7, pp. 1645–1660, Sep. 2013.

13. Y.Fan,Y.Yin,L.Xu,Y.Zeng,andF.Wu, "IoTbasedsmartrehabilitation system," IEEE Trans. Ind. Informat., vol. 10, no. 2, pp. 1568–1577, 2014.

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Analysis of Transformer Oil by Using MATLAB Software

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ABSTRACT:

Transformer is a device on which cost effective supply of electricity mostly depends. Hence, to manage the life of transformers, to reduce failures and to extend the life of transformer, some measures are being adopted. Power system reliability depends on the consistency of electrical equipment.DGA is most useful technique for fault detection in oil insulated transformer. When more than one fault exists in a transformer, other methods sometimes fail to diagnose. This paper carried the fuzzy three ratio method which overcomes the drawbacks of the conventional three-ratio method. This paper first carries the fuzzy membership functions for codes "zero," one", "two", then it transfer the conventional logic "AND" and "OR" used in IEC three-ratio method into fuzzy logic . Accuracy of the carried method is much higher than the Conventional IEC Method. It is a sensitive and reliable technique for detection of incipient fault for oil immersed transformer. The fault type of transformer can be obtained efficiently as well as easily. Multiple faults can be diagnosed by using fuzzy method, while, it may not be possible for any conventional method. Cost of maintenance can be reduced and the life of transformer can be increase by applying fuzzy logic method the life. Fuzzy logic is the largest investment in the utility's system. Detection of incipient fault in power transformer is a crucial. DGA is a successful technique to detect these potential faults and it provide wealth of diagnostic information. This method is the most effective condition monitoring tool of power transformer and hence identifying a suitable condition –base asset management decision.

Keywords: *Power Transformer, Fuzzy Logic method, Dissolved Gas-In-Oil Analysis (DGA), Conventional Three-Ratio Method*

I.INTRODUCTION

The power transformer is a major apparatus in a power system, and its correct functioning is vital to system operations These devices, such as, Buchholz relays or differential relays, respond only to a severe power failure requiring immediate removal of the transformer from service, in which case, outages are inevitable. Thus, preventive techniques for early detection faults to avoid outages would be valuable. In this way, analysis of the mixture of the faulty gases dissolved in insulation oil of power transformer has received worldwide recognition as an effective method for the detection of incipient faults. The insulating organic compounds (cellulose paper and oil) produce gas when subjected to thermal and electric stress. Most gases originate in insulating oil and their composition is influenced by temperature.The significant source in this knowledge base is the gas ratio method. Some limitations of this approach are overcome by incorporating the diagnostic procedure and the synthetic expertise method. Proper functioning of power transformers is critical to secure operation of the power system. Methods to identify fault conditions before they deteriorate to a severe state have attracted great research interest.The following table indicates specification of Power transformer;

Table 1.1: Power transformer specification

KVA	10000	
Voltage at no load	HV	33000(Volts)
	LV	11000 (Volts)

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Current	HV	175(Amperes)
	LV	525 (Amperes)
Temperature Rise	45/50 Degree-Celsius	
Frequency	50Hz	
Impedance Voltage	8.35%	
Volume of Oil	6050 Litres	
No load loss	8.5KW	
Load loss	57KW	
Weight of Oil	5200Kgs	
Total weight	22700Kgs	

II. LITERATURE REVIEW

Fault gases in transformers are produced by degradation of transformer oil or other insulating materials, e.g. cellulose and paper. When discharge or overheating occurs, the oil around the fault will decompose into specific gases, which dissolve in the oil. Different fault types are therefore reflected by the different compositions of the gases-in-oil. Fault gases in transformers are produced by degradation of transformer oil or other insulating materials, e.g. cellulose and paper .

Hongzhong Ma, compare the fuzzy three ratio method and conventional IEC three ratio method. Programming is carried out by using MATLAB. Self-learning and adaptive fuzzy diagnosis systems, were developed to overcome the shortcomings of the IEC conventional system to learn automatically from the many practical and valuable diagnosis results as well as accuracy is high of fuzzy method as compared to IEC conventional method. Ali A Albakrey presents modified fault diagnosis method for power transformers using fuzzy logic technique.

The fuzzy analysis proves highly applicable to the problem, because it combines the values of gas concentrations with their evolution during the time period.[Fuzzy logic method does not need to spend a lot of time for "learning", it's programming is easy. Simulation results from practical generation and distribution transformer data show the program work well and the accuracy of the carried method is much higher than the conventional IEC method.

The fuzzy expert system combines the expertise and experience of the diagnosis experts with the diagnosis system using fuzzy if-then rules. The gas attribute thresholds to classify fault types were fuzzified to manipulate the imprecision and incompleteness of the DGA. The approach was designed according to existing classification criteria (e.g., IEC/IEEE standards). Such diagnosis was promising; however, many limitations exist. For example, the fuzzy expert system cannot learn from previous diagnosis results because the membership functions and the diagnostic rules were determined by practical experience or trial-and-error tests. Moreover, the diagnosis accuracy depends on the completeness and representation of accumulated human knowledge.

Transformers are usually designed for continuous operation in the system. These causes the windings to experience shear mechanical and electrical stresses. As these stresses cause the windings to heat, efficient cooling of the transformer is required. The rise in heat can deteriorate the insulation used in the windings and this heat rise can damage the transformer. To overcome this problem almost all the load bearing transformers are liquid filled. The liquid in all of these units is “transformer oil”, petroleum-based insulating oil refined specifically to meet the requirements of this application.

Fault detection can be classified based on either detection by signal model or model based on approach. In this work model based upon the parameter estimation is employed for fault detection. Signal model based fault detection methods are usually used for detecting machine vibration imbalance and bearing fault or knocking etc.

The two methods for fault diagnosis classification are: classification method (with structural knowledge) inference method (without structural knowledge). When the basic relationship between fault and symptoms is particularly or fully known in the form of

casual relation the inference method of fault diagnosis is employed. Fault tree is an inference method of fault diagnosis apart from neutral network and fuzzy based techniques. The symptoms and events are considered as binary variables and condition art of the rules are evaluated by Boolean equation. However fault tree is not popular method because of continuous nature of fault and symptoms. In this work inference method is based on AI technique is used for fault diagnosis.

Fault diagnosis is usually followed by fault detection wherein kind, size and location of fault is determined. In past decade the technique of neural network is rowing as data driven method which provides total new perspective for diagnosis.

III. PROPOSED SYSTEM:

We will describe a simple and efficient method of diagnosis of transformer incipient faults by fuzzy three gas ratio method. In the proposed system contains 10 MVA power transformer, due to increase in transformer oil temperature there are some internal faults are occurred. Here in this paper we have to discuss about IEC and Fuzzy three gas ratio method which is useful to identify transformer faults, which can be described as in the following.

A) FUZZY DIAGNOSIS SYSTEM:

The following block diagram indicates that data base of dissolved gas in oil goes towards fuzzification and membership function block; then output of both the block is given to rule base fuzzy inference system. Here we will get fuzzy output i.e.the knowledge-based fuzzy rule; by using defuzzification converts fuzzy output into crisp output.At last we are able to diagnose the fault in power transformer.

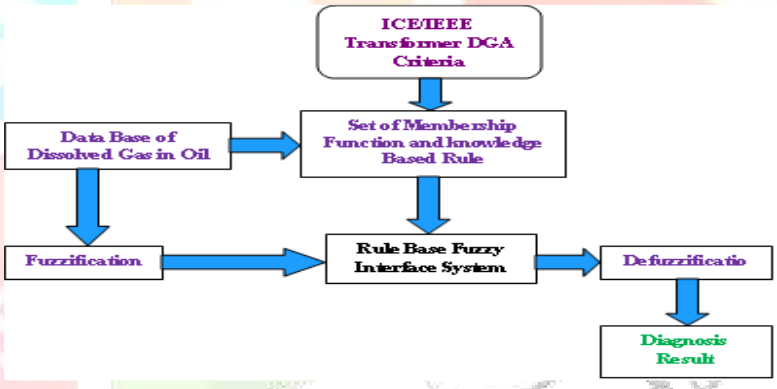

Figure1.1: Fuzzy diagnosis system

B) COST ESTIMATION TABLE:

Description	Quantity	Value (INR)	Per Unit (INR)
3p,33/11kv,10000 KVA OLTC Power Transformer Including Bushing, Radiator, Conservator, Transformer oil, Tools &Accessories	1	1,742,628	1,742,628
Mounting arrangements for Transformer	1	2,743	2,743
Labour and transport	1	618	618
Pipe Earthing	1	810	810
MATLAB	1	100000	100000
Total			**1,846,799**

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IV. RESULTS:

Sample of transformer oil check by using IEC conventional method and Fuzzy logic method; final output of MATLAB software are shown in following window

A)Required user inputs of fuzzy three gas ratio method**:**

Enter the value of concentration of Hydrogen gas in ppm H2 for the DGA sample:150
Enter the value of concentration of Methane gas in ppm CH4 for the DGA sample:110
Enter the value of concentration of Ethane gas in ppm C2H6 for the DGA sample:90
Enter the value of concentration of Ethylene gas in ppm C2H4 for the DGA sample:280
Enter the value of concentration of Acetylene gas in ppm C2H2 for the DGA sample:50

Three Ratios

X = Acetylene C2H2 / Ethylene C2H4

X =0.1785

Y = Methane CH4 / Hydrogen H2

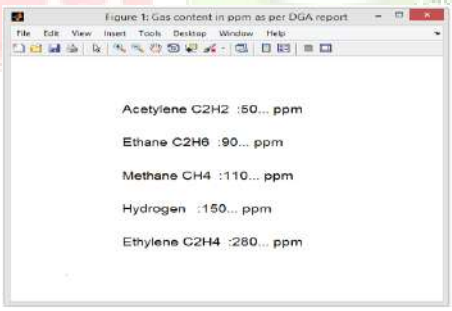
Y = 0.733

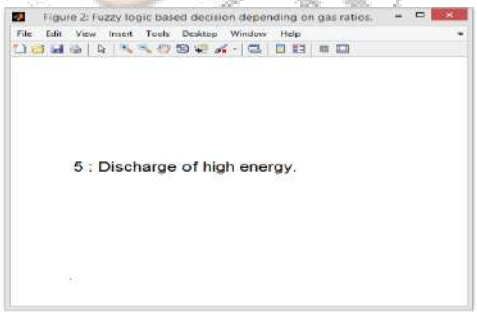
Z = Ethylene C2H4 / Ethane C2H6

Z =3.111

Fault is Discharge of High Energy.

Output of Fuzzy Three Gas Ratio Method:





B) Required user inputs of IEC based conventional three ratio method:

Amount of gas present in oil sample:
Enter the value of concentration of Hydrogen gas in ppm H2 for the DGA sample :150
Enter the value of concentration of Methane gas in ppm CH4 for the DGA sample :110
Enter the value of concentration of Ethane gas in ppm C2H6 for the DGA sample :90
Enter the value of concentration of Ethylene gas in ppm C2H4 for the DGA sample :280
Enter the value of concentration of Acetylene gas in ppm C2H2 for the DGA sample :50
Roger Ratio

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X = Acetylene C2H2 / Ethylene C2H4

X = 0.1785

Y = Methane CH4 / Hydrogen H2

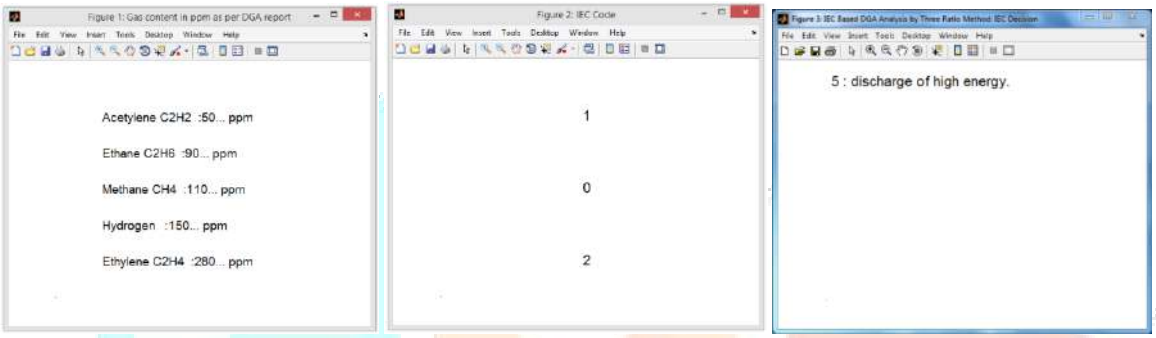
Y = 0.733

Z = Ethylene C2H4 / Ethane C2H6

Z = 3.111

Fault is Discharge of High Energy

Output of IEC Based Conventional Three Gas Ratio Method:



Comparatively Study of Fuzzy and IEC conventional method:

Sr. No.	Fuzzy Three Gas Ratio Method	IEC Conventional Method
1	Accuracy 88.89%	Accuracy 66.67%
2	Programming short	Programming lengthy
3	Lot of time required for learning	Less time required for learning
4	After IEC code generation fault will detect.	In fuzzy method we can easily detect the fault.

V. CONCLUSION

A Power transformer fault diagnose method based on Fuzzy Three Ratio Method. This method can overcome the drawbacks of the Conventional IEC Three Ratio Method such as: no decision, can't diagnose multiple faults. Simultaneously this method does not need to spend a lot of time for learning, its programming is easy. Simulation results from practical generation and distribution transformer data show the program work well and the accuracy of the proposed method is much higher than the Conventional IEC Method. The 33kv/11kv Distribution Substations Power Transformer was taken for study of Identification of Transformer Incipient faults by using Fuzzy logic-IEC based 3 gas ratio method at Sonai, Ahmednagar.

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REFERENCES

[1]. W. Xu, D. Wang, Z. Zhou and H. Chen, "Fault diagnosis of power transformers: application of fuzzy set theory, expert systems and artificial neural networks", IEE Proc.-Sei. Meas. Technol 1997, 144(1),1997.

[2].Yann-Chang. Huang, TzerYm Hong and Ching-Lien Huang, ―Developing a New Transformer Fault Diagnosis System through Evolutionary Fuzzy Logic‖, IEEE Transactions, 12(2), pp 761-767,1997.

[3].Teo. Brescia, Sergio. Bruno, La Scala Massimo, Silvia Lamonaca, Giuseppe Rotondo, and UgoStecchi, ―A fuzzy-logic approach to preventive maintenance of critical power transformer, Electricity Distribution, 20th International Conference and Exhibition , pp. 1 – 5,2009.

[4]. Rahul Soni, KaushalChaudhari, "An Approach to Diagnose Incipient Faults of Power Transformer Using Dissolved Gas Analysis of Mineral Oil by Ratio Methods Using Fuzzy Logic", (SCOPES)-2016.

[5].K. Tomsovic, M. Tapper, and T. Ingvarsson, "A fuzzy information approach to integrating different transformer diagnostic methods," IEEE Trans. Power Del., vol. 8, no. 3, pp. 1638–1646, Jul. 1993.

[6].C E lin, J M ling. "An Expert System for Transformer Fault Diagnosis Using Dissolved Gas Analysis," IEEE Trans on Power Delivery, vol. 8, pp.231~238, Jun. 1993.

[7].CS Chang, CW Lim, and Q Su, " Fuzzy-Neural approach for Dissolved Gas Analysis of Power Transformer Incipient Faults," in Australasian Universities Power Engineering Conference (AUPEC 2004), 26-29 September 2004, Brisbane, Australia.

[8].Hongzhong Ma, Zheng Li, P.Ju, Jingdong Han, and Limin Zhang, "Diagnosis of Power Transformer Faults Based on Fuzzy Three-Ratio Method," in The 7th International Power Engineering Conference, IPEC 2005, Nov 2005.

SELF TUNING CONTROL SYSTEM FOR UPFC APPLICATION BY PR CONTROLLER

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Abstract: The growing energy demand has caused the interconnected power systems to operate close to their stability limit. As a consequence oscillations occurs, such oscillations weaken the system security and if not effectively damped can lead to widespread blackouts. A relatively recent solution based on the advancements in high-power semiconductors is the Flexible AC Transmission System (FACTS) technology meant for transmission locations. FACTS technology comprises of a multitude of FACTS devices among which the Unified Power Flow Controller (UPFC) possesses a unique capability of providing both power flow and voltage control particularly, with a suitable transient control system the UPFC can satisfactorily mitigate power system oscillations. This thesis proposes an adaptive control scheme that supplements an existing Proportional Resonant (PR) UPFC control system in damping power system oscillations. PI controller can also be used but it has more steady state error than PR controller. However, its application in a power system that experiences continuously changing system conditions demands its frequent re-tuning. On the other hand, the proposed scheme in this project is a Self Tuning (ST) controller that automatically adapts to the system changes and thereby provides an optimal control for a wide range of operating scenarios. By using ST Controller the problem of retuning is get solved. The simulation results based on MATLAB/ SIMULINK were performed to verify the effectiveness of PR controller of UPFC.

Keywords: **Flexible AC Transmission System, Unified Power Flow Controller, self-tuning, proportional integral, proportional resonant**

INTRODUCTION

Most of those systems embody a grid-connected voltage-source convertor whose practicality is to synchronies and transfer the variable created power over to the grid. This paper is describing the recently introduced proportional resonant (PR) and their quality for grid-connected converters current control. energy technologies, like wind and solar primarily based energy generation systems, are receiving national and worldwide attention due to the rising rate of consumption of nuclear and fossil fuels Another feature of the adopted convertor is that it's typically pulse width modulated (PWM) at a high change frequency and is either current- or voltage-controlled employing a designated linear or nonlinear management formula. The deciding criterion once choosing the suitable management theme sometimes involves an optimum exchange between value, complexity and wave form quality required for meeting (for example) new power quality standards for distributed generation in low-voltage grids, this controller will have a big impact on the standard of this equipped to the grid by the PV electrical converter, and thus it's necessary that the controller provides a top quality curving output with smallest distortion to avoid making harmonics. 2 controllers that are employed in current controlled PV inverters are the PI controller with the grid voltage feed-forward and also the PR controller. Exploring the simplicity of PI controllers and to boost their overall performance, several variations are planned within the literature together with the addition of a grid voltage feed forward path, multiple-state feedback and increasing the proportional gain. Generally, these variations will expand the PI controller information measure however; sadly, they additionally push the systems towards there. In brief, the fundamental practicality of the PR controller is to introduce associate infinite gain at a specific resonant frequency for eliminating steady state error at that frequency, Associate in Nursing is so conceptually almost like a measuring instrument whose infinite DC gain forces the DC steady-state error to zero. The resonant portion of the PR controller will so be viewed as a generalized AC flexibility of calibration the resonant frequency, makes an attempt at victimization multiple PR controllers for by selection compensating low-order harmonics have additionally been for three-phase active power filters, for three-phase uninterruptible power provides

(UPS) and for single part electrical phenomenon (PV) inverters. The PR controller provides gain at a definite frequency (resonant frequency) an almost no gain exists at the opposite frequencies. In this paper the PR controllers are introduced and the performances are represented victimization frequency analysis. Then, typical management methods for each single-phase and three-phase RES victimization PI and PR are represented and compared in terms of performance and simple implementation. From the read purpose that electronic power converters can notice increasing grid-interfaced applications either as inverters process DC energy from RES for grid injection or as rectifiers learning grid energy for various load usages, this paper aims to produce a comprehensive reference for readers on the combination of PR controllers and filters to grid-connected converters for enhancing their trailing performances. To begin, the paper reviews frequency domain derivation of the perfect and non-ideal PR controllers and filters, and discusses their similarities as compared to classical PI management. Limits for the present harmonics. Typically, PI controllers with grid voltage feed forward are utilized in order to manage the present of grid-connected converters.

SYSTEM OVERVIEW

Unified power flow controller

The Unified Power Flow Controller is consists of two switching converters, that are considered as voltage sourced inverters using gate thyristor valves. These inverters "VSC1" and "VSC2" are operated with a common dc link provided by a dc storage capacitor. With this arrangement the ac power converter in which the active power can freely flow in either direction between the ac terminals of the two inverters and each inverter can severally produce as well as absorb the reactive power at its own ac output terminal. Since the series converter of the UPFC will inject a voltage with variable magnitude and phase angle it can exchange active power with the transmission line with the help of series transformer. However a UPFC as a whole (both converter) cannot supply or absorb active power in steady state (except for the power drawn to compensate for the losses).Until it has a power source at dc terminals. Therefore the shunt branch is needed for compensate (from the system for any real power drawn/supplied by the series branch and the losses. When the power balance is not maintained, at that time the capacitor cannot remain at a constant voltage. Shunt branch also can independently exchange reactive power with the system. Inverter 2 provides the main function of the UPFC by injecting a voltage Vpq with controllable magnitude Vpq ($0 \leq Vpq \leq Vpqmax$) and phase angle ρ ($0 \leq \rho \leq 360°$), at the power frequency, insert with line by an insertion transformer. This injected voltage considered as synchronous ac voltage source.

The function of converter1 is to provide or absorb the active power required by converter 2 at the common dc link. The power of the dc link is converted back to ac and coupled to the transmission line by a shunt-connected transformer. If reactive power is needed then inverter 1 can also produce or absorb controllable reactive power, so it can provide independent shunt reactive compensation for the line. It is also important to note that whereas there is a closed "direct" path for the active power negotiated by the action of series voltage injection through Inverters 1 and 2 back to the line, corresponding the reactive power exchanged is supplied or absorbed locally by Inverter 2 and therefore the reactive power cannot flow through the line. So the Inverter 1 can be operated at a unity power factor or be controlled to have a reactive power exchange with the line independently of the reactive power exchanged by Inverter 2. That means there is no continuous reactive power flow. Inverter-1 is connected to the power system through a transformer T1 in shunt and the inverter-2 power system through another transformer T2 such that the secondary of the transformer T2 is in series with the transmission line. The transformers T1 and T2 can be referred to as shunt and series transformers respectively for the purpose of clarity.

Where the shunt inverter and series inverter of a UPFC are modeled as a voltage source series with their transformer reactance is the simplest of al1 the models. The model provides for detailed interaction between the series and the shunt inverter. Figure shows the UPFC model. Xsh and Xse represent the reactance of transformers T1 and T2 respectively. *Vsh* and *Vse,* represent the voltage generated by the shunt and the series inverter respectively. Bus-E and bus-F represent the UPFC bus and the transmission line side bus of UPFC respectively.

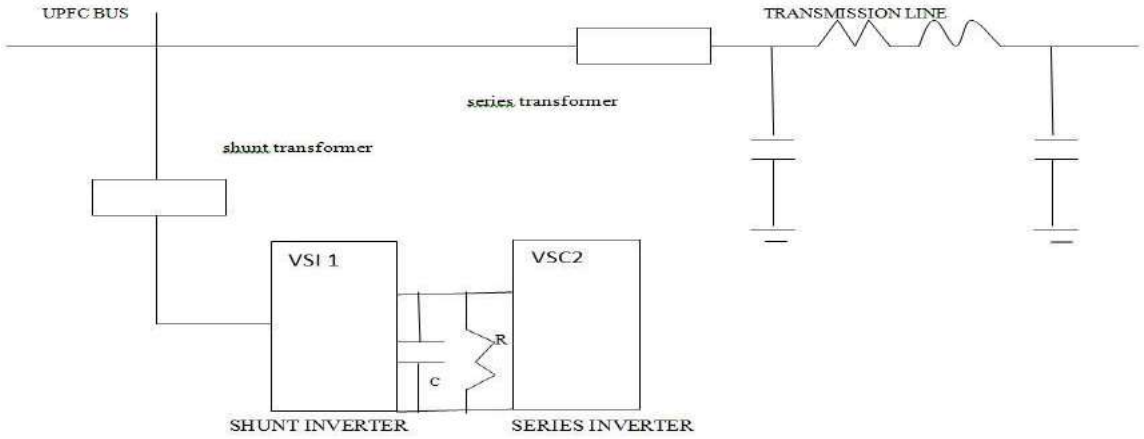

Figure 1: Unified power flow controller configuration

For performing load flow studies with UPFC, the series and the shunt inverters are assumed to produce balanced 50 Hz voltages of variable magnitude and phase angle. The shunt and the series voltage sources phasors can be mathematically represented as Where V_{sh} and V_{se}, are the root mean squared magnitudes of the shunt and the series voltage sources.

$$\hat{V}_{sh} = V_{sh}(\cos\theta_{sh} + j\sin\theta_{sh})$$

$$\hat{V}_{se} = V_{sem}(\cos\psi_{se} + j\sin\psi_{se})$$

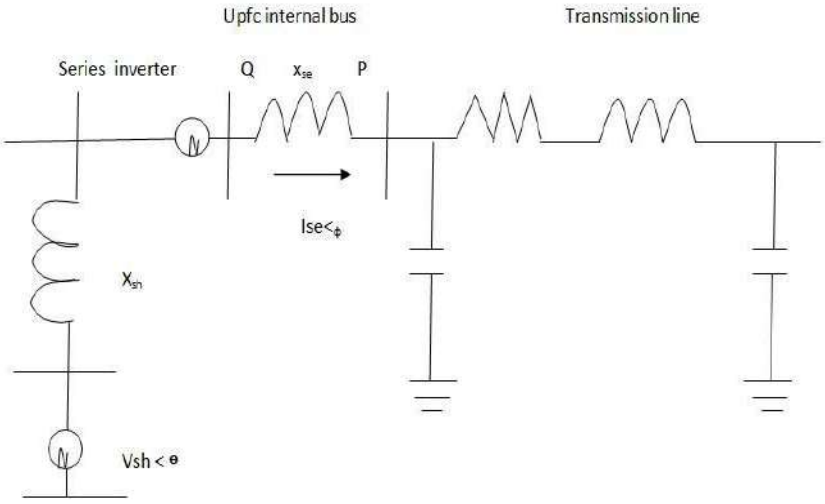

Figure 2:UPFC model

III UPFC CONTROLL SYSTEM

The unified power flow controller (UPFC) is one of the most commonly used FACTs controllers and its main function is to control the voltage, phase angle and impedance of the power system thereby modulating the line reactance and controlling the power flow in the transmission line. The main components of the UPFC are two voltage source inverters (VSIs) connected by a common dc storage capacitor which is connected to the power system by a coupling transformers. One (VSIs) is connected in shunt to the transmission system through a shunt transformer, while the another (VSIs) is connected in series to the transmission line by a series transformer. Three phase system voltage of controllable magnitude and phase angle (Vc) are inserted in series with the line to control real and

reactive power flows in the transmission line. So, this inverter will exchange active and reactive power within the line. The shunt inverter is operated in such a way as to demand this dc terminal power (positive or negative) from the line keeping the voltage across the storage capacitor (Vdc) constant.

There are many possibilities of operating configurations by combing two or more converter blocks with flexibility. Among them, there is a novel operating configuration, namely the Generalized Unified Power Flow Controller (GUPFC) which is significantly extended to control power flows of multiline or a sub-network rather than control power flow of single line by a Unified Power Flow Controller (UPFC) or Static Synchronous Series Compensator (SSSC). The UPFC consists of two branches. The series branch consists of a voltage source converter which injects a voltage in series by a transformer. Since the series branch of the UPFC can inject a voltage with variable magnitude and phase angle it can exchange active power with the transmission line. The energy storing capacity of this dc capacitor is generally small. Therefore, real power drawn by the shunt converter should be equal to the real power produced by the series converter. The reactive power in the shunt or series converter can be chosen independently, giving greater flexibility to the power flow control. The coupling transformer is used to connect the device to the system

Proportional Integral (PI) Controller-:

Now days, the PI controller is most commonly used in industrial application due to its simple structure, easy to design and low cost. Despite these advantages, the PI controller fails when the controlled object is extremely nonlinear and uncertain. PI controller will remove forced oscillations and steady state error resulting in operation of on-off controller and P controller respectively. However, introducing integral mode has a negative effect on speed of the response and overall stability of the system. Thus, PI controller can not increase the speed of response. It can be expected since PI controller cannot have means to predict what will happen with the error in near future. This problem can be resolved by introducing derivative mode which has ability to predict what will happen with the error in near future and thus to decrease a reaction time of the controller. PI controllers are very often used in industry, especially when speed of the response is not an issue.

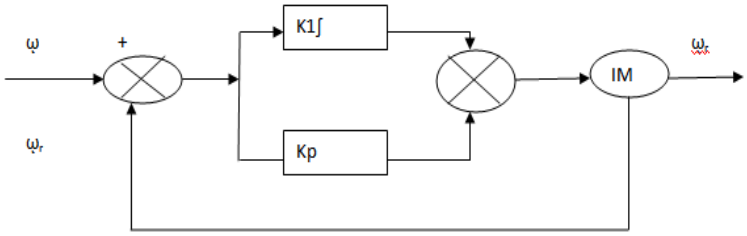

Figure 3. Block diagram PI controller

IV.SYSTEM'S SIMULATION AND RESULTS

In this project 3 phase system of 25 kv, 100MVA is used. One 3 phase Pi section feeder of 21km and another feeder of 2 km is used. Then one RC system is used for storing the active power in the system. We have also used 2 coupling transformer, one is shunt coupling transformer which will take or inject voltage from or to shunt converter or transmission line. Another transformer is series coupling transformer which connects series converter to transmission line and exchange of power between series converter and transmission line is done by series transformer.

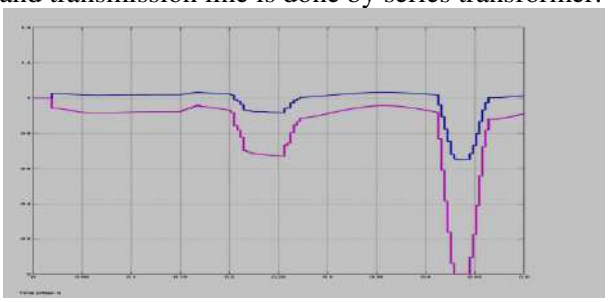

Figure 4: Voltage waveform of series transformer of UPFC

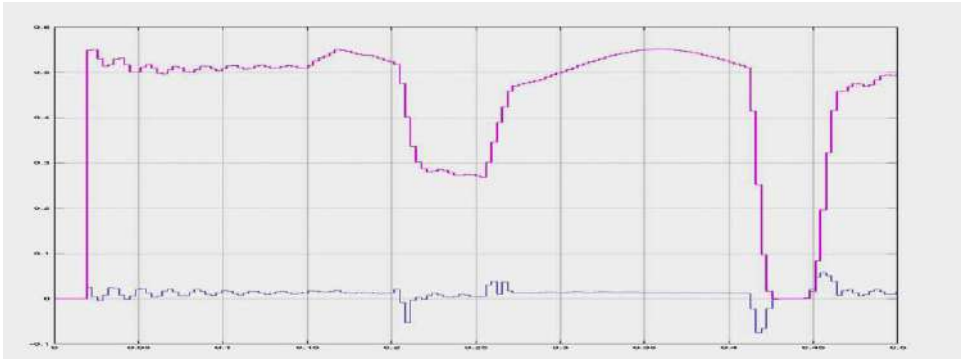

Figure 5: Active and reactive power of series transformer of UPFC

The above 2 figure (fig 5 and 6) graphs shows the voltage, active and reactive power waveform of series transformer of Unified power flow controller. As there is a 3 phase fault between 0.4 to 0.45s and single line to ground fault between 0.2 to 0.25sec, there is a distortion and drop in wave at that time.

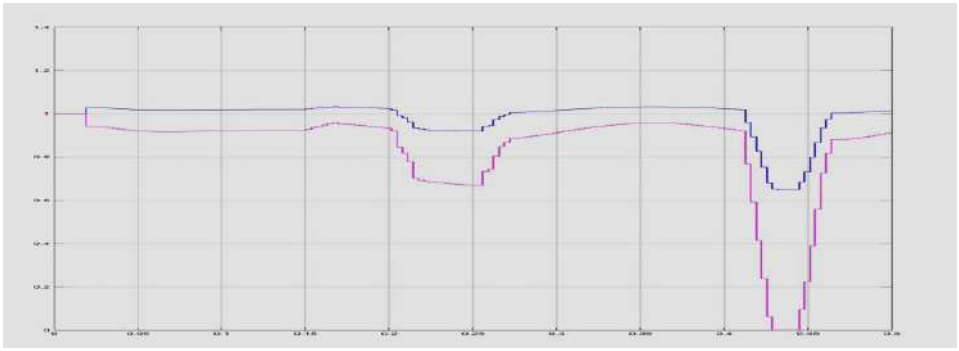

Figure 6: Voltage of shunt transformer of UPFC

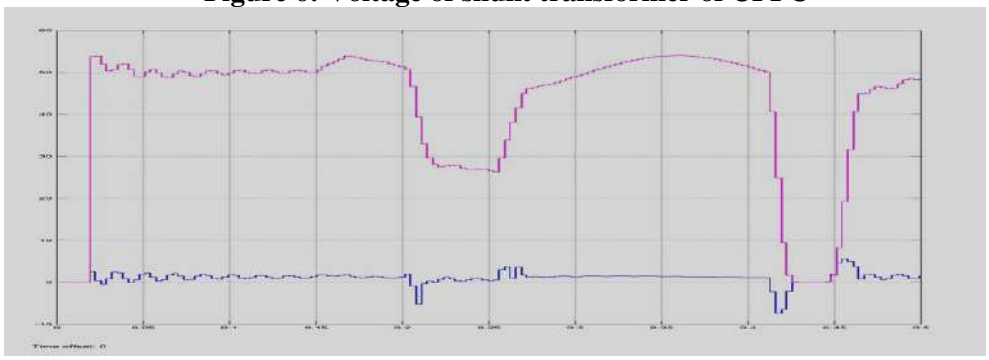

Figure 7: Active and reactive power of shunt transformer of UPFC

The above 2 figure (fig 6 and 7) graphs shows the voltage, active and reactive power waveform of shunt transformer of Unified power flow controller. As there is a 3 phase fault between 0.4 to 0.45s and single line to ground fault between 0.2 to 0.25sec, so there is a distroation and drop in wave at that time. The above graph shows the 3 phase current waveform of shunt transformer of UPFC. As there is a fault between 0.4 to 0.45s and single line to ground fault between 0.2 to 0.25sec , so there is a distortion and drop in wave at that

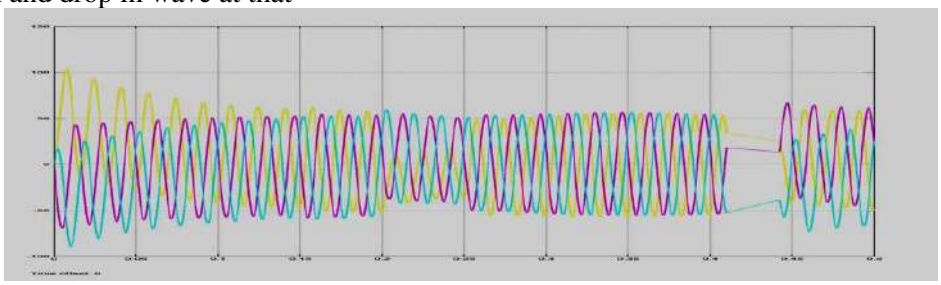

Figure 8: Three phase current near shunt transformer of UPFC

CONCLUSION

The Unified Power Flow Controller (UPFC), with its unique combination of fast shunt and series compensation, is a powerful device which can provide power regulation, i.e. voltage magnitude and phase control. The add-on self tuning with PR controller provided significant damping improvement for the inter-area mode as compared to the conventional PI-UPFC controllers. The use of constrained-RLS over the standard RLS identifier for online parameter identification ensured favorable control performance even during large disturbances. UPFC can be used to improve transient stability margin or to damp low frequency oscillations. The UPFC is the versatile and sophisticated power equipment that has emerged for the control and optimization of power flow in transmission systems. It offers major potential advantages for the static and dynamic operation of transmission lines.

REFERENCE

1. An Add-On Self-Tuning system for a UPFC Application"," in Proc. IEEE Power Eng. Soc. Gen. Meet., 2007, pp. 1–6. 2. Z.Hamid, I. Musirin Member IEEE, M.M.Othman, M.R.Khalil Faculty of Electrical Engineering, Mara University of Technology, Selangor, Malaysia "Optimum Tuning of Unified Power Flow Controller via Ant Colony Optimization Technique".

3. Bruno, Student Member, IEEE, and Massimo La Scala, Senior Member "Unified Power Flow Controllers for Security-Constrained Transmission Management Sergio", IEEE June 2010.

4. A. Ajami1, PHD Student, S.H. Hosseini2, Member IEEE."line current balancing exploitation unified power flow controller"

5.Sajjad Golshannavaz, Farrokh Aminifar, Member, IEEE, and Daryoush Nazarpour "Application of UPFC to Enhancing Oscillatory Response of Series-Compensated Wind Farm Integrations" IEEE transactions on smart grid, vol. 5, no. 4, july 2014

6.G. M. Huang and Y. Li, "Impact of Thyristor Controlled Series Capacitor on Bulk Power System Reliability," in proc. IEEE Power Engineering Society Summer Meeting, Chicago, America, Jul. 2002,pp. 975-980.

7. H. I. Shaheen, Student Member, IEEE, G. I. Rashed, Student Member, IEEE, and S. J. Cheng, Senior Member "Design of New Nonlinear optimum prognosticative Controller for Unified Power Flow Controller ", IEEE ©2008

8. A brand new Control Strategy for the Unified Power Flow Controller" IEEE Trans.Ind. Electron., vol. 59, no. 8, pp. 3102–3112, Aug. 2012.

9. S.R. Samantaray1 L.N. Tripathy2 P.K. Dash "Differential equation-based fault locator for unified power flow controller-based transmission line using synchronized phasor measurements"

10. R. Sadikovic, P. Korba, and G. Andersson, "Self-tuning controller for damping power system oscillations with FACTS devices," in Proc. IEEE Power Eng. Soc. Gen. Meet., 2007, pp. 1–6.

11. Wei Qiao, Student Member, IEEE, and Ronald G. Harley, Fellow"load flow studies with upfc power injection mode", IEEE FEBRUARY 2007

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Software Quality Improvement Approach Towards Defect Management Process

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Abstract: Software quality issues require unique consideration particularly in perspective of the requests of value programming item to meet consumer satisfaction. Programming improvement extends in many associations require appropriate imperfection administration process with a specific end goal to deliver high quality programming item and decrease the number of defects. The objectives of this investigation are the manner by which to deliver brilliant programming and lessening the quantity of defects. Subsequently, the target of this paper is to give a system to overseeing programming defects by following characterized life cycle processes. The strategy begins by checking on defects, defect models, best practices and standards. A system for defect management life cycle is proposed. The significant commitment of this study is to characterize a defect management guide in programming advancement. The appropriation of a compelling defect management process accomplishes a definitive objective of creating high quality software products and contributes towards continuous software process improvement.

Keywords: Defects; Defect Management, Software Quality

I INTRODUCTION

Most programming associations or IT departments are involved with the utilization of defect management procedure to enhance the productivity of the software development projects. Software quality is an imperative perspective in programming improvement which ensures quality software product is produced. Software quality is characterized as the level of conformance to particular utilitarian necessities, determined quality gauges and great programming building hones. The IEEE meaning of software quality are expressed as how much a system, segment, or process meets determined prerequisites; how much a system, segment, or process meets client or client needs or desires. In any case, in managing programming designing exercises, programming quality issues or bugs may happen along the term that the item is being created. The kinds of issues might be allowed as software errors, faults or failures. A little deformity may cause harm as far as financial, loss of client trust. The deformities may decrease the product item quality and consumer loyalty. Imperfection which is damaging in nature is lack in the product item will without a doubt diminish the product item quality. Hence, influence the productivity and nature of programming building forms. Above all the deformity in an application may give negative effect to all periods of software improvement process for example, software development process, software design, programming execution, programming testing and software maintenance phases.

In the present circumstance, there is absence of process coherence and visibility between software development and administrations particularly regarding overseeing software error, faults, failures and defects. This issue gives extraordinary impact to software quality change as entirety. This gives motivation towards proposing new defect management demonstrate that can advances better software process improvement. Table I described on software error, fault and failure. The IEEE definitions error, fault and failure are also given in Table 1.

Table 1: Software Quality and Problem Types

Software Quality and Problem Types	*Description*
Software error	Section of code that are partially or totally incorrect as a result of a grammatical, logical or other mistake made by a systems analyst, a programmer, or member of software development team IEEE definition: Human action that leads to incorrect result
Software fault	Software errors that cause the incorrect functioning of the software during a specific application IEEE definition: Incorrect decision taken when understanding the given information
Software failure	Software faults become software failures only when they are activated, when a user tries to apply the specific software section that is faulty. The root of any software failure is software error. IEEE definition: Inability of a function to meet the expected

	requirements.

II. RELATED RESEARCH APPROACH

This area depicts the related research works approach that is applicable to this investigation. The accompanying Table 1 expresses the meaning of every product quality issue. This research characterizes nine reasons for software error which are faulty prerequisites definition, client designer communication failures, consider deviations from software necessities, intelligent outline errors, coding errors, rebelliousness with documentation and coding directions, weaknesses of the testing procedure, technique errors and documentation errors.

This paper researches on the administration of these deformities by characterizing the process life cycle. The survey is performed on defect management tool, defect process, standards and best practices. Research on the necessities of a structure for defect management system. In which the defect following procedure is actualized by utilizing a web-enabled defect tracking system that permit project management, advancement, quality assurance and management of software issues. This demonstrates defect following is a critical practice that ought to be considered for the proposed show. Recognized the metric utilized for defect management that is the defect density. The computation is depends on the measure of the quantity of aggregate defect discovered separated by the extent of the system measured. The system estimate is measured by lines of code (LOC). This demonstrates that there is a requirement for defect prediction and prevention process. The survey on existing standard and best practices are likewise conducted. The Capability Maturity Model (CMM) characterized five maturity levels of and their key process area (KPAs) .The maturity levels are:

1) Level 1: Initial
2) Level 2: Repeatable
3) Level 3: Defined
4) Level 4: Managed
5) Level 5: Optimizing**

Level 5 contains the KPA which is identified with defect management, the Defect Prevention (demonstrated by the image **). Maturity Model Integration (CMMI) which is a more current process change structure include an applicable procedure regions (PAs), known as Causal Analysis and Resolution (CAR). ISO/IEC 20000 is an information technology. The audit on ISO/IEC 20000 shows the presence of procedures, for example, Incident Management and Problem Management which are related to Defect Model.

III. RESEARCH WORK

This segment explains the research approach that is being utilized to conduct this investigation. This study starts with literature survey by finding the meaning of defect, and any current defect models. We have examined this phase under Related Research Work as expressed in the segment above. The discourse incorporates defect, defect models, best practices and measures. The second stage includes the analysis of necessities and models of the defect management process. The third stage is the execution of defect management life cycle. The exploration approval organize considers testing the model on completed software project and contrasting with existing software tools. A few tools have certain criteria that satisfy just certain process in the defect process life cycle. The research approach is shown in figure1.

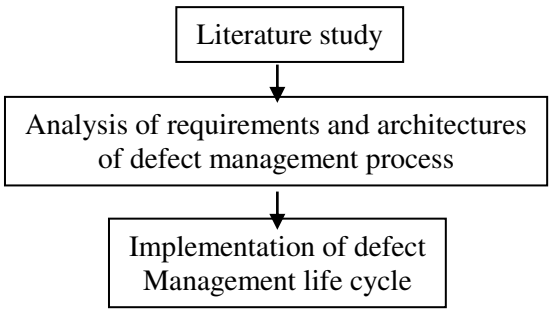

Figure 1: Research Approach

IV. ANALYSIS OF REQUIREMENTS AND ARCHITECTURES OF DEFECT MANAGEMENT PROCESS

The necessities and plan for defect management process incorporates contrasting the current principles and best practices with the proposed structure. This stage figures out what would be incorporated into the system and the plan of the structure. The CMM, CMMI and ISO/IEC 20000 have been reviewed. The audit demonstrates that the defect related processes are incorporated into a higher maturity level of process change structure. Be that as it may, on account of ISO/IEC 20000, there is no particular cycle has been introduced for this system. In this manner, there is a need to find superior life cycle based approach for defect management process.

Table 2 shows additionally Key Process regions or procedures in light of three norms or best practices that are important for the usage of the defect management life cycle. The principal section shows the models or best practices. Column 2 demonstrates the occurrence, defect or issue related KPAs/PAs/forms that shows up at higher development level (ML5). At long last, segment 3 expresses the change, setup or discharge related KPAs/PAs/forms that show up at a error of lower and higher development level (ML2 and ML5).

Table 2: Key Process Zones

Standards & Best Practices	***KPAs/PAs/ Processes***	
	Incident, defect or problem related	***Change, configuration or release related***
CMM	Defect Prevention	Process Change Management (ML5) Technology Change Management (ML5)
CMM1	Causal Analysis & Resolution (ML5)	Configuration Management (ML2)
ISO IEC20000	Incident Management Problem Management	Change Management Configuration Management Release Management

Different benchmarks, for example, ISO/IEC 12207 and ISO/IEC 15504 additionally give guide and life cycle way to deal with software advancement processes. In this manner this research likewise alluded to the current models as standard to build up the customized defect life cycle approach. The last phase of this research, which is the execution of the defect management life cycle, is discussed about in the outcomes and finding discourse area. Six stages are engaged with the life cycle that will give positive effect to the software quality change.

V. RESULTS AND FINDINGS: IMPLEMENTATION OF DEFECT MANAGEMENT LIFE CYCLE

In light of the research of prerequisites and engineering led in the before inquire about stage, the vital defect management rehearses are defect analysis, defect prevention, defect resolution, defect monitoring and defect process improvement. Defect Identification is identified with Incident Management in ISO/IEC 20000. Defect Analysis is applicable to Causal Analysis and Resolution (CMMI) and Problem Management (ISO/IEC 20000). The third practice, Defect Prevention can be contrasted with Defect Prevention (CMM). The change/arrangement/discharge related KPAs/PAs/procedures can be gathered together. The fourth practice, Defect Resolution is related with Process Change Management and Technology Change Management KPAs in CMM. Configuration Management PA in CMMI; and Change Management, Configuration and Release Management forms in ISO/IEC 20000. This investigation verified that defect expectation is additionally critical and it can be allocated under Defect Process Improvement, stage 6. This is related with CMMI maturity level 5 in Organizational Process Performance (OPP) and Quantitative Project Management (QPM) KPAs. The vital defect management practices are explains as below.

A. Defect Identification:

At the point when a defect over and over happens, they should be recognized and recorded in the system. Defects are distinguished at two areas, around then defect was at first identified and at the time the defect has been settled.

B. Defect Analysis:

Defect analysis, defect prevention, defect resolution, defect monitoring and defect process improvement include defect order and scientific classification by utilizing particular naming plans. The grouping of defect speaks to data, for example, stages and exercises of the product advancement stages that the defect injection happens. The system to find out scientific classifications is created. A Meta scientific classification looking at the changed sorts of scientific categorizations are produced and arranged into three angles qualities, structure write and properties. The scientific categorization contains qualities as expressed follow.

1) Location
2) Timing
3) Symptom
4) End Outcome
5) Mechanism
6) Cause (Error)
7) Severity
8) Cost

C. Defect Prevention:

In this stage, the defects are researched. Conclusion is performed on the basic reasons for defect. Underlying driver examination is led at this stage and preventive measures are taken to stay away from the recognizes from happening once more.

D. Defect Resolution:

This procedure includes ask for change and settling the deformity.

E. Defect Monitoring:

Defect observing includes guaranteeing the defect management process is usually performed at project level. This progression likewise includes the check of fixes that have been made to determine the defect.

F. Defect Process Improvement:

Defect process change includes the movement to predict potential software defects from test information. The identify forecast adds to the early location of defect in software improvement life cycle. This stage includes software measurements, for example, the utilization of defect removal effectiveness and defect density. Defect removal effectiveness is calculated as the quantity of defects before arrival of item to the aggregate number of basic defects. Figure 2 outlines the defect management life cycle which contains the six stages: defect identification, defect analysis, defect prevention, defect resolution, defect monitoring and defect process improvement.

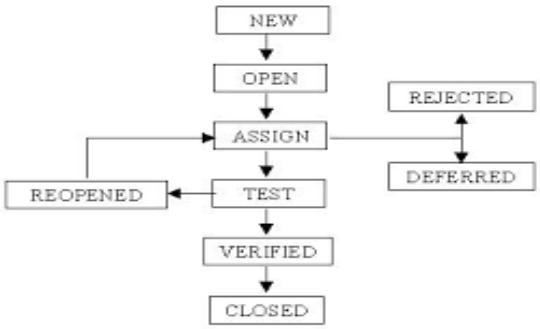

Figure 2: Defect Management Life Cycle

The research approval stage later will consider software activities and defect software apparatuses to confirm the usage of the defect management life cycle arrangement. The proposed arrangement likewise will be approved towards existing procedure change structures, for example, CMMI 1.3 and ISO/IEC 20000 to guarantee the procedure congruity between software development stage and benefits and along these lines give positive effects towards ceaseless software quality change.

VI. CONCLUSION

This paper has introduced an existence cycle process for managing defects in software development projects that can be utilized by associations. The model can be utilized as a part of

agreement to existing defect management device accessible in the market these days. In future we might want to investigate every stage in defect management completely and how it adds to software procedure and quality change. Likewise, we might want to additionally examine and characterize process measurements particularly in the imperfection counteractive action and process change stages.

VII. REFERENCES

[1] R. S. Pressman, Software Engineering: A Practitioner's Approach, 7th ed., New York: McGraw-Hill International, 2009.

[2] D. Galin, Software Quality Assurance: from Theory to Implementation, England: Pearson Education Limited, 2004.

[3] A. Gupta, J. Y. Li, R. Conradi, H. Ronneberg, and E. Landre, "A Case Study Comparing Defect Profiles of a Reused Framework and of Applications Reusing It," Springer, 2008.

[4] A. A. Rahman, "The Framework of a Web-Enabled Defect Tracking System," Proc. IEEE International Conf. on Advanced Communication Technology, Korea, 2004, vol. 2, pp. 609-695.

[5] N. Hasim and A. A. Rahman, "Defect Density: A Review on the Calculation Size Program," Proc. 4th International Conf. on Machine Vision: Computer Vision and Image Analysis, Pattern Recognition and Basic Technologies, Singapore, 2011, Proc. SPIE vol. 8350.

[6] M. C. Paulk, B. Curtis, M. B. Chrissis, The Capability Maturity Model: Guidelines for Improving the Software Process, MA, Reading: Addison Wesley, 1995.

[7] M. C. Paulk, "How ISO 9001 Compares with the CMM," IEEE Software, vol. 12(1), 1995, pp. 74–83.

[8] SEI, "CMMI for Development, Version 1.3, CMMI-DEV, V1.3," No. CMU/SEI-2010-TR-033, Pittsburgh, PA: Software Engineering Institute.

[9] ISO, "ISO/IEC 20000-1: 2005, Information Technology – Service Management - Part 1: Specification," London, UK, 2005a.

[10]ISO, "ISO/IEC 20000-2: 2005, Information Technology – Service Management - Part 2: Code of Practice," London, UK, 2005b.

[11] ISO, "ISO/IEC 12207: 2008, Systems and Software Engineering - Software Life Cycle Processes, London, Uk, 2008a.

[12] ISO, "ISO/IEC 15504-5: 2006, Information Technology - Process Assessment, Part 5: An Exemplar Process Assessment Model," London, UK, 2006.

[13] ISO, "ISO/IEC TR 15504-6: 2008, Information Technology - Process Assessment, Part 6 An Exemplar System Life Cycle Process Assessment Model," London, UK, 2008b.

[14] D. Vallespir, F. Grazioli, and J. Herbert, "A Framework to Evaluate Defect Taxonomies," Proc. XV Argentina Congress on Computer Science, 2009.

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Selective Harmonic Elimination in Multilevel Inverter Using Sine Cosine Algorithm

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Abstract: Multilevel inverters (MLIs) are getting popular in high power application due to its inherent characteristics of minimal switching losses due to low switching frequency. There are various techniques available for reduction of harmonics. However, minimizing the total harmonic distortion in multilevel inverters as well as the elimination of selected harmonic order using conventional methods do not yield promising results. Therefore, authors have adopted optimization based approach for elimination of 5th, 7th and 11th order harmonics of 9 level inverter and 5^{th} order of 5 level inverter. A novel Sine cosine optimization technique has introduced in this work. The proposed method efficiently eliminates the pre-specified harmonic order with reduced THD.
Keywords: Selective Harmonic Elimination, THD, Sine Cosine Algorithm, Multi Level Inverter, Optimization.

INTRODUCTION

Multilevel inverters(MLIs) has got an edge over two-level inverters due to its quality power output and low switching losses due to adaption low switching frequency. MLIs are getting popular in high power applications based on medium voltage sources like batteries, super capacitors solar panels etc. They include numerous switches having special momentousness of switching angles. For efficient switching, many modulation strategies based on switching frequency has been implemented in the past. Firstly, there are fundamental switching frequency based methods i.e. space vector control and selective harmonic elimination (SHE). Secondly, high switching frequency pulse width modulation (PWM) based methods i.e. sinusoidal PWM (SPWM) and space vector PWM [1-3]. Out of these SPWM which uses phase-shifting technique to reduce the harmonics is most popular due to its simplicity and robustness. But as this method has higher switching frequencies incur higher switching losses non-affordable in high power applications. Hence, SHE based on low switching frequencies which can achieve efficient minimization selective harmonics in output waveforms with wide modulation indices, has been widely accepted and being explored.All manuscripts must be in English. These guidelines include complete descriptions of the fonts, spacing, and related information for producing your proceedings manuscripts.

