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# Detergent Removal from Sullage by Photo-catalytic Process

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**Abstract:Photo-catalysis has emerged as a powerful technological boon to ultimately decompose and recycle the non-biodegradable organics. Detergents that are considered to be stringently non-biodegradable or sparingly degradable are severe concerns for the agriculturists as they gradually render the soil unfit for agriculture. The present research study has applied photo-catalysis technology to degrade commercial detergents available in the sullage (washroom wastewater) of the residential campus of an engineering college. The COD (Chemical Oxygen Demand) has been taken as a parameter for monitoring the degradation rate of detergent. Photo-catalyst used is $TiO_2$. The degradation studies are conducted under artificial source of UV radiations in an indigenously designed reactor. Dose of photo-catalyst is varied and optimized. It has been observed that the COD has been effectively brought down to the level of 40 mg/L with an optimal dose of 35 mg/L photo-catalyst. The sullage is rendered to be fit for gardening applications. The research outcomes find significant applications in the recycling of sullage for gardening and irrigation applications and will save huge amount of water and electricity both.**

***Key words:Photo-catalysis, Detergents, $TiO_2$, COD.***

## 1. INTRODUCTION

Till 1960s BOD was the most important parameter of concern in wastewaters [12]. However with the advancement in science and technology, the synthesis of variety of non-biodegradable organics has become very common. They have become integral part of our day to day life. The concentration of detergents, variety of cleansers used in households, pesticides, fertilizers, insecticides, plastic traces, polythene traces etc. is increasing in wastewaters rapidly. They are non-biodegradables and are persisting in nature. They create difficulties in conventional wastewater treatment. They join food chains and accumulate in human bodies exhibiting long term disorders. Conventional technologies for removal of non-biodegradable organics are quite inefficient. However, photo-catalysis has emerged a powerful boon for degradation of non-biodegradable organics [16]. Detergent is one such commonly used non-biodegradable organics which is commonly present in domestic wastewaters, and laundry wastewaters.

With rising population and over exploitation, the water resources are depleting day by day. There is great need for recycling of water. Sullage is the wastewater generated from bathrooms [17]. It is rich in terms of urine but BOD is not high. It also contains significant quantity of detergents. At many water scarce places the sullage is recycled for gardening applications. However the detergents present in the sullage affect to the fertility of soil in long term. Thus they require to be removed. Photo-catalysis can be applied for removal of detergents from sullage as well as from various wastewaters.

The present work explores the photo-catalysis technology for treatment of detergent containing wastewaters. Some parameters of process are investigated experimentally and optimized for highest rate of degradation.

### 1.1 Detergents and their chemistry

In a dictionary detergent is simply defined as cleaning agent. However, the word detergent has tended to imply synthetic detergents specifically, generally termed as surface-active agent or surfactant. The synthetic detergents are made from petrochemicals [18]. Synthetic detergents dissolve or tend to dissolve in water or other solvents. To enable them to do this, they require distinct chemical characteristics. Hydrophilic (water loving) groupings in their molecular structure, and hydrophobic (water hating) groupings, help the detergent in its "detergency" action. This detergency depends on

the balance of the molecular weight of the hydrophobic to the hydrophilic portion. This is called the HLB value. There are four main classes of detergents, anionic, cationic, amphoteric.

### 1.2 Problems due to detergents in wastewater

Detergents pose a variety of problems in the wastewater treatment. They are surfactants. Thus they hinder the transfer of oxygen from atmosphere to the water in the process of aeration. They reduce the oxygen transfer efficiency to 15%. They hinder the biological treatment also. They trap the colloidal particles and keep them on surface thus reducing the efficiency of coagulation. Once they find a way in to surface of sub-surface waters, they join to food chain. They accumulate in body and exhibit long term disorders like carcinogenicity, mutagenicity, fertility loss, loss of potency, allergy etc in long term. During coagulation of water they form halides. The above-mentioned bad effects are even exaggerated.

### 1.3 Limitations of Conventional Wastewater Treatment Technologies in detergent removal

The linear alkyl sulfonates are biodegradable under aerobic conditions, but not in anaerobic conditions. The benzyl sulfonates are strongly resistant to biodegradation. Generally the removal of detergents from wastewater is favored by methods like adsorption. But these methods simply transform the problem from one phase to another. They do not solve the problem. The final disposal of solid sorbent material containing detergents is again a problem. From this bulk, detergents may again find way in to surface and sub-surface waters.

### 1.4The photo-catalysis technology

The photo-catalysis is a phenomenon recognized by researchers [5, 6, 9]. Semiconductors have a property that they emit an electron when light wave of appropriate wave length fall upon them. Some of the common conductors are Titanium di oxide, silicon di oxide, zinc oxide etc. Titanium di oxide is considered to be the most active. $TiO_2$ emits electron when UV radiation falls on it which ultimately results into hydroxyl radical formation [19].

$TiO_2 + UV = TiO_2^+ + e$

$H_2O = H^+ + OH^-$

$OH^- - e + TiO_2^+ = TiO_2 + OH^*$

$OH^*$ + organic compound = products of mineralization

The UV radiation is obtained from sun or it can be obtained from UV lamps.

Fujishima*et al* [9] first described the reactor design and process parameter aspects in his bibliographic work.

### 1.5 Review of research in photo-catalysis

The process has so many variables listed as- pH, temperature, intensity of light, concentration of organic compound, concentration of catalyst, specific surface area of catalyst etc. The process is complex and is still in nascent stage for degradation kinetics modeling. Several researchers [2, 13, and 14] have used this technology for removal of VOCs. Brillas*et al* (1998) [9] presented a scientific look into the process and described the electron transfer phenomenon. Augugliaro*et al* (1999) and Cao *et al* (2000) [4 and 8]applied the process for treatment of toluene in gaseous phase. Alex *et al* (2003) [3] used this technology for removal of benzoic acids using specially designed cascade reactor configuration. Later researchers showed interest in the investigations of formation of intermediate products of the process too Pal *et al* (2000) [15]. Hakimi*et al* (2003) [10] applied photo-catalysis technology for treatment of industrial wastewaters. Alpert *et al* (1991) [1] treated hazardous waste using photo-catalysis. Meng Nan Chong *et al* (2010) [11] has presented a review of recent developments in photo-catalysis technology. In fact the great deal of research going on in the arena of photo-catalysis can be described by the bibliography given at the end.

The present work has used the photo-catalysis technology for removal of detergents from sullage.

## 2. MATERIALS AND METHODS

The detergent used for experimental studies is commercial detergent available from the local market in the brand name of *Nirma*. It is dissolved in distilled water to obtain desired concentrations. The photo-catalyst used is Qualigens grade. The indigenously designed reactor is as shown in the figure 1. Figure 2 gives the inside view of the same. The reactors are provided with UV lamps - Narva UVK-125 W (Germany) having peak wavelength at 332 nm.

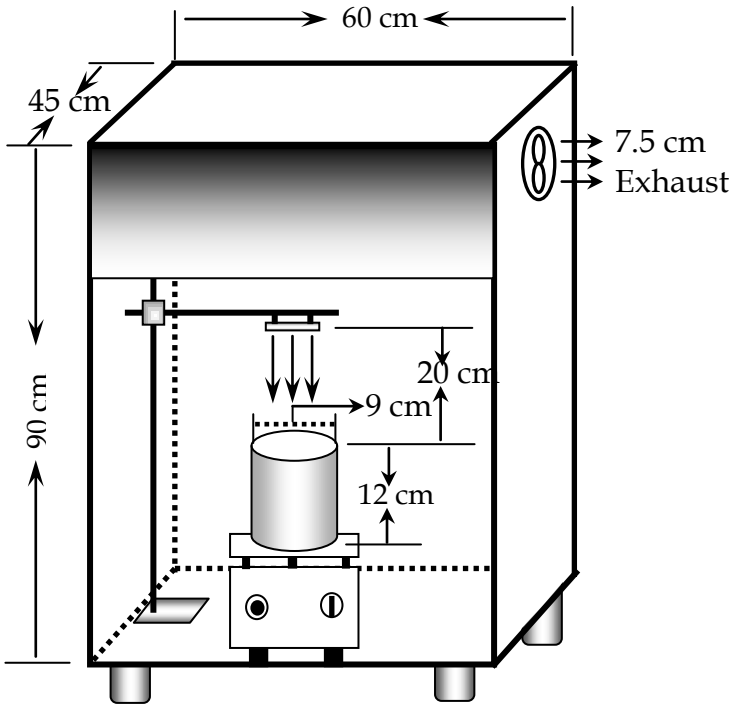


Fig 1: Schematics of slurry type reactor.

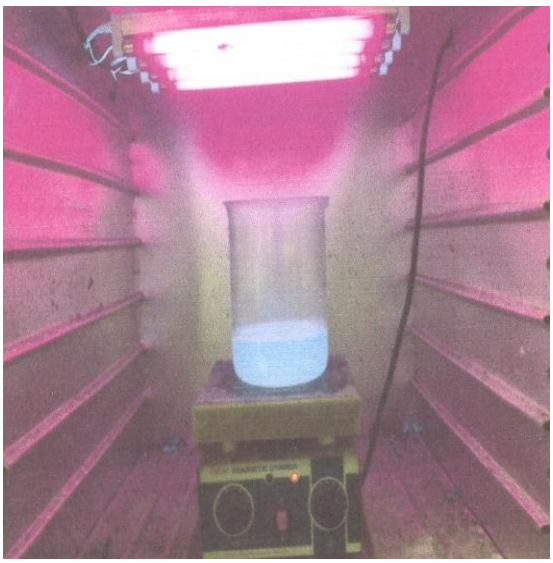

Fig 2: Inside view of slurry type reactor.

## 3. RESULTS AND DISCUSSIONS

The present work has focused on optimization of the most crucial parameter of the process that is catalyst concentration. The same has been varied in the range 25 to 45 mg/L and the COD removal with time is observed. The results are depicted in figure 3 to 7:

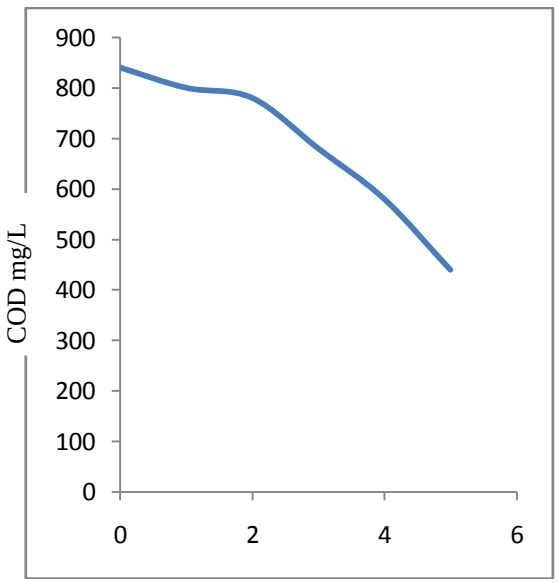


Fig 3: COD Removal with time, catalyst concentration is 25 mg/L.

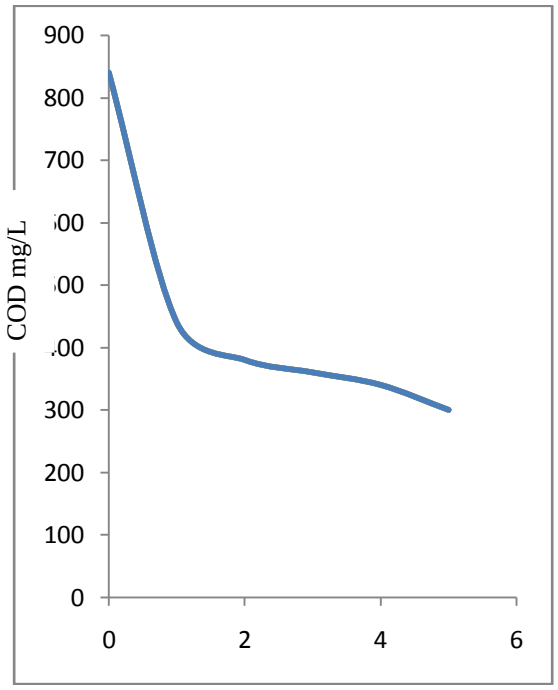


Fig 4: COD Removal with time, catalyst concentration is30 mg/L.

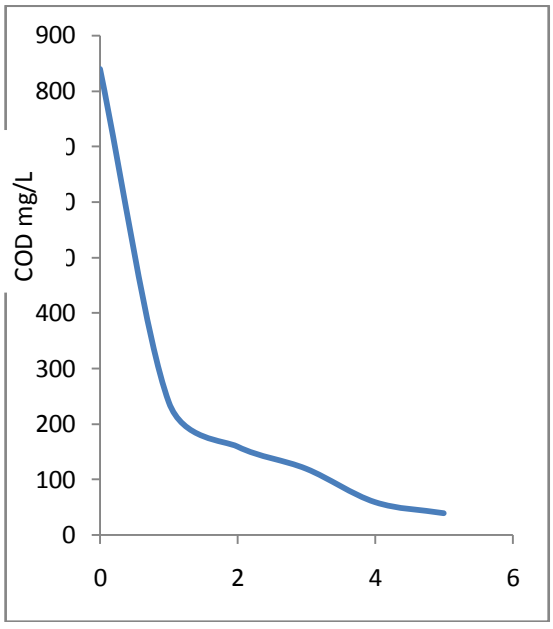


Fig 5: COD Removal with time, catalyst concentration is 35 mg/L.

