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Message from IJERGS

This is the Sixth Issue of the Sixth Volume of International Journal of Engineering Research and General Science. A total of 5 research articles are published and we sincerely hope that each one of these provides some significant stimulation to a reasonable segment of our community of readers.

In this issue, we have focused mainly on the Innovative Ideas. We also welcome more research oriented ideas in our upcoming Issues.

Author's response for this issue was really inspiring for us. We received many papers from many countries in this issue but our technical team and editor members accepted very less number of research papers for the publication. We have provided editors feedback for every rejected as well as accepted paper so that authors can work out in the weakness more and we shall accept the paper in near future.

Our team have done good job however, this issue may possibly have some drawbacks, and therefore, constructive suggestions for further improvement shall be warmly welcomed.

IJERGS Team,

International Journal of Engineering Research and General Science

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IMPROVING PRODUCTIVITY AND MAINTAINACE EFFICIENCY OF AN AUTOMOBILE INDUSTRY THROUGH LEAN - PRODUCTION CUM MAINTANCE SYSTEM

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Abstract— A production practice that aims to minimize shop floor inventory and maintenance related losses in a Lean Developed production model. To achieve as close to minimum inventories means stockless production, with minimum maintenance losses.

As possible its origins extending deep into developed works on tight material control policies. By eliminating the costs of storage and capital tied up in inventory it is possible to eliminate seven wastages like zero defects, setup time, breakdowns, handling, lead time and surging. Goals of Lean production is, all the efforts directed for achieving zero inventory by producing the components or assembly parts when exactly it needed, and such tight scheduling is possible only by an efficient maintenance system . This thesis introduces the development of Lean based maintenance system and their immediate effects on the productivity of industry. In an exploring automobile industry many techniques are invented and implemented to discover to know how an automobile manufacturer can bring down his costs, using the advance production management theories, in their existing processes.

This research work discusses the combined issues and solution of lean thinking and maintenance in a way to improve performance indicators. The impacts of lean thinking focus maintenance in an organization. The need of maintenance to align itself with the business objectives in relevant of any organization performance measures are important inputs to improvement the productivity of organization, and maintenance in particular, through lean tools and activities.

Keywords— Lean production, Lean maintenance, stockless production, JIT, Impact of lean thinking, Zero inventories, and Performance indicators.

Introduction

Today, the organizations must be flexible in their operations, capable of producing quality products and delivering the products to the customers with competitive price. These demands highlight the need for high levels of overall system trustworthiness that include the reliability of human resources, machines, tools, material handling systems, other value adding processes. Low efficiency, downtime, and poor machine performance is often linked to incomplete plant repairs, which in turn can lead to reduced manufacture levels, increasing costs, market opportunities, and lower profit. These factors have given firms the inspiration to explore worldwide with proactive modern management methods.

Maintenance: As per EN 13306 “Combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function (function or a combination of functions) of an item which are considered necessary .The key purpose of maintenance is “total asset life cycle optimization” and this purpose should be attained in a cost - valuable way and in according with environment and safety guideline. Hence, that maintenance management must align with business activities at strategic, tactical, and operational levels.

Maintenance management: Maintenance management is described as activities in order to ensure the efficiency, effectiveness and cost-effectiveness in the maintenance area and where the overall goal is to contribute to company’s profitability and competitiveness.

Lean Thinking and Maintenance: Production units are expecting to gain economical cost, quality, and service and on time deliveries. The effect of preservation on these variables has provoked increased attention to the preservation areas as an combine part of competence improvement.

Lean maintenance: The systematic approach to identify, analyze and eliminate waste through proper management and continuous improvement. In industry, lean approach is as same the concept of efficient maintenance by eliminating waste in maintenance is Lean maintenance.

Parts of Lean maintenance: Proactive - This is not similar to tradition system of maintenance in which reactive action are taken after break down occurrence, in which maintenance operation take place on equipment failures by performing repairing works. In proactive lean maintenance system prevention are more important than repair and follow before the equipment failures. By the execution of preventive and predictive maintenance repairing in the form of maintenance can be eliminated.

Planning and scheduling - Planned maintenance give the comfort zone to do the work with a predefined strategy that identify task, steps of process, labor selection as per skill, availability of parts and materials, suitable time to perform maintenance, and technical expertise. Scheduled maintenance is the issuance of a work order with a designed time frame to perform the task coordinated among the different departments.

Total productive maintenance - TPM is the main pillar of lean maintenance. For optimizing the reliability and effectiveness, it is an initiative of lean maintenance. TPM is proactive maintenance based on team work , based, utilize every level employees of the organization. TPM prepare for a shop floor maintenance system to save from kinds of

IMPROVING PRODUCTIVITY AND MAINTAINACE EFFICIENCY OF AN AUTOMOBILE INDUSTRY THROUGH LEAN - PRODUCTION CUM MAINTANCE SYSTEM

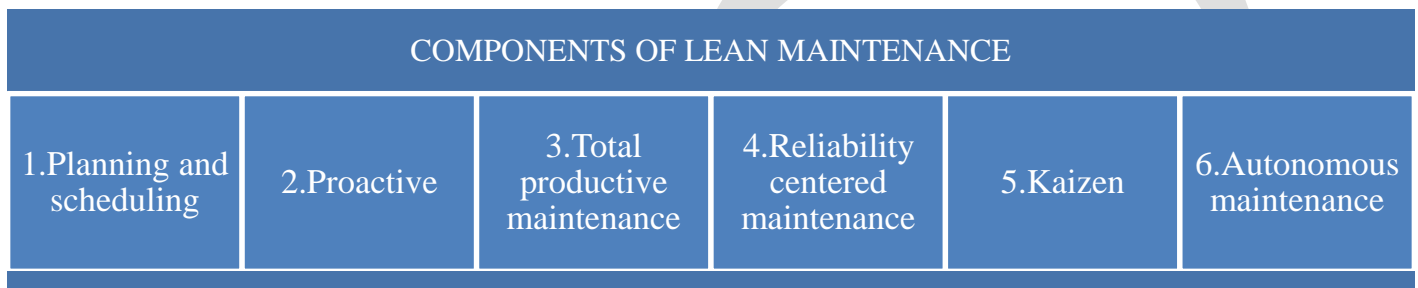


FIGURE-1: PARTS OF LEAN MAINTENANCE

Reliability centered maintenance - To determine the maintenance requirements of physical damage (break down) in present operating context. While TPM objectives is to maintain equipment effectiveness with reliability, RCM concept is based on optimizing maintenance effectiveness.

Kaizen - Kaizen is a methodology of continues improvement whether it is small in volume or importance. Kaizen in the kaizen methodology every process should be evaluated at the regular basis in terms of different parameters like required time, required resources, in form of quality etc.

Autonomous maintenance - This is system of periodic maintenance examples equipment lubrication, cleaning, Vibration check and noise difference etc.

Waste: Waste is defined as any resource or activity related to the process that is not contributing value to the end “product”, in this case defined as equipment availability.

Laws of Simplicity:

Reduce – To simplify the process best way is to reduction in steps.

Organize – Organizing the working and process in a well know system is key step to simplify the work.

Time – Saving of time give the more comfortable situation, as it provide more time to perform efficient work.

Knowledge & Skill – An overall view (knowledge) and skill about the subject make the work simpler.

Differences - Ease and difficulty require each other.

Emotion – Getting the emotions are very good.

Trust – Trust on self and team make the work feel simple.



FIGURE 2: LAWS OF SIMPLICITY

5S Workplace Organization: There five ‘5’ which guide to follow lean tools these 5s are Short, Set in order, Shine, Standardize, and Sustain.

Sort – Shorting is the step which ensure only required and useful tools and raw and components are available at work place and no unnecessary items in any form available in the work place and un-useful process is being follow in the work place so only the fruitful, really required tools, components, instruments and process are shorten and available at the work place

Set in order - Optimization of work place is possible just by a simple way of arranging the tools and instruments and all other working facilities like files, drawings, manuals in a manner that all these are set in order in which these will be used. For identification nominate the items to make easier to find them and use.

Shine – At work place each items must be in clean status which help to develop a positive attitude for working so keep a habit of swiping and cleaning on every day.

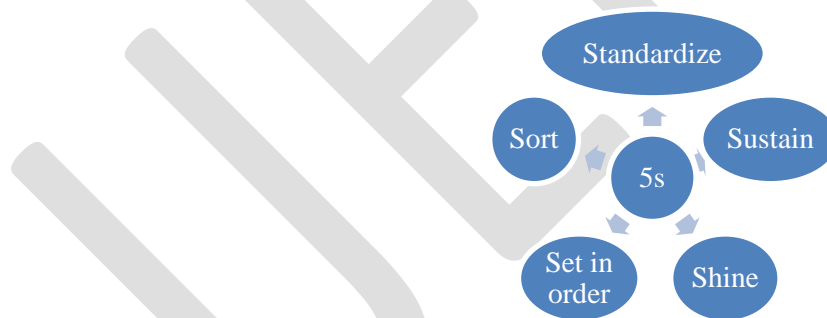


FIGURE - 5S WORKPLACE ORGANIZATION

Standardize - By making the stands for each step of process all over work become the standardize and each staff can perform the same efficiency in a standardize work system which will leads the quality production in lower cast with minimum possibilities of defects.

Sustain - All ‘four - S’ describe above must be maintain same position on regular bass and due to this the result will become a successfull implementation of 5S.

Literature review: Maintenance is considered as an activity that contributes to improving the availability, efficiency and productivity of each piece of equipment. The maintenance in the industrial sector has increasingly gained importance in enterprises. The current

demands of today's companies require the maintenance and management responsible to seek new forms of organization, using innovative techniques and methodologies to manage in the most efficient way. Maintenance shares significant operating costs in an organization. It is considered as a main pillar of the organizational performance. The combined issues of lean thinking and maintenance in particular performance is applicable as indicators to identify the impact of lean thinking within maintenance. Lean practices in manufacturing involve the elimination of wastes. Lean manufacturing are widely used by industries to eliminate waste and make the process more efficient. Concepts Lean manufacturing is a widely discussed and applied manufacturing philosophy, in a variety of industries across the globe. The fundamental concept of lean manufacturing is to provide a quality product while also ensuring that the product does not cost too much to the customer. Lean Manufacturing has become a worldwide phenomenon. It is quite successful in drawing the attention of companies of all sizes.

PROBLEM FORMULATION:

1. Breakdown Maintenances issues.
2. Lack of integrated maintenance planning and production scheduling.
3. Lack of fundamental production concept, Trick & techniques.
4. Lack of work efficiency.
5. Unawareness about the practice TPM.
6. Unnecessary loads.
7. Uncontrolled Waste formation.
8. Process Waste: Wastes due to long setup time, waiting time of inventory, waiting time of machinery, waiting time of man force, long Set-up Times, unskilled handling, Zero Lead time.
9. Absence of standardize target and Performance records.
10. Miss assumption.

PROPOSED METHODOLOGY:

1. Preventive maintenance - It is a form of maintenance practice where machine conditions controlled by performing maintenance preferably before failures to decrease the number of breakdowns.

Implement: To implement preventive maintenance better than corrective or breakdown maintenance, we use a schedule maintenance plan for machines. Suggested preventive schedule maintenance plan format has shown below.

INTEGRATED MAINTENANCE PLANNING AND PRODUCTION SCHEDULING								
Allocate machine	Pre-Check	Observation (Failure / PI)		Operate the M/C	Plan Mant. in prod. breaks	Ensure parts Ava.	Follow Maint. sch.	Obs. and Per. Fb.
		Ok	Sch. Maint.					
Area 1								
Area 2								
Area 3								
Area 4								
Area 5								
Area 6								

TABLE1: SAMPLE FORMAT FOR INTEGRATED MAINTENANCE PLANNING AND PRODUCTION SCHEDULING

2. Integrated maintenance planning and production scheduling- In the case of a preventive maintenance strategy, both maintenance and production decisions are relevant. Determining maintenance decisions individually based only on the state of machines.

INTEGRATED MAINTENANCE PLANNING AND PRODUCTION SCHEDULING								
Allocate machine	Pre-Check	Observation (Failure / PI)		Operate the M/C	Plan Mant. in prod. breaks	Ensure parts Ava.	Follow Maint. sch.	Obs. and Per. Fb.
		Ok	Sch. Maint.					
Area 1								
Area 2								
Area 3								
Area 4								
Area 5								
Area 6								

TABLE 2: SAMPLE FORMAT FOR INTEGRATED MAINTENANCE PLANNING AND PRODUCTION SCHEDULING

Where: Sch. - Schedule, Maint. – Maintenance, Fail. - Failure, PI - Pre indication, M/C – Machine, Obs. – observation, Fb. – feedback, Per. – performance, Prod. – Production, Ava. – Availability

3. Apply fundamental concept of Lean maintenance like -

- Reduce all resource needs (inputs) to the lowest possible level consistent with achieving the desired level of equipment reliability (output).
- Developed Reliability (loss in quality, stop times, loss in speed).
- Storage (reduce the store value at the same time as you protect service level to preservation)
- Use of new technology like Ensure less need for maintenance, better maintainability achieves the best operation means quality and value at the least possible cost.

4. Implementation of 5S methodology: To develop enthusiasm, avoid slow working, and to organizing process, it is suggested to implement 5S in following steps.

DepartmentsXY Z...	Implementation format of 5S methodology					Date dd/mm/yy
Form No. -	00X	Sort	Set in order	Shine	Standardize	Sustain
Work space						
Machines/ Equipments						
Work bench/ Table/ panel						
Process						
Quality Checks						
Feed back						
Others/ Miscellaneous						
Remarks						

Sign. Name
	Prepared by	Filled by	Checked by	Approval / Authority

TABLE 3: TABULAR FORMAT OF 5S FOR IMPLEMENTING, CONTROLLING AND COLLECTING FEEDBACK.

5. TPM Implementation

6. Ergonomics –

ERGONOMICS PARAMETERS OBSERVATION FORMAT					
Parameters	OBS.	Parameters	OBS.	Parameters	OBS.
Observation date		Exertion Posture		Asked correction	
Location Department		Exerted body part		Suggested correction	
Machine		Exertion in minutes		Approved corrections	
Operator		Operators complains		Remarks (if any)	

TABLE 4: FORMAT FOR ERGONOMICS PARAMETERS OBSERVATION

7. Just In Time Manufacture (JIT): JIT will lead the organization to producing the necessary units, in the necessary quantities at the necessary time with the required quality.

8. Performance indicators - The system of performance indicators it is required to use the tools like score board. Performance indicators tools must have with the criteria which restricted to shaping the appropriate standards or result of work in practice.

Score Board - Performance indicators Format For a Day				
Name	X	Y	Z	B
Performance indicators range				
Sectors				
Participants Departments				
Actions				
Review				
Standard				
Aims/ Target				
Time				
Previous measure				
Organizational goals				

TABLE 5: SCORE BOARD - PERFORMANCE INDICATORS FORMAT FOR A DAY

9). Re-configurability: TO eliminate the situation of miss assumption in the work cell or stores required the ability to change the process and check each and every single machines for the process go from good part to good part as quickly as possible. The absences of such practice result in manufacture time lost. Such practice will avoid the disturbance of the mechanic to check a number of unlike maintenance parts or components in the work shop at the time of maintenance it will also result in form of saving of time for selection of actual requirement.

RESULT & DISCUSSION

I). Result of implementation of Preventive maintenance.

1. Reduction in disturbance in work plan improved by 30 %.
2. Improvement in availability of repairing parts and components 30%.
3. Maintenance efficiency improved by 30%.
4. Growth observed in production flow 10%.

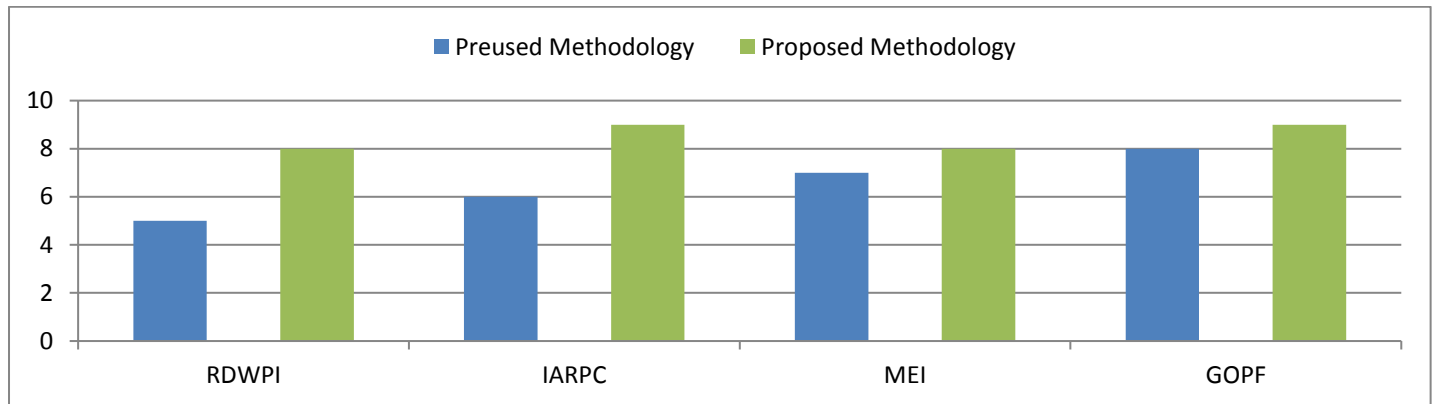


Figure: Result of implementation of Preventive maintenance

II). Effect due to integrated maintenance planning and production scheduling:

1. Efficiency of control and planning 20 % improved.
2. Control on uncertainty 30 % improved.
3. Systematic Plan for maintenance 50% improved.
4. Reduction in clashing of production and maintenance plan 10% better.
5. Problem solving approach 0% changes.
6. Effective Problem shooting 10% improved.
7. Achieving the target of scheduled repair 10% improved.
8. Improvement in repair parts inventory management 10 % improved.