To eliminate the selected low order harmonics from the output voltage/current waveform of a cascaded multilevel inverter, parallel switching of corresponding power switching devices with suitable angles must be followed. To calculate these switching angles, the nonlinear mathematical equations derived from the Fourier series expansion of the output voltage of the inverter must be solved. In most of the recently reported research on SHE techniques; the transcendental equations were solved by iterative procedures like Newton-Raphson, particle swarm optimization, simulated annealing, bat algorithm, Cuckoo search algorithm etc. [4]. In Newton-Raphson method, one needs to have initial guess very close to exact solution to succeed which may not be necessarily obtained due to unknown search space in SHE [5-7]. GA has been used to obtain optimal switching angles for inverters [8]. Despite their usefulness in SHE, they are complicated due to random selection of parameters based on trial and error method. PSO which overcomes the problem of initial guess provides faster convergence and efficient elimination of challenging lower order harmonics, struggles to attain the global optima as it frequently traps in local optima [9-11].

This paper presents the recently introduced sine cosine algorithm [12] to eliminate lower order harmonics in five level and 9 level inverters. This algorithm generates multiple initial random solutions and allows them to run near or away to best solution using a mathematical model based on sine and cosine functions. With the proposed method, the optimum switching angles are calculated to eliminate desired harmonic order with faster convergence and reduced THD.

SELECTIVE HARMONIC ELIMINATION

Ideally, in the multilevel inverters, for every voltage level, there could be multiple switching angles. The number of eliminated harmonics is decided by the number of voltage steps and number of switching angles in each voltage step. However, because of the complexity of the problem, most studies proposed so far are for one switching angle per one voltage level.

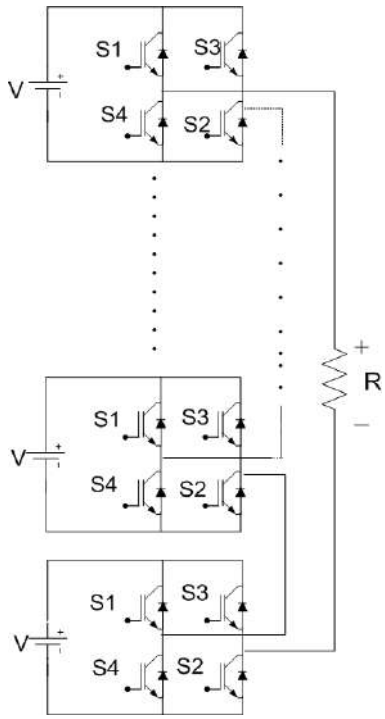

Fig. 1. n-level CHB topology

Here, (n-1)/2 switching angles are used for N levels of voltage output. It means 2 switching angles for 5 level inverter and 4 switching angles for 9 level inverter. Fourier expansion for generated voltage waveform using the SHE-PWM method is given by:

$$\boldsymbol{V(\omega t) = \sum_{m=1,3,5\ldots}^{\infty} \frac{4 * Vdc}{m * \pi} (\cos(m * \alpha 1) + \cdots \cos(m * \alpha N)) * \sin(m * \omega t)} \quad (1)$$

Where N - no of switching angles
m - Harmonic order
V - Output voltage
Vdc -Supply voltage

For n level CHB inverter, transcendental equations are reduced to following:

$$\begin{aligned}
&\frac{4Vdc}{\pi}(\cos(\alpha 1) + \cos(\alpha 2) + \cos(\alpha 3) + \cdots + \cos(\alpha N)) = V_f \\
&\cos(5 * \alpha 1) + \cos(5 * \alpha 2) + \cos(5 * \alpha 3) + \cdots + \cos(5 * \alpha N) = 0 \\
&\cos(7 * \alpha 1) + \cos(7 * \alpha 2) + \cos(7 * \alpha 3) + \cdots + \cos(7 * \alpha N) = 0 \\
&\cos(11 * \alpha 1) + \cos(11 * \alpha 2) + \cos(11 * \alpha 3) + \cdots + \cos(11 * \alpha N) = 0 \\
&\cos(m * \alpha 1) + \cos(m * \alpha 2) + \cos(m * \alpha 3) + \ldots + \cos(m * \alpha N) = 0
\end{aligned} \quad (2)$$

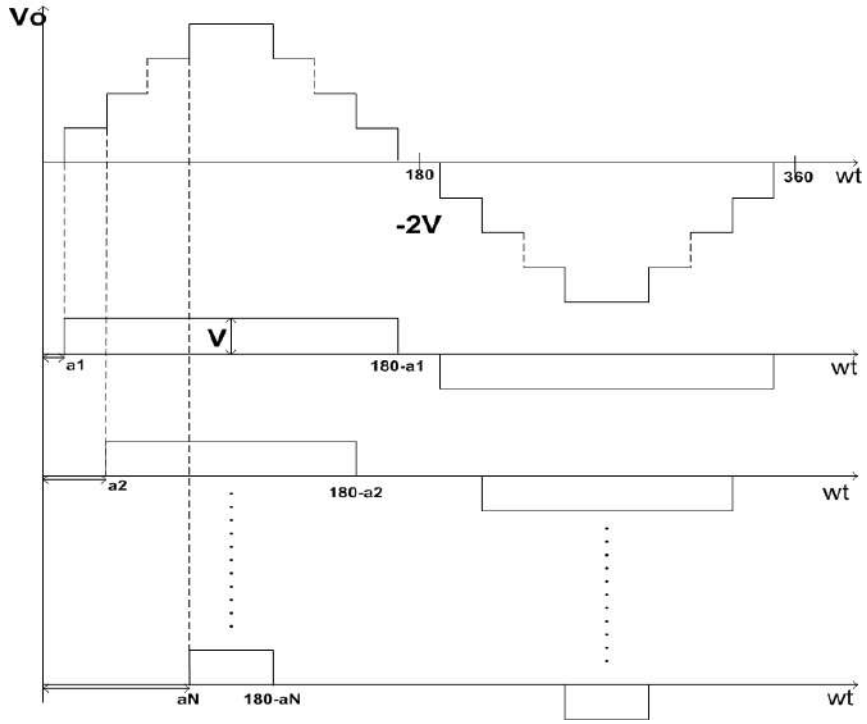

Fig. 2. Staircase output phase voltage of N level inverter

Switching angles must satisfy both the transcendental equations and following condition.

$0 \leq \alpha 1 \leq \alpha 2 \leq \ldots \alpha N \leq \pi/2$.

Here the objective has been set as to minimize the THD as well as to eliminate the lower order harmonics. Triple harmonics are not considered for elimination as they disappear in three phase system automatically.

SINE COSINE ALGORITHM

Recently, Mirjalili [12] introduced new stochastic optimization method named as sine cosine algorithm (SCA) in which up gradation is based on sine and cosine functions. Like others this too is population based in which it starts with a random set of solutions/search agents situated randomly in the search space. The search agents are guided toward an optimal solution in the search space via evaluation of fitness function for each search agent in each iteration. It is one of the fastest converging algorithms and it can successfully balance exploration and exploitation to determine the global optima of challenging test functions. The algorithm keeps track of the best solution's position P achieved by all search agents in the population at each iteration. The mathematical model used in the SCA algorithm is based on the following update function for any search agent Xi [12, 13]:

$$x_{ij}^{t+1} = \begin{cases} x_{ij}^{t} + r_1 * sin(r_2) * |r_3 P_j^t - x_{ij}^t| \text{ if } s < 0.5 \\ x_{ij}^{t} + r_1 * cos(r_2) * |r_3 P_j^t - x_{ij}^t| \text{ if } s \geq 0.5, \end{cases} \quad (3)$$

$$r_1 = a - t\frac{a}{T_{\max}} \quad (4)$$

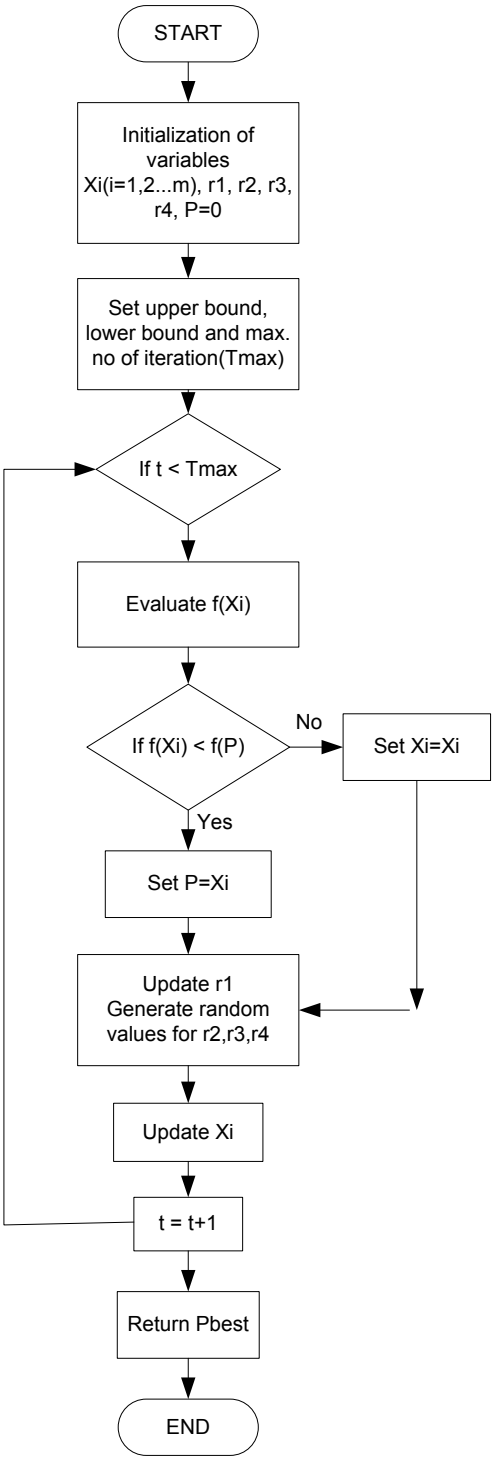

Fig. 3. Flow chart of SCA algorithm

where t is current iteration number, and r1 is a control parameter that balance the exploration and exploitation phases of the algorithm which decreases linearly from a constant value a to 0 by each iteration according to equation (4). Each of r_2, r_3, and s are random numbers. The detailed flow of the used sine cosine algorithm to find optimal solution is depicted in the form of flow chart in Fig. 3. This algorithm will calculate the values of α1, α2… αN with the help of mathematical functions given in above equation (2).

EXPERIMENTAL RESULTS

In this section, the experimental results from MATLAB simulation are presented. MATLAB code of Sine-Cosine algorithm is being run along with Simulink model of cascaded five level and nine

level inverter. Here maximum THD of Simulink model is the fitness function which is to be reduced. Switching angles are calculated at each given modulation index. Modulation index is varied from 0.8 to 1 based on literature. For each modulation index the best switching angles which gives least THD is calculated. From SCA, calculated switching angles versus modulation index graph are shown in figure 4.

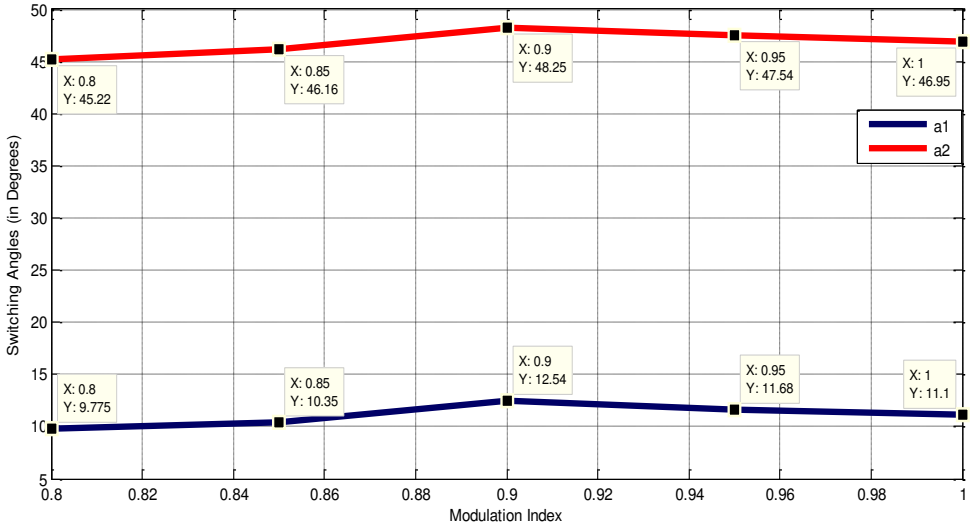

Fig. (4)(a). Modulation index verses switching angles for 5 level CHB

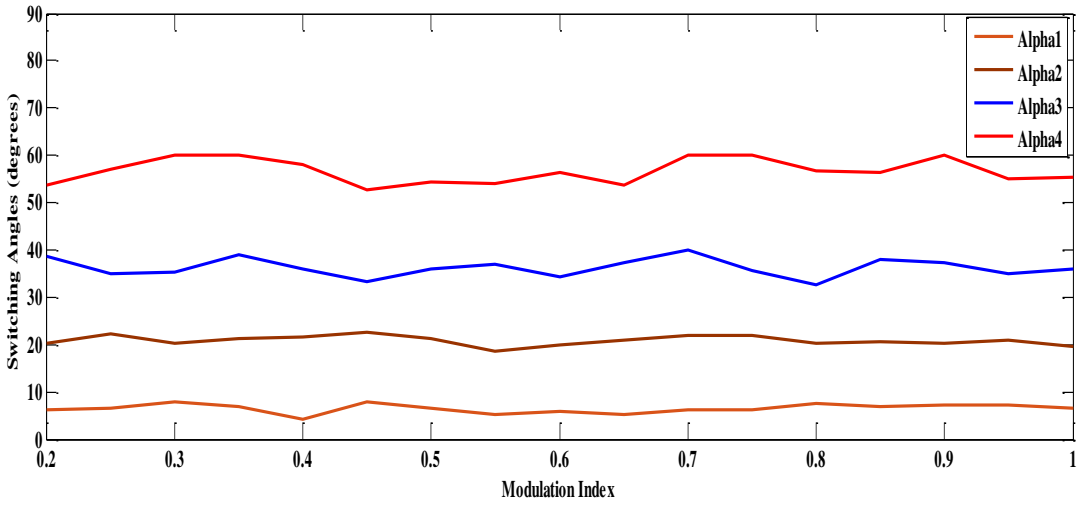

Fig. (4)(b). Modulation index verses switching angles for 9 level CHB

Fig. 5 shows the variation of THD over modulation index. The THD is found reduced and floating near similar values during the set mechanical indices.

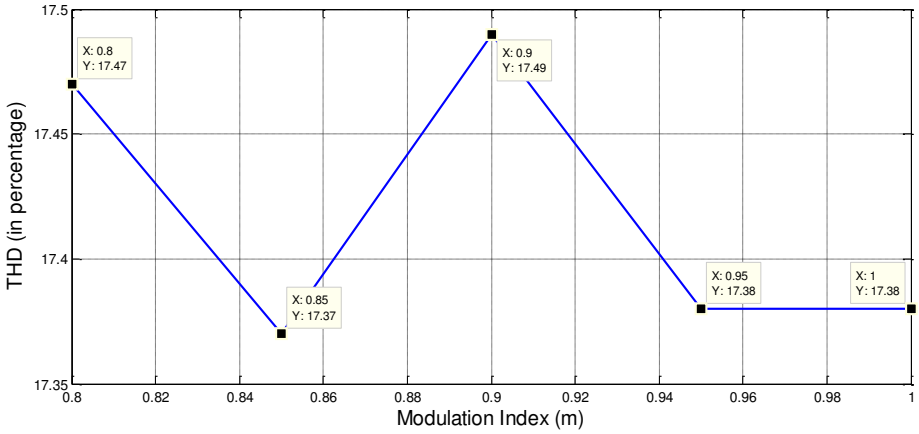

Fig. 5(a). THD verses modulation index for 5 level inverter

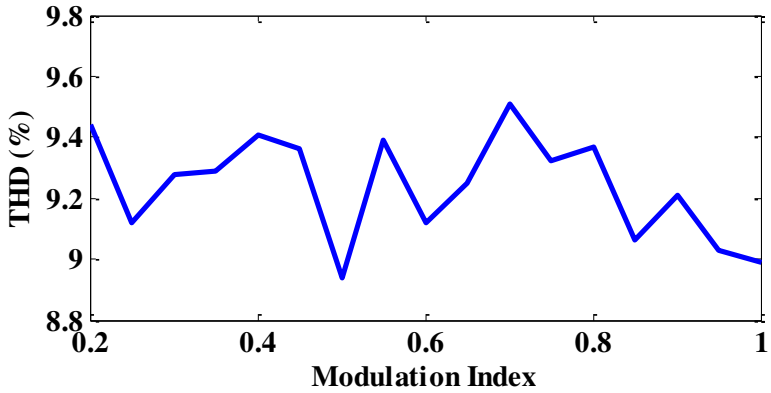

Fig. 5(b). THD verses modulation index for 9 level inverter

Fig. 6 shows the FFT analysis for 5 and 9 level inverter of MATLAB simulation. Optimized THD for both 5 and 9 level inverter is shown. In 5 level inverter THD reduced to 17.1% and for 9 level inverter it is

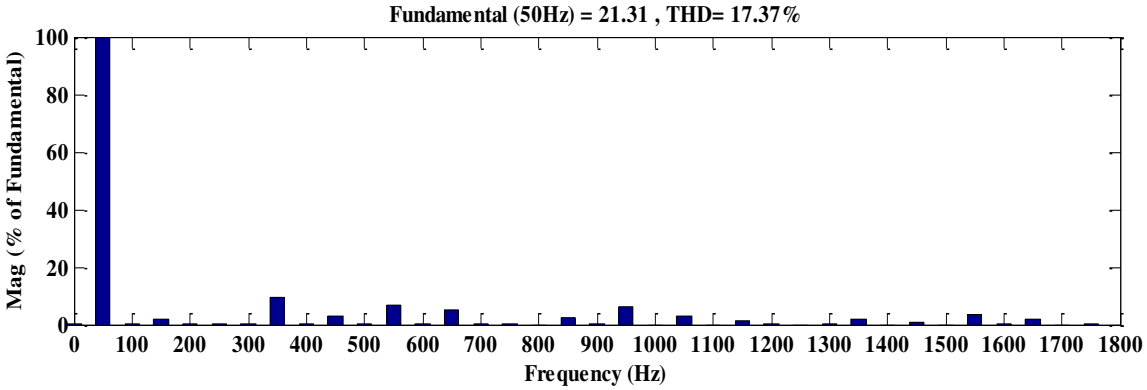

Fig. 6(a). Harmonics analysis using FFT for 5 level inverter

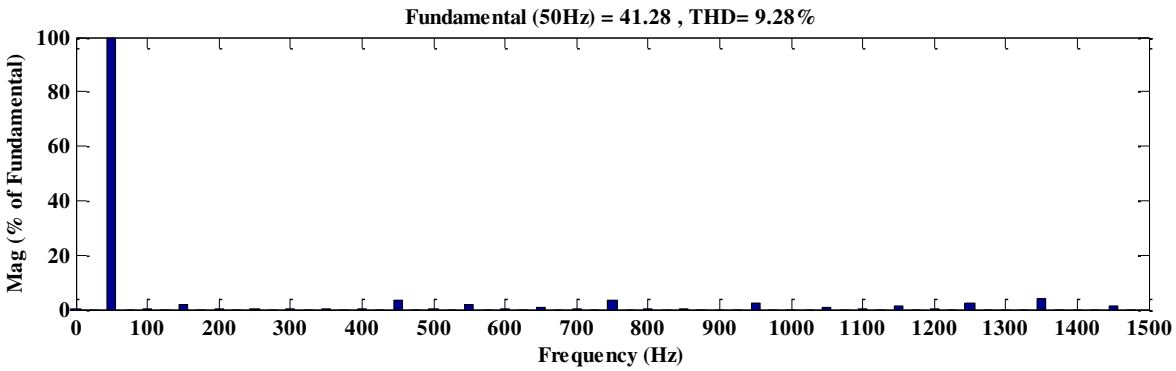

Fig. 6(b). Harmonics analysis using FFT for 9 level inverter

To validate the switching angles from Simulink result, THD calculation is done in hardware. A five level inverter with two H-bridge modules and a nine level inverter with four H-bridge is used for the validation of simulink result. Where each module consists of a DC source and four IGBT switches. 10V of DC supply is provided with 180 mA currents to each module. Output voltage waveform from hardware for phase voltage waveform with R load is shown in Fig. 7. Here switching frequency is same as fundamental frequency i.e. 50 Hz. It reduces switching losses and hence efficiency increased. At five different modulation index switching angles calculated which has given similar and reduced THD values. These angles are used to eliminate 5th harmonic.

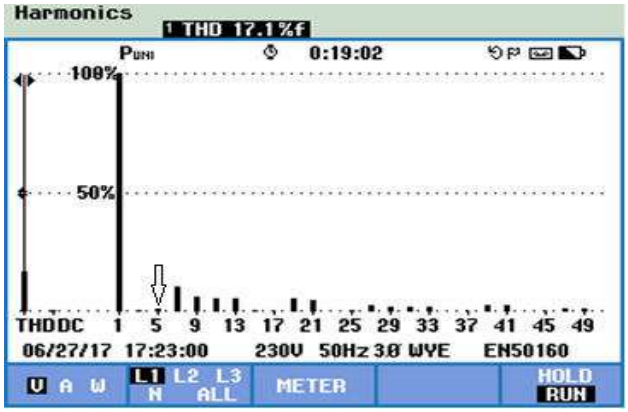

Fig. 7(a) THD results of 5 Level CHB Inverter from Hardware

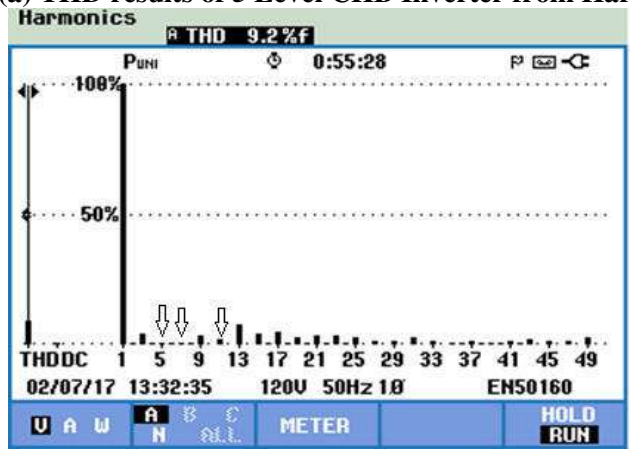

Fig. 7(a) THD results of 5 Level CHB Inverter from Hardware

The proposed method has given successful elimination of 5th harmonic in adapted five level CHB topology and 5^{th}, 7^{th} and 11^{th} order harmonics in nine level CHB topology.

CONCLUSION

In this paper, selective harmonic elimination in cascaded multilevel H-bridge inverter using recently introduced sine cosine algorithm is presented. The proposed technique is experimented for 5 level and 9 level inverter. The proposed method has been found fast converging and efficient in removing the low order harmonics. The implementation is conducted in both simulation and hardware modes. The results found very encouraging with reduced THD. Further, the elimination of similar lower order harmonics at higher levels may be conducted in future work.

REFERENCES

[36] J. Rodriguez, J. Lai, and F. Peng, Multilevel inverters: a survey of topologies, controls and applications,IEEE Trans. Ind. Appl., vol. 49, no. 4, pp. 724-738, Aug. 2002.

[37] A.M. Massoud, S.J. Finney, A. Cruden, and B.W. Williams, Mapped phase-shifted space vector modulation for multilevel voltage source inverters, IET Electr. Power Appl., vol. 1, no. 4, pp. 622-636, Jul. 2007.

[38] M.T. Bina, Generalised direct positioning approach for multilevel space vector modulation: theory and implementation, IET Electr. Power Appl., vol. 1, no. 6, pp. 915-925, Nov. 2007.

[39] N.Vinoth kumar, V.Kumar Chinnaiyan, Pradish.M, MS Divekar, " Selective Harmonic Elimination : An Comparative Analysis for Seven level Inverter" Proceedings of the Students' Technology Symposium, 2016 IEEE.

[40] J. Rodr´ıguez, J. Lai, and F. Z. Peng, "Multilevel inverters: A survey of topologies, controls and applications," IEEE Trans. Ind. Electron., vol. 49, no. 4, pp. 724–738, Aug. 2002.

[41] H. S. Patel and R. G. Hoft, "Generalized harmonic elimination and voltage control in thyristor inverters: Part I—Harmonic elimination," IEEE Trans Ind. Appl., vol. IA-9, no. 3, pp. 310–317, May/Jun. 1973.

[42] H. S. Patel and R. G. Hoft, "Generalized harmonic elimination and voltage control in thyristor inverters: Part II—Voltage control technique," IEEE Trans. Ind. Appl., vol. IA-10, no. 5, pp. 666–673, Sep./Oct. 1974.

[43] Khaled El-Naggar, Tamer H. Abdelhamid, "Selective harmonic elimination of new family of multilevel inverters using genetic algorithms", Energy Conversion and Management Elsevier 2007, pp. 89–95.

[44] H. Taghizadeh and M. Tarafdar Hagh, "Harmonic Elimination of Cascade Multilevel Inverters with Nonequal DC Sources Using Particle Swarm Optimization", IEEE Trans. Ind. Electron., vol. 57, no. 11, pp. 3678-3684, 2010.

[45] A. Kouzou, "Selective Harmonics Elimination PWM applied to Multilevel Four-Legs DC/AC Converter Based on Particle Swarm Optimization" IEEE 2015.

[46] Mehrdad Tarafdar Hagh, Member, Hassan Taghizadeh, and Kaveh Razi "Harmonic Minimization in Multilevel Inverters Using Modified Species-Based Particle Swarm Optimization" IEEE Trans. On Power Electronics, vol. 24, no.10, pp. 2259-2267, 2009.

[47] Seyedali Mirjalili, "SCA: A Sine Cosine Algorithm for solving optimization problems", Knowledge-Based Systems Elsevier 2016, pp. 120–133.

[48] Ahmed Ibrahem Hafez, Hossam M. Zawbaa, E. Emary, Aboul Ella Hassanien, "Sine Cosine Optimization Algorithm for Feature Selection", IEEE 2016.

A Review Of Different Techniques Of Power Transformer Protection

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Abstract: The power transformer is an electrical equipment that needs continuous monitoring and fast protection since it is very expensive and an essential element for a power system to perform effectively. The most common protection technique used is the percentage differential logic, which provides discrimination between different operating conditions and internal fault. Unfortunately, there are some operating conditions of power transformers that can affect the protection behavior and the power system stability.

This paper presents an overview of existing protection algorithms used for protection of power transformer. It includes a discussion of new techniques which have been introduced using intelligent hybrid systems and those being proposed to protect the power transformer.

***Keywords*:** Power Transformer, differential protection schemes, CT saturation, Artificial Neural Network (ANN).

INTRODUCTION

The power transformer is a piece of electrical equipment that needs continuous monitoring and fast protection since it is very expensive and an essential element for a power system to perform effectively. Power transformer internal faults may cause extensive damage and/or power system instability. Thus, different transformer protection schemes are used to avoid interruptions of the power supply and catastrophic losses. The most common protection technique is the percentage differential logic, which provides discrimination between an internal fault and an external fault or a normal operating condition.

However, a simple detection of a differential current is not sufficient to distinguish internal faults from other situations that also produce such a current. Some of these situations appear during transformer energization (inrush currents), current transformer (CT) saturation, among others, which can result in an incorrect trip. The correct and fast discrimination of internal faults from the other situations mentioned is one of the challenges for modern protection of power transformers. Concerning the identification of internal faults as opposed to inrush currents, the approach traditionally used is the aforementioned differential logic together with harmonic restraint. In this method, transformer inrush current due to energization is recognized on the basis of second and other harmonic components obtained by filters.

New algorithms that have been developed for differentiating between internal fault current and other situations that also produce such current should be known for proper maintenance of power transformer as it is an essential element for power system.

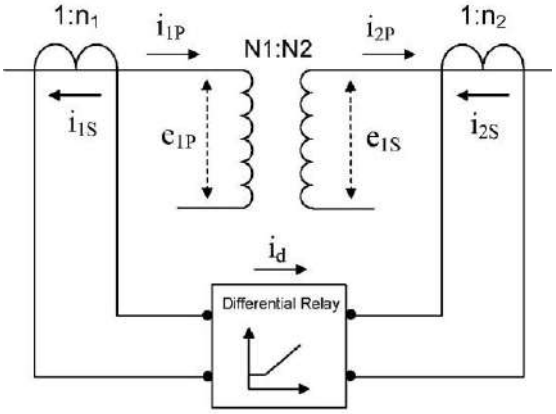

Figure.1. Differential scheme used for the protection of large power transformers

DIFFERENTIAL PROTECTION

The diagram illustrating the differential logic used for the protection of large power transformers is shown in Fig. 1. The illustration also shows the connection of CTs coupled to the primary and secondary branches. N1:N2 is the turn ratio between the primary and the secondary windings of the transformer, and 1: n1 and 1:n2 are the turn ratios between the branches and the CTs, selected to make N1n1=N2n2. Under normal conditions and external faults for a single-phase transformer, the currents i1S and i2S (secondary currents of CTs) are equal. However, in the case of internal faults, the difference between these currents becomes significant, causing the differential relay to trip.

The differential current

$$id = i1S - i2S \quad (1)$$

gives a sensitive measure of the fault current.

Considering the restraint current ir = (i1S +i2S)/2, the relay will operate when

$$id \geq K.ir \quad (2)$$

where K is the slope of the differential characteristic.

As mentioned before, certain phenomena can cause a substantial differential current to flow when there is not any fault, and these false differential currents are generally sufficient to cause tripping. However, in these situations, the differential protection should not disconnect the system because an internal fault is not present.

Magnetizing currents appear during transformer energization due to its core magnetization and saturation. The slope of the magnetization characteristic in the saturated area determines its magnitude. In modern transformers, large inrush currents can be reached. In transformer energization, as the secondary winding is opened, the differential current can reach sufficiently high values, causing a false relay operation. Some other phenomena that cause false differential currents are magnetizing inrush currents during an external fault removal, transformer over excitation, as well as CT saturation.

CT SATURATION

CTs are employed to provide a reduction of the primary current as well as to supply galvanic insulation between the electric network and equipment connected to the CT secondary, including protective relays. Therefore, CTs are made to support fault currents and other phenomena for a few seconds, which can reach values of up to 50 times the magnitude of the load current. The current signals supplied on the secondary of a CT should be exact reproductions of the corresponding current signals on its primary. Although modern devices perform satisfactorily well in this condition for most cases, the protection design needs to take into account the possible errors eventually introduced by CTs, so that the relay performance in the presence of these errors can be enhanced. The CT performance under load current is not such a concern compared to the fault situation in which the relay should operate. When faults occur, the current values can reach high levels. They can also contain a significant dc component as well as the remnant flux in the CT core. All these factors can lead to the saturation of the current transformer core and can produce significant distortion in the secondary current. In this case, the secondary current of a CT cannot represent its primary current exactly. Thus, relays that depend on this current to make their decision can easily operate incorrectly during this period, affecting the reliability of the protection.

The possibility of CT saturation should then be carefully considered in a protection system design in terms of relay performance. Some methods are used to avoid it, but some of the solutions can affect the cost of such a piece of equipment.

DISCRIMINATION OF INTERNAL FAULTS

Many algorithms have been developed to discriminate internal faults. Few modern techniques that have been developed are discussed.

DISCRIMINATION USING INTELLIGENT TOOL

Segatto and Coury have used ANN for discrimination of internal faults with other operating conditions. Training process was done using multilayer perceptron (MLP) for discriminating internal faults from other situations described.

In their method, the simulated cases were the situations that involved a significant differential current. Steady state and capacitor bank energization were not included. For the transformer of 25MVA a total of 2556 cases (7668 patterns, considering a moving window of three steps) were generated.

For training and validation processes, 50% of the cases in which the saturation phenomenon caused by the current transformers was considered. The architecture used for the purpose is shown in Fig.2. The differential current per phase are the input signals and the output will indicate the fault situation, if the cases.

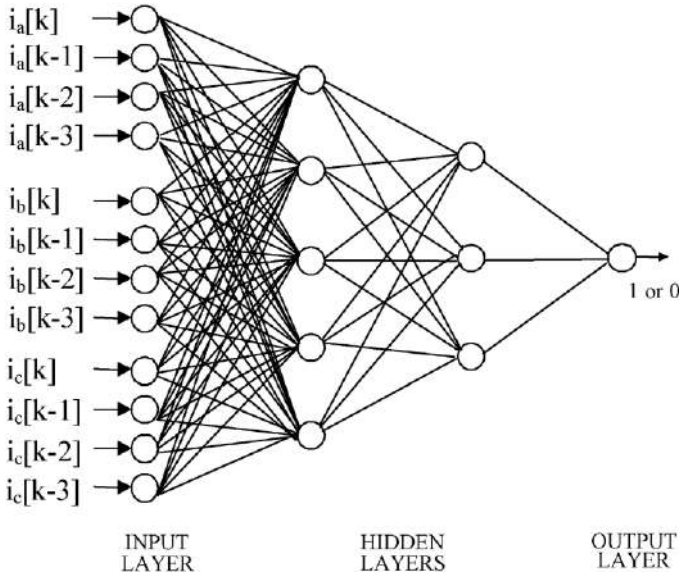

Figure.2. ANN used for pattern recognition

DISCRIMINATION USING CLARKE'S TRANSFORM

Barbosa et al, proposed an algorithm in which uncoupled signals was obtained by applying Clarke's Transform to the three-phase currents in the secondary winding current of the CT in both transformer ends. The equations are represented as

$$\begin{bmatrix} I_{\alpha ph}(k) \\ I_{\beta ph}(k) \\ I_{\gamma ph}(k) \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & \frac{-1}{2} & \frac{-1}{2} \\ 0 & \frac{\sqrt{3}}{2} & \frac{-\sqrt{3}}{2} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \left[I''_{ph}(k) \right] \qquad (1)$$

where

$$\left[I''_{ph}(k) \right] = \left[I'_{ph}(k) \quad I'_{ph+120^0}(k) \quad I'_{ph-120^0}(k) \right] \qquad (2)$$

ph is the phase of current reference and k is the sample number of the discrete signal. Clarke's transform could be applied to both phasors as well as the instantaneous values.

The main concept of using Clarke's Transform is carried out in a pattern-recognition process to discriminate internal faults, sympathetic inrush, energization and over-excitation. The differential α-β-γ components of the current are used.

$$\Delta\alpha_{ph} = \left| \sum_{k=0}^{N} I_{\alpha ph}(k) + i_{\alpha ph}(k) \right| \qquad (3)$$

$$\Delta\beta_{ph} = \left| \sum_{k=0}^{N} I_{\beta ph}(k) + i_{\beta ph}(k) \right| \qquad (4)$$

$$\Delta\gamma_{ph} = \left| \sum_{k=0}^{N} I_{\gamma ph}(k) + i_{\gamma ph}(k) \right| \qquad (5)$$

where Iα(k), Iβ(k), Iγ(k), iα(k), iβ(k) and iγ(k) are α-β-γ components of the primary and secondary currents from a transformer, respectively, and N is the number of signal samples in the observation window.

The computed values of the differential α-β-γ components of the currents are approximately zero in the case of a normal operation, while the range of each differential current value fluctuates according to the specific situation. Therefore, the various phenomena of the transformer could be discriminated.

With input of the differential α-β-γ components of the current, fuzzy system is used to determine the fault condition more accurately than conventional differential protection methods, which has predefined rules to discriminate between steady state and fault conditions.

DISCRIMINATION USING HARMONIC COMPONENT, GA AND FLUX-RESTAINT DIFFERENTAIL CURRENT

Magnetizing inrush current have high second harmonic component and internal fault has low second harmonic component. Similarly over-excitation current has high fifth harmonic component compare to internal fault.

Barbosa et al. proposed another algorithm in which the current signals are the inputs to the Genetic Algorithm (GA) in order to extract the fundamental and harmonic components of both the primary and the secondary currents from the protected transformer.

The decision making is done by use of Fuzzy System. Rules are formed by using four variables. The first two are the harmonic components i.e. second harmonic and fifth harmonic component, third the operating current (iop=id/irt) where id(=| ip+is|) is differential current, ip is primary current and is is secondary current and lastly the flux-restraint differential current (dFlx)

$$d_{Flx} = \frac{\left(\Delta t/_2\right)\left(v_{p,k} - v_{p,k-1}\right) - L_p\left(i_{p,k} - i_{p,k-1}\right)}{\left(i_{p,k} - i_{s,k}\right) - \left(i_{p,k-1} - i_{s,k-1}\right)} \qquad (6)$$

where d_{Flx} is the flux-restraint differential current; Δt is the sampling interval; i is the input current; v is the primary voltage; Lp is the leakage inductance of the primary winding and k is the number of sample.

Using these four quantities 16 rules are formed to differentiate between steady state and fault condition.

DIFFERENTIATING USING FUZZY LOGIC-BASED RELAYING TECHNIQUE

As described earlier, second harmonic component is used to differentiate between inrush (high second harmonic component) and internal fault (low second harmonic component). Recently in power system the frequency environment has been made complicated and the quality of second harmonic component in inrush state has been decreased because of the improvement of core steel. Due to this reason, the traditional approaches will likely to mal-operate in the case of magnetizing inrush with low second harmonic component and internal fault with high second harmonic component.

Shin et al. proposed a relaying algorithm a relaying algorithm to enhance the fault detection sensitivities of conventional techniques by using a fuzzy logic approach. The algorithm consists of flux-differential current derivative curve, harmonic restraint and percentage differential characteristic curve.

The proposed fuzzy-based relaying algorithm prevents trip mal-operation of relay in the case of magnetizing inrush with low second harmonic component and internal fault with high second harmonic component and then show improved accuracy and robustness against the change in conditions in power system.

DIFFERENT METHODS FOR CT SATURATION CORRECTION

CT saturation is one of the phenomenon which causes false tripping of the differential protection. Before development of the CT saturation correction, the algorithm were not able to cope-up with CT saturation and leads to unnecessary tripping. It can be stated that the CT saturation phenomenon may impair protection system reliability if appropriate algorithms for saturation detection and/or correction are not applied to eliminate the problem.

- One of the methods of avoiding CT saturation is by increasing the size of the CT core. Another is using a core material that supports larger flux densities. Both can affect the cost and case of transformer application.
- If the RMS value supplied by CT is distorted by saturation, the RMS value sensed will be much lower than the actual fault current.

- One of the approaches is that if the CT saturation characteristic is known, an estimate of the input current when the CT saturates can be found, assuming a zero-offset waveform and resistive burden.
- Other approaches have used Kalman filters and iterative approaches. These methods are not convenient for real-time applications.

Some of the methods developed using intelligent systems are described below.

Recurrent ANNs Correcting The Distorted Signals Originated from Saturated CTs.

Segatto and Coury used the Stuttgart Neural Network Simulator (SNNS) to train the different architectures in order to correct the distorted signals. Due to its efficiency, simplicity and user-friendly graphic interface the program was chosen.

Using the SNNS simulator, the Elman training method was carried out. The training stage finished in 7000 cycles, where it reached the mean square error of 0.0005. in this method, 1600 training patterns were used, whereby 800 were utilized in the training and 800 in the validation process. The ANN input and output layers contain 24 neurons each. For such a result, the best ANN topology obtained was 24+20+24, with 24 neurons in the input layer, 20 neurons in the hidden layer, 24 neurons in the recurrent layer and 24 neurons in the recurrent layer and 24 neurons in the output layer, which reconstructed the input signal.

In the result obtained, a total of 188 patterns (94 for internal faults and 94 for inrush situations) were used for testing the architectures. These patterns were not used in the training stage. The Elman ANN obtained an accuracy rate of 98.5%.

Advantage of this algorithm is that no pre-processing of signals was required.

a) CT Saturation Detection with Optimized Neural Network

Waldemar and Daniel proposed CT saturation detection with genetically optimized neural network. Advantages of neural computing methodologies over conventional approaches include faster computation, learning ability, robustness and noise rejection.

While preparing a useful and efficient ANN-based classification/recognition unit, one has to take into consideration the issues of the ANN choice (structure type, number of layers and neurons activation functions, input signals) and its training (learning method, initial conditions). Choosing the type of ANN structure and its further parameters are rather a matter of the designer experiences with ANN usage since, unfortunately there are no general practical rules that could be applied for that purpose. The heuristic way sequential trial-and-error attempts maybe followed, however this may not guarantee the optimal ANN structure to be found.

An optimization approach based on genetic principles was proposed and its efficiency was studied.

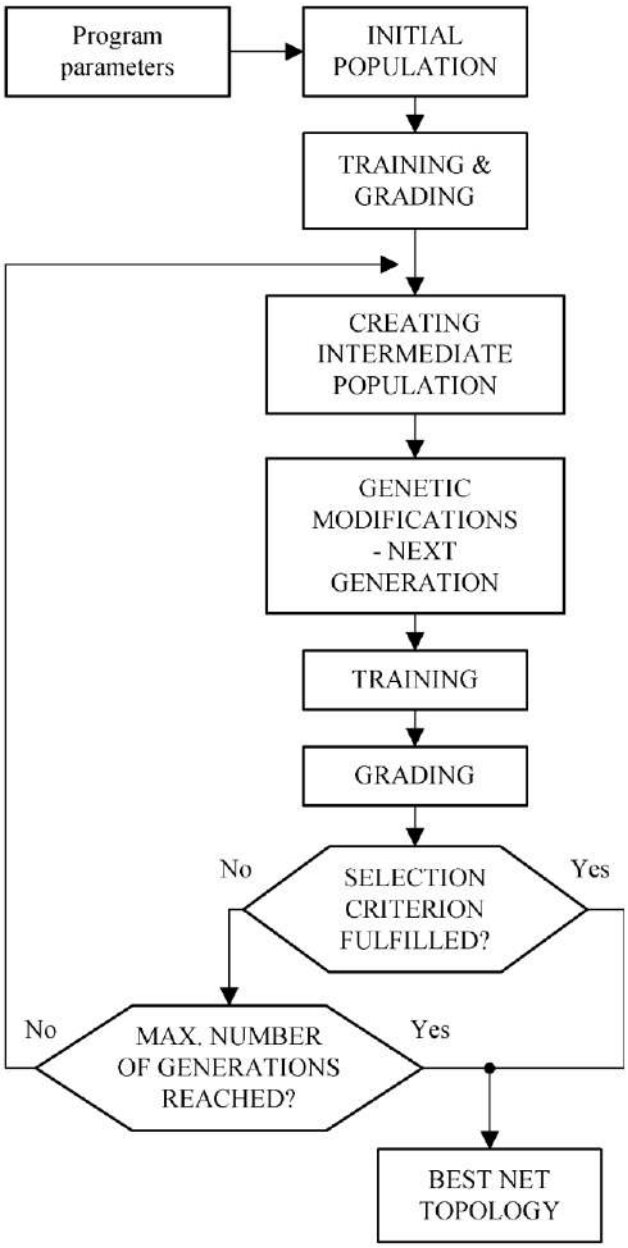

Figure.3. Flowchart of the GA procedure for the ANN topology optimization.

In Fig.3, the block scheme of the genetic optimization procedure as applied for the ANN structure optimization is presented.

In this method, optimization of the neural CT saturation detector was performed out of a population of neural networks consisting of 20 individuals. The ANNs are being trained with the first half and tested with the second half. The Levenberg-Morquardt training algorithm was adopted with the desired output of the ANN set to 1.0 for the periods of linear CT operation and 0.0 when the CT was saturated.

In order to drive the optimization process in both efficiency and ANN size directions, the quality index ($Q_{eff/size}$) was proposed.

$$Q_{eff/size} = \frac{1}{(1 - Q_{eff}).2.n_{ANN}} \tag{7}$$

where

$$Q_{eff} = \frac{number\ of\ correct\ decisions}{number\ of\ all\ testing\ cases} \tag{8}$$

and n_{ANN} is ANN size (total number of neurons).

The values of $Q_{eff/size}$ are inversely proportional to the total number of neurons of ANNs being assessed, thus giving a chance of obtaining efficient yet reasonably small ANNs.
The best ANNs obtained for respective quality indices are:

- For Q_{eff} index- ANN having 14 neurons (13-1), classification efficiency equal 0.978;
- For $Q_{eff/size}$ index- ANN having 6 neurons (3-2-1), classification efficiency 0.954.

b) Correction of CT distorted signal due to saturation caused by Faults using ANNs

Yu et al. proposed use of an ANN to correct CT saturation caused by faults in power systems including DC offset and random fault incidence angle. The ANN was trained to provide the inverse function of CT. ANN presented was trained only for resistive load.

The algorithm for running the network was implemented on an Analog Devices ADSP-2101 digital signal processor. The calculating speed and accuracy proved to be satisfactory for real-time applications.

Neural network structure is a feed-forward type network with two hidden layers, shown in Fig.4. The input layer of the network has 32 input nodes. Two hidden layers, one with 10 nodes and another with 6 nodes, were used. Each of the hidden nodes accumulates a sum of the samples presented at the input layer multiplied by a weighing factor for each connection. The output node accumulates the sum of outputs of the 6 hidden nodes and processes the sum through a tan-sigmoidal function. A feed-forward topology has the advantage of simplicity and inherent stability.

To train the network, a range of fault cases were defined. Variables for the test cases included fault impedance magnitude, X/R ratio, and closing angle. Combining all three sets of parameters, fault impedance magnitude, X/R ratio and fault incidence angles, and produces around 40 sets of waveform data to train the neural network.

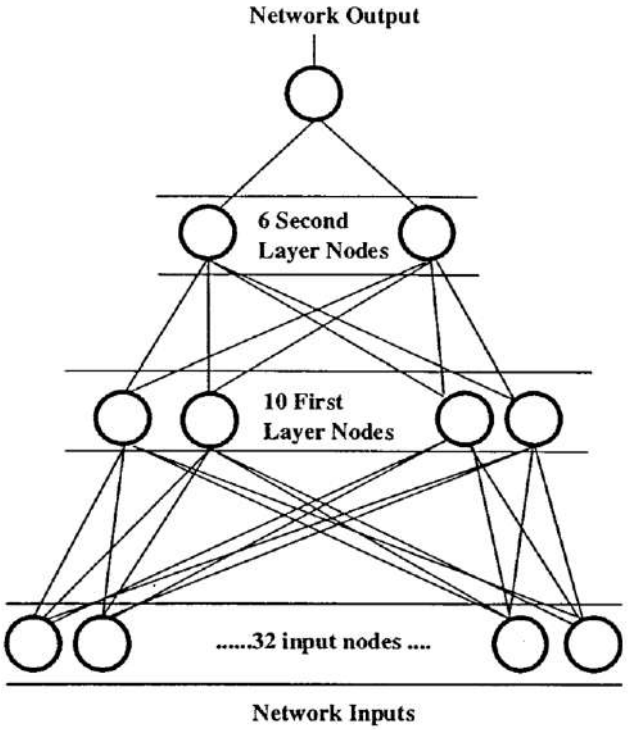

Figure.4.The network structure

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J. CONCLUSION

For the protection of the power transformer different methods have discussed. Different methods for fault detection, CT saturation correction and basic differential protection has been explained. The

conclusion comes here that all methods have individual importance but CT saturation correction by ANN is effective but the training of ANN is time consuming.

REFERENCES

[14] A. G. Phadke and J. S. Thorp, "A new computer-based flux-restrained current-differential relay for power transformer protection," IEEE Trans. Power App. Syst., vol. PAS-102, no. 11, pp. 3624–3629, Nov. 1983.

[15] D.C. Yu, Z. Wang, J.C. Cummins, H.-J. Yoon and L.A. Kojovic, "Correction of Current Transformer Distorted Secondary Currents Due to Saturation Using Artificial Neural Networks" IEEE Trans. Power Del., vol. 18, no. 2, pp. 189-194, April 2001.

[16] D.C. Yu, Z. Wang, J.C. Cummins, H.-J. Yoon, L.A. Kojovic and D. Stone, "Neural Network for Current Transformer Saturation Correction" IEEE Transmission and Distribution, vol. 1, pp. 441-446, 1999.

[17] M.-C. Shin, C.-W. Park, and J.-H. Kim, "Fuzzy logic based relaying for large power transformer protection," IEEE Trans. Power Del., vol. 18, no. 3, pp. 718–724, Jul. 2003.

[18] E. Segatto and D. Coury, "A differential relay for power transformers using intelligent tools," IEEE Trans. Power Syst., vol. 21, no. 3, pp. 1154-1162, Aug. 2006.

[19] D. Barbosa, D.V. Coury and M. Oleskovicz, "Power Transformer Differential Protection Based on Clarke's Transform and Fuzzy Systems" IEEE Trans. Power Del., vol. 26, no. 2, pp. 1212-1220, April 2011.

[20] D. Barbosa, D.V. Coury and M. Oleskovicz, "New approach for power transformer protection based on intelligent hybrid systems" IET Generation, Transmission and Distribution, vol. 6, no. 10, pp. 1003-1018, 2012.

[21] A. Zilouchian and M. Jamshidi, Eds., Intelligent Control Systems Using Soft Computing Methodologies. Boca Raton, FL: CRC, 2000.

[22] Z.Kovacic and S. Bogdan, Fuzzy Controller Design. Boca Raton, FL: CRC., 2005.

[23] Y. C Kang, J. K. Park, S. H. Kang, A. T. Johns and R. K. Agganval, "An Algorithm for compensating secondary currents of current transformer" IEEE Transactions on Power Delivery, Vol 12, No. 1, January 1997, pp. 116-126.

[24] Waldemar Rebizant and Daniel Bejmert, "Current-Transformer Saturation Detection With Genetically Optimized Neural Networks" IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 22, NO. 2, APRIL 2007, pp. 820-827.

[25] M. Kezunovit, C. W. Fromen and F. Phillips, "EXPERIMENTAL EVALUATON OF EMTP-BASED CURRENT TRANSFORMER MODELS FOR PROTECTIVE RELAY TRANSIENT STUDY" IEEE Transactions on Power Delivery, Vol. 9, No. 1, January 1994, pp. 405-413.

[26] Manoj Tripathy, Rudra Prakash Maheshwari, and H. K. Verma, "Power Transformer Differential Protection Based On Optimal Probabilistic Neural Network Optimal Probabilistic Neural Network" IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 25, NO. 1, JANUARY 2010, pp. 102-112.

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Power Quality Improvement By Using DVR

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Abstract: A three phase four wire Dynamic Voltage Restorer (DVR) with bidirectional power electronic transformer structure is proposed to inject required compensating series voltage to the electric power system in such a way that continuous sinusoidal voltage is seen at load side ever at heavy fault occurrences at utility side. The Proposed structure is composed of a three phase four- leg inverter, three single phase high frequency transformers, three cyclo converters and high frequency harmonic filter that are connected to the utility. Three dimensional space vector modulation (3DSVM) methods is used for pulse generation. Fourth added wire enables the DVR to compensate unbalance voltage disturbance that are customer power quality problems in electrical utility. In this paper proposed DVR performance was studied via simulation results. This simulation results validated the satisfying operation of the proposed DVR
Keywords: **PET, DVR; 3DSVM; Power Quality.**

INTRODUCTION

Power quality is one of major problems in the today's scenario. It has become important with the introduction of complex devices, whose performance is very sensitive to the quality of power supply. Power quality problem is an occurrence developed as a nonstandard voltage, current or frequency that results in a failure of end use equipments. Some of the major problems dealt here is the power sag and swell. This paper describes the effectiveness of using dynamic voltage restorer (DVR) in order to mitigate voltage sags and swells in low voltage distribution systems. Dynamic Voltage Restorer can provide the most cost effective solution to mitigate voltage sags and swells that is required by customer. The Dynamic Voltage Restorer (DVR) is a rapid, flexible and resourceful solution to power quality problems.

Power quality is of great importance in all modern environments where electricity is involved, power quality can be essentially influenced by an important factor like quality service. One of the major concerns in electricity industry today is power quality problems. Presently, most of the power quality problems are due to different fault conditions. These conditions cause voltage sag, voltage swell, transients, voltage interruption and harmonics. These problems may cause the apparatus tripping, shutdown commercial, domestic and industrial equipment, and miss process of drive system. Dynamic voltage restorer (DVR) can provide the lucrative solution to mitigate voltage sag by establishing the appropriate voltage quality level, necessary. It is recently being used as the active solution for mitigation of power quality problems.

LITERATURE REVIEW

Design and study of DVR is presented in [1-5]. It gives an overview of DVR control scheme and its modelling. It shows that DVR provide efficient voltage restoration capability. The basic structure and the operating principle of DVR are shown. Different compensation technique of DVR is discussed.