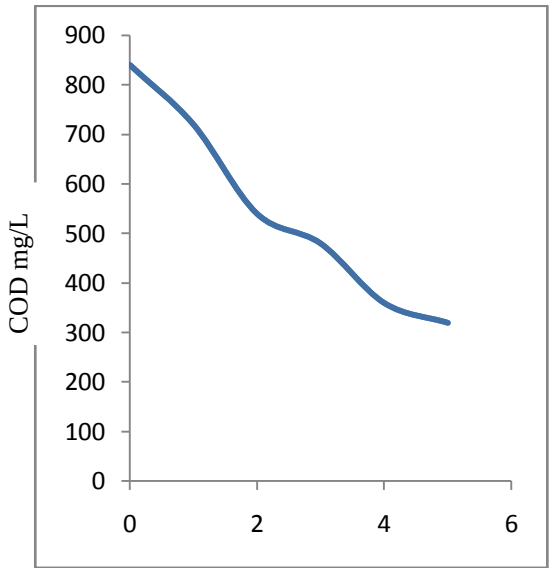


Fig 6: COD Removal with time, catalyst concentration is 40 mg/L.

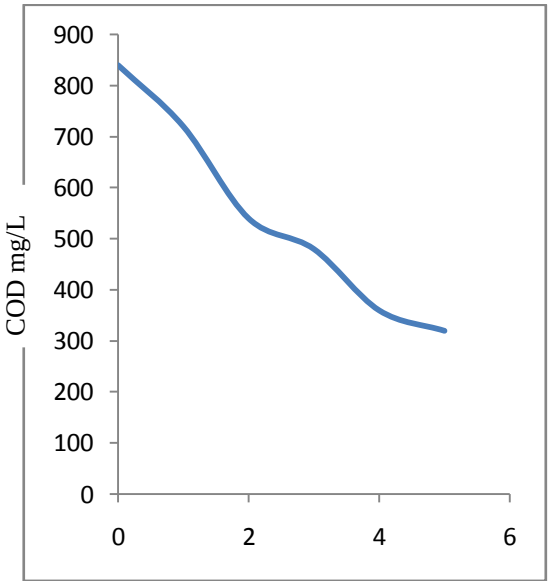


Fig 7: COD Removal with time, catalyst concentration is 45 mg/L.

The overview of figures from 3-7 makes it evident that the $TiO_2$ is a powerful photo-catalyst to decompose detergent. In fact as the process has used commercial detergent, which is not 100% pure. As per the technical information provided by the producer of the Nirma detergent, it is only 11% detergent and rest is boosters, binders, enzymes and some base materials including aromatic compounds. The COD is a combined parameter that takes into account all organics together. The

figures also indicate that the catalyst concentration has a profound effect on the degradation rate. 35 mg/L catalyst concentration has come out to be the optimum as it results into the minimum COD.

The catalyst concentration has complex effect on degradation of organics. As the degradation reaction takes place on the surface of the catalyst, the higher surface area will obviously have high degradation rate. In consequence, it requires higher concentration of the catalyst. However the reaction is driven by UV radiation. Hence its penetration in the liquid slurry is also equally important. The higher concentration of the catalyst can hinder the radiation penetration, resulting into lowered reaction rate. Hence, an optimization is required. In the present study, the optimal catalyst concentration comes out to be 35 mg/L. it must be recognized that the optimum dose is subjected to other variable combinations like pH, intensity of light, initial organic concentration etc.

## 4. CONCLUSIONS

Photo-catalysis is an effective method of removal of detergents from water. The method can be effectively applied for sullage which is produced in large quantity from residential areas and campuses. It can be easily recycled for irrigation applications. The laundry wastewaters are rich in terms of detergents. They can also treated by this method. The present work has optimized the catalyst concentration for degradation of detergent, the future researchers may like to optimize other parameters also for the same.

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# AUTOMATIC PRODUCT HANDLING, IDENTIFICATION AND SORTING USINGLabVIEW

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**ABSTRACT: Till date automation in small and medium scale industries has not enjoyed the same rate of growth as in other information technology sectors, lagging significantly behind automation in large batch production. The use of LabVIEW in controlling a robotic arm is a latest technique which is being implemented in this project. Through this project our efforts are to increase the efficiency by building an automated system which would employ and also reduces manpower. It involves the use of a robotic arm which would identify the object positioning, pick it and then place it in the desired location. With the use of this system the process of packaging can be done effectively without any manpower and also does not require constant monitoring and guidance. This paper focuses on designing a robotic arm for picking and placing an object controlled using LabVIEW. This is expected to improve the accuracy and simplicity in control.**

## INTRODUCTION

Robot is a machine to execute different task repeatedly with high precision. Thereby many functions like collecting information and studies about the hazardous sites which is too risky to send human inside. Robots are used to reduce the human interference nearly 50 percent. The first robotic arm to be used in an automobile

Industry was "UNIMATE" in GM motors USA in 1950s. From then there has been tremendous improvement in the research and development in robotics. Now robots are an integral part of almost all industries. In this paper, we introduce LabVIEW based control of the robotic arm. The action of picking or placing is also given through the LabVIEW panel. We have gained substantial experience when using the LabVIEW real-time programming environment coupled with the industrial- quality data acquisition cards, both made by National Instruments. The methodology of virtual instruments (VI) software tools combined with the graphical programming environment was found to be very efficient for interactive cycles of design and testing which are at the core of robotics prototyping.

## MECHANICAL HARDWARE

### 1. Robotic Arm

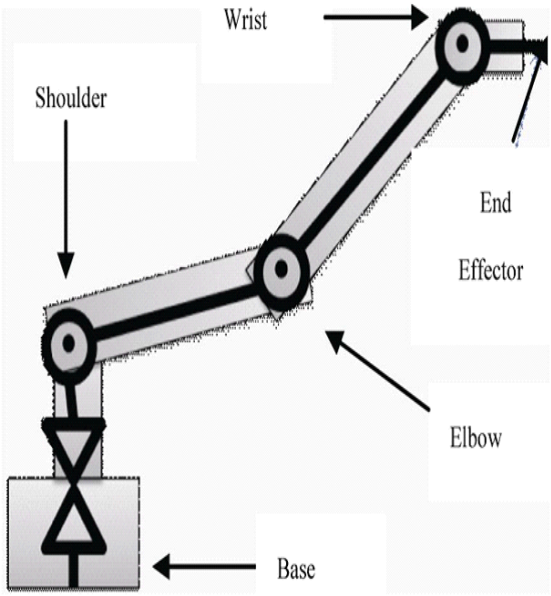


Fig. 1.The Design Model

The robotic arm is designed for simple pick and place purposes. Thus, a simple structure withfour degrees of freedom is sufficient. This design has four revolute joints which is located at the base, shoulder, elbow and wrist. These four joints emulate the motion of a human arm. In this project, only two links will be used. A two finger gripper will serve as the end effecter. Due to time constrain and the complexity to build a gripper, a commercially available gripper was used for this project. For motion and movements of the joins, actuators like servo motors are considered. A radio control servo motor is attached to every joint of robotic arm.

## 2. PC-Based Data Acquisition (DAQ)


Fig. 2 DAQ MX 6009 Card

DAQ is data acquisition. It is device which contains both ADC and DAC in it. It is interface between analog output of sensor and the PC. The data traditinal experiments in it signal from sensors o are sent to analog or digital domain, read by experimenter, and recorded by hand. In automated data acquisition systems the sensors transmit a voltage or current signal directly to a computer via data acquisition board. Software such as LabVIEW controls the acquisition and processing of such data. The benefits of automated systems are many such as:

1. Improved accuracy of recording
2. Increased frequency with which measurements can be taken
3. Potential to automate pre and post processing and built in quality control

The device range can be as follows; Minimum and maximum voltages the ADC can digitize. DAQ devices often have different available ranges.

1. 0 to +10 volts
2. -10 to +10 volts

## ROLE OF LabVIEW

### A. Introduction to LabVIEW

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a development environment based on graphical programming. It is a graphical programming language that uses icons instead of lines of text to create applications. In contrast to text based programming languages, where instructions determine program execution, LabVIEW dataflow programming, where data determine execution. LabVIEW empowers to build solutions for scientific and engineering systems. LabVIEW gives flexibility and performance of a powerful programming language without the associated difficulty and complexity.

### B. Front Panel

The front panel is the user interface of the VI [10]. We build the front panel with controls and indicators, which are the interactive input and output terminals of the VI respectively. Controls are knobs, push buttons, dials, and other input devices. Indicators are graphs, LEDs and other displays. Controls simulate instrument input devices and supply data to the block diagram of the VI. Indicators simulate instrument output devices and display data the back panel acquires or generates.

### C. Control Palette

The various sub palettes used are,
Numeric controls sub palette: numeric controls are included in the front panel for user interface to change the gain values in the design of the PID controller.
Graph sub-palette: graph indicators are used for generating the response curves of the system.

### D. Function Palette

The function palette is available only on the block diagram. The functions palette contains the VIs and functions used to build the block diagram. Select window >> Show Function Palette or Right-Click the block diagram workspace to display the Function palette .The Functions Palette can be placed anywhere on screen. Different hardware and software components can make the virtual instrumentation system. There is wide variety of hardware components can be used to monitor or control a process or test a device.

### E. Tools Palette

The tools palette used in front panel and block diagram. The Tool palette is available on the front panel and block diagram. A tool is a special operating mode of
the mouse cursor. While selecting a tool, the cursor icon changes to the tool icon. Use the tools to operate and modify front panel and block diagram objects. Select Window>> show Tools palette to display the Tools palette and it can be placed anywhere on the screen.

### F. Block Diagram

After building the front panel, add code using graphical representation of control with front panel objects. The block diagram contains this graphical source code. Front panel objects appear as terminals from the block diagram. Every control or indicator on the front panel has a corresponding terminal on the block diagram. Additionally, the

block diagram contains functions and structures from build-in LabVIEW VI libraries. Wires connect each of the nodes on the block diagram, including control and indicator terminal, function, and structure.

### G. Interfacing

RS232 is interfaced with PIC microcontroller series 16F877A which acts as interface between mechanical setup (drivers) and LabVIEW. LabVIEW acts as a controller for the entire process and interfacing mechanism shown below figure

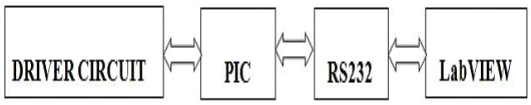


Fig. 3 Interfacing Mechanism

## RESULTS

The Front panel and Block Diagram of LabVIEW is shown below

### A. Front Panel

The fig3.Shows the front panel of the LabVIEW, where the process can be initiated, controlled, terminated and indicates the position of Robotic Arm. The Front Panel also alerts and indicates the error in circuit connection.

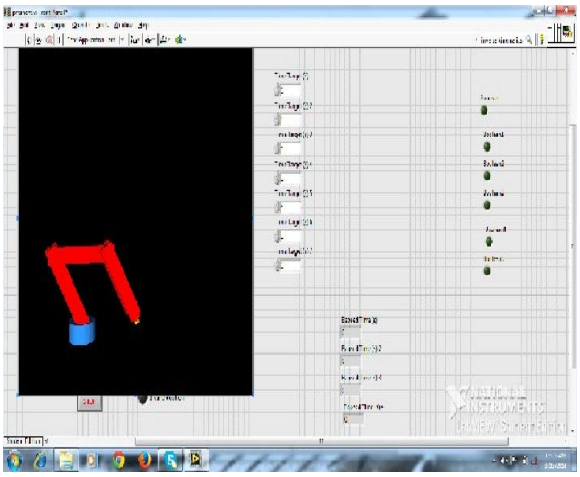

Fig. 4 Front Panel of the Process

### B. Block Diagram

The Figure shows the Block diagram of LabVIEW. The VI shown in the diagram is the overall control mechanism of automated robotic arm.

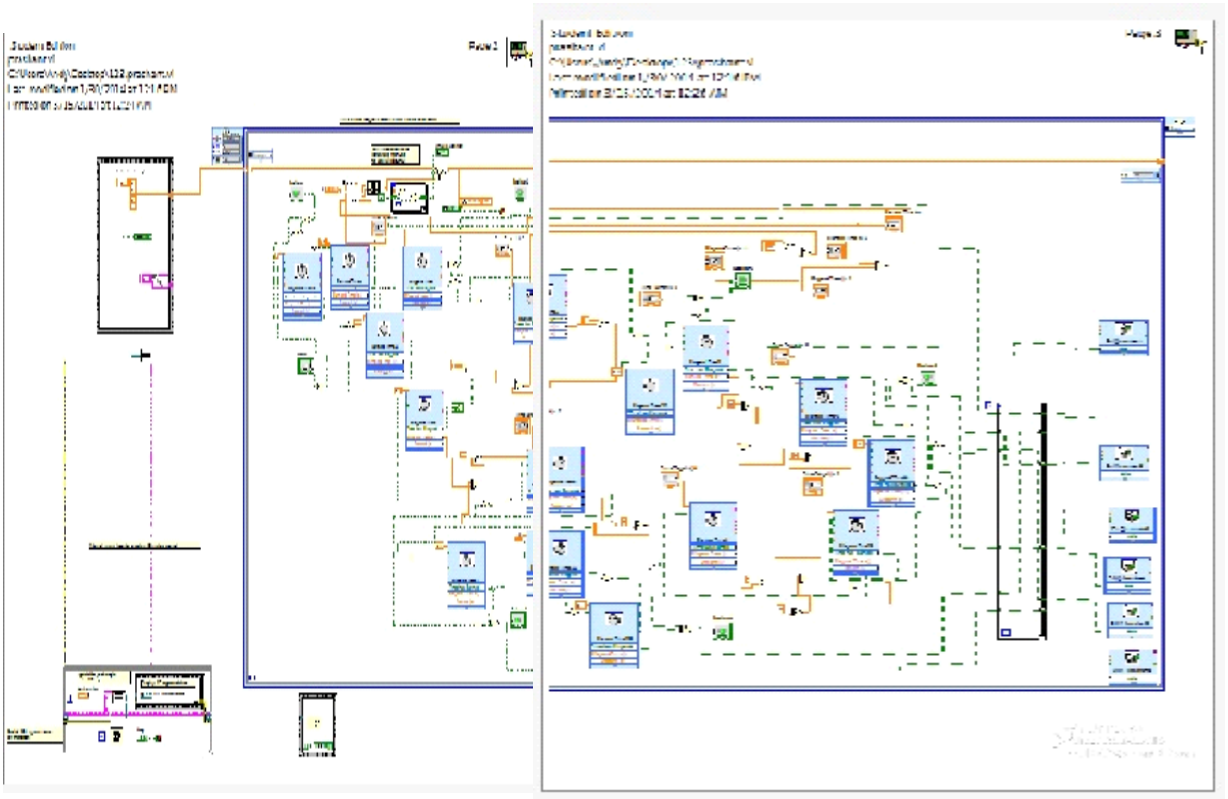

Fig 5 VI program of the overall process

## CONCLUSION AND FUTURE WORK

Acquisition of measurements and modification of actuations are the usual tasks carried out by LabVIEW TM and DAQ boards. This implementation paradigm based on personal computer and standard operating systems constitutes a new trend in automation. It allows the user to avoid such aged, specialized or expensive solutions as analog PID loops, programmable logic controllers (PLC) or dedicated hardware based on digital signal processors (DSP).