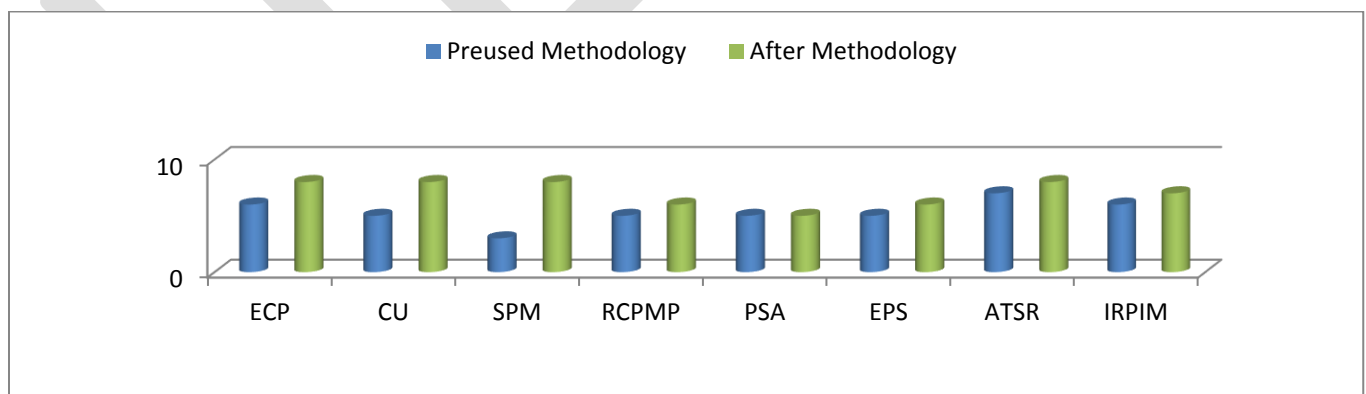


Figure: Effect due to integrated maintenance planning and production scheduling

III). Lack of fundamental production concept, Trick & techniques:

1. Control on equipment and parts inventory 20% improved.

2. Stop times 10% decline.
3. Storage issue 0% No change.
4. Technological awareness for minimum maintenance 10% improved.

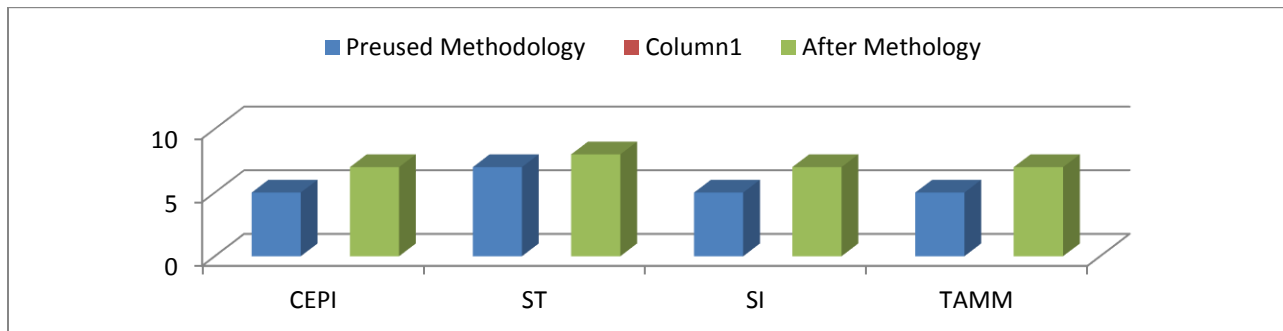


FIGURE: LACK OF FUNDAMENTAL PRODUCTION CONCEPT, TRICK & TECHNIQUES

IV). Improving work efficiency by implementing 5S methodology:

1. Enthusiasm at working area among the staff 20% better.
2. Working speed 10% improved.
3. Control on waste of time and work force 20% better.
4. Control over variation of work due to variant level of skills of different operators 30% improved.

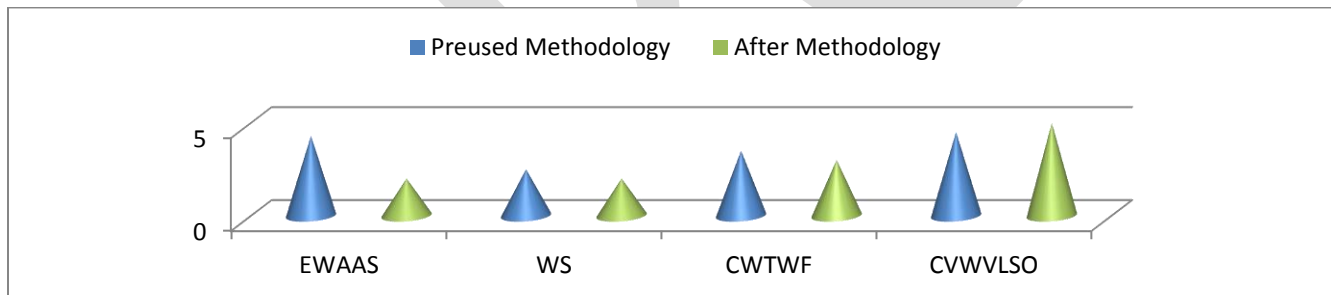


FIGURE: IMPROVING WORK EFFICIENCY BY IMPLEMENTING 5S METHODOLOGY

V). Comparative chart for Awareness & implementation of TPM

1. Top management support 50 % better.
2. TPM awareness 30 % better.
3. Autonomy to operators 10 % better.
4. Impact of TPM on employees 40 % better.

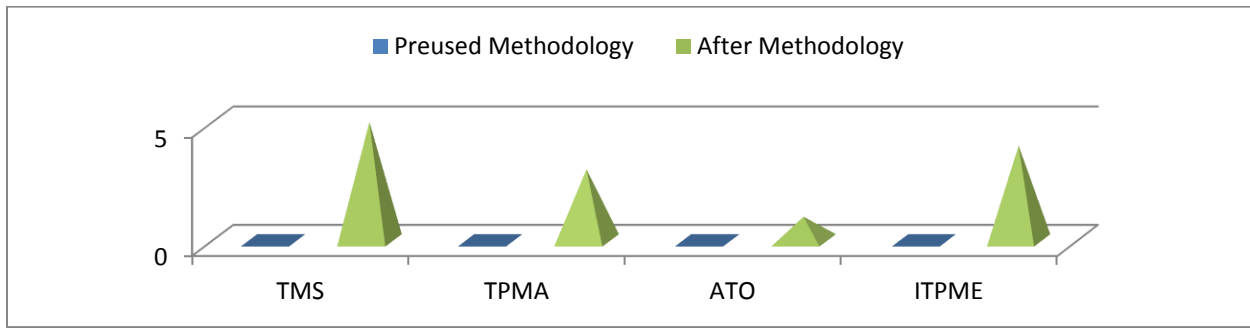


FIGURE: COMPARATIVE CHART FOR AWARENESS & IMPLEMENTATION OF TPM

VI). Comparative chart for Counter of Unnecessary loads before and after Ergonomics concepts:

1. Feel of Unnecessary loads 30 % decreased.
2. Physical fatigue 20% decreased.
3. Possibility of errors and mistakes 10 % decreased.
4. Injuries probability 40 % decreased.

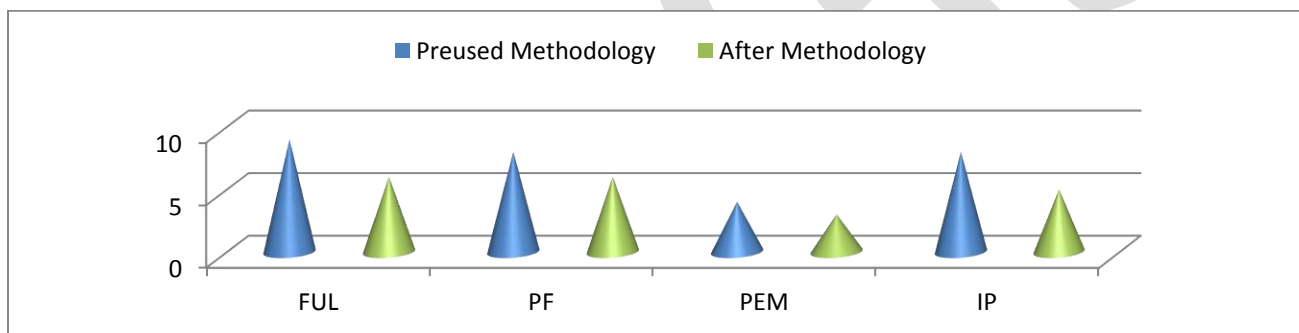


FIGURE: COMPARATIVE CHART FOR COUNTER OF UNNECESSARY LOADS BEFORE AND AFTER ERGONOMICS CONCEPTS

VII). Comparative chart for Uncontrolled Waste formation before and after JIT:

1. Over manufacture of parts and products 10 % decreased.
2. Unnecessary Inventory 20 % decreased.
3. Control over Faulty Products 0 % no change.
4. Unnecessary Transport 30 % decreased.
5. Waiting Time 30 % decreased.

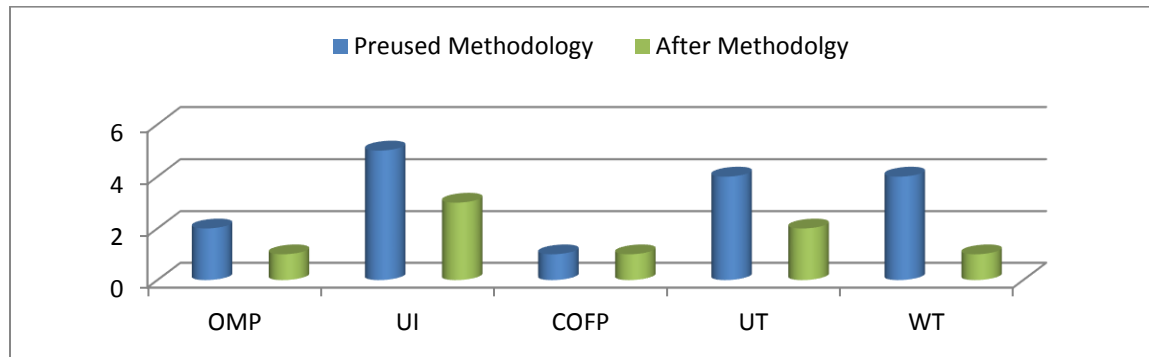


FIGURE: COMPARATIVE CHART FOR UNCONTROLLED WASTE FORMATION BEFORE AND AFTER JIT

VIII). Comparative chart for Process Waste:

1. Setup time 0 % No change.
2. Waiting time for inventory 10 % decreased.
3. Waiting time of machinery 10 % decreased.
4. Waiting time of man force 10 % decreased.

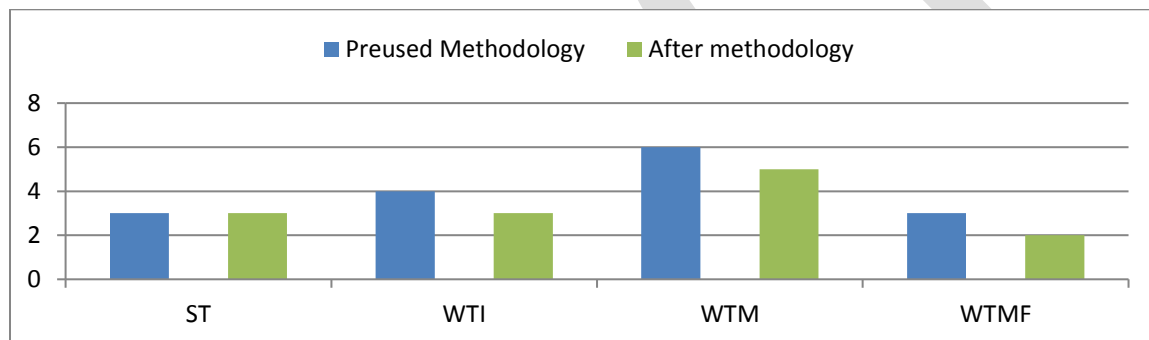


FIGURE: COMPARATIVE CHART FOR PROCESS WASTE

IX). Standardize target, Performance records and Re-configurability:

1. Clearly of targets 20% improved.
2. Ease of performance monitoring 20% improved.
3. Real time performance recodes 20% improved.
4. Continues effort 30% improved.

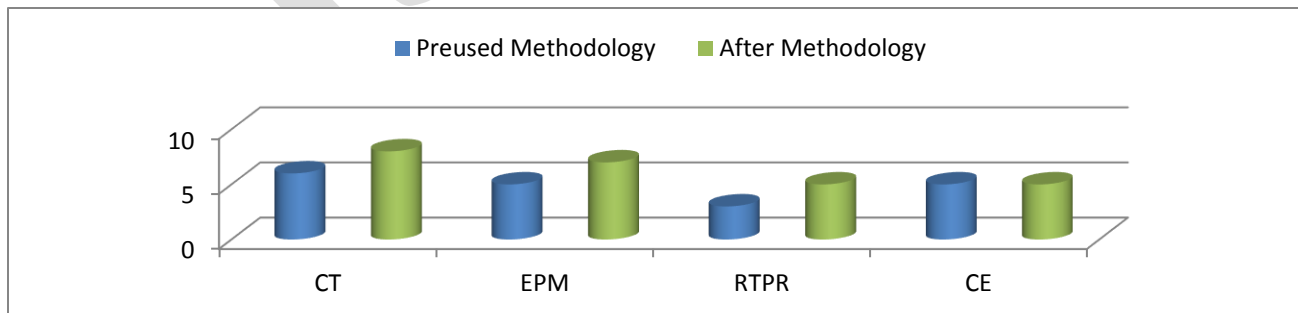


FIGURE: STANDARDIZE TARGET, PERFORMANCE RECORDS AND RE-CONFIGURABILITY

X). Comparative chart for Miss Assumption:

1. Unplanned maintenance 30% improved.
2. Disturbance due to maintenance of the mechanic 20% improved.
3. Disturbance to the mechanic 20% improved.
4. Sequencing of machine for maintenance 20% improved.

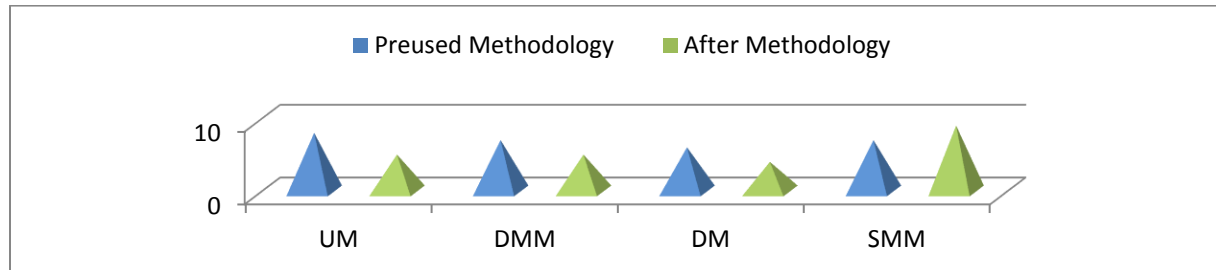


FIGURE: COMPARATIVE CHART FOR MISS ASSUMPTION

CONCLUSION:

This research study mainly focuses on Lean Productive Maintenance and its impact on organization performance. It is an empirical investigation. The study is confined to the automobile Industry.

This research guides to: reduce frequency of machine breakdown, reduces maintenance cost, reduced production cost, enhance quality with control on rejection, leads to high productivity, produce quality product, in less efforts, less time, in least cost and develop the environment in which everyone want to excel for quality products, improve productivity.

This research methodology summaries following points.

- If proper training will be provided it will reduce implementation tenure.
- Major barriers in found implementing Lean are lack of experience and awareness, resistance to change.
- Observed improvement in employees' behavior such as morale and attitude, creativity, initiative, belongingness and commitment, problem solving nature, co-ordination and cooperation.
- Noticed that there is improvement in productivity and quality and reduced machine breakdown production cost and rejection.
- Lean system is helpful for reducing man-hours of production and maintenance department.

FUTURE CONCEPT:

Majority of small scale Indian automobile industries are hesitant to adopt Lean maintenance practices, there is further scope to explore to do comparative analysis among Lean maintenance system implemented and non-implemented small scale industries. There is also scope for research in service sector industries where heavy use of machineries in operation. For examples Transportation and Hospital etc.

During the Lean maintenance practices, It has been found that on life of machine no much concern. Hence there is need to evaluate machine's life on various parameters and if required that machine should be discarded. Operator's performance also needs to be evaluated properly not only on the basis of production but also on the basis of reduction in breakdowns and maintenance cost. It will be helpful to give due regards, awards, recognition and monetary benefits to operator as per the performance of machine.

We surveyed the models integrating maintenance reasoning into production problems, optimizing the performance of the production system in the long term. First, we provided a brief background on the common maintenance concepts and solution approaches. We

then divided the production problems in to production planning and maintenance situations into no control and partial control over machine conditions.

Implement the Integrated maintenance and production planning with partial control over machine conditions in the context of a periodic review production system. The goal should be to determine the optimal amount of investment in maintenance for a given production quantity considering the inventory on hand.

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Analysis and Optimization of Strongly Coupled Magnetic Resonance for Wireless Power Transfer Applications

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Abstract—The objective of the proposed research work is to investigate the use of self resonating coils operating in a strongly coupled mode for wireless power transfer applications, study and optimize the results of using coils of different geometries on power transfer efficiency and demonstrate the concept by transferring power wirelessly. Using the theoretical analysis, derived equations and simulations, a structure made of cylindrical coils with source radius 7.5cm capable of delivering wireless output power up to 4 watts at an efficiency of 70% wirelessly over 10cm was built. A further increase in efficiency of about 8% was achieved by using a combination of a cylindrical source and spiral receiver which also has the significant advantage of being easier to implement in future applications due to sizeable reduction in volume required on the receiving side. Finally the wireless power transfer was also given a physical dimension by demonstrating the lighting of bulbs at 20cm at an efficiency of 51% and the wireless charging of an i-pod was attempted.

Keywords— Magnetic coupling, resonance, wireless power transfer, cylindrical coil, spiral receiver, electromagnetic simulation software, strongly coupled regime

1.INTRODUCTION

Wireless power transfer(WPT) is recently getting much attention as an alternative energy transfer scheme without any physical contact between the source and the load. The genius inventor Nikola Tesla's future envisioned of energy radiation through huge towers and intended for household consumption is the basic behind the WPT process. Although existing 100 years well before the arrival of the electric grid, but in recent past there has been a remarkable progress and research interest in making the WPT scheme commercially viable. In addition to this, surge in use of personal gadgets and consumer electronic devices those require regular charging and battery maintenance, the energy transfer through WPT technique is in demand as convenient and safe methods. It is quite apparent; WPT products will provide better quality of life in term of convenience but lagging much behind in economical point of view. However, there is abundant prospective in use of WPT as it is capable of powering household devices like remotes and clocks which in turn would reduce the use of large no of batteries every year. The chemical batteries being disposed is seen to be a major source which contaminating the ground water and produce toxins even when destroyed by incinerators. Also in some cases where wiring is not cost effective, risky or impossible then WPT may be considered as the only facilitating technology.