Different control technique commonly used for Voltage Source Inverter (VSI) is presented in [6-10]. Different control scheme is shown and are discussed. The performance of various techniques are evaluated and compared.

The performance evaluation of DVR with Sinusoidal Pulse Width Modulation (SPWM) and Space Vector Pulse Width Modulation (SVPWM) is presented in [11-14]. Two PWM based control techniques are shown to control the VSI. SVPWM technique is compared with SPWM technique and shows that SVPWM has better DC utilisation and lesser harmonics are produced as compared SPWM.

Simulation of SVPWM and its application in three phase inverter is presented in [15-16]. The paper gives an idea of SVPWM algorithm and its simulation. The simulation result shows that SVPWM techniques are best suited for high power applications.

New scheme to control the two level VSI is presented in [17]. Detailed study of one of the SVPWM scheme i.e. seven segment space vector modulation (SVM) is done. Determination and realization of different switching states, sector value calculation, approximation of reference voltage vector and switching time calculation for linear modulation range is discussed.

SVPWM based DVR is presented in [18-21]. In this control algorithm in which the three phase supply, is converted into synchronously rotating d-q reference frame. The d-component gives information for depth of sag and q-component tells us about phase shift information. The error generated is given to SVPWM for DVR operation.

Dynamic voltage restorer (DVR) provide the worthwhile solution to mitigate voltage sag by establishing the proper voltage quality level, necessary.[1] It is recently being used as the active solution for mitigation of power quality problems.

PROPOSED WORK-:

Dynamic voltage restorer (DVR) provide the worthwhile solution to mitigate voltage sag by establishing the proper voltage quality level, necessary.[1] It is recently being used as the active solution for mitigation of power quality problems.

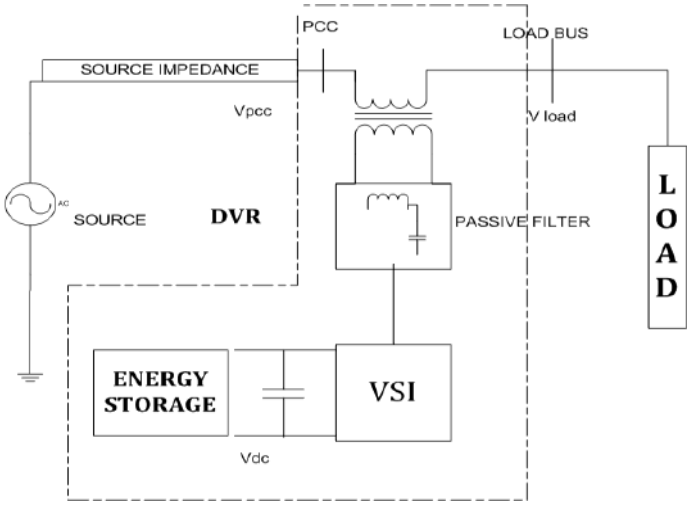


Figure 1: Basic Structure of A DVR

Basic principal of DVR is to transfer the voltage sag compensation value from DC side of the inverter to the injected transformer after filter. The compensation capacity of a particular DVR depends on the maximum voltage injection capability and the active power that can be supplied by the DVR. When DVR's voltage disturbance occurs, active power or energy should be injected from DVR to the distribution system A DC system, which is connected to the inverter input, contains a large capacitor for storage energy. It provides reactive power to the load during faulty conditions. When the energy is drawn from the energy storage capacitors, the capacitor terminal voltage decrease. Therefore, there is a minimum voltage required below which the inverter of the DVR cannot generate the require voltage thus, size and rating of capacitor is very important for DVR power circuit.

The proposed DVR is shown in Fig. 2. The purpose of control scheme is to maintain the load voltage at a desired value. In order to control the three-phase four-wire inverter, 3DSVM method is used that has some advantages such as more efficiency, high DC link voltage utilization, lower output voltage THD, less switching and conduction losses, wide linear modulation range, more output voltage magnitude and its simple digital implementation

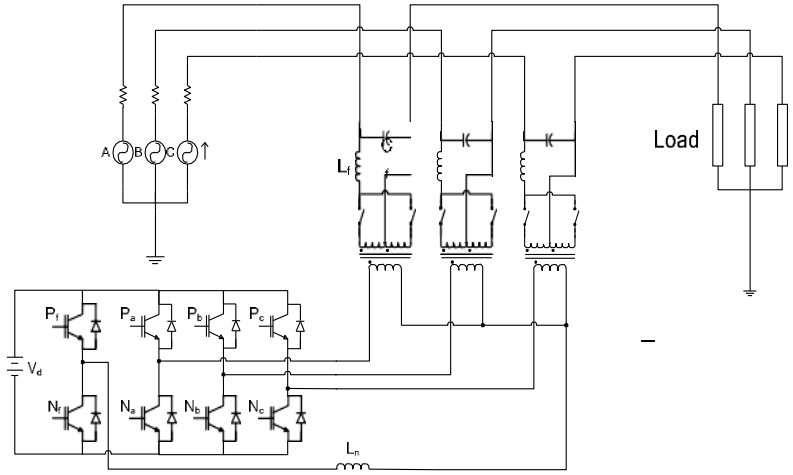
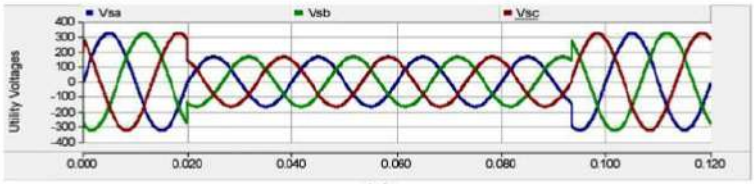


Fig. 2. Three-Phase Four-Wire DVR

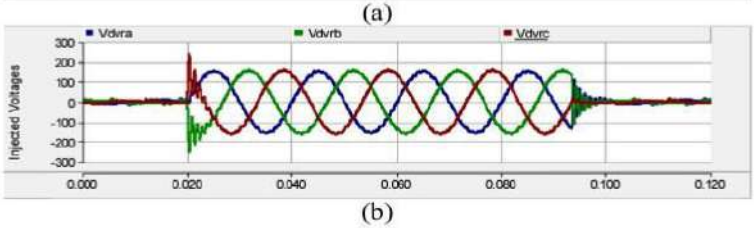
- **The main objectives of this Proposed system are:-**
  1. Detection of voltage sag/swell in the power system network.
  2. To mitigate the power quality issue using DVR and its behavioural study.
  3. To select the best suitable control technique for DVR.
  4. To control the device in order to obtain desired performance.

SIMULATION & RESULTS

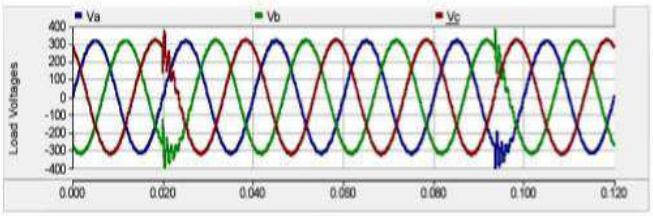
In this section, the proposed system in Fig. 2 is simulated in PSCAD-EMTDC. It should be noted that the series transformers are operating in the linear region. Fig. 3 shows the simulation results under unbalance voltage sag condition with the values of 60%, 50% and 40% on phases a, b, and c, respectively. As can be seen, under such conditions Fig. 3.(a), the DVR injects unbalance voltage Fig. 3.(b) in such a way that the load voltage Fig. 3.(c) remains balanced and sinusoidal and doesn't sense the voltage sag. Fig. 5.2 shows the simulation results under balance voltage sag condition. It is clear that the load voltage is restored to the nominal condition (before sag occurrence) after a time lower than a half cycle.



(a)

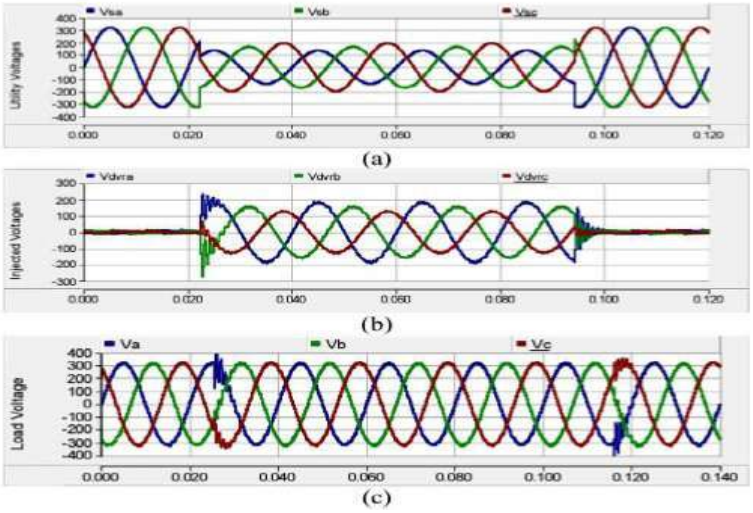


(b)



(c)

3. Unbalanced voltage sag, (a) utility voltages (b) injected voltages (c) load voltages



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4. Balanced sag (a) utility voltages (b) injected voltages (c) load voltages

As can be seen, the load voltage remains continuously balanced and sinusoidal.

The THD values of utility voltages and load voltages compensated are given in TABLE. The THD of the load voltage is less than 3% that lays in the criterion reported in IEEE standards 5l9-l992[22].

Voltage	THD_a	THD_b	THD_c
Utility Voltage	%38.87	%32.02	%4l.66
Load Voltage	%2.28	%l.9l	%2.37

CONCLUSION

The proposed DVR performance was studied via simulation results. This simulation results validated the satisfying operation of the proposed DVR.

According to the results, DVR injects appropriated series voltage during utility voltage disturbance and maintains the load voltage at desired value. Also the THD values of the load voltage are less than the standard values.

REFERENCES

[1] Anita Pakharia, Manoj Gupta ―Dynamic Voltage Restorer for Compensation of Voltaage Sag and Swell: A Literature Review‖, International Journal of Advance in Engineering & Technology, vol 4, issue 1, july 2012, pp.347-355.

[2] Himadri Ghosh, PradipkumarSaha, ― Design and Simulation of a Novel Self Supported Dynamic Voltage Restorer (DVR) for Power Quality Improvement.‖ International Journal of Scientific & Engineering Research, vol. 3, issue 6, june2012, pp 1-6.

[3] Mahmoud A. El-Gammal, Amr Y. Abou-Ghazala,―Dynamic Voltage Restorer for Voltage Sag Mitigation‖ International Journal on Electrical Engineering and Informatics- volume-3, number 1, march 2011, pp 1-11.

[4] Rosli Omar, NasrudinAbd Rahim, ― Mitigation of Voltage Sags/Swells Using Dynamic Voltage Restorer (DVR)‖ ARPN Journal of Engineering and Applied Sciences, vol. 4, no. 4, june 2009, pp.50-56

[5] M.N. Tandjaouli, C. Benachabia, ― Sensitive Loads Voltage Improvement Using Dynamic Voltage Restorer‖ 2011 International Conference on Electrical Engineering and Informatics, Bandung, Indonesia, 17-19 July 2011

[6] Ajay K. Damor, Prof. V. B. Babaria, ― Voltage Sag Control Using DVR‖, National Conference on Recent Trends

[7] E. Babaei ,M. FarhadiKangarlu, "Voltage quality improvement by a dynamic voltage restorer based on a direct three-phase converter with fictitious DC link," IET Generator Transmission Distribution, vol. 5, Iss. 8, pp. 814–823, 2011.

[8] A. A. D. RanjithPerera and S. S. Choi, "Performance Improvement of the Dynamic Voltage Restorer With Closed-Loop Load Voltage and Current-Mode Control," IEEE Transactions on Power Electronics, vol. 17, no. 5, Sept. 2002.
[9] N. H. Woodley, L. Morgan, and A. Sundaram, "Experience with an inverter-based dynamic voltage restorer," IEEE Transactions Power Delivery, vol. 14, pp. 1181– 1186, Jul. 1999.
[10] C. Ngai-man Ho, S. H. Chung and T. K. Au, "Design and Implementation of a Fast Dynamic Control Scheme for Capacitor-Supported Dynamic Voltage Restorers," IEEE Transactions on Power Electronics, vol. 23, no. 1, Jan. 2008.
[11] C. S. Chang, S. W. Yang, and Y. S. Ho, "Simulation and analysis of series voltage restorer (SVR) for voltage sag relief," in Proceedings IEEE Power Electronics System Winter Meeting, vol. 4, pp. 2476–2481, Jan. 2000.
[12] Y.W. Li, F. Blaabjerg, D. Mahinda Vilathgamuwa and P.C. Loh, "Design and Comparison of High Performance Stationary-Frame Controllers for DVR Implementation," IEEE Transcations on Power Electronics, vol. 22, no. 2, Mar. 2007.
[13] M. J. Ryan, W. E. Brumsickle and R. D. Lorenz, "Control topology options for single-phase UPS inverters," IEEE Transactions Industrial Applications, vol. 33, pp. 493–501, Mar./Apr. 1997.
[14] Chris Fitzer, Mike Barnes and Peter Green, "Voltage Sag Detection Technique for a Dynamic Voltage Restorer," IEEE Transactions on Industry Applications, vol. 40, no. 1, Jan./Feb. 2004.
[15] M. F. McGranaghan, D. R. Mueller, and M. J. Samotyj, "Voltage sags in industrial systems," IEEE Transactions Industry Applications, vol. 29, pp. 397–403, Mar./Apr. 1993.
[16] J. G. Nielsen, F. Blaabjerg, and N. Mohan, "Control strategies for dynamic voltage restorer compensating voltage sags with phase jump," in Proceedings IEEE APEC'01, vol. 2, pp. 1267–1273, 2001.
[17] C. Zhan, V. K. Ramachandaramurthy, A. Arulampalam, C. Fitzer, S. Kromlidis, M. Barnes, and N. Jenkins, "Dynamic voltage restorer based on voltage space vector PWM control," IEEE Transactions Industry Applications, vol. 37, pp. 1855–1863, Nov./Dec. 2001.
[18] N.Prakash, J.Jacob and Reshmi V, "Comparison of DVR Performance with Sinusoidal and Space Vector PWM Techniques", International Conference on Magnetics, Machines & Drives.
[19] P. Ananthababu, B. Trinadha and K. Ram charan, "Performance of Dynamic Voltage Restorer (DVR) against Voltage sags and swells using Space Vector PWM Technique," International Conference on Advances in Computing, Control, and Telecommunication Technologies, 2009.
[20] P. Roncero-Sánchez and J. Enrique Ortega-Calderon "A Versatile Control Scheme for a Dynamic Voltage Restorer for Power-Quality Improvement" IEEE Transactions on Power Delivery, vol. 24, no. 1, Jan. 2009.
[21] Rodriguez, J.Moran, P.L.Correa and C.Silva, "A vector control technique for medium voltage multilevel inverters," IEEE Transactions, IE-49, pp. 882–887, 2002.
[22] Kiran P. Varade, P. C. Tapare,and C. Veeresh, "Enhancement of Power Quality using Power Electronics Transformer based DVR ," International Journal of Science Technology Management and Research ,vol.2,issue 5, 2017

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Enhancement of Power Quality by Injecting Series Voltage using DVR

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Abstract: The proposed controller supplements the voltage-sag compensation control of the DVR. It does not require phase-locked loop and independently controls the magnitude and phase angle of the injected voltage for each phase. Fast least error squares digital filters are used to estimate the magnitude and phase of the measured voltages and effectively reduce the impacts of noise, harmonics, and disturbances on the estimated phasor parameters, and this enables effective fault current interrupting even under arcing fault conditions. The results of the simulation studies performed in the MATLAB/SIMULINK R2009a software environment indicate that the proposed control scheme: 1) can limit the fault current to less than the nominal load current and restore the point of common coupling voltage within 10 ms; 2) can interrupt the fault current in less than two cycles; 3) limits the dc-link voltage rise and, thus, has no restrictions on the duration of fault current interruption; 4) performs satisfactorily even under arcing fault conditions; and 5) can interrupt the fault current under low dc-link voltage conditions.
Keywords: Power Quality, Voltage Harmonics, Voltage Sag, Voltage Swells. DVR, Fault Current Interrupting

INTRODUCTION

With rapid developments in the industry, power quality becomes very important. Power quality is defined as any power problem manifested in the voltage, current or frequency deviations that result in failure or mal function of the customer equipment. Power quality issues can be classified as short duration voltage variations, long duration voltage variations, waveform distortions, transients, voltage imbalance and voltage flicker. Among the various power quality issues, voltage sag, voltage swell and harmonics are more dominant in the distribution system. To compensate these problems, Dynamic voltage Restorer (DVR) is used. DVR is a series compensating device to mitigate voltage sag and voltage swell. It is also used as series active filter to mitigate harmonics. Interline Dynamic Voltage Restorer (IDVR) is used to provide an economical solution for compensating voltage sag.

The dynamic voltage restorer (DVR) is a custom power device utilized to counteract voltage sags. It injects controlled three-phase ac voltages in series with the supply voltage, subsequent to voltage sag, to enhance voltage quality by adjusting the voltage magnitude, wave shape, and phase angle. Fig. 1.1 shows the main components of a (i.e., a series transformer T_S, a voltage- source converter (VSC), a harmonic filter, a dc-side capacitorC_{DC}, and an energy storage device. The line-side harmonic filter consists of the leakage inductance of the series transformer L_f and the filter capacitorC_f.

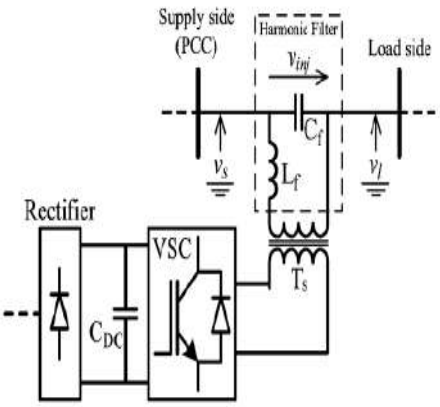


Fig.1.1.Schematic diagram of a DVR

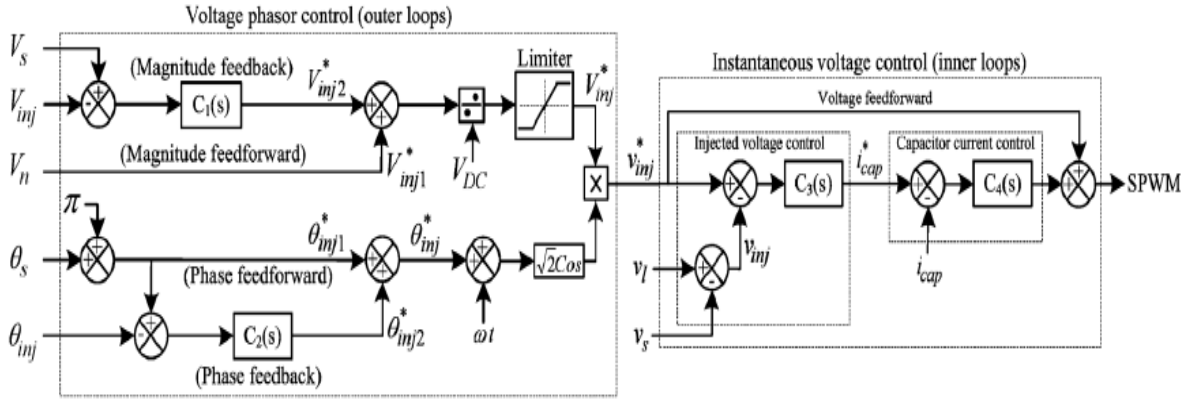
The DVR is conventionally bypassed during a downstream fault to prevent potential adverse impacts on the fault and to protect the DVR components against the fault current. A technically elaborate approach to more efficient utilization of the DVR is to equip it with additional controls and enable it also to limit or interrupt the downstream fault currents. A control approach to enable a DVR to serve as a fault current limiter is provided. The main drawback of this approach is that the dc-link voltage of the DVR increases due to real power absorption during fault current-limiting operation and necessitates a switch to bypass the DVR when the protective relays, depending on the fault conditions, do not rapidly clear the fault. The dc-link voltage increase can be mitigated at the cost of a slow-decaying dc fault current component using the methods introduced.

To overcome the a fore mentioned limitations, this paper proposes an augmented control strategy for the dvr that provides: 1) voltage-sag compensation under balanced and unbalanced conditions and 2) a fault current interruption (FCI) function. The former function has been presented.

It should be noted that limiting the fault current by the DVR disables the main and the backup protection (e.g., the distance and the overcurrent relays). This can result in prolonging the fault duration. Thus, the DVR is preferred to reduce the fault current to zero and interrupt it and send a trip signal to the upstream relay or the circuit breaker (CB).

It should be noted that the fault current interruption function requires 100% voltage injection capability. Thus, the power ratings of the series transformer and the VSC would be about three times those of a conventional DVR with about 30%–40% voltage injection capability. This leads to a more expensive DVR system. Economic feasibility of such a DVR system depends on the importance of the sensitive load protected by the DVR and the cost of the DVR itself.

The performance of the proposed control scheme is evaluated through various simulation studies in the MATLAB R2009a platform. The study results indicate that the proposed control strategy: 1) limits the fault current to less than the nominal load current and restores the PCC voltage within less than 10 ms, and interrupts the fault current within two cycles; 2) it can be used in four- and three-wired distribution systems, and single-phase configurations; 3) it does not require phase-locked loops; 4) it is not sensitive to noise, harmonics, and disturbances and provides effective fault current interruption even under arcing fault conditions and 5) it can interrupt the downstream fault current under low dc-link voltage conditions.



PROPOSED FCI CONTROL STRATEGY

2.1 . Proposed Fault Current Interruption Control Strategy

The adopted DVR converter is comprised of three independent H-bridge VSCs that are connected to a common dc-link capacitor. These VSCs are series connected to the supply grid, each through a single-phase transformer. The proposed FCI control system consists of three independent and identical controller's one for each single-phase VSC of the DVR. Assume the fundamental frequency components of the supply voltage, load voltage, and the injected voltage, Fig. 1 are

$$v_s = V_s \times \cos(\omega t + \theta_s) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

$$v_l = V_l \times \cos(\omega t + \theta_l) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$v_{inj} = v_l - v_s = V_{inj} \times \cos(\omega t + \theta_{inj})$. 3

Two identical least error squares (LES) filters are used to estimate the magnitudes and phase angles of the phasors corresponding V_S to V_{inj} $(i.e., \overrightarrow{V_S} = V_S \angle \theta_S)$ and (i.e., and $\overrightarrow{V_{inj}} = V_{inj} \angle \theta_{inj}$ respectively in 5 ms).

The fault current interruption function requires a phasor parameter estimator (digital filter) which attenuates the harmonic contents of the measured signal. To attenuate all harmonics, the filter must have a full-cycle data window length which leads to one cycle delay in the DVR response. Thus, a compromise between the voltage injection speed and disturbance attenuation is made. The designed LES filters utilize a data window length of 50 samples at the sampling rate of 10 kHz and, hence, estimate the voltage phasor parameters in 5 ms. Fig. 3 depicts the frequency response of the LES filters and indicates significant attenuation of voltage noise, harmonics, and distortions at frequencies higher than 200 Hz and lower than 50 Hz. Reference demonstrates the effectiveness of this filter in attenuating the noise, harmonics, and distortions for the sag compensation mode of operation as well. The next section shows that this filter also performs satisfactorily in the FCI operation mode, even under arcing fault conditions where the measured voltage and current signals are highly distorted.

Fig. 2 shows a per-phase block diagram of the proposed DVR control system corresponding to the FCI operation mode, where is the nominal rms phase voltage. The control system of Fig. 2 utilizes v_s,v_l , the dc-link voltageV_{DC} , and the harmonic filter capacitor current i_{cap},as the input signals. The reported studies in this paper are based on the overcurrent fault detection method. The fault detection mechanism for each phase is activated when the absolute value of the instantaneous current exceeds twice the rated load current.

The proposed multi loop control system includes an outer control loop (voltage phasor control) and an inner control loop (instantaneous voltage control). The inner loop provides damping for the transients caused by the DVR harmonic filter, and improves the dynamic response and stability of the DVR. The inner loop is shared by the sag compensation and the FCI functions. When a downstream fault is detected, the outer loop controls the injected voltage magnitude and phase angle of the faulty phase(s) and reduces the load-side voltage to zero, to interrupt the fault current and restore the PCC voltage. The DVR "outer" voltage phasor control and "inner" instantaneous voltage control, corresponding to each phase, are described in the following two subsections.

2.2 Voltage Phasor Control System

In the FCI operation mode, the required injected voltage phasor is equal to the source voltage phasor, but in phase opposition [i.e., the injected phasor $\overrightarrow{V_{inj}} = V_{inj} \angle \theta_{inj}$ is controlled to be$V_S \angle (\theta_S + \pi)$]. Performance of the voltage phasor control, in terms of transient response, speed, and steady-state error, is enhanced by independent control of voltage magnitude and phase, and incorporating feed forward signals to the feedback control system. Fig. 2 shows two proportional-integral (PI) controllers (and) that are used to eliminate the steady-state errors of the magnitude and phase of the injected voltage, respectively. Parameters of each controller are determined to achieve a fast response with zero steady-state error.

The output of the phasor control system is a reference phasor denoted by$\overrightarrow{V_{inj}^*} = V_{inj}^* \angle \theta_{inj}^*$. To eliminate the effects of the dc-link voltage variations on the injected voltages, V_{inj}^* is normalized by V_{dc} . The magnitude and the phase angle of $\overrightarrow{V_{inj}^*}$ are independently calculated and the magnitude is passed through a limiter (Fig. 2). The resulting phasor magnitude and phase angle are converted to the sinusoidal signal V_{inj}^*, which is the reference signal for the instantaneous voltage control.

2.3 Instantaneous Voltage-Control System

Under ideal conditions, a voltage sag can be effectively compensated if the output of the phasor-based controllerV_{inj}^*, is directlyfed to the sinusoidal pulse-width modulation (SPWM) unit. However, resonances of the harmonic filter cannot be eliminated under such conditions. Therefore, to improve the stability and dynamic response of the DVR, an instantaneous injected voltage controller and a harmonic filter capacitor current controller are used to attenuate resonances.

The generated reference signal for the injected voltage $V_{inj}^{*}$is compared with the measured injected voltage V_{inj}, and the error is fed to the voltage controller. As shown in Fig. 2, the output of the voltage controller i_{cap}^{*}, is the reference signal for the filter capacitor current control loop. It is compared with the measured capacitor current i_{cap}, and the error is fed to the current controller.

The steady-state error of the proposed control system is fully eliminated by the PI controllers in the outer control loop (i.e., C_1 and C_2), which track dc signals (magnitude and phase angle). Therefore, there is no need for higher order controllers in the inner control loop which are designed based on sinusoidal references. Thus, in Fig. 2, $C_3$and C_4 are pure gains k_v and K_c, respectively.

A large k_v result in amplification of the DVR filter resonance and can adversely impact the system stability. Thus, the transient response of the DVR is enhanced by a feed forward loop, and a small proportional gain is utilized as the voltage controller. A large K_c damps the harmonic filter resonance more effectively, but it is limited by practical considerations (e.g. amplification of capacitor current noise, measurement noise, and dc offset). Therefore, the lowest value of the proportional gain which can effectively damp the resonances is utilized. The output of the current controller is added to the feed forward voltage to derive the signal for the PWM generator.

STUDY MODEL AND RESULT

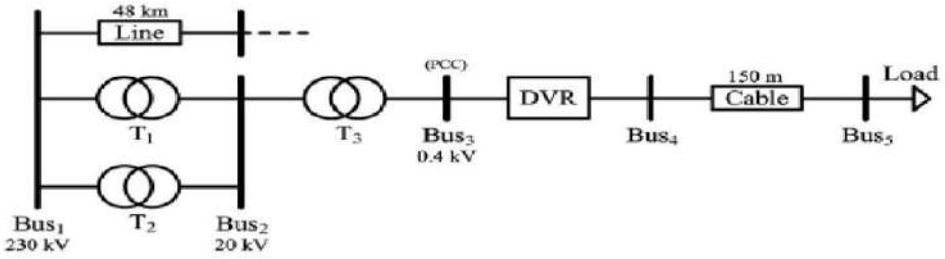


Fig.3.1. Single-line diagram of the system used for simulation studies.

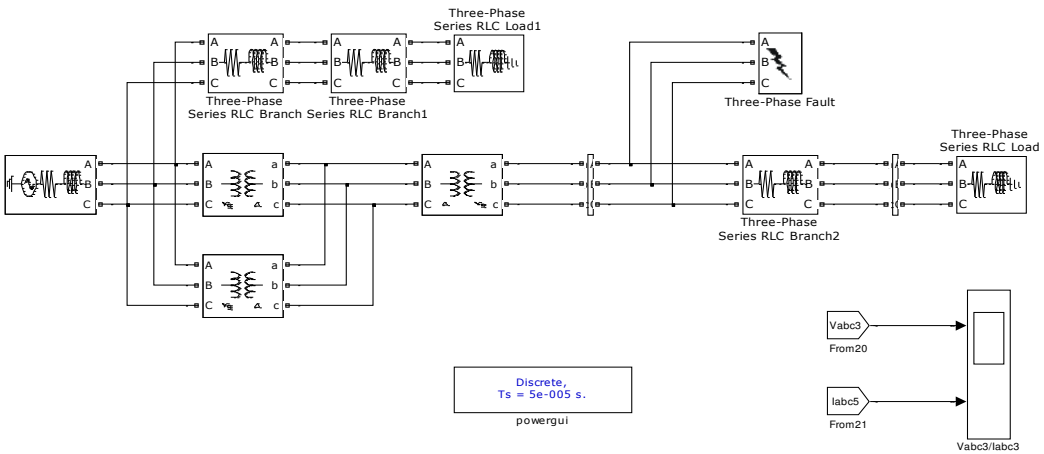


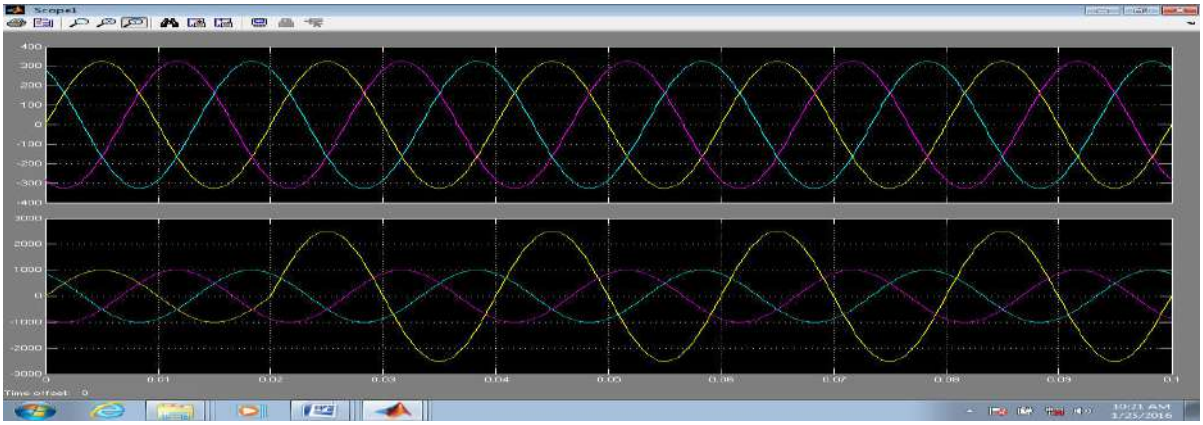
Fig.3.2. Design System for simulation studies

Fig. 3.1 depicts a single-line diagram of a power system which is used to evaluate the performance of the proposed DVR control system under different fault scenarios, in the MATLAB software environment. A 525-kVA DVR system is installed on the 0.4-kV feeder, to protect a 500-

kVA, 0.90 lagging power factor load against voltage sags. Parameters of the simulated power system and the DVR are given. In the reported studies, the base voltage for per-unit values is the nominal phase voltage. Besides, voltage and current waveforms of phases A, B, and C are plotted by solid, dashes, and dotted lines, respectively.

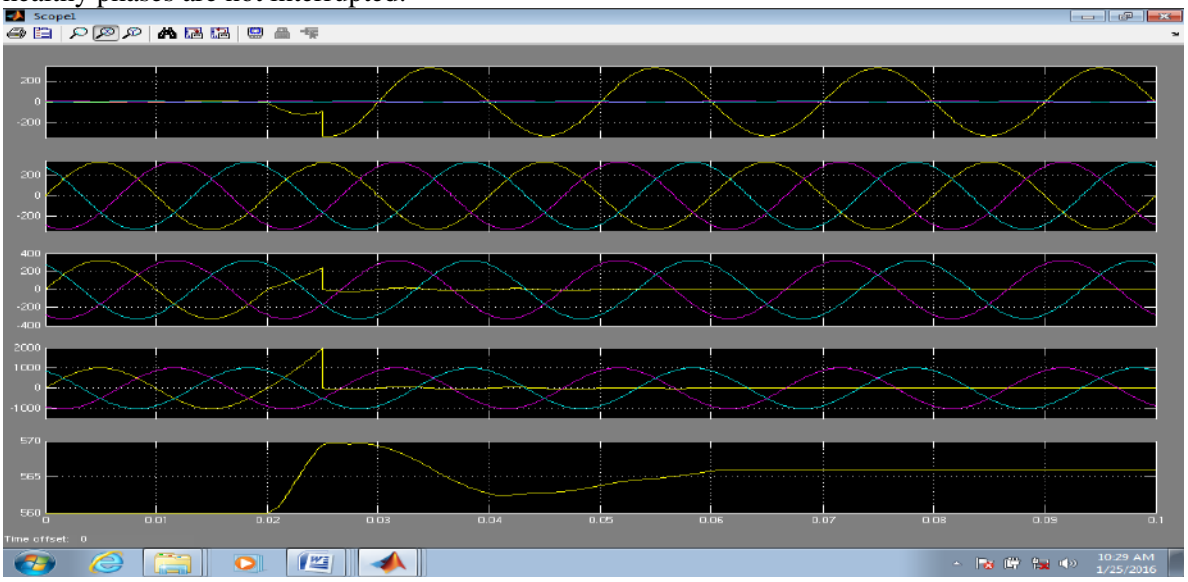
3.1 Single-Phase-to-Ground Downstream Fault

Phase-A of the system of Fig. 6.2 is subjected to a fault with the resistance of 0.2Ω at 10% length of the cable connecting BUS_4 to BUS_5, at t= 20 ms. If the DVR is inactive (Fig. 9), the PCC voltage does not considerably drop and the fault current is about 2.5 p.u. It must be noted that although the PCC voltage drop is not considerable, the fault current must be interrupted by the DVR to prevent possible damages to the VSC before the fault is interrupted by the relays. The reason is that the operation time of the overcurrent relays is considerable for a fault current of about 2.5 p.u.



Graph.3.1.(a) Voltages at BUS_3, (b) Fault currents, during downstream phase-to phase fault

Graph 3.1. illustrates that the proposed DVR control strategy successfully interrupts the fault current in the faulty phase in about two cycles. Graph 6.6 shows that the dc-link voltage rises less than 1.8%. Graph 3.2 also shows that only the faulty phase of the DVR reacts to fault current, and the healthy phases are not interrupted.



Graph.3.2.(a) Injected voltages, (b) Source voltages. (c) Load voltages. (d) Line currents. (e) DC-link voltage, during the single phase-to-ground downstream fault.

CONCLUSION

Simulation studies conclude that the dc-link voltage rise caused by the proposed FCI mode of operation is proportional to the fault current, and depends on the type of fault. The results also

indicate that the maximum dc-link voltage rise occurs under the most severe three-phase fault which is about 15%, and can be tolerated based on DVR appropriate design. It must be noted that to prevent operation of three-phase induction motors under unbalanced voltage conditions, they must be equipped with protective devices which detect such conditions and disconnect the load when any of the phases is de-energized by the single-phase operation of the FCI function. Furthermore, disabling the single-phase fault current interruption capability can be provided as an operational option and the operator can decide either to use or disable this function depending on the type of load.

REFERENCES

G. Eason, B. Noble, and I. N. Sneddon (1955). On certain integrals of Lipschitz-Hankel type involving products of Bessel functions. Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551.

[27] N. G. Hingorani, "Introducing custom power," *IEEE Spectr.*, vol. 32, no. 6, pp. 41–48, Jun. 1995.

[28] J. G. Nielsen, F. Blaabjerg, and N. Mohan, "Control strategies for dynamic voltage restorer compensating voltage sags with phase jump," in *Proc. IEEE APEC'*, 2001, pp. 1267–1273.

[29] G. J. Li, X. P. Zhang, S. S. Choi, T. T. Lie, and Y. Z. Sun, "Control strategy for dynamic voltage restorers to achieve minimum power injection without introducing sudden phase shift," *Inst. Eng. Technol. Gen. Transm. Distrib.*, vol. 1, no. 5, pp. 847–853, 2007.

[30] S. S. Choi, B. H. Li, and D. M. Vilathgamuwa, "Design and analysis of the inverter-side filter used in the dynamic voltage restorer," *IEEE Trans. Power Del.*, vol. 17, no. 3, pp. 857–864, Jul. 2002.

[31] B. H. Li, S. S. Choi, and D. M. Vilathgamuwa, "Design considerations on the line-side filter used in the dynamic voltage restorer," *Proc. Inst. Elect. Eng., Gen. Transm Distrib.*, vol. 148, no. 1, pp. 1–7, Jan. 2001.

[32] S. S. Choi, B. H. Li, and D. M. Vilathgamuwa, "Dynamic voltage restoration with minimumenergy injection," *IEEE Trans. Power. Syst.*, vol. 15, no. 1, pp. 51–57, Feb. 2000.

[33] Y. W. Li, D.M. Vilathgamuwa, P. C. Loh, and F. Blaabjerg, "A dualfunctional medium voltage level DVR to limit downstream fault currents," *IEEE Trans. Power. Electron.*, vol. 22, no. 4, pp. 1330–1340, Jul. 2007.

[34] Y. W. Li, D. M. Vilathgamuwa, F. Blaabjerg, and P. C. Loh, "A Robust control scheme for medium-voltage-level DVR implementation," *IEEE Trans. Ind. Electron.*, vol. 54, no. 4, pp. 2249–2261, Aug. 2007.

[35] S. S. Choi, T. X. Wang, and D. M. Vilathgamuwa, "A series compensator with fault current limiting function," *IEEE Trans. Power Del.*, vol. 20, no. 3, pp. 2248–2256, Jul. 2005.

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A Novel Algorithm For Generation Rescheduling Based Congestion Management

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Abstract—The practitioners and researchers has received considerable attention solving complex optimization problems with metaheuristic algorithms during the past decade. Many of these algorithms are inspired by various phenomena of nature. One of the promising solutions for secure and continuous power flow in the transmission line is rescheduling based congestion management approach but the base problem is rescheduling cost.. To solve the congestion with minimized rescheduling cost , a new population based algorithm, the Lion Algorithm (LA), is introduced in this paper . The basic motivation for development of this optimization algorithm is based on special lifestyle of lions and their cooperation characteristics. Based on some benchmark Lion Algorithm (LA) is compared with the existing conventional algorithms such as Particle Swarm Optimization (PSO), Genetic Algorithm (GA), Artificial Bee Colony (ABC), and Firefly (FF) by analyzing the convergence, cost, and congestion. In IEEE 30 bus system experimental investigation is carried out and the obtained results by the proposed algorithm LA (Lion Algorithm) in comparison to the other algorithms used in this paper**.**

Keywords— Rescheduling; congestion management; Optimization algorithm; LA

INTRODUCTION

To solve complex problems[2] in research field nature-inspired computing [1] intends with uncertainty, only based on natural inspiration[3], imprecise and high conflicts, partially true. A nature-inspired computing [4] is bio-inspired computing, starts emerging from the day of nature's behavior is be executed for solving real life problems [5].

In all the emerging fields[8],[9] the application of the bio-inspired optimization algorithm are going to used. 1970 [6], [7] . Evolutionary algorithms and Swarm intelligence is two category of the bio-inspired optimization algorithm[10],[11]. A new search algorithm called as Lion's Algorithm(LA) is proposed based on social behavior in this paper . Strongest mammal in the world is Lion due to its unique social behavior. On the basis of the behavior the Lion's algorithm is formulated to search for optimal solution in a huge search space.

Based on lion's unique social behavior a novel optimization algorithm Lion Algorithm (LA) is introduce in this paper.. to solve a minimization problem a simple LA model was proposed [12] in this paper. Hence, the main contributions of the paper is as follows:

- Based on lion's social behavior introduce a new optimization algorithm.
- Expands the system problem as a Large scale global optimization problem.
- To solve large scale system problem we studies the performance competency o the algorithm.
- solve the objective model in such a way that, the congestion management is accomplished.
- To accomplish congestion management, adaptive searching behaviour and swarm intelligence are incorporated with LA.

The rest of the paper is organized as follows Section II gives literature review, Section III Inspiration, Section IV gives the model of rescheduling based congestion management, Section V gives the steps of the lion algorithm , Section VI gives the results and discussion and Section VII gives the references.

Model of Rescheduling based Congestion Management

CONGESTION COST

The cost of rescheduling is defined here as congestion cost as mentioned in eq. (1)

$$C_{total} = \sum_{j \in N_g} (C_j \Delta P_G^+(j) + D_j \Delta P_G^-(j)) \$/n \quad (1)$$

where, C_{total} refers to the cumulative cost of modifying the active power output (\$/n), $C_j : j = 1,2,\ldots,N_g$ and D_j refer to price bids for incremental power and decremental power in \$/MWn by j^{th} GENCO, $\Delta P_G^+(j)$ and $\Delta P_G^-(j)$ are the active power increment of the generator(MW) and active power decrement of the generator(MW) respectively.

CONSTRAINTS:

The minimization of rescheduling cost has to be formulated as constrained minimization function.

Consider $\Delta P_G : 0 \le j \le N_g$ (MW), where ΔP_G denotes the change in power generated by MW for a cost of $f(\Delta P_G)$ in \$ for G^{th} generation unit. The minimization function can be defined as

$$S^* = \underset{\Delta P_G \forall G}{\arg\min} \sum_{j=1}^{N_g} f(\Delta P_G(j)) \quad (3)$$

The constraints given below.

(i) Generation capacity constraint:

$$P_G^{\min} \le P_G \le P_G^{\max} \quad (4)$$

where, P_G refers to the quantity of active power that is generated in MW, $P_G^{\min}$ and $P_G^{\max}$ denotes the minimum and maximum quantity generated in MW.

(ii) Real power balance constraints:

$$\sum_{j=1}^{N_g} P_G - (P_{PD} + P_{TL}) = 0 \quad (5)$$

Where, P_{PD} and P_{TL} denote the power demand and transmission losses in MW.

(iii) Stability Limits:

The given sequential stability limits are the important criteria to define and ensure congestion mitigation.

$$V_G^{\min} \le V_G \le V_G^{\max} \quad (6)$$

$$\partial_G^{\min} \le \partial_G \le \partial_G^{\max} \quad (7)$$

$$P_G^2 + Q_G^2 \le (S_G^{\max})^2 \quad (8)$$

In eq. (6) and (7), $(V_G^{\min}, V_G^{\max})$ and $(\partial_G^{\min}, \partial_G^{\max})$ are voltage and angle limits that define voltage stability from the generator. P_G^2, Q_G^2 denotes the power flow in MVA and $S_G^{\max}$ represents maximum power flow limit.

(iv) Ramp up limits:

For equal up and down rescheduling costs, the ramp limits can be defined as

$$\Delta P_G^{\min} \le \Delta P_G \le \Delta P_G^{\max} \quad (10)$$

where, $\Delta P_G^{\min}$ and $\Delta P_G^{\max}$ are changes in minimum and maximum quantity generated in MW.

OBJECTIVE MODEL:

The cost of $f(\Delta P_g)$ for j^{th} generation unit is defined as the sum of cumulative cost for rescheduling and the violation level on the voltage of the respective transmission line. The cost function to define the rescheduling strategy is given below.

$$f(\Delta P_g) = C_{total} + P_{profile} C_{profile} + P_{constraints} C_{constraints} \quad (11)$$

Where, $P_{constraints}$ and $P_{profile}$ denote the penalty cost imposed on violating the constraints and voltage profile, respectively.

Steps of the Proposed Lion Algorihtm

In recent days, LA-based rescheduling strategy is a advanced optimization algorithm, which is based on social behaviour of lions, has become popular. Hence, this paper adopts LA to solve the objective model, as given in eq. (11) and so the congestion can be minimized.

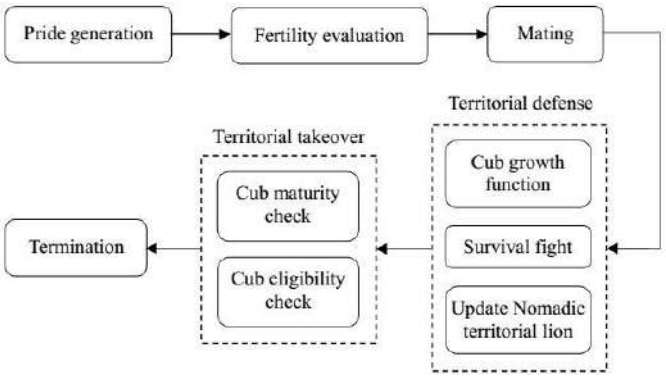

Fig 1. Steps of the Proposed LA for Rescheduling based Congestion Management

The description of the steps of LA algorithm as illustrated in fig.2 is explained below.
1. Pride Generation 6. Territorial Take over 6a Cub maturity check 6b Cub eligibility Check
2. Fitness Evaluation 7. Termination
3. Fertility Evaluation
4. Mating
5. Territorial Defence 5a.Cub growth function 5b Survival fight 5c. Update Nomadic territorial lion

ALGORITHM 1: PSEUDO CODE OF FERTILITY EVALUATION

Input: , , , and

Output: , , , and

// Evaluation

If

else

Reset

End if

// Evaluation

If is not adequate

Set and to zero
Do

Compute

If

Reset

Till reaches
End if

ALGORITHM 2: PSEUDO CODE OF TERRITORIAL DEFENCE

Obtain nomad coalition

Choose

If wins

Eliminate from the nomadic world

Kill and
Reset age(cubs)

Defence result

Else

Update nomad coalition

Defence result

End if

ALGORITHM 3: PSEUDO CODE OF TERRITORIAL TAKEOVER.

Input:

If

End if

If

If

Clear

End if

RESULTS AND DISCUSSION

Convergence Analysis

The convergence analysis of the proposed optimal congestion management technique and conventional techniques from various bus systems are shown in fig 2. The generator limits and Cost coefficients of IEEE -14 Bus System is shown in table –I. The convergence of all the techniques is analysed by the ability to minimize the cost function in correspondence with the number of iterations. In the rescheduling process performed for IEEE 14 bus system, the rescheduling cost incurred by LA is extremely lesser than the conventional algorithms such as PSO, GA, ABC and FF. Initially, the cost function is found to be at peak level and as the number of iteration increases, the rescheduling cost incurred by LA gets minimized. Moreover, the rescheduling strategy with minimized cost is observed at the last iteration, i.e., 100^{th} iteration. From the convergence analysis on IEEE Fourteen (IEEE-14) bus system, it is observed that the rescheduling cost minimization occurred by LA is 28% better than ABC and 35% better than the other conventional methods PSO, GA, and Firefly respectively.

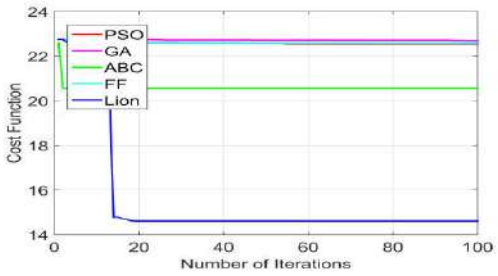

Fig 2 Demonstration of convergence analysis by PSO,GA,

Table –I GENERATION LIMITS AND COST COEFFICENTS OF IEEE 14 BUS SYSTEM ABC,FF and Lion Algorithm LA from IEEE- 14 bus systems

A. STATISTICAREPORT

Table II show the statistical reports on the minimized rescheduling cost obtained from LA-based rescheduling strategy and other conventional rescheduling algorithms. The statistical parameters include best case, worst case, mean performance, median performance and the standard deviation (also referred as Std in the Tabulations) between the mean and the individual performances. Table II show comparison of rescheduling cost reduction in percentage by LA With Conventional methods From IEEE 14 Bus System.

Methods	Best	Worst	Mean	Median	Std
PSO	14.627	22.586	20.972	22.551	3.547
GA	22.684	22.725	22.697	22.691	0.016719
ABC	20.541	20.587	20.555	20.55	0.018705
Firefly	20.544	22.605	21.372	20.564	1.1184
Lion	14.614	20.548	18.166	20.521	3.2412

Case Scenario	PSO Algorithm	GA Algorithm	ABC Algorithm	FF Algorithm
Best	LA is 85% better.	LA is 35% better.	LA is 28% better.	LA 28% is better.
Worst	LA is 90% better	LA is 95% better	LA is 18% better	LA is 90% better
Mean	LA is 13% better	LA is 19% better	LA is 11% better	LA is 15% better
Median	LA is 9% better	LA is 9% better	LA is 14% as LA	LA is 2% better
Std. Deviation	LA is 8% better	LA is 99% better	LA is 99% better	LA is 65% better

TABLE-II Stastical Report On Rescheduling Cost Reduction By La With Convetional Methods From IEEE 14 Bus System

TABLE III Comparison Of Rescheduling Cost Reduction In Percentage By LA With Conventional Method From IEEE 14 BuS System

All together we can finalize that the rescheduling cost minimization by LA-based rescheduling strategy is more effective when compared to the other conventional methods.

B. COST ANALYSIS

Table IV and Table V summarizes the congestion cost, compensation cost and final cost incurred by LA-based rescheduling strategy and other existing algorithms from IEEE 14 bus systems. On the basis of comparison, it is found that LA is better than GA, PSO & ABC Algorithms.

Generator number	P_i^{min} (MW)	P_i^{max} (MW)	a_i ($/MWhr)	b_i ($/MWhr)	c_i ($/hr)
1	10	160	0.005	2.450	105.00
2	20	80	0.005	3.510	44.100
3	20	50	0.005	3.890	40.600

Methods	Congestion cost ($)	Compensation cost ($)	Final cost ($)
PSO	14.495	805.59	22.551
GA	14.48	821.06	22.691

ABC	9.3972	1115.3	20.55
FF	14.495	809.47	22.589
LA	2.5485	1206.5	14.614

TABLE IV. Cost Analysis Of Rescheduling Cost Incurred By LA With Conventional Methods From IEEE 14 Bus System

TABLE V. Comparison In Percentage Of LA With other Algorithm From IEEE 14 Bus System

Name of Algorithm	GA Based Rescheduling Strategy	GA Based Rescheduling Strategy	PSO Based Rescheduling Strategy	ABC Based Rescheduling Strategy
LA Algorithm	LA is 35% Better.	LA is 35% Better.	LA is 28% Better.	LA is 35% Better.

C. CONGESTION ANALYSIS

The congestion analysis of the proposed optimal congestion management technique and conventional techniques from two bus systems IEEE 14 bus system are shown in fig.3. Fig.3(a), fig.4(b), fig.4(c), fig.4(d) and fig.4(e) explains how the corresponding congestion management techniques performed from IEEE 14 bus system to minimize the congestion that occurred in buses. Initially, below the minimum margin, there are two congested buses and fig.(a), (b), (c), (d) represents the congestion management by PSO, GA, ABC, and FF, in such a way that congestion is recovered. However, it is not so effective when compared to congestion management technique LA as shown in fig. (e), LA makes a drastic change by which the congested buses are reduced from two to one. Here the efficiency of LA is higher than the other conventional methods. Thus we can say that LA leads the position in terms of performance while comparing with the other techniques.