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# The Study of Internet Banking Usage: A Case study of SBI Dana Bazaar Branch, Jalgaon.

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**Abstract: SBI is pioneer in internet banking. But it does not mean to say that implement of new technology is always advantages because actual use of technology is also important. Objective of this study is to analyze the awareness and usage of internet banking among the account holders of SBI Dana bazaar branch Jalgaon. The objective of selecting this case study is felt due to the fact that most of the account holders of SBI Dana bazaar branch are business and trading firms. Banking transactions are vast among these account holders. And they can be benefited much from the internet banking. The study is based on the primary data collected through questionnaire from 75 accounts holder of SBI, Dana Bazaar Branch. The study reveals good awareness of internet banking among respondents but limited to content and information sharing only. They are still not habitual to use internet banking for transaction purpose.**

***Keywords: Internet Banking & its Usage, SBI, Digital Baking, Electronic Banking.***

## I. INTRODUCTION: INTERNET BANKING

Internet Banking System is a system that has been developed in order to help clients to do day-to-day transactions electronically from any place. Internet banking systems means that clients can now do banking at the leisure of their homes.

It is also known as online banking, the system allows both transactional and non-transactional features. Online banking or internet banking allows customers to conduct financial transactions on a secure website operated by the retail or virtual bank. (Kaushik, 2012)

- **Products and Services offered by SBI:**
  1. E-Ticketing
  2. SBI E-Tax
  3. RTGS/NEFT
  4. E-Payment
  5. Fund Transfer
  6. Third Party Transfer
  7. Demand Draft
  8. Cheque Book Request
  9. Account Opening Request
  10. Account Statement
  11. Transaction Enquiry
  12. Demat Account Statement

**1. E-Ticketing:**

E-Ticketing provides service to book railway, air and bus tickets online through Online SBI. Railway ticket can be booked through irctc.co.in. Railway tickets are available in to forms.

- I-ticket (where the delivery of tickets will be made at your address) or
- E-tickets (e-ticket is generated & can be printed at home.)

Air flight tickets and selected bus transport ticket of metro cities are also available through E-Ticket Services

**2. SBI E-Tax:**

This facility enables to pay TDS, Income tax, Indirect tax, Corporation tax, Wealth tax, Estate Duty and Fringe Benefits tax online through SBI E-Tax. The online payment feature facilitates anytime, anywhere payment and an instant E-Receipt is generated once the transaction is complete. The Indirect Tax payment facility is available to Registered Central Excise/Service Tax Assesses who possesses the 15 digit PAN based Assesses Code.

**3. E-Payment:**

A simple and convenient service for viewing and paying bills online. Using the bill payment anybody can view and Pay various bills online, directly from your SBI account. It can pay telephone, electricity, insurance, credit cards and other bills from the comfort of your house or office, 24 hours a day, 365 days a year.

It can also set up Auto Pay instructions with an upper limit to ensure that your bills are paid automatically whenever they are due.

**4. RTGS/NEFT:**
It can transfer money from State Bank account to accounts in other banks using the RTGS/NEFT service. The RTGS system facilitates transfer of funds from accounts in one bank to another on a "real time" and on "gross settlement" basis. This system is the fastest possible interbank money transfer facility available through secure banking channels in India. It can transfer an amount of Rs.1 lacs and above using RTGS system. National Electronic Funds Transfer (NEFT) facilitates transfer of funds to the credit account with the other participating bank.

**5. Fund Transfer:**
The Funds Transfer facility enables to transfer funds within accounts in the same branch or other branches. It can transfer aggregating Rs.1 lacs per day to own accounts in the same branch and other branches. To make a funds transfer, it should be an active Internet Banking user with transaction rights. Funds transfer to PPF account is restricted to the same branch.

**6. Third Party Transfer:**
It can transfer funds to trusted third party's account by adding them as third party accounts. The beneficiary account should be of any SBI branch. Transfer is instant. it can do any number of Transactions in a day for amount aggregating Rs.1lakh.

**7. Demand Draft:**
The Internet Banking application provides to register demand drafts requests online. You can get a demand draft from any of your Accounts (Savings Bank, Current Account, Cash Credit or Overdraft). Limit can be set to issue demand drafts from your accounts or use the bank specified limit for demand drafts. A printed advice can also be obtained from the site for record purpose.

**8. Cheque Book Request:**
A request can be posted through internet banking account for a cheque book. Cheque book can be requested for any Savings, Current, Cash Credit, and Over Draft accounts. It enables to opt for cheque book with 25, 50 or 100 cheque leaves. Cheque book can be delivered to registered address or any other address provided in request.

**9. Account Opening Request:**
OnlineSBI enables it to open a new account online. You can apply for a new account only in branches where you already have accounts. You should have an INB-enabled account with transaction right in the branch. Funds in an existing account are used to open the new account. You can open Savings, Current, Term Deposit and Recurring Deposit accounts etc.

**10. Account Statement:**
The Internet Banking application can generate an online, downloadable account statement for any accounts for any date range and for any account mapped to username. The statement includes the transaction details, opening, closing and accumulated balance in the account. The account statement can be viewed online, printed or downloaded as an Excel or PDF file.

**11. Transaction Enquiry:**
OnlineSBI provides features to enquire status of online transactions. It can view and verify transaction details and the current status of transactions.

**12. Demat Account Statement :**
OnlineSBI enables it to view Demat account statement and maintain such accounts. The bank acts as your depository participant. In the third party site, you can mark a lien on your Demat accounts and use the funds to trade on stock using funds in your SBI savings account. It can provide Demat account details and generate the statement of holding, statement of transactions and statement of billing. (Kaushik, 2012)

## II. OBJECTIVES:

- To analyze the awareness & usage of internet banking by SBI customers.
- To identify the strength and weaknesses of it and reasons of that.
- To suggest the appropriate measures to increase the use of internet banking by customers.

## III. RESEARCH METHODOLOGY

- **Type of Research:** it is a survey research method collecting actual facts and figures.It is descriptive in nature using both primary and secondary data. Secondary data is used to conceptualize the objective, nature and scope of the survey. And primary data is used to collect actual facts regarding proposed problems in objectives.

- **Types of Data:**
- **Primary data:** primary data were collected through structured questionnaire methods. Primary data includes actual facts about

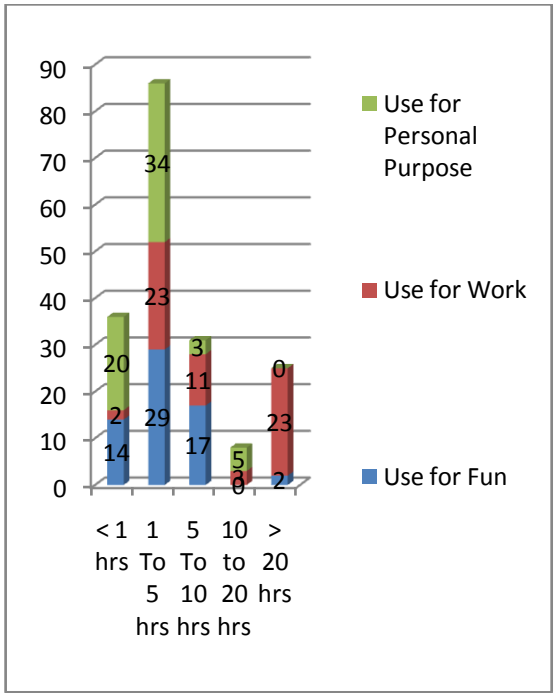
awareness and usage of computer, internet and internet banking. Some formal discussions are held with branch manager to know additional information about the branch, its customers and their professions.

- **Secondary data:** Secondary data were collected through various sources such as official's reports & websites etc. most of the secondary data is collected through internet.

- **Sample Size:** There are 183 accounts holders of SBI Dana Bazaar Branch. Out of which 112 are current account of trading firms. 96 of which are found active and 75 accounts are taken as sample for the study.

## IV. Data Analysis and Interpretation:

### 1. Use of Computer for Fun, Work and Personal Purpose per Week:

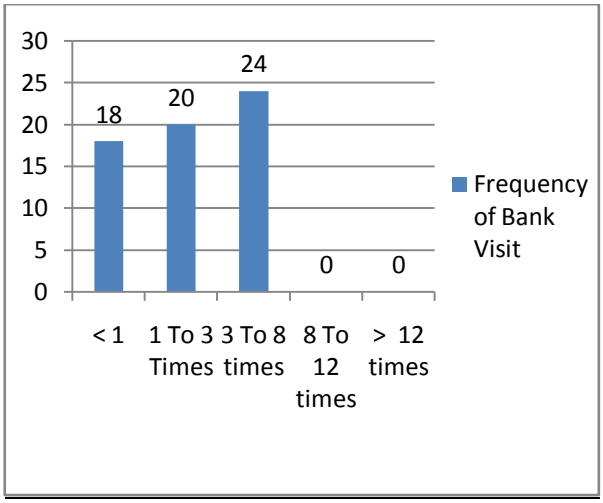



Sources: Primary Data.

Fig. 1: Use of Computer Hours

**Interpretation:**
Figure 1 reflects Computer hours required for office work is high (> 20 Hrs) as compared to fun and personal purpose (1-10 Hrs). But more clients are found using computer for fun and personal purpose against work. Use of computer for work is very limited in spite of its advantages.

### 2. Frequency of Bank Visit per Week:

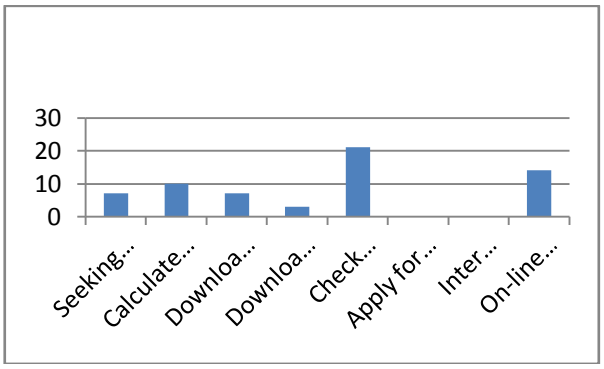



Sources: Primary Data.

Fig. 2

**Interpretation:**
Figure 2 reflects 72 % of clients visit bank for transaction purpose. The frequency of these clients is between 2 to 8 visits per week. This frequency is positive from the internet usage point of view.

### 3. Use of Internet Banking Facility:




Source: Primary Data

Fig. 3: Use of Internet Banking Facility.

**Interpretation:**
Figure 3 reflects use of internet banking for various purposes. Most of the clients of SBI Dana Bazaar Branch are using internet banking facility for Seeking product and rate information, Calculate loan payment information, Download loan application, Download personal bank transaction activity, Check balance on-line. That is majority of clients are using internet banking facility for searching information on product or services offered by bank. Very few clients are using internet banking for On-line bill payment.

**4. The reasons behind limited use of internet banking for online transaction purpose:**

**Interpretation:**

Reasons for limited use of internet banking transaction reported as lack of awareness, concern of online fraud and internet security, don't know how to use it etc.

## V. Findings:

**Awareness and use of computer as well as internet:**

Majority of client's use of computer for personal and official purpose is good. They are using www web 2 services as well. They have performed online transaction. That suggests their good awareness, use of computer and internet.

**Analysis of need for internet banking:**

The frequency of visit to bank & ATM for different transaction purpose is also considerable. Inter firm transactions are also considerable among them. Exp. Third party transfer, bill payments etc. this suggest there is good scope to use internet banking for day to day transaction purpose.

**Strength & Weaknesses:**

Most of the clients of SBI Dana Bazaar Branch are using internet banking facility for Seeking product and rate information, Calculate loan payment information, Download loan application, Download personal bank transaction activity, Check balance on-line. That is majority of clients are using internet banking facility for searching information on product or services offered by bank.

But Very few clients are using internet banking for On-line transaction purpose. The reasons are lack of awareness, concern of online fraud and internet security; don't know how to use it.

## VI. Suggestions:

- Bank can provide user's manuals as well as Training to the customers so that they can be inclined to use the internet banking for transaction purpose.
- Training can be provided on following aspects:-
    - Online Fund Deposit
    - Online Fund transfer, RTGS, NEFT
    - Online Third party transfer
    - Online Tax filling
    - Online Bill Payment etc.
- Such a training programme can be frequently introduced for new customers.

## VII. Conclusions:

Internet banking is gaining popularity and it is very essential for new age customer. Use of internet banking is very beneficial to customers as it saves lots of harassment and cost incurred on the coordination for banking transaction.

From the above analysis, I conclude that, awareness of computers, internet and internet banking among SBI account holder is high as well as use of computer and internet for personal and official purpose is also good. Similarly, Use of internet banking is high for searching online information but, in spite of its advantages, use of internet banking for online transaction purpose is very limited.