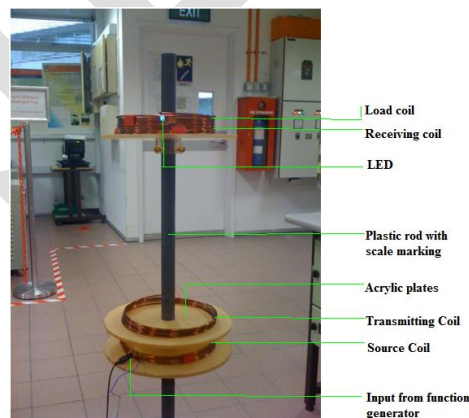


Fig. 1: Strongly coupled magnetic resonance powering the LED.

But unfortunately various methods of radiative, non-directional WPT systems using radio waves have resulted in failure due to the inherent poor efficiencies and other non-radiative techniques using lasers or microwaves are either unsafe or unsuitable for consumer use. Therefore this paper explores the use of a novel WPT technique that utilizes self resonant coils tuned to operate in a strongly coupled regime. This process is both safe for everyday use and highly energy efficient in the dimensions comparable to a typical room

making it greatly suitable for consumer applications.

2.CONTENTES

The basic idea behind this paper is that two nearby coils resonated at the same operating frequency operates in the strongly coupled regime mode. In this operating mode energy will be transferred between them at optimum efficiency whereas other surrounding non-resonated objects will interact very weakly. Although it seems very much analogous to normal inductive coupling but basic dissimilarity is that the inductive coupling works only for short distance and the receiver should be placed in the field of the transmitter coil. But by resonating both coils efficiency as well as the distance of operation will be enhanced vividly. This phenomenon can be compared to an opera singer shattering a particular glass when he/she sings the right frequency. In strongly coupled regime evanescent coupling is setup between the resonating coils which is electromagnetic equivalent of quantum-mechanical tunneling [2]. This means that energy is transferred from transmitter to receiver in much shorter time intervals than energy can be dissipated through ohmic and radiative losses thus improving efficiencies. In short the energy transfer rate \gg energy dissipation rate when operating in strongly coupled regime.

For the resonators let us consider a transmitting and receiving coil of cylindrical conducting loops with a capacitor attached to the ends. For this configuration, the resonant angular frequency of the circuit is determined by the well known equation

$$\omega = \frac{1}{\sqrt{LC}} \quad (1)$$

Where, ω is the resonant angular frequency, L is the inductance of the coil and C is the capacitance of the coil. The coupling coefficient of the coils is given by the following equation. [2]

$$k = \frac{\omega M}{2\sqrt{L_1 L_2}} \quad (2)$$

Where L_1 and L_2 are the inductance of primary and secondary coil respectively and the mutual inductance can be derived from Biot-savart's law using simple approximations as

$$M = \frac{\mu_0 \pi N^2 r^2 r_b^2}{2(r^2 + D^2)^{3/2}} \quad (3)$$

Where r , r_b are the primary and secondary coil radius respectively, N is number of turns of secondary coil and D is the distance between coils. By comparing this with the, M value defined by the Groover's tables, it is verified that, the error due to approximations made are negligible for dimensions comparable to a typical room. The intrinsic loss rate of the system is given by the following equation [2]. And the ohmic or absorption loss and radiation loss are

$$\Gamma = \frac{(R_{ohm} + R_{rad})}{2L} \quad (4)$$

$$R_{ohmic} = \frac{l}{4\pi a} \sqrt{\frac{\mu_0 \omega}{2\sigma}} = \frac{rN}{2a} \sqrt{\frac{\mu_0 \omega}{2\sigma}} \quad (5)$$

$$R_{radiative} = \sqrt{\frac{\mu_0}{\epsilon_0}} \left[\frac{\pi N^2}{1.2} \left(\frac{\omega r}{c} \right)^4 + \frac{2}{3\pi^3} \left(\frac{\omega h}{c} \right)^2 \right] \quad (6)$$

where N is the number of turns, σ is conductivity and 'a' is the radius of conductor used in coil.

$$R_{radiative} = \sqrt{\frac{\mu_0}{\epsilon_0}} \left[\frac{4\pi^5 N^2}{3} \left(\frac{r}{\lambda} \right)^4 \right] = 15600\pi^2 N^2 \left(\frac{r}{\lambda} \right)^4 \quad (7)$$

where, λ is wavelength, which is a function of frequency. The efficiency of the system, η , is function of the coupling-to-loss ratio, κ/Γ [2]

The first term is a magnetic dipole radiation term and the second term is due to the electric dipole of the coil. The second term is much smaller than the first term by about 10^{50} times for our experimental parameters and can be ignored for simplicity. Therefore by substituting for ω and c we get

$$\eta = \frac{\frac{k^2}{\Gamma^2} \sqrt{1 + \frac{k^2}{\Gamma^2}}}{\left(1 + \sqrt{1 + \frac{k^2}{\Gamma^2}} \right) \frac{k^2}{\Gamma^2} + \left(1 + \sqrt{1 + \frac{k^2}{\Gamma^2}} \right)^2} \quad (8)$$

For the system to be efficient, the system must operate in the strongly coupled region ($\kappa/T \gg 1$) and as large as possible. Therefore by maximizing κ/T , it is possible to get max efficiency. By using (1 - 6), the following formula is derived for cylindrical coils of similar dimensions.

$$\frac{\kappa}{T} = \frac{\mu_0 \pi \omega r^3}{2(r^2 + D^2)^{3/2}} \left[\frac{N}{\frac{1}{a} \sqrt{\frac{\mu_0 \omega}{8\sigma}} + \frac{\pi N r^3 \omega^4}{16c^4} \sqrt{\frac{\mu_0}{\epsilon_0}}} \right] \quad (9)$$

From (9) the only obvious predictions are that it is possible to increase efficiency by increasing conductivity or radius of conductor 'a' or by decreasing distance D. The rest of the factors do not have a straight forward relationship with efficiency and (9) needs to be differentiated with respect to a variable to maximize efficiency.

3.SIMULATION

A. Efficiency vs resonant frequency

It is imperative to state that each system has its own optimum efficiency regime i.e strongly coupled region ($\kappa/T \gg 1$), where power transfer is highly efficient. Using the equations in section II the following simulations are created to verify the concepts. As a starting point two cylindrical coils of 5 turns each of radius 7.5cm connected to a suitable capacitor C is chosen and efficiency vs resonant frequency is simulated in Fig. 2. For this particular setup the band from 1MHz to 100MHz is the strongly coupled region. Fig 3 is the simulation of κ/T vs frequency. Comparing fig 2 and fig 3, the theory is verified that in the region where $\kappa/T \gg 1$, efficiencies are very high and this is the strongly coupled region for this setup.

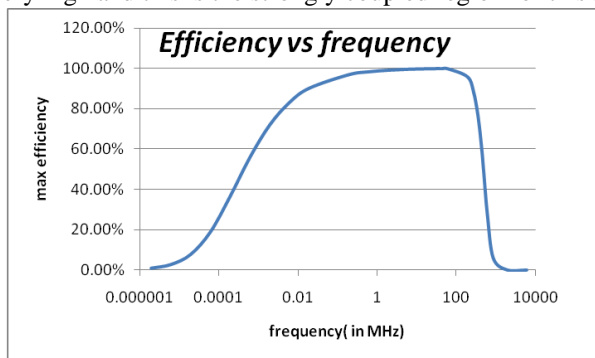


Fig. 1: Frequency characteristics of efficiency

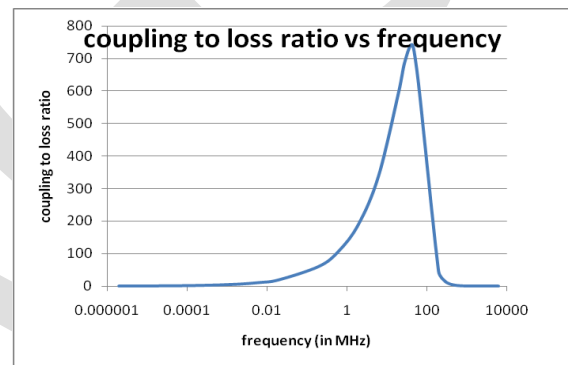


Fig. 2: Coupling to loss ratio versus frequency.

B. Efficiency vs coil size

When radius of the cylindrical coil is changed the optimum efficiency band also changes with it. In Fig. 4 the simulation shows the strongly coupled regions for different coil sizes. This phenomenon can be explained with (8) since r has multiple factors in the equation and there will always be an optimum 'r' if other variables are fixed.

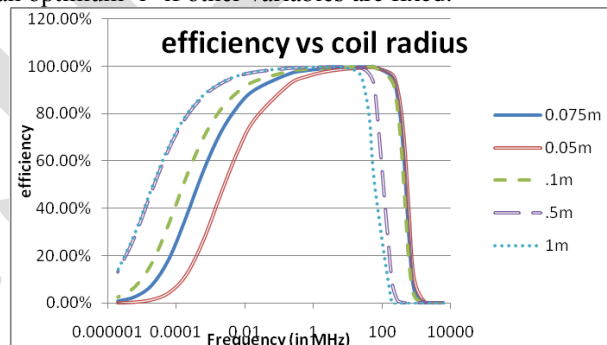


Fig. 3: Efficiency versus coil radius.

C. Efficiency vs distance

When the distance is simulated as a variable in Fig. 5, it is seen that the optimum efficiency band does not shift. It rather shrinks down to a peak point because the resonance can no longer compensate for the increase in distance. This is verified from (8).

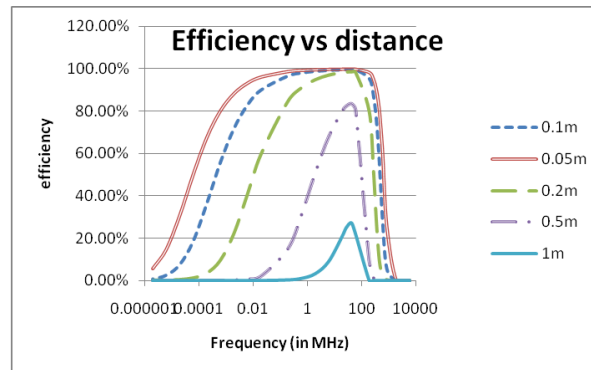


Fig. 5: Efficiency versus coil distance.

D. Simulation of magnetic coupling

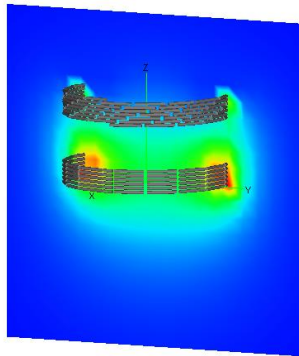


Fig. 4: Red areas indicate strongest magnetic field followed by yellow, green and blue.

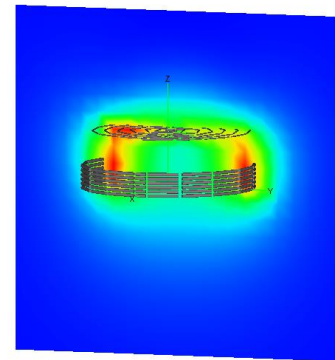


Fig. 5: Better coupling between cylinder transmitter and spiral receiver.

The parameter coupling coefficient is very much important to calculate the efficiency of power transfer and hence is required to consider different coil shape. Traditionally only cylindrical coils are used for coupling purposes but theoretically it is possible to design equivalent spiral coils such that they have a higher coupling coefficient but also higher ohmic losses due to increased length when compared to cylindrical coils. When the first effect dominates over the second there is higher efficiency [5]. Fig. 6 and Fig. 7 using electromagnetic simulation software indicate that spiral receiver combination with cylindrical transmitter shows better magnetic coupling as compared to cylindrical coils.

4.EXPERIMENT AT LOW POWER

The experiment is designed such that the setup is easy to handle. Two cylindrical coils of 7.5 cm radius 5 turns each are inductively coupled to a source and load coil of similar dimensions. Although wires can be directly connected to the resonating coils, it is easier to do it this way. A frequency of 2 MHz is chosen which is in the strongly coupled regime and does not interfere with any allocated spectrum. It is also safer than using very high frequencies like 100MHz which is also in the optimum efficiency band. For this frequency range the appropriate capacitor to be used is 1000pF. The exact resonant frequency is found to be 2.05MHz which is slightly different from the calculated resonant frequency of 1.93MHz (1). This discrepancy is attributed to the coils not being perfect cylinders.

A. Efficiency vs load for different distances

Fig 8 shows the graph of efficiency vs load for different distances. As expected according to (8) the efficiency decreases with increasing distance. But by using strongly coupled resonance it is seen that power can be transmitted over distances much larger than any inductive system can.

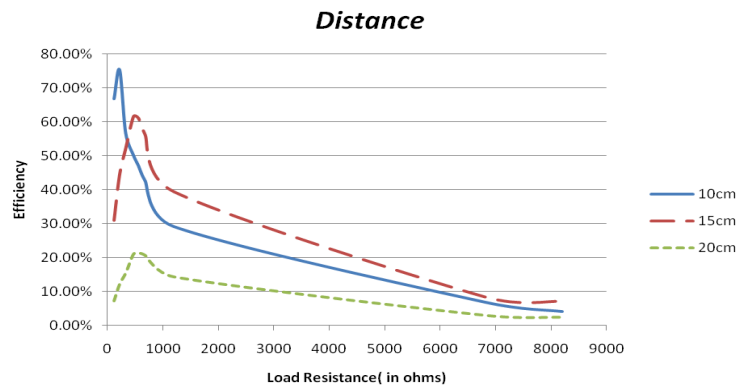


Fig. 8: Efficiency degradation with increasing coil distance

B. Shape of the coil

The shape of the coil is more relevant when considering the volume that the receiver coils will occupy in future applications. Different coil sizes and shapes were experimented with but the most efficient configuration was attained when cylindrical transmitter and spiral receiver combination is used. An efficiency improvement of 8% is seen due to increase in mutual inductance which increases coupling coefficient (2) and thus the efficiency. This confirms with the simulation in Fig. 9 shows a graph of efficiency vs load for such a configuration.

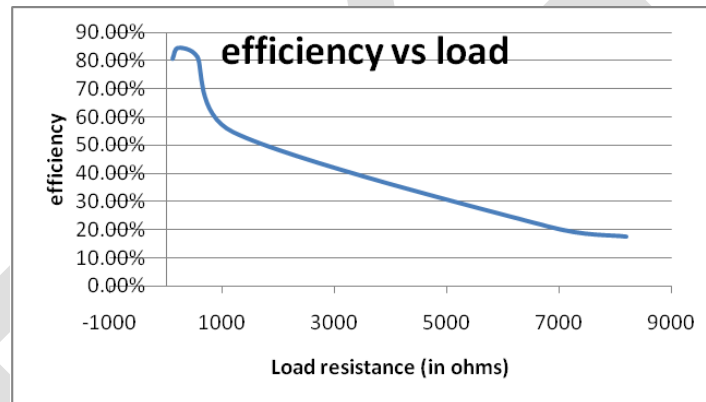


Fig. 9: Efficiency characteristics through a cylindrical transmitter and spiral receiver.

C. Network of resonators

It is perceived that when an additional coil resonating at the same frequency is put between the transmitter and receiver coil then efficiency as well as range is enhanced. An intermediate coil can act as a relay of energy source for the next resonator. An analogy can be drawn to WIFI routers and extenders. But it should be noted that each hop will add ohmic losses but still this method can extend range and efficiency when compared to have one pair of transmitter and receiver. Fig. 10 shows the powering of a LED using a network of resonators at 60cm which otherwise would not be possible.



Fig. 6: Practical experimental setup.

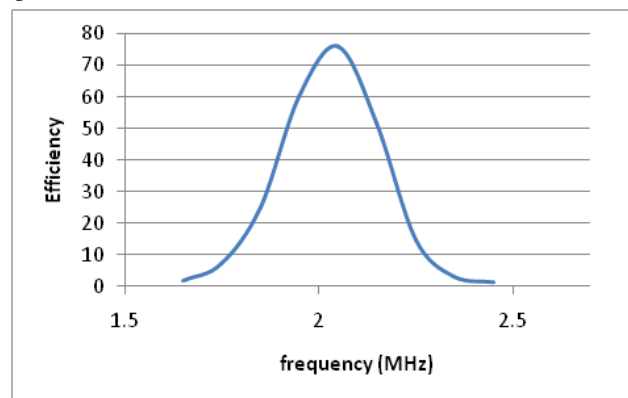


Fig. 7: Powering of a LED using a network of resonators at 60cm.

5.EXPERIMENT AT HIGH POWER

Ideally for future applications a crystal oscillator output would be amplified by a power amplifier and connected to a resonator. For this purpose a Colpitts oscillator was built and tested successfully. For the amplification a high speed amplifier HSA4014 was used. Power levels up to 4 watts were experimented with. Efficiency vs frequency. This experiment (Fig. 11) serves to prove that at the resonance point of the system there is a sharp increase in efficiency. At the resonance point of 2.05 MHz the efficiency is largest. This phenomenon is comparable to an opera singer who can shatter a glass by singing the right frequency.

A. Efficiency vs load for different power levels

With the power amplifier the WPT system can be tested at various power levels. The input power can be increased by increasing the amplitude of signal into the power amplifier. This experiment (Fig. 12) proves that the power input does not have an effect on efficiency. The small reduction in efficiency is due to heating of the wire and capacitors. This can be easily solved by using high power components.

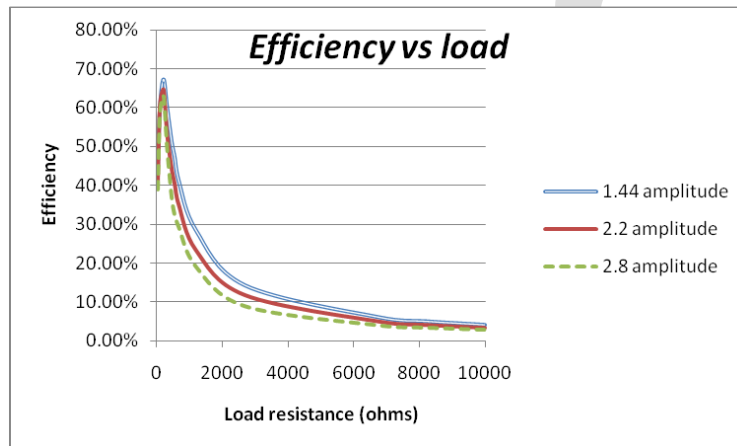


Fig. 8: Effect of input power on efficiency.