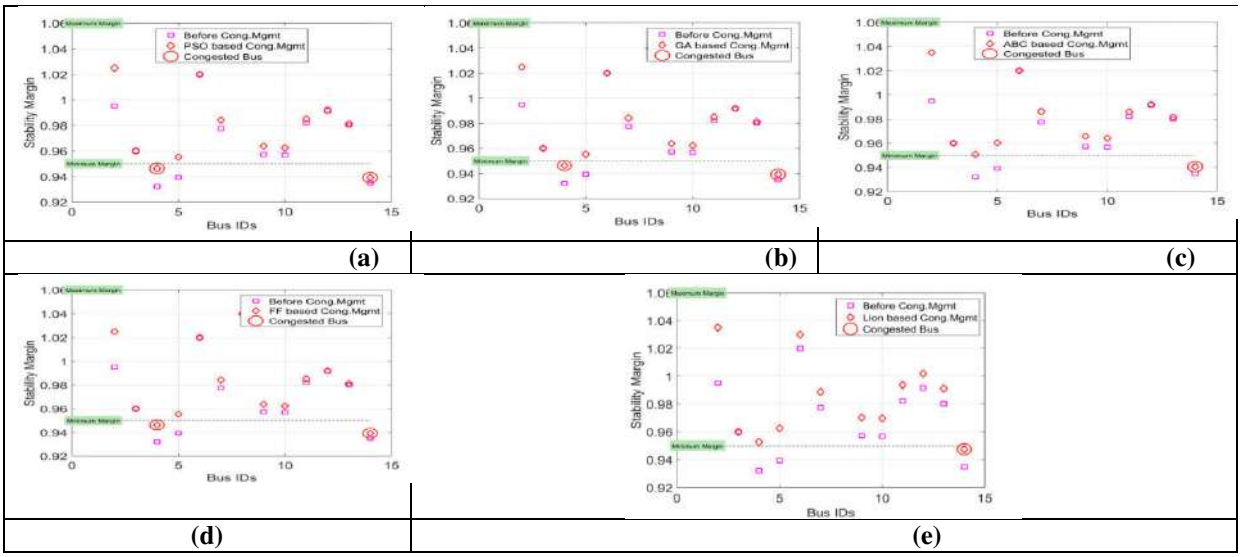

FIG. 3 DEMONSTRATION OF CONGESTION ANALYSIS BY PSO,GA,ABC,FF AND LA FROM IEEE BUS SYSTEMS (A),(B),(C),(D),(E) FROM IEEE 14 BUS SYSTEM

CONCLUSION

In recent years, generation rescheduling is the technique adopted to provide power system security and continuous power supply without congestion in the transmission line. However, rescheduling of the generator is one of the congestion management approaches, which also raises the challenge of minimizing the rescheduling cost. In the view of that, rescheduling cost was minimized in this paper by exploiting LA algorithm and, further the performance was compared with the conventional algorithms such as PSO, GA, ABC, and FF respectively. This comparison was substantiated by analysing the convergence, cost, and congestion mitigation of the entire algorithms. Thus, it is concluded that the performance of the LA-based rescheduling strategy is superior to the existing conventional methods by minimized rescheduling cost in computation.

REFERENCES

[1] Rozenberg, G., Bck, T., Kok, J., 2011,"Handbook of Natural Computing in Springer Publishing Company 1st Ed.

[2] Liu.J, Tusi K.C. 2006, "Toward nature-inspired computing," University of Michigan Press, Aaa Arbor.

[3] Zhang J., 2009, "Advances in Fuzzy Method for Natural Computing," IEEE Ninth International Conference on Hybrid Intelligent Systems 2p18-23

[4] Shadbolt, N., 2004. Nature-inspired computing," IEEE journal on Intelligent Systems 19(1), p. 2-3.

[5] Souza, J.G., Costa J.A.F., 2009, " Unsupervised data clustering and image segmentation using natural computing techniques, 'IEEE International Conference on System, Man and Cybernetics p. 5045-5050.

[6]Rechenberg,I.,1973 . " Evolutionstrategie :Optimierung Technisher System each Prinzipien des Biologischen Evolution" Fromman Hozlboog Verlag, Stuttgart, (German)

[7] Holland, J.H.,1975, "Adaptation in natural and artificial systems," University of Michigan Press, Aaa Arbor.

[8] Bongard, J.,2009, "Biologically Inspired Computing ," IEEE Computer Journal 42940,p 95-98.

[9] Forbes, N., 2000, "Biologically Inspired Computing," Computing in Science & Engineering 2(6), p. 83-87.

[10] David, E.G. 1989, "Genetic Algorithm in Search Optimization and Machine Learning, " Addison Wesley, p 41 n,

[11] Storn, R. 1996. "On the usage of differential evolution for function optimization," Biennial Conference of the North American Fuzzy Information Processing Society (NAFIPS),p 519

[12] B.R. Rajakumar, "Lion Algorithm for Standard and Large Scale Bilinear System Identification: A Globle Optimization Based on Lion's Social Behaviour.

[13] Md Sarwar and Anwar Shahzad Siddiqui, "Anefficient particle swarm optimizer for congestion management in deregulated electricity market ", Journal of Electrical Systems and Information Technology, vol. 2, no. 3, pp.269–282,December 2015.

[14] Sadhan Gope, Arup Kumar Goswami, Prashant Kumar Tiwari and Subhasish Deb, "Rescheduling of real power for congestion management with integration of pumped storage hydro unit using firefly algorithm", International Journal of Electrical Power & Energy Systems, vol. 83, pp. 434-442, December 2016.

[15] Sumit Verma and V. Mukherjee, "Firefly algorithm for congestion management in deregulated environment", Engineering Science and Technology, an International Journal, vol.19, no.3, pp. 1254-1265, September 2016.

Analysis and Design of Modular Multilevel Cascade Inverter for Speed-Sensorless control of Induction Motor Drive

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Abstract - This paper presents theoretical discussions on a speed-sensorless start-up method for an induction motor driven by a modular multilevel cascade inverter based on double-star chopper cells (MMCI-DSCC) from stand- still to middle speed. This motor drive is suitable, particularly for a large-capacity fan- or blower-like load. The load torque is proportional to a square of the motor mechanical speed. The start-up method is characterized by combining capacitor-voltage control with motor-speed control. The motor-speed control with the minimal stator current plays a major role in eliminating a speed sensor from the drive system and in minimizes an ac- voltage fluctuation occurring across each dc capacitor. Experimental results obtained from the 400-V 15-kW downscaled system with no speed sensor verify that the motor-speed control proposed for the DSCC-based drive system can enhance the start-up torque by a factor of three under the same ac-voltage fluctuation. Several start-up waveforms show stable performance from steady state to middle speed with different load torques.

Keywords: Medium-voltage induction motor drives, minimal stator current, modular multilevel cascade inverters, speed- sensorless start-up method.

INTRODUCTION

A modular multilevel cascade inverter based on double- star chopper cells (MMCI-DSCC) has each leg of the DSCC consists of two positive and negative arms and a center-tapped inductor sitting between the two arms. Each arm consists of multiple bidirectional dc/dc choppers called as "chopper cells." The low- voltage sides of the chopper cells are connected in cascade, while the electrically floating high-voltage sides of chopper cells are equipped with a voltage sensor and a dc capacitor. As the count of cascaded chopper cells per leg increases a synergy effect of lower voltage steps and phase-shifted PWM leads to lower harmonic voltage and current as well as lower EMI emission.

When a DSCC is applied to an ac motor drive, the DSCC would suffer from ac-voltage fluctuations in the dc-capacitor voltages of each chopper cell in a low-speed range, because as a stator-current frequency gets reduced, the ac-voltage fluctuation gets more serious [7]. In [10] proposed a simple start-up method with no speed sensor, in which a DSCC continued to be operated at an appropriate constant frequency, e.g., 30 Hz, to reduce the ac-voltage fluctuation during the start-up. Here, the ac output voltage was adjusted appropriately to produce a required start- up torque. For DSCC-driven induction motors other start-up methods from steady state, where each of the motors was equipped with a speed sensor [11]-[13]. A serious ac-voltage fluctuation in a low-speed range can be mitigated by superimposing a circulating current and injecting a common mode voltage on each leg of the DSCC [10]. Usually, it is desirable to eliminate a speed sensor from a motor drive.

This motor drive is applicable to a fan/blower-like load. The load torque is proportional to a square of the motor mechanical speed, and is changing gradually to be considered as steady-state conditions. The start-up method discussed in this paper is characterized by combining capacitor-voltage control with motor-speed control. The mean dc voltage of each of the dc capacitors is regulated by capacitor-voltage control [7] and in mitigating the ac voltage fluctuation appearing across each dc capacitor, which fluctuates at the stator-current frequency [4]. It is possible to eliminate a speed sensor from the drive system and to mitigate the ac-voltage fluctuation in all the frequency range using motor speed control.

Circuit Configuration and Capacitor-Voltage Control of the DSCC

Fig. 1(a) shows the main circuit configuration of the DSCC. As shown in Fig. 1(b) each leg consists of eight cascaded bidirectional chopper cells and, as shown in Fig. 1(c) a center- tapped inductor per phase. The center tap of each inductor is connected directly to each of the stator terminals of an induction motor, where *iu* is the u-phase stator current. The center-tapped inductor is more cost effective than two non coupled inductors per leg, because the center tapped inductor presents inductance *Lz* only to the circulating current *iz* and no inductance to the stator current *iu* [7]. It brings significant reductions in weight, size, and cost of the magnetic core. These advantages in the center- tapped inductor are mostly welcomed, particularly applications to motor drives, in which no ac inductors are required between the inverter and the motor. In Fig. 1, instantaneous currents iPu and iNu are the u- phase positive- and negative-arm currents, respectively, and iZu is the u-phase circulating current defined as follows[7]:

$$i_{Zu} \triangleq \frac{1}{2}(i_{Pu} + i_{Nu}) \qquad (1)$$

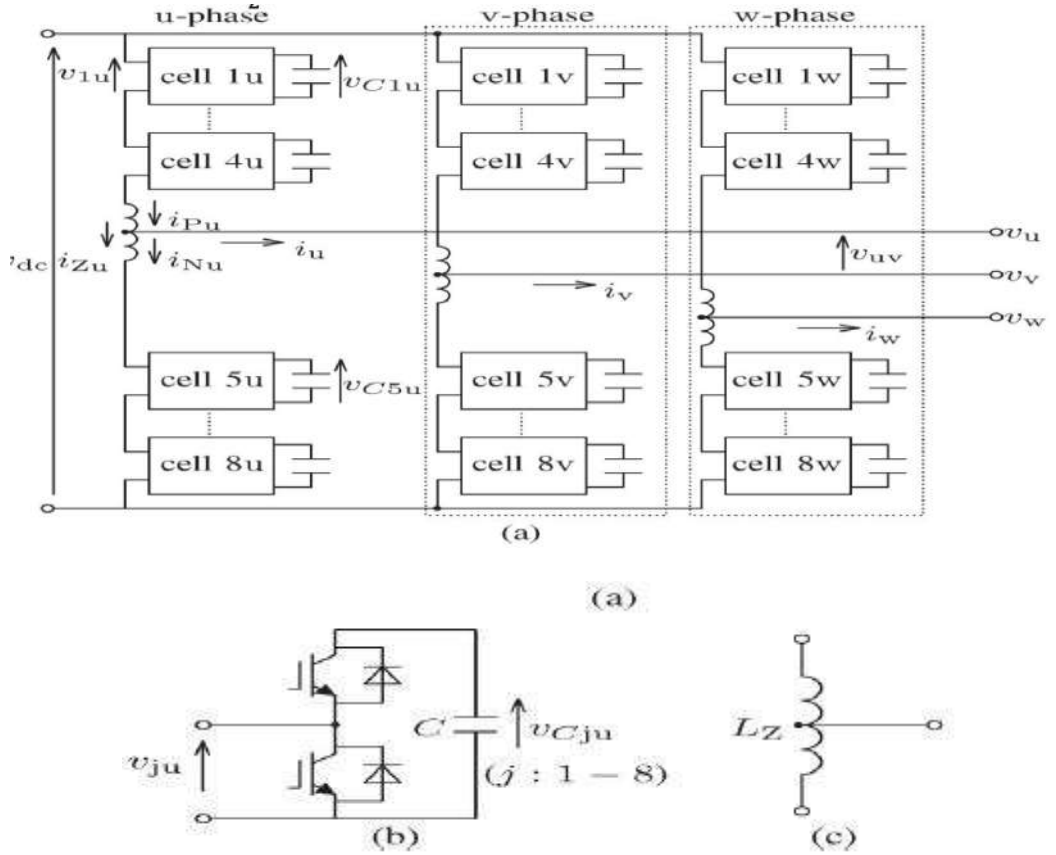

Fig 1 : Circuit configuration for an MMCI-DSCC. (a) Power circuit. (b) Chopper cell. (c) Center-tapped inductor.

Note that for the capacitor-voltage control iZu includes ac and dc components to be used. The dc component flows from the common dc link to each leg, while the ac component circulates among the three legs. The individual ac components included in the three-phase circulating currents cancel each other out, so that no ac component appears in either motor current or dc-link current [14]. The arm currents *i*Pu and *i*Nu can be expressed as linear functions of two independent variables *iu* and iZu as follows [7]:

$$i_{Pu} = \frac{i_u}{2} + i_{Zu} \quad (2)$$

$$i_{Nu} = \frac{i_u}{2} + i_{Zu} \quad (3)$$

$$i_{Zu} \triangleq \frac{1}{2}(i_{Pu} + i_{Nu}) \quad (4)$$

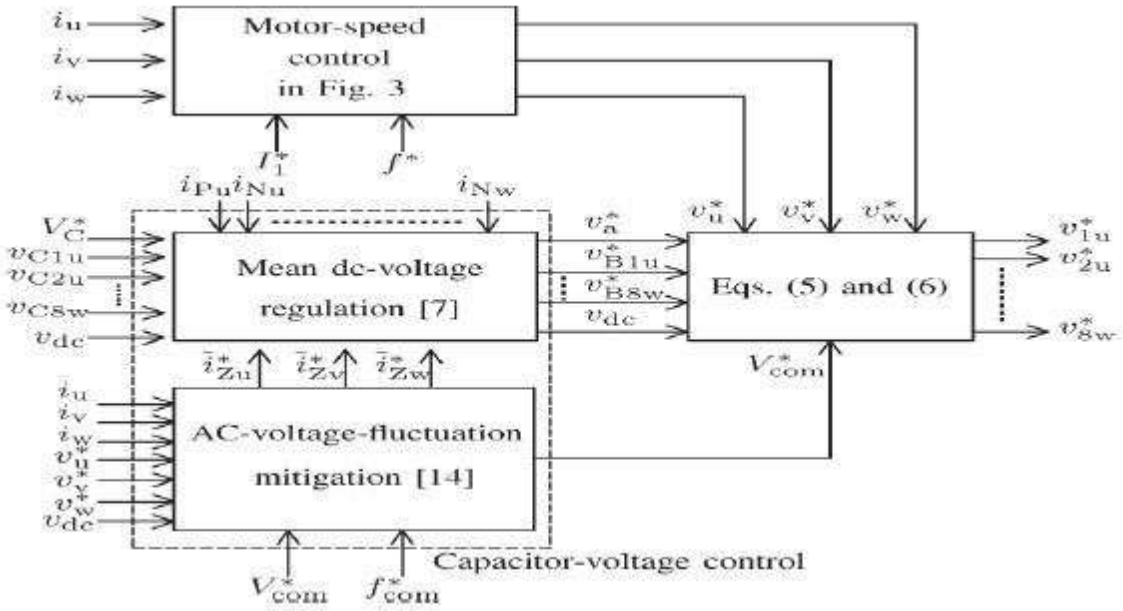

Fig 2: Overall control block diagram for the start-up method

CAPACITOR-VOLTAGE CONTROL

Fig. 2 shows the overall control block diagram of the startup method. The 24 dc-capacitor voltages vcjuvw, the dc-link voltage vdc, and the six arm currents zWw and zWw are detected, and they are input signals for the block diagram. Note that the three stator currents z'uvw are calculated from the detected arm currents

The mean dc-voltage regulation can be achieved by using the "arm" balancing control applied to the six arms and the "individual" balancing control applied to the one arm at the same time [7]. The ac-voltage fluctuation can be mitigated by the sophisticated control discussed in [13]. This control interacts the common-mode voltage vcom, which is injected to three center-tap terminals of the DSCC with the ac components of the three circulating currents ~izuvw. This can mitigate the ac- voltage fluctuation at the stator-current frequency, thus leading to start up from standstill. As a result, the remaining ac-voltage fluctuations are independent of the time-varying frequencies of the stator current, but dependent on a fixed frequency of the injected common-mode voltage (50 Hz in this experiment). The circulating-current feedback control included in the mean dc-voltage regulation block yields a command voltage ofv_{a*}.

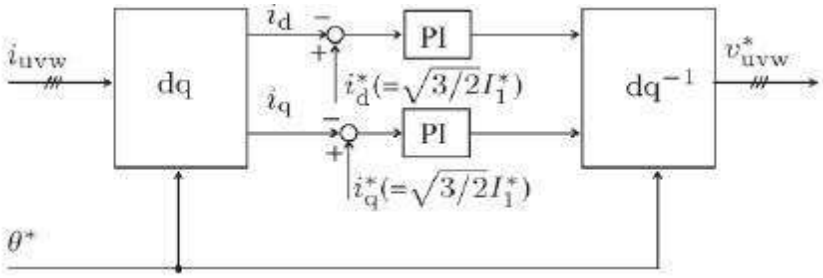

Fig 3: Block diagram for the motor-speed control based on a feedback control of the stator current.

Finally, command *u*-phase voltages for each chopper cell, i.e., *v*j∗u, are given as follows [14]

$$v_{ju}^{*} = v_{a}^{*} + v_{Bju}^{*} + \frac{v_{a}^{*}+v_{com}^{*}}{4} + \frac{v_{dc}}{8} (j = 1-4) \quad (5)$$

$$v_{ju}^{*} = v_{a}^{*} + v_{Bju}^{*} + \frac{v_{a}^{*}+v_{com}^{*}}{4} + \frac{v_{dc}}{8} (j = 5-8) \quad (6)$$

Here, *v** and v^{*}_{Biu} are used to regulate the mean dc voltage, v^{*}_{u} is the command motor voltage given by Fig. 3 described in the later section, v^{**}_{om} is the command common-mode voltage, and Vdc is the dc-link voltage used as feed forward control. The command rms value of the common-mode voltage *v*com should be set as high as possible to reduce the amplitude of each ac circulating current, because it is inversely proportional to Vcom [14]. Moreover, there is no relationship between common-mode voltage and power rating of the motor.

MOTOR-SPEED CONTROL

Control Principles

The motor-speed control forms a feedback loop of three-phase stator currents to realize a stable start-up from standstill. This requires the current sensors attached to the ac terminals. The stator current in one phase is calculated by the corresponding arm currents detected. Therefore, no additional current sensor is required. Fig. 3 shows the block diagram for the motor-speed control. The three-phase stator currents are transformed into dc quantities by using the *dq* transformation to enhance current controllability. In Fig. 3, 9* is the phase information used for the d q transformation, whereas i*d and i*q are the command currents given by

Note that i^{*}_{1} and /* are given not by feedback control, but by feed forward control. Here, /0 is the phasor magnetizing current *11* is the phasor stator current and is the phasor torque current. Note that /0and /2 are orthogonal to each other in steady-state conditions. The rms value of *111, h* is given in Fig. 3 as follows:

$$i_{d}^{*} = i_{q}^{*} = \sqrt{\frac{3}{2}} i_{1}^{*} \quad (7)$$

Note that i_{1*} and f_{*} are given not by feedback control, but by feed forward control. Here, I_{0*} is the phasor magnetizing current I_{1*} is the phasor stator current and is the phasor torque current. Note that $I_{0*}$and I_{2*} are orthogonal to each other in steady-state conditions. The rms value of I_{1*}, I_1 is given in Fig. 4 as follows:

$$I_1 = \sqrt{I_0^2 + (\frac{L_2}{M} I_2)^2} \quad (8)$$

The motor torque T_M is expressed by using I_0 and I_2 that are the rms values of I_{0*}andI_{2*}, respectively, as follows [17]

$$T_M = 3PMI_0I_2 \quad (9)$$

Where, P is the pole-pair number.

The motor-speed control has no capability to control the magnetizing current and the torque current independently. However, when the phasor stator current changes from *IHi* to *IHj,* the torque current decreases from I2i to I2j and the magnetizing current increases from Ioi to Ioj, respectively, to keep the area of triangle constant. In other words both Io & I2 would change each of the amplitude automatically when Iichanges. The slip frequency *fs* is described by using I2and Ioas follows :

$$f_8 = \frac{R_2}{2\pi M} \frac{I_2}{I_0} \quad (10)$$

Experimental System Configuration

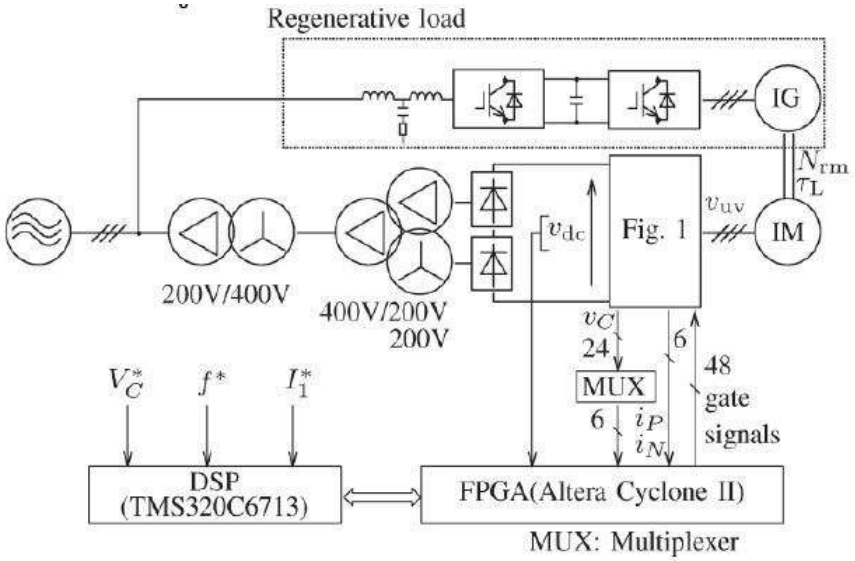

Fig 4: 400-V 15-kW downscaled system used in the experiments

Experimental System Configuration

Fig. 4 shows the system configuration of the 400-V 15-kW own scaled system. Table 2 summarizes the circuit parameters used in the experiments. Table 3 summarizes the specifications of the 380-V 15-kW induction motor tested. Here, a three phase 12-pulse diode rectifier, consisting of a three-winding transformer with a A-A-Y connection and two three-phase six-pulse diode rectifiers,

is used as the front end. When the supply voltage matches the motor voltage, a transformer less medium-voltage motor drive can be achieved by replacing the 12-pulse diode rectifier with a six-pulse diode rectifier. Neither electrolytic capacitor nor film capacitor is connected to the common dc link [20].

The ac output terminals of the DSCC are directly connected to the induction motor rated at 380 V and 15kW. The regenerative load in Fig. 6 consists of an induction generator rated at 190 V and 15 kW and two identical PWM converters connected back to back. The field oriented control is applied to the induction generator, which enables an arbitrary instantaneous torque *tl* to be loaded on the induction motor.

Table-1: Circuit Parameters used in t ie Experimen

Rated active power		15kW
Rated line-to line rms voltage	Vs	400V
Rated dc-link voltage	Vdc	570V
Center-tapped inductor	Lz	4.0 mH (12%)
DC capacitor of chopper cell	C	3.3 mF
DC- capacitor voltage	Vc	140 V
Unit capacitance constant	H	52MS[19]
Cell count per leg	N	8
Triangular-wave-carrier freq.	Fc	2 kHz
Equivalent carrier frequency	Nfc	16 kHz

Table-2: Motor Parameters used in the Experiments

Rated output power		15 kW
Rated frequency		50 Hz
Rated line-to-line rms voltage	V	380V
Rated mechanical speed	Nrm	1460 rpm.
Rated stator rms current	I1	32 A
Rated magnetizing current	I0	184 A
Pole-pair number	P	2
Moment of motor inertia	Jm	01 okg*m^2
Moment of load inertia	Jl	01 okg*m^2

An over current protection for each chopper cell has been implemented, in which the DSCC is disconnected from the ac mains when amplitude of either of the arm currents reaches 45A. The command dc-capacitor voltage was set to 7_C*=140 V. A square-wave common-mode voltage and square-wave circulating currents were used to mitigate the ac-voltage fluctuation of each dc capacitor, in which the rms value of the common-mode voltage *Vcom* and its frequency /com were set to Vcom = 180 V and */com* = 50 Hz, respectively, for the following reasons.

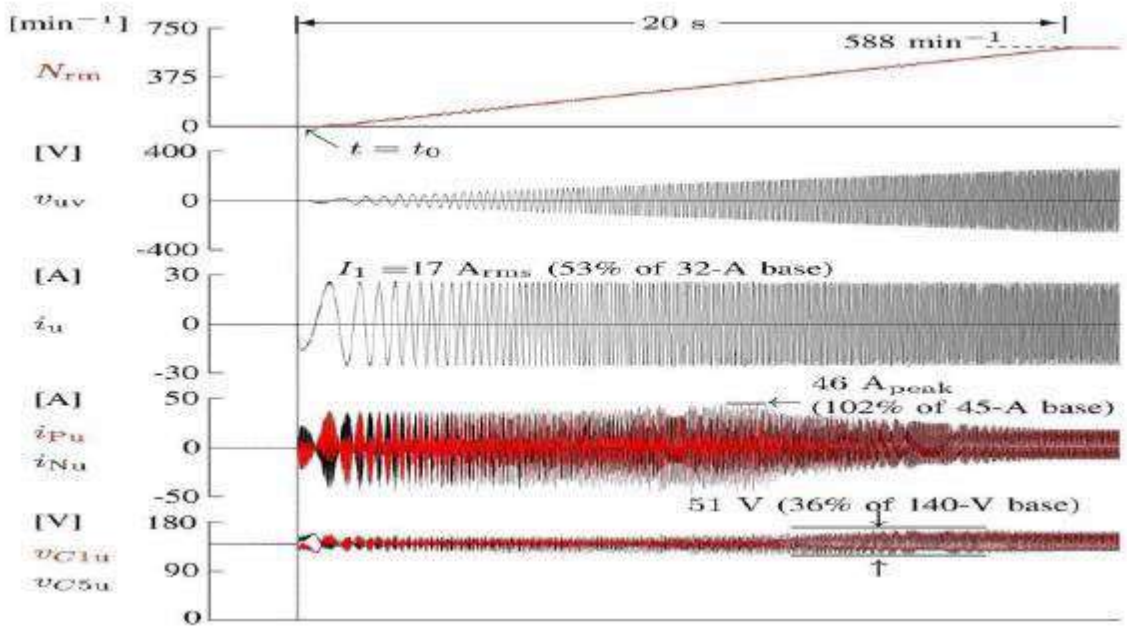

Fig 1: Experimental start-up waveforms when *I*** = 17A (53%), and *T*l = 60%, where *Io* = 12A (65%).

The command for the stator rms current *I** in the motor- speed control was determined by experiments.

- The command common-mode voltage V_c*_{om} was set to make the modulation index of the DSCC be around unity.
- The command frequency f_{com} was set to be less than one-tenth of the carrier frequency of *fc* to achieve good controllability of the ac circulating current [13].

RESULTS

This paper has proposed a practical start-up method for a DSCC-driven induction motor with no speed sensor from steady state to middle speed. This start-up method is characterized by combining

capacitor-voltage control and motor-speed control. The motor-speed control with the minimal stator current under a load torque is based on the combination of feedback control of the three-phase stator currents with feed forward control of their frequency and amplitude. The arm- current amplitudes and ac-voltage fluctuations across each of the dc capacitors can be minimizes to acceptable levels.

An experimental result obtained from a 400-V 15-kW down- scaled system has shown that the motor loaded with 60% can achieve a stable start up from steady state to a middle speed of *Nrm* = 588 min^{-1} without overvoltage and over current. The start-up torque has been increasing by a factor of three, without additional stress on both arm ac-voltage and currents fluctuations. This method is suitable particularly for adjustable-speed drives of large-capacity fans, blowers, and compressors for energy savings.

CONCLUSION

This paper has proposed a practical start-up method for a DSCC-driven induction motor with no speed sensor from steady state to middle speed. This start-up method is characterized by combining capacitor-voltage control and motor-speed control. The motor-speed control with the minimal stator current under a load torque is based on the combination of feedback control of the three-phase stator currents with feed forward control of their frequency and amplitude. The arm- current amplitudes and ac-voltage fluctuations across each of the dc capacitors can be minimizes to acceptable levels.

REFERENCES

[1] J. Rodriguez, S. Bernet, J. O. Bin Wu, and S. Pontt, "Multilevel voltage- source-converter topologies for industrial medium-voltage drives," *IEEE Trans. Ind. Electron.,* vol. 54, no. 6, pp. 293o-2945, Dec. 2oo7.

[2] H. Akagi, "Classification, terminology, and application of the modular multilevel cascade converter (MMCC)," *IEEE Trans. Power Electron.,* vol. 26, no. 11, pp. 3119-313o, Nov. 2o11.

[3] A. Lesnicar and R. Marquardt, "An innovative modular multilevel converter topology suitable for a wide power range," in *Conf. Rec. IEEE Bologna PowerTech,* 2oo3, [CD-ROM].

[4] M. Hagiwara and H. Akagi, "Control and experiment of pulse-width- modulated modular multilevel converters," *IEEE Trans. Power Electron.,* vol. 24, no. 7, pp. 1737-1746, Jul. 2oo9.

[5] M. Hiller, D. Krug, R. Sommer, and S. Rohner, "A new highly modular medium voltage converter topology for industrial drive applications," in *Conf. Rec. EPE*, 2oo9, pp. 1 -1o.

[6] S. Rohner, J. Weber, and S. Bernet, "Continuous model of modular multilevel converter with experimental verification," in *Conf. Rec. IEEE- ECCE,* 2o11, pp. 4o21-4o28.

[7] A. Antonopoulos, L. Angquist, S. Norrga, K. Llves, and H. P. Nee, "Modular multilevel converter ac motor drives with constant torque from zero to nominal speed," in *Conf. Rec. IEEE-ECCE,* 2o12, pp. 739-746.

[8] J. Kolb, F. Kammerer, and M. Braun, "Dimensioning and design of a modular multilevel converter for drive applications," in *Conf. Rec. EPE,* 2o12, pp. LS1a-1.1-1-LS1a-1.1-8, [CD-ROM].

[8] A. J. Korn, M. Winkelnkemper, and P. Steimer, "Low output frequency operation of the modular multilevel converter," in *Conf. Rec. IEEE-ECCE,* 2o1o, pp. 3993-3997.

[9] M. Hagiwara, I. Hasegawa, and H. Akagi, "Startup and low-speed operation of an adjustable-speed motor driven by a modular multilevel cascade inverter (MMCI)," *IEEE Trans. Ind. Appl.,* vol. 49, no. 4, pp. 1556-1565, Jul./Aug. 2o13.

[10] J. Holtz, "Sensorless control of induction motor drives," *Proc. IEEE,* vol. 9o, no. 8, pp. 1359-1394, Aug. 2oo2.

[11] A. Munoz-Garcia, T. A. Lipo, and D. W. Novotny, "A new induction motor *V/f* control method capable of high-performance regulation at low speeds," *IEEE Trans. Ind. Appl.,* vol. 34, no. 4, pp. 813-821, Jul./Aug. 1998.

[12] H. Fujita, S. Tominaga, and H. Akagi, "Analysis and design of a dc voltage-controlled static var compensator using quad-series voltage- source inverters," *IEEE Trans. Ind. Appl.,* vol. 32, no. 4, pp. 97o-977, Jul./Aug. 1996.

A survey paper on Internet of Things

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Abstract- Over the last decade Internet has made significant impact in our economies and societies by bringing in remarkable communication and networking infrastructure. The world-wide web has been a major driver of global information and media sharing. From Desktop networking Internet is continuing to become more pervasive, with the advent of low cost wireless broadband connectivity, by connecting to new embedded devices and handhelds. In continuation with this trend, it is poised to emerge as an "Internet of Things" where the web will provide a medium for physical world objects to participate in interaction. This way the digital information technology can integrate the physical world to the online world to provide a common interaction platform. The Internet of Things (IOT) describes a worldwide network of intercommunicating devices. It integrates the ubiquitous communications, pervasive computing, and ambient intelligence. At this point (IOT) must be seen as a vision where "things", especially everyday objects, such as nearly all home appliances but also furniture, clothes, vehicles, roads and smart materials, and more, are readable, recognizable, locatable, addressable and/or controllable via the Internet. This will provide the basis for many new applications, such as energy monitoring, transport safety systems or building security. This vision will surely change with time, especially as synergies between Identification Technologies, Wireless Sensor Networks, Intelligent Devices and Nanotechnology will enable a number of advanced applications.

KEYWORDS: INTERNET OF THINGS, PERVASIVE COMPUTING, WIRELESS SENSOR NETWORKS, INTELLIGENT DEVICES AND NANOTECHNOLOGY.

INTRODUCTION

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

a) IoT for the Automotive Fleet Industry

Meet the demand for new functions and best-in-class security with scalable solutions that make it easy to connect and control IoT devices.

b) IoT for Utilities

Make mission-critical operations more efficient, safe, and secure by deploying an IoT-ready utility communications infrastructure.

c) IoT for Smart Cities

Use the IoT to improve quality of life, foster economic growth, and deliver on eco-sustainability initiatives. At its core, IoT is simple: it's about connecting devices over the internet, letting them talk to us, applications, and each other. The popular, if silly, example is the smart fridge: what if your fridge could tell you it was out of milk, texting you if its internal cameras saw there was none left, or that the carton was past its use-by date? Where it's most common, in Britain at least, is home heating and energy use – partially because the government is pushing energy companies to roll out smart meters (although it has been questioned whether it can be delivered on schedule). They have clever functions that let you turn on heating remotely, set it to turn down the temperature if it's a sunny day, or even turn off when there's no-one home. Some can tell the latter with motion-sensing cameras, or simply by seeing that your smartphone (and therefore you) has left the premises.

IoT is more than smart homes and connected appliances, however. It scales up to include smart cities – think of connected traffic signals that monitor utility use, or smart bins that signal when they need to be emptied – and industry, with connected sensors for everything from tracking parts to monitoring crops.

Why does it matter? There's a reason the government is encouraging energy companies to hand you a smart meter: all that data and automated use is more efficient, meaning we use less energy. Many areas of IoT show such benefits, though some smart gadgets are more about whizz-bang effects than efficiency, which may well be why we're seeing more smart heating than smart fridges in the UK.

I. SECURITY CONCERN

Everything new and shiny has downsides, and security and privacy are the biggest challenges for IoT. All these devices and systems collect a lot of personal data about people – that smart meter knows when you're home and what electronics you use when you're there – and it's shared with other devices and held in databases by companies. Security experts argue that not enough is being done to build security and privacy into IoT at these early stages, and to prove their point have hacked a host of devices, from connected baby monitors to automated lighting and smart fridges, as well as city wide systems such as traffic signals. Hackers haven't, for the most part, put much attention to IoT; there's likely not enough people using connected appliances for an attack against them to be worth the effort, but as ever, as soon as there's a financial benefit to hacking smart homes, there will be a cyber-criminal working away at it.

So the short answer is yes, IoT is relatively safe: you're not likely to face serious loss or damage because of your smart meter, any more than your home PC, at least. However, there's no guarantee, and so far not enough is being done to ensure IoT isn't the next big hacking target.

a) Effects of IoT on business & Work:

This all depends on your industry: manufacturing is perhaps the furthest ahead in terms of IoT, as it's useful for organizing tools, machines and people, and tracking where they are. Farmers have also been turning to connected sensors to monitor both crops and cattle, in the hopes of boosting production, efficiency and tracking the health of their herds.

The examples are endless, and all we can predict is that connected devices will likely creep into most businesses, just the way computers and the web has. When the efficiencies are with tools or plants, it's easy to appreciate the potential benefit, but when it's office workers who are being squeezed for

more productivity, it could take on a bit of a dystopian shade: imagine your security access card being used to track where you are in the building, so your boss can tot up how much time you're spending in the kitchen making tea. On the flip side, a smart tea maker that knows just when you're in need of a cup could be very handy indeed.

b) Iot for Healthcare

Smart pills and connected monitoring patches are already available, highlighting the life-saving potential of IoT, and many people are already strapping smart watches or fitness bands to their wrists to track their steps or heartbeat while on a run.

There's a host of clever connected health ideas: Intel made a smart band that tracks how much patients with Parkinsons shake, collecting more accurate data than with paper and pen; Sonamba monitors daily activities of senior or ill people, to watch for dangerous anomalies; and people with heart disease can use AliveCore to detect abnormal heart rhythms.

Healthcare is one area where more data has the potential to save lives, by preventing disease, monitoring it and by analyzing it to create new treatments. However, our health is also one of the most sensitive areas of our lives, so privacy and security will need a bit more preventative medicine first.

FEASIBILITY OF IOT

This is perhaps the best query being Googled about IoT: is it real?

Surprisingly, it's tough to answer. Technology is full of marketing and hype – it's often difficult to decide early on whether an innovation is truly ground-breaking or not. After all, many tech pundits mocked the first iPhone.But the internet of things is one of those wider ideas that isn't dependent on a single project or product. Smart fridges may well be the appliance of the future, or could fall by the wayside as too much tech for too little gain, but the idea of connected sensors and smart devices making decisions without our input will continue.

A decade from now, everything could be connected or perhaps only bits and pieces with specific benefits, such as smart meters; and we may call it IoT, smart devices or not call it anything at all, the way smartphones have simply become phones. You've likely heard the phrase "Internet of Things" — or IoT — at some point, but you might also be scratching your head figuring out what it is or what it means.

The IoT refers to the connection of devices (other than typical fare such as computers and smartphones) to the Internet. Cars, kitchen appliances, and even heart monitors can all be connected through the IoT. And as the Internet of Things grows in the next few years, more devices will join that list. We've compiled a beginner's guide to the IoT to help you navigate the increasingly connected world.

Terms and Basic Definitions

Below, we've provided a glossary defining the Internet of Things:

1. Internet of Things: A network of internet-connected objects able to collect and exchange data using embedded sensors.
2. Internet of Things device: Any stand-alone internet-connected device that can be monitored and/or controlled from a remote location.
3. Internet of Things ecosystem: All the components that enable businesses, governments, and consumers to connect to their IoT devices, including remotes, dashboards, networks, gateways, analytics, data storage, and security.
4. Entity: Includes businesses, governments, and consumers.
5. Physical layer: The hardware that makes an IoT device, including sensors and networking gear.
6. Network layer: Responsible for transmitting the data collected by the physical layer to different devices.
7. Application layer: This includes the protocols and interfaces that devices use to identify and communicate with each other.

8. Remotes: Enable entities that utilize IoT devices to connect with and control them using a dashboard, such as a mobile application. They include smartphones, tablets, PCs, smartwatches, connected TVs, and nontraditional remotes.
9. Dashboard: Displays information about the IoT ecosystem to users and enables them to control their IoT ecosystem. It is generally housed on a remote.
10. Analytics: Software systems that analyze the data generated by IoT devices. The analysis can be used for a variety of scenarios, such as predictive maintenance.
11. Data storage: Where data from IoT devices is stored.
12. Networks: The internet communication layer that enables the entity to communicate with their device, and sometimes enables devices to communicate with each other.

IOT PREDICTIONS, TRENDS, AND MARKET

BI Intelligence, Business Insider's premium research service, expects there will be more than 24 billion IoT devices on Earth by 2020. That's approximately four devices for every human being on the planet.And as we approach that point, $6 billion will flow into IoT solutions, including application development, device hardware, system integration, data storage, security, and connectivity. But that will be money well spent, as those investments will generate $13 trillion by 2025.Who will reap these benefits? There are three major entities that will use IoT ecosystems: consumers, governments, and businesses. For more detail, see the Industries section below.

IoT Industries

Several environments within the three groups of consumers, governments, and ecosystems will benefit from the IoT. These include:

Infrastructure	**Retail**	**Logistics**	**Banks**
Oil, gas, and mining	Insurance	Connected Home	Food Services
Manufacturing	Transportation	Defense	Agriculture
Utilities	Hospitality	Healthcare	Smart Buildings

IoT Companies

There are literally hundreds of companies linked to the Internet of Things, and the list should only expand in the coming years. Here are some of the major players that have stood out in the IoT to this point:

GE (GE)	**AT&T (T)**	**Cisco (CSCO)**	**IBM (IBM)**
Amazon (AMZN)	Skyworks (SWKS)	Apple (AAPL)	Sierra Wireless (SWIR)
Honeywell (HON)	Hitachi	T-Mobile (TMUS)	Comcast (CMCSA)
Google (GOOGL)	Iridium Communications (IRDM)	Ambarella (AMBA)	ARM Holdings (ARMH)

IoT Platforms

One IoT device connects to another to transmit information using Internet transfer protocols. IoT platforms serve as the bridge between the devices' sensors and the data networks.

The following are some of the top IoT platforms on the market today:

1. Amazon Web Services
2. Microsoft Azure
3. ThingWorx IoT Platform
4. IBM's Watson
5. Cisco IoT Cloud Connect
6. Salesforce IoT Cloud
7. Oracle Integrated Cloud
8. GE Predix

IoT Security & Privacy

As devices become more connected thanks to the IoT, security and privacy have become the primary concern among consumers and businesses. In fact, the protection of sensitive data ranked as the top concern (at 36% of those polled) among enterprises, according to the 2016 Vormetric Data Threat Report.

Cyber-attacks are also a growing threat as more connected devices pop up around the globe. Hackers could penetrate connected cars, critical infrastructure, and even people's homes. As a result, several tech companies are focusing on cyber security in order to secure the privacy and safety of all this data.

MORE TO LEARN

BI Intelligence has compiled an exhaustive and detailed report on the Internet of Things that is your one-stop resource for all you need to know about the IoT.

The report gives a thorough outlook on the future of the Internet of Things, including the following big picture insights:

1. IoT devices connected to the Internet will more than triple by 2020, from 10 billion to 34 billion. IoT devices will account for 24 billion, while traditional computing devices (e.g. smartphones, tablets, smartwatches, etc.) will comprise 10 billion.
2. Nearly $6 trillion will be spent on IoT solutions over the next five years.
3. Businesses will be the top adopter of IoT solutions because they will use IoT to 1) lower operating costs; 2) increase productivity; and 3) expand to new markets or develop new product offerings.
4. Governments will be the second-largest adopters, while consumers will be the group least transformed by the IoT. And when you dig deep
5. into the report, you'll get the whole story in a clear, no-nonsense presentation:

a) The complex infrastructure of the Internet of Things distilled into a single ecosystem
b) The most comprehensive breakdown of the benefits and drawbacks of mesh (e.g. ZigBee, Z-Wave, etc.), cellular (e.g. 3G/4G, Sigfox, etc.), and internet (e.g. Wi-Fi, Ethernet, etc.) networks
c) The important role analytics systems, including edge analytics, cloud analytics, will play in making the most of IoT investments
d) The sizable security challenges presented by the IoT and how they can be overcome
e) The four powerful forces driving IoT innovation, plus the four difficult market barriers to IoT adoption
f) Complete analysis of the likely future investment in the critical IoT infrastructure: connectivity, security, data storage, system integration, device hardware, and application development
g) In-depth analysis of how the IoT ecosystem will change and disrupt 16 different industries
h) The choice is yours. But however you decide to acquire this report, you've given yourself a powerful advantage in your understanding of the fast-moving world of the IoT.

CONCLUSION

In conclusion, it can be easily said that IoT has a great future in fleet Industry, Utilities, Smart Cities, Security, Business, Work, Healthcare, Industries and companies.

REFERENCES

[1] https://networks.nokia.com/innovation/iot-automotive-fleet.

[2] The Internet of Things: A survey" Author LuigiAtzori, AntonioIera and GiacomoMorabito https://doi.org/10.1016/j.comnet.2010.05.010.

[3] "Smart objects as building blocks for the Internet of things" Gerd Kortuem University of Lancaster, Fahim Kawsar Waseda University Lancaster University , Tokyo Lancaster and Vasughi Sundramoorthy Lancaster University, Lancaster.

[4] "Applications of Internet of Things (IoT) in Sports World" by Sachin Menon1, Master in Computer Applications and Prof. India Dhanamma Jagli VESIT, Mumbai University Chembur, Mumbai – India Volume 4, Issue 6, June 2016 International Journal of Advance Research in Computer Science and Management Studies Research Article / Survey Paper / Case Study Available online at: www.ijarcsms.com ISSN: 2321-7782 (Online) Impact Factor: 6.047.

[5]"Future internet: The Internet of Things" by Lu Tan and Neng Wang, Computer Science and Technology Department, East China Normal University, Shanghai, China.

[6]Website: http://ieeexplore.ieee.org/abstract/document/5579543.

[7]"Internet of Things – New security and privacy challenges" by Rolf H.Weber.

[8] https://doi.org/10.1016/j.clsr.2009.11.008.

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The present Operating Systems and their Future with Reconfigurable Architecture

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ABSTRACT: This paper is meant as an advent to working structures, their major features and what sorts exist, as well as viable benefits received via putting ordinary software functionality in hardware. By introducing hardware aid inside the form of reconfigurable architecture, along with programmable logic gadgets, no longer best new capability and higher overall performance can be carried out however additionally progressed determinism and predictability. Those houses make it less difficult for builders of actual-time systems while seeking to both calculate and are expecting timing constrains. Programmable good judgment devices can be offered, why are they reconfigurable? Working systems in hardware are nevertheless within the development phase and one version of how an operating system in hardware should appear like might be presented, together with layers and message passing.

Keywords: Reconfigurable architecture(RA), Operating system(OS), Hardware operating system(HRA), programmable logic device(PLD), parallelism hardware, software.

1. INTRODUCTION

Needs on pc performance have multiplied swiftly over the years? Video processing and gaming are among the fields main the way while pushing computers closer to the breaking point. Pc scientists have placed loads of awareness on enhancing laptop hardware; introducing a couple of center valuable processing gadgets (CPUs) and stepped forward cache as an example. With the intention to take the next step closer to better performance it is not enough to enhance hardware; software improvements are needed to absolutely take benefit of new technology.

On the grounds that introducing reconfigurable structure (RA), tested software program-based totally algorithms regarded to be aid demanding can be moved all the way down to hardware with enhanced overall performance. This migration must now not handiest be confined to algorithms but also parts of an operating gadget (OS).

Section 2 presents what an OS is, accompanied with the aid of phase, 3 with a purpose to introduce one of a kind forms of OS. Section 4 will supply a quick summary of differences between an excessive-stage programming language (HLPL) and a hardware description language (HDL). styles of programmable good judgment devices (PLDs) including a instance is located in segment 5, followed through segment 6 which mentions with few phrases approximately extended laptop performance. Section 7 presents advantages which can be completed via introducing hardware help for OS. An instance of the way a hardware operating system (HOS) may want to appear like is presented in section eight. In the end the paper is ended with acknowledgements in segment 9, précis with conclusions in phase 10 and at closing future paintings in section 11.

2. OPERATING SYSTEM

An operating gadget (OS) is this system that, after being initially loaded into the computer through a boot application, manages all of the different packages in a laptop. The opposite packages are known as packages or utility applications. The application applications make use of the working device by way of making requests for offerings via a described application interface (API). In addition, users can have interaction at once with the working gadget through a person interface which includes a command line or a graphical person interface (GUI).

OS is stated to take care of two rather unrelated responsibilities, dealing with assets and extending the system [1]. Those responsibilities are very critical so let us take a look at them in more elements.

2.1 Resource management

Resource management is the dynamic allocation and de-allocation via a running system of processor cores, memory pages, and numerous types of bandwidth to computations that compete for those resources. The objective is to allocate sources a good way to optimize responsiveness difficulty to the finite sources to be had. Traditionally, resource management answers were highly unsystematic, and now the very assumptions underlying the conventional techniques fail to hold. First, packages increasingly differ of their potential to take advantage of assets, especially

processor cores. 2d, utility responsiveness is approximately -valued for "pleasant- Of-service" (QOS) packages, relying on whether or not cut-off dates are met. Third, energy and battery power have come to be constrained. This communicate will recommend a scheme for addressing the working machine resource management problem.

An example of machine resources at work can be seen while you open any software in your laptop. As the software is loading, the working gadget is reserving a specific amount of reminiscence and CPU time that this system wishes to characteristic. It does this through using gadget sources that are to be had at the existing time. System assets are not limitless. if you have 4 GB of RAM set up for your laptop, but the working system and various packages are the use of a total of 2 GB, you actually simplest have 2 GB of gadget sources (within the form of machine memory, in this situation) which might be readily available for other things.

If not enough reminiscence is to be had, home windows will try to keep some matters in a swap record (or paging document), a digital reminiscence document stored on the difficult force, to free up memory for the program.

If even this pseudo-useful resource fills up, which happens when the change document reaches its maximum viable length, windows will begin alerting you that "virtual memory is full" and which you need to near down programs to free up some reminiscence.

How assets in a computer are shared among users or applications can be divided into two businesses; in time and in area. Whilst a useful resource is shared in time, it manner that there are several packages or users who need to use a useful resource at the equal time. The simplest way to solve this trouble is to allow them to take turns the usage of the aid. The order wherein this happens is decided by the OS; this is referred to as scheduling. Shortest task first, priority primarily based and spherical robin are only some of the scheduling algorithms to be had.

2.2 Extension of machine

The structure of a computer may be very scary to have a look at. There are instruction units, memory, registers, buses etc. For a programmer this will be too much to realize, however information required if you are advised to do some low stage programming. This is wherein the OS is available in. The OS hides all the low level bits and portions from the programmer (see figure 1) and introduces a miles simpler view. Get admission to low degree capability is obtained through machine calls provided through the OS.

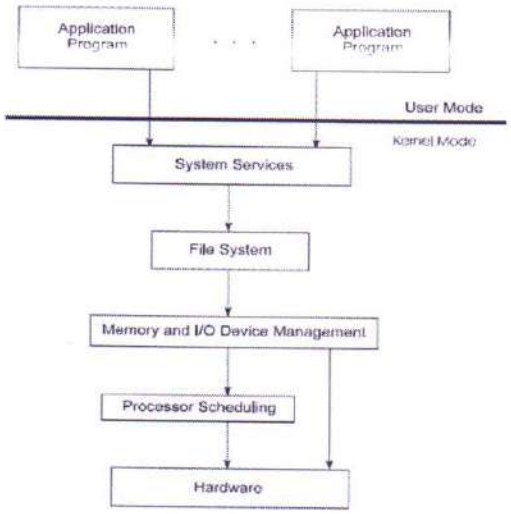

Fig. 1: Layout of operating system

3. TYPES OF OPERATING SYSTEMS

There are specific types of widespread working systems that are advanced and used as middleware.

a. Real-Time Operating System:

Real-time running system additionally known as RTOS; are used for dealing with the manipulate equipment, scientific units and business structures. It manages the laptop assets and handles the

operation in a precise way by means of presenting identical amount of time for each operation. It has very little consumer-interface functionality, and no stop-user utilities.
There are two types of real-time operating systems.

Hard Real-Time Systems-the gadget assure the finishing touch of the important undertaking on time. on this system, the secondary garage is limited or missing with statistics stored in ROM and the virtual memory is also nearly never observed.

Soft Real-Time Systems-these are much less restrictive and consequently these provide the first precedence to the critical responsibilities than the alternative tasks. They preserve the concern until the assignment receives finished. Those have limited software than difficult real-time systems. As an instance, Multimedia, digital fact, superior medical projects like undersea exploration and planetary rovers and so on.

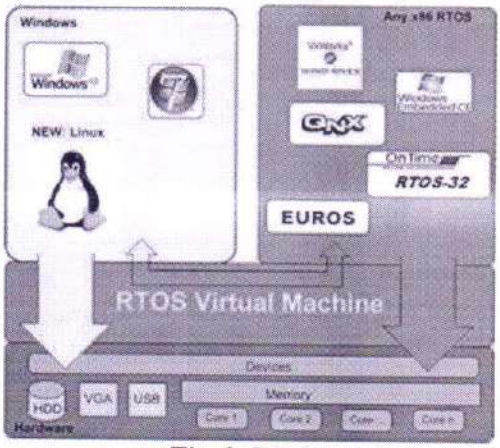

Fig. 2: RTOS

b. Single-User, Single Task Operating System:

From the names itself it gets clean that these running structures work on unmarried venture and unmarried user at a time. Right here, an unmarried tasks or operation may be accomplished correctly and carefully via a single consumer. The Palm OS for Palm hand held computer systems is a great instance of a contemporary unmarried-user, unmarried-venture running machine.

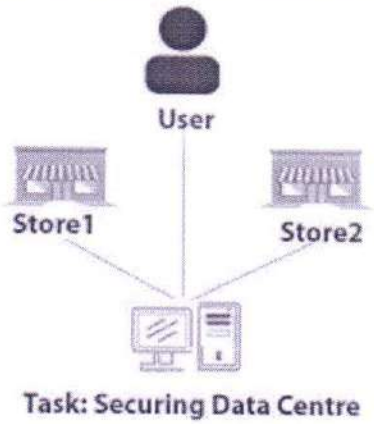

Fig.3:Single-User, Single Task Operating System

c. Single-User, Multi-Task Operating System:

Those running systems works on a couple of venture and technique them simultaneously at a time. The processors of this OS divides the time the various several done responsibilities. This division of time is known as as Time Sharing systems. right here, the processors switch swiftly among the processes. for instance, the consumer can pay attention to music at the pc even as writing an articl e using phrase processor software. customers also can switch between the packages and switch the facts among them; home windows 95 and all later variations of windows are examples of multitasking OS.

Fig. 4: Single-User, Multi-Task Operating System

d. Multiuser Operating System:

In those OS, more than one users are allowed to access the identical data or statistics at a time through a network. The users also can engage amongst every-other. some examples of this kind of Os are: Linux, UNIX, and windows 7.