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# Green HR Practices: An Empirical Study of Cargill, Jalgaon

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**ABSTRACT: There is a growing need for the integration of environmental management into Human Resource Management (HRM) – Green HRM – research practice. A review of the literature shows that a broad process frame of reference for Green HRM has yet to emerge. A concise categorization is needed in this field to help academics, researchers and practitioners, with enough studies in existence to guide such modeling. This article takes a new and integrated view of the literature in Green HRM, using it to classify the literature on the basis of entry-to-exit processes in HRM (from recruitment to exit), revealing the role that HR processes play in translating Green HR policy into practice. The contribution of this article lies in drawing together the extant literature in this area, mapping the terrain in this field, and in proposing a new process model and research agenda in Green HRM.The Greening of HR Survey examines the types of environmentally friendly "green" initiatives that companies are utilizing involving their workforce and human resource practices. The results confirm that companies are incorporating and working toward integrating a number of green practices. The world is a smaller place thanks to the Internet, global trading and new communication and technology. More companies are expanding overseas and now manage a global workforce that has unique benefits, rules/laws and different languages and currencies.**

## I. INTRODUCTION TO GREEN HR

"Green HR" is an employment model designed to assist industry professionals in retaining, recalling, preserving and developing talent needed to ensure future business initiatives and strategies are met. Efficiency afforded by the "Green HR" model can lower operational costs and enables industry professionals to better utilize their investment in knowledge capital, Green HR is one which involves two essential elements: environmentally friendly HR practices and the preservation of knowledge capital. Green HR involves reducing your carbon footprint via less printing of paper, video conferencing and interviews, etc. Companies are quick to layoff when times are tough before realizing the future implications of losing that knowledge capital. Green HR initiatives help companies find alternative ways to cut cost without losing their top talent; furloughs, part time work, etc.

## II. OBJECTIVES OF THE STUDY

- To study the effectiveness of Green HR mechanism at Cargill.
- To determine current green sustainability of Cargill.
- To determine measures of green success.
- To understand that how Green HR policies and practices can improve the environmental performance of organizations.

## III. RESEARCH METHODOLOGY

The type of research used in this project is descriptive in nature. Primary data was collected using the questionnaire. A survey was done with the researcher meeting the respondents in their respective places. The respondent's reference to each question was carefully noted in the carefully observed and registered Questionnaire. Analysis techniques are used to obtain finding and arrange information in a logical sequence from the raw data collected. After the tabulation of data the tools provide a scientific and mathematical solution to a complex problem.

## IV. IMPORTANCE OF THE STUDY

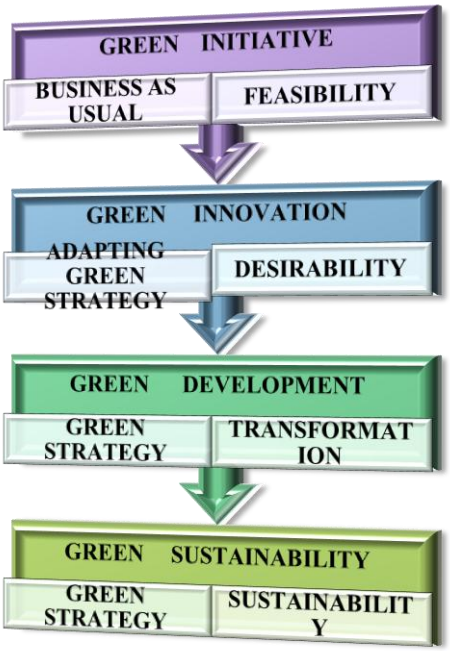
We are entering a green economy-one in which consumer and employee expectations and future environmental change will require business to address "green" issues. Environmental conscious organizations will become increasingly prominent as we re-enter into a period of growth. Green HR is

a not just a strategy used primarily for reducing the carbon footprint of each employee and talent retention. Green HR is one which involves two essential elements: preservation of knowledge capital and environmentally friendly HR practices. Green HR involves reducing your carbon footprint via less printing of paper, video conferencing and interviews, etc.Companies are quick to layoff when times are tough before realizing the future implications of losing that knowledge capital. Green HR initiatives help companies find alternative ways to cut cost without losing their top talent; furlough, part time work etc. "Green HR" is an employment model designed to assist industry professionals in retaining, recalling, preserving and developing talent needed to ensure future business initiatives and strategies are met. HR professionals in organization can develop a powerful social conscience and green sense of responsibility internal and external customers, stakeholders, partners etc. Recent times, consumers demand ethics and environmental credentials as a top priority. Society and business see their agenda align.

## V. PUTTING HUMAN CAPITAL MANAGEMENT PROCESSES ONLINE ALSO HELPS TO:

- Significantly reduce wasted time and effort in collecting paper forms and building reports.
- Push out information right now, rather than waiting for paper newsletters and forms to be printed and collected.
- Provide easy to use multimedia content including video, PowerPoint, audio, text, pictures.
- Reduces carbon footprint by reducing paper usage.
- Reduces waste by preventing hard copy from being thrown in the bin.
- Easily gather employee feedback.
    - Save lot of money on printing costs
    - Get managers talking more to employees by streamlining existing processes.

## VI. Green Transformation Process of Cargill




Many organizations are still considering the feasibility of going green in their business while others are exploring the desirability to adapt a green business strategy. However, in order for HR to consider becoming green and incorporating green practices in their strategies and people development plans, it is critical that organizations adopt a strategic decision to incorporate a green approach to their desired business results. The most important way to do this is to make changes to both the internal and external value chain that defines the business in its industry together with the competitors and the supply chain that directly impacts the final business results. The framework indicates an organization's developmental decision to make the move to green performance within the context of corporate sustainability.

## VII. SURVEY AT CARGILL:

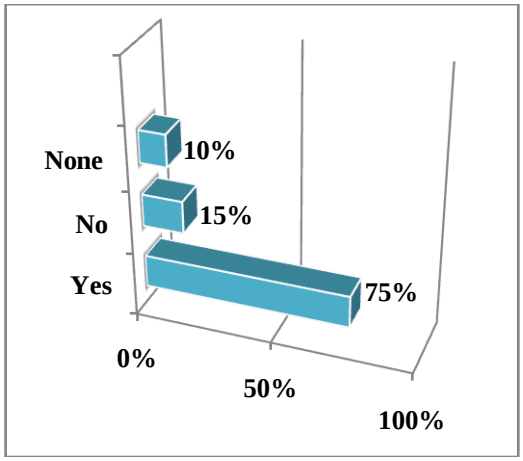
The survey noted that 60% of organizations are measuring their cost savings – this is up from 39% last year. Among the organizations that have a formal green program, the most common practices are:

- Recycling and paper reduction (97%)
- Web and/or teleconferencing (95%)
- Healthy living and wellness (85%)
- Internal green communication programs (81%).

## VIII. Data Interpretation and Data Analysis

1. Green HR has the better ability to respond to environment changes?

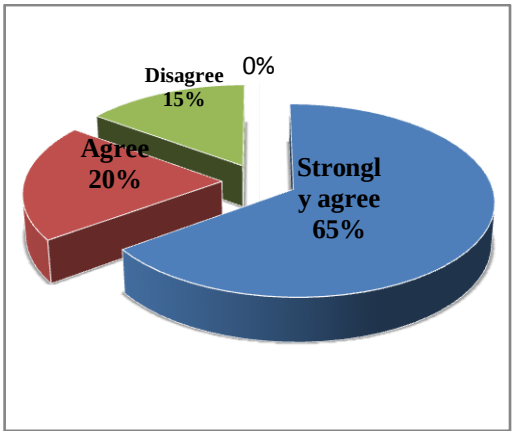
A) Yes B) No C) None




**Inference** -from the above pie chart it is found that in view of 75% respondents green HR has the better ability to respond to environmental changes whereas only 15% respondents opined that green HR does not respond to environmental changes and 10% respondents are unaware about the green HR ability.

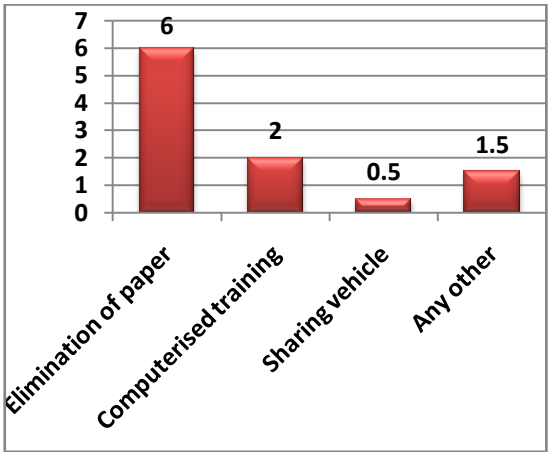
2. Is green HR More meaningful in career planning?

A) Strongly agree B) Agree C) Disagree




**Inference**-from the above pie chart it is found that as green HR is aligned with all the strategic activity so 65% respondents feels that it is meaningful in career planning but 15% respondents are aware of the concept and disagree that going green doesn't help in career planning.

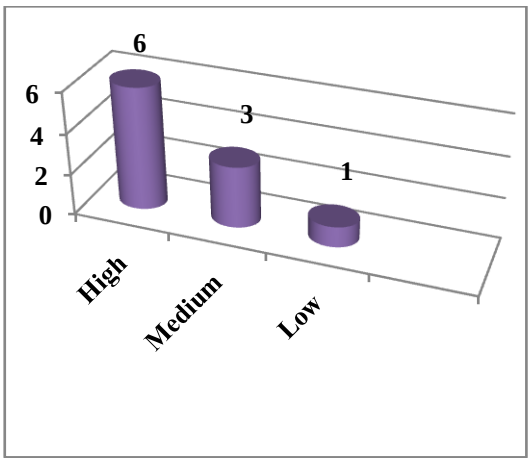
3. Best practice for going Green can be?
   A) Elimination of excess use of paper
   B) Computerized training
   C) Sharing of vehicle
   D) Any other




**Inference-** From the above pie chart it is depicts that 60% respondents felt that elimination of excess use of paper is best practice for going green whereas 15% respondents feels that there are many other things for going green like providing limited resources, going for 3R's – REDUCE, RECYCLE, REUSE. They felt that policies are important but more can be done at individual level.

4. Role of Green HR in environment management?

A) High B) Medium C) Low




**Inference**-From the above pie chart it is shows that in view of 60% respondents Green HR has positive impact on environment whereas 10% respondents feel that there is no impact of green HR on external environment.

## IX. FINDINGS

a. It is revealed that role of HR professional is very big for Green HRM. Companies that want to be more earth-friendly need to make sure current employees are on board with the goals. This can be accomplished through

communication and training by the HR professionals.

b. Discloser of study shows that Impact of Green awareness is fruitful. There are numbers of program which offers monthly electronic communications, including newsletters and interactive games, as well as working with companies to appoint green coordinators in local offences to help develop plans and serve as points of contact for green practices.
c. It is founded that changing attitudes and behaviours related to environmental issues in the workplace. Flexibility is often the driver of change, and it's at the heart of the sustainable management initiative.
d. It is concluded that it retires burdensome paper-based processes and improve the process efficiency.
e. It shows that it also reduces turnaround times and as well as costs/paper consumption.
f. Study shows that it help in additional tools for automated and business processes.
g. It also revealed that it is important to improve the Green Hr policies at Employee level for the better result.
h. It is found that people thinks it's very necessary to go Green but again they don't know how to take the first step so the proper training and communication should be done.
i. It may also reveal data to add an HRM element to the knowledge base and Green Management in general for academics.

## X. CONCLUSION

It is concluded that Green ideas and concepts are beginning to gather pace within the HR space, often complementing existing sustainability-based initiatives. Increasingly they are delivering tangible benefits to the business, rather than simply adding a gloss to brand and reputation. During the research, researcher has observed the new processes, policies and tools are actually helping to ensure compliance and improve process too. And with legislation now in place to effectively formalize the need for a new corporate approach to the environment, now's the time for HR to embrace the green agenda. In future research into Green HRM may provide interesting results for all stakeholders in HRM. It is concluded that specific focus on waste management and recycling; for employees, they may help them lobby employers to adopt Green HRM policies and practices that help safeguard and enhance workers health and well-being.

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# ANALYSIS OF SPRING BACK DEFECT IN RIGHT ANGLE BENDING PROCESS IN SHEET METAL FORMING

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**ABSTRACT: In the project work, the deformation mechanics of the spring back phenomenon in the Right Angle Bending of sheet-metal was examined and a new method that could efficiently reduce spring back in the Right Angle Bending of sheet metal was proposed. Both the finite element analysis and experiments were performed to analyze the deformation mechanics and the effects of process parameters on the formation of spring back. The axial stress distribution in the bent sheet obtained by the finite element simulations was classified into three zones: the bending zone under the punch corner (zone I), unbending zone next to the bending zone (zone II), and the stress-free zone (zone III). It is found that the stress distribution in zone I is quite uniform and hence has little influence on the spring back. While the stress distribution in zone II results in a positive spring back, whereas the stress distribution in zone III produces a negative spring back. The total spring back therefore depends on the combined effect of those produced by zone II and zone III. A reverse bend approach that can efficiently reduce spring back was also proposed to reduce the spring back in the Right Angle Bending process. The finite element analysis performed in the present study was validated by experiments as well. Although the reverse bend approach can reduce spring back efficiently, it may cause uneven surface at the die corner area. Hence, the use of reverse bend approach must be cautious if high surface quality is required. The proposed reverse bend approach provides the die design engineer with a novel idea to reduce the spring back occurred in the Right Angle Bending of sheet metals. In addition to the reverse bend approach, the analysis of deformation mechanics of spring back performed in the present study also provides researchers with a better understanding of the formation of spring back.**

## INTRODUCTION

Spring back is a main defect occurred in the sheet-metal forming processes and has been thoroughly studied by researchers. Among them, quite a few efforts have been made to obtain a deep understanding of the spring back phenomenon. The beam theory has been applied to formulate the curvature before and after loading by some researchers [1-3]. Hill [4] also presented a general theory for the elastic-plastic pure bending under the plane strain condition. The spring back occurring in the bending of high strength steels was discussed by Davies [5], and Chu [6]. Nader [7] examined the effects of process parameters on the spring back in the V-bending process by developing theoretical models. In addition to various theories on prediction of spring back, efforts were also made to reduce the spring back. Liu [8] demonstrated an efficient method that dramatically reduced the spring back using the double-bend technique. A bending restriking process was proposed by Nagai [9] to reduce spring back. Wang [10] showed by conducting experiments that the spring back could be reduced by the over-bend approach. Chan and Wang [11] have proposed a strain-hardening plane-stress bending model to predict the deformation behavior and spring back of narrow strips. A computer aided design method for straight flanging using finite element method was presented by Livatyali and Altan [12]; they also investigated flanging with coining as a method to eliminate spring back and to improve part quality. The finite element simulation and experimental approach were also employed by researchers [13-15] to study the spring back and side-wall curl in the sheet metal forming.