B. Use of cylindrical transmitter and spiral receiver

The concept of using spiral structures to increase efficiency has already been discussed in section II. This experiment (Fig. 13) served to verify that the idea holds good at higher power levels. An efficiency increase of about 8% was achieved consistent with the findings in section 4.

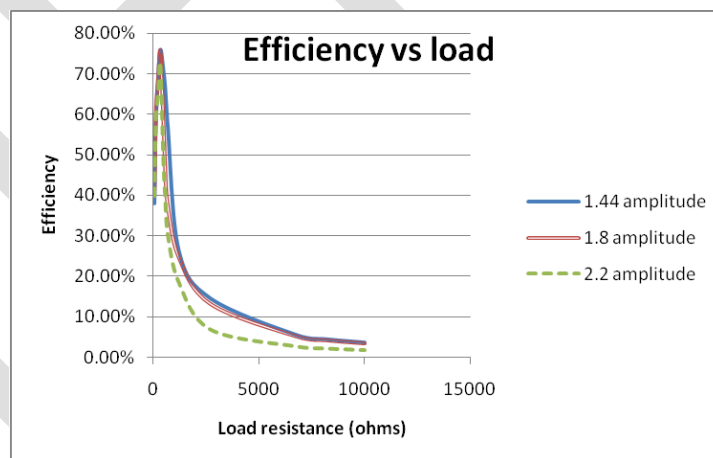


Fig. 9: Spiral receiver coil with cylindrical transmitter.

C. Powering bulbs

To add a physical perspective to the project bulbs of different rating were lit wirelessly at high efficiencies (Fig. 14). A 12 V bulb was lit at a distance of 20 cm at 51% efficiency with an output power of 1 watt. Other bulbs of rating 2.4V, 3.6V and 7.2V were also powered successfully.



Fig. 10: Bulbs of different rating lit wirelessly with high efficiencies.

D. Powering multiple loads and effect of extraneous objects

The following experiment (Fig. 15) is designed to demonstrate for powering multiple devices with different geometry resonated at the same frequency. Here we can see that a single source is able to efficiently power two separate receiver coils of dissimilar dimension operated at same resonant frequency. Note that experimental bench setup comprises the smaller coil and the receiver coil which is out of the line of sight. With an unique advantageous of not interacting with non-resonating object or extraneous objects, the resonant magnetic waves are very much efficient in transferring power wirelessly with loss of very less energy.

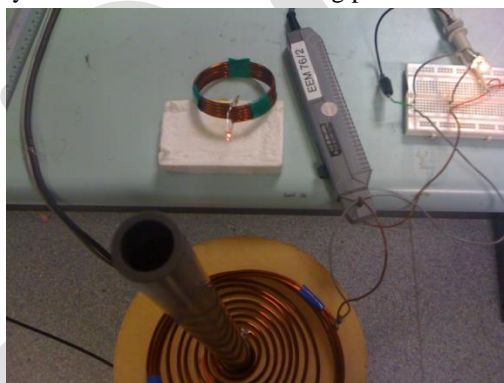


Fig. 11: Using a single source and a spiral receiver to power the bulb and a smaller cylindrical receiver to power the LED.

E. Wireless charging of an ipod

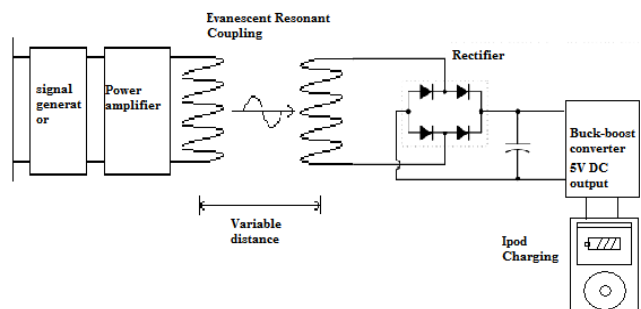


Fig. 16: Full-Bridge rectifier circuit with Buck-boost receiver.

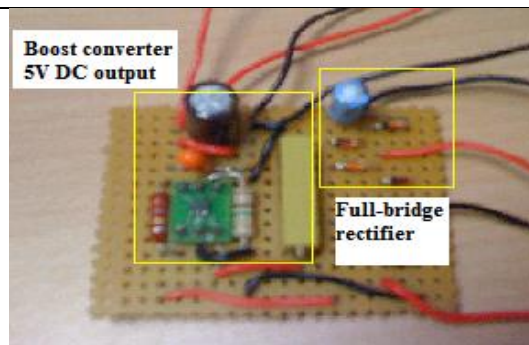


Fig. 12: Suitable high current buck-boost converter with Full-Bridge rectifier circuit

Due to the popularity and prevalence of music players and gadgets, any aspiring wireless charging system should be able to power such devices. The basic idea would be to convert the high frequency power output into a 5V DC form for the iPod to start charging. Besides to facilitate the mobility of the device, the converter should be able to create a constant 5V DC from a variable AC

supply. But due to difficulties procuring a suitable high current buck-boost converter, a boost converter LTC3429 was used in its place. This circuit (Fig. 17) was tested and worked well at low frequency AC supply and charged the ipod but broke down when 2MHz range frequency is used. The reason for this was identified as the diodes in the rectifier not being able to recover fast enough to rectify the high frequency AC supply. This high frequency rectification is identified as an issue for further development.

6.SAFETY AND PRECAUTIONS

Due to the high frequencies nature of this experiment and to explore future commercial applications, it is prudent to verify the safety aspect of the current setup. In general people are very suspicious of electromagnetic radiation and they are right to do so. But by following strict guidelines posed by governmental and other international organizations like the International Commission for Non-ionizing Radiation Protection (ICNIRP), we can ensure safety. With guidelines from these international bodies the safety aspect of this project is analyzed and it is shown that the current setup is completely safe. Within the scope of this project we are only concerned about non-ionizing radiation for which the ICNIRP has published detailed guidelines [11]. According to the report the ways in which electromagnetic radiation can affect living tissue are

- A time-varying magnetic field coupling with living tissue to result in induced circulating currents within the body.
- Exposure to electromagnetic fields above 100 kHz can lead to absorption of energy and temperature increases.

In these cases, the parameter Specific Absorption Rate (SAR) is used to assess health risks. The ICNIRP also estimates that a average person has a resonant absorption frequency close to 70MHz.

It is the view of the ICNIRP that the results from the epidemiological research on EMF field exposure and cancer are not strong enough in the absence of support from experimental research to form a scientific basis for setting exposure guidelines. After incorporating sufficient safety factors, it was concluded that for frequencies between 1-10 MHz the guideline formula is $B < 0.92/f$. This constraint was verified in the project setup using a tesla meter to measure magnetic field. This shows that the current setup operating at 2.05 MHz range for applications in the range of tens of watts should be safe for public use. Besides the frequency used is much different from the human body resonant frequency of 70MHz. But it should be noted that there not enough literature to decide if this setup would interfere with pacemakers or critical devices. To the best of the author's knowledge there was no observable effect on mobile phones or other electronics during experiments. Therefore it is the author's opinion that pacemakers would not be affected by the current setup.

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Dynamic pressure compensation analysis in pre-compensated hydraulic spool type valve

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Abstract— The main objective of the present work is to analyze the pressure compensation phenomenon and observe the variations in output flow as per change in pressure margins across the directional flow control valve. A MATLAB code is created and Simulink model is built for dynamic analysis of capturing compensator spool behavior in typical pre-compensated mobile control valve. Simulation results are compared with the test results and correlation is established.

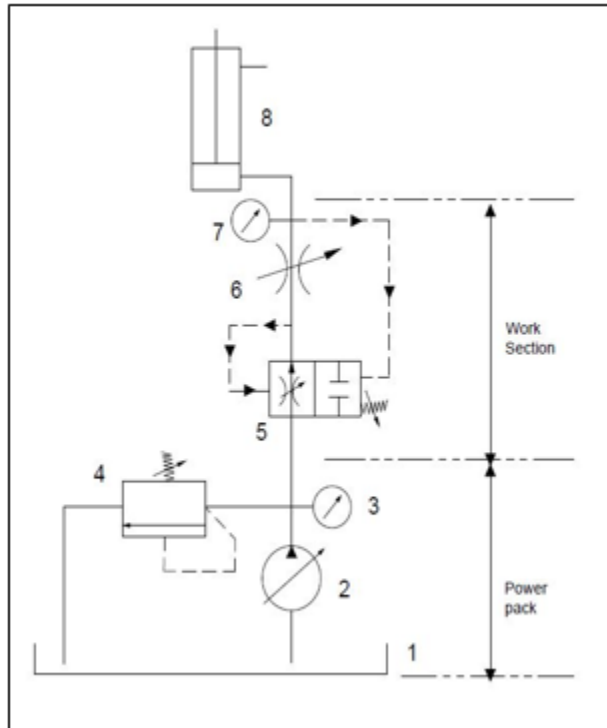
Keywords— Spool, compensator, orifice pressure drop, flow, MATLAB-Simulink, Coefficient of discharge.

INTRODUCTION:

In case of mobile valve equipments, OEMs demand precise flow control through the valve to the actuator such as hydraulic cylinder or motor irrespective of changes in load induced pressure. Therefore, development of pressure compensated control valve is today's only preferred technology in order to satisfy the demands for better flow performance. There are different types of spool valves based upon the type of actuations mechanism, number of operating positions. These spool valves include a shaft element called as spool which moves inside a bore of the manifold of the valve and provides the passage for oil to flow from one port to another. In order to achieve flow control irrespective of changes in load induced pressures, these spool valves are assembled with one more spool which is called as compensator spool. Depending upon the position of the compensator spool with respect to main flow spool, pressure compensated valves are classified as either pre-compensated valves or post-compensated valves. In pre-compensated valves, compensator is located upstream (before) main spool whereas in case of post-compensated valves it is located downstream (after) main spool. Furthermore, in pre-compensated valves, compensator is in normally open position which is alike to normally closed position in post-compensated valves. Overall, the function of the compensator remains same and it is to maintain constant flow through the work port of valve by varying its position for taking into account the variations in the load induced pressure. Such pressure compensated valves are usually helpful while operating sectional valves simultaneously at different pressures for controlling different functions of the machine at a time.

HOW PRE-COMPENSATED SYSTEM WORKS:

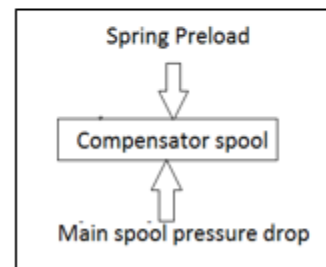
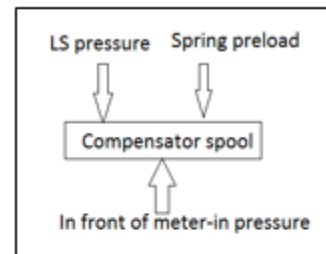
Hydraulic schematic below shows the typical circuit of pre-compensated valve. Out of the total pressure drop across the valve, part of pressure drop occurs across the compensator and remaining pressure drop occurs across the main spool. A compensator spool is similar to pressure reducing valve where it works between two pressures. On one side compensator experiences the force induced because of the pressure which is generated after compensator orifice which is known as control chamber force and on other side it experiences the force created because of pressure dropped after main spool (metering) orifice which is known as load sense chamber force. The load sense chamber pressure is always less than control chamber pressure. Thus, the difference in two pressure values is the pressure drop occurring across main spool which is shown in free body diagram of compensator. Since the load sense pressure is lesser than control chamber pressure, a spring is installed in load sense chamber which will provide pre-load generating pressure equivalent to main spool pressure drop.



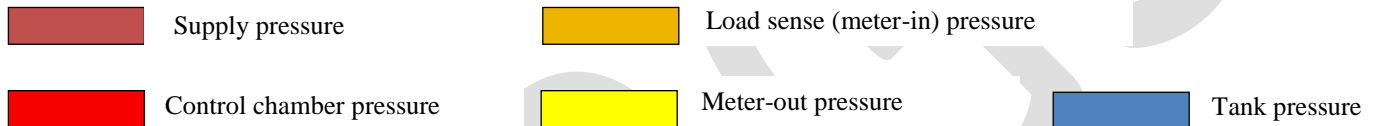
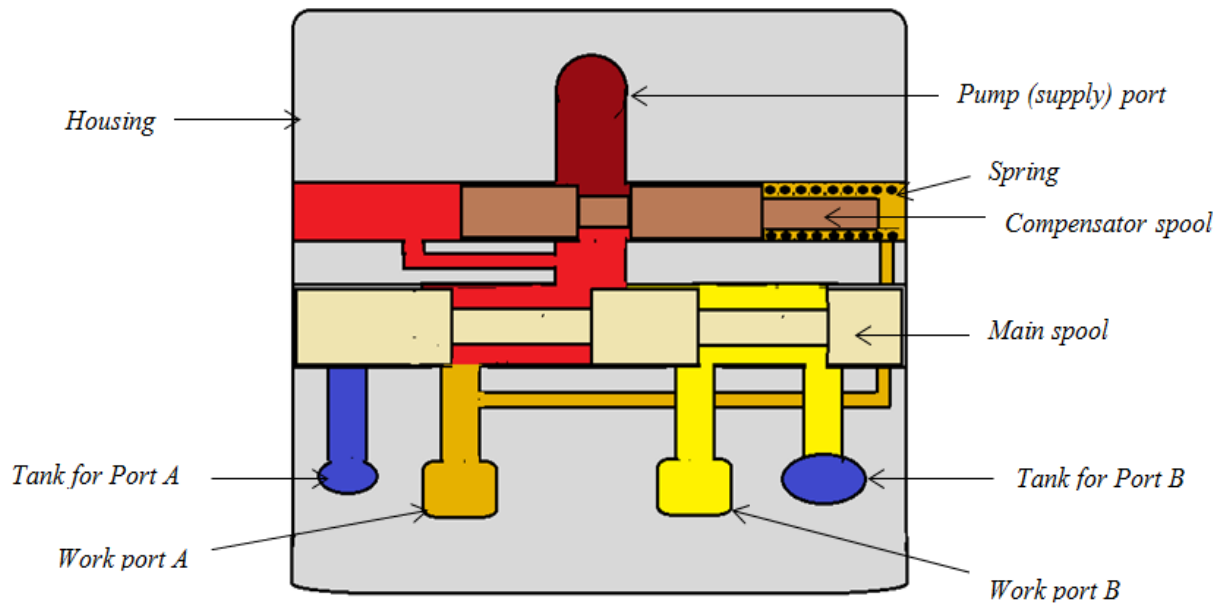
Nomenclature of the symbols in the schematic is as follows

1. Reservoir (Tank)
2. Variable displacement unidirectional pump
3. Pressure gauge for measuring inlet/supply pressure
4. System relief valve
5. Compensator spool (Normally open)
6. Main spool (Metering orifice)
7. Pressure gauge for measuring load sense pressure
8. Actuator (Double acting cylinder)

Therefore, it can be concluded that the pressure created by spring pre-load on spool cross-sectional area is the amount of pressure drop occurring across main spool. When there is increase in the total pressure drop across valve then pressure acting on compensator through control chamber increases which makes compensator to shift from its normally open position by some amount and causes the excess of pressure drop across itself keeping constant pressure drop across main spool ultimately maintaining constant flow through main spool. The position which compensator will achieve is called as equilibrium position and is dependent on the amount of change in total pressure drop. Therefore pressure compensation is a dynamic phenomenon which we are going to capture in present study through simulation in SIMULINK.

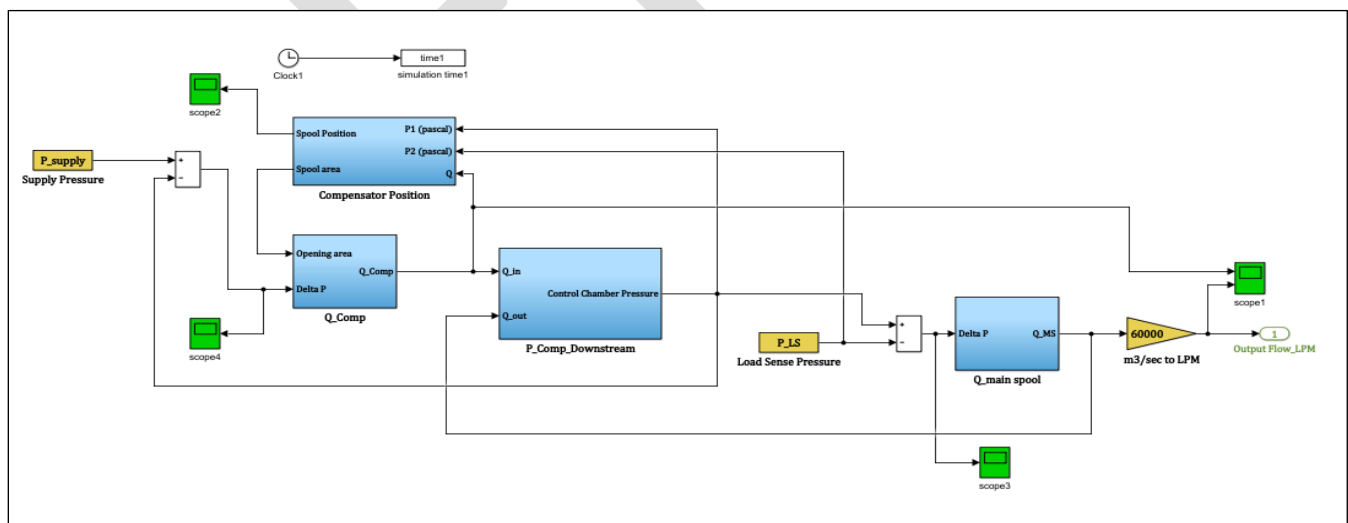


TYPICAL ARCHITECTURE OF PRE-COMPENSATED VALVE:

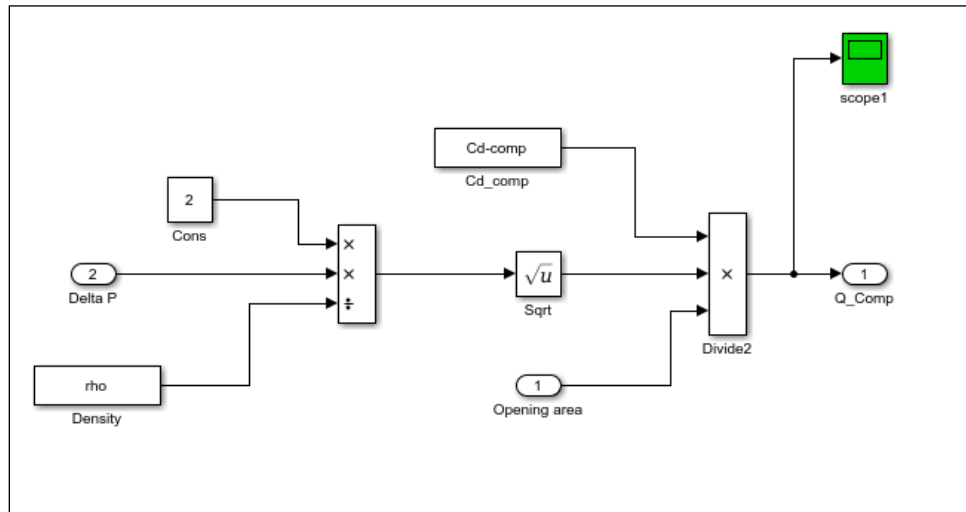


DYNAMIC ANALYSIS OF PRESSURE COMPENSATION:

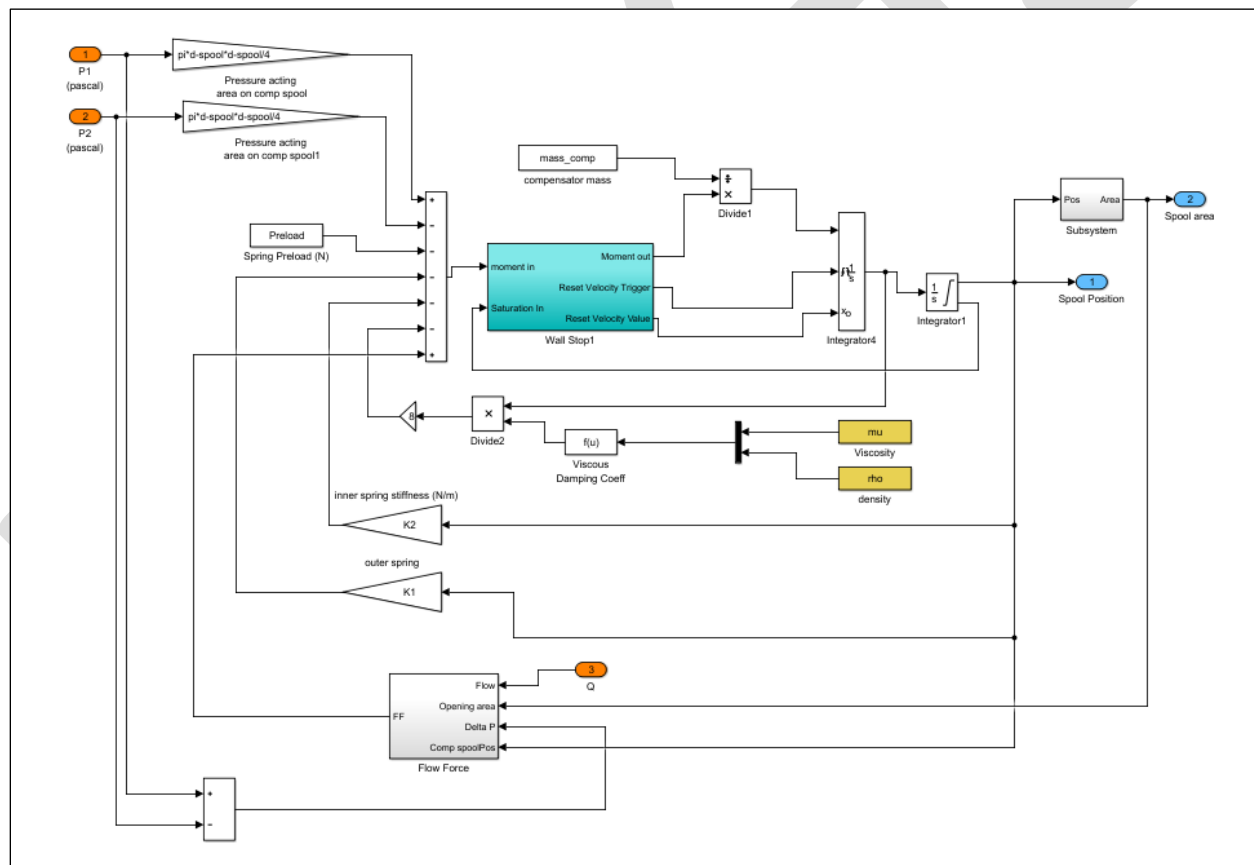
To analyze pressure compensation phenomenon, a math model in MATLAB-SIMULINK is build. It includes the analysis of compensator spool position with respect to time, main spool flow variation with respect to variation in load induced pressure. Generated math model is shown below.



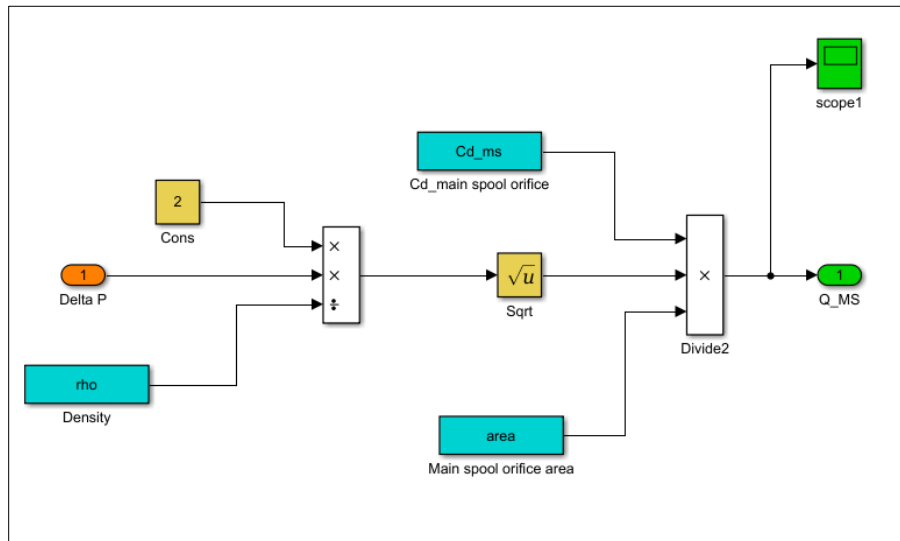
Overall valve level math model



Math model for compensator spool flow



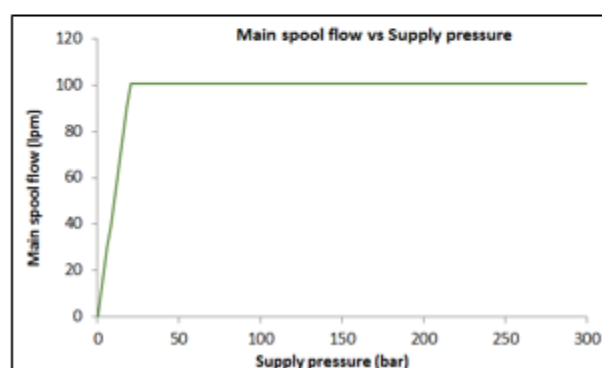
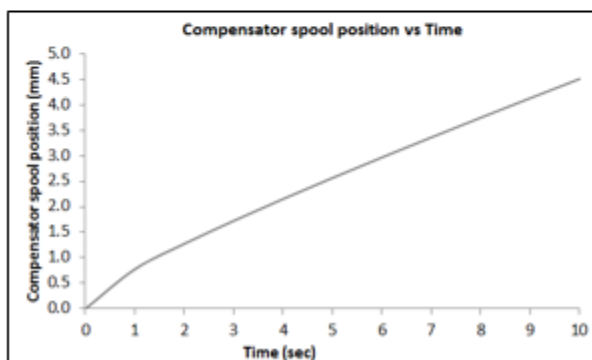
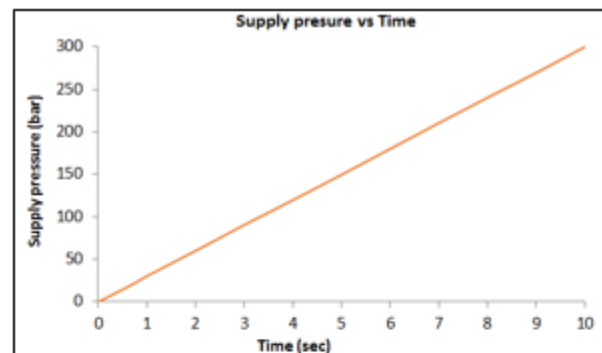
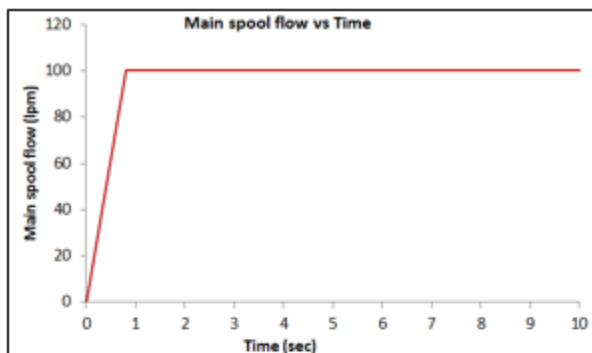
Math model for compensator spool position



Math model for metering spool flow

SIMULATION APPROACH AND RESULTS:

The simulation for compensation analysis is done with the assumption of some parameters such as coefficient of discharge at compensator spool, coefficient of discharge at main spool, oil density



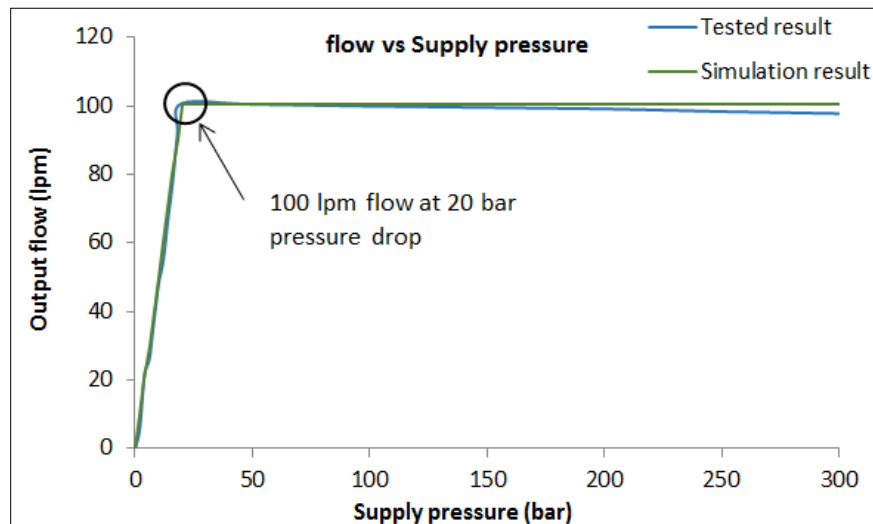
TEST CONDITIONS:

In experimental testing, supply pressure is ramped up with respect to time up to 300 bar and flow meter is connected to the hose which is passing oil coming out of the work port to reservoir. Two pressure sensors were used to sense supply pressure as well as load sense pressure. The load sense pressure was zero gauge pressure. Therefore, the variation of supply pressure replicates the variation of total pressure drop across valve with respect to time. Difference of two pressure reading is then calculated at every data point and then graph of work port flow versus total pressure drop is plotted.

As the tested valve was rated for 100 lpm flow at 20 bar pressure drop, we first compared the tested output flow value with simulated result at same pressure drop. The main spool of valve was shifted to its full displacement to allow maximum area of notch to open and thus to allow flow pass to work port. During this, pressure difference of 20 bar was maintained between supply and load sense.

Tested flow rate (lpm)	Simulated flow rate (lpm)
100.78	100.3

N	Supply pressure (bar)	Simulated flow rate (lpm)	Tested flow rate (lpm)
1	0.50	2.50	1.10
2	2.00	10.03	6.19
3	4.00	20.06	22.14
4	6.00	30.09	26.58
5	8.00	40.12	37.20
6	10.00	50.15	48.48
7	12.00	60.18	55.95
8	14.00	70.21	67.66
9	16.00	80.24	78.92
10	18.00	90.27	92.53
11	20.00	100.30	100.78
12	50.00	100.30	100.49
13	100.00	100.30	99.95
14	150.00	100.30	99.57
15	200.00	100.30	99.18
16	250.00	100.30	98.40
17	300.00	100.30	97.81



Simulated results and tested results match very well together and therefore it can be inferred that the correct physics of pre-compensation is captured in the math model.

CONCLUSION:

This paper focuses on modeling and simulation of pre-compensated hydraulic spool type valve system. Developed model can be utilized for prediction of required properties of any pre-compensated spool type valve. The simulated results of output flow are compared with tested results.

With the use of this model, it is possible for any hydro-mechanical engineer to predict the mean values of specific characteristics prior to freezing the design. Furthermore, this would assist to optimize the design for better compensation effect in valve.

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Rapid Extraction and characterization of *E.coli* phospholipids and study of its potential application in liposomal drug delivery systems

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Abstract- Liposomes are the class of drug delivery systems which are considered as biodegradable, biocompatible, flexible, non-ionic and non-toxic and provides direct interaction of the drug with cell and can modulate the distribution of drug and also increase the therapeutic index of drugs. It can also be modified and used to deliver genes and protect some sensitive tissues to a particular kind of drugs. Manufacturing of liposomes requires use of expensive raw material (synthetic phospholipids) from specialized commercial suppliers makes the liposomal based drugs very expensive due to complex extraction procedure which time taking and products obtained in a very less amount. In this research work extraction of phospholipid of *E.coli* bacteria was done by solvent extraction procedure and characterized by paper chromatographic, spectroscopic techniques like UV- Visible, Photoluminescence, FTIR and dynamic light scattering techniques, particle size analyzer and zeta potential. It has been found that phospholipid so obtained has same properties as that of synthetic phospholipids and it can be an alternative to synthetic phospholipids to reduce the cost of the drug delivery systems. Such methods are ecofriendly, less time consuming and an abundant amount of product is obtained for the development of liposomes.

Keywords- liposome, drug delivery, phospholipids.

1. Introduction

Liposomes are the drug delivery systems used for the systemic administration of drugs. Liposome, a tiny vesicle made up of the same material as a cell membrane ¹. Its membranes are composed of natural phospholipids having a head group attracted to water and a tail group which is made up of a long hydrocarbon chain. The tail group is repelled by water and also may contain mixed lipid chains containing surfactant properties ². In the presence of aqueous medium, the heads are attracted to water and line up to form a surface facing the water and tails are repelled by water, and line up to form a surface away from the water same as in a cell. The hydrocarbon tails of one layer face the hydrocarbon tails of the other layer and the combined structure forms a bilayer ³. When phospholipid membranes are disrupted, they will reassemble themselves into tiny spheres which are smaller than a normal cell either as bilayers or monolayers ⁴. The bilayer structures are known as liposomes and the monolayer structures are known as micelles. As a drug delivery systems liposome played an important role in potent drug formulation to improve therapeutics⁵.

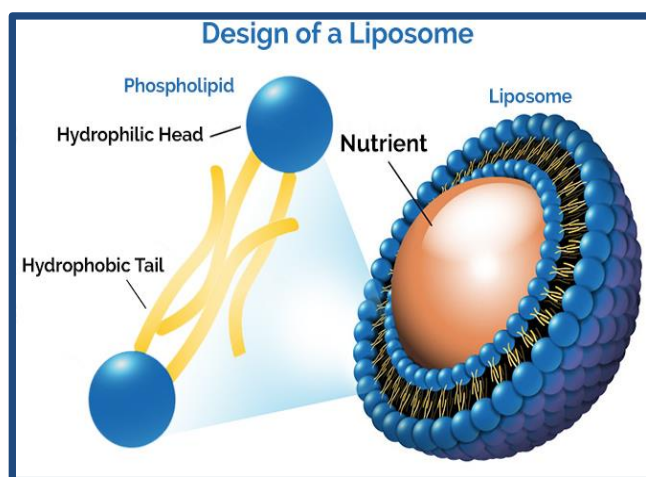
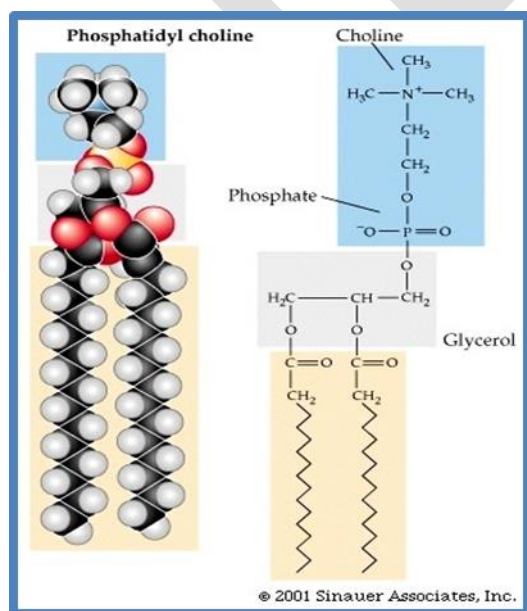


Figure 1. Liposome (Ref: Integratedhealth)

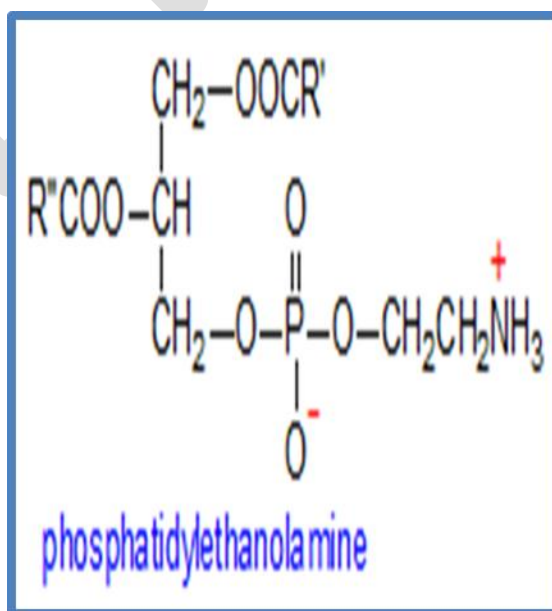
As a drug delivery system liposomes have many advantages such as they provide controlled drug delivery and controlled hydration and also provide sustained release and can carry both water and lipid soluble drugs⁶. Liposomes are biodegradable, biocompatible, flexible and non-toxic and non-ionic. It provides direct interaction of the drug with cell and can modulate the distribution of drug and also increase the therapeutic index of drugs⁷.