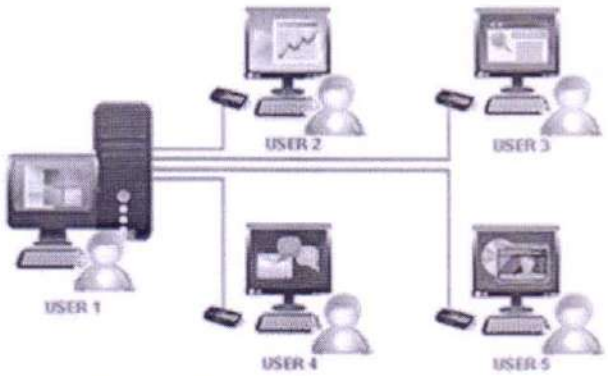

Fig.5: Multiuser Operating System

e. Multiprocessing Operating System:

Here, a unmarried manner runs on two or more processors. all of the processing and their control takes vicinity in a parallel way, therefore this OS also are referred to as as Parallel Processing. each processor works on one-of-a-kind components of the equal undertaking, or, on or greater extraordinary duties. As their execution works in parallel, these are relevant for high speed execution, and additionally to boom the energy of laptop. as an example: Linux, UNIX and windows 7 are examples of multiprocessing OS.

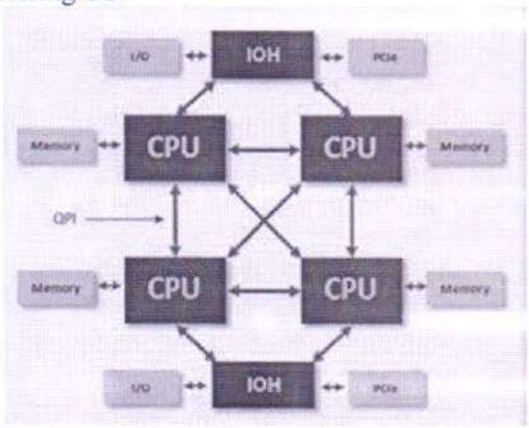

Fig.6: e. Multiprocessing Operating System

f. Embedded Operating System:

Those are embedded in a tool, which is located in ROM. these are relevant and evolved handiest for the wanted resources and for that reason developed. these OS are much less resource in depth. in particular, relevant in appliances like microwaves, washing machines, traffic manipulate structures etc.

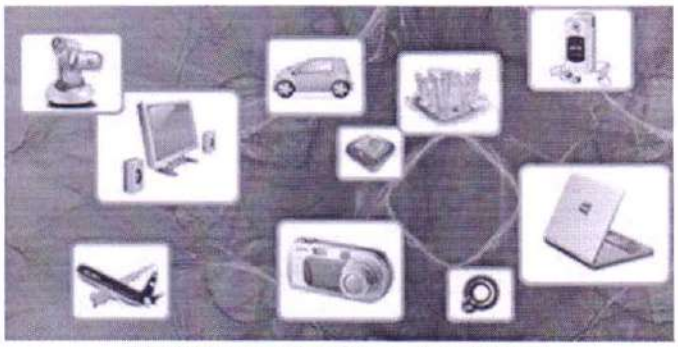

Fig.7: Embedded Operating System

g. Distributed Operating System:

In those OS, the computers paintings in co-operation with each other. As this OS manages a collection of unbiased computers and makes them appear to be a single pc is called a disbursed running system.

Fig.8:Distributed Operating System

Along with those OS, the alternative evolved OS are mobile running structures, which are now well-known in all kinds of modern and advanced mobiles; among them the maximum renowned and well-known are the Android OS with all multitasking and application features. In Batch Processing and Interactive systems, the execution of applications takes location in batches. the web and Offline Processing structures offers the processing of facts in on-line mode.

4. PROGRAMMING LANGUAGES

A device programming language typically refers to a programming language used for device programming; such languages are designed for writing device software program, which generally calls for distinct development procedures whilst in comparison with software program. Machine software program is pc software designed to function and control the pc hardware, and to offer a platform for strolling software. Device software program includes software categories which include working systems, software, tool drivers, compilers, and linkers.

While growing software nowadays, a HLPL is generally used to implement capability. C. C++ and Java are only a small collection of HLPLs. hardware was static and tough to reconfigure, however with the creation of programmable hardware a new location of programming languages has derived, HDLs, together with VHDL and Verilog. Instructions written in a HLPL are translated into binary code before it is able to be understood by a principal processing unit (CPU). HDL isn't always translated inside the same way as a HLPL, in place of device code; it's far translated into gates (AND, no longer...), latches (D, JK...) and so forth. And connections among the components. [2] A clear distinction between HLPLs and HDLs is that HLPL instructions are executed serially, one after another, in a CPU. HDL instructions can instead be performed in parallel way to the hardware.

5. PROGRAMMABLE LOGIC DEVICES

A programmable common sense tool (PLD) is an electronic aspect used to build reconfigurable digital circuits. Unlike a logic gate, which has a fixed characteristic, a PLD has an undefined function on the time of manufacture. Earlier than the PLD may be used in a circuit it have to be programmed. this is, reconfigured.

Today many forms of programmable common sense devices (PLDs) are available which may be utilized in specific fields. In [2] is a listing with names of gadgets that hardware and software program can be downloaded to:

- Programmable common sense device (PLD)
- Easy Programmable logic tool (SPLD)
- Complicated Programmable common sense device (CPLD)
- discipline Programmable Gate Array (FPGA)
- Area Programmable Interconnect (FPIC) CPLDs:

PALs and GALs are to be had handiest in small sizes, equal to a few hundred common sense gates. For larger good judgment circuits, complex PLDs or CPLDs can be used. Those incorporate the equivalent of several buddies linked by using programmable interconnections, all in one included circuit. CPLDs can update hundreds, or even hundreds of hundreds, of logic gates.

Some CPLDs are programmed using a chum programmer; however this technique becomes inconvenient for gadgets with masses of pins. A 2nd approach of programming is to solder the device to its revealed circuit board, then feed it with a serial statist ics stream from a private pc. The CPLD consists of a circuit that decodes the facts move and configures the CPLD to carry out its exact logic characteristic. a few manufacturers (such as Altera and Micro semi) use JTAG to program CPLD's in-circuit from .JAM files.

FPGAs:

At the same time as friends have been being evolved into GALs and CPLDs (all mentioned above), a separate movement of improvement changed into occurring. This kind of tool is based totally on gate array era and is known as the field -programmable gate array (FPGA). Early examples of FPGAs are the 82s100 array, and 82S105 sequencer, through Signetics, introduced within the late Seventies. The 82S100 was an array of AND phrases. The 82S105 additionally had turn flop functions.

FPGAs use a grid of common sense gates, and as soon as saved, the facts does not exchange, similar to that of an ordinary gate array. The time period "subject-programmable" manner the tool is programmed by using the client, now not the manufacturer.

FPGAs are commonly programmed after being soldered all the way down to the circuit board, in a manner just like that of large CPLDs. In maximum larger FPGAs, the configuration is risky and should be re-loaded into the tool every time strength is implemented or one of a kind functionality is required. Configuration is generally saved in a configuration promenade or EEPROM. EEPROM versions can be in-system programmable (usually thru JTAG).

The difference among FPGAs and CPLDs is that FPGAs are internally based totally on look-up tables (LUTs) while CPLDs shape the logic functions with sea-of-gates (e.g. sum of products). CPLDs are supposed for simpler designs while FPGAs are supposed for greater complicated designs. In preferred, CPLDs are a very good preference for wide combinational logic packages, whereas FPGAs are more appropriate for massive nation machines (i.e. microprocessors).

Other variants:

At gift, an awful lot hobby exists in reconfigurable systems. Those are microprocessor circuits that include some fixed functions and other features that may be altered by code walking on the processor. Designing self-changing systems calls for engineers to analyze new methods, and that new software program tools be advanced.

PLDs are being bought now that include a microprocessor with a set characteristic (the so-called core) surrounded by using programmable logic. These devices permit designers deal with adding new capabilities to designs without having to fear approximately making the microprocessor paintings.

6. SEARCH FOR BETTER PERFORMANCE

To beautify overall performance in computer systems, new technologies and strategies had been applied and presented over time. Without cache memory and pipeline help in the CPU, computers might run a lot slower [2]. A floating factor unit (FPU) is one example of hardware that aids the CPU to make quicker mathematical calculations. as opposed to iterating calculations in the CPU with software, the CPU can send a message to the FPU to hurry up the calculation. The FPU is mainly built to deal with calculations, not anything else. Through introducing caches, pipelines, FPUs and other additives, computer performance is improved to new tier however also pushes the rate tag. Better overall performance needs extra silicon area to in shape the additives which end up in a higher price for the product [2].

7. BENEFITS WITH HARDWARE SUPPORT FOR OPERATING SYSTEMS

In phase 4 an example why capability in hardware is faster than software changed into presented. This turned into only a tiny and clean feature but result in an extraordinary development in performance. Could it's viable to enlarge this simple instance to a more complicated one or even pass parts from the OS down to hardware?

The answer for the question is yes, so the following sections will present blessings which are the end result of transferring parts from the OS right down to hardware.

7.1 Speed

One primary benefit with hardware is its far lots faster than software program. Better overall performance way that operations take less time to execute. Create project, droop assignment and so on. Are a few examples of operations that may be advanced? Algorithms that may be achieved in parallel are the ones that attain most increase in performance when located in hardware. Relying on the operation that is moved to hardware, a speed-up of five to one thousand instances is not possible [2].

7.2 Real parallelism

In a CPU, instructions are achieved one after any other in serial as presented before. In a system with numerous procedures it seems like the CPU is genuinely able to execute several strategies on the identical time, however this is unluckily no longer genuine. At any time, only one technique is capable of execute in the CPU. way to the scheduler, who comes to a decision what method is granted get admission to the CPU, it seems like actual parallelism; that is normally known as pseudo parallelism, real parallelism is carried out thanks to the introduction of PLD era, along with FPGA. Algorithms that was implemented in software can be translated into hardware the usage of a HDL and therefore utilize parallelism. [5][1] This characteristic in hardware allows the system to attain better performance.

7.3 Determinism

In philosophy, determinism is a philosophical standpoint that everything is decided with the aid of earlier grounds or different already given conditions [6]. Laplace as soon as stated [7]:

"We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes."

- Pierre Simon Laplace, A Philosophical Essay on Probabilities

Laptop technology is a ways from body structure but the means of determinism is translatable into the virtual global of ones and zeros. Hardware is by using nature deterministic in regard to time and as a result makes it easier to expect.

7.4 Predictability

In an RTOS its miles critical to make correct predictions of worst case execution time (WCET) for a application, to ensure that every one responsibilities meet their deadline whilst scheduled. These predictions are made easier if the gadget has deterministic characteristics (which hardware has), to make this a bit clearer, here are examples.

Example 1: CPU

A CPU is going for walks a small application; there are not such a lot of other packages or interrupts. In small scale, a CPU is therefore predicable. While the CPU is scheduled with many packages, interrupts and so forth. It receives tougher to expect.

Example 2: Hardware

In hardware (gates, latches...) it is feasible to construct state machines where instructions are stored and all statistics is dispatched from point to point. These country machines work in parallel with each other, due to the fact that they're in hardware. So despite the fact that the system is massive, it's far made from small nation machines which can be achieved in parallel leading it to be predictable. This arrangement is appropriate both for small and big structures.

8. A HARDWARE OPERATING SYSTEM EXAMPLE

An HOS still in the research segment, supplied by means of [8], may be protected on this phase. RC, as pointed out in advance (see section 5), is a paradigm gaining increasingly more attractiveness inside the area of laptop technological know-how. An HOS, or run- time partial reconfiguration environment, is a crucial a part of RC. As opposed to executing tasks sequentially like software program OS; an HOS executes hardware blocks (HBs) in parallel. HBs could be defined in extra element later.

8.1 The layers

An HOS consists of the subsequent four wonderful layers (see fig.9): software, architectural, bridging and physical.

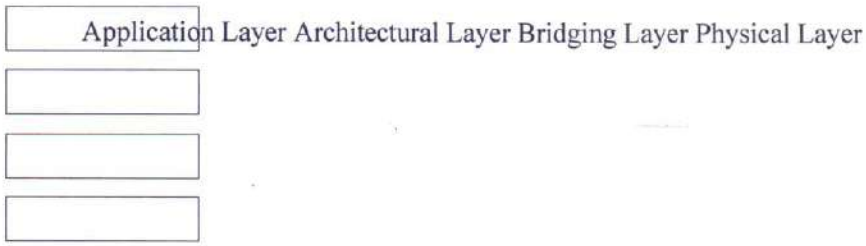

Fig. 9: HOS layered structure

8.1.1 The Application Layer

The utility layer shields the person from the internal shape of the machine. That is done by way of providing a graphical user interface (GUI) which interacts with the user when developing and executing packages. In order for impartial builders to program applications for hardware running structures (HOSes), a trendy manner of designing applications desires to be defined. For this cause, a set of general regulations was evolved known as utility modeling language (AML). AML includes styles of components: HBs and connections. HBs are used to explain hardware capability; together with connections they shape hardware applications. A connection connects HBs and shows wherein inputs and outputs cross between them .For a deeper dialogue approximately AML and a greater complete example of a hardware utility, we refer with [8] and [9] respectively.

8.1.2 The Architectural Layer

The architectural layer is in price of offering a improvement environment. The surroundings uses a summary version of the RA and resources the software layer with an abstract view of hardware software that could then be modeled. Two sub-layers form what we name the architectural layer: the utility design interface (ADI) and the middle machine (CS). The sub-layers are related together using an item framework. While designing the architectural layer, and the application layer, three

necessities have been saved in thoughts. Performance, duties have to be performed at the best pace possible. Modifiability, changes cannot be an high-priced procedure with recognize to money and time. And in the end portability, you must be able to port an HOS to multiple systems. In short, the whole lot wanted whilst developing hardware packages for an HOS is furnished as an abstraction through the ADI. The ADI is the critical component in the system while looking to port an HOS to some other platform. If problems rise up right here, the whole porting system will suffer; for the sake of portability, the ADI need to be saved as easy as viable. But a easy ADI has to depend more at the CS to understand its capability. As a result, overall performance takes a success as traffic among the two sub-layers will increase. The CS is likewise an abstraction however on a lower degree; the entirety needed to control and execute HBs on hardware architecture to be extra unique. The primary undertaking of the CS is to interrupt down hardware programs into messages which might be later exceeded down to lower layers inside the layer shape.

8.1.3 The Bridging Layer

The motive of the bridging layer is to tie the abstraction of the RA together with the hardware in the system. A protocol becomes designed to deal with verbal exchange between the architectural layer and the bridging layer. This communication line, bridge, makes use of the hardware request and reaction message structure (HRRMS) to permit the architectural layer to bypass execution timeslots forward to the bridging layer. Timeslots deliver HBs so that you can later be accomplished with the aid of the RA. A HRRMS appears special depending on whether it is a request or a response message.

8.2 Implementations

Due to the fact that this HOS is still in the studies section, you cannot find it on the market. But, some implementation attempts should be mentioned. Starting from the top, the utility layer has been realized to a large quantity. The AML has been layout in addition to a preproduction model of a GUI. Linux and C++ were used while understanding the architectural layer. With the JBits API [10] as a base, the Java programming language changed into used to put in force the physical layer.

9. SUMMARY AND CONCLUSIONS

The future of OSes and higher overall performance is probably the integration of software program and hardware. There are a number of benefits that hardware can offer to developers thanks to the introductions of PLDs and HDLs. Similarities among HLPLs and HDLs makes it even less complicated to translate software program into hardware. Builders of actual-time structures can use the benefit of determinism that is herbal in hardware to make better predictions for WCET and the rate of hardware to carry out complicated mathematical calculations in much less time, in which it used to be not possible with the timing constraints. Parts of OSes or algorithms can be places in hardware, depending on how lots capability is parallelizable, performance growth in one of kind scales.

It is not sufficient to boom the performance in hardware, to be capable of make use of new era it's miles essential to no longer go away software at the back of. way to OSes, builders do not need to issue how the hardware is truly working, but in the destiny with HOSes, developers is probably able to write code for each software and guide it by means of writing code for hardware. This is an thrilling field and plenty has appear the final many years, we trust the mixture of software program with hardware assist is the future.

10. FUTURE WORK

Continuing research how an HOS structure could be implemented, what elements of an OS can be moved from software into hardware? today HOSes are nonetheless in its studies segment, but future work may be to assist it leave the studies level and get out in the field with any luck we can come to a degree in the close to destiny while software program builders can use HOSes to develop and integrate software with hardware in new approaches. A question that could be thrilling to investigate is if it's far tougher for developers to put in writing algorithms that can be parallelized or written in serial. Is the brain certainly better to apprehend serial commands or parallel instructions. depending how the human brain thinks? This could we outdoor the context of this paper and area, but it's miles an interesting notion.

11. REFERENCES

[1] Tanenbaum Andrew. Modern Operating System (second edition). Prentice Hall. 2001

[2] Lindh, Lennart & Klevin, Tommy. rogrammerbarakretsar : Utveckling av inbyggda system. Studentliteratur. 2005

[3] Wikipedia. Reconfigurable computing. <http://en.wikipedia.org/w/index.php?title=Reconfigurab e_c omputing&oldid=318577595> (accessed October 14, 2009).

[4] Wikipedia. Field-programmable gate array. <http://en.wikipedia.org/w/index.php?title=Fieldprogram able_ gate_array&oldid=319854435> (accessed October 12, 2009).

[5] Nordström, Susanna. Configurable Hardware Support for Single Processor Real-Time Systems. Mälardalen University Press
Licentiate Theses. 2008

[6] Nationalencyklopedin. Determinism. <http://www.ne.se/lang/determinism> (accessed October 13, 2009).

[7] Wikipedia. Pierre-Simon Laplace. < ttp://en.wikipedia.org/w/index.php?title=Pierre-Simon_Laplace&oldid=316059480> (accessed October 5, 2009).

[8] Grozal, Voicu & Villalobos, Rami. What next? A hardware operating system?.Instrumentation and Measurement Technology
Conference 2004. 2004.

[9] Villalobos, Ricardo & Abielmona, Rami & Grozal, Voicu. A Bridging Layer for Run-Time Reconfigurable Hardware Operating
Systems. IEEE International Instrumentation and Measurement Technology Conference 2008.

[10] Xilinx.JBitsSDK.<http://www.xilinx.com/products/jbits/index.htm> accessed October 13, 2009)

[11] PERRY, D. E. and WOLF, A. L: 'Foundations for the study of software architecture,' Software Engineering Notes, 17(4), 1992. [12] SHAW, M. and GARLAN, D: 'Software Architecture: Perspectives on an Emerging Discipline', (Prentice-Hall, New York,1996)

[13] HILTUNEN, M. A.: 'Configuration Management for Highly-Customizable Services,' International Conference on Configurable
Distributed Systems, May 1998.

[14] A. Baumann, G. Heiser, J. Appavoo, D. DaSilva, O. rieger, R. Wisniewski, and J. Kerr. Providing dynamic update in an operating system. In Proceedings of the 2005 USENIX Annual Technical Conference, 2005.

[15] A. Veitch and N. Hutchinson. Dynamic Service Reconfiguration and Migration in the Kea Kernel. In Proceedings of the International Conference on Configurable Distributed Systems (ICCDS), 1998.

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Future Trends in Engineering Education and Research

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***Abstract*—**Engineers play a key role in our societal development, contributing to and enabling initiatives that drive economic progress, enhance social and physical infrastructures, and inspire the changes that improve our quality of life. Simultaneously, industry and manufacturing are facing unprecedented challenges due to globalization and distributed manufacturing. As a result, the business environment of manufacturing enterprises is characterized by continuous change and increasing complexity. The challenges for companies arise not only from the need for flexible technical solutions, but also from managing complex socio-technical systems, and contribute tangibly to the sustainable development of manufacturing and the environment. Researchers and graduates with the ability to understand both complex technological processes and the creative arts and social skills are increasingly sought after in today's industrial and business world in areas of: Manufacturing Management, Health and Service Sectors, Product Engineering and Technical Sales, Transportation and Logistics. Using their strong technical and communication skills, engineering managers oversee a variety of team-based activities. By focusing on the critical role of engineering in solving our most complex global issues, we aspire to make the profession more attractive to both male and female students.

Keywords: Engineering Education, Grand Challenges for Engineering, Sustainability, Socio-technical Systems

INTRODUCTION

The major global challenges we are facing today need to be addressed in the multifaceted context of economy, society, environment and technology. In recent years, the consensus of calling for sustainable development and implementation has emerged. Along with this belief, high added value, knowledge-based, competitive sustainable manufacturing has been widely considered as main enabler. Engineering in general and engineering design and manufacturing in particular, affects virtually every aspect of our society and engages a substantial set of the population in carrying out engineers' plans and designs. But what is the role of engineering in responding to society's needs as well as in shaping them? This question is being asked with increasing urgency by a society that has benefited from great advances in technology, and at the same time, seen dislocations and experienced fears associated with technology. Often the questions about technology are confused with questions about engineering in the mind of the public despite a growing literature on the relation of technology to the rest of society. The list of impacts and side effects of technology is long and growing and has contributed to society's ambivalence about technology. While it would be wrong to blame the engineer for the apparent lack of interest by large portions of society in understanding the technological process with its constraints and possibilities, engineers can do much to reduce society's ambivalence if they could overcome their own parochialism.

The National Academy of Engineering has announced on 15 February 2008, the "Engineering Grand Challenges". These are: 1) Make Solar Energy Economical; 2) Provide Energy from Fusion; 3) Develop Carbon Sequestration Methods; 4) Manage the Nitrogen Cycle; 5) Provide Access to Clean Water; 6) Engineer Better Medicines; 7) Advance Health Informatics; 8) Secure Cyberspace; 9) Prevent Nuclear Terror; 10) Restore and Improve Urban Infrastructure; 11) Reverse Engineer the Brain; Enhance Virtual Reality; 12) Advance Personalized Learning; 13) Engineer the Tools of Scientific Discovery.

ENGINEERING IN SOCIETY

Engineering is an integral part of society. Unfortunately some people, including engineers by training, regard engineering as simply Applied Science. What is needed is an education that emphasizes engineering and society, or better yet, engineering in society or "Engineering Arts", as opposed to the more traditional Engineering Science. In universities, it is something exotic and mysterious that goes on by itself in the Faculty of Engineering. Engineers, in general, have tended to focus on the development of new technologies rather than the social setting - government

bureaucracies, school systems, and public service. As engineering functions inseparably from the society of which it is a part, to operate within that reality, we need to comprehend better than we do what requirements and constraints are put on engineers by the rest of society and what role the engineer realistically can or should play in that society.

A. Socio-Technical Systems

The complexity of the interactions between society and engineering is at the root of unrealistic expectations about traditional engineering, as social entities are often inadequately organized to develop and use engineering effectively. It is also at the root of the frustration of engineers unable to bring their capabilities to bear on the solution of social problems or the effective organization of the engineering enterprise. A more realistic possibility, which engineers should find congenial, is that has been termed the socio-technical system. As Engineers, and particularly Industrial and Manufacturing Systems Engineers, have to deal with systems—technical systems—all the time and are familiar with how they need to be designed, analyzed and managed. In the socio-technical model, the entire society is visualized as a vast integrated system, with the varied social and technical areas of human activity as major interacting subsystems. In this context engineering does appear as one of the subsystems.

B. Why a Socio-Technical System?

It is by now a truism to say that any single technology can be used in multiple, and sometimes unexpected, ways. But we need to add to this observation that, in each different use, the technology is embedded in a complex set of other technologies, physical surroundings, people, procedures, etc. that together make up the socio-technical system. It is only by understanding this system that we can parse out the environmental and societal and ethical issues and impacts. Many of the ethical issues are intimately related to the social and environmental systems. They are socio-technical systems, and the ethical issues associated with them are based in the particular combination of technology and social systems. It is the technology, embedded in the social systems that shapes the ethical issues. The dilemma is to balance society's rights with individual rights and freedoms.

C. Trends In The Socio-technical System

Great technologies have over the ages created social revolution. Note how technology made possible the industrial revolution, how the automobile has affected the sprawl of cities and suburbs. In this century the computer-inspired age of information and wireless communication has changed everything all over the globe. The global village seems more a reality than a tired Canadian cliché. We are increasingly dependent on computers as more and more information is coming on-line. When the industrial revolution made the mass production of standard goods possible, it also took away the consumers freedom of choice. Henry Ford, who was striving for utility, simplicity, and low cost, stated: "You can have any colour you want, as long as it is black". Computers in the information age promise to give us back individuality, through flexible, reconfigurable computerized manufacturing that allow large varieties of individualized products. However, a fundamental residue of the information age is the increase in complexity — complexity of technological systems, of business systems, and of social systems. They seem to demonstrate a form of the second law of thermodynamics. Entropy is always on the rise. We see this particularly in large-scale systems. Large-scale, interconnected systems include global distributed manufacturing, transportation, the environment and the earth's ecosystem, and the strategic defense and security systems. In his best-selling book Megatrends, John Naisbitt observed that the computer is a tool that manages complexity, and as such, just as highways encourage more cars, the computer invites more complexity into society. The question is whether the ability of computers to manage complexity and information and decision systems can keep up with the continuous increase in complexity. There is considerable hope, because the power of modeling, simulation and availability of supercomputers may be brought to bear on socio-technical problems, giving us new understanding and ability to manage our societal problems. As the social and business systems have also been adapting to the information age, intellectual property has become an important branch of law, and has contributed its own ambiguities to an increasingly litigious society.

SOCIETY AND EDUCATION OF ENGINEERS

To understand how engineering responds to the needs of society, we must examine its social structure and its function. Most people who study engineering in North America have higher physics, biology and mathematics skills and some communication and social ones. This appears to limit their

involvement in politics and their success in communicating with the rest of society. Society, in turn, often views the engineer as a narrow, conservative, numbers-driven person, insensitive to subtle societal issues. The systematic study of socio-technical problems is rarely included in the engineering curricula as an important sphere of engineering activity. The curricula usually focus on man-made artifacts to the exclusion, except for specialized cases at the graduate studies level, of biological systems and organisms. This narrow focus has kept engineering away from not only a rich source of inspiration for specific technical feats and lessons offered by systems of great subtlety and complexity, but also a deeper understanding of environmental change. Most high school students today do not view an engineering education as a path to success and prestige worthy of the sacrifices of a rigorous curriculum. Even bright young engineering students, upon graduation, switch to careers in business management, law, and medicine. On the other hand, engineering continues to be a powerful instrument for social mobility and advancement for immigrants and the poor. But is well recognized by most governments that in order for a country to prosper and compete globally, we need to graduate more scientists and engineering, as they contribute immeasurably to the nations wealth creation. This situation accentuates the perceived social gap between engineers and other professions in society. In different societies engineering provides most of the same artifacts: shelter, energy and communications, manufacturing, water supply, extraction and use of resources, and disposal of waste. There are societies where engineers carry out broader functions by virtue of the position they hold. In several European and developing countries, they head state organizations and major industry conglomerates, participate in government, and enjoy high social prestige.

A. Social Needs And Responsibility

Man-made products, albeit often extensions of our body, have not generally evolved through the gradual process that has shaped man and other biological species. Thus, we constantly face the question of whether the technology we develop enhances the long-range survival of our species. It should be mentioned however, that there is increasing body of research that use biological evolution as a metaphor for developing products and systems, ElMaraghy [2008]. An important determinant of how well engineering satisfies its social purpose is the breadth of engineering. Engineering today continues overwhelmingly to focus on inanimate products or machines, as engineering school curricula worldwide continue to bypass socio-technological. This lopsided orientation grew out of obvious historical origins that have had major consequences for society. The factory environment so single-mindedly rationalized by the engineer F. W. Taylor overlooked the effective integration of the worker - the biological unit - and the machine in the production process. This is the case almost everywhere in the world, with the notable exception of Japan, where a different social ethos has produced a more effective integration with the human, as well as the artificial version, known as intelligent robots.

Another reason for the difficulty engineers encounter in dealing with social issues has to do with the various, and often conflicting, needs of social groups (educational, economic, environmental, health, public service, spiritual, and government) that engineering and technology may be expected to satisfy. The recurrent conflict between advocates of independent and targeted research is an example and an inevitable result of the tension between short-and long-range needs. If pushed to the extreme, however, such conflicts may cross the boundary between what is socially useful and what is out of control. Most governments that fund research, including in Canada are on the brink with regards to this issue. There must be a balance between short- and long-term needs. They both serve a purpose. You cannot have Strategy without implementation and application. Similarly operating without a long term "discovery" research base can be disastrous in the long run. The health care system for instance has absorbed an ever-greater portion of our gross national product, regardless of the state of our economic prosperity. At the same time, it has priced itself outside the financial reach of millions of north Americans. It may be argued that engineers need to question their cultural responsibility to society as they contribute to its change. This effort must begin in the universities, in educating future engineers, our researchers, and in professional societies [Duderstadt, 2008], such as CIRP and SME [2008]. In the following paragraphs, Bugliarello [1991] offers five guiding principles, some of which are already deeply embedded in the conscience of engineers.

1) ***Uphold the dignity of man.*** This is a fundamental value of our society that never should be violated by an engineering design. This happens could happen when the design or operation

of a technological product fails to recognize the importance of individuality, privacy, diversity, and aesthetics.

2) ***Avoid dangerous or uncontrolled side effects and by-products.*** This demands a rigorous development of a design or a technology considering all the functional requirements and constraints - be they political, economic, popular, or intrinsically technological.
3) ***Make provisions for consequence when technology fails.*** The importance of making provisions for the consequences of failure is self-evident, especially in those systems that are complex, pervasive, and place us at great risk if they fail.
4) ***Avoid buttressing social systems that perform poorly and should be replaced.*** This runs much against the grain of most engineers. Short -run technological fixes can put us at much greater risk in the long term. In the case of energy, for instance, technological or commercial fixes cannot mask the need to rethink globally the impact of consumerism and the interrelationship of energy, environment, and economic development.
5) ***Participate in formulating the "why" of technology.*** At present the engineering profession is poorly equipped to do so both in this country and elsewhere. Few engineers, for instance, have been involved in developing a philosophy of technology. This separation of engineering and philosophy affects our entire society. Engineers, in shaping our future, need to be guided by a clearer sense of the meaning and evolutionary role of technology.

The great social challenges we face require a rethinking of the human-artifact-society interrelationship and the options it offers us to carry out a growing number of social functions using quasi-intelligent products to instruct, manufacture, inspect, control, and so on.

ENGINEERING AND RESEARCH INTO THE FUTURE

The current generation of students is much more attuned to global issues and the need for new approaches than their predecessors. Duderstadt [2008] has discussed the future of engineering in detail. By focusing on the critical role of engineering in solving our most complex global issues, we aspire to make the profession more attractive to both male and female students, especially the latter. The new definition of engineering, by the Montreal Engineering Summit [Engineers Canada, 2009] will assist in this regard. The summit defined engineers as: "The enablers of dreams". Engineers play a key role in our societal development, contributing to and enabling initiatives that drive economic progress, enhance social and physical infrastructures, and inspire the changes that improve our quality of life. As a profession, we are committed to helping provide the best possible quality of life for all Canadians. "It is our aspiration that engineers will continue to be leaders in the movement towards use of wise, informed and economical, sustainable development. This should begin in our educational institutions and be founded in the basic tenets of the engineering profession and its actions. We also aspire to a future where engineers are prepared to adapt to changes in global forces and trends and to ethically assist the world in creating a balance in standard of living for developing and developed countries alike." [Engineering 20/20, NAE]. The following Montreal declaration [Engineers Canada, 2009] expresses the profession's resolve to help ensure Canada and its citizens thrive and prosper—today and into the future.

1. Deliver Canadian engineering innovation domestically and to the global community
2. Deliver specific engineering capabilities that will be needed in the future to improve health and safety, provide for a cleaner environment, and enable more sustainable development
3. Address areas in which advocacy by the engineering profession can lead to public policy development and directly contribute to Canadians' quality of life
4. Make educational enhancements that will encourage broader participation in the profession by all segments of the population and foster innovation

At a high level, we acknowledge that we must:

- Pursue greater collaboration across disciplines and professions
- Increase engineers' influence in policymaking
- Re-examine our accreditation process
- Transform engineering education and practice
- Encourage the greater participation of underrepresented groups such as Aboriginal Peoples
- Attract and retain women in much greater numbers

It appears that the Faculty of Engineering at McMaster University [2009] has also been paying close attention to the Sustainability and Globalization issues. They recently announced their 2009-2014 Strategic Plan, that includes very similar engineering educational objectives.

"Amongst the most important trends that will help define the future of the Faculty, we identified the following:

- Challenges in developing secure and sustainable forms of resources, including energy and water
- The need to develop more sustainable practices in all branches of engineering
- Increased opportunities for technology to improve human health
- Globalization and its impact on industrial supply chains, education, research and the human condition
- The challenge of demographics that will see an unprecedented wave of retirements in the western industrial world over the next decade."

The Guiding Principles and Core Professional values are also very similar to what was discussed in the proposed University of Windsor "Bachelor of Engineering Arts- Management Engineering" (BEA-ME) articulated as follows: To provide an innovative and stimulating learning environment where students can prepare themselves to excel in life; To achieve the next level in research results and reputation by building on existing and emerging areas of excellence; To build an inclusive community with a shared purpose; To be honest, mutually respectful, fair and inclusive; To foster a collegial, interdisciplinary and innovative work environment; To respect and reflect diversity in our opinions, our recruitment and the community we build; To conduct ourselves according to the highest standards of professionalism, acting ethically and with integrity; and to expect no less of our students; To instill in our students a love of learning ; To inspire our students to see themselves as global engineers; To be stewards of the environment and exercise social responsibility in our research and education.

Goals that were discussed include the following:

1. Develop a vertically and horizontally integrated curriculum following the "Versatilist T Model".
2. Develop clear and achievable learning objectives and student outcomes for each course
3. Offer high level team work and practical experience in all courses.
4. Enhance the multi-disciplinary educational experience of students as well as outreach opportunities
5. Increase the level of student engagement in all engineering programs
6. Increase Faculty involvement formal international exchange (e.g. Stanford University d-Lab in Design)
7. Develop a coordinated approach to Outreach Activities and international networking.
8. Increase our engagement in public policy and debates related to engineering and technology as well as their relation to socio-technical issues.
9. Develop a new undergraduate Minor in Management Engineering with the Faculty of Arts and Social Science.

SUMMARY

In the past 25 years, several major trends have emerged that magnify the social impact of engineering and the challenge to engineering to address pivotal social issues. These trends are too well known and documented to be further underscored here: the sharpening of engineering prowess in the creation of products; the broadening of the social needs that engineering is called to address; geopolitical and economic shifts that are placing new demands on engineering; the coming to the fore of a series of issues of wide societal impact such as the environment that stem at least in part from engineering and technology themselves and demand urgent attention. Engineering has contributed to this situation by its failure to emphasize manufacturing and production in formal engineering education and in the system of professional recognition. That emphasis is being developed, laboriously, only now and engineering has been slow also in responding to the immense challenges of globalization, and of the environment. The greatest challenge that globalization presents engineers and engineering education is how to increase throughout the world the rate of technological, economic, and social progress through the creation of new and more adaptable technologies and better socio-technical integration. Figure 1 illustrates the new paradigm for engineering education and research. Furthermore, North American engineering has not participated to any major extent in the

development of strategies for the reform of the health care and education systems as two key service activities that together absorb well over 15 percent of NA GNP. Engineering also has been absent from the attack on some of the most vexing problems of urban areas. Poverty, drugs, and alienation are all interconnected socio-technological problems of our cities, with their deteriorating infrastructure and the loss of easily accessible jobs in manufacturing. This creates an added dilemma between societal values and individual values to simultaneously achieve technical excellence, manufacturing competitiveness and quality of life. To address these challenges of the future, the Industrial and Manufacturing Systems Engineering Department (IMSE) at the University of Windsor, Canada is proposing to introduce an innovative, the first in Canada, "Bachelor of Engineering Arts" (BAE) in the field of Management Engineering. The educational approach is, therefore, more multi-disciplinary and includes the study of human factors involved in industrial operations, service industries, the health sector, and indeed any business, organization or government. The Structure and themes of the BEA-ME program are illustrated in Figures 1 and 2. This paper was an opportunity to explore the connection between Engineering and other disciplines, such as the Arts, Sciences, Engineering, Humanities, Social Sciences and Business. The context and objectives from developing a new curriculum and delivery methods for the proposed BEA (Bachelor of Engineering Arts) program have been discussed, with particular emphasize on breadth across engineering subjects and exposure to technology management and communication, as well as the humanities and arts. Our vision is to offer a world-leading integrated, interdisciplinary undergraduate education for students interested in an educational experience that offers a rich mixture that balances technical subject with a deep understanding of the role of an engineer in addressing sustainability and the other grand challenges and key socio-technical issues affecting our global village. The most obvious applications of the proposed BEA curriculum relates to sustainability and the development of eco-effective designs, human networks, processes and products. The sustainable processes and practices will provide greater applications in the goods and services businesses, as well as in health care, communications technologies, and public service. We aspire to graduate Leaders who can develop engineering methodologies that can sustain societies anywhere, leading to the concept of a Global Renaissance Engineer. This is a rare opportunity for educators, researchers and students from everywhere to discuss the merits of a strategic decision to integrate a technical education with the humanities, business, arts, etc.. The timing of this proposal fits well with the University of Windsor construction underway of the new "Centre for Engineering Innovation" (CEI). Such events, activities and projects, as well as the accompanying publicity, will hopefully help in the efforts to increase the breadth and depth of the education of engineers in the future.

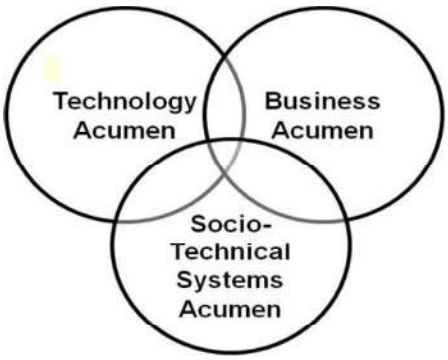

Figure- 1 A New Paradigm for Engineering Education and Research

Figure 2 Structure of the BEA-ME Program

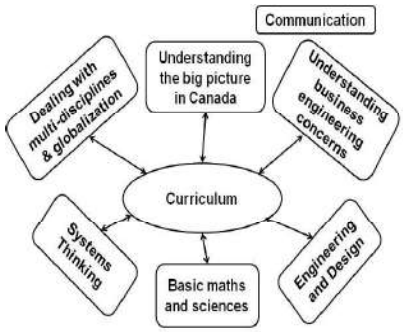

Figure 3 Main Themes for the BEA Curriculum

REFERENCES

[1] Bugliarello, George, 1991, "The Social Function of Engineering," in Engineering as a Social Enterprise (Washington: National Academy Press, 1991) 73- 88.

[2] Duderstadt James J., 2008, Engineering for a Changing World: A Roadmap to the Future of Engineering Practice, Research, and Education. The Millennium Project, The University of Michigan; 131 pages; http://milproj.dc.umich.edu/

[3] ElMaraghy, H., 2008, "Changing and Evolving Products and Systems – Models and Enablers", Changeable and Reconfigurable Manufacturing Systems, Springer-Verlag Publishers, ISBN: 978-1-

[4] Engineers Canada; May 2009a "Leading a Canadian Future: The New Engineer In Society"; A declaration by Canada's engineering profession: The Montreal Declaration Issued at the National Engineering Summit May 21, Montréal, Québec

[5] Lu, S.C-Y.; ElMaraghy, W; Schuh, G; and Wilhelm, R.,2007, "A Scientific Foundation of Collaborative Engineering" (Keynote Paper), CIRP Annals, Vol. 56, No. 2, pp. 605-364, 2007.

[6] McMaster University; 2009 "Engineering a Sustainable Society"; Faculty of Engineering Strategic Plan 2009- 2014; 24 pages.

[7] National Academy of Engineering, 2008, "The Grand Challenges for Engineering", National Academy of Sciences, on behalf of the National Academy of Engineering, 52 pages, http://www.engineeringchallenges.org/cms/challenges.aspx.

[8] SME, 2008 "Manufacturing Education Leadership Conference", Society of Manufacturing Engineers (SME), Robert Morris University, Pittsburgh, PA, 26-27 June 2008.

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Vibration Analysis of Granite Epoxy Composite cracked beam by various Techniques - A Review

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Abstract: The ability to retain mechanical vibrations is a standout amongst the most imperative normal for stone epoxy composites, even better than the cast press. Consequently, these materials have been used for assembling of machine establishments and accuracy instruments. The target of this paper is to refresh perusers the different vibration based break conclusion systems exhibited by different analysts for a split bar structures. Harm in structure changes its dynamic qualities. It brings about difference in common frequencies and changes in mode shapes, firmness of the pillar. With an examination of these change one can decide the position and profundity of breaks.

Keywords: Beam, Crack Detection, Vibration analysis.

1. INTRODUCTION

Beams are broadly utilized as auxiliary component in common, mechanical, marine and aeronautical application. Harm is one of the imperative perspectives in basic investigation. Crack examination is done to guarantee the security and also financial development of the businesses. Amid operation, all structures are subjected to degenerative impacts that may cause start of basic imperfections, for example, splits which, as time advances, prompt the calamitous disappointment or breakdown of the structure. To dodge the surprising or sudden disappointment, prior break recognition is basic. Bringing this belief system into thought crack identification is a standout amongst the most imperative areas for some scientists. Numerous scientists to create different procedures for early discovery of break area, profundity, size and example of crack in a structure. Numerous nondestructive systems for crack location have been being used around the world. However the vibration based technique is quick and economical for split/harm distinguishing proof. In this paper endeavors have been made to exhibit different practical solid expository numerical and test procedures created by different scientists for vibration investigation of crack beams. In this paper the impact of different parameters like break measure, crack area, of shaft on modular parameters subjected to vibration of a cracked bar likewise have been checked on.

Ranjan K. Behera [1] has exhibited to display a slanted open edge split in a cantilever shaft and investigate the model utilizing a limited component bundle, and additionally test approach. The examinations are completed utilizing examples having slanted edge breaks of various profundities, positions and split slants to approve the FEA comes about accomplished.

Aniket S. Kamble [2] has introduced split is demonstrated as a rotational spring and condition for non-dimensional spring solidness is created. By assessing initial three characteristic frequencies utilizing vibration estimations, bends of split proportional firmness are plotted and the crossing point of the three bends demonstrates the break area and size. The time adequacy information got is additionally utilized as a part of the wavelet investigation to get time-recurrence information.

Marco A. Perez [3] has exhibited to research the attainability of utilizing vibration-based strategies to recognize harms maintained by composite overlays because of low-speed impacts. Four harm markers in light of modular parameters were evaluated by contrasting perfect and harmed states. It's accuracy in deciding the area of harm, its affectability in regards to harm degree and relevant relationships with lingering bearing limit.

Missoum Lakhdar [4] has introduced the discovery of harm by vibration examination, whose primary goal is to misuse the dynamic reaction of a structure to detectunderstand the harm. The trial

comes about are contrasted and those anticipated by numerical models to affirm the viability of the approach.

P. K. Jena [5] has exhibited the blame discovery of Multi broke thin Euler Bernoulli shafts through the information of changes in the regular frequencies and their estimations. The spring model of break is connected to build up the recurrence condition in view of the dynamic solidness of numerous split shafts. Hypothetical articulations for bars by common frequencies have been detailed to discover the impact of break profundities on normal frequencies and mode shapes. Cantilever shaft with two breaks investigation demonstrate a productive condition of the exploration on various splits impacts and their recognizable proof.

Kaushar H. Barad [6] has displayed discovery of the split nearness on the surface of pillar compose basic component utilizing common recurrence. Initial two regular frequencies of the split bar have been acquired tentatively and utilized for finding of break area and size. Amit Banerjee [7] has displayed to acquire data about the area and profundity of transverse open different splits in a pivoting cantilever bars. Mode state of harmed pivoting pillar is acquired utilizing limited component recreation. Utilizing fractal measurement of mode shape profile, harm is distinguished.

Prasad Ramchandra Baviskar [8] have introduced the technique for various splits identification in moving parts or bars by checking the characteristic recurrence and expectation of break area and profundity utilizing Artificial Neural Networks (ANN). In experimentation, essentially bolstered shaft with single break and cantilever bar with two splits are considered. To research the legitimacy of the proposed technique, a few expectations by ANN are contrasted and the outcomes given by FEM.

Murat Kisa [9] have displayed a novel numerical method pertinent to dissect the free vibration investigation of uniform and ventured split bars with round cross section.It is uncovered that the information of modular information of broke shafts frames a vital angle in surveying the basic disappointment.

N.V.Narasimha Rao L [10] has introduced vibration examination of a broke cantilever shaft with transverse break. A fluffy rationale derivation framework is utilized to examine the split in cantilever bar.

Saidiabdelkrim [11] has displayed to break down the vibration conduct of solid pillars both tentatively and utilizing FEM programming ANSYS subjected to the split under free vibration cases.

FB Sayyad [12] has introduced endeavors are made to create appropriate techniques that can fill in as the premise to discovery of split area and break estimate from estimated pivotal vibration information. This strategy is utilized to address the converse issue of surveying the split area and break estimate in different pillar structure.

A. Dixit [13] has exhibited harm measure which relates the strain vitality, to the harm area and size. The strain vitality articulation is computed utilizing modes and common frequencies of harmed pillars that are inferred in view of single bar examination thinking about both lessening in mass and firmness. The technique is appropriate to bars, with score like non-spreading breaks, with subjective limit conditions. The diagnostic articulations inferred for mode shapes, ebb and flow shapes, characteristic frequencies and enhanced strain vitality based harm measure, are checked utilizing tests. The harm measure was appeared to be to a great degree touchy to the harm as both the brokenness in firmness and furthermore the shape are contained in the harm measure. An impediment of the harmed measure was that it relied upon precise estimation of harmed mode shapes.

D.K. Agarwalla [14] has introduced the impact of an open break on the modular parameters of the cantilever bar subjected to free vibration is broke down and the outcomes got from the numerical technique i.e. limited component technique (FEM) and the trial strategy are thought about. Mode shapes in amplifying sees enable the scientists to get a thought of the huge changes at the split area.

Mousa Rezaee [15] has introduced the vitality adjust strategy is proposed with the expectation of complimentary vibration examination of a broke cantilever bar by considering both the auxiliary damping and the damping because of the break. The solidness changes at the split area are thought to be a nonlinear adequacy subordinate capacity which causes the frequencies and mode states of the pillar to shift constantly with time.

Patil Amit V [16] has exhibited Crack profundity and break area of a shaft can be anticipated by fluffy controller is inside nanoseconds. By Comparing the Fuzzy outcomes with the hypothetical outcomes can anticipate the relative break profundity and relative split area in an extremely precise way. By Comparing the Fuzzy outcomes with the hypothetical outcomes it is watched that the created Fuzzy Controller can foresee the relative break profundity and relative split area in an exceptionally precise way.

S.P.Mogal [17] has introduced vibration investigation is completed on a cantilever pillar with two open breaks to consider the reaction attributes. In first stage neighborhood consistence frameworks of various level of flexibility have been utilized model transverse splits in shaft on accessible articulation of stress power factor and strain energy release rate. The outcomes got numerically are approved with comes about acquired from reproduction (FEM).

Jialai Wang[18] has exhibited harm location procedure utilizing abnormality profile of a basic mode shape. The mode-state of a broke pillar is first gotten diagnostically by utilizing a general capacity. Its anomaly profile is then extricated from the mode shape by a numerical channel. The area and size of the split in the shaft can be dictated by the pinnacle esteem showing up on the inconsistency profile. The fruitful recognition of the split in the composite bar shows that the inconsistency based technique is fit for evaluating both the area and size of the break and can be utilized productively and adequately in harm distinguishing proof and wellbeing observing of pillar write structures.

Patil Amit V [19] has exhibited estimation of characteristic frequencies is introduced for discovery of the area and size of a split in a cantilever bar. Numerical counts has been finished by fathoming the Euler condition for un-break bar and broke shaft to get initial three normal frequencies of various methods of vibration thinking about different split positions for the bar. ANSYS programming is utilized for investigation of break and un-split cantilever shaft.

Pankaj Charan Jena [20] has introduced the strain vitality thickness work likewise connected to analyze the couple of greater adaptability delivered to in view of the nearness of break. Considering the adaptability an extra firmness network is taken away and therefore, it is utilized to locate the normal recurrence and mode state of the split light emission end states of bar. The distinction of mode states of cantilever shaft, essentially upheld pillar and Clamped – Clamped bar in the middle of the initial three methods of split and un-broke separately bar with its enhanced view at the zone of the split region are considered.

II. MATERIALS & METHODS

Vibration investigation of Granite Epoxy Composite material is trailed by creators by their strategies, for example, hypothetical, trial, limited component technique, Artificial Neural Networks. Vibration investigation of Mild steel material is finished by hypothetical, wavelet examination, limited component examination, MATLAB strategies. Investigation of Glass/polyester, fiber glass, E-glass fiber epoxy sap is finished by utilizing numerical model examination, consistence grid, and numerical, exploratory techniques.

III. DISCUSSION

Prior, broke vibrating structures are adequately examined by different scientists utilizing the distinctive nondestructive assessment and non-dangerous methods. As indicated by some analyst changes in progression qualities can be utilized as a data hotspot for distinguishing of vibrating shaft or structure in nearness of split. Specialists chipping away at different structures have examined the impact of break area, split profundity, split slant on normal recurrence of a broke bar subjected to vibration. Exchange grid strategy utilizes the info information of changes in mode shapes and normal frequencies for assurance of break area and split profundity. The physical measurements, limit conditions and the material properties of the structure assume vital part for the assurance of its dynamic reaction. The position, profundity proportion, introduction and number of breaks are enormously impact the dynamic reaction of the structure. Numerous analysts have chipped away at the utilization of fake neural system and fluffy rationale idea for finding of split in a vibrating shaft structure. Some have taken a shot at the application Continuous Wavelet investigation for recognizing

of split in vibrating shaft. Idea of break mechanics, push power factor and learning of strain vitality discharge rate has been utilized for examination of split discovery.

IV. CONCLUSION

It has been observed that the adjustments in characteristic frequencies and mode shapes are two imperative parameters that decide break size and area of the split individually. A few analysts have considered composite structures in their investigation to break down the impact of different parameters like split area, break estimate, break profundity, split slant on the dynamic conduct of structures subjected to vibration. Scientists are directly concentrating on utilizing the idea of Artificial Neural Network (ANN), fluffy Logic and hereditary Algorithm as a successful device for vibration examination of harmed structures. Different models have been created by analysts utilizing different speculations and ideas to think about the dynamic qualities of harmed vibrating structures having different kinds of break like Transverse, Longitudinal, Slant, Gaping, Surface, Subsurface, breathing, open edge split and inner breaks.

REFERENCES

[1] Ranjan K. Behera, Anish Pandey, Dayal R. Parhi, "Numerical and Experimental Verification of a Method for Prognosis of Inclined Edge Crack in Cantilever Beam Based on Synthesis of Mode hapes", International Conference on Innovations in Automation and Mechatronics Engineering,ICIAME,pp.67-74,2014.

[2] Aniket S. Kamble, D. S. Chavan, "Identification of crack parameters in a cantilever beam using experimental and wavelet analysis", International Journal on Mechanical Engineering and Robotics (IJMER), pp.23-27, 2014.

[3] Marco A. Perez, Lluis Gil, Sergio Oller, "Impact damage identification in composite laminates using vibration testing", Composite Structures 108,pp.267–276,2014.

[4] Missoum Lakhdar ,Djermane Mohammed, Labbaci Boudjemâa, Abdeldjebar Rabiâa, Moudden Bachir, "Damages detection in a composite structure by vibration analysis", TerraGreen 13 International Conference 2013 - Advancements in Renewable Energy and Clean Environment,pp.888-897,2013.

[5] P. K. Jena, D. N. Thatoi, J. Nanda, D. R. K. Parhi, "Effect of damage parameters on vibration signatures of a cantilever beam", International Conference on Modelling, Optimisation and Computing (ICMOC 2012),pp.3318-3330,2012.

[6] Kaushar H. Barad, D. S. Sharma, Vishal Vyas,"Crack detection in cantilever beam by frequency based method", Nirma University International Conference on Engineering (NUiCONE), pp.770-775, 2013.

[7] Amit Banerjee, G Pohit, "Crack Investigation of Rotating Cantilever Beam by Fractal Dimension Analysis", International Conference on Innovations in Automation and Mechatronics Engineering, ICIAME, pp.88-195, 2014.

[8] Prasad Ramchandra Baviskar,Vinod B. Tungikar, "Multiple Cracks Assessment using Natural Frequency Measurement and Prediction of Crack Properties by Artificial Neural Network", International Journal of Advanced Science and Technology,pp.23-38,2013.

[9] Murat Kisa, M. Arif Gurel, "Free vibration analysis of uniform and stepped cracked beams with circular cross sections", International Journal of Engineering Science, pp. 364-380, 2007.

[10] N.V.Narasimha Rao L, K.V.P.Chandhu, D, satyanarayana, "Fault diagnosis of dynamics cracked structure using Fuzzy Inference system", International Journal of engineering trends in Engineering and Development, pp. 601-610, 2012.