In the present study, the Right Angle Bending process of aluminum alloy AA5052-H34, as shown in Fig. 1, was studied. The effects of the process parameters on the spring back occurring in the Right Angle Bending process were first examined by both the finite element analysis and experiments. In addition, the deformation mechanics of the spring back phenomenon was investigated in detail by the finite element analysis. A reverse bend approach was then proposed to reduce the spring back in the Right Angle Bending process. The proposed approach was demonstrated to be very efficient by the finite element analysis and was validated by experiments conducted in the present study. Performed using aluminum alloy AA5052-H34 sheet as specimen. Since spring back is mainly due to the elastic recovery of the stress distribution along the axial direction, the stress distributions in the bent sheet obtained from the finite element simulations were transformed into the axial direction accordingly, and the stress distribution mentioned hereinafter is associated with axial direction. Figure 3 shows the stress distribution in the bent sheet along the axial direction at the end of bending process before the punch is removed. Based on the stress distribution patterns, the bent sheet is classified into three zones: flat zone under the blank holder, bending zone at the die corner and unbending zone at side wall, which are marked by I, II, and III, respectively, in Fig. 3, and the stress distributions in zone I and zone III are displayed in Fig. 3 as well. While Fig. 4 displays the stress distribution in zone II. Since the stress distribution in the flat zone is nearly uniform compression, it is obvious that the spring back is independent of the flat zone, i.e., zones I, and is mainly attributed to the stress distributions in zone II and zone III.

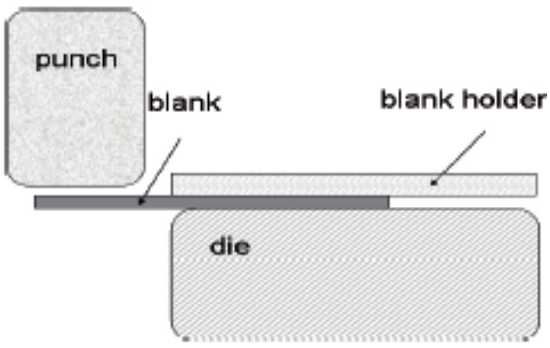


Fig. 1. A Sketch of Right Angle-Bending

## FINITE ELEMENT MODEL

In the present study, the sheet-metal was assumed to be very wide and the Right Angle Bending could be simplified to a 2-D plane-strain problem. The tooling used in the bending process was modeled as rigid bodies. As for the sheet-metal, the 4-node plane-stress element was adopted to construct the mesh. Since the number of elements in the thickness direction has significant effect on the accuracy of the simulation, the convergence tests were performed to determine a suitable number of elements to be used in the thickness direction. In the present study, 6 layers of elements in the thickness direction were used in most of the simulations. After the sheet-metal being bent into an L-shape, the punch and blank holder were removed and the spring back was measured by comparing the difference of the bent angle before and after the tooling was removed, as shown in Fig. 2. In each simulation, the Coulomb friction coefficient was used to describe the interface friction condition between the tooling and sheet-blank. The finite element code ABAQUS was adopted to conduct all the simulations and the material properties of AA5052-H34 obtained from the tension tests conducted in the present study were used for the finite element simulations.

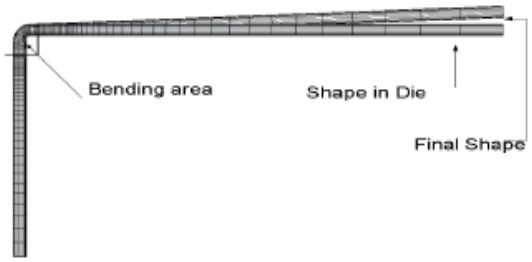


Fig. 2 The shapes before and after tooling removal

## DEFORMATION MECHANICS IN RIGHT ANGLE –BENDING

In order to examine the deformation mechanics along the whole sheet after bending, the finite element simulations were

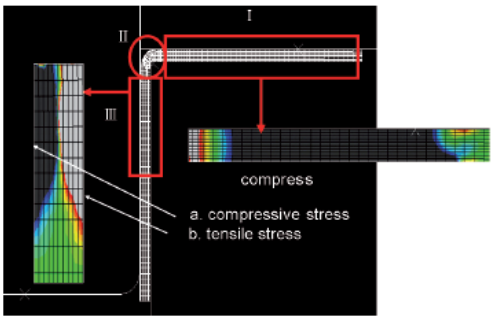


Fig. 3. Stress distribution in the bent sheet before tooling removal

The stress distribution in zone II, as shown in Fig. 4, follows the bending theory that the sheet is compressed inside and stretched

outside. The elastic recovery of the sheet in this zone, equivalent to an application of an opposite moment, makes the sheet to bend outward, resulting in a positive spring back. While the stress in zone III, as shown in Fig. 3, has an opposite distribution pattern to that in zone II, i.e., tension inside and compression outside. The elastic recovery of the sheet in this zone therefore creates a negative spring back. Consequently, the total spring back is determined by the combined effects contributed by both zone II and zone III. The bent sheet has a positive spring back after the punch is removed, if the spring back phenomenon is dominated by the stress distribution in zone II. On the other hand, the Right Angle Bending process results in a less amount of spring back, if the stress distribution in zone III is predominant. It implies that the deformation of sheet-metal other than the die corner area also contributes to the spring back.

To further illustrate the effects of the stress distributions in zone II and zone III on spring back, the finite element analysis was performed to examine the stress distributions in the Right Angle Bending of 0.5 mm thick AA5052-H34 sheet with different die corner radii ranging from 0.1mm to 3 mm. The finite element simulation results indicate that the larger the die corner radius, the more significant is the spring back. The stress distributions in zone III for the Right Angle Bending with different die corner radii are shown in Fig. 5. It is noted in Fig. 5 that the area of non-uniform stress distribution in zone III becomes small when the die corner radius increases, resulting in a smaller negative spring back created by the stress distribution in zone III. In consequence, the stress distribution in zone II dominates the spring back and the amount of spring back increases.

The above stress analysis clearly explains the deformation mechanics of the spring back phenomenon that occurs in the right angle bending process, especially the formation of negative spring back in zone III. Since the spring back is inevitable in the Right Angle Bending process, in order to reduce the total spring back, an optimum process design is required to make the stress distribution in zone III more significant to balance the spring back caused by the elastic recovery of the stress distribution in zone II. However, over-adjustment will result in a negative spring back and should be avoided.

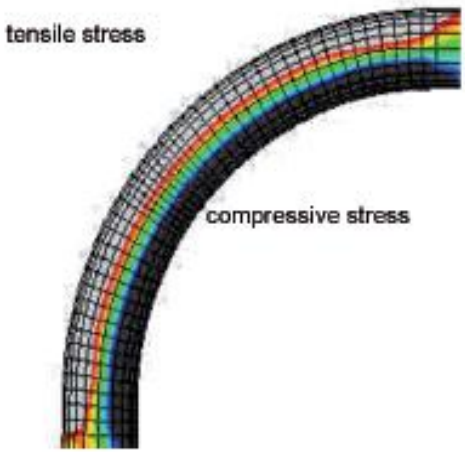


Fig. 4. Stress distribution in zone II

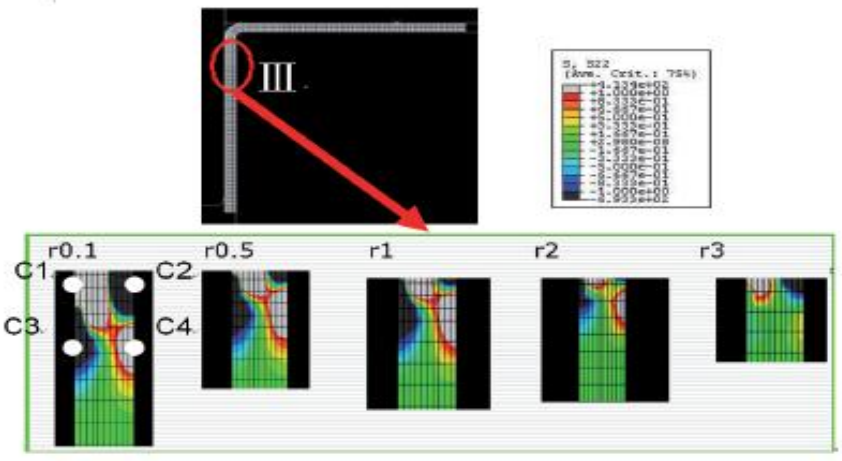


Fig. 5. The stress distributions in zone III for different die radii

**REVERSE BEND APPROACH**

The practical approach commonly adopted in the sheet-metal industry to reduce the spring back is to compensate the spring back by bending the sheet inward. However, it is not possible to do this if the draft angle for the punch is negative. In the present study, a reverse bend approach was proposed to reduce the spring back in the Right Angle Bending of sheet-metal. In the reverse bend approach, the sheet metal is first bent

locally to an opposite direction of the desired bend into a hemispherical bead shape and then is bent at the bead location by the punch to the desired shape, as shown in Fig. 6. The reverse bend is located at the desired bending position, and the dimensions of the reverse bend are characterized by band width (b) and bend height (h), as shown in Fig. 7. The main purpose of adding a reverse bend to the V-bending process is to change the deformation mechanics in the stress distributions in both zone II and zone III. The stress distribution in zone III is much improved when the reverse bend approach is applied to the Right Angle Bending process, as shown in Fig. 8. As seen in Fig. 8, the area of the non-uniform stress distribution increases and produces significant negative spring back to reduce the total spring back. However, the reverse bend may cause uneven surface at the die corner area, as shown in Fig. 9. Hence, the use of reverse bend approach must be cautious if high surface quality is required.

The efficiency of the reverse bend approach proposed in the present study was demonstrated by the finite element analysis, and was validated by the Right Angle Bending experimental data as well. Both the finite element simulation results and the experimental data indicate that a larger reverse bend height yields a significant effect on the reduction of spring back. The proposed reverse bend approach provides an alternative to reduce the spring back in the Right Angle Bending process of sheets.

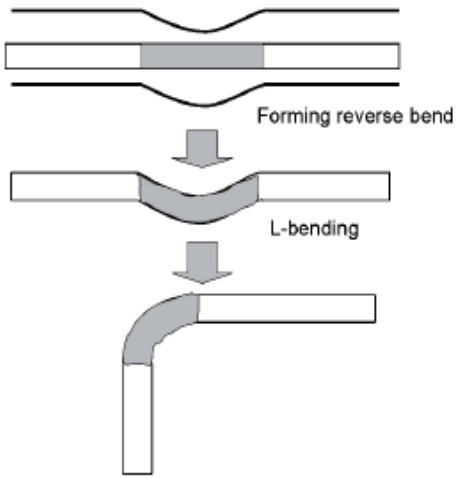


Fig. 6. Reverse Bend Approach in L – Bending

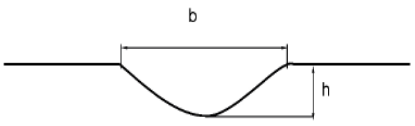


Fig. 7. Dimensions of the Reverse Bend

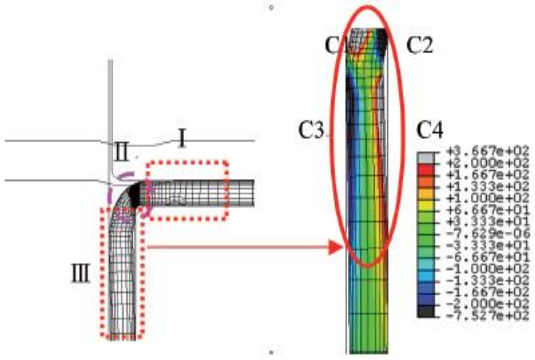


Fig. 8. The Axial Stress Distribution after Right Angle Bending With Reverse Bend

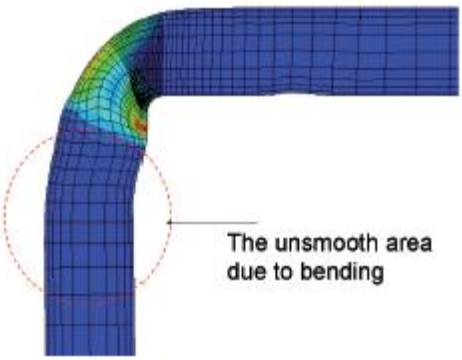


Fig. 9. The Unsmooth Area after Right Angle Bending With Reverse Bends.

## CONCLUSION

The deformation mechanics of spring back phenomenon in the Right Angle Bending of sheet-metals was investigated by the finite element analysis. The axial stress distribution in the bent sheet was classified into three zones: the flat zone under the blank-holder (zone I), bending zone around the die corner (zone II), unbending zone next to the bending zone (zone III). The stress distribution in zone I is quite uniform and hence has little influence on the spring back. While the stress distribution in zone II results in a positive spring back, whereas the stress distribution in zone III produces a negative spring back. The total spring back therefore depends on the combined effect of those produced by zone II and zone III. The finite element analysis also indicates that the smaller die radius and die gap will reduce the spring back in Right Angle Bending the process.