1.1 Phospholipids : building block of liposome

Phospholipids are made up of two fatty acids (long chains of hydrogen and carbon molecules), which are attached to a glycerol 'head.' The glycerol molecule is also attached to a phosphate group, and this is the hydrophilic part of the molecule. The 'tail' ends of the fatty acid chains opposite the glycerol is the hydrophobic part of the molecule⁸.



A. Phosphatidylcholine



B. Phosphatidylethanolamine

Figure 2. Two main constituent of biological membrane

They are essential components of cell membranes and are found in small concentrations in other parts of the cell. It should be noted that all glycerophospholipid are members of the broader class of lipids known as phospholipids. The hydrophobic nature of lipid molecules allows membranes to act as effective barriers to more polar molecules. In this topic, we discuss the chemical and physical properties of the various classes of lipid molecules. The phosphate, together with such esterified entities, is referred to as a “head” group. Phosphatides with choline or ethanolamine are referred to as phosphatidylcholine (known commonly as lecithin) or Phosphatidylethanolamine (known commonly as cephalin), respectively. These phosphatides are two of the most common constituents of biological membrane⁹. Where phosphatidylcholine is the principal phospholipid in animals, PE is the principal one in bacteria. One of the primary roles for PE in bacterial membranes is to spread out the negative charge caused by anionic membrane phospholipids. In the bacterium *E. coli*, PE plays a role in supporting lactose permease's active transport of lactose into the cell, and may play a role in other transport systems as well. PE plays a role in the assembly of lactose permease and other membrane proteins. It acts as a 'chaperone' to help the membrane proteins correctly folds their tertiary structures so that they can function properly.^{9, 10}

1.2 Liposome in Global Healthcare Market

Present day liposomes are used as ideal drug delivery systems in pharmaceutical industry and this occupies a large are in global pharma market and drug delivery. Among the major areas Western Europe with 13% of the total market dominates followed by North America and South Asia with contribution of 12% and 11% respectively. The area like Oceania is also influenced by the liposomal preparations and contributed approximately 8% to the world market.



Figure 3. Global market of liposome (Ref: Asian J. Pharm. Tech)

In the present scenario USA is the leading producer and trader of liposomal based products. USA holds the top rank with 41% of the total world market. Taiwan and South Korea are among the good competitor for USA. Taiwan with 19% and Korea with 14% stood at second and third spot. India too appeared on the frame and started the journey along with Hong Kong. Both the countries rank fifth with China holding the fourth spot with share of 10%. France and Spain are those countries which have strong pharmaceutical background and as far as the trading of liposomal products is concerned these countries stand at the sixth spot with individual share of six percent.¹¹ According to Cientifica, a nanotechnology research consultancy of European Space Agency, Nanocarriers will account for \$ 54.4 billion of \$ 136 billion market of Total Nanotechnology based drug delivery system by 2021. In which Liposome will account for \$ 15 billion by 2021 globally. Liposomes also have some disadvantages such as less stability, low solubility, short half-life, high production cost, and quick uptake by cells of reticulo -endothelial system.^{10, 11} But due to Biodegradability, Protective against leakage of Drugs to sensitive tissues, Non toxicity and easy modification, Liposome is most promising versatile drug carrier system used in drug delivery. Development of Liposomal gene delivery system (Lipoplex) has also proven the efficiency of Liposome in genetic engineering^{9, 11}.

Liposomal based drugs are still very expensive due to high cost of production. Liposomes are made up of phospholipids (synthetic lipid) which are very much expensive. Hence to reduce the cost there must be some alternatives for the building blocks of liposome-phospholipids. Phospholipids are generally found in natural living system like plant, animals and microbes¹². The natural phospholipids are described in pharmacopeias and relevant regulatory guidance documentation of the Food and Drug Administration (FDA) and European Medicines Agency (EMA). Natural phospholipids are in general well known to regulatory authorities. In addition, their track record as excipient with very high tolerability and biocompatibility is outstanding. So Extraction and Characterization of phospholipid from natural resources is done and furthermore, Synthesis of Liposome from such natural phospholipid can also be done. Synthetic phospholipids play compared to natural phospholipid (including hydrogenated phospholipids), as derived from the number of drug products containing synthetic phospholipids, a minor role. Natural phospholipids are used in oral, dermal, and parenteral products including liposomes¹³.

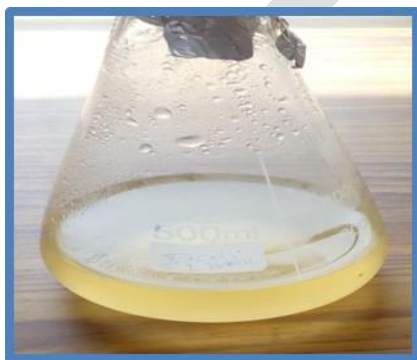
Natural phospholipids instead of synthetic phospholipids should be selected as phospholipid excipients for formulation development, whenever possible, because natural phospholipids are derived from renewable sources and produced with more ecologically friendly processes and are available in larger scale at relatively low costs compared to synthetic phospholipids. Synthetic phospholipids are obtained by a series of complex and time taking process by using harmful and toxic solvents. Such methods are hazards for human health and environment. Also, the cost of extraction is very high and the production is low. Hence, liposomes made from synthetic phospholipids are very much expensive and not accessible to common people. Whereas natural phospholipids are easy to extract,

purified and isolate and can be obtained on a large scale with reproducible quality and are less expensive. Phospholipids are well established excipients for pharmaceutical applications. Extraction of such natural phospholipids is crucial to exploits its potential use. Bacterial cell membrane (E.coli) contains abundant Phosphatidylethanolamine which are the main building blocks of Liposome. So, such natural phospholipid can be used for the synthesis of liposome instead of using synthetic and expensive phospholipid procured from lipid manufacturers. Natural phospholipids are purified from, e.g., soybeans or egg yolk using nontoxic solvent extraction and chromatographic procedures with low consumption of energy and minimum possible waste. Here in this research work, we have extracted the E.coli phospholipids and characterization was done to study its potential application in the development of liposomes and also we report that the bacterial cell can be economical source of phospholipids.

2. Material and Methods

2.1 Extraction of bacterial phospholipids

Bacterial Species E.coli strain MTCC 1687 was procured from CSIR-Institute of Microbial Technology, Chandigarh, India. Bacteria were cultured in 250ml Luria-Bertani (LB) Broth and left of growth in incubator at 37°C at 200rpm for 24 hr. Turbidity was observed after 24 hrs, which shows full growth of bacteria in the culture medium and an optical density was measured at 600nm. Modified Bligh and Dayer Method (Bligh & Dayer, 1959)¹⁴ was used with in which Chloroform and methanol was added in the ratio 1:2 to the bacterial culture. 100 ml bacterial culture solution was taken in flask and 125 ml Chloroform and 250 ml Methanol solution was added to it. The solution was stirred with magnetic stirrer for 10 minutes.



4A. Turbidity observed in culture medium



4B. Stirring solution on magnetic stirrer

Figure 4

After this 125 ml methanol was added and stirred for 1 minute then 125 ml dH₂O was added. Then the sample was centrifuged at 1000 rpm for 10 minutes. Biphasic system was observed. The bottom phase contains phospholipid and upper phase has methanol and water. Pasteur pipette was used to separate the bottom phase from upper phase. About 100ml of sample was obtained. Solvent was evaporated using rotary evaporator. The extracted sample solution contains phospholipid. The solution was filtered and stored in brown vials and labeled. Various analytical tools were used to characterize the sample.

2.2 Characterization of phospholipids

2.2.1 Thin Layer Chromatograph Analysis

Thin Layer Chromatography Analysis of sample was done to detect the presence of phospholipid. Chloroform/Methanol/Ammonia is mixed in the ratio 65:35:4 (v/v/v) and a solvent system were prepared. TLC silica gel plate was dipped into the solution and after ten minutes plate was removed from the solution, dried and watched under UV Light.



5A. TLC Plate



Phosphatidylethanolamine

5B. TLC analysis under UV Light

Figure 5

Spotted thick line was observed under UV Light hence, presence of Phosphatidylethanolamine phospholipid was confirmed by Thin Layer Chromatography agreements with previous work.^{15, 16}

2.2.2 UV-Visible Spectra Analysis

UV Visible spectroscopy is an important analytical tool which involves the promotion of electrons from ground state to the higher energy or excited state. UV Spectroscopy is type of absorption spectroscopy in which light of ultra-violet region (200-400nm) is absorbed by the molecule. Absorption of the ultra violet radiations results in the excitation of the electrons from ground state to higher energy state. The energy of UV radiation that is absorbed is equal to the energy difference between the ground state and higher energy state. Absorption of incident radiation by bonding/nonbonding electrons represents a high energy (~100 kCal/mole) transition. This corresponds to a high frequency, i.e. low wavelength, absorption band which is observed at 200 ~ 800 nm in the UV and visible range of detection. In Solution, electronic absorption spectra are found with broad, generally unresolved bands.^{17, 18} UV-Visible spectroscopy of the sample was done on SHIMADZU UV-3600 Plus and data were taken and studied. It is generally observed that phospholipid UV absorption occurs between 200 nm to 400 nm.^{19, 20}

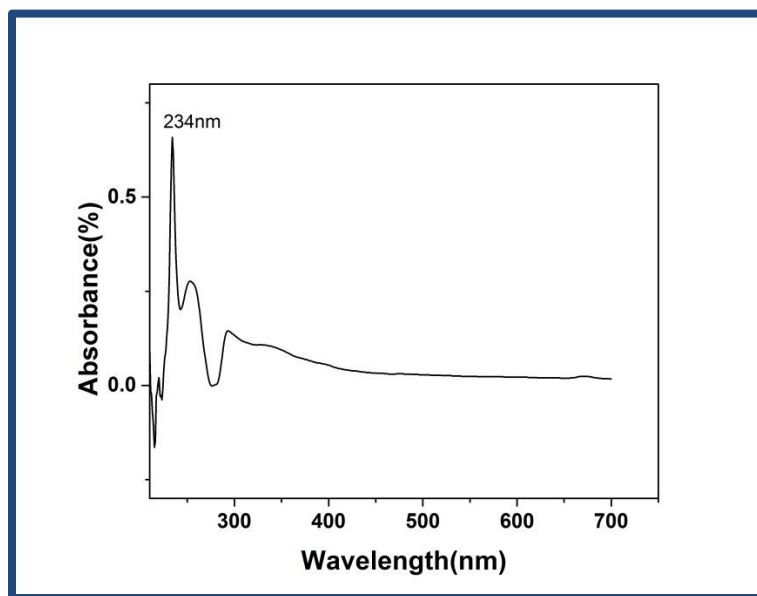


Figure 6. UV-Visible spectra of Phosphatidylethanolamine (PE)

Since, Phospholipid has no chromophore groups so UV detection can be carried out between 200-250 nm. From graph it is observed that a sharp peak is obtained at 234 nm and it is coincident with other experiments²⁰.

2.2.3 Photoluminescence Spectral Analysis

Photoluminescence (PL) spectroscopy is a useful technique for the study and characterization of materials and dynamical processes occurring in materials, specifically the optical properties of the materials. Photoluminescence, which occurs by virtue of electromagnetic radiation falling on matter, may range from visible light through ultraviolet, X-ray, and gamma radiation. It has been shown that, in luminescence caused by light, the wavelength of emitted light generally is equal to or longer than that of the exciting light (i.e., of equal or less energy). As explained below, this difference in wavelength is caused by a transformation of the exciting light, to a greater or lesser extent, to non-radiating vibrational energy of the atoms.²¹

The Characterization of the liquid sample was done on the HORIBA Fluoromax-4 Photoluminescence spectrophotometer taking 234 nm as here it is observed that the emitted radiation has higher wavelength than the excited radiation as it was 234 nm in the case of UV-Visible Spectrophotometer. Here, the wavelength of emitted radiation is 407 nm which is found to be coincident with the previous research papers.^{21, 22}

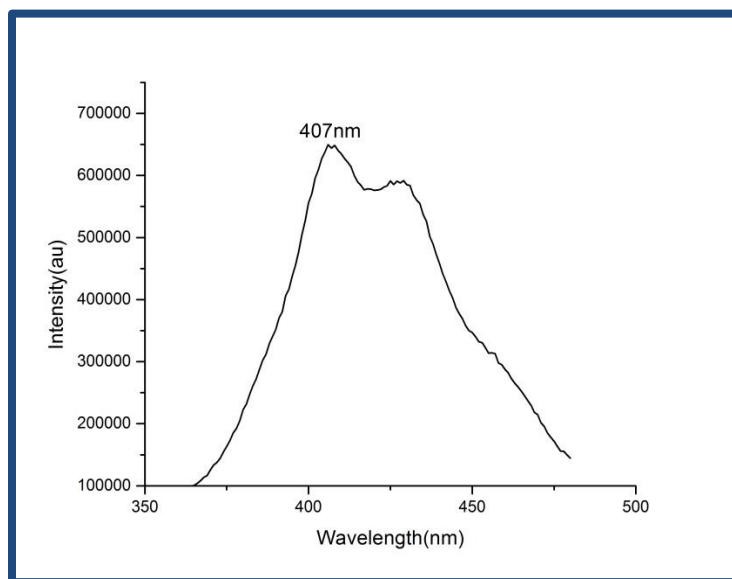


Figure 7. Photoluminescence Spectra of Phospholipid

2.2.4 FTIR Spectra Analysis

Fourier Transform Infra-Red Spectroscopy is one of the most powerful analytical tools for determining the presence of various organic or inorganic functional groups in the sample. Each molecule has specific vibrational frequency on account of the absorption of the IR radiation. FTIR of the sample was done using Parkin Elmer® Spectrum-2 FTIR Spectrophotometer in KBr at a Relative Humidity (RH) of 20 % in the ambient. The resolution was 1cm^{-1} . A Phosphatidylethanolamine molecule has one amine group, phosphate group, a carbonyl group, alcohol and alkyl groups. In FTIR Characterization of the sample these functional groups were detected with their respective vibrational frequencies. These functional groups have vibrational frequency are in coincidence with the FTIR analysis of previous research and experimental work^{23, 24, 25, 26}. The stretching frequency of various functional groups in the sample is given below:

Sl.No	Vibrational Frequencies (In cm^{-1})	Functional Group Present
1.	1261	Phosphate (PO_2^-)
2.	3397	Alcohol (OH^-)
3.	2924	Amine (NH_3^+)
4.	1667	Carbonyl (C=O)
5.	2853	Hydrocarbon (C-H)

Table 1 -Vibrational frequencies of functional groups present in the sample.

FTIR data are obtained are in coincident with the data obtained by Pohle et al ²⁷. The results for the phospholipids studied here clearly demonstrate that the conformational properties critically depend on their actual lipid structure, sample composition and sample temperature.

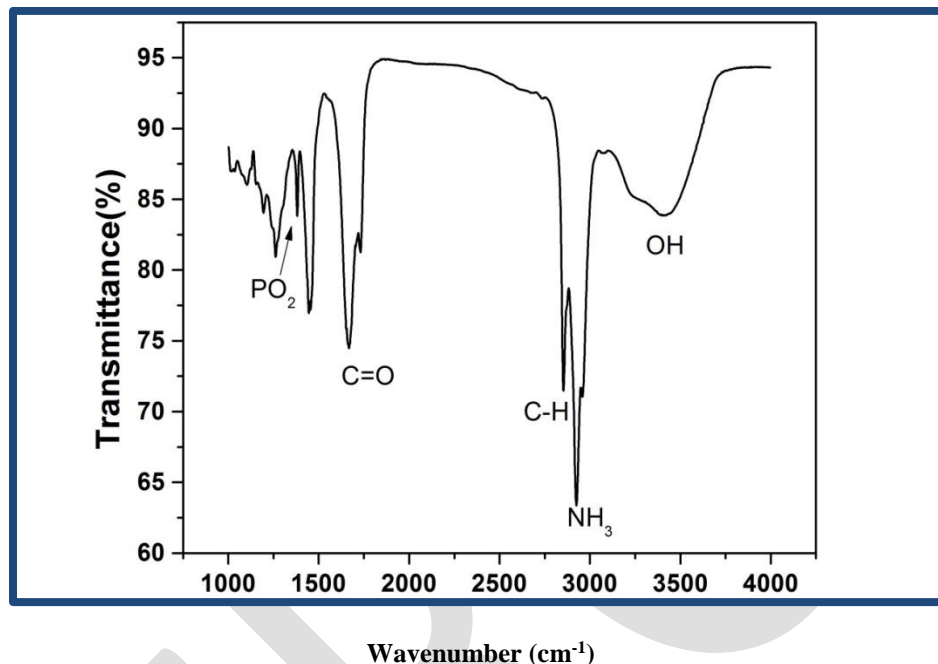


Figure 7. FTIR Spectra of Phospholipid

2.2.5 Particle Size Analysis

For particle size analysis was done on Malvern Zetasizer and a detailed study was done and an average particle size was found to be 965.5 nm by series dilution of the sample. The important colloidal characteristics of an emulsion system include its particle size. Typically, there may be particle size variation in the molecules chosen for making drug delivery systems such as Phosphatidylethanolamine. It is important to opt best size analysis methods for study smaller particle emulsion system. Simple calculations suggested that a micro emulsion was formed only when sufficient water was present to satisfy the hydration of both the phospholipid head groups and the hydroxyl groups of the co-surfactant associated with the droplet. Micro or nano emulsion cannot be considered as inert as drug molecule can alter their properties. Emulsions are generally inherently unstable system thermodynamically and therefore, one would expect them undergo change in their particle size with time ^{28, 29, 30}.