[11] Saidi abdelkri, Hamouine abdelmadjid, Abdellatif megnounif , Chabani abdelmadjid, Benahachelif souad, "Crack detection in concrete beams using experimental modal data", International Conference on Structural Dynamics, EURODYN ,pp.2123-2126,2011

[12] FB Sayyad, B Kumar and SA Khan, "Approximate analytical method for damage detection in free-free beam by measurement of axial vibrations", International Journal of Damage Mechanics,pp.133-142,2013

[13] A. Dixit, S. Hanagud, "Single beam analysis of damaged beams verified using a strain energy based damage measure", International Journal of Solids and Structures 48, pp. 592–602, 2011.

[14] D.K. Agarwalla, D.R. Parhi, "Effect of Crack on Modal Parameters of a Cantilever Beam Subjected to Vibration", Procedia Engineering 51 pp. 665 – 669, 2013.

[15] Mousa Rezaee and Reza Hassannejad, "Damped free vibration analysis of a beam with a fatigue crack using energy balance method"; International Journal of the Physical Sciences Vol. 5(6) , pp. 793-803,2010.

[16] Mr. Patil Amit V., Prof. Meghna Pathak, Dr. P.K. Sharma, "Review of numerical solution to the detection of crack in structure by using fuzzy logic", International Journal of Advance Research In Science And Engineering(IJARSE),Vol. No.3,August 2014

[17] S.P.Mogal, Dr.R.K.Behera, S.Y.Pawar, "Vibration analysis of cracked beam", International Journal of Advanced Engineering Technology, Vol 3, pp.371-377, 2012.

[18] Jialai Wang, Pizhong Qiao, "on irregularity-based damage detection method for cracked beams", International Journal of Solids and Structures 45 ,pp.688–704,2008

[19] Mr. Patil Amit V., Prof. Meghna Pathak, Dr. P.K. Sharma, "Theoretical and Software analysis of Crack detection in Structure", International Journal of Engineering and Technical Research (IJETR), Volume-2, Issue-5, May 2014

[20] Pankaj Charan Jena, Dayal R. Parhi, Goutam Pohit, "Faults detection of a single cracked beam by theoretical and experimental analysis using vibration signatures", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 4, Issue 3,pp. 01-18,2012.

A review on Friction and wear behaviors of brake's friction materials

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Abstract:The friction brakes pad are an important component in the braking system of automotive.As there is conversion of kinetic energy to Heat energy,temperature of Friction pair increased which cause coefficient of Friction decreases.This paper gives information about the work done by the many researchers to stabilize the coefficient of friction and to decrease the wear of the friction brakes pad by taking different combination of friction material.Most of the researchers have proved that initailly coefficient of friction increases upto certain temperature,then it decreases which causes poor friction performance of the Brake.

Keywords: Friction brakes, friction and wear,Friction coefficient,Thermal conductivity.

INTRODUCTION

A friction brake is to stop a vehicle by converting the kinetic energy of the vehicle to heat, via friction, and dissipates heat by conduction and convection. Some heat absorbed by physical and chemical reactions on friction interface.Additionally, friction brake materials should have resistance to corrosion; low wear rate, low noise, and stable friction, etc.Friction brakes are classified as metallic, carbon, and non-asbestos organic pads. Metallic based pads content as steel and copper, carbon based pads content graphite and non-asbestos organic pads content non-ferrous metals like Kevlar, and fiberglass. In Old days asbestos was used as reinforced fiber in friction brake as it has high melting point, mechanical strength and high coefficient of Friction. As it has low thermal conductivity which tends to give less friction performance and increase wear. It is carcinogenic to human's respiratory organs. As hardness of brake disk is more than plate, peaks on the surface of brake disk are pressed into the friction plate Due to high speed of brake disk some friction material is removed due to shearing which forms debris.This adhered on the disc to form a friction film which has influences on the friction and wear of brake pair.[2] In this paper the research progress on this field is studied and summarized.

Table 1:Classification and Properties of Friction Brake Material

Asbestos	Metallic Matrix	Semi metallic	Non-metallic
• Asbestos as reinforced fiber • weak thermal conductivity of asbestos tended to reduce its friction performance and increase wear. • carcinogenic to human's respiratory organs	• Monomer casting metal includes steel, CI ,Br • Easy adhesion and low COF at high temp. and speed • Powder metallurgy friction material mainly includes iron based-high temp. strength, hardness, and thermal stability copper based-stable COF,high K and iron–copper based-High K and WR • **planes, trucks, trains**	• metal fiber, ceramic fiber, and copper or iron Powder • Great heat resistance • High power absorption, • Excellent tribological properties • low frequency noise , easy rusting, and serious damage to brake disk • **motorcycles, and other light vehicles**	• Resin and rubber as Binder • Excellent tribological properties • Kevlar and carbon as Organic fibre • **planes and race cars**

II LITERATURE SUMMARY

Algan IB and Kurt A analyze the effect of The Effect of Metal Fibers and Borax Powders to Wear and Friction Performance on the Organic Based Brake Pads. They tested the material combination with 1%, 3%, and 5% borax powder, 1.5%; 3%; 4.5% and 6% copper fibers, and 1.5%; 3%; 4.5%, and 6% bronze fibers by weight. Copper and bronze fibers were 1 mm in size. By addition of borax powder enhanced the wear resistance but friction coefficient values are low. Friction test concludes low fade and normal friction coefficient values. Due to addition of bronze and copper fiber recovery and friction coefficient is increased while increased the wear rate.[1]

Xingming Xiao, Yan Yin, Jiusheng Bao, Lijian Lu and Xuejun Feng have focused on Micro-contact on brake's friction interface where loose granular film and dense sheet film created during braking. Due to sliding, micro-asperities between friction pair are deformed and dropped to form some loose granular films. After increasing braking pressure and surface temperature loose granular films are cut and get welded to form dense sheet film. Friction surface materials react with oxygen in air and oxidation film forms which is having low intensity, hard and brittle.Due to brittleness it easily cracked and forms a Debris.Due to oxidation film friction coefficient decreases and the wear resistance increses.Due to thermal degradation some gases like CO, CO2, CH 4, and H2 comes out and creats gas cushion film on the interface which reduce the friction coefficient. Due to thermal decomposition of Organic components which are in friction materials at high temperature liquid lubrication films generates which results liquid lubrication between interfaces. Due to this friction coefficient falls which are helpful to reduce wear. With the increasing braking pressure initially friction coefficient increases then decreases but wear rate keeps on increasing. [2]

Sanjeev Sharma, Jayashree Bijwe and Mukesh Kumar worked on non asbestos organic material with Nano- and Micro-Sized Copper Particles as Fillers. They developed micro composite with 10 % (wt) Cu with size of particles 400 -600 μm and in the nano composite only a part (2 %) of the micro powder was replaced by a Nanopowder with size of nano particles 50 -200 mm.The concludes that the due to nano Cu powder wear resistance, hardness, thermal conductivity, thermal diffusivity and density increased. The thermal conductivity of the composites plays an important role in the enhancement of the Friction performance. [3]

Maciej Szlichting, Dariusz M.Bielinski, Jacek Grams, and Zbigniew Pedzich have focused on the influence of the kind of composite material on morphology and composition of its surface layer and Tribological properties. They have suggested that due to tribochemical phenomena there is the possibility of reduction of the wear of brake pads. The tribochemical phenomena should be considered for both elements of the friction pair.[4]

A L Craciun, C Pinca-Bretotean, C Birtok-Baneasa and A Josan have worked on composite material for friction and braking application. In this paper they developed the composite material by adding coconut fiber reinforcement in aluminum matrix with different Percentage (0%, 5%, 10%, and 15%). Friction performance is good in case of higher percentage of coconut fiber. [5]

M. Alemani, S.Gialanella, G.Straffelini n, R.Ciudin, U.Olofsson, G.Perricone and I. Metinoz investigate the sliding behavior of a low-steel friction material against a cast iron disc at different applied loads, to investigate the effect of the temperature rise induced by frictional heating. Oxidation of kinetics of the disc increases with temperature. Iron oxides become important components of the friction layer which reduces the abrasive component of wear although wear rate is enhanced by tribo-oxidation of the disc due to decom- position of the phenolic binder. [6]

Shangwu Fan, Litong Zhang, Laifei Cheng, JianxinZhang, ShangjieYang and HeyiLiu have studied the Wear mechanisms of the C/Sic brake materials. They fabricated C/Sic brake materials chemical vapor infiltration with composition as 65 wt % C, 27 wt% Sic, and 8 wt % Si.Due to local high temperature Oxidation-abrasion happened which causes adhesive wear and weakens the carbon fiber strengthening. Silicon is the significant factor in adhesive wear. High wear rates observed due to adhesive wear can cause high wear rates and a large unstable friction coefficient so Si available in the brake materials should be removed. [7]

TejSingh, Amar Patnaik, Brijesh Gangil and Ranchman Chauhan has studied the effect of nano filler in brake materials. The brake friction materials were containing nanoclay and multi-wall carbon nano tube. The result shows multi-wall carbon nano tube enhances the friction and fade performance,

but decreases the wear performance, whereas nanoclay affects the reverse as that of multi-wall carbon nano tube. In nanoclay filled friction composites recovery response is more. [8]

W.J.Wang, F.Wang, K.K.Gu, H.H.Ding, H.Y.Wang, J.Guo, Q.Y.Liu, and M.H.Zhu investigates tribological properties of metro brake shoe materials. Velocity and pressure of braking have major effect on the friction coefficient. With increasing velocity and pressure wear loss of brake shoe rings is increases. [9]

Piyush Chandra Verma et.al studied friction layer in friction pair at high-temperature. Cast iron and friction material was the friction pair and tested at 25 °C, 170 °C, 200 °C, 250 °C, 300 °C and 350 °C.Thermal degradation of phenolic resin have major influence on tribological behavior of friction material. At temperature 170 °C to 200 °C transition in wear rate observed from low to Severe. [10]

M. Polajnar, M.Kalin, I.Thorbjornsson, J.T.Thorgrimsson, NValle and A.Botor-Probierz studied the Friction and wear performance of functionally graded ductile iron for brake pads. During braking after a removal of surface material thickness due to friction wear resistance increases and friction coefficient get stabilize. On ductile-iron pads graphite (solid lubricant) nodules were formed and on the carbon-reinforced ceramic disc a patchy and layered transfer film was formed.[11]

K.W. Liew and Umar Nirmal has studied the Frictional performance of Non-commercial asbestos brake pad and non-asbestos brake pad materials. The Non-commercial asbestos brake pad and non-asbestos brake pad materials were tested and compared. Friction layer generated on the friction surface have major effect on the frictional performance which enhances stability of friction coefficient and hence improves the fade resistance. Non-asbestos brake pad materials showed highest friction coefficient among all friction materials. Stabilization of the friction coefficient has occurred after 7 km sliding distance when it slides against cast iron disc. [12]

Mohamed K chaou, Amira Sellami, Riadh Elleuch and Harpreet Singh studied the friction characteristics of a brake friction material with brass fiber at different sliding speeds and nominal contact pressure. At the low contact pressure coefficient of friction increases from 0.35 to 0.38 and at high contact pressure it varies 0.22 to 0.24. Initially at sliding velocity 3 m/s and contact pressure 0.6 Mpa stable friction film was generated on the surface, which provided excellent friction stability along with reduced wear. At sliding velocity 6 m/s and contact pressure 1.2 Mpa the friction coefficient values show a slight discontinuity and the fibers were found to be more agglomerated. Agglomeration reduces the wear performance. At sliding velocity 6 m/s and contact pressure 1.2 Mpa deterioration of the pad surface are observed due to oxide film formation at high temperature conditions.[13]

Vishal Mahale, Jayashree Bijwe and Sujeet Sinha studied performance of NAO brake-pads having nano-potassium titanate particles in the Pad. Composite without potassium titanate particles, and two composite with 3% micro and3% nano- potassium titanate particles were studied. Results shows inclusion of 3 wt% potassium titanate in friction material decreased overall friction coefficient which shows its lubricating property. But wear and fade also decreases. Composite with Nano-potassium titanate particles shows better performance than its counterpart with micro potassium titanate particles.[14]

M.Djafri, M.Bouchetara, C.Busch and S.Weber studied tribological behavior of the brake disc materials based on humidity and corrosion. Cast iron, chromium bearing steel and aluminum based composite was used for this study. Results showed as humidity increased, water film formed which act as lubricant. In case Cast iron friction coefficients increased with increasing humidity from 20 to 40% also it decreases in between 40 to 90 % humidity whereas in case of chromium steel it gets decreases. In case aluminum composites there is no any influence of humidity on friction coefficient. Wear rate decreases in all cases. [15]

III CONCLUSIONS

With the view of all researchers, during braking initially coefficient of friction increases, after certain

Temperature it decreases. To stabilize the friction coefficient the different material with addition of different type of filler either in micro or Nano from can be developed. Bonding strength between

fiber and matrix may improve the Wear resistance fade resistance and mechanical properties. New developed friction material should lower the emissions and increase fuel efficiency. Thermal conductivity of friction material can play major role in performance of friction pair.With consideration of different materials for friction pad; focus on dimensional analysis of it can be done in future.

REFERENCES

1. Algan iB and Kurt A[2016] The Effect of Metal Fibers and Borax Powders to Wear and Friction Performance on the Organic Based Brake Pads. Journal of Powder Metallurgy & Mining. Volume 5, Issue 1.
2. Xingming Xiao, Yan Yin, Jiusheng Bao, Lijian Lu and Xuejun Feng [2016] Review on the friction and wear of brake materials, Advances in Mechanical Engineering,Vol. 8(5) 1–10
3. Sanjeev Sharma, Jayashree Bijwe,Mukesh Kumar [2013] Comparison Between Nano- and Micro-Sized Copper Particles as Fillers in NAO Friction Materials, Nanomaterials and Nanotechnology,Vol 3,Art 12:2013.
4. Maciej Szlichting, Dariusz M.Bielinski, Jacek Grams,Zbigniew Pedzich [2016] The influence of the kind of composite friction material on morphology and composition of its surface layer and tribological properties,Tribologia,121-144.
5. A L Craciun, C Pinca-Bretotean, C Birtok-Baneasa ,A Josan [2016] Composites materials for friction and braking application" Materials Science and Engineering.
6. M. Alemani, S.Gialanella, G.Straffelini,R.Ciudin,U.Olofsson,G.Perricone,I.Metinoz [2017] Dry sliding of a low steel friction material against cast iron at different loads: Characterization of the friction layer and wear debris,Wear,1450-1459.
7. Shangwu Fan, Litong Zhang, Laifei Cheng, Jianxin Zhang, Shangjie Yang,Heyi Liu [2010] Wear mechanisms of the C/SiC brake materials,Tribology International,25-28.
8. Tej Singh, Amar Patnaik, Brijesh angil, Ranchan Chauhan [2015] Optimization of tribo-performance of brake friction materials: Effect of nano filler, Wear, 10-16.
9. W J Wang,FWang,K K Gu,HH Ding,HY Wang,J Guo,Q YLiu,M H Zhu[2015] ` braking tribological properties of metro brake shoe materials,Wear,498-506
10. Piyush Chandra Verma, Rodica Ciudin,Andrea Bonfanti,Pranesh Aswath,Giovanni Straffelini, Stefano Gialanella [2016] Role of the friction layer in the high-temperature pin-on-disc study of a brake material,Wear,56-65.
11. Polajnar, M.Kalin, I.Thorbjornsson,J.T.Thorgrimsson,NValle,A.Botor-Probierz [2017] Friction and wear performance of functionally graded ductile iron for brake pads,wear,85-94.
12. K.W. Liew, Umar Nirmal [2013] Frictional performance evaluation of newly designed brake pad materials, Material and design, 25-33.
13. Mohamed Kchaou,Amira Sellami,Riadh Elleuch,Harpreet Singh [2013] Friction characteristics of a brake friction material under different braking conditions Material and design,533-540.
14. Vishal Mahale, Jayshree Bijwe, Sujeet Sinha [2017] Influence of nano-potassium titanate particles on the performance of NAO brake-pads, Wear, 727-737.
15. M.Djafri, M.Bouchetara, C.Busch, S.Weber [2017], Effects of humidity and corrosion on the tribological behavior of the brake disc materials, wear, 8-15.

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Review of Finite Element Analysis of chain and sprocket for Roller Conveyor System

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Abstract: A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyor systems are commonly used in many industries. Many factors are important in the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand .Now day's major breakdown in continuous running plant is too costly. The motor and gearbox was directly coupled through chain and sprocket to the shaft, the overall subject of Project is the optimization analysis of Chain drive, shaft and sprocket.

Keywords: Existing Design, Design Validation, Modelling, ANSYS, Failure Study

INTRODUCTION

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Many kinds of conveying systems are available, and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys.

Chain drive is one of the commonly used drive train to transfer this power. Chain assembly consist of chain, driving sprocket and driven sprocket. The driving sprocket is connected to engine output shaft, which transfer power to driven sprocket by chain. Further this driven sprocket transfer power to drive shaft. Therefore in chain assembly driving sprocket has a chance for design and optimization for weight reduction. Due to high power transfer and high speed of rotation, high stress induces in sprocket teeth, also high speed leads to the vibrations. Hence it is important to design and manufacture sprocket properly, also mounting of sprocket is important. While transferring power from driving to driven sprocket, chain exerts high load on sprocket teeth so, maximum loads acting on teeth are calculated.

Finite Element Method" is a mathematical technique used to carry out the stress analysis. In this method the solid model of the component is subdivided into smaller elements. Constraints and loads are applied to the model at specified locations. Various properties are assigned to the model like material, thickness, etc. The model is then analyzed in FE solver. The results are plotted in the post processor. The scalar plot shows us the stresses and deformations over entire span.

PROBLEM STATEMENT

The semi-finished material has to be transported from one station in the assembly to another at a distance of up to 30meters or more. The method of manual transport by fork-lift is time consuming. A mechanism for continuous and uninterrupted transport is desired.

NEED FOR ANALYSIS

The geometry of the roller conveyor is amenable to the usage of 3D modeling. The design of the roller conveyor parts would necessitate knowledge of the fundamentals for Product Design coupled with intuition gained by experience of the Design Engineer. The information like `weight of the roller conveyor and `location of the Centre of Gravity can be readily offered by the three dimensional CAD interface. Although it is iterative process the physical design can of each iteration for testing is not possible for conformance to the conditions specified (test conditions) could be done through the utilization of a suitable tool – ANSYIS "Software for Analysis" Maintaining the Integrity of the Specifications

OBJETCTIVE OF WORK

The following are the objectives of the study:

1. Study existing roller conveyor system.
2. Geometry modeling existing chain and sprocket for roller conveyor.
3. Analysis of existing roller conveyor parameter.
4. Modification of critical conveyor parts for weight reduction.
5. Analysis of Modified design for same loading condition.

V. LITRATURE REVIEW

ParagNikam. [1] Int. Journal of Engineering Research and Application www.ijera.com ISSN: 2248-9622, Vol. 6, Issue 9(Part-5) Sepember.2016, pp.66-69 www.ijera.com 66|Page Design Optimization of Chain Sprocket Using Finite Element Analysis

Alspaugh M. A. [2] presents latest development in belt conveyor technology & the application of traditional components in non-traditional applications requiring horizontal curves and intermediate drives have changed and expanded belt conveyor possibilities. Examples of complex conveying applications along with the numerical tools required to insure reliability and availability will be reviewed. This paper referenced Henderson PC2 which is one of the longest single flight conventional conveyors in the world at 16.26 km. But a 19.1 km conveyor is under construction in the USA now, and a 23.5 km flight is being designed in Australia. Other conveyors 30-40 km long are being discussed in other parts of the world.

S.H. Masood et. al. [3] presents an application of concept of concurrent engineering and the principles of design for manufacturing and design for assembly, several critical conveyor parts were investigated for their functionality, material suitability, strength criterion, cost and ease of assembly in the overall conveyor system. The critical parts were modified and redesigned with new shape and geometry and some with new materials. The improved design methods and the functionality of new conveyor parts were verified and tested on a new test conveyor system designed, manufactured and assembled using the new improved parts.

The improved methodology for design and production of conveyor components is based on the minimization of materials, parts and costs, using the rules of design for manufacture and design for assembly. Results obtained on a test conveyor system verify the benefits of using the improved techniques. The overall material cost was reduced by 19% and the overall assembly cost was reduced by 20% compared to conventional methods.

A. Göksenliet. al. [4] in this study failure analysis of an elevator drive shaft is analyzed in detail. Failure occurred at the keyway of the shaft. Microstructural, mechanical and chemical properties of the shaft are determined. After visual investigation of the fracture surface it is concluded that fracture occurred due to torsional-bending fatigue. Fatigue crack has initiated at the keyway edge. Considering elevator and driving systems, forces and torques acting on the shaft are determined; stresses occurring at the failure surface are calculated. Stress analysis is also carried out by using finite element method (FEM) and the results are compared with the calculated values. Endurance limit and fatigue safety factor is calculated, fatigue cycle analysis of the shaft is estimated. Reason for failure is investigated and concluded that fracture occurred due to faulty design or manufacturing of the keyway (low radius of curvature at keyway corner, causing high notch effect). In conclusion effect of change in radius of curvature on stress distribution is explained by using FEM and precautions which have to be taken to prevent a similar failure is clarified.

Gys van Zyl et. al. [5] the shaft of a conveyor belt drive pulley failed in service. An investigation was performed in order to determine the failure root cause and contribution factors. Investigation methods included visual examination, optical and scanning electron microscope analysis, chemical analysis of the material and mechanical tests. A finite element analysis was also performed to quantify the stress distribution in the shaft. It was concluded that the shaft failed due to fatigue and that the failure was caused by improper reconditioning of the shaft during routine overhaul.

DimaNazzalet. al. [6] discusses literature related to models of conveyor systems in semiconductor fab. A comprehensive overview of simulation-based models is provided. We also identify and discuss specific research problems and needs in the design and control of closed-loop conveyors. It is

concluded that new analytical and simulation models of conveyor systems need to be developed to understand the behavior of such systems and bridge the gap between theoretical research and industry problems.

John Usher et al. [7] provide the details of analysis of the reliability and availability of two common designs of the line-shaft roller conveyor. The first is a standard design in which each roller is belted directly to a spinning line shaft under the conveyor. The second is a new design in which only one top roller is belted to the line shaft and all other rollers are belted to the one powered roller in a series arrangement. The main reason for this design is that the upper belts are faster to replace than belts connected to the line shaft, thus increasing system availability. However, the latter design is less reliable in that the failure of a single belt may lead to multiple roller failures.

In order to shorten the product development time and improve the product quality, 3 dimensions at CAD/CAE system is essential. It is necessary to develop a system which utilizes the concept design data at the early stage for the whole process of the product development. The purpose of this paper is to improve the product quality by the sufficient design study iteration at the early stage of design. A CAD system which can be used for the concept design and an appropriate CAD environment should be developed and another purpose is to shorten the product development time at the late stage of design, this is proposed by C. Sekimoto [8] in his paper.

SCOPE OF THE STUDY

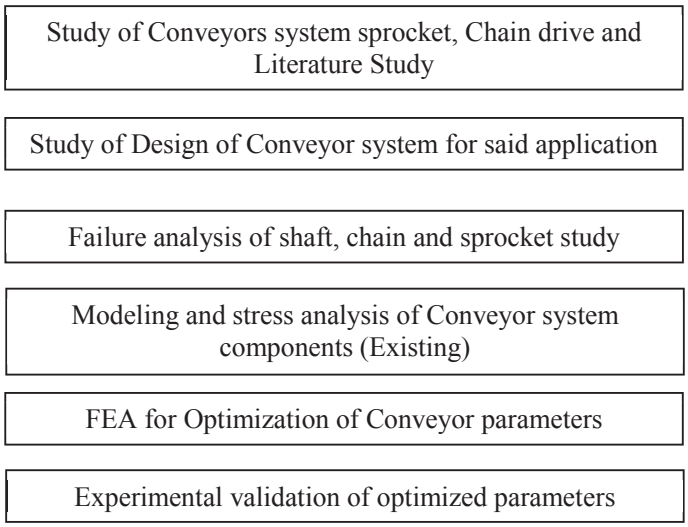
The mechanical elements of the Roller Conveyer need to be designed individually and tested in the assembly environment. The structure need to be tested for external forces acting on the entire assembly and parts.

SOFTWARE FOR DESIGN AND ANALYSIS (CREO AND ANSYS)

Creo is a family or suite of design software supporting product design for discrete manufacturers and is developed by PTC. The suite consists of apps, each delivering a distinct set of capabilities for a user role within product development. Creo runs on Microsoft Windows and provides apps for 3D CAD parametric feature solid modeling, 3D direct modeling, 2D orthographic views, Finite Element Analysis and simulation, schematic design, technical illustrations, and viewing and visualization.

Ansys is user friendly finite element analysis software which can also use for modeling and meshing varies kind of analysis can carried out in Ansys. ANYAS 16.0 include the following new enhancement that improves the solution procedure and features high performance computing due to shared memory parallel capability in Ansys distributed Ansys now run on windows 32- and 64-bit systems.

PROPOSED FLOW OF WORK AND METHODOLOGY



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Conflict of interest: I would like to declare that we have no conflict of interest

Ethical statement: I would like to declare that we have followed ethical responsibilities

REFERENCES

[1] ParagNikam. Int. Journal of Engineering Research and Application www.ijera.com ISSN : 2248-9622, Vol. 6, Issue 9,(Part-5) Sepember.2016, pp.66-69 www.ijera.com 66|Page Design Optimization Of Chain Sprocket Using Finite Element Analysis

[2] M. A. Alspaugh, "Latest Developments in Belt Conveyor Technology"MINExpo 2004, Las Vegas, NV, USA. September 27, 2014.

[3] S.H. Masood· B. Abbas · E. Shayan · A. Kara "An investigation into design and manufacturing of mechanical conveyors Systems for food processing", Springer-Verlag London Limited 2004.

[4] A Göksenli, I.B. Eryürek, "Failure analysis of an elevator drive shaft" at science direct journal - Engineering Failure Analysis 16 (2009) 1011–1019.

[5] Gys van Zyl, AbdulmohsinAl-Sahli, "Failure analysis of conveyor pulley shaft" at science direct journal - Case Studies in Engineering Failure Analysis 1 (2013) 144–155.

[6] DimaNazzal, Ahmed El-Nashar"Survey of Research in Modeling Conveyor-Based Automated Material Handling Systems In wafer fabs" Proceedings of the 2007 Winter Simulation Conference.

[7] John Usher, John R, G. Don Taylor "Availability modeling of powered roller conveyors".

[8] C.Sekimoto "Development of Concept Design CAD System", Energy and Mechanical Research Laboratories, Research and Development Center, Toshiba Corporation.

Experimental Investigation of Strength of V & U Groove Butt Welded Joint Carbon Steel Materials Used in Pressure Vessel by Using GTAW & SMAW Welding Techniques

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Abstract: This Welding is an area in which technological development out match in its science base which is primarily driven by the phenomenal industrial demand for welded structure. Reliability, Reproducibility and Viability requirements are forcing Technologists to look at weld defects such as distortion, hot cracking, in a systematic and logical approach than on experimental basis. Distortion is an unwanted physical change from specifications in a fabricated structures is caused by non-uniform expansion and contraction of the weld metal during heating and cooling cycle of the welding process many factors viz., material properties, welding process and procedures adopted make accurate prediction of distortion difficult. Type of Groove was taken to analyze tensile, compressive, shear, bend and impact strength in butt weld joints.

The current study aim to compare mechanical properties of A516 Gr.70 and IS 2062 E250 for different groove angle and bevel heights keeping root opening, voltage and current constant. The specimens are prepared by using V groove butt weld joints by SMAW process then compare the tensile strength. High tensile jointed material between these materials is taken for comparing of strength of U & V groove geometry. Mechanical tests such as tensile test, impact test and hardness test have been conducted to find out the mechanical properties such as tensile strength, impact strength of HAZ.

Keywords: **Bevel height, groove angle, root opening, U groove butt weld joint, V groove weld joint, SMAW, GTAW Welding.**

INTRODUCTION

Welding is a joining process of similar metals but nowadays it is also joining dissimilar metals by the application of heat. Welding can be done with or without the application of pressure. It is can be done addition of filler materials or without addition of filler materials. While welding the edges of metal pieces either melted to plastic condition and it is used for permanent joints. The joint gets stronger after cooling down. It's heats when the weld pool is used with the work-piece and produces weld in that time. In all fabrication companies welding is very essential. Welding is used in steel fabrication its uses and is expanded in other industrial sectors like construction, mechanical and car manufacturing etc.

A. SHIELDED METAL ARC WELDING.

It is one of the methods of fusion welding process for joining two metal pieces by melting their edges by an electric arc between two conductors. The electrode and the work piece are conductors.The electric current allows the electric arc to melt two metal pieces, a filter material is used which enables the pieces to mix and as it cools it solidifies into one piece.

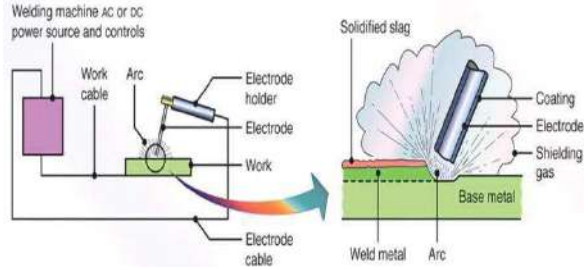

Fig-1.1 SMAW Welding

B. GAS TUNGSTEN ARC WELDING

GTAW welding is an electric arc welding process in which the fusion energy is produced by an electric arc burning between the work piece and the tungsten electrode. If it is necessary to use filler material it is added a bare wire either manually or automatically. The arc and the weld pool are protected against the damaging effects of the atmospheric air by an inert shielding gas during the welding process the electrode. A shielding gas is lead to the welding zone from the nozzle where it replaces the atmospheric air.

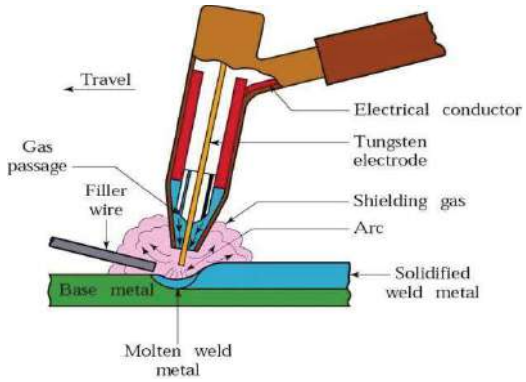

Fig-1.2 GTAW Welding Process

C. CARBON STEEL MATERIALS

A-516-70 is the most widely used pressure vessel steel. It maintains its strength to temperatures of 345º C and can be used to -50ºC if normalized and impact tested. It is commercially available in thicknesses from 6mm to 40mm in the "as rolled" condition.

There are other Indian standard carbon steels that are used in pressure vessel IS 2022 and IS 2062, but they are for specialized small market applications and we shall not take one of them for strength comparative with international standard carbon steel i.e. SA 516 grade 70.

LITERATURE REVIEW

G.B.Jang, H.K.Kim and S.S.Kang et.al. "The Effects of Root Opening on Mechanical Properties, Deformation and Residual Stress of Weldments" In the present case, a study was performed to accumulate data on the behavior of built-up parts and to verify the effects of root opening on the mechanical properties of the welded parts. For that purpose, tensile, bend, impact and hardness tests were carried out on weld specimens having 0-2, 6-10 and 30-40 mm root openings. Additionally, the finite element common code (MARC) was used to study the effects of 0-2, 6-10 and 30-40 mm root openings on residual stress and weld deformation in multipass welding.

G. Magudeeswaran et.al "Optimize the Process Parameters of Activated Tungsten Inert Gas welding." The activated GTAW (ATIG) welding process mainly focuses on increasing the depth of penetration and the reduction in the width of weld bead has not been paid much attention. The shape of a weld in terms of its width-to-depth ratio known as aspect ratio has a marked influence on its solidification cracking tendency.

Bhawandeep Singh et.al Observed the Performance of activated GTAW process in mild steel welds. Gas tungsten arc welding is fundamental in those industries where it is important to control the weld bead shape and its metallurgical characteristics. However, compared to the other arc welding process, the shallow penetration of the GTAW welding restricts its ability to weld thick structures in a single pass thus its productivity is relativity low.

M. Murugananth , S.S.Babu, and S.A.David et. al "Optimization of Shielded Metal Arc Weld Metal Composition for Charpy Toughness" This coupled model was used to optimize the carbon, nickel, and manganese concentrations in a weld to achieve a maximum toughness of 120 J at -60°C. The coupled model used linear and nonlinear techniques to explore the possible combinations of carbon, manganese, and nickel concentrations for a given set of welding process parameters. An

optimum weld metal composition was achieved only with nonlinear methods. The number of iterations and the exploration of input parameter space varied depending upon the type of nonlinear technique.

G. Atkins, D.Thiessen , N.Nissley, and Y.Adonyi et. al. "Welding Process Effects in weldability Testing of Steels" This work was part of a nationwide program for the development of new high-performance steels with 70 ksi (485 MPa) minimum yield strength, improved toughness, and lower manufacturing costs through the elimination of preheat for welding. The purpose of the present work was to evaluate the fusion zone hydrogen-induced cracking susceptibility of single-pass weld deposits made using four different welding processes at equivalent diffusible hydrogen levels.

T. Kasuya and N.Yurioka et.al "Carbon Equivalent and Multiplying Factor for Hardenability of Steel" The carbon equivalent and the multiplying factor are indexes for hardenability of steels. The carbon equivalent is used generally in welding and is related to the critical cooling time for the full martensite structure in the HAZ. The multiplying factor is used in heat treatment of hardenable steels and is related to the critical diameter for the full martensite.

A. Q. Bracaense and S. Liu et al. "Chemical Composition Variations in Shielded Metal Arc Welds" The use of shielded metal arc (SMA) welding can result in chemical composition variations along the weld length. Manganese and silicon, commonly found in low-carbon steel welds, change in composition with weld position. This research was performed to better characterize the composition variations observed in structural steel welds and to understand the controlling factors that determine the extent of these composition changes.

OBJECTIVES

Determine the overall joint strength of a single U & V welded joint at optimum geometrical configuration i.e. root gap, root face and bevel angle with two different carbon steel materials used in pressure vessel and two different welding techniques.It can also be defined as determination of high strength groove joint geometry by experimental method on the basis of tensile strength, hardness, Micro test and Macro test toughness of HAZ as use in the ASME Section IX.

Objective of proposed project is to find out,

1 Suitable Material
2 Suitable welding Technique
3 Suitable groove geometry between U & V
4 Increasing Welding Strength
5 Minimize cost of welding

EXPERIMENTAL INVESTIGATION OF STRENGTH OF V & U GROOVE BUTT WELDED JOINTS

EXPERIMENTAL METHODOLOGY

However the steel can able to weld in different welding processes which results into having different strength. So welding effect of GTAW and SMAW welding process on steel is changes its property.

The mechanical property of the SMAW piece and GTAW welding piece for IS 2062 Gr.250 Material and SA516 Gr 70 material is to be analyzed and each weldment has to shows the strength value that closer to parent metal property.

Chemical composition for the both metal on which we need to experiment is shown below.

Composition	C	Si	Mn	S	P	CE
IS 2062 Gr.250	0.23	0.40	1.50	0.045	0.045	0.42
A 516 Gr.70	0.27	0.40	1.20	0.035	0.035	0.42

Welding material & its Composition for above material is shown below.

Composition	C	Si	Mn	S	P
E 7018	0.15	0.75	1.60	0.035	0.035
ER 70 S-2	0.07	0.70	1.40	0.035	0.035

WELDING PARAMETERS

Because of inspection two processes of different welding processes have same parameter and electrode and base metal. The process parameters for two different welding process are same.

Phase	3phase, 50 cycles/sec
Current	50 A to 400 A
Open circuit voltage	80 volts
Efficiency	0.85%
Power factor	0.4
Energy consumption	4kWh/kg of Metal deposit
Welding speed	1 min/200mm

The SMAW and GTAW welding same chemical composition electrodes grade E 7018 and ES 70 SP2 for carbon steel used. The welding parameters of each process should same including the electrodes for testing of the welded material with same procedure have to select same material.

C. *Destructive Test*

Tensile test: The yield and ultimate strength and ductility i.e. %age elongation, %age reduction in area can be obtained either in ambient condition or in special environment like low temperature, high temperature, corrosion etc. depending upon the requirement of the application using tensile test which is usually conducted at constant strain rate (ranging from 0.0001 to 10000 mm/min)

Bend test: Bend test is the most common and important method used destructive tests to determine the ductility and soundness for the presence porosity, inclusion, penetration and other macro-size internal weld discontinuities of the weld joint produced using under one set of welding conditions.

Hardness test: Hardness of any material is defined as resistance to indentation and is commonly used as a measure of resistance to abrasion or scratching. For the formation of a scratch or causing abrasion, a relative movement is required between two bodies and out of two one body must penetrate/indent into other body.

Impact Testing: The prepared specimen was placed on the Anvil with V-notch gauge. The Pendulum was set to predetermined level 298 J and released to strike and fracture the positioned specimen. The value of Energy Impacted was taken and recorded.

Metallographic Testing: Metallographic samples were produced from welds in accordance to ASTM E 23. Grinding, Polishing, etching with 2% Nital and Metallographic examination of butt and groove welds were performed using optical microscope Olympus PMG3 with magnification X500.

STAGE WISE EXPERIMENTAL PROCEDURE

STAGE 1

There are four carbon steel plates we have taken .i.e. two of IS 2062 Gr.E250 and two of A516 Gr 70 having the length and width 125mmX160mm and 8mm thick plate. Two plates of same material will be butt welded by SMAW welding method with V Groove which is having 60^0 angle & 2mm root gap.

All welding and sample preparation is done as per ASME section.XI and tested for tensile test. Superior of IS2062 Gr.E250 & SA516 Gr.70 is investigated. High strength welded material is found to be SA516 Gr.70 during testing.

This superior of above carbon steel which is SA 516 Gr.70 material is taken for investigation high strength joint for two groove weld i. e U & V groove in stage 2.

Result for Stage 1

Table: Result for Mechanical Properties of IS 2062 Gr.E250

Sample		1A	1B	1C
Thickness	mm	8.01	8.04	8.01
Width	mm	19.00	19.00	19.00
Ultimate Load	KN	75.12	74.96	76.62

Ultimate Strength	MPa	493.59	490.70	503.45
Fracture	At	Base metal	Base metal	Base metal
Result	found	Satisfactory	Satisfactory	Satisfactory

Table: Result for Mechanical Properties of SA516 Gr.70

Sample		2A	2B	2C
Thickness	mm	8.46	8.37	8.46
Width	mm	19.00	19.00	19.00
Ultimate Load	KN	88.56	88.64	86.84
Ultimate Strength	MPa	550.95	557.38	540.25
Fracture	At	Base metal	Base metal	Base metal
Result	found	Satisfactory	Satisfactory	Satisfactory

STAGE 2

In stage 2, we will make again four plates of SA 516 Gr.70 material having the length and width 125mmX450mm and 14mm thick plate to make two test sample according to ASME section IX. Two plates are joined by two different welding method (i.e root run and first layer by GTAW then remain welding by SMAW) with V Groove which is having 60^0 angle & 2mm root gap. And another two plates joined by again SMAW & GTAW with U Groove which is having 50^0 angle & 2mm root gap. GTAW is abbreviation for GTAW welding. All welding and sample preparation is done as per ASME section IX. We have carried out Dye Penetration test for each joint as Nondestructive test before destructive test.

Result for Stage 2

In tensile test as per ASME section IX, for "V" groove welded sample the average Ultimate Tensile Strength is found 551.76 MPa which is little beat higher than that of "U" goove welded joint and also Test sample is break on parent material for "V" groove welded joint but it is break on weld for "U" groove welded test sample.

In Hardness test as per ASTM E384, It is measured on HV10 scale results comparison as follows

Sample	**"V" Groove**	**"U" Groove**
On weld	199.67	210.33
On HAZ(R)	184	190.33
On HAZ(L)	187	195.67
Parent Material (R)	175.67	171.33
Parent Material (L)	167	167.33

For Macro test and bend test as per ASME section IX , the results for both groove weld joints found satisfactory and having no difference in results.

In Microstructure test as per ASTM E112, for both groove welded joint following are observations

1. Microstructure at parent material shows ferrite & pearlite aggregate. Structure appears to be of normalized material
2. Microstructure at HAZ reveals coarse grains.
3. Microstructure at weld reveals ferrite carbide aggregate in fine boundary ferrite.
4. Microstructure for both grooves joint shows satisfactory penetration, fusion and absence of significant inclusion or other defects.

In Impact test as per ASTM E23 done at (-)25^0C, the result are as follows

Sample	**"V" Groove**	**"U" Groove**
Average Energy absorbed when notch location at Weld (J)	40.4	111.7
Average Energy absorbed when notch location at HAZ (J)	185	166.6

CONCLUSION

In stage 1, the basic conclusion found by the comparative study international standard carbon steel i.e. SA 516 Gr.70 with Indian standard carbon steel material i.e. IS 2062 Gr. E250 on basis of tensile strength. High strength welded material is found to be SA516 Gr.70 during tensile testing. The above welded plates are tested for tensile test as per ASME IX.

The fabrication cost of pressure vessel with SA516 Gr.70 is also higher than that of IS2062 Gr.250. The pressure build in the pressure vessel fabricated with SA516 Gr.70 is higher.

In stage 2, It is primarily seen that the welding consumables are required in U groove welded joint is higher hence the fabrication cost is higher than that of V groove welded joint in small thickness plate..

In impact testing, the impact energy at weld for "U" groove welded joint is found higher than that of "V" groove welded joint. Hence the "U" groove welded joint may used where impact required higher than normal operation. In our experiment, it is seen that the impact energy for "U" groove welded material is higher than that of "V" groove welded material at (-) 25^0C. It is also seen that heat input to welded joint in "V" groove is higher than that of "U" groove which may affect test results for higher thickness material.

Hence both "U" groove and "V" groove welded joints had their own significance at point of view. Type of use will be deciding factor which groove will be use for fabrication.

ACKNOWLEDGMENT

We would like to give sincere thanks to all the members who are directly or indirectly part of this work.

REFERENCES

[1] G.B.Jang, H.K.Kim and S.S.Kang et.al. "The Effects of Root Opening on Mechanical Properties, Deformation and Residual Stress of Weldments"
[2] G. Magudeeswaran et.al "Optimize the Process Parameters of Activated Tungsten Inert Gas welding."
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[7] A. Q. Bracaense and S. Liu et al. "Chemical Composition Variations in Shielded Metal Arc Welds"

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Design and Analysis of Helical Compression Spring for Special Purpose Application

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Abstract*:* The die set system used in the wire straightening and cutting system is comprises of die plate, bolster plate and guides mutually helped by helical compression spring. This spring plays an important role in smooth movement of the die set by supplying energy stored in it as well as keeps sufficient pressure on the plate provided at the bottom of the rod. It acts as suspension system to absorb the shocks and stores the mechanical energy. It is made up of elastic materials such that it can be twisted, pulled or stretched by the application of force and regain its original shape when the force is released due to this the stresses are produced along the length of the helical compression coil spring. On account of these stresses coil springs fail prematurely before its service life. The present work is investigation on reduction of premature failure and improvement in service life of helical compression spring. The life of spring is improved by optimum design and analysis by variation of wire diameter. Results indicate that the stresses decrease with increase in wire diameter and number of turns of coil spring. Due to this, deflection of spring is within limit and there is reduction in premature failure of coil spring.

Keywords: Helical Compression Spring, Die Plate, Deflection of spring, Premature Failure.

INTRODUCTION

A spring is basically defined as an elastic body whose function is to distort when loaded and to recover its original shape when the load is removed. Mechanical springs are used in machines and other applications mainly to exert force, to provide flexibility, to store or absorb energy. it is also termed as a resilient member.

Spring material and its quality can be normally taken into consideration or highlighted in such cases as (i) Spring installed in mechanical products failed either by fracture or by significant deformation in use. Here the quality requirements set up in the initial quality design stage were not achieved in the actual product (ii) A mechanical product newly designed or improved where a new design of spring is required of higher quality (iii) A cost reduction requested for the spring have been used without any difference of the quality. Here although the quality requirements at the design stage were satisfied in use the springs were used in the severer condition than the initially expected or some important quality requirement failed to be included in the initial quality requirements in the design stage.

When a spring has failed due to the above reasons an investigation is need to be carried out to find out the quality of the material used for the spring and manufacturing process used to make it. Considering the availability,design,quality level, price and the matching with working processes, the most suitable material can be selected.

LITRATURE REVIEW

After Studying the Literature it can be concluded that a lot of work has been done in the field of design, analysis and material selection for compression spring .

Kaiser B., Pyttel B. and Berger, C. [1] reported on procedure and preliminary research results of long-term fatigue tests up to a number of 109 cycles on shot peened helical compression springs with two basic dimensions, made of three different spring materials (oil hardened and tempered SiCr- and SiCrV-alloy steel). Their result shows that the various spring types in test exhibit different fatigue properties and also different failure mechanisms in the VHCF regime.

Prawoto Y., Ikeda, M., Manville S.K. and Nishikawa, A. [3] discussed about automotive suspension coil springs, their fundamental stress distribution, materials characteristic, manufacturing and common failures. An in depth discussion on the parameters influencing the quality of coil springs is also presented. This paper discussed several case studies of suspension spring failures. The failures

presented range from the very basic including insufficient load carrying capacity, raw material defects such as excessive inclusion levels, and manufacturing defects such as delayed quench cracking, to failures due to complex stress usage and chemically induced failure. FEA of stress distributions around typical failure initiation sites are also presented.

Berger C. and Kaiser B [4] reported that the results of very high cycle fatigue tests on helical compression springs which respond to external compressive forces with torsional stresses. The results of these investigations can add an important contribution to the experience of fatigue behaviour in the very high cycle regime. Most investigations performed on that field deal with specimens under tensile or rotating bending load.

Ronald E. Giachetti [5] stated that the material and manufacturing process selection problem is a multi-attribute decision making problem. These decisions are made during the preliminary design stages in an environment characterized by imprecise and uncertain requirements, parameters, and relationships. Material and process selection decisions must occur before design for manufacturing can begin

W.K. Chan, Thomas K. L [7] Using Grey relational analysis, the multi-criteria weighted average is proposed in decision-making process to rank the materials with respect to several criteria. It will guide the selection process and help a decision maker solve the selection problem. This selection process is multi-objectives, which may contradict with one another. The selection of the final material should be a consideration of all those factors but not the particular.

Prasenjit Chatterjee, Chakraborty Shankar [8] the large number of available materials together with the complex relationships between various selection criteria, often make the material selection process a difficult and time consuming task. A systematic and efficient approach towards material selection is necessary in order to select the best alternative for a given engineering application.Hence, these preference ranking methods can be efficiently applied to any type of material selection decision-making problem having any type of criteria and any number of alternatives.

Gadakh V. S. [12]application of multi objective optimization on the basis of ratio analysis (MOORA) method is applied for solving multiple criteria (objective) optimization problem in milling process. Six decision making problems which include selection of suitable milling process parameters in different milling processes are considered in this paper. In all these cases, the results obtained using the MOORA method almost match with those derived by the previous researchers which prove the applicability, potentiality, and flexibility of this method while solving various complex decision making problems in present day manufacturing environment.

PROBLEM STATEMENT

Presently Company is facing a lot problems due to premature failure of the die set spring under the loading of 1000 N and maximum allowable deflection of 25 mm. when the operations are carried out the spring undergo setting and does not attains original length as well as failure occurs with crack generation and distortion of the spring. Failure of die set spring may result in sudden depreciation in the resisting power of the die plate against the press force applied to form the product and consequently may lead to threat of injury or damage to the component. Hence the spring must be designed for reliability and to withstand the compression loading during operation over its life time

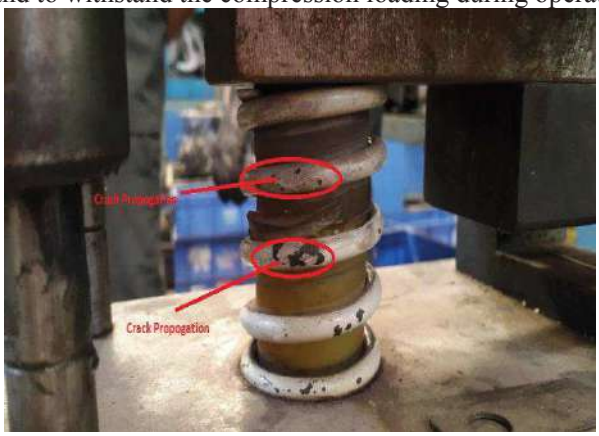

Figure 1. Helical Compression Spring under Study

H. OBJECTIVE

- To study and analyze existing helical compression spring.
- To study the deflection and stress on spring.
- To design a spring to withstand against compression load.
- To develop new model of spring with moderate specification.
- To do comparative study between existing and new developed spring.

METHODOLOGY

Mathematical analysis has been done on existing and new spring. They both have different specification and material composition. Multi objective optimization on the basis of ratio analysis (MOORA) method is adopted for material selection criteria for new spring. Further stress and deformation modulation done by ANSYS software, it shows comparative study of stress and deformation Development and testing of the new spring done using load testing machine

DESIGN CONSIDERATIONS

As per the industries constraints the following design parameters are considered while analysing existing spring and designing new spring. The maximum load acting on the spring is 1000 N. The maximum allowable deflection in the spring is 25 mm. The outer diameter of the shaft is 40 mm and hence clearance between spring and shaft is of 2 mm is considered

I. SPECIFICATION OF EXISTING SPRING

Material: A286 Alloy,Rockwell hardness: C35-42,E = 200000Mpa,G = 71.7 X 103Mpa,Number of turns: 5.5,Wire Diameter: 6 mm,Mean diameter: 45,Free Length:- 90 mm

CALCULATION FOR MAXIMUM DEFLECTION AND STRESS USING MATHEMATICAL FORMULATION

i. Maximum Deflection $(\delta) = 43.14\ mm$
ii. Maximum shear stress $(\sigma) = 635.55\ Mpa$

While designing the new spring material selection will be the important criteria to be considered. Hence the multi objective optimization on the basis of ratio analysis is adopted for material selection. Multi-objective optimization on the basis of ratio analysis (MOORA)[12].is the process of simultaneously optimizing two or more conflicting criteria subject to certain constraints.
From MOORA method Chrome Vanadium selected. It will be the best suitable material for new spring.

SPECIFICATION OF NEW SPRING

Material: Chrome Vanadium, Rockwell hardness: C41-45, E = 207000Mpa, G = 79 X 103, Number of turns: 8, Wire Diameter: 8 mm, Mean diameter: 45, Free Length: - 90 mm

CALCULATION FOR MAXIMUM DEFLECTION AND STRESS USING MATHEMATICAL FORMULATION

1) Maximum Deflection $(\delta) = 24.62\ mm$
2) Maximum shear stress$(\sigma) = 308.832\ Mpa$

STRUCTURAL ANALYSIS

In this section ANSYS Structural is use for experimentation. It is finite element analysis software, which makes use of complex algorithms and mathematical formulae to carry out the simulations, based on user inputs.

The CAD model as shown in fig of helical compression spring are developed by using CREO 2.0 and simulations were out using ANSYS 14.0 software

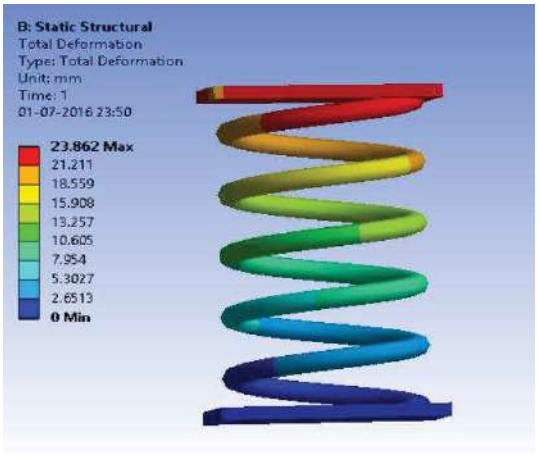

Figure 4. Total Deformation of Existing Compression Spring for 500 N Load

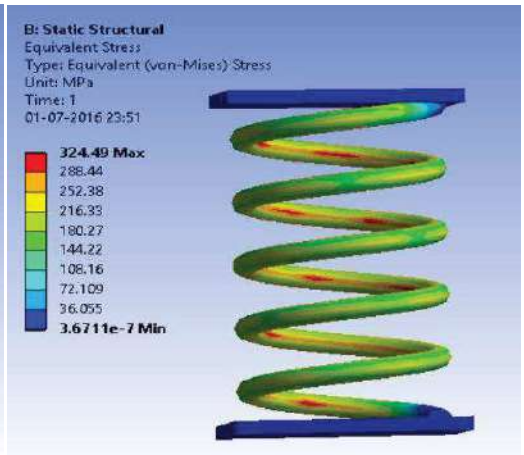

Figure 5. Von Mises Stress on Existing Compression Spring for 500 N Load

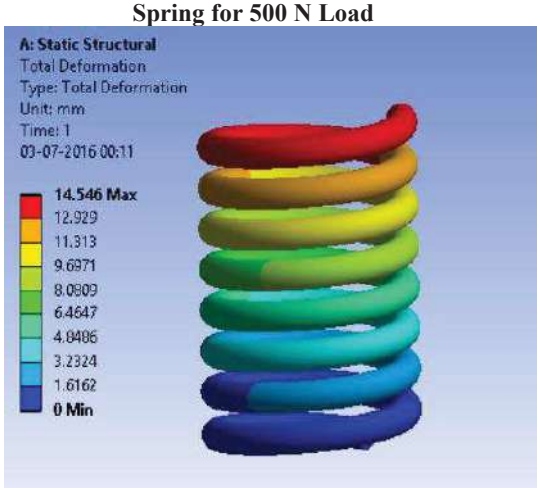

Figure 6. Total Deformation of New Compression Spring for 500 N Load

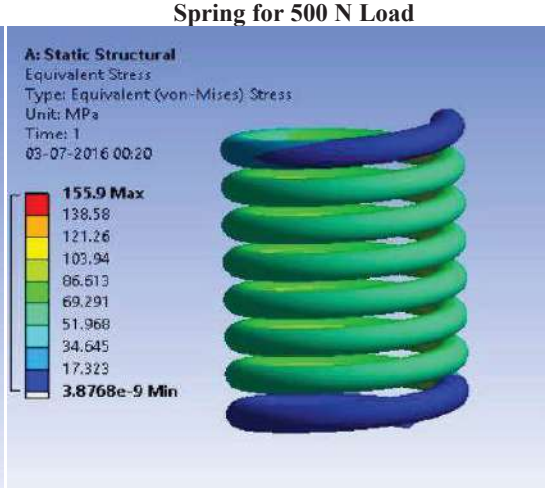

Figure 7. Von Mises Stress on New Compression Spring for 500 N Load

For analysis on existing and new spring boundary conditions are applied to check results for 1000, 900, 800, 700, 600 and 500 N respectively

EXPERIMENTAL VADILATION

The experimental procedure for the testing of the manufactured spring according to our requirement. This includes actual manufacturing and testing of the spring using load testing machine.