A reverse bend approach was also proposed in the present study to reduce the spring back in the Right Angle Bending process. The finite element analysis reveals that the stress distribution pattern varies with the use of the reverse bend approach, resulting in a significant reduction of spring back. However, the reverse

bend approach may cause uneven surface around the die corner. Hence, the use of the reverse bend approach must be cautious if the surface quality is required.

The finite element analysis performed in the present study was validated by experiments as well. The good agreement between the finite element simulation results and the experimental data confirm the efficiency in using the finite element analysis in the Right Angle Bending process of sheet-metals.

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# Computational Fluid Dynamics (CFD) Simulation of Helical Coil Induction Water Heater using Induction Cooker

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**Abstract: This communication presents a comparative performance study of helical coil induction water heater with three, four and five helical coils through a computational fluid dynamics (CFD) simulation. Helical coil is designed and modelled as per selection of one variable parameters keeping others constant. Simulations were performed using variable flow rate of water through helical coil with different number of turns N=3.25, N=4 and N=5. The values of water outlet temperature observed with variable flow rates of water during the CFD analysis using Fluent software is getting affected with the help of different helical coil configurations by changing number of turns with coil pitch, coil diameter and coil tube diameter retains constant. The heat supplied to helical coil from induction cooker which used in CFD as heat flux on surface of coil. Results indicated that the water outlet temperature from helical coil is increases with increase in number of turns except for N=3.25.**

***Keywords: Computational Fluid Dynamics (CFD), Helical Coil, Fluent, Coil Pitch.***

## I. INTRODUCTION

Helical coils are widely used in applications such as heat recovery system, chemical processing, food processing, nuclear reactors and high-temperature gas cooling reactors [1]. Because of helical coils have a compact configuration, more heat transfer surface can be provided per unit of space than by the use of straight tubes, ease of manufacture and longer operating life. Industrial demands of electricity and especially water at certain temperature of $85^0$-$90^0$ for different processes to fulfill demands it required lot of electricity or fuel and also for hot water required at particular temperature using different techniques including Electric Heater, Gas Water Heater, Storage Heat Pump water heater, Heat Exchanger using burning of fuel etc. Due to deficiency of resources in environment it is necessary to find out alternative energy resources or use available resources effectively; so for water heating process it should aimed at having effective use over the supplied electricity, the new technique of water heating using induction heating process is being developed. Typical applications of induction heating are melting of metals, heating of metals for design, Brazing, Welding and all sorts of Surface Treatments. These process is required to verify results obtained in the experimentation with software; the tool developed named CFD Fluent simulation is used.

CFD simulation can be used to study the fluid flow and heat transfer for a wide variety of engineering equipment. In this study, we use heat transfer simulation to analyze the efficiency of helical coil induction water heater to observe the water temperature at outlet of helical coil when certain constant heat supplied form induction cooker where continuous flow of water from helical coil [2]. With heat transfer simulation the determination of the efficiency of the system and water outlet temperature from helical coil with applying heat flux to it, and design engineer can gain insight into the physical processes involved, thus giving guidance for improvements to be design.

Nihar P Bara (2013), states the main benefits of using induction processes when compared to any other heating process (gas furnace) are among others, their fast heating rate, good reproducibility, little energy consumption which verified with finite element analysis (FEA) of induction furnace [3].

The previous work done by Ordoñez Flores Rafael, Reyes Castillo Fabiola and Carreño Hernández Carlos (2013) on water heater by magnetic induction described new device which projected to heat the shower water as it obeys the excessive water wasting at start of knob of water, so it anticipates a water and gas saving. This water heater consumes not as much of electrical energy in the resistance based boiler and it doesn't store

hot water which signifies use of less energy than the gas based [4].

A review study done by N. D. Shirgire and P. Vishwanath Kumar (2013), on comparison of helical coil and straight tube heat exchanger heat transfer coefficient of helical coil is affected by geometry of heat exchanger. Helical coils offer beneficial over straight tubes due to their compactness with improved heat transfer coefficient. The effectiveness of heat exchanger greatly affected by hot water mass flow rate and cold water flow rate. When cold water mass flow rate is constant and hot water mass flow rate increases the effectiveness decreases and increase in cold water mass flow rate for constant hot water mass flow rate resulted in increase in effectiveness henceforth flow rate of fluid plays vital role in experimenting with helical coil [5].

With the above advantages for fluent simulation; model is being developed with required dimensions in 3D drawing software and these is utilized in grid generation of solid-fluid interface to apply heat transfer process. After meshing of model is used in fluent software to analyze the heat transfer trough varying boundary conditions different output can be achieved. In this work we have find out the water outlet temperature from helical coil with heat flux applied on it.

## II. MODELLING OF HELICAL COIL

The 3D model for each helical coil is created using CAD Package CATIA V5 R19. It is imported in Ansys fluent workbench. The extra length added at inlet and outlet of helical turns of coil which helps in reducing the non-uniformity of flow. The geometrical specifications of the helical coil have chosen somewhat arbitrarily. Diameter of helical coil is D=0.1095m center to center, pitch of helical coil is P=0.0095 m, helical tube diameter is $d_0$=0.0095m and thickness 0.5 mm with variable number of turns "N' is selected as N=3.25, N=4 and N=5.

- Extra length added to inlet of helical coil = 130 mm

Extra length added at outlet of coil varies with number of turn selected for simulation purpose is as follows:

1. For N=3.25 Extra length added to outlet of helical coil = 75 mm
2. For N=4 Extra length added to outlet of helical coil = 95 mm
3. For N=5 Extra length added to outlet of helical coil = 120 mm

Generally these modelled is designed with solid-fluid interface required for grid generation and applying heat transfer from solid body to fluid flowing through it as shown in figure 6. The model of helical coil N=3.25, N=4 and N=5 is shown in figure 1.

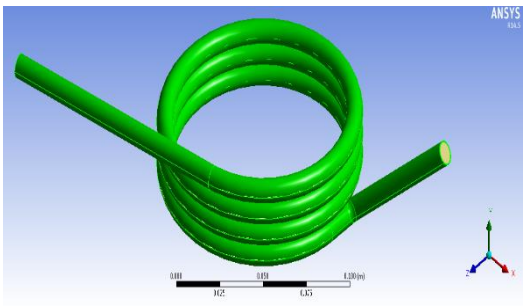


Fig. 1 Model of helical coil N=3.25

Then all the parts are defined i.e. inlet is defined as Inflow, outlets as Outflow and wall.

## III. GRID GENERATION FOR THE HELICAL COIL WITH SOLID-FLUID INTERFACE

The ANSYS ICEM-CFD is used for discretization of domain. Initially a relatively coarser mesh is generated. This mesh contains tetrahedral cells having triangular faces at the boundaries. Care is taken to use tetrahedral cells as much as possible. It is meant to reduce numerical diffusion as much as possible by structuring the mesh in a well manner, particularly near the wall region. Later on, a fine mesh is generated for this fine mesh, the edges and regions of high temperature and pressure gradients are finely meshed which is solid fluid interface.

Table I: Mesh details

| Parameter | Details |
|---|---|
| 1.Global Mesh Size | 10 mm |
| 2. Surface Mesh Size | 10 mm |
| 3. Curve Mesh Size | 10 mm |
| 4.Mesh Type | tetrahedral |
| 5.No.of Elements | 430767 |
| 6.Mesh Quality | 0.4 |

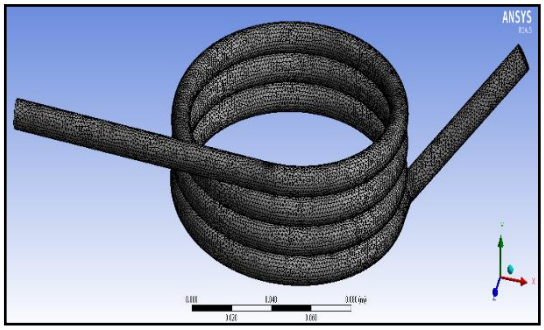


Fig. 2 Meshing domain of helical coil N=3.25

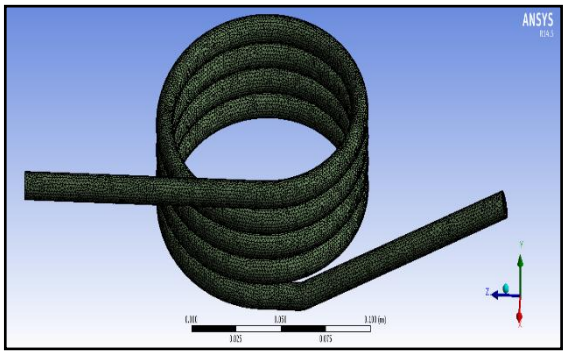


Fig. 3 Meshing domain of helical coil N=4

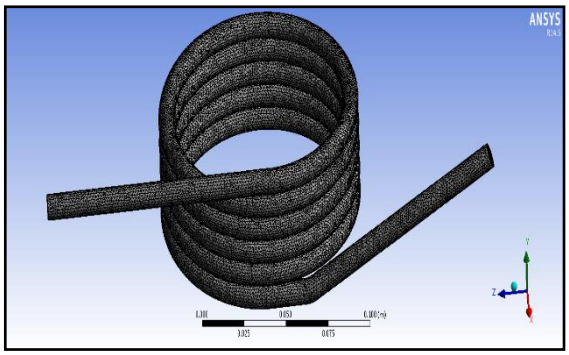


Fig. 4 Meshing domain of helical coil N=5

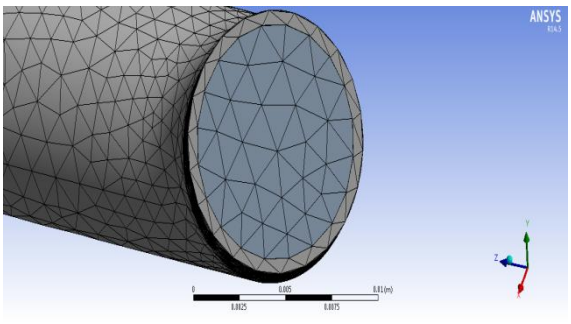


Fig. 5 Close-up view of mesh of helical coil N=3.25

## IV. PHYSICS OF THE SIMULATION FOR CFD ANALYSIS

### a. Initial Assumptions:

Keeping inlet temperature to helical coil constant for each observations and mass flow rate of water assumed arbitrarily for all inlets of helical coil.

### b. Viscous Model:

The laminar model is selected to analyze the heat transfer and contour presentation. Energy model is set to ON position which permits heat transfer analysis.

### c. Boundary Conditions:

Boundary conditions are used according to the need of the model. Boundary conditions used at inlets are mass flow rate of water consider arbitrary as 16, 24, 36, 46, 52, 62, 74, 80, 86, 94 in LPH and at outlets static pressure is applied. Domain surface is used as a wall with 'No Slip Condition' and heat flux data taken from table II where we utilized actually heat supplied from induction cooker Q=1200 W.

Table II: Computed value of a heat flux of different helical coil using Heat supply using Induction cooker is 1200 W for CFD analysis

| Sr. no. | Helical coil (N) | Heat flux (q) |
|---|---|---|
| Unit | | W/m2 |
| 1 | N=3.25 | 33092.507 |
| 2 | N=4 | 26887.65 |
| 3 | N=5 | 21510 |

## V. SOLVER PARAMETERS

The high resolution scheme and Auto-time scale is used for convergence control. The convergence criteria are RMS residual type and convergence rate 1e-03 is used for mass and momentum etc. which gives the water outlet temperature from different helical coil configuration after certain number of iterations. The general simulation parameters helical coil with solid fluid assembly is summarized as given below in table III

Table III: Details of simulation

| Parameter | Ansys Fluent |
|---|---|
| Domain of simulation | Helical coil with solid liquid interface |
| Laminar model | Viscous |
| Heat Transfer model | Thermal Energy |
| Fluid | Water |
| Solid | Steel |
| Reference Pressure | 1 atm. |
| Inlet | Mass flow rate and Temperature of Fluid |
| Outlet | Static pressure |
| Discretization | High Resolution |
| Residual Type | RMS |
| Residual Target | 1e-03 |

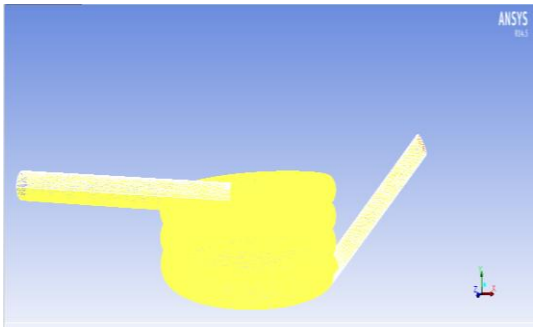


Fig. 6 FLUENT simulation model of helical coil N=3.25

## VI. RESULTS AND DISCUSSION

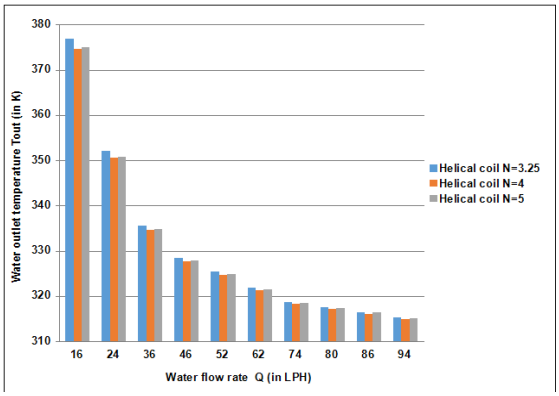


Fig. 7 Variation in water outlet temperature vs. water flow rate for different helical coil N=3.25, N=4 and N=5 using CFD fluent

It is observed from the figure 7 variation in water outlet temperature Vs. water flow rate for different helical coil N=3.25, N=4 and N=5 using CFD fluent that when one helical coil is selected at different water flow rate viz. 16 LPH to 94 LPH the water outlet temperature using CFD fluent decreases with increase in water flow rates. During the change of helical coil as number of turns increases form N=3.25 to N=5 value of water outlet temperature using CFD is also increased at particular water flow rate. Water outlet temperature of helical coil N=3.25 is found to be maximum among different coil configurations available at particular flow rate and it decreases in helical coil N=4 and rise again for helical coil N=5 as number of turns of coil increases.