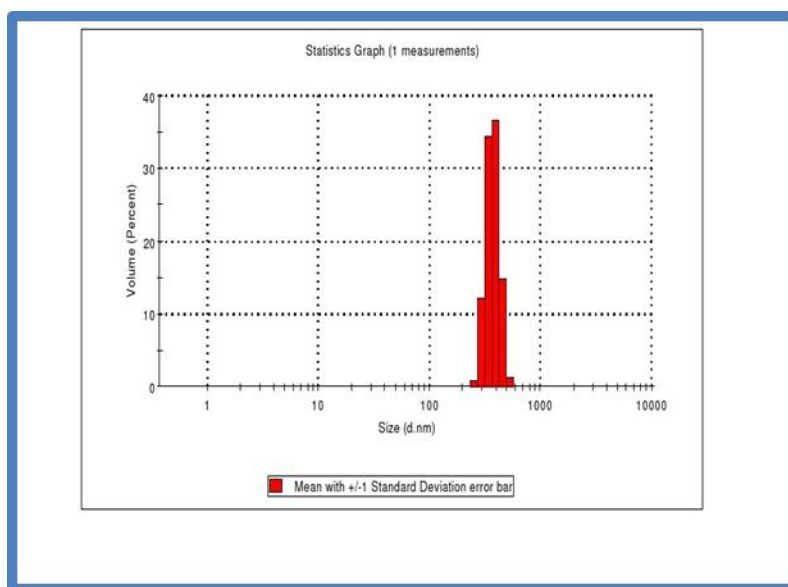


Figure 8 Static Graph of Particle Size

2.2.6 Zeta Potential Analysis

The zeta potential is a key indicator of the stability of colloidal dispersions. The magnitude of the zeta potential indicates the degree of electrostatic repulsion between adjacent, similarly charged particles in dispersion. For molecules and particles that are small enough, a high zeta potential will confer stability, i.e., the solution or dispersion will resist aggregation. When the potential is small, attractive forces may exceed this repulsion and the dispersion may break and flocculate. Zeta potential is related to the charge on the surface of the particle, and so influences a wide range of properties of colloidal materials, such as their stability, interaction with electrolytes, and suspension rheology. The Zeta Potential of the sample was done on the Malvern Zetasizer and the potential found to be -7.5mV which is due to higher probability of stability of phospholipid in the emulsion system.^{31, 32, 33, 34}

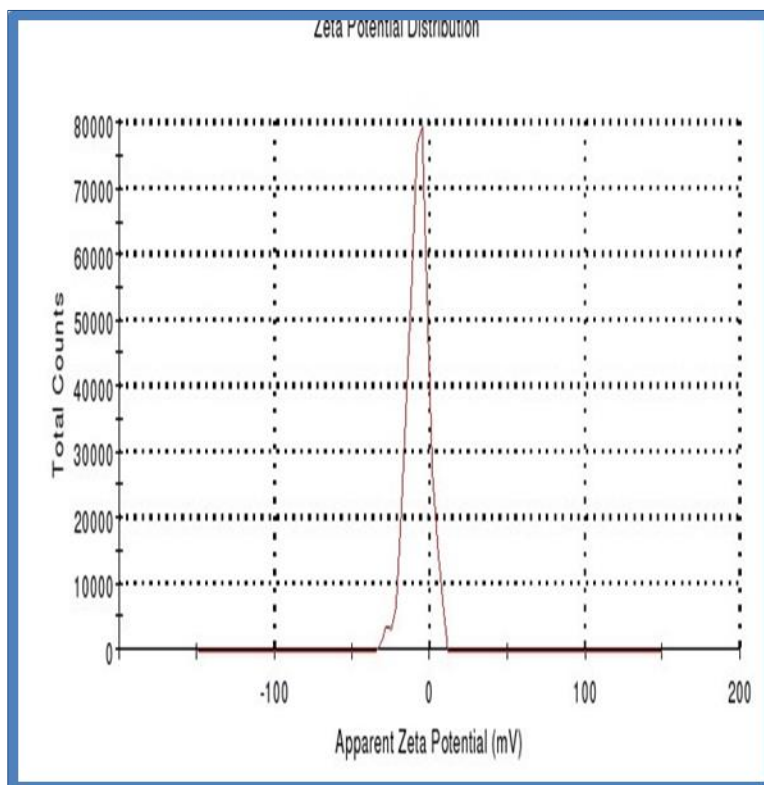


Figure 9. Zeta Potential of Phospholipid molecule (in mV)

3. Result and Discussions:

3.1 Bacterial Culture

It is essential to harvest healthy cells so as to obtain abundant amount of phospholipids. This was indicated by absorbance peak at A_{600} nm that doesn't count for dead cells in the culture. Also, a good turbidity has shown good bacterial colony growth.

3.2 Characterization of phospholipids

Characterization of phospholipids was done by chromatographic method and various spectroscopic techniques. It has shown characteristic peak absorption at 234 nm in UV region and luminescence peak at 407 nm. While the in FTIR spectra analysis the presence of phosphate, alcohol, amine, carbonyl functional groups were shown at a vibrational frequency of 1261, 3397, 2924, 1667, 2853 per centimeter respectively. The particle size and zeta potential of phospholipid molecule were found to be 965.5 nm and -7.5 mV respectively with agreement with previous research works.

4. Conclusion

In this research work we have successfully demonstrated the rapid and easy extraction of phospholipid from bacterial cells. It is important to conclude that such economical way of extraction as compared to expensive synthetic lipids commercially available

from limited manufacturers and suppliers can open the door for innovative research work for liposomes as model drug delivery system. Further work in this area can promote inexpensive but effective investigations of several water soluble drug that can be encapsulated and delivered to the cells. The drug delivery systems prepared from natural resources is quite feasible, economic and having low production cost which also reduced the price of drugs and easily available to common people.

5. Acknowledgements

Authors are thankful to Dr. A.S Bhattacharyya, Assistant Professor, Co-GEET, Central University of Jharkhand, Ranchi for valuable suggestions and technical support.

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REVIEW OF DIFFERENT TREATMENTS USED FOR DISPERSE DYE EFFLUENT

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ABSTRACT: Disperse dyes are largest group of dye used for dyeing of polyester, nylon and cellulose triacetate. The waste water generated during dyeing process contains dyes and other chemical auxiliaries which are major environment concern due to their toxic and carcinogenic impact. These paper reviewed different technique available for disperse dye removal from textile effluent.

KEY WORDS: Disperse Dye, Treatment for textile effluent

INTRODUCTION:

According to Aragao et al, Disperse dyes are characterized by low molecular weight and low solubility. Disperse dye is aromatic compound insoluble in water while soluble in organic solvent. It contains mainly azo and anthraquinone based chromophore. Szpyrkowicz et al. investigated that Azo group is mostly widely used among all disperse dye for commercial purpose. Christie has observed that Anthraquinone dyes are second most important group after Azo dye and it contain wide range of colours in visible spectrum. Disperse dye have high degree of fixation on fibre (about 90-100%) still some of its portion served as residue goes under effluent during dyeing and printing process (up to 100%), (Reife. A.1996). Major source of release of disperse dye in effluent is manufacturing process and dyeing process of polyester fibres. Lixuan Wang et al (2014) said that disperse dyes containing wastewater contain refractory organics. Disperse dye waste water contain toxic substances like benzene, naphthalene series, azo, anthraquinone, Halide, nitrocellulose, aniline and phenol substances. Only 2% product during the dyeing is drain away. Disperse dye contains -NO₂, -NH₂, -COOH and other functional group which characterized as alkali and acid group consequently. Disperse dye waste water containing mainly two parts of organic matter. One part is disperse dye and the other part is intermediates produced during dye production process. These organic molecules are so small that is partially dissolved in water. Disperse dye can disperse in water with the help of dispersant.

Disperse dye are hard to degrade and due to stability and their reductive toxic by-product survive longer time in the effluent. Anthraquinone dye are more resistant to degrade than azo and nitro compound because of stabilized aromatic ring structure while some azo dyes are hazardous to human health as toxic amines are released by their reduction. Some disperse dye have tendency to serve as bioaccumulate (Banat, 1996).

Removal of disperse dye from effluent is important and challenging job. Formation of toxic aromatic amine is another major threat cause by disperse dye.

Possible impact of dye effluent to aquatic life when released in to aquatic ecosystem without appropriate treatment.

1. Dye can block penetration of sunlight and hamper the growth of photoautotrophic organisms.
2. Suspended solids and oily substances of effluent interfere with oxygen transfer mechanism of aquatic life.
3. Some Inorganic chemicals used in dyeing process are toxic to aquatic life.
4. Organic compounds are undergo chemical and biological changes and depleted oxygen level of receiving stream.

DIFFERENT AVAILABLE TREATMENT TECHNOLOGIES FOR DISPERSE DYE LIKE PHYSICAL, CHEMICAL AND BIOLOGICAL ARE REVIEWED IN THIS LITERATURE.

PHYSICAL TREATMENT TECHNOLOGIES:

NUMBER OF TECHNIQUES ARE AVAILABLE FOR DISPERSE DYE REMOVAL. ADSORPTION IS WIDELY USED PHYSICAL TREATMENT. ACCORDING TO MARKANDEYA ET AL. (2018), ADSORPTION IS THE TECHNIQUE TO REMOVE DYE MOLECULE FROM EFFLUENT WITH BINDING ON THE SURFACE OF ADSORBENT BY PHYSICAL OR CHEMICAL INTERACTIONS. HALBUS ET AL. 2013 FOUND THAT ADSORPTION IS CHEAP AND EFFICIENT METHOD FOR COLOUR REMOVAL FROM WASTE WATER BUT IT CAN GENERATE HUGE AMOUNT OF SLUDGE. THEY USED IRAQI DATES PALM SEEDS ACTIVATED CARBON TO TREAT DISPERSE DYE 26 FROM EFFLUENT. EFFECT OF DIFFERENT PARAMETERS SUCH AS pH, CONTACT TIME AND DOSES WERE STUDIED FOR CHECKING BEHAVIOUR OF ADSORPTION PROCESS IN REMOVAL OF DISPERSE DYE. 66.47% DISPERSE BLUE DYE CAN BE REMOVED BY IRAQI DATES PALM SEEDS ACTIVATED CARBON WHILE 54.33% REDUCTION IN DYE CAN BE ACHIEVED BY COMMERCIAL ACTIVATED CARBON.

ADSORPTION OF DISPERSE RED-11, DISPERSE BLUE-26 AND DISPERSE RED-156 WERE INVESTIGATED WITH UNTREATED ALUMINA AND SURFACE TREATED ALUMINA. SURFACE TREATED ALUMINA FOUND MORE EFFECTIVE THAN UNTREATED ALUMINA. ADSORPTION OF DISPERSE DYE INCREASES WITH INCREASES pH IN THE RANGE OF 2-8. ABOVE pH8 ADSORPTION WAS DECREASED. SEQUENCE OF ADSORPTION OF DYES ARE DISPERSE RED -11>DISPERSE BLUE-26>DISPERSE RED-156 ACCORDING TO THEIR POLARITY. NON POLAR COMPOUNDS ARE MORE EASILY ATTACHED TO ALUMINA SURFACE THAN POLAR COMPOUND WAS OBSERVED BY GAWADE ET AL. IN 2005.

MODIFIED MAGNETITE NANO PARTICLES IS COATED WITH TYLTRIMETHYL AMMONIUM BROMIDE USEFUL FOR TREATMENT OF DISPERSE RED 167 AND DISPERSE BLUE 183 FROM WASTE WATER OF TEXTILE INDUSTRY. RAJABI ET AL (2016) OBSERVED THAT ADSORPTION PROCESS DEPENDED ON pH, SURFACTANT CONCENTRATION AND INTIAL DYE CONCENTRATION. THEY GOT HIGHER THAN 95% REMOVAL EFFICIENCY ACHIEVED IN 10 MIN. EVEN AT 500 MG/L DYE CONCENTRATION.

TIWARI ET AL. (2017) HAD PREPARED ZEOLITE FROM CENOSPHERETO TREAT DISPERSE ORANGE 25 AND DISPERSE BLUE 75:1 FROM WASTE WATER. THEY ACHIEVED 93% AND 88% REDUCTION AT OPTIMIZED CONDITION AND 0.6 AND 0.8 MG/L ADSORBENT DOSAGE. AFTER TREATMENT WITH DYE, ZEOLITE CAN BE REGENERATED BY RECOVERING OF DISPERSE DYE. MONOLAYER ADSORPTION WAS BEST FITTED IN THESE STUDIES. THEY ALSO WORKED (2015) WITH CENOSPHERE FOR REMOVAL OF DISPERSE BLUE 79:1 AND DISPERSE ORANGE 25 (DYE) FROM WASTE WATER BY BATCH ADSORPTION PROCESS UNDER DIFFERENT CONDITION AND GOT REDUCTION UP TO 78% OF DISPERSE BLUE AND 81% DISPERSE ORANGE.

HEMSAS ET AL. (2014) HAD INVESTIGATED POTENTIAL OF OLIVE STONES WHICH WAS EARLIER CONSIDERED AS A WASTE FOR REMOVAL OF DISPERSE DYE IN BATCH ADSORPTION PROCESS. THEY HAD PREPARED ACTIVATED CARBON FROM OLIVE STONE AND CHECKED EFFECT OF DIFFERENT PARAMETERS LIKE pH, TEMPERATURE, COLOR, AGITATION SPEED, TEMPERATURE, AND INTIAL DYE CONCENTRATION. THEY HAVE OBSERVED THAT WHOLE PROCESS IS HIGHLY DEPENDENT ON pH. THEY GOT 95% REDUCTION IN DYE BLUE PALANIL AND YELLOW TERAZIL AT pH 3, 50 RPM, 20°C AND WHOLE PROCESS REQUIRE 30 MIN TIME FOR COLOR RAMOVAL.

COLUMN MADE UP OF FLY ASH AND SAND COMBINATION (1:1, 1:2 AND 1:3) FOR ADSORPTION STUDIES FOR REMOVAL OF DISPERSE 354 DYE OF 1-20 PPM SOLUTION HAD BEEN CARRIED OUT BY JAMDAKAR ET AL. (2015). THE PRESENCE OF SiO₂ AND OTHER OXIDES HELP IN REMOVAL OF COLOUR. THE WHOLE PROCESS IS DEPENDENT ON INITIAL CONCENTRATION OF DYE SOLUTION. DYE REMOVAL EFFICIENCY IS DECREASES WITH INCREASING CONCENTRATION OF DYE. THEY GOT 82% REDUCTION AT LOWER CONCENTRATION OF DYE SOLUTION WHILE 69% REDUCTION ACHIEVED AT HIGHER CONCENTRATION OF DYE.

ADSORPTION BY SAW DUST FOR REMOVAL OF DISPERSE YELLOW 22 CONTAIN EFFLUENT HAD BEEN STUDIED BY DESHANNAVAR (2015), OPTIMUM CONDITION FOR ADSORPTION HAD BEEN CONCLUDED BY THEM. COLOUR REMOVED AT INITIAL CONCENTRATION OF 201 MG/L DYE, 2.1pH, 40 MIN. AGITATION TIME AND 3 G/L DOSAGE. DYE REMOVAL RATE DECREASE WITH INCREASE CONCENTRATION OF DYE.

DISPERSE BLUE 79 ADSORPTION WAS CARRIED OUT WITH THE HELP OF FLY ASH AND SOIL IN BATCH AND COLUMN TECHNIQUE BY ALBANIS ET AL. (2000). HE GOT AVERAGE 60.3% REDUCTION BY USING COLUMN OF SOIL MIXTURE WITH 20% FLY ASH CONTENT IN

CONCENTRATION OF 50MG/L DYE SOLUTION.

SHENG H. LIN (1993) HAS OBSERVED THAT DISPERSE DYE C. I. DISPERSE DYE RED 60 WAS REMOVED BY ACTIVATED ALUMINA AND MOLECULAR SIEVE GREATLY IN COMPARE TO GRANUAL ACTIVATED CARBON, DIATOMITE AND SAW DUST IN 2 HOUR REACTION TIME.

ADAM ET AL. (2012) HAD INVESTIGATED POTENTIAL OF FRUIT WASTE (DURIO ZIBETHINUS HUSK), DZH FOR REMOVAL OF DISPERSE DYE UNDER DIFFERENT CONDITION OF pH, TEMPERATURE, AND CONTACT TIME. THEY FOUND THAT DURIO ZIBETHINUS HUSK, DZH IS CHEAPER ADSORBENT COMPARE TO ACTIVATED CARBON FOR REMOVAL OF DB 60 IN AQUEOUS SOLUTION. THEY COMPLETELY REMOVE DB60 5 GM/L DOSAGE BY USING DZH UNDER CONTROL CONDITION OF pH 9 AND 30°C IN 1 HOUR RETENTION TIME.

DISPERSE YELLOW 22 REMOVAL USING WOOD DUST WAS CARRIED OUT BY DESHANNAVAR ET AL (2014). THEY HAVE STUDIED BATCH ADSORPTION STUDY OF COLOUR REMOVAL AND IMPACT OF DIFFERENT PARAMETERS LIKE pH, TEMPERATURE, ADSORBATE DOSAGE, INTIAL CONCENTRATION AND CONTACT TIME FOR DYE REMOVAL. THEY FOUND THAT MAXIMUM REMOVAL OCCURS AT 21 MG/L DYE CONCENTRATION AND 3 G/L ADSORBATE DOSAGE IN 40 MINUTES TIME.

REMOVAL OF DISPERSE DYE ORANGE 30 BY BAMBOO BASED ACTIVATED CARBON FIX BED COLUMN EXPERIMENT CARRIED OUT BY AHMADA ET AL. (2014). VARIOUS PARAMETERS LIKE BED DEPTH, FLOW RATE AND DYE CONCENTRATION. 39.97 MG/GM BED CONCENTRATION BED GIVES HIGHEST RESULT.

DISPERSE RED 170 WAS TREATED WITH CARBON DERIVED FROM BAMBOO WASTE BY LIANGGUI WANG (2012) UNDER CONTROL pH, TEMPERATURE, DYE CONCENTRATION AND CONTACT TIME.

DISPERSE OF YELLOW 42 ADSORPTION BY BENTONITE AND ORGANO MODIFIED BENTONITE WAS STUDIED UNDER DIFFERENT CONDITION IN BATCH PROCESS BY HASHEMIAN ET AL (2013). HE FOUND THAT DYE REMOVAL RATE IS INCREASING WITH ADSORBENT DOSE. ORGANO MODIFIED BENTONITE IS MORE EFFECTIVE THAN UNTREATED BENTONITE. IT IS COST EFFECTIVE ADSORBENT.

EL-SAYED ET AL. (2011) HAD PREPARED ACTIVATED CARBON FROM SUGAR CAN STALKS BY TREATED WITH PHOSPHORIC ACID WAS USED FOR DISPERSE 2BLN DYE AT pH NEAR 1.5 AND 27.1MG/G ACTIVATED CARBON DOSE. THEY ALSO FOUND THAT PROCESS IS EXOTHERMIC AND SPONTANEOUS.

CHEMICAL TREATMENT:

COAGULATION AND FLOCCULATION EFFICIENCY FOR DISPERSE DYE REMOVAL CAN BE MEASURED BY WONG ET AL (2007), THEY USED THREE DIFFERENT COAGULANT NAMED ALUM, POLYALUMINIUM CHLORIDE AND $MgCl_2$ FOR COMPARISON OF EFFICIENCY. IMPACT OF COAGULANT AID AND SETTLING TIME OF FLOC WAS ALSO CONSIDERED. THEY OBSERVED THAT PACI IS MORE EFFECTIVE THAN ALUM AND $MgCl_2$ FOR REMOVING COLOUR AND COD IN TEXTILE WASTE WATER CONTAINING DISPERSE AND REACTIVE DYE.