RESULTS AND DISCUSSION

Following table shows the comparative result of deflection and stress for existing and new spring for different load condition using ANSYS.

Table 1 Comparison of Existing and New Spring on the basis of ANSYS and Experimental result

Sr. No.	*Load(N)*	*ANSYS result*				*Experimental result*
		Existing Spring		*New Spring*		
		Deflection (mm)	*Stress (N/mm2)*	*Deflection (mm)*	*Stress (N/mm2)*	*Deflection (mm)*
1	500	23.86	324.49	14.56	155.9	10.31
2	600	26.51	386.3	16.62	183.42	11.69
3	700	31.81	463.56	18.70	220.1	13.8
4	800	42.42	525.37	20.78	265.95	15.89

5	900	38.46	579.45	27.01	288.88	19.56
6	1000	39.77	648.96	23.65	366.83	21.89

From table 1 it can be observed that as the load increases the deflection and stress also increases for both the springs which are quite obvious phenomenon. Therefore we know that form table 1 deflection and stresses are directly proportional to each other. The deflection from experiment is also less for new spring.

CONCLUSION

The deflection in the spring decreases with reduction in the stresses when change in certain parameters. The number of turns affects the deflection and stress adversely. As the number of turns increases the deflection decreases and stresses also decreases. This effect is impossible without change in wire diameter as wire diameter has the influence on the deflection and the stresses. Therefore as the wire diameter increases the deflection and stresses also decreases. This happens due to the better spring index achievement.

REFERENCES

1. Kaiser B., Pyttel B. and Berger, C., "VHCF-behavior of helical compression springs made of different materials", International Journal of Fatigue, vol. 33, 2011, pp. 23-32.
2. Pollanen I. and Martikka H., "Optimal re-design of helical springs using fuzzy design and FEM", Advances in Engineering Software, vol.41 (3), 2010, 410-414.
3. Prawoto Y., Ikeda, M., Manville S.K. and Nishikawa, A., "Design and failure modes of automotive suspension springs", Engineering Failure Analysis, vol. 15(8), 2008, pp. 1155-1174.
4. Berger C. and Kaiser B., "Results of very high cycle fatigue tests on helical compression springs", International Journal of Fatigue, vol. 28 (5), 2005,pp.1658-1663.
5. Ronald E. Giachetti, " A decision support system for material and manufacturing process selection", Journal of Intelligent Manufacturing, Vol. 9, 1998, pp. 265-276.
6. Krishna S., Vignesh S., " Hybrid Springs for Power Generation", journal of Mechanical and Civil Engineering, Volume 12, Issue 3 Ver. III,2015,pp. 1-6.
7. W.K. Chan, Thomas K. L., " Multi-criteria material selections and end-of-life product strategy: Grey relational analysis approach", Materials and Design, Vol. 28, 2007, pp. 1539-1546.
8. Prasenjit Chatterjee, Chakraborty Shankar, " Material selection using preferential ranking methods", Materials and Design, Vol. 35, 2012, pp. 384-393.
9. K.L. Edwards, " Selecting materials for optimum use in engineering components", Materials and Design, Vol. 26, 2005, pp. 469-473.
10. Sharma Avinash, Bergaley Ajeet, "Design and Analysis of Composite Leaf Spring – A Review", International Journal of Engineering Trends and Technology,Vol.9, No. 3,2014, pp. 124-128.
11. Yong-Huang Lin, Lee Pinch Chan, "Dynamic multi-attribute decision making model with grey number evaluations", Expert Systems with Applications, Vol. 35,2008, pp. 1638-1644.
12. GadakhV.S.,"Application of MOORA method for parametric optimization of milling process ",International Journal Of Applied Engineering Research, Dindigul, Vol.1,No. 4, 2011, pp. 743-758.
13. Prasad Karande, Shankar Chakraborty "Application of multi-objective optimization on the basis of ratio analysis (MOORA) method for materials selection", Elesvier, Material and Design 37, 2012, pp. 317-324

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Mechanical Behavior & Analysis of Composites of Aluminium LM-30 Reinforced with TiB2 for Piston at High Temperature

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Abstract*:* The growing steel prices have significantly affected the manufacturing expenditure in automobile and household industries, thus making a strong case for substituting steels with materials having lightweight and high-strength to weight ratio. The aluminum and its alloys have outstanding properties such as lightweight, wear, and corrosion resistance that make them suitable in numerous industrial applications. In today's scenario, customer perceived Quality is very important in view of increasing competition in global market. The engine sector is one of the example in which customer expectations in terms of Quality & Cost are boosted across world.

Aluminium metal matrix composites with reinforcing particles shows great results at elevated temperature. In present work, base aluminium metal matrix LM-30 reinforced with 5, 10, 15 and 20% of TiB2 were made using stir casting process. The new metal matrix composite (MMC) formed was tested for different elevated temperatures. This paper mainly focused on the results of stress- strain, hardness-reinforcement and microstructure analysis of AMMC.

Keywords: Aluminium metal matrix composite, LM-30, TiB2, stir casting, high temperature, hot tensile test.

I INTRODUCTION

Among commercial aluminium casting alloys, aluminium TiB2 alloy are the most important ones. Mainly due to their excellent combination of properties such as good castability, good surface finish, light weight, fewer tendencies to oxidation, low coefficient of thermal expansion, high strength-to-weight ratio and strength to cost ratio, good corrosion resistance. These properties led to their excessive use in many automobile and engineering sectors where wear, tear and seizure are the major problems in addition to the weight saving. Some of these components are cylinder heads, pistons, connecting rods and drive shafts for automobile industries and impellers, agitators, turbine blade, valves, pump inlet, in many marine and mining sectors.

Generally the prediction of behavior of material at high temperature is very difficult and therefore hot tensile test is used to test the material subjected at high temperature. In this research work aluminium piston is taken as reference and by adding the composite material aluminium strength is increased at high temperature.

II LITERATURE REVIEW

Jonathan A. Lee [2003] developed the new material for piston. NASA **398** is an aluminum-silicon alloy that may be used in a bulk alloy form with silicon content ranging from **6%** to **18%.** At high silicon levels the alloy exhibits excellent dimensional stability, low thermal expansion, high surface hardness and wear resistant properties. new material in hyper eutectoid aluminium piston & studied the cast aluminium alloy for tensile strength of many other applications (pistons, cylinder heads, cylinder liners, connecting rods, turbo chargers, impellers, actuators, brake calipers and rotors) at elevated temperatures from **232°C to about 400°C**. Automotive legislation requiring low exhaust emission, the novel NASA alloys also offer dramatic increase in strength, enabling components to utilize less material, which can lead to reducing part weight and cost as well as improving gas mileage and performance for automobile engines.[1]

Ronald G. Munro [2000] in his study, the physical, mechanical, and thermal properties of polycrystalline TiB2 are examined with an emphasis on the significant dependence of the properties on the density and grain size of the material specimens. Using trend analysis, property relations, and interpolation methods, a coherent set of trend values for the properties of polycrystalline TiB2 is

determined for a mass fraction of TiB2 _ 98 %, a density of (4.5_0.1) g/cm3, and a mean grain size of (9_1) _m.[2]

III PROBLEM DEFINICATION

Past research and experiences had indicated that during the operation of the IC engine, Pistons are subjected to combination of thermal stresses & high fatigue cycle, tensile stresses, compressive stresses responsible of fatigue cracking in weakest zone, which is commonly the hottest part i.e. area facing the combustion chamber.

Due to high temperature area, a conventional piston looses their property to withstand for cyclic load and thermal stresses. Wear occurs due to continuous friction between piston and cylinder liners. The reduction in mechanical properties of piston which affects the reliability and efficiency of piston. So, it is necessary to focus on mechanical properties of pistons at high temperature and improve its efficiency.

Hence problem statement is "To find out suitable material for piston, which operates at high temperature & to suggest alternative piston material to overcome existing problem".

IV MATERIAL PREPARATION

Aluminium LM-30 cast al alloy which is hypereutectic Al-si alloy mixed with (reinforced) particles of titanium diboride (TiB2) in proportion of 0%, 5%, 10%, 15% and 20% to form metal matrix composite. For preparing the composite aluminium stir casting is used. [3]

Firstly aluminium was melted in electrical furnance at 760 °C and hold for 5 minutes for homogenization of the temperature while being stirred at 600 rpm using a zirconium coated ms stirrer. Reinforcement was preheated at a specified 800 °C temperature 30 min in order to remove moisture or any other gases present within reinforcement. The preheating was done in muffle furnace. The preheating promotes the bonding between reinforcement and matrix.

To create vortex the molten slurry of LM-30 alloy is stirred by stirrer for 5 minutes at 600 rpm in clockwise & anticlockwise direction. By using nitrogen gas so as to avoid the formation of blow holes or inclusions in casting the molten slurry is degassed. During stirring of molten metal the preheated TiB2 particles are added at same stirring rate. Due to vortex formation, negative pressure is created at center and TiB2 particles get well disperse in Al matrix. The stirring is carried about 25 minutes holding time and casting is prepared in form of round bar after the molten melt is poured into sand mould. Round bar of dimensions Ø16x200 are prepared by sand mould which are then prepared according to standard ASTM E21:2009 as gauge diameter 10 by gauge length 50 (Ø10x50). The five sets containing 4 bars of PureLM-30 and 5 to 20% of reinforcements.

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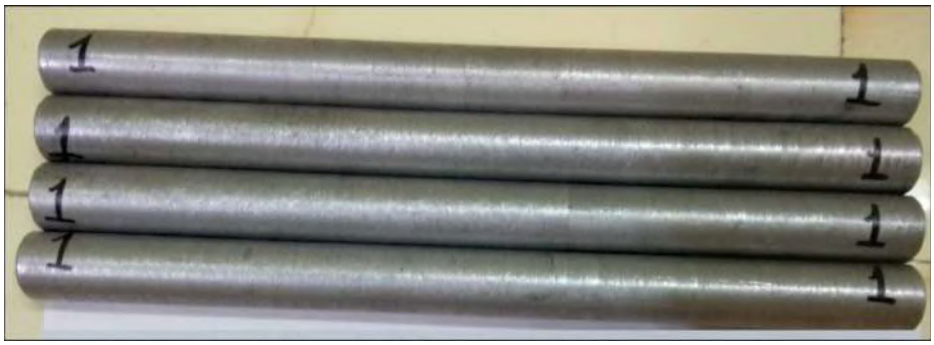

Figure 1. Cast Samples Ø20 x 100mm

D. CHEMICAL ANALYSIS

Chemical analysis is done by Spectrometer in which samples are neat polished on polish papers of different grades and then finally polished on velvet polish paper upto its mirror finish.

Then samples are placed on flat of spectro surfaced and needle is put on polished face. Electric arc is generated by means of argon substance and the different element readings are generated. The

chemical **analyser** is of SPECTROMAXX Company Germen made. In which pure argon (99.99% purity) gas used at 7 bar pressure .

Table 1. Chemical Analysis of TiB2

Ti	**B**	**C**	**Fe**	**Si**
67.95	30.89	0.06	0.04	0.132

Table 2. Chemical Analysis of LM-30

Silicon	Iron	**Copper**	**Magnesium**	**Manganese**	Nickel	**Zinc**	Tin	**Titanium**	**Aluminium**
Si	Fe	**Cu**	**Mn**	**Mg**	**Ni**	Zn	Sn	**Ti**	**Al**
17.940	**0.853**	**4.811**	**0.512**	**0.150**	**0.030**	**0.060**	**0.1**	**0.099**	**Balance**

V EXPERIMENTAL SET-UP [5]

Hot tensile test set-up Fig. 2 shows that the hot tensile set-up made by SHIMADZU AUTOGRAPH, showing the furnace consists of aluminium specimen. This machine consists of temperature control knob on panel to set the temperature between (0-900^{0}C). Temperature inside the furnace is continuously monitored by thermo-couple placed inside the furnace. According to the dimension mentioned above, the tensile force in specimen is twice the applied load through the hydraulic jack. All tests were conducted under steady state condition. After the specimen was fixed as shown in fig.2, the kiln temperature was raised to the required temperature and then held constant for half an hour to allow the test specimen to reach the same temperature. During the load test, there was no temperature measurement of specimen to minimize the damages to the test specimen. However, temperatures inside the kiln and on specimen surface were continuously measured by thermo-couples. In addition, a temperature monitoring study was conducted before the strength tests. During the strength test, the target temperature was maintained and the test sample was loaded to failure.

The furnace or closed chamber is used in order to ensure temperature setting consistency and to avoid temperature or thermal gradient along the test bar.

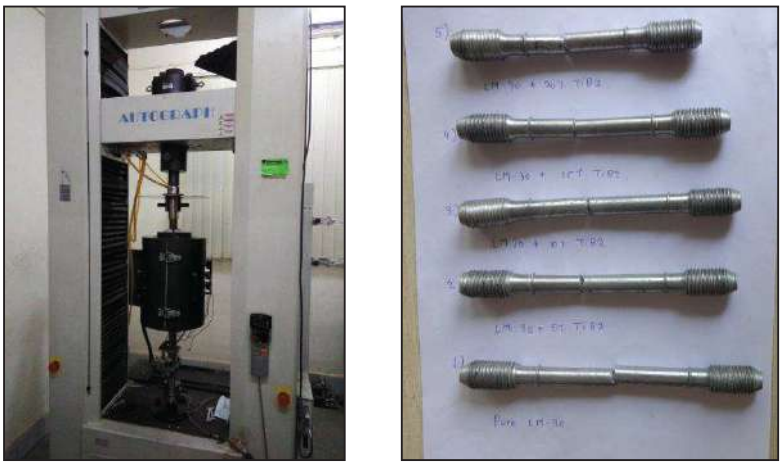

Figure 2. Shimadzu Autograph Machine and tested samples

VI EXPERIMENTAL result and analysis [4]

a) Combine Stress-Strain graph at Room Temp., 100°C, 150°C and 200°C

The above stress-strain graph we clearly observed that, At the plastic deformation stage, the dislocation accumulates dramatically with the further straining, which results in the obvious work hardening. Meanwhile, with the increase of strain, the gradually-accumulated energy can provide the sufficient driving force for dislocation movement under a certain deformation degree. As a consequence, the dynamic softening mechanisms, such as dynamic recovery (DRV) and dynamic recrystallization (DRX), initiates and decreases the increasing rate of flow stress in the uniform

deformation stage. With the further straining, strain concentration or necking occurs because some mesoscopic defects such as microvoids and microcracks initiate and grow inside the material. However, because the flow stress is sensitive to strain rate, the deformation resistance in the necking region increases and the local deformation slows down. Then, the necking transfers to the sections with weak deformation resistance. Therefore, the necking sites transfer and diffuse continuously, making the flow stress decreases slowly in the diffusion necking stage. With the increase of deformation degree, the damage inside specimen becomes more and more serious, and the diffusion of necking cannot continue anymore. Finally, the localized necking occurs and the stress drops rapidly in the localized necking stage. Consequently, the hot tensile deformation is a competitive process of work hardening, dynamic softening and the development of voids or cracks.

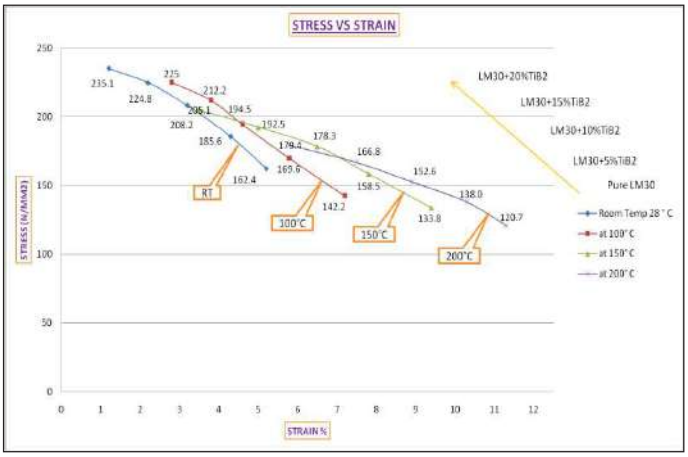

Figure 3. Stress VS % Strain

Table 3. Test Results

	Room Temp			100 °C			150 °C			200 °C		
	UTS in MPa	YTS in MPa	Elongation (%)	UTS in MPa	YTS in MPa	Elongation (%)	UTS in MPa	YTS in MPa	Elongation (%)	UTS in MPa	YTS in MPa	Elongation (%)
LM 30 Pure	162.4	108.8	5.2	142.2	95.27	7.2	133.8	89.64	9.4	120.7	80.86	11.3
LM 30 + 5% TiB2	185.6	126.13	4.3	169.6	116.17	5.8	158.5	108.57	7.8	138.0	94.53	10.3
LM 30 + 10% TiB2	208.2	145.75	3.2	194.5	136.15	4.6	178.3	124.81	6.5	152.6	106.82	8.9
LM 30 + 15% TiB2	224.8	161.85	2.2	212.2	152.78	3.8	192.5	138.6	5	166.8	120.09	7.5
LM 30 + 20% TiB2	235.1	176.32	1.2	225	168.75	2.8	205.1	153.82	3.5	179.4	134.55	5.8

OBSERVATIONS:

1. At room temperature, alloy composition having 20% of reinforcement of TiB2 has high stress value while it has at the most less elongation 1.2%.
2. As the temperature increases, we can see the difference in stress values of alloys. Room temperature having highest strength carrying capacity while, the elongation is maximum for 200 °C for pure aluminium alloy.
3. The trends of graph for room temperature and for 100°C are likely to be same but as the temperature increases further the trend is changing.
4. For each graph of different temperatures, the UTS values became smaller as compared to room temperature.
5. For each graph of different temperatures, % elongation values become increasing compared to room temperature graph.
6. As the temperature increases, even though increasing the reinforcement percentage, uts decrease. But elongation decreases with increases in temperature.

7. Though the trends of graphs are different, but for each individual trend, the graph shows linearity.
8. So we can conclude that, the designing of any components for a particular temperature can be predicted easily as it will depend upon the linearity of aluminium.

b) Hardness VS Reinforcement

The Brinell test consists of measuring the indent depth to which a carbide ball or diamond ball is forced by a heavy load beyond the depth of a previously applied light load i.e. the reading is taken after releasing the load. The diameter of the hybrid compositeLM-30 TiB2 is 10mm. applied load = 100kgf = 980.6N. At different areas in hybrid composite TiB2 we applied a load for 15 seconds by using load lever. The indentation mark was seen under scale microscope.

While the piston A4658 observed hardness is 78 BHN.

Table 4. Hardness values

Composite	Load(Kgf)	Hardness
LM-30	100	94
LM30+5% TiB2	100	106
LM30+10%	100	118
LM30+15%	100	128
LM30+20%	100	137

ON

From the above analysis following conclusions are drawn:

a) LM30 TiB2 metal matrix composites were synthesized successfully.TiB2 reinforcement phase was made to be distributed uniformly in the LM-30 matrix phase by the in-situ method.A uniform distribution of reinforcement particles has been obtained in the matrix phase.

b) Mechanical properties gets improved by using reinforcing material in LM-30

c) The ultimate tensile strength of material, stress values, hardness are increased by addition of reinforcing material TiB2.

d) The in-situ preparation of TiB2 in LM-30 refines its grain structure and ensures equal-axial matrix grains.The matrix becomes finer by addition of TiB2 Particulates.

e) The increased volume fraction of the TiB2 particles contributed to increase the strength of composites.

f) Due to increase in temperature, uts decreases and elongation increases but Titanium holds the strength of material at elevated temperature as compared to pure aluminium alloy.

REFERENCES

[9] Jonathan A. Lee, Cast Aluminum Alloy For High Temperature Applications, The 132nd TMS Annual Meeting & Exhibition San Diego Convention Center, San Diego, CA March 2-6,2003.

[10] Ronald G. Munro, Material Properties of Titanium Diborid, Journal of Research of the National Institute of Standards and Technology, Volume 105, Number 5, September–October 2000.

[11] Aluminium and aluminium alloy ingots and castings for general engineering purposes **BS 1490 Standard.**

[12] Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials **ASTM E21:2009**

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Evaluation And Investigation Of The Tribological Properties Of Sae40 Oil By Using Four Ball Extreme Pressure Oil Testing Machine

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Abstract: Extreme Pressure (EP) additives are used when components are operated under extreme pressure. This work studies the effect of base oils on the tribological performance of EP additives. The difference between the absorbability of the EP additives and that of base oils dominates the mutual compatibility and performance of the EP additive. When used, the EP additive forms a saturation layer on the rubbing surfaces. The concentration of EP additive in the saturation layer exceeds the additive concentration in the lubricants. Therefore, during operation, the protecting layer can reduce the contacting stress of rubbing surfaces by chemical and physical methods to prevent local plastic deformation from inducing serious wear. Under the harshest conditions, the immediate formation of films in a chemical reaction is important when plastic deformation of the contact region cannot be avoided. The high rate of formation of chemical films can prevent direct metal-to-metal contacts to reduce wear.

A comparative account of performance of the tested compounds is presented on the basis of various tribological parameters such as initial seizure load, 2.5 s seizure delay load, weld load, mean Hertz load, flash temperature parameter, pressure wear index, friction coefficient (m) and wear scar diameter (*d*), etc. All the tested complexes have been found to possess significant Extreme Pressure (EP) efficiency under the experimental conditions of four ball test.

In this paper, evaluated and investigated of tribological properties of SAE 40 lubricating oils without using extreme pressure additives.

Keywords*:* Lubrication Oil SAE 40, Load, Pressure, Temperature, Speed, Alloy Steel Balls, F.B.E.P.O.T.M. (Four Ball Extreme Pressure Oil Testing Machine).

I. INTRODUCTION

Lubrication is the process, or technique employed to reduce wear of one or both surfaces in close proximity, and moving relative to each another, by interposing a substance called lubricant between the surfaces to carry or to help carry the load (pressure generated) between the opposing surfaces. The interposed lubricant film can be a solid (e.g. graphite, MoS_2) a solid/liquid dispersion, a liquid, a liquid-liquid dispersion (a grease) or, exceptionally a gas. Functions of lubricants are as follow.

1. It reduces wear and tear of the surfaces by avoiding direct metal to metal contact between the rubbing surfaces, i.e. by introducing lubricants between the two surfaces.
2. It reduces expansion of metal due to frictional heat and destruction of material.
3. It acts as coolant of metal due to heat transfer media.
4. It avoids unsmooth relative motion.
5. It also reduces power loss in internal combustion engines.

A) Types of Lubrication

a)Fluid–film lubrication

b)Boundary lubrication

a)Fluid–film lubrication:

This type of lubrication is used when two surfaces of the materials rotate against each other while being completely separated. The liquid lubricants form a very thin film between the moving surfaces and thus avoid the direct metal to metal contact and reduce friction. This condition is known as fluid film lubrication. The resistance to movement of sliding moving parts is only due to the internal resistance between the particles of the lubricants moving over each other. Therefore lubricant chosen should have the minimum viscosity under working conditions and at the same time, it should remain in place and separate the surfaces.

Delicate machines and light instruments like watches, clocks, guns, sewing machines, scientific instruments etc. are provided with thick fluid film lubrication.

b)Boundary lubrication:

Boundary lubrication may happen slide or rotate against one another under heavy load, and such conditions there may be contact between the moving surfaces and film breaks down under these conditions, an oil is used which interact with the solid surface of the metal that will between the two sliding surfaces. This can be possible by adsorption of lubricant molecules on the surfaces or by chemical reaction of the lubrication substances with metal surfaces.

B) Classification of Lubricant

A. Solid lubricants

Solid lubricants are used for railway tract joints, chains, air compressors, open gears, heavy machines etc. the examples of solid lubricants are wax, talc, mica, molybdenum disulphide graphite etc.

B. Semi solid lubricants

It is used where the machine parts are subjected to slow speed, heavy load & sudden jerks. The examples of semi solid lubricants are grease & Vaseline.

C. Liquid lubricants

Liquid lubricants are used in delicate and light machines which work at high speed but under low pressure. Mineral oils, vegetable oils & animal oils are the various types of liquid lubricants.

D. Synthetic lubricants

It can be used, where extreme temperature, chemical reactive atmosphere or some very particular operating conditions are involved & where all other lubricants fail to work effectively. e.g. polyglycols, silicones, organic amines, imines & amides.

E. Additives in Lubricating Oils

Lubricants operate in the boundary between moving metal parts to prevent the contact that could lead to an increase in friction, increase in wear and eventually welding. The classic type of component used to prevent these phenomena is a boundary lubricity additive. The boundary lubricity additive typically functions by adsorbing on the metal surface to form a film that will reduce metal-to-metal contact. This function is achieved because the boundary lubricity additive has a polar head group that can interact with the metal surface and a tail group that is compatible with the lubricant carrier (mineral oil, synthetic base stock or water). A classic example of a boundary lubricity additive is an ester which could be available as a natural product (canola oil, lard oil, tall oil fatty acid, etc.) or as a functionalized molecule (monobasic ester, diester, polyol ester, complex ester).

The lubricating oils are selected considering the various operations condition like temperature rise, working load, normal working temperature; Pressure, Extreme conditions etc.

The four ball extreme pressure tester is utilized for finding out the load carrying capacity and weld point of SAE 30 of lubricating oils without E.P. Additives;

The parameters were determined as Wear-Scar Diameter (WSD), Initial Seizure Load (ISL), Just Before Weld Load (JBWL) And Weld Load (WL) etc.

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The Four Ball Tester is widely accepted as the industry standard for conducting WP, EP, Frictional and Fatigue Property tests on lubricants. The Ducom Four Ball Tester has the unique capability of evaluating lubricants for their Wear Preventive, Extreme Pressure, Frictional Properties and Fatigue Properties, all in one machine. The test system is capable of carrying out a number of standards applicable to lubricant characterization and its capabilities extend beyond the scope of these standards, allowing users to perform a variety of customized tests.

This instrument uses four balls, three at the bottom and one on top. The bottom three balls are held firmly in a ball pot containing the lubricant under test and pressed against the top ball. The top ball is made to rotate at the desired speed while the bottom three balls are pressed against it. The lubricant under test is characterized by the evaluating the wear scar formed on the balls after the test and evaluating the load at which the lubricant fails and the four balls weld together. Frictions levels of the lubricant under test can also be evaluated using the TR 30 L test system.

A Vertical spindle rotates a chuck between speeds of 1200 rpm to 1800 rpm, in which metal ball of 12.7mm diameter. Were used test specimen is fitted below it three identical balls are clamped together tightly in a cup filled with lubricating oil to be tested. The cup is mounted on a thrust bearing which automatically centers the top ball held in the chuck. Thus, the load is evenly distributed over three points of contact between the top rotating ball and the underlying three stationery balls.

(See following figure 1.)

III. EXPERIMENTAL PROCEDURE

First place the three test balls in the test-lubricant cup. Place the lock ring over the test balls and screw down the nut securely. Pour the lubricating fluid to be tested over the three test balls until they are covered. Bring the lubricant and cup to 18 to 35°C. Press one ball into the ball chuck and mount the chuck into the chuck-holder. Install the test-lubricant cup assembly on the test apparatus in contact with the fourth ball. Place the spacer between cup and thrust bearing.

Placing the weight tray and sufficient weights on the horizontal arm in the correct notch for a base test load of 70 kg then release the lever arm and gently apply Start the motor and run for 10 sec. Remove the test-lubricant cup assembly remove the chuck and discard the ball finally measure the scar diameter of test balls.

Figure 1. The Four Ball Extreme Pressure Oil Testing Machine.

Removing the test balls then cleaning the balls with cleaning solvent and then rinse solvent .Wipe dry with a soft cloth. Place the individual balls on a suitable holder and by means of a microscope, measure to the nearest 0.01 mm the scar diameters both parallel (horizontal) and normal (vertical) to the striations in the scar surface of one of the three test balls.

Leaving the balls clamped in the cup. Pour out the lubricating fluid. Wash the ball surfaces with cleaning solvent and then the rinse solvent. Finally using a microscope, measure the scar diameters both parallel (horizontal) and normal (vertical) to the striations in the scar surface of one of the three test balls. Measurements by microscope of the scar diameters on all three balls, then wear scar measurements on all three test balls must be made.

Unless and until welding does not occur on the check run, repeat the test at the next higher load until welding is verified. Continue this procedure until the last non seizure load is determined. Procedure until a total of ten runs below the weld point is recorded The various Advantages of this machine are

a) a)The construction is quite easy to understand.
b) b)The balls used in this testing machine are easily available and of low cost.
c) c)The range of temperature for testing Oil is quite large 18^0C to 35^0C.
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The measurements are taken horizontally and vertically. These measurements are recorded in observation table. Measurements of the wear spots on each of the three lower balls taken. The mean value of these six measurements is obtained (3 vertical and 3 horizontal). The average scar diameter readings are plotted against Load, Corrected load can be calculated

$$\text{Corrected Load} = \frac{\text{Load x Hertz Diameter}}{\text{Average Scar Diameter}}$$

(Where, Load in kg, Hertz Diameter in mm, Average Scar Diameter in mm.)

V. RESULTS

1. Testing lubricating oil SAE 30 without using Extreme Pressure Additives to find out their load carrying capacity & weld loads. Under various loads & their various parameters for time duration 10Seconds.The above Graph Graph1 and Graph 2 Shows, Minimum Scared Diameter plotted against Applied Load (Load in kg) is shown between for various regions up to weld point.

2. After conducting the test for SAE 30 lubricating oil, it is found that the following results for various parameters.

(i) Last Non Seizure Region.
(ii) Initial Seizure Region.
(iii) Immediate Seizure Region.
(iv) Just Before Weld Region.
(v) Weld Region.

Measurement of minimum scar diameter

$$\text{Minimum scar diameter} = \frac{\text{Average Reading}}{2} \text{ in mm.}$$

Table 1. Observation Table of Oil-SAE40

SR. NO.	PRESSURE (P) KG/CM^2	APPLIED LOAD (W) KG	TEMPERATURE (T) ^{0}C	TIME (T) SEC.	MINIMUM SCAR DIAMETER (D) MM	REMARKS REGIONS / LOADS
1	15	75	31	10	0.8570	LNSR/L
2	20	100	33	10	0.8970	ISR/L
3	25	125	35	10	1.0395	ISR/L
4	30	150	37	10	1.0850	ISR/L
5	35	175	39	10	1.0865	ISR/L
6	40	200	41	10	1.2280	IMSR/L
7	45	225	43	10	1.3195	IMSR/L
8	50	250	45	10	1.3775	IMSR/L
9	55	275	47	10	1.5475	IMSR/L
10	60	300	50	10	1.5675	IMSR/L
11	65	325	52	10	1.5745	IMSR/L
12	70	350	55	10	*1.8070*	IMSR/L
13	75	375	59	10	2.1320	IMSR/L
14	80	400	63	10	2.2400	JBWR/L
15	82	410	65	10	2.2915	WR/L

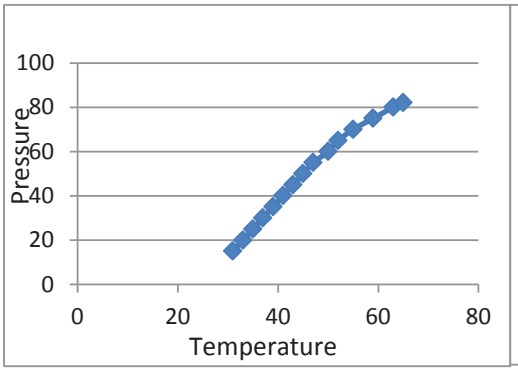

Figure 2. Pressure Vs Temperature (For Oil SAE40)

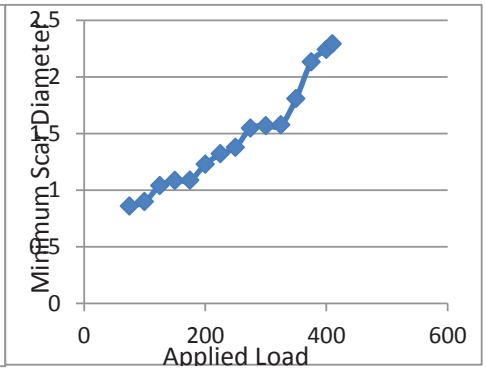

Figure 3. Minimum Scar Diameter (d) mm Vs Applied Load (W) Kg

(For Oil SAE40)

CONCLUSION

Experimentation on four ball extreme pressure tester shows that in case of SAE 30 lubricating oil if Applied Load increases the Minimum Scar Diameter, Weld Load and Temperature also increases.

The measurement of mean scar diameter shows that the wear of test balls in experiment; from experiment it is also observed that there is proportionality between volumes of material from the fixed balls and the wear scar diameter.

REFERENCES

[1] A.D.Dongare.Dr. G.J.Vikhe (October 2012) "The Standard test methods for measurement of extreme pressure properties of various lubricating oil by using four ball extreme oil testing machine " International Journal of Engineering Research And Development E-ISSN 2278-067x,P-Issn:2278-800x, Www.Ijerd.Com Volume 4, Issue 6, PP. 06-11

[2] Yuan-Ching Lin, Yu-Hsien Cho, And Chin-Te Chiu, (2011), Tribological Performance of Ep Additives In Different Base Oils, Department of Mechanical Engineering National Taiwan University of Science and Technology 43, Keelung Road, Section 4,Taipei 106, Taiwan, ROC.

[3] Girma Biresaw, Svajus J. Asadauskas, and Ted G.McClure, (2009) ,Polysulfide and Biobased

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[4] R.B. Rastogi,M.Yadav, A. Bhattacharya,(2001),Application of molybdenum complexes of 1-aryl-2,5 dithiohydrazodicarbonamides as extreme pressure lubricant additives, Department of Applied Chemistry, Institute of Technology, Banaras Hindu University, Varanasi 221005, India. Wear 252(2002)686-692.

[5] W. Piekoszewski, M. Szczerek, W. Tuszynski,(2001),The action of lubricants under extreme pressure conditions in a modified four-ball tester,Tribology Department, Institute for Terotechnology (ITeE), ul. Pulaskiego 6/10, 26-600 Radom, Poland.Wear 249(2001)188-193.

[6] R.B. Rastogi,M. Yadav,(2003),Suspension of molybdenum–sulphur complexes in paraffin oil as extreme pressure lubricants, Department of Applied Chemistry, Institute of Technology, Banaras Hindu University, Varanasi 221 005, Tribology International 36 (2003)511-506.

[7] Editor by Sudhir Singhal "Recent Advance in Tribology" papers presented at the Xth National conference on " Industrial Tribology" Indian Institute of Petroleum, Dehradun, India. March 24-26, 1993; Tata MC Graw Hill Publishing Company Ltd. New Delhi.

[8] Lubrication Engineering (Section–I, Fundamental, Concepts and Practices), Lubrications Foundations association of Iron and steel engineers (AISE). Volume 53, No.9 (Sept.1997)32.

[9] S.P. Jones & Ralph Jansen (Member, STLE) (Ohio Are space Institute Cleveland, Ohio- 44135) and Robert L. Fusaro (Fellow, STLE) (National Aeronautics and Space Administration - NASA, Lewis research Center, Cleveland Ohio-44135),"Preliminary Investigation of Neural Network Techniques Predict Tribological Properties' Tribology transactions Volume-40, No.2. (April 1997) 314-316, 319.

[10] Richard E. Rush (Member, STLE, the Uno-ven Company, Arlington Hights, Illinois),"A review of the more common standard grease tests in use today." Journal of the Society of Tribologists & Lubrication Engineers (JSTLE – Lubrication Engineering) Volume 54, No.3 (March 1997) 22, 24 to 25.

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Evaluation And Investigation Of The Tribological Properties Of Sae40 Oil By Using Four Ball Extreme Pressure Oil Testing Machine

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Abstract: Extreme Pressure (EP) additives are used when components are operated under extreme pressure. This work studies the effect of base oils on the tribological performance of EP additives. The difference between the absorbability of the EP additives and that of base oils dominates the mutual compatibility and performance of the EP additive. When used, the EP additive forms a saturation layer on the rubbing surfaces. The concentration of EP additive in the saturation layer exceeds the additive concentration in the lubricants. Therefore, during operation, the protecting layer can reduce the contacting stress of rubbing surfaces by chemical and physical methods to prevent local plastic deformation from inducing serious wear. Under the harshest conditions, the immediate formation of films in a chemical reaction is important when plastic deformation of the contact region cannot be avoided. The high rate of formation of chemical films can prevent direct metal-to-metal contacts to reduce wear.

A comparative account of performance of the tested compounds is presented on the basis of various tribological parameters such as initial seizure load, 2.5 s seizure delay load, weld load, mean Hertz load, flash temperature parameter, pressure wear index, friction coefficient (m) and wear scar diameter (*d*), etc. All the tested complexes have been found to possess significant Extreme Pressure (EP) efficiency under the experimental conditions of four ball test.

In this paper, evaluated and investigated of tribological properties of SAE 40 lubricating oils without using extreme pressure additives.

Keywords*:* Lubrication Oil SAE 40, Load, Pressure, Temperature, Speed, Alloy Steel Balls, F.B.E.P.O.T.M. (Four Ball Extreme Pressure Oil Testing Machine).

I. INTRODUCTION

Lubrication is the process, or technique employed to reduce wear of one or both surfaces in close proximity, and moving relative to each another, by interposing a substance called lubricant between the surfaces to carry or to help carry the load (pressure generated) between the opposing surfaces. The interposed lubricant film can be a solid (e.g. graphite, MoS_2) a solid/liquid dispersion, a liquid, a liquid-liquid dispersion (a grease) or, exceptionally a gas. Functions of lubricants are as follow.

1. It reduces wear and tear of the surfaces by avoiding direct metal to metal contact between the rubbing surfaces, i.e. by introducing lubricants between the two surfaces.
2. It reduces expansion of metal due to frictional heat and destruction of material.
3. It acts as coolant of metal due to heat transfer media.
4. It avoids unsmooth relative motion.
5. It also reduces power loss in internal combustion engines.

A) Types of Lubrication

a)Fluid–film lubrication

b)Boundary lubrication

a)Fluid–film lubrication:

This type of lubrication is used when two surfaces of the materials rotate against each other while being completely separated. The liquid lubricants form a very thin film between the moving surfaces and thus avoid the direct metal to metal contact and reduce friction. This condition is known as fluid film lubrication. The resistance to movement of sliding moving parts is only due to the internal resistance between the particles of the lubricants moving over each other. Therefore lubricant chosen should have the minimum viscosity under working conditions and at the same time, it should remain in place and separate the surfaces.

Delicate machines and light instruments like watches, clocks, guns, sewing machines, scientific instruments etc. are provided with thick fluid film lubrication.

b)Boundary lubrication:

Boundary lubrication may happen slide or rotate against one another under heavy load, and such conditions there may be contact between the moving surfaces and film breaks down under these conditions, an oil is used which interact with the solid surface of the metal that will between the two sliding surfaces. This can be possible by adsorption of lubricant molecules on the surfaces or by chemical reaction of the lubrication substances with metal surfaces.

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Solid lubricants are used for railway tract joints, chains, air compressors, open gears, heavy machines etc. the examples of solid lubricants are wax, talc, mica, molybdenum disulphide graphite etc.

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It can be used, where extreme temperature, chemical reactive atmosphere or some very particular operating conditions are involved & where all other lubricants fail to work effectively. e.g. polyglycols, silicones, organic amines, imines & amides.

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The lubricating oils are selected considering the various operations condition like temperature rise, working load, normal working temperature; Pressure, Extreme conditions etc.

The four ball extreme pressure tester is utilized for finding out the load carrying capacity and weld point of SAE 30 of lubricating oils without E.P. Additives;

The parameters were determined as Wear-Scar Diameter (WSD), Initial Seizure Load (ISL), Just Before Weld Load (JBWL) And Weld Load (WL) etc.

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This instrument uses four balls, three at the bottom and one on top. The bottom three balls are held firmly in a ball pot containing the lubricant under test and pressed against the top ball. The top ball is made to rotate at the desired speed while the bottom three balls are pressed against it. The lubricant under test is characterized by the evaluating the wear scar formed on the balls after the test and evaluating the load at which the lubricant fails and the four balls weld together. Frictions levels of the lubricant under test can also be evaluated using the TR 30 L test system.

A Vertical spindle rotates a chuck between speeds of 1200 rpm to 1800 rpm, in which metal ball of 12.7mm diameter. Were used test specimen is fitted below it three identical balls are clamped together tightly in a cup filled with lubricating oil to be tested. The cup is mounted on a thrust bearing which automatically centers the top ball held in the chuck. Thus, the load is evenly distributed over three points of contact between the top rotating ball and the underlying three stationery balls.

(See following figure 1.)

III. EXPERIMENTAL PROCEDURE

First place the three test balls in the test-lubricant cup. Place the lock ring over the test balls and screw down the nut securely. Pour the lubricating fluid to be tested over the three test balls until they are covered. Bring the lubricant and cup to 18 to 35°C. Press one ball into the ball chuck and mount the chuck into the chuck-holder. Install the test-lubricant cup assembly on the test apparatus in contact with the fourth ball. Place the spacer between cup and thrust bearing.

Placing the weight tray and sufficient weights on the horizontal arm in the correct notch for a base test load of 70 kg then release the lever arm and gently apply Start the motor and run for 10 sec. Remove the test-lubricant cup assembly remove the chuck and discard the ball finally measure the scar diameter of test balls.

Figure 1. The Four Ball Extreme Pressure Oil Testing Machine.

Removing the test balls then cleaning the balls with cleaning solvent and then rinse solvent .Wipe dry with a soft cloth. Place the individual balls on a suitable holder and by means of a microscope, measure to the nearest 0.01 mm the scar diameters both parallel (horizontal) and normal (vertical) to the striations in the scar surface of one of the three test balls.

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Unless and until welding does not occur on the check run, repeat the test at the next higher load until welding is verified. Continue this procedure until the last non seizure load is determined. Procedure until a total of ten runs below the weld point is recorded The various Advantages of this machine are

a) a)The construction is quite easy to understand.
b) b)The balls used in this testing machine are easily available and of low cost.
c) c)The range of temperature for testing Oil is quite large 18^0C to 35^0C.
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The measurements are taken horizontally and vertically. These measurements are recorded in observation table. Measurements of the wear spots on each of the three lower balls taken. The mean value of these six measurements is obtained (3 vertical and 3 horizontal). The average scar diameter readings are plotted against Load, Corrected load can be calculated

$$\text{Corrected Load} = \frac{\text{Load x Hertz Diameter}}{\text{Average Scar Diameter}}$$

(Where, Load in kg, Hertz Diameter in mm, Average Scar Diameter in mm.)

V. RESULTS

1. Testing lubricating oil SAE 30 without using Extreme Pressure Additives to find out their load carrying capacity & weld loads. Under various loads & their various parameters for time duration 10Seconds.The above Graph Graph1 and Graph 2 Shows, Minimum Scared Diameter plotted against Applied Load (Load in kg) is shown between for various regions up to weld point.

2. After conducting the test for SAE 30 lubricating oil, it is found that the following results for various parameters.

(i) Last Non Seizure Region.
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(iii) Immediate Seizure Region.
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Table 1. Observation Table of Oil-SAE40

SR. NO.	PRESSURE (P) KG/CM^2	APPLIED LOAD (W) KG	TEMPERATURE (T) ^{0}C	TIME (T) SEC.	MINIMUM SCAR DIAMETER (D) MM	REMARKS REGIONS / LOADS
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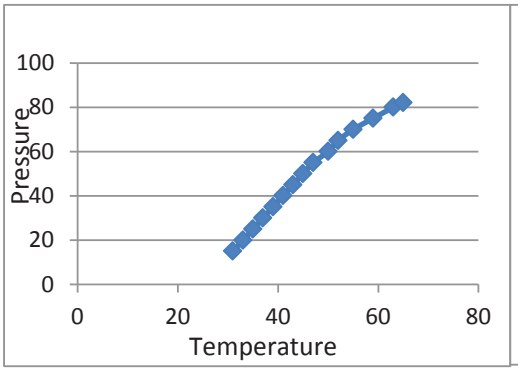

Figure 2. Pressure Vs Temperature (For Oil SAE40)

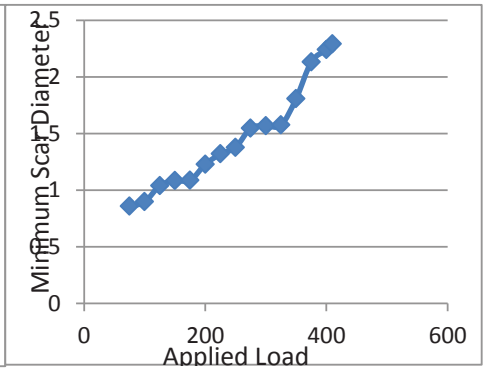

Figure 3. Minimum Scar Diameter (d) mm Vs Applied Load (W) Kg

(For Oil SAE40)

CONCLUSION

Experimentation on four ball extreme pressure tester shows that in case of SAE 30 lubricating oil if Applied Load increases the Minimum Scar Diameter, Weld Load and Temperature also increases.

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REFERENCES

[1] A.D.Dongare.Dr. G.J.Vikhe (October 2012) "The Standard test methods for measurement of extreme pressure properties of various lubricating oil by using four ball extreme oil testing machine " International Journal of Engineering Research And Development E-ISSN 2278-067x,P-Issn:2278-800x, Www.Ijerd.Com Volume 4, Issue 6, PP. 06-11

[2] Yuan-Ching Lin, Yu-Hsien Cho, And Chin-Te Chiu, (2011), Tribological Performance of Ep Additives In Different Base Oils, Department of Mechanical Engineering National Taiwan University of Science and Technology 43, Keelung Road, Section 4,Taipei 106, Taiwan, ROC.

[3] Girma Biresaw, Svajus J. Asadauskas, and Ted G.McClure, (2009) ,Polysulfide and Biobased

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[4] R.B. Rastogi,M.Yadav, A. Bhattacharya,(2001),Application of molybdenum complexes of 1-aryl-2,5 dithiohydrazodicarbonamides as extreme pressure lubricant additives, Department of Applied Chemistry, Institute of Technology, Banaras Hindu University, Varanasi 221005, India. Wear 252(2002)686-692.

[5] W. Piekoszewski, M. Szczerek, W. Tuszynski,(2001),The action of lubricants under extreme pressure conditions in a modified four-ball tester,Tribology Department, Institute for Terotechnology (ITeE), ul. Pulaskiego 6/10, 26-600 Radom, Poland.Wear 249(2001)188-193.

[6] R.B. Rastogi,M. Yadav,(2003),Suspension of molybdenum–sulphur complexes in paraffin oil as extreme pressure lubricants, Department of Applied Chemistry, Institute of Technology, Banaras Hindu University, Varanasi 221 005, Tribology International 36 (2003)511-506.

[7] Editor by Sudhir Singhal "Recent Advance in Tribology" papers presented at the Xth National conference on " Industrial Tribology" Indian Institute of Petroleum, Dehradun, India. March 24-26, 1993; Tata MC Graw Hill Publishing Company Ltd. New Delhi.

[8] Lubrication Engineering (Section–I, Fundamental, Concepts and Practices), Lubrications Foundations association of Iron and steel engineers (AISE). Volume 53, No.9 (Sept.1997)32.

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Review of Transfer Coal Conveyor Shaft Optimization Analysis and Modification in Sprocket Structure

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Abstract: Now day's major breakdown in continues running plant is too costly. In conveyor system the motor and gearbox was directly coupled through chain and sprocket to shaft of the roller conveyor. The overall subject of project is study the failure causes of shaft and optimization analysis of drive shaft used in transfer coal conveyor. 3D model of shaft prepared in CATIA and Ansys analysis is performed to quantify the stress distribution in the shaft. Based on results of FEA modification will be done in conveyor system component by reducing and changing different material for shaft. Testing the finalized shaft by UTM machine and validation of weight reduction results.
Keywords: Shaft, Sprocket, CATIA, FEA, UTM, Optimization.

INTRODUCTION

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Many kinds of conveying systems are available, and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys.

The shaft is important component of conveyor system which carries the total load of the transfer material. Conveyor system consist of motor, gear box, driving sprocket, driven sprocket, chain etc. The driving sprocket is mounted on gear box output shaft and driven sprocket is mounted on conveyor shaft. The power is transfer from motor to conveyor shaft with the help of chain. Since the shaft of conveyor system is design and optimization for weight reduction. Due to high power transfer, high speed of rotation, transfer material weight carrying the high stresses developed in shaft. Also high speed causes vibration.

Finite element method is a mathematical technique used to carry out the stress analysis. In this method the solid model of the component is subdivided into smaller elements. Constraints and loads are applied to the model at specified locations. Various properties are assigned to the model like material, thickness, etc. The model is then analyzed in FE solver. The results are plotted in the post processor. The scalar plot shows us the stresses and deformations over entire span.

PROBLEM STATEMENT

In many industries the old conveyor system is used. But the weight of these old conveyor system is too much. So optimization is done to reduce material and cost.

NEED FOR ANALYSIS

The geometry of the roller conveyor is amenable to the usage of 3D modeling. The design of the roller conveyor parts would necessitate knowledge of the fundamentals for Product Design coupled with intuition gained by experience of the Design Engineer. The information like `weight of the roller conveyor and `location of the Centre of Gravity can be readily offered by the three dimensional CAD interface. Although it is iterative process the physical design can of each iteration for testing is not possible for conformance to the conditions specified (test conditions) could be done through the utilization of a suitable tool – ANSYIS "Software for Analysis" Maintaining the Integrity of the Specifications

OBJECTIVE OF WORK

The following are the objectives of the study:

1. Study the failure cause of shaft.

2. Study existing roller conveyor system.
3. FEA is performed to find stress distribution on existing conveyor shaft.
4. Analysis of existing roller conveyor parameter.
5. Modification of conveyor system component for weight reduction.
6. Analysis and testing of Modified design for same loading condition.

LITRATURE REVIEW

Alspaugh M. A. [1] presents latest development in belt conveyor technology & the application of traditional components in non-traditional applications requiring horizontal curves and intermediate drives have changed and expanded belt conveyor possibilities. Examples of complex conveying applications along with the numerical tools required to insure reliability and availability will be reviewed. This paper referenced Henderson PC2 which is one of the longest single flight conventional conveyors in the world at 16.26 km. But a 19.1 km conveyor is under construction in the USA now, and a 23.5 km flight is being designed in Australia. Other conveyors 30-40 km long are being discussed in other parts of the world.

S.H. Masood et. al. [2] presents an application of concept of concurrent engineering and the principles of design for manufacturing and design for assembly, several critical conveyor parts were investigated for their functionality, material suitability, strength criterion, cost and ease of assembly in the overall conveyor system. The critical parts were modified and redesigned with new shape and geometry and some with new materials. The improved design methods and the functionality of new conveyor parts were verified and tested on a new test conveyor system designed, manufactured and assembled using the new improved parts.

The improved methodology for design and production of conveyor components is based on the minimization of materials, parts and costs, using the rules of design for manufacture and design for assembly. Results obtained on a test conveyor system verify the benefits of using the improved techniques. The overall material cost was reduced by 19% and the overall assembly cost was reduced by 20% compared to conventional methods.