## VII. CONCLUSIONS

It is concluded from Computational Fluid Dynamics (CFD) simulation using Fluent as number of turns of helical coil is increases the water outlet temperature also increases at constant flow rates keeping other parameters constant. This heat is supplied through induction cooker which is contactless, pollution free and safety for water heating process. Using CFD simulation variable parameter can be optimized to design helical coil which gives maximum water outlet temperature which is being utilized in industry for continuous requirement.

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# Materials Selection Criteria for Thermoelectric Power Generators Performance Enhancement: A Critical Review

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**ABSTRACT: World from the last few years facing difficulties regarding energy management, energy consumption and sources of energy like renewable and non renewable, are insufficient in comparison of the future energy trends. This is not only due to world population but also a long range of electrical and electronics based demands of modern life are responsible for it. These all causes the world that leads to the need of introduction of some techniques, modifications, nuclear power plants and nano cells to overcome the energy crisis. Thermoelectric modules playing an important role by the conversion of waste heat into electricity. The implementation of thermoelectric devices with cheap, single step power generation and without any pollution can be considered as key factors to green energy generations. In such regions the thermoelectric generators can be used to produce adequate amount of power like heat of stoves, wood, daily wastage. Such issues are also come into picture in engineering fields due to large scale consumption of energy and low efficiency of modern high facilitated devices. Attempts are also being made to improve the competitiveness of thermoelectric generators in directions other than by improving the figure-of-merit for materials. In particular, efforts are focused on increasing the electrical power factor, decreasing cost and developing environmental friendly materials. In addition to this the fuel cost is low or free as in waste heat recovery systems using thermoelectric generator. The cost per unit power generation is mainly determined by the power per unit area and operating period. Thus in this paper all desirable properties of good materials for thermoelectric generators are discussed.**

**KEYWORDS:** ***Thermoelectric power generation, Waste-heat recovery, Alternative green technology, Direct energy conversion, Electrical power, Thermoelectric materials.***

## I. INTRODUCTION:

Thermoelectric (TE) devices create electricity from a thermal gradient or create a thermal gradient from electricity via the thermoelectric effect. This phenomenon comprises three related effects, uncovered as a series of discoveries made primarily by Thomas Johann Seebeck, Jean-Charles Peltier, and William Thomson (Lord Kelvin) in the 19th century[1]. The Seebeck effect asserts that a potential gradient will be created across a conducting material when one side of the material is hotter than the other. In reality, charge carriers (electrons and holes) in the material having higher thermal velocities on the hot side of the material naturally diffuse more quickly from the hot side to the cold side than in the opposite direction. If the thermal gradient across the material is maintained, flowing charge carriers build up on the cold side of the object, and this separation of charge creates a potential difference between the two sides of the material which counters this charge imbalance. In the case that the material is part of a circuit, this voltage induces a current which be used to power a load [1]. Figure1 illustrated a conductor under a thermal gradient, charge carriers (electrons in this case) on the hot side have higher thermal velocities, diffusing more quickly to the cold side of the material than electrons on the cold side diffuse to the hot side. This leaves an excess of carriers on the cold side, and a potential gradient and electric field are created across the material[2] and essentially constitutes a conversion of thermal energy to electricity. The potential difference created per degree of temperature gradient across the material is its Seebeck coefficient, S, and is material-dependent [1].

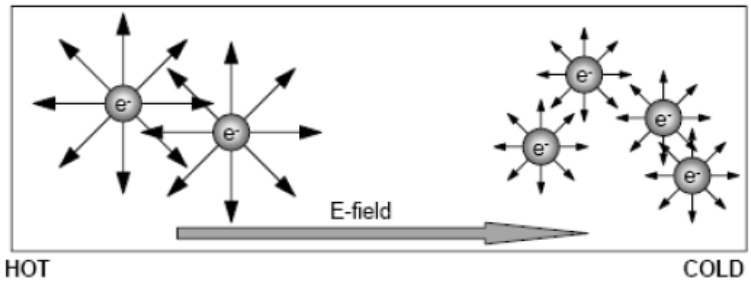


Fig 1. Conversion of thermal energy to electricity under a thermal gradient [2].

The Seebeck effect's complement is the Peltier effect which states that when current is applied to a conducting material, a temperature difference is induced between the sides of the material where current enters and exits [1]. Flowing charge carriers carry heat from one end of the material to the other, effectively cooling one side and heating the other. The heat transferred per unit of current applied is the Peltier coefficient, Π, is also material dependent. Lord Kelvin later discovered that the Peltier coefficient is directly related to the Seebeck coefficient by the absolute temperature at which the quantities are measured. The Thomson effect describes the heating or cooling of a homogeneous conducting material due to current passing through it as a result of a thermal gradient [1]. The energy management (in its form of electricity) in the rural regions or icy areas is also a big deterrent in the daily life activities. In some of these areas the electric power is neither feasible to supply nor be economic for production.

## II.THERMOELECTRIC DEVICES AND APPLICATIONS:

Thermoelectric devices have been created and commercialized from materials which are particularly efficient in converting thermal to electrical energy and vice versa. TE devices are useful for either generating power (by the Seebeck effect) or for localized heating and cooling (by the Peltier effect). Schematics of a typical thermoelectric device used in both ways are shown in Figure 2. This device is comprised of two semiconductor "legs," one n-type (electrons) and one p-type (positively-charged holes), which are connected electrically in series and thermally in parallel. When a temperature difference is maintained between the top and bottom of the legs, holes and electrons flow from hot to cold, and both legs contribute to the current which powers a load (Figure 2a). On the other hand, when power is supplied to this circuit, heat is transferred by flowing electrons and holes from one side of the device to the other, creating a temperature difference at opposite ends of the device (Figure 2b).

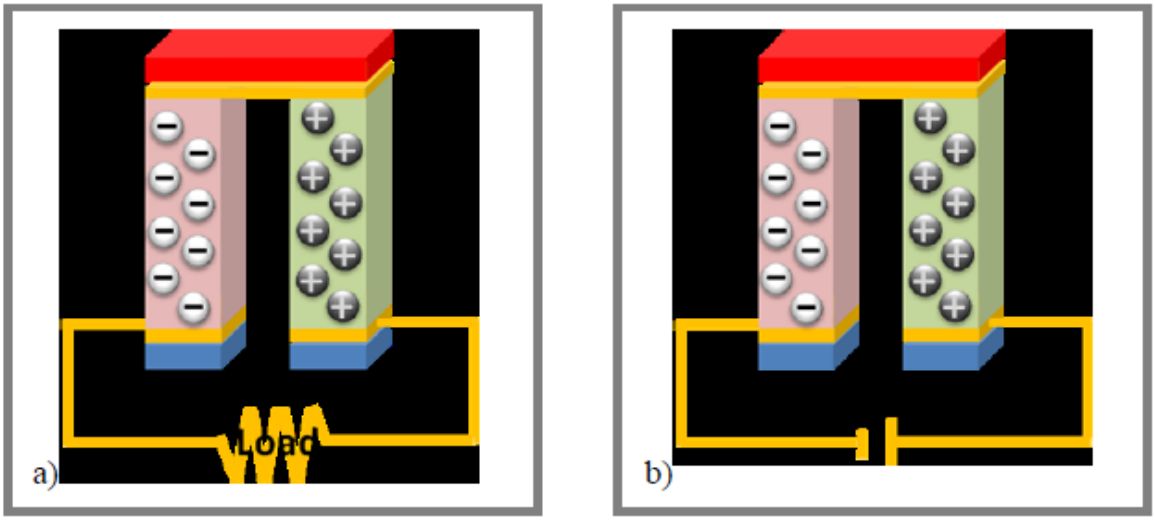


Fig 2: Schematics of single elements of a typical thermoelectric device (a) a load is powered from a supplied temperature gradient for a Peltier cooler (b) a hot side and a cold side are created as a result of power applied to the device [7].

The practicality of their use is determined by cost-benefit analysis dependent on factors such as device efficiency, ease of integration, need for remote power generation, and cost of the heat source. Because current TPGs are not of particularly high efficiency (typically <5%) [1] and are often costly, they are generally only practical in locations where traditional power generation is not available, such as on spacecraft. However, if TPG efficiency increases, applications in transportation (e.g., in hybrid vehicles and submarines) and in peak power generation (e.g., using waste heat from nuclear and fossil fuel power plants and possibly in conjunction with solar panels) may become accessible

.

## III.THERMOELECTRIC MATERIAL PROPERTIES:

There is a great deal of ongoing research in the TE field to improve material and device efficiency. The efficiency of the n- and p-type semiconducting materials comprising TE devices can be directly measured or calculated from important material properties which are individually measured. Thermoelectric materials are rated by a dimensionless figure of merit, ZT, where a higher ZT translates to higher efficiency. ZT is given by

$$ZT = \frac{S^2 \sigma T}{k}$$

where S is the Seebeck Coefficient, σ is electrical conductivity, T is the temperature at which these properties are measured, and κ is thermal conductivity.1 The electrical component of ZT, $S^2\sigma$, is often considered separately and is dubbed the thermoelectric power factor. The thermoelectric properties defining ZT are not independent, however, and there is an important tradeoff between all of these traits. Indeed, a low thermal conductivity is desirable for higher ZT, yet thermal conductance depends on heat transfer by both phonons and electrons, so a high electrical conductivity yields a high thermal conductivity as well. This relationship is best described by the Wiedemann-Franz law, which equates the ratio of electronic contribution to thermal conductivity to electrical conductivity to a constant (the Lorenz number) times the temperature at which these properties are measured [1]

$$LT = \frac{Ke}{\sigma}$$

Furthermore, a high Seebeck coefficient necessitates a large charge separation in the material (i.e. more carriers on one side than the other), but a high electrical conductivity will cause quick and easy diffusion to negate this potential difference. High thermal conductivity also means difficulty in maintaining a high thermal gradient, also causing Seebeck coefficient to suffer. The majority of TE devices currently on the market utilize bulk semiconducting materials which are alloyed to reduce thermal conductivity, yielding ZT≈1 near room temperature. In order for TE devices to be efficient enough to enter the power generation playing field, the efficiency of the semiconducting materials must increase dramatically and over a wide temperature range. A ZT of 2 would make TE devices viable for more niche applications and a ZT of 3 would allow TPGs to compete with traditional mechanical power generators [3]

## IV. SIGNIFICANCE OF FIGURE OF MERIT (ZT):

Greater the value of ZT more will be the conversion efficiency of a thermoelectric material and vice versa. So it is clear that to improve the performance of a thermocouple the electrical conductivity should be increased and thermal conductivity should be reduced. Some researchers tend to improve ZT with different advanced methods like combination of suitable materials, palleting techniques and nano technology etc (Kantser et al., 2006; Bejenari et al., 2010; Kuei et al., 2004; Bilu et al., 2001). Generally, the phonon waves are responsible for the thermal conductivity, so to reduce it, the flow of phonons should face some interactions. The nano techniques; in which the nano size particles able to distort the oscillations of phonons that reduce the thermal conductivity and hence a significant improvement in the figure of merit which has been employed in the silicon nano wires successfully (Zheng, 2008). The figure of merit also studied for the oxygen deficient perovskites that determines their thermal and electrical properties and concluded to the enhancement of seebeck coefficient (Rodriguez et al., 2007; Brown et al., 2006; Jianlin et al., 2009; Mingo N., 2004; Bhandari et al., 1980; Micheal et al., 2008) and hence the thermo power generation. In this presented work we compare the experimental and theoretical values of the figure of merit (ZT) for some of the common thermoelectric materials like Cu, Fe, Constantan and Nichrome.

## V. DEPENDENCES OF FIGURE OF MERIT (ZT):

It is clear that the figure of merit of a thermocouple is affected directly by the electrical conductivity but inversely by the thermal conductivity of the

thermoelectric material. (a) The thermal conductivity of a material is the ease with which the heat flows through itself and its expression from literature is given by:

$$\lambda = \frac{\Delta Q}{\Delta t} \times \frac{1}{A} \times \frac{x}{\Delta T}$$

Where, $\frac{\Delta Q}{\Delta t}$ is the rate of heat flow, $\frac{\Delta T}{x}$ is the temperature gradient, $\Delta T$ is the time for which the heat flow, A is the area of cross section of the thermoelectric materials with thickness x.(b) The electrical conductivity of a thermoelectric material is the ease of the material to allow the passage of electric current and is given by

$$\sigma = \frac{1}{\rho} = \frac{1}{RA}$$

Where R is the resistance of thermoelectric material in ohms, and $R = \frac{\rho l}{A}$ where $\rho$ is the resistivity (specific resistance) of the material in Ωm, $l$ and A are the length and area of cross-section of the material respectively.