NOUREDDINE ET AL (2008) HAD OBSERVED THAT CRYSTALLINE HYDROXYAPATITE FORMED BY REACTION OF $Ca(NO_3)_2$ AND $(NH_4)_2HPO_4$ REAGENT TIN AQUEOUS SOLUTION IS USED AS ADSORBENT FOR REMOVAL OF DISPERSE DYE IN BATCH MODE. COLOUR REMOVAL EFFICIENCY INCREASES WITH INCREASING ADSORBENT DOSE. POORLY CRYSTALLINE HYDROXYAPATITE WAS USED TO REMOVE DISPERSE BLUE SBL DYE FROM AQEOUS SOLUTION. THEY OBSERVED THAT INTIAL ADSORPTION RATE DURING PROCESS IS HIGHER AND WHOLE PROCESS IS HIGHLY DEPENDENT ON pH. HIGH DYE UPTAKE AT LOW pH. ELECTROSTATIC NATURE OF DYE AND CALCIUM HYDROXYAPATITE FOUND.

YEAP ET AL. (2014) HAD PREPARED NOVEL HYBRID POLYMER FROM POLYALUMINUM CHLORIDE- POLY (3- ACRYLAMIDE- ISOPROPNOL CHLORIDE) MADE UP OF ORGANIC AND INORGANIC POLYMER. IT SHOWS 92% CHEMICAL OXYGEN DEMAND AND 95% REDUCTION IN COLOR AT pH 7.5 50 MG/L SOLUTION OF RCB DYE. IT GIVES 93% FOR COD AND 96% FOR COLOR AT pH 3 USING 20 MG/L DTY DYE CONCENTRATION.

ARSLAN-ALATON AND S. DOGRUEL (2004), HAD INVESTIGATED PHOTO (U.V)-DEGRADATION OF DISPERSE DYE EFFLUENT WITH THE HELP OF SILICADODECATUNGSTATE (SiW₁₂O₄₀4-/-5-) NANOPARTICLES. DECOLOURIZATION EFFICIENCY DEPEND UP ON THE HETEROPOLY ACID (PHOTOCATALYST) LOADING, NATURE OF THE ORGANIC SOLVENT, I.E. THE ELECTRON DONOR, AND THE PRESENCE OF VARIOUS DYE ASSISTING CHEMICALS. THEY ALSO OBSERVED THAT COLOUR REMOVAL EFFICIENCY WAS HINDER BY DYE AUXILLRY CHEMICALS. DECOLORIZING EFFICIENCY OF DISPERSE DYE BATH RECOVERS IS 55%.

PHALAKORNKULE ET AL. INVESTIGATED EFFICIENCY OF ELECTRO COAGULATION OF BLUE REACTIVE, RED DISPERSES AND MIXED DYE DECOLOURIZATION IN 2010. REACTIVE BLUE 140 AND DISPERSE RED 1 WERE SELECTED FOR INDIVIDUAL AND MIXTURE WAS TAKEN FOR TREATMENT. THEY GOT SATISFACTORY RESULT FOR INDIVIDUAL AS WELL AS MIXTURE. FOR 100 MG/L DYE CONCENTRATION THEY GOT >95% REDUCTION FOR DECOLOURIZATION. THEY FOUND THAT IRON IS SUPERIOR COAGULANT COMPARE TO ALUMINIUM IN THEIR STUDY.

ADVANCED OXIDATION TREATMENT:

OXIDATION IS ONE OF MOST POTENTIAL ALTERNATIVE TREATMENT AGAINST CONVENTIONAL TREATMENT. OZONE IS TREATED WITH DISPERSE DARK BLUE 148 AT 0.1 G/L INVESTIGATED BY S EREN ET AL. OZONE IS EFFICIENT IN REMOVING COD, pH, TEMPERATURE AND CONDUCTIVITY.

FAROUK KM WAIL (2015) HAS SELECTED THREE COMMERCIAL DISPERSE DYE NAMED DISPERSE YELLOW 23, DISPERSE RED 167, DISPERSE BLUE 2BLN FOR STUDY FENTON PROCESS FOR TEXTILE POLLUTANT REMOVAL. HE USED 3G/L H₂O₂ AND 120 MG/L FERROUS SULPHATE HEPTA HYDRATED DOSAGE FOR TREATMENT OF WASTEWATER CONTAINING ABOVE DYE. HE GOT 84.66%, 77.19% AND 79.63% COLOR REDUCTION IN 160MIN RETENTION TIME AND CHEMICAL OXYGEN DEMAND REDUCTION UP TO 75.81%, 78.03% AND 78.14% OF ABOVE DYE.

NANO-IRON MODIFIED GOLDMINE WASTE AS A CATALYST IN FENTON REACTION FOR TREATMENT OF DISPERSE ORANGE 288 WAS INVESTIGATED BY MEI HUANG (2011). HE OBSERVED THAT NANO-IRON MODIFIED GOLDMINE WASTE GIVES BETTER PERFORMANCE THAN THE FENTON PROCESS

ELECTROCHEMICAL OXIDATION FOR REMOVAL OF POLLUTANT WAS CARRIED OUT BY (SZPYRKOWICZ ET AL, 2000.) UNDIVIDED CELL REACTOR USING DIFFERENT ANODE AND 0.1M NaCl AS A SUPPORTING ELECTROLYTE SOLUTION. TREATMENT EFFECTIVENESS DEPEND UP ON SUPPORTING ELECTROLYTE.IN THE REACTOR, pH OF MEDIUM AND ANODE MATERIAL USED. Ti/Pt-Ir ANODE AND 0.05M Na₂SO₄ AS SUPPORTING ELECTROLYTE IN ACIDIC MEDIUM. OH REDICAL IN WATER IS GENERATED BY CHLORINE HYPOCHLORIDE SPECIES GAIN DURING ELECTRO-OXIDATION OF CHLORIDE AT ANODE. THE CONTROL OF INCREASE THREE FOLD TIME REACTION RATE. ELECTOCHEMICAL OXIDATION OF DISPERSE ORANGE 1, DISPERSE RED 1 AND DISPERSE RED 13 WAS CARRIED OUT USING Ti/TiO₂ THIN FILM ELECTRODE WITH NaCl AND Na₂SO₄ MEDIUM. 100% COLOUR REMOVAL CAN BE ACHIEVED AFTER ONE HOUR TREATMENT. THEY ALSO OBSERVED THAT FASTER COLOUR REMOVAL CAN BE ACHIEVED BY USING 0.1MOL/L NaCl UNDER U.V LIGHT AND +1.0V WHICH ALSO REDUCES TOC LEVEL UP TO 60%.

FEHIMAN CINER, OMUR GOKKUS, (2013) HAD STUDIED DISPERSE YELLOW 119 AND DISPERSE RED 167 REMOVAL BY FENTON AND SOLAR LIGHT EFFECT ON FENTON REACTION. PROCESS IS DEPENDENT ON pH, Fe⁺⁺ CONCENTRATION, H₂O₂ CONCENTRATION AND OXIDATION TIME. IN FENTON DARK REACTION 98% SAC AND 90% COD REMOVAL WERE ACHIEVED AT pH 3, Fe⁺⁺(50 MG/L), H₂O₂ (75 MG/L) AND 15 MIN OXIDATION TIME. SOLAR FENTON REACTION GIVES 99% SAC REDUCTION FOR DY199 AND DR 167. COD REMOVED 98.3% AND 98.4% RESPECTIVELY. FENTON ASSISTED WITH SOLAR IS MORE EFFICIENT THAN FENTON PERFORMED IN DARK.

SONOLYTIC DEGRADATION OF DISPERSE DYE HAD BEEN INVESTIGATED BY VERMA ET AL (2015). POTENTIAL OF CHEMICAL ADDITIVE IN COMBINATION WITH ULTRASONICATION WAS CHECKED FOR DECOLORIZATION OF MIXTURE OF REACTIVE BLACK 5 (RB5), CONGO RED (CR), AND DISPERSE BLUE 3 (DB3).THE PS AND SS WAS PRODUCING SCAVENGING EFFECT OF SULFATE REDICALS TO ENHANCE THE DECOLORIZATION EFFICIENCY. MAXIMUM 93% REDUCTION IS ACHIEVED IN 8 HOUR SONICATION TIME IN WASTE WATER CONTAINING RB5 DYE.

BALLA ET AL., IN 2010 INVESTIGATED POTENTIAL OF ELECTROCOAGULATION AND ELECTROFLOTTATION FOR REMOVING COLOUR CONTAINING REACTIVE, DISPERSE AND MIXTURE OF DYES IN EXTERNAL AIR-LIFT REACTOR. THEY USED YELLOW TERASIL 4G, RED TERASIL 343 150%, BLUE TERASIL 3R02 DYE FOR TREATMENT. THEY OBSERVED THAT ALUMINIUM ELECTRODE GIVES BETTER DYE REMOVAL EFFICIENCY THAN OTHER METAL ELECTRODE.

COMPARISON OF DIFFERENT TREATMENT OF ADVANCE OXIDATION:

COMPARISON OF FENTON, OZONE, HYPOCHLORITE AND ELECTROCHEMICAL OXIDATION ARE COMMONLY USED METHOD FOR REMOVAL OF POLLUTION LOAD. AMONG THIS BEST RESULT FOR DISPERSE DYE REMOVAL AND COD OBTAIN BY FENTON PROCESS UNDER THE OPTIMUM CONDITION OF pH AND DOSAGE OF COAGULANT.

OZONATION IS BEST TREATMENT FOR COLOR REMOVAL. IT GIVES MAXIMUM REDUCTION IN APPARENT COLOR REMOVAL IN 1 MINUTE AT DOSAGE OF 50 MG/DM³ BUT NOT SUFFICIENT FOR COD REMOVAL WHILE ELECTROCHEMICAL OXIDATION GIVES 90% OF COLOUR REMOVAL AND 39% OF COD REMOVAL.

BIOLOGICAL TREATMENT:

DISPERSE DYE EFFLUENT IS TREATED WITH ACTIVATED SLUDGE IN THE REACTOR BY TING-CHI HSU AND CHIH-SHENG CHIANG (1997). THEY FOUND THAT BOD REMOVAL RATE COEFFICIENT $K = 0.00063$ L/MG BOD/HR, SLUDGE YIELD COEFFICIENT $Y = 0.26$ KG MLVSS YIELD/KG BOD REMOVED, AND SLUDGE ENDOGENOUS DECAY COEFFICIENT $K_d = 0.003$ L/DAY.

KURADE ET AL. (2015) HAD OBSERVED THAT BERVIBACILLUS LATEROPOREUS ARE EFFECTIVE TOOL FOR BIOREMEDIATION OF DISPERSE RED 54 CONCENTRATION OF 50 MG/L SOLUTION WITHIN 48 HOURS WITH THE HELP OF YEAST EXTRACT, PEPTONE AND SUPPLEMENTED MEDIUM. 100% REDUCTION IN DYE REMOVAL IS ACHIEVED BY THIS METHOD. WHOLE PROCESS IS BASED ON ENZYME ACTIVITY OF BACTERIA. TRYOSINASE, VERATYL ALCOHOL OXIDASE AND NADH-DCIP REDUCTASE ENZYMES ARE RESPONSIBLE FOR THE COLOR REMOVAL.

RUHSANA SATAR AND QAYYUM HUSAIN (2009) HAD USED SALT-FRACTIONATED BITTER GOURD (MOMORDICA CHARANTIA) PROTEINS AND H₂O₂ FOR REMOVAL OF DISPERSE DYE. VARIOUS PHYSICAL PARAMETERS WERE TESTED BY THEM. DISPERSE RED 17 IN PRESENCE OF 0.4MM PHENOL REMOVE DYE UP TO 60% AND 40% REDUCTION IN DISPERSE BROWN 1 DYE ACHIEVED. GOUARD PEROXIDASE IS ACT AS CATALYST TO RECALCITRANT DYE.

YUZHU FU AND T VIRARAGHAVAN IN 2004 PREPARED POLYSULPHONE SOLID MATRIX MADE UP OF IMMOBILIZED ASPERGILLUS NIGER DEAD FUNGAL BIOMASS IN COLUMN STUDY. FUNGAL BIOMASS WAS IMMOBILIZED ON IN FORM OF SPHERICAL BEADS FOR IMPROVEMENT OF ADSORPTION CAPACITY AND STRENGTH. THEY USED THIS MATRIX FOR ACID, BASIC AND DISPERSE DYE. BEAD ADSORBED 0.1 MG/GM DISPERSE RED DYE.

ANTHRAQUINONE DYE CI DISPERSE RED 15 (DR 15) WAS TREATED WITH YEAST P. ANOMALA BY ITOH ET AL (1996). DISAPPEARANCE OF DYE WAS MEASURED BY SPECTROPHOTOMETER. HE INVESTIGATED POSSIBLE PATHWAY FOR BIODEGRADATION OF DR 15. DISPLACEMENT OF HYDROXYL GROUP RESULT IN THE PV12 AND FURTHER REDUCTION IN TO LQ AND 1-HAQ RESPECTIVELY.

KULKARNI ET AL (2014), HAD STUDIED SOLVENT RED 24 FOR DEGRADATION. $99 \pm 0.8\%$ DEGRADATION OF LICHEN PERMELIA PERLATA FOUND. OPTIMUM pH IS 8 AND TEMPERATURE IS 50°C.

BIO SLUDGE GENERATED FROM WATER TREATMENT PLANT CONTAINING ABILITIES TO ADSORB DISPERSE DYE AND ORGANIC MATTER INVESTIGATED BY SIRIANUNTAPIOON ET AL (2006). THEY ALSO FOUND THAT DISPERSE RED 60 IS MORE EASILY ADSORBED ON BIO SLUDGE THAN DISPERSE BLUE 60 AND THIS BIO SLUDGE CAN BE REUSED BY AFTER BEING WASH WITH 0.1N NaOH. DISPERSE DYE ADSORPTION IS MORE EFFECTIVE ON RESTING BIO SLUDGE THAN AUTOCLAVE SLUDGE BECAUSE DISPERSE DYE ADSORBED ON BOTH LIVING AND DEAD BIO SLUDGE. DYE ADSORPTION EFFICIENCY CAN BE IMPROVED BY ADDING GLUCOSE IN TO THE SYSTEM.

KADAM ET AL. IN 2013 WAS CONDUCTED STUDIED ON DECOLOURIZATION AND DEGRADATION OF DISPERSE RED 73 ADSORBED ON SUGERCAN BAGGASES USING RHIZOPHORIC PLANT GROWTH PROMOTING BACTERIA. THEY USED 4 DIFFERENT STRAINS OF BACTERIA LIKE RHODOBACTER ERTHROPHOLIS, AZOTOBACTER VINELANDDI, RHIZOBIUM MELILOTI, BACILLUS MAGATERIUM. AMONG VARIOUS CONSTRODIA RHIZOBIUM RARB SHOWED COMPLETE DECOLORIZATION IN 48 HOURS UNDER THE CONDITION OF 90% MOISTURE CONTENT, 30°C TEMPERATURE AND 6 PH.

WATHARKAR ET AL. HAS CARRIED OUT STUDIED OF POTENTIAL OF ORNAMENTAL PLANT FOR DEGRADATION OF DISPERSE, DISULPHONATED TRIPHENYL METHANE TEXTILE DYE. THEY USED PETUNIA GRANDIFLORA JUSS FOR REMEDIATION OF BRILLIANT BLUE G DYE. WILD AND TISSUE CULTURE SPECIES SHOW REDUCTION UP TO 86%. THEY ALSO CONDUCTED STUDIED ON PHYTOTOXICITY. NO HARMFUL METABOLITES WERE FOUND DURING PHYTO REMEDIATION STUDY.

DISPERSE DYE EFFLUENT WAS STUDIED TO REMOVE COLOUR WITH THE HELP OF UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR BY GONCALVES ET AL (2000), REACTOR WAS FED BY GLUCOSE, DYE AND BIODEGRADABLE ORGANIC MATTER. THEY FOUND THAT USAB IS UNSUCCESSFUL TREATMENT FOR DISPERSE DYE REMOVAL EVEN AT LOW CONCENTRATION.

MEMBRANE TECHNOLOGY:

NANO FILTER MADE UP OF POLYAMIDE SPIRAL WOUND MEMBRANE FOR REMOVAL OF ANTHRAQUINONE DYE WAS INVESTIGATED BY ASKARI ET AL. (2015). PH AND DYE CONCENTRATION HAS MOST SIGNIFICANT EFFECT ON DISPERSE 56 REMOVAL. 90% REDUCTION IS ACHIEVED IN DISPERSE BLUE 56.

DISPERSE DYE 73 REMOVAL FROM SYNTHETIC TEXTILE WATER BY USING PHOTOCATALYTIC PROCESS COMBINED WITH MICRO FILTRATION HAD BEEN STUDIED BY BUSCIO ET AL. (2015). THEY CHOOSE TITANIUM DIOXIDE AND AEROXIDE P25 WERE SELECTED AS CATALYST. THEY FOUND THAT USING THAT METHOD GOOD QUALITY PERMEATE CAN BE ACHIEVED AT PH 4, DYE CONCENTRATION 50MG/L AND 2 GM/L TiO₂ LOADING. BY THIS METHOD 60% AND 90% COLOUR REDUCTION AND 98% CHEMICAL OXYGEN DEMAND (COD) REDUCTION ACHIEVED. OXIDANT SPECIES GENERATED DURING PHOTOCATALYTIC PROCESS ARE KEY FACTOR FOR COLOUR AND COD REDUCTION. MAJOR DEFECT OF THIS PROCESS IS RECOVERY OF PHOTOCATALYST.

BIOTRANSFORMATION OF AZO DISPERSE BLUE 79 WAS STUDIED BY A. CRUZ AND G. BUITRON (2000). AN ANAEROBIC DECOLORIZATION USING SEQUENTIAL BATCH BIOFILTER GIVES 95% DYE REDUCTION AT 48MG/L CONCENTRATION IN PRESENCE OF CO-SUBSTRATE IN 24 HOUR AND 120 MG/L SOLUTION REQUIRE 72 HOURS. THEY FOUND THAT DISPERSE BLUE 79 WAS BIO TRANSFORMED IN TO AMINES, WAS POSSIBLE REASON OF DECOLORIZATION. THE AMINE PRODUCED IN THE FIRST STAGE WAS DEGRADED IN THE AEROBIC FILTER IN 24 HOURS.

ACKNOWLEDGMENT: WE ARE THANKS TO V.P.SCIENCE COLLEGE AND MAN MADE TEXTILE RESEARCH ASSOCIATION (MANTRA) FOR PROVIDING DETAIL INFORMATION ABOUT DYES.

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ISSN 2091 - 2730