A. Göksenli et. al. [3] in this study failure analysis of an elevator drive shaft is analyzed in detail. Failure occurred at the keyway of the shaft. Micro structural, mechanical and chemical properties of the shaft are determined. After visual investigation of the fracture surface it is concluded that fracture occurred due to tensional-bending fatigue. Fatigue crack has initiated at the keyway edge. Considering elevator and driving systems, forces and torques acting on the shaft are determined; stresses occurring at the failure surface are calculated. Stress analysis is also carried out by using finite element method (FEM) and the results are compared with the calculated values. Endurance limit and fatigue safety factor is calculated, fatigue cycle analysis of the shaft is estimated. Reason for failure is investigated and concluded that fracture occurred due to faulty design or manufacturing of the keyway (low radius of curvature at keyway corner, causing high notch effect). In conclusion effect of change in radius of curvature on stress distribution is explained by using FEM and precautions which have to be taken to prevent a similar failure is clarified.

Gys van Zyl et. al. [4] the shaft of a conveyor belt drive pulley failed in service. An investigation was performed in order to determine the failure root cause and contribution factors. Investigation methods included visual examination, optical and scanning electron microscope analysis, chemical analysis of the material and mechanical tests. A finite element analysis was also performed to quantify the stress distribution in the shaft. It was concluded that the shaft failed due to fatigue and that the failure was caused by improper reconditioning of the shaft during routine overhaul.

Dima Nazzal et. al. [5] discusses literature related to models of conveyor systems in semiconductor fabs. A comprehensive overview of simulation-based models is provided. We also identify and discuss specific research problems and needs in the design and control of closed-loop conveyors. It is concluded that new analytical and simulation models of conveyor systems need to be developed to understand the behaviour of such systems and bridge the gap between theoretical research and industry problems.

John Usher et al. [6] provide the details of analysis of the reliability and availability of two common designs of the line-shaft roller conveyor. The first is a standard design in which each roller is

belted directly to a spinning line shaft under the conveyor. The second is a new design in which only one top roller is belted to the line shaft and all other rollers are belted to the one powered roller in a series arrangement. The main reason for this design is that the upper belts are faster to replace than belts connected to the line shaft, thus increasing system availability. However, the latter design is less reliable in that the failure of a single belt may lead to multiple roller failures.

In order to shorten the product development time and improve the product quality, 3 dimensions at CAD/CAE system is essential. It is necessary to develop a system which utilizes the concept design data at the early stage for the whole process of the product development. The purpose of this paper is to improve the product quality by the sufficient design study iteration at the early stage of design. A CAD system which can be used for the concept design and an appropriate CAD environment should be developed and another purpose is to shorten the product development time at the late stage of design, this is proposed by C. Sekimoto [7] in his paper.

SCOPE OF THE STUDY

The mechanical elements of the Roller Conveyer need to be designed individually and tested in the assembly environment. The structure need to be tested for external forces acting on the entire assembly and parts

SOFTWARE FOR DESIGN AND ANALYSIS (CATIA V5 AND ANSYS)

CATIA V5 provides three basic platforms: P1, P2 and P3. P1 is for small and medium sized process oriented companies that wish to grow toward the large scale digitized product Definition. P2 is for the advanced design engineering companies that require product, process and resource modelling. P3 is for the high-end design application and is basically for Aerospace Industry, where high quality surfacing or class-A surfacing is used for designing. A good feature is that any change made to the external data is notified to user and the model can be updated quickly. A workbench is defined as a specified environment consisting of a set of tool, which allows the user to specific design tasks in a particular area.

Ansys is user friendly finite element analysis software which can also use for modeling and meshing varies kind of analysis can carried out in Ansys. ANYAS 16.0 include the following new enhancement that improves the solution procedure and features high performance computing due to shared memory parallel capability in Ansys distributed Ansys now run on windows 32- and 64-bit systems

PROPOSE FLOW OF WORK AND METHODOLOGY

- Study of Conveyors system and Literature Study.
- Study of Design of Conveyor system for said application
- Optimization of shaft study.
- Modeling and stress analysis of conveyor system components (Existing).
- FEA for optimization of conveyor parameter.
- Experimental validation of optimized parameters.

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Lastly my special thanks to my family members for their support and co- operation during this project work.

Conflict of interest: I would like to declare that we have no conflict of interest.

Ethical statement: I would like to declare that we have followed ethical responsibilities.

REFERENCES

[1] M. A. Alspaugh (2004). Latest Developments in Belt Conveyor Technology. MINExpo 2004, Las Vegas, NV, USA.
[2] S.H. Masood, B. Abbas, E. Shayan, A. Kara (2004). An investigation into design and manufacturing of mechanical conveyors Systems for food processing. Springer-Verlag London Limited 2004.
[3] A Göksenli, I.B. Eryürek, "Failure analysis of an elevator drive shaft" at science direct journal - Engineering Failure Analysis 16 (2009) 1011–1019.
[4] Gys van Zyl, AbdulmohsinAl-Sahli, "Failure analysis of conveyor pulley shaft" at science direct journal - Case Studies in Engineering Failure Analysis 1 (2013) 144–155.
[5] DimaNazzal, Ahmed El-Nashar"Survey of Research in Modeling Conveyor-Based Automated Material Handling Systems In wafer fabs" Proceedings of the 2007 Winter Simulation Conference.
[6] John Usher, John R, G. Don Taylor "Availability modeling of powered roller conveyors".
[7] C.Sekimoto "Development of Concept Design CAD System", Energy and Mechanical Research Laboratories, Research and Development Center, Toshiba Corporation

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Burning Characteristics of In-cylinder Combustion Process of Hydrogen Fuel

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Abstract: This paper primarily provides a step – by – step approach for validating non-premixed turbulent combustion models in a cylinder. The focus is given to model Hydrogen combustion in a Gas Turbine Combustion Chamber. The simplest geometries for producing turbulent, non-premixed flames has the advantage that the flow field can be predicted quite well with existing models. The complex geometries for non-premixed flame propagation in a swirl condition are significantly sensitive to initial turbulence level. As hydrogen has a very low density than carbon fuels, it has to be injected at very high velocity to produce a diffusive flame. The results for mean velocity components, turbulent kinetic energy, mixture fraction, temperature, and major chemical species are presented and compared with experimental data. The Ansys fluent 15.0 [1] multi-dimensional CFD code is used in this work to simulate a non-premixed turbulent hydrogen-air flame. Advantages and disadvantages of the models are discussed in relationship to the results.

Keywords: Non–premixed, Turbulence, Computational modeling, Combustion models, RANS

INTRODUCTION

Combustion is an important process in engineering, which involves the fluid flow, chemical reaction, heat transfer. Typical engineering applications include internal combustion engines, power station combustors, gas turbine engines, boilers, furnaces and much more combustion equipment. The complete combustion of Carbon fuels would only yield CO_2 and H_2O. Worldwide, human activities currently release about 37 billion metric tons of carbon dioxide along vast quantities of pollutants. It states that there is an enormous pressure to improve the combustion efficiency of low emissions or alternative fuel source. Hydrogen combustion has considerable potential for powering automobiles and generating energy while it is still a relatively new area of study.

Combustion processes are complex and are governed by basic transportation equations for fluid flow and heat transfer. Due to the instinct flammable property of hydrogen, it is not feasible to burn hydrogen in conventional internal combustion engine without any modifications. It is essential to understand the hydrogen flame propagation and evolution of its burning characteristics before using it in existing combustor. All these processes can be predicted with the help of Computational Fluid Dynamics (CFD). Because of a complex interaction of chemical reactions and processes, advanced models have been developed, applied and are improved to analyze the flow field in realistic engine geometries. This paper covers all aspects of flame that include products for combustion, the reactants, the type of oxidizer, the fluid dynamics and the thermodynamic side of the process.

BACKGROUND

In 1965, Harlow and Fromm [2] marked the beginning of CFD era with an idea of computer experiments and numerical solution. Before that, Gaussian elimination for the solution of a linear equation and Runge-Kutta method were established.

A. LAMINAR FLAME MODELLING

Spalding and Stephenson [3] have stated the problem of laminar flame structure and propagation. The one-dimensional laminar flame appears in many practical scenarios. The problem associated with laminar flame modeling is that the known data for chemical kinetics, transport and thermodynamic properties are used to calculate the propagation speed and distribution through flame concentrations, temperature, and reaction rate.

Hirschfelder and Curtiss [4] developed the equation for unsteady flame propagation to calculate flame structure and propagation, except for the computer hardware and numerical algorithms needed to solve equations.

Warnatz [5] carried out modeling studies for ozone, hydrogen, and hydrocarbon laminar flames. A special issue of Combustion Science and Technology [6] examined, a broad range of problems in the modeling of laminar premixed flame.

In 1980, reactive flow simulation was made available by the introduction of Chemkin family of combustion models from Sandia National Laboratories, Livermore [7]. Chemkin established industry standards for computational combustion, with common solution techniques, problem formulation, and problem results. It made it possible for students and professionals to communicate more conveniently.

B. CURRENT CAPABILITIES

A conceptual model of diesel combustion was developed at Sandia/Livermore [8] based on multi-laser in-cylinder, complex diagnostics. Some different researchers used kinetic modeling to compute ignition and formation of hydrocarbon under rich conditions. This model is then coupled to a soot production model by Frenklach [9] to predict the level of soot formation.

Johansson [10] has led an experimental development of HCCI engine. The engine performed well with extremely low NOx and soot. Computational modeling stepped in immediately to provide a much-needed explanation for the behavior of HCCI engine.

C. TURBULENT HYDROGEN JET FLAME

Cheng et al. [11] performed an experiment of lifted hydrogen flame. A hydrogen injected into the still air from the nozzle of diameter 2 mm with a jet velocity of 680 m/s. Nine species and 17 reaction Westbrook model were used. The governing equations are a compressible three-dimensional Navier-Stokes equation. Conservation equations for total energy and chemical species. The equation of total mass conservation is also solved.

Tanahashi et al. [12] carried out the first 3D chemically reactive combustion DNS simulating Hydrogen / Air premixed flame to study the effect of fine-eddies on the burning. Nishika et al. [13] conducted a DNS of premixed flame with an irreversible single step reaction to construct a combustion model in terms of progress variable. Earth Simulator a supercomputer is used to carry out DNS of homogeneous turbulence with 4096 grid points.

R.S Barlow [14] performed an experiment to provide detailed information on NO production in turbulent jet flames with simple boundary. Experimental results discussed the predictions using Monte Carlo pdf and Conditional Moment Closure models. In this study, the comparison is made between Laminar flamelet and Eddy dissipation model for the same flow conditions.

D. COMPUTATIONAL METHODS AND GOVERNING EQUATIONS

E. COMPUTATIONAL APPROACHES

Reynolds Averaged Navier-Stokes (RANS) [15] computation is first possible approach because the calculation of the instantaneous flow field in a turbulent flame is possible. Solving these equations provide averaged quantities corresponding to the averaged time for stationery mean flow. The temperature prediction with RANS at a point is constant corresponding to the average temperature at that point.

The second level corresponds to Large Eddy Simulation (LES) [15]. The large turbulent scales are calculated whereas the effects of small eddies are modeled using subgrid closure rules. LES determines the instantaneous position of large-scale resolved flame front but a subgrid model be still required to consider the effects of small turbulent scales on combustion.

The third level of combustion simulation is Direct Numerical Simulation (DNS) where the full instantaneous Navier-Stokes equations are solved without any model for turbulent motions. All turbulence scales are determined, and their effects on combustion are captured. DNS would predict all time variations of temperature with high resolution. It requires very high-performance computers and hence it is costlier than RANS and LES [16,17].

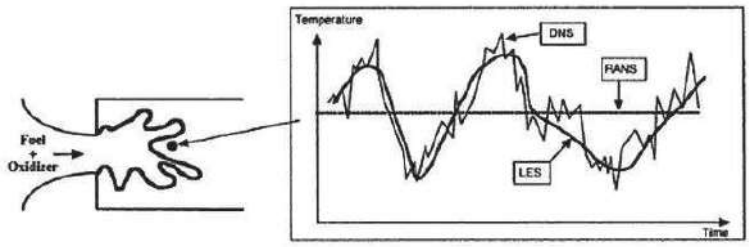

Figure 1: Time evolutions of local temperature for RANS, LES and DNS [16]

Table 1: Comparison between RANS, LES, and DNS

Approach	Advantages	Drawbacks
RANS	Coarse numerical grid Geometries simplification (2D flows, Symmetry) Reduced numerical costs	Only mean flow field models required
LES	Unsteady features Reduced modelling impact	Models required 3D simulations required Needs precise codes Numerical costs
DNS	No models needed for turbulence/combustion interaction tool to study models	Prohibitive numerical costs Limited to academic problems

II. GOVERNING EQUATIONS

The partial differential equations that govern a reactive flow are [18]:

Conservation of mass

$$\frac{\partial \rho}{\partial t} + \frac{\partial (\rho u_i)}{\partial x_i} = 0 \qquad (1)$$

An ideal gas law is used to calculate the density:

$$\rho = \frac{P}{\left(RT \sum_{i=1}^{n} \frac{Y_i}{M_i} \right)} \qquad (2)$$

Conservation of Momentum/Navier-Stokes equation

$$\frac{\partial (\rho u_j)}{\partial t} + \frac{\partial (\rho u_i u_j)}{\partial x_i} = -\frac{\partial p}{\partial x_j} + \frac{\partial \tau_{ij}}{\partial x_i} + F_i \qquad (3)$$

The viscous stress tensor is given as:

$$\tau_{ij} = \mu s_{ij} + \frac{2}{3} \mu \frac{\partial u_k}{\partial x_k} \delta_{ij} \qquad (4)$$

$$s_{ij} = \left(\frac{\partial u_j}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right) \qquad (5)$$

Conservation of Energy

$$\frac{\partial \rho h_t}{\partial t} + \frac{\partial \rho u_j h_t}{\partial x_j} = \frac{\partial p}{\partial t} - \frac{\partial Q_j}{\partial x_j} - \frac{\partial u_i \tau_{ij}}{\partial x_j} + u_j F_j + S_r + S_e$$

$$Q_j = -k \rho \frac{\partial h_t}{\partial x_j} \qquad (6)$$

Conservation of Species

$$\frac{\partial(\rho Y_\alpha)}{\partial t}+\frac{\partial(\rho u_j Y_\alpha)}{\partial x_j}=\frac{\partial\left(D_{L,\alpha}\rho\frac{\partial Y_\alpha}{\partial x_j}\right)}{\partial x_j}+\omega_\alpha \qquad (7)$$

Y_α is the mass fraction of the species α; α =1 to N and ω_α is the mass burning rate.

The reduced mass fraction

$$Y=\frac{Y_f}{Y_{f,u}} \qquad (8)$$

Y_f is the fuel mass fraction and $Y_{f,u}$ is the fuel mass fraction in the unburnt mixture.

Favre Averaged Equations [15,19]

A Reynolds Averaged Navier-Stokes (RANS) approach is used to simulate the turbulent flame propagation

Reynolds Averaging

Under Reynolds Averaging, a variable ϕ is decomposed into a mean value $\bar{\phi}$ and fluctuating one ϕ'

$\phi=\bar{\phi}+\phi'$ where $\phi'=0$ (9)

Favre Averaging

In case of variable density flow, density weighted averaging is often used [34] i.e., a random variable is decomposed into its density - weighted ϕ ensemble average component $\tilde{\phi}$ and fluctuating part ϕ''

$$\phi=\tilde{\phi}+\phi'' \text{ where } \tilde{\phi}=\frac{\overline{\rho\phi}}{\bar{\rho}} \text{ and } \overline{\rho\phi''}=0 \qquad (10)$$

Turbulence Model

A turbulence model is close to turbulence Reynolds stresses $\overline{\rho u_i'' u_j''}$. Following the Boussinesq hypothesis, the turbulence Reynolds stresses are described as follows:

$$\overline{\rho u_i'' u_j''}=-\mu_t\left(\frac{\partial\tilde{u}_i}{\partial x_j}+\frac{\partial\tilde{u}_j}{\partial x_i}-\frac{2\partial\tilde{u}_k}{3\partial x_k}\delta_{ij}\right)+\frac{2}{3}\bar{\rho}k \qquad (11)$$

where, k is the turbulent kinetic energy. Under two-equation models, the k-epsilon model has been most popular which solves for two scalar characteristics of turbulence.

Turbulence Kinetic Energy k:

$$k=\frac{1}{2}\overline{u_i'' u_j''} \qquad (12)$$

Turbulent Dissipation Rate (epsilon):

$$\varepsilon=C_d\frac{k^{3/2}}{l_t} \qquad (13)$$

There are three approaches in turbulent non-premixed combustion model to simulate chemical non-equilibrium. Rich Flammability where rich regions are modeled as a mixed but unburnt mixture. Steady Laminar Flamelet model, where chemical non-equilibrium due to diffusion can be a model. Unsteady Laminar Flamelet where slow forming product species that are far from chemical equilibrium can model.

III. COMBUSTION MODELS

The prediction of turbulent reactive flows largely depends on the proper choice of a combustion model. It is the most challenging aspects when modeling turbulent combustion with RANS/FANS approaches. The combustion model is based on the following single step reaction

$$Fuel + r_j Oxidiser \rightarrow (1 + r_j) Products \qquad (14)$$

Eddy Dissipation Model was introduced by Magnussen [19] and widely used the model because of fast, irreversible, one-step chemistry. The combustion is determined by the turbulent mixing process. There is no coupling at the end of reaction

Eddy Dissipation Concept is an extension of EDM, which allows detailed kinetics to be included in the calculations. The model assumes that chemical reactions occur within the smallest turbulent structures, called fine structures. The properties of fine structures are derived from step-wise energy cascade model and expressed with quantities related to the main flow, such as turbulent kinetic energy (k) and turbulent dissipation rate (epsilon). Both combustion models are based on the reaction rate approach.

In the Flamelet approach [16], the flame is modeled as an ensemble of thin and steady laminar flames, strained by turbulent motion. Two scalar equations, for mixture fraction and its variance, have to solved independently of the number of species involved in the chemical mechanism. The integration is not carried out during the CFD calculation but is part of the flamelet library generation, to reduce the computational cost. The flamelet libraries are created with the mixture fraction ranging between zero and unity.

IV. FLOW MODELLING OF NON-PREMIXED HYDROGEN JET FLAME

The validation study considers flame propagation in a simple cylinder containing a non-premixed hydrogen-air mixture.

The inner diameter of the tube is 3.75mm; outer diameter is 4.8mm. The air velocity has been fixed at 1 m/s for all measurements. The Reynolds number for the flame is 10,000 with 100% hydrogen in the fuel jet. The vertical length is 2 m. The flame has a visible length of 675 mm. The temperature and species measurements have been obtained by Raman/Rayleigh/laser-induced fluorescence (LIF) [14].

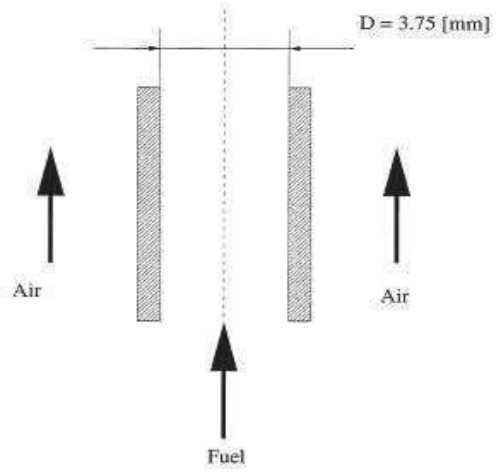

Figure 2: Inlet geometry

Ansys Fluent 15.0 pressure based steady solver is used to perform the calculations. A 2D axisymmetric configuration is used to represent the geometry. The computational domain chooses in order to get all flame features and extended over along the axial direction. The grid was structured and contained 3408 elements and 3778 nodes.

Table 2: Features of CFD Model

Parameters	Values / Models
Combustion model	Eddy Dissipation Model Flamelet Model
Airflow velocity	1 m/s
Fuel flow velocity	296 m/s
Kinetic model	1 step, 5 step
Solver	2D Axisymmetric pressure based solver
Formulation	Steady
Discretization	2nd order upwind

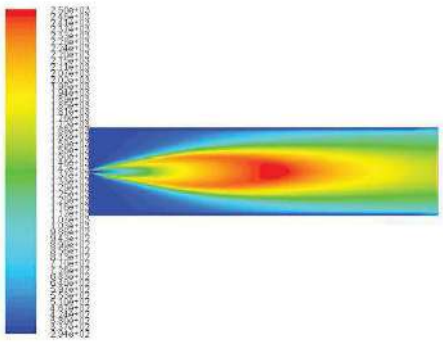

Figure 3: Temperature (EDM)

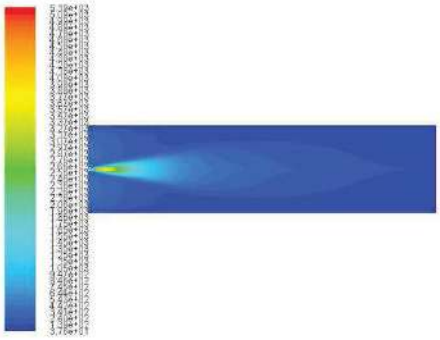

Figure 4: Turbulent Intensity (EDM)

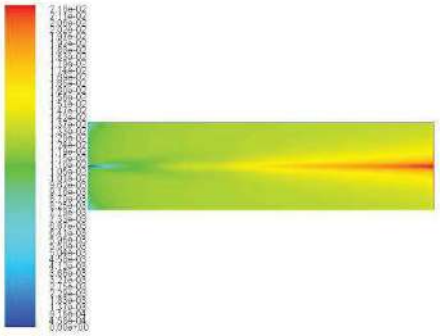

Figure 5: Mass fraction of Pollutant (NOx)

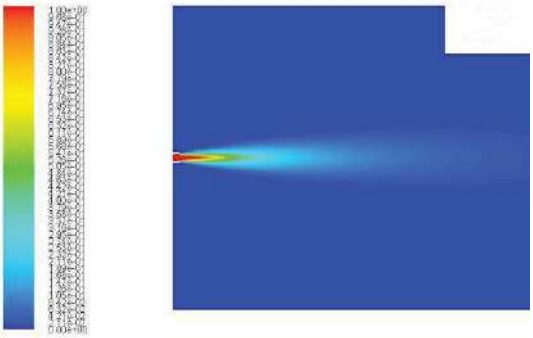

Figure 6: Mass fraction of Hydrogen

V. FLOW MODELLING OF HYDROGEN IN GAS TURBINE COMBUSTION CHAMBER

A. COMBUSTION PROCESS

Air from the engine compressor enters the combustion chamber at a velocity up to 150 m/s, but because of this velocity the airspeed is far too high for combustion, it must be diffuse to slow down the velocity and raise the static pressure. A region of low velocity must be created in the chamber so, that the flame will remain alight throughout the chamber. The fuel must be burned with a part of air entering the chamber, in the primary combustion zone. Approximately 20 percent of the air mass flow rate is taken in by the snout.

The wall of the flame tube body, adjacent to the combustion zone, has selected a few secondary holes through which a further 20 percent of the main flow of air passes into the primary zone. It creates a region of Low-velocity recirculation and takes the form of a toroidal vortex. The conical fuel spray from the nozzle intersects the recirculation vortex at its center. This action assists in breaking up the fuel and mixing it with air.

Combustion should be completed before the dilution air enters the flame tube. Otherwise, the incoming air will cool the flame and result in incomplete combustion.

B. SIMULATION OF COMBUSTION PROCESS

The fuel and primary air enters the chamber separately, in the non-premixed form. The leading edges of the vanes have 45° angles to the axis of the combustor. The outlet has a surface area of 150 cm^2. There are six side air inlets, each with a surface area of 2 cm^2. The gaseous fuel inlet is a spherical tube with small six inlets, each with a surface area of 0.14 cm^2. The primary air enters through the swirl of area 57 cm^2, which is made of 8 vanes. (Figure 7)

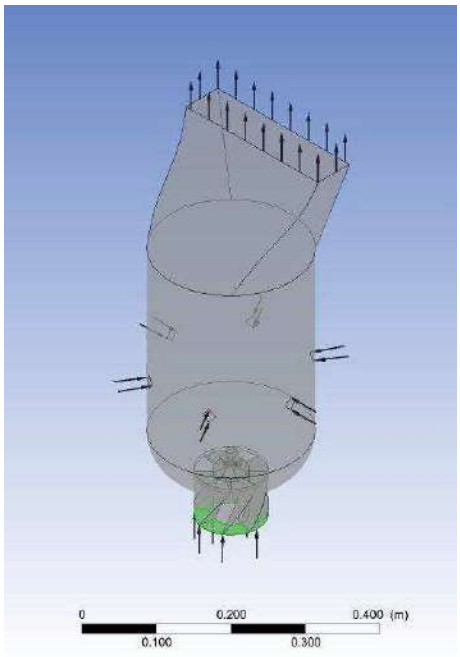

Figure 7: CAD model of Combustion Chamber

The mesh was created in Ansys environment. Hex-dominant elements could not be used due to the small channels, gaps and bores. Hence, the mesh was built up from 106651 elements, 74189 tetrahedrons and 31433 nodes. 5.5 mm element size was used, but adjacent to the inlet surfaces, vane walls and flame front, the mesh was fine for higher resolution. Inflation layers were created along the vanes and walls. (Figure 8)

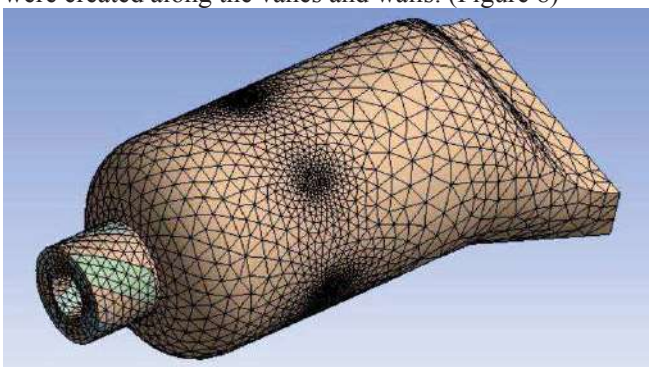

Figure 8: Generated mesh of Combustion chamber

Table 3: Physics domain

Model	Type
Turbulence Model	K-epsilon
Turbulent wall functions	scalable
Combustion model	Eddy Dissipation
Turbulence	Medium intensity and Eddy Viscosity ratio

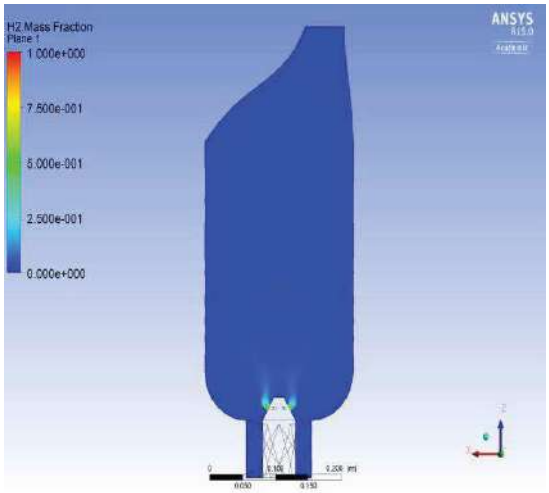

Figure 9: Mass fraction of H_2

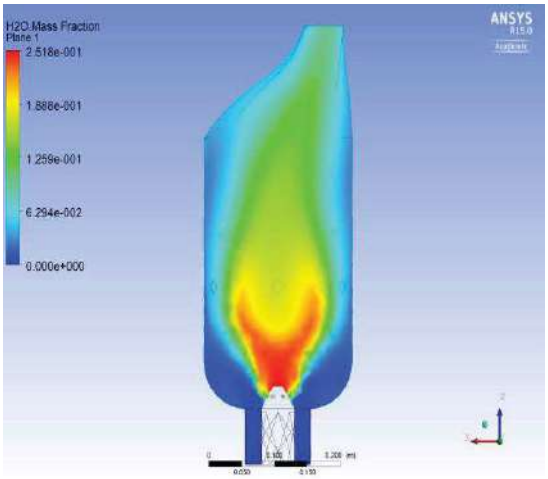

Figure 10: Mass fraction of H_2O

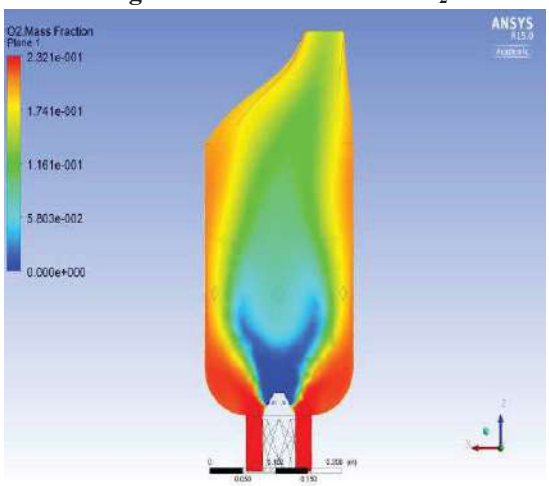

Figure 11: Mass fraction of O_2

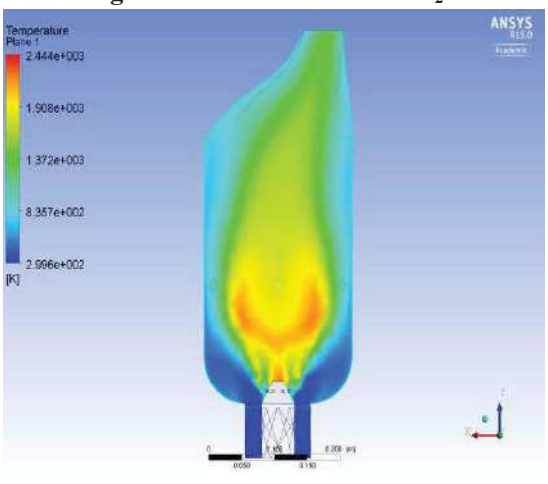

Figure 12: Temperature

The results are quantitatively analyzed, of course considering several results only a few of them are shown. The temperature distribution for given boundary conditions is shown in figure 12. The flame temperature obtained from EDM model is 2444 K, which is acceptable flame temperature for Hydrogen as per experimental data as the figure shows, the cold gaseous fuel and air enter the chamber across the swirling vanes and when the mixture reaches the activation conditions, the flame front forms.

As Hydrogen has a very low density it should be injected with very high velocity. Several simulations were performed to model the Hydrogen jet flame. Hydrogen diffuses very rapidly near fuel nozzle and burns fast. Thus, the diffusive flame is seen in the combustion chamber. Due to high-speed airflow and fuel inlet, it is not feasible to use in practical application as it needs a more detailed study with advanced combustion models is necessary.

VI. CONCLUSION

The present work shows the implementation of standard combustion models to model turbulent non-premixed jet flame. CFD based computational approaches can strongly contribute to improving the performance, efficiency, and emissions of the combustion chambers. Advanced models have been developed and as explained other computational approaches such as LES, DNS can be applied to

simulate combustion of Hydrogen in a practical application. As in this case, Gas turbine combustor is used, further, it can be simulated in conventional internal combustion engines and industrial furnaces to study and improve the combustion efficiency either by modelling input parameters or modeling combustor design.

However, development of adequate and accurate CFD methodology and the efficient computer codes for combustion simulation with acceptable time-consumption are still challenging task.

REFERENCES

[4] FLUENT. FLUENT 15.0 User's Guide. Fluent Inc. (2015).

[5] Harlow, F. and Fromm, J. (1965). Computer Experiments in Fluid Dynamics. *Sci Am*, 212(3), pp.104-110.

[6] Spalding, D. and Stephenson, P. (1971). Laminar Flame Propagation in Hydrogen+Bromine Mixtures. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 324(1558), pp.315-337.

[7] Hirschfelder, J., Curtiss, C. and Campbell, D. (1953). The theory of flames and detonations. *Symposium (International) on Combustion*, 4(1), pp.190-211.

[8] J. Warnatz, Ber. Bunsen. Phys. Chem. 82 (1978) 643–649.

[9] Special Issue on Laminar Flame Propagation Premixed Gases, in C.K. Westbrook, J.A. Miller (Eds.), Combust. Sci. Technol., vol. 34. 1984

[10] R.J. Kee, J.A. Miller, T.H. Jefferson, CHEMKIN: A General-purpose, Problem-independent, Transportable, FORTRAN Chemical Kinetics Code Package, Sandia Laboratories report SAND80- 8003, 1980

[11] J.E. Dec, A Conceptual Model of DI Diesel Combustion-Based on Laser-sheet Imaging, Society of Automotive Engineers report SAE-970873, 1997.

[12] Wang, H. and Frenklach, M. (1991). Detailed reduction of reaction mechanisms for flame modelling. *Combustion and Flame*, 87(3-4), pp.365-370.

[13] M. Christensen, B. Johansson, P. Einewall, Society of Automotive Engineers report SAE-972874, 1997.

[14] Cheng, T., Wehrmeyer, J. and Pitz, R. (1992). Simultaneous temperature and multispecies measurement in a lifted hydrogen diffusion flame. *Combustion and Flame*, 91(3-4), pp.323-345.

[15] Tanahashi, M., Fujimura, M., and Miyauchi, T. (2000). Coherent fine-scale eddies in turbulent premixed flames. *Proceedings of the Combustion Institute*, 28(1), pp.529-535.

[16] S. Nishiki, T. Hasegawa, R. Borghi, R. Himeno, Proc. Combust. Inst. 29 (2002) 2017–2022

[17] R. S. Barlow, Sandia H2/He Flame Data - Release 2.0, http://www.ca.sandia.gov/TNF, Sandia National Laboratories (2003)

[18] Versteeg, H. and Malalasekera, W. (1995). *An introduction to computational fluid dynamics*. Harlow, Essex, England: New York.

[19] GALLETTI, C., PARENTE, A. and TOGNOTTI, L. (2007). Numerical and experimental investigation of a mild combustion burner. *Combustion and Flame*, 151(4), pp.649-664.

[20] Obieglo, A., Gass, J., and Poulikakos, D. (2000). Comparative study of modeling a hydrogen non-premixed turbulent flame. *Combustion and Flame*, 122(1-2), pp.176-194.

[21] VERVISCH, L. (2006). Thierry Poinsot and Denis Veynante, Theoretical and Numerical Combustion (second ed.), Edwards, USA (2005) 520 pp. *Combustion and Flame*, 144(3), pp.642-643.

[22] ERTESVÅG, I. and MAGNUSSEN, B. (2000). The Eddy Dissipation Turbulence Energy Cascade Model. *Combustion Science and Technology*, 159(1), pp.213-235.

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Stress Analysis of Steam Piping System using ASME Code B31.1

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Abstract: This Paper is about the design of steam piping and its stress analysis of a given process flow diagram. The prime objective of this project is to design the piping system and then to analyze its main components. Wall thicknesses are calculated for all pipes which were found very safe for the operating pressure. For header pipe the calculated wall thickness is 0.114 inch and the standard minimum wall thickness is 0.282 inch which is greater than the calculated one by more than 2.4 times. Different loads such as static loads, thermal loads of all pipes were also included.. After load calculations, spacing supports carried out. Thermal and static analysis of main system pipe has been done and results were compared with ASME Power Piping Code B31.1.After calculation of all applied loads they were analyzed both manually and on ANSYS software. The results obtained from both methods were compared and found safe under available applied loads.
Keywords-Code B31.1, ANSYS, Steam piping.

I. INTRODUCTION

Piping System design and analysis is a very important field in any process and power industry.

Piping system is analogous to blood circulating system in human body and is necessary for the life of the plant. The steam piping system, mentioned in the paper will be used for supplying steam to different locations at designed temperature and pressure. This piping system is one of the major requirements of the plant to be installed. The goal of quantification and analysis of pipe stresses is to provide safe design. There could be several designs that could be safe. A piping engineer would have a lot of scope to choose from such alternatives, the one which is most economical, or most suitable etc. Good piping system design is always a mixture of sound knowledge base in the basics and a lot of ingenuity.

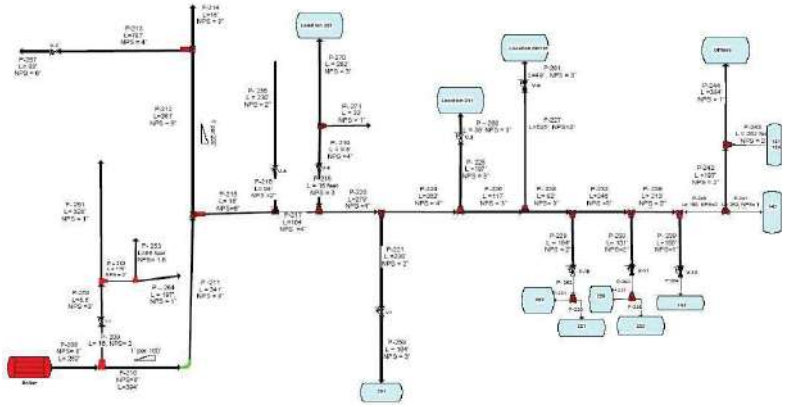

Fig.1 layout of piping system

II PIPING STANDARD AND CODES

A. Piping Code Development

The increase in operating temperatures and pressures led to the development of the ASA (now ANSI) B31 Code for pressure piping.Codes and standards were established to provide methods of manufacturing, listing and reporting design data [3].

"A standard is a set of specifications for parts, materials or processes intended to achieve uniformity, efficiency and a specified quality". Basic purpose of the Standards is to place a limit on the number of items in the specifications, so as to provide a reasonable inventory of tooling, sizes and shapes and verities [4]. Some of the important document related to piping are:

I. American Society of Mechanical Engineers (ASME) II. American National Standards Institute (ANSI) III. American Society of Testing and Materials (ASTM) IV. Pipe Fabrication Institute (PFI) V. American Welding Institute (AWS) VI. Nuclear Regulatory Commission (NRC)

On the other side "A code is a set of specifications for analysis, design, Manufacture and construction of something". The basic purpose of code is to provide design criterion such as permissible material of construction, allowable working stresses and loads sets [4]. ASME Boiler and Pressure vessel codeB31 used for the design of commercial power and industrial piping system. This section has the following sub section [1].

B31.1: For Power Piping. B31.3: For Chemical plant and Petroleum Refinery Piping. B31.4: Liquid transportation system for Hydrocarbons, liquid petroleum gas, and Alcohols. B31.5: Refrigeration Piping. B31.8: Gas transportation and distribution piping system.

B31.1 Power piping code concerns mononuclear piping such as that found in the turbine building of a nuclear plant or in a fossil-fueled power plant. B31.3 code governs all piping within limits of facilities engaged in the processing or handling of chemical, petroleum, or related products.

Examples are a chemical plant compounding plant, bulk plant, and tank farm. B31.4 governs piping transporting liquids such as crude oil, condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, liquid alcohol, and liquid anhydrous ammonia. These are auxiliary piping with an internal gauge pressure at or below 15 psi regardless of temperature. B31.5 covers refrigerants and secondary coolant piping for temperatures as low as 320oF. B31.8 governs most of the pipe lines in gas transmission and distribution system up to the outlet of the customer's meter set assembly. Excluded from this code with metal temperature above 450oF or below - 20oF. As for as the steam piping is concerned, B31.1 Power piping is used because of its temperature and pressure limitations which is discussed below in detail.

B. B31.1 Power Piping

This code covers the minimum requirements for the design, materials, fabrication, erection, testing, and inspection of power and auxiliary service piping systems for electric generation stations, industrial institutional plants, and central and district heating plants. The code also covers external piping for power boilers and high temperature, high-pressure water boilers in which steam or vapor is generated at a pressure of more than 15psig and high-temperature water is generated at pressures exceeding160psig or temperatures exceeding 250oF. This code is typically used for the transportation of steam or water under elevated temperatures and pressure so this is the reason that why this code is selected for the steam piping system which is external to the boiler [5].

C. ASME Code Requirements

Boiler outlet section of the steam system comes under the category of ASME Code B31.1 Power. In order to ensure the safety of the piping system, code requirements should be fully satisfied.

III.PIPING DESIGN PROCEDURE D. Process Design

This process is based on the requirement of the process variables. It defines the required length & cross sectional area of pipe, the properties of fluid inside the pipe, nature & rate of flow in it. These variables affect the positioning and placements of equipments during lay outing and routing. The operating and design working conditions are clearly defined. The end of Process Plan Design is the creation of a Process Flow Diagram (PFD) and Process & Instrumental diagram (PID), which are used in the designing & lay outing of the Pipe.

E. Piping Structural Design

In piping structural design, according to pressure in pipelines, the design and minimum allowablethicknesses are calculated; according to the required codes and standards. ASME codes for various standards are available, for process fluid flow, ASME B31.1 is used.

IV. STATIC LOADS CALCULATIONS

For Static loads calculation, considering a pipe no. 208 and taking its section up to first vertical leg of the expansion loop. This pipe is to be considering as a straight beam with uniformly distributed load. In beam design considering only the load in vertical direction along with the load of the plate. Assuming that the beam is supported only in the middle, thus this beam acting as double cantilever

beam. Neglecting weight of the beam and finding moment for one side of the beam in order to calculate the section modulus of the beam [4].

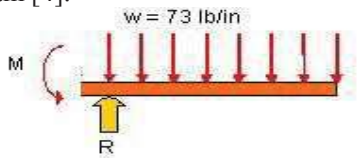

Figure -3 Uniformly load distributed Cantilever Beam

Finding the reaction in the middle of the beam, maximum moment and section modulus of this beam using the following equations [4].

R = w x L Where

w = 73 lb/in ,L = 8 i006E

= 568.14 lb

(6) Mmax = w/2 x L²

Using same as in above Equation (6) we get,

= 2.28in-kips Z = M/σallowable

Using the value of M from Equation and for allowable stress = 27 ksi

= 2.28/27 = 0.10 in3

For Z=>0.1

Required section comes out to be C5 x 9 Section modulus = Zy = 0.45 in3

Zx = 3.5 in4

Beam Analysis

Now the beam will be analyzed for maximum stress and deflection, to check whether it is in the desired limit or not. The analysis will be done through manual calculations as well as through ANSYS.

Manual Analysis

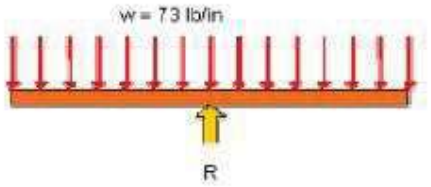

Figure -4 Double Cantilever beam

R = Vertical load + Beam Load = 585.44 lb

Mmax = w x L2/2

Total distributed load of the beam at one end of the support = w x L

= 73 x 8= 585.44 lb

The maximum moment at the center of the beam at L/2 distance of the beam is,

Mmax = w x L x (L/2) = 585.44 x 8/2 = 2.342 in-kips

For maximum bending stress using the following equation [4].

σ = M/Z = 2.342/0.45 = 5.204 Kips

5.20 < 27 = σ all Now to find the maximum deflection,

y max = wL4/(8EI)

(7) Where I = 0.632 in4, w = 73 lb/in ,L = 8 in E = 29 x 106psi

From Equation (7) the deflection comes out to be: y max = 0.00204 in

As the working stress and the deflection are well with in the limits so the beam used is quite safe with working conditions.

V.ANSYS Analysis

Analysis were performed for beam in ANSYS for the following data.

Element type = Beam 3

Material properties

Modulus of Elasticity = 29.0 Mpsi, Poison's Ratio = 0.283, Density = 0.286 lb/in3

Type of Loads

One Vertical constraint in middle Gravity = 9.81(386.22 in/sec2)

Final Meshing = 100 divisions for each section of beam. The two sections of the beam is meshed by refining it from 10 divisions up to 100 divisions at increment of 10 divisions but there is no change found either in maximum deflection or maximum stress.

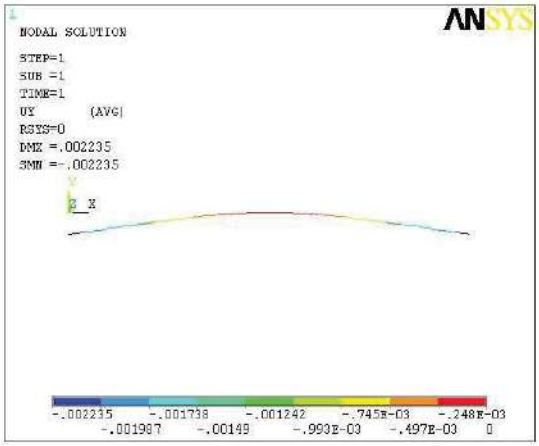

Figure 1 Deformed Shape of the beam (inch)

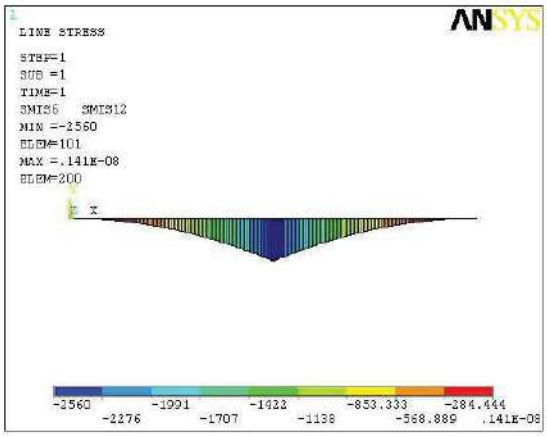

Figure 2 Bending Moment diagram of the beam (lb-in)

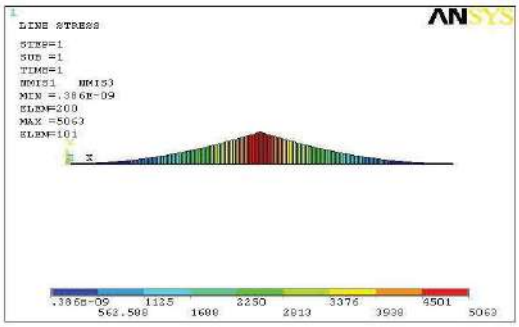

Figure 3 Max. Stress distribution diagram (psi)

Table -1 Comparison of Analysis of Beam

Method	Max. Deflection, in	Max. B. Moment, in- Kips	Max. Stress, kips
Manual	0.00204	2.342	5.20
ANSYS	0.00222	2.560	5.063

Results and Discussion:

From Table 1 it is cleared that the difference in deformation between the two methods is 8%, for bending moment the difference is 8.5% while in maximum stress the difference is 2.8 %. Comparing these values to the allowable limits for deflection and stress, the beam is found to be safe for the available loads.

Conclusion

Following conclusions are made from the analysis of the designed system.

1. The designed pipe verified all the conditions defined by the ASME Boiler and Pressure Vessel code B31.1. Thickness and working pressure calculated are in the safe limit. Thermal and Sustained analysis results obtained are in the safe limits defined by the Code.
2. Supporting Assembly confirms to the safety requirements of AISC standards.

3. The analysis shows that the complete system is safe and the results are verified by manual calculations and ANSYS software.

References

[1] Ming Li, ManoharLalAgrawal Stress analysis of non-uniform thickness piping system with general piping analysis software, Nuclear Engineering & Design, Volume 241,*Issue 3,March 2015,Pages 555-56.*

[2] F.J.M.Q. de Melo, C.A.M. Oliveira, The thermal and mechanical behavior of structural steel piping, *International Journal of Pressure Vessels and Piping*, *Volume 82, Issue 2*, *February 2014*, *Pages 145-15.*

[3] G. Mathan, N. Siva Prasad, Study of dynamic response of piping system with gasketed flanged joints using finite element analysis, *International Journal of Pressure Vessels and Piping*, *Available online 8*
October 2011.

[4] Martin M. Schwarz, Flexibility analysis of the vessel-piping interfac**e**, *International Journal of Pressure Vessels and Piping*, *Volume 81, Issue 2*, *February 2004*, *Pages 181-189.*

[5] Fu-Zhen Xuan, Pei-Ning Li, Finite element-based limit load of piping branch junctions under combined loadings, *Nuclear Engineering and Design*, *Volume 231, Issue 2*, *June 2004*, *Pages141-150.*

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—A Comparative Study of Services Provided By Health Insurance Companies In Rahata (Maharastra)‖

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1 Introduction:

Health insurance market in India is under development till now in rural sector there is lot of potential to growth in health insurance. The Health of your family is very important for individual .when faced with hospitalization for one or more family members, the medical bill can severely dent for individual saving. The cost associated with hospitalization might be very high and you need to be better prepared for such as emergency.

Health insurance is personal insurance that provides coverage for the cost of hospital and medical expenses arising from illness or injury. Health Insurance products in India narrowly cover hospitalization benefits with a sum-assumed limit.

In such times health insurance provides the much needed financial relief. Some of the existing health insurance schemes currently available are individual, family, group insurance schemes, and senior citizens insurance schemes, long –term health care and insurance cover for specific diseases. The latest entrants are the Third Party Administration or TPAs. These are intermediaries who being all the components of health care delivery-hospitals, physicians, clinics, long-term care facilities and pharmacies into a single entity. Health insurance safeguards against the cost of illness, mobilizes funds for health services and increases the efficiency of such services. Health insurance requires sufficient information and data for development of a good product, proper pricing and health management. Many Insurers, therefore is expected to invest the premium money in such a way as to earn sufficient money for meeting the expenses of insurance and insurance claims. The major public and private Health insurance companies in India are the:-

New India
ICICI Lombard
United
National
Oriental
Reliance health insurance
Tata AIG
Bajaj Allianz Insurance
Oriental Insurance
Aviva Life Insurance
SBI
Star Health and Allied Insurance Company Ltd
National Insurance Company

The Health Insurance quote must emanate from a reputable company that provides full quality coverage for you and your **family**

Rational for the study:, RAHATA,

This study would help to which type of services provided health insurance in Rahata

This Study is also helpful to which hospitals passes health insurance claims(Ex-Cashless, Non-cashless)

3. Objectives of Study:

The following specific objectives are taken up for the study.

To study the customer satisfaction for Health Insurance companies in RAHATA

To study the process of claim settlement of health insurance policies

- To find out the awareness level of health insurance in RAHATA

4.Statement of Hypotheses:

This study will be conducted on the following hypothesis

1) The awareness of health insurance is comparatively low in RAHATA.

Research Methodology: Research Methodology will provide a structure for decision-making like implicit question are posed, explicit answer proposed, collection analysis and interpretation of information. Here in this study Descriptive and Exploratory Research method is followed, where researchers are looking for conclusions

Research Design –

The research study is of qualitative research type and research design

Sources of Data Collection-

The data to be collected for various aspects for this research, the data will be collected through following sources –

Primary sources-

Feedback from health insurance customers (Policy holders)

Secondary sources- Secondary data will be collected through

Business news papers like ,Economic times, business standard
Marketing and research book
Internet web side
Insurance Magazines- Insurance world, The Outlook Money

Sampling Technique

The samples will be selected through **Random sampling method** from **Rahata (Maharashtra)**
Health Insurance customers---50

Sampling Area- RAHATA (Maharashtra)

Research Instrument*:*

Questionnaires for Health Insurance Policy Holders

5.Limitation-

Due to business secrecy some health insurance Advisors, and Hospitals, may not disclose the real information this may affect the outcomes of the study.

As the research is limited for **RAHATA (Maharashtra)** the result may or may not vary with other regions.

The study restricts the services of health insurance companies like public and private sectors health insurance companies namely Oriental Insurance Company Ltd., New India Assurance Company Ltd. ,Star Health and Allied Insurance Company Ltd, ICICI Prudential life insurance company Ltd, Aviva Life Insurance.

6. Review Of Literature: -

The review of literature helps to understand the importance, background and present situation related to the subject selected for the research work. Therefore it is necessary to review relevant and literature related to the subject manner.

Manish Joshi,Dr Navindra kumar Totala (Dec-2014) ―Innovation in Health Insurance Service quality as a key factor ie the attributes of service quality in health insurance sector identified the study can be beneficial to the Managers, Health entrepreneurs ,as well as public & private hospitals, insurance companies.

Narang (2010) define the health care include five factors of service quality for delivery system, diagnostic care, facility ,quality of drug and health personal conduct.

Aagja and Garg (2010) five factors of service quality here identified as admission,Medical service, overall service, discharge and social responsibility

Fucker and Admas (2001) define ―Patient satisfaction as predicated by relating to caring ,reliability,empathy as well as responsiveness.

Dr.Yogeswar phathak and shilpi Malaya(2012) ―To study of factors influencing health insurance cover‖ is defined range of coverage of health related problems,lower premiums,greater government incentives,convenient and cashless hospitalization for issued

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person etc.and to improve our low level of health insurance penetration and increase the number of person having access to health care.

Maumita Ghosh (June-2013)-—Awarness and willingness to pay for health insurance the result shown that Educated people are reluctant to invest more in other modes of savings which is turn give them high return.

as premium payable per annum rather than big medical expenses and also better utilization of their health care facilities.

Kulkarni (2000) undertaken a case study in Gujarat and provided that SEWA a type of health insurance scheme is strongly preferred by those who can afford and not access the services of various other scheme.

Krishnamurthy, V (1995): _Health and Medical Care in the Plantation Sector', paper prepared for International Workshop on Health Insurance in India.

Analysis of research data:

The data obtained after Marketing research Methods will be clearly tabulated, graphically represented and analyzed. Chi-square Test and suitable statistical tool will be applied as per the requirement of the collected data.

8. Conclusion and Recommendations:

Depending on the interpretations and findings pertinent to the Research, conclusions are drawn. Thereafter the suggestions are made.