## VI.THERMOELECTRIC POWER GENERATOR PERFORMANCE CALCULATION:

The performance of the thermoelectric calculation[8]

$$Z = \frac{\alpha^2}{kR}$$

Where Z = Thermoelectric material figure of Merit

$\alpha$ = See back Coefficient is given by

$$\propto = -\frac{\Delta V}{\Delta T}$$

$\Delta V = Voltage\ difference$

$\Delta T$ = temperature difference

R is the electric resistivity

K is the thermal conductivity
This figure of merit can be multiplied by T average absolute temperature of hot and cold platesof the thermoelectric module, K

$$ZT = \alpha^2 T/kR$$

Here

$$T = T_H + T_L/2$$

Where $T_H$ = Temperature at hot End
$T_L$ = Temperature at cold end

See back Coefficient

$$\propto = -\frac{\Delta V}{\Delta T}$$

By the second law of thermodynamics, the ideal (absolute maximum efficiency of the thermoelectric power generator operating as a reversible heat engine is Carnot efficiency

$$\eta = W_e/Q_H$$

$$\eta_{carnot} = 1\text{-}T_L/T_H$$

The maximum conversion efficiency of an irreversible power generator can be estimated using

$$\eta = \eta carnot\left[\frac{\sqrt{1+ZT}-1}{\sqrt{1+ZT}+\ TL/TH}\right]$$

## VII. THERMOELECTRCI MATERIALS FOR POWER GENERATORS:

Among the vast number of materials known to date, only a relatively few are identified as thermoelectric materials. As reported by Rowe [4], thermoelectric materials can be categorized into established (conventional) and new (novel) materials. Today's most thermoelectric materials, such as Bismuth Telluride ($Bi_2Te_3$)-based alloys and PbTe-based alloys, have a ZT value of around unity (at room temperature for $Bi_2Te_3$ and 500-700K for PbTe). However, at a ZT of 2-3 range, thermoelectric power generators would become competitive with other power generation systems. The figure-of- merit Z of a number of thermoelectric materials together

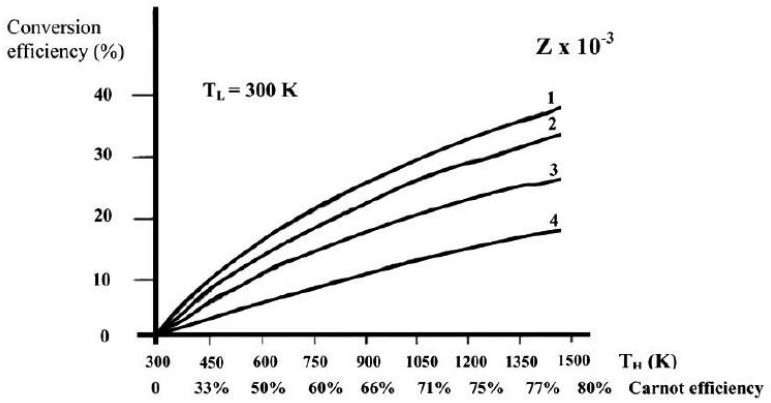


Fig. 3. Conversion efficiency as a function of temperature and module material figure-of-merit [4].

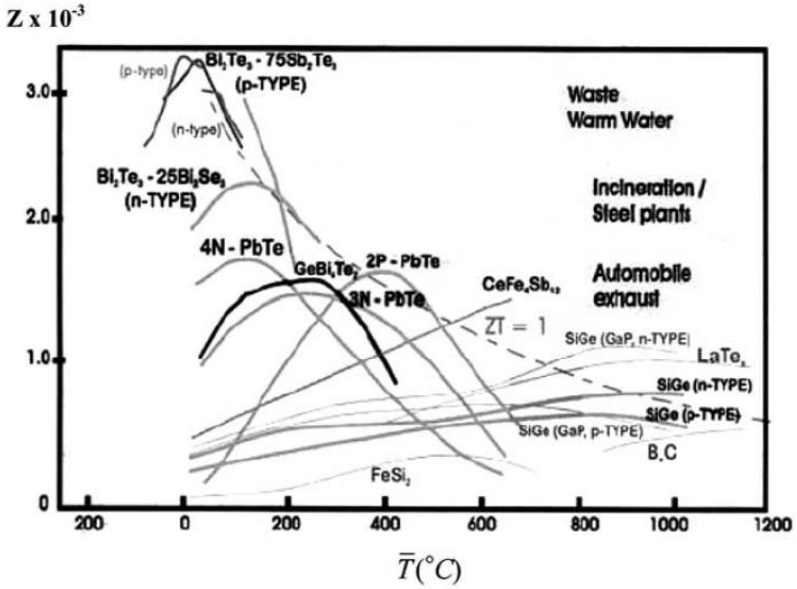


Fig. 4. Figure-of-merit of a number of thermoelectric materials and their potential applications [4].

with potential power generating applications relevant to waste heat energy is shown in Fig.(4) [4]. Effective thermoelectric materials should have a low thermal conductivity but a high electrical conductivity. A large amount of research in thermoelectric materials has focused on increasing the Seebeck coefficient and reducing the thermal conductivity, especially by manipulating the nanostructure of the thermoelectric materials. Because the thermal and electrical conductivity correlate with the charge carriers, new means must be introduced in order to conciliate the contradiction between high electrical conductivity and low thermal conductivity as indicated by Weiling and Shantung [5]

materials and can be used at temperatures up to around 450K. The intermediate temperature range - up to around 850K is the regime of materials based on alloys of Lead (Pb) while thermo elements employed at the highest temperatures are fabricated from SiGe alloys and operate up to 1300K. Although the above mentioned materials still remain the cornerstone for commercial and

## VIII. CONVENTIONAL THERMOELECTRIC MATERIALS:

Rowe [4] reported that established thermoelectric materials (those which are employed in commercial applications) can be conveniently divided into three groupings based on the temperature range of operation, as shown in Fig. (4).Alloys based on Bismuth (Bi) in combinations with Antimony (An), Tellurium (Te) or Selenium (Se) are referred to as low temperature practical applications in thermoelectric power generation, significant advances have been made in synthesizing new materials and fabricating material structures with improved thermoelectric performance. Efforts have focused primarily on improving the material's figure-of-merit, and hence the conversion efficiency, by reducing the lattice thermal conductivity [4].

## IX. NOVEL THERMOELECTRIC MATERIALS & MODULE CONFIGURATION:

It was recently reported in [6] that a material which is a promising candidate to fill the temperature range in the ZT spectrum between those based on $Bi_2Te_3$ and PbTe is the semiconductor compound ß-$Zn_4Sb_3$. This material possesses an exceptionally low thermal conductivity and exhibits a maximum ZT of 1.3 at a temperature of 670K. This material is also relatively inexpensive and stable up to this temperature in a vacuum [6]. Another recent direction to improve the competitiveness of thermoelectric materials, other than by improving the figure-of-merit, is by developing novel thermoelectric module shapes.

## X. CONCLUSION:

Study of thermoelectric materials selection criteria indicates that efficiency of the thermoelectric generator depends upon the figure of merit for materials, is key consideration for comparing the efficiency of thermoelectric materials. It is observed that most commonly used thermoelectric materials, are Cu, Fe, Constantan and Nichrome, Bismuth Telluride ($Bi_2Te_3$)-based alloys and Lead Telluride (PbTe)-based alloys. Effective thermoelectric materials should have a low thermal conductivity but a high electrical conductivity. A lot of research in thermoelectric materials is focused on increasing the Seebeck coefficient and reducing the thermal conductivity, especially by manipulating nanostructure of thermoelectric materials.

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# Experimental Verification and CFD Analysis of Single Cylinder Four Strokes C.I. Engine Exhaust System

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**Abstract: The more amount of air pollution is due to emissions from an internal combustion engine. Exhaust system plays a vital role in reducing harmful gases but the presence of after treatment systems increases the exhaust back pressure. To analyse the exhaust energies available at different engine operating conditions and to develop an exhaust system for maximum utilization of available energy at the exhaust of engine cylinder is studied. Design of each device should offer minimum pressure drop across the device, so that it should not adversely affect the engine performance.**
**This paper deals with the exhaust system designed and through CFD (Fluent) analysis, a compromise between two parameters namely, more maximisation of brake thermal efficiency with limited back pressure was aimed at. In CFD analysis, three exhaust diffuser system (EDS) models with different angels are simulated using the appropriate boundary conditions and fluid properties specified to the system with suitable assumptions. The back pressure variations in three models are discussed in. Finally, the model with limited backpressure was fabricated and Experiments are carried out on single cylinder four stroke diesel engine test rig with rope brake dynamometer. CFD analysis of exhaust diffuser systems and the performance of the engine are discussed.**

***Keywords: Exhaust Diffuser system (EDS), Computational Fluid Dynamics (CFD), Backpressure, Fuel Consumption.***

## 1. Introduction

The exhaust system of an I.C. engine has significant influence on the global engine operation. Among the different component of the system the exhaust system is having paramount relevance on the gas exchange process. Though the intake system is dominant on the cylinder filling process, the exhaust system is capable to influence the gas exchange process in several aspects, like the piston work during the exhaust stroke, the short-circuit of fresh charge from the intake into the exhaust and even the filling of the cylinder. In this sense, the most influential boundary condition imposed by the exhaust system is the pressure at the valve and especially the instantaneous pressure evolution. The mean backpressure is determined mainly by the singular elements, such as the turbocharger, the catalytic converter and the silencer. The instantaneous pressure evolution imposed by the exhaust system at the exhaust valve depends essentially on the layout and dimensions of the pipes, therefore an adequate design of the exhaust system geometry can improve the engine power and efficiency, and reduce the emissions of pollutants.

To reduce the exhaust emissions from C.I. engines, it is very important to understand the overall effects of devices installed in the exhaust system. Effective utilization of exhaust energy is economically possible to reduce exhaust emissions from old engines instead of engine and fuel modifications. More efforts are required on the development of the aftertreatment devices, by further study of the theory of operation for diesel engines. Favourable operating parameters providing in the after-treatment devices during the whole operating range of the engine requires proper design of after-treatment devices by considering overall effects of its installation, in the exhaust system. Obtaining economically, maximum conversion efficiency of the pollutants without adversely affecting the engine performance with durability is the ideal requirement from the after treatment devices.

Backpressure on engine cylinder is completely dependent on exhaust system design, its operating condition and atmospheric pressure (i.e. almost constant). The exhaust system routes exhaust gas from the engine and then exhaust it into the environment, while providing noise attenuation, after treatment of the exhaust gas to reduce emissions and energy recovery. One of the most important sources of vehicle noise, the noise

associated with exhausting combustion gases from the engine, is controlled using mufflers. A number of sound reduction techniques are employed in mufflers, including reactive silencing, resistive silencing, absorptive silencing, and shell damping. Exhaust gas properties which are important for the exhaust system design include its physical properties; exhaust gas temperature, which depends on the vehicle duty and/or test cycle and the exhaust gas flow rate. Exhaust system materials are exposed to a variety of harsh conditions, and must be resistant to such degradation mechanisms as high temperature oxidation, condensate and salt corrosion, elevated temperature mechanical failure, stress corrosion cracking, and inter granular corrosion.

During the exhaust stroke when the piston moves from BDC to TDC, pressure rises and gases are pushed into exhaust pipe. Thus the power required to drive exhaust gases is called exhaust stroke loss and increase in speed increases the exhaust stroke loss. The network output per cycle from the engine is dependent on the pumping work consumed, which is directly proportional to the backpressure. To minimise the pumping work, backpressure must be low as possible. The backpressure is directly proportional to the exhaust diffuser system design.The shape of the inlet cone of exhaust diffuser system contributes the backpressure. This increase in backpressure causes increase in fuel consumption. Indeed, an increased pressure drop is a very important challenge to overcome. [1], [2]

## 2. Causes, Effects and Possible Remedies for Backpressure Rise Problem

To minimize the pumping work the backpressure must be as low as possible for obtaining the optimal output from the engine. The backpressure is directly proportional to the pressure drop across the design of complete exhaust system components. Each alternation in exhaust system causes variations in backpressure on C.I. engine. There are various factors because of which backpressure rise problem exists in old as well as new properly designed C.I. engine applications during complete operating life. Few of them are discussed here - An increased C.I. engine population has created pressures on controlling engine out emissions. In most of the C.I. engine applications lack of space availability needs compactness of after treatment devices, it creates restriction in exhaust flow hence causes backpressure rise. Diesel after treatment strategies may include muffler, particulate filter or catalytic converter, thermal reactor, turbocharger, EGR system etc. in the exhaust system for heat recovery and emission control activities. Particulate filters are designed to trap particulate matter (PM) to achieve a net decrease in PM emissions. The device captures ash, but the accumulation of ash in the device is sufficient to cause a rise in backpressure. In practice, these devices need to be regenerate quickly and relatively cheaply when they become blocked. The failure of catalyst may be due to system component meltdown, carbon deposit, catalyst fracture, deactivation of diesel catalyst etc. Aftertreatment device component failure may cause backpressure rise, mostly it happens because particulate matter consists of non-combustible compounds. Poor engine performance may happen as a result of a clogged or choked after treatment device. The broken pieces can move around and get in position to plug up the flow of exhaust through the device. They are just melted enough and reduce surface area. Either way, it doesn't work much anymore, even though it may look good on the outside. Engine emissions increase as the engine deteriorates. Normal engine wear typically causes an increase of particulate matter (PM) emissions and a decrease of $NO_x$ emissions. The major categories of fuel additives include engine performance, fuel handling, fuel stability, and contaminant control additives. Engine lubricants are composed of base oil, viscosity modifier and an additive package. One of the main drivers in the development of oil formulations for engines with exhaust aftertreatment is the reduction of sulphated ash, phosphorous and sulphur. Sulphur increases PM in all classes of engines. Sulphur is also known to interfere with several engine emission control strategies. Development of alternative fuels once promoted by the desire to reduce exhaust emissions is now increasingly driven by climate change issues and energy security. There is a clear correlation between some fuel properties and regulated emissions. Drawing general conclusions is, however, difficult due to such factors as Inter corelation of different fuel properties, different engine technologies, or engine test cycles. Hence a comprehensive and practically feasible approach is a must to improve the complex system of after treatment. Thus, any modification in engine system causes rise in backpressure on engine in internal combustion engines. As a remedial action for modern internal combustion engine performance enhancement through controlling the rise in backpressure following points must be considered. The regeneration technique employed must be easy, quick and economic activity. Particulate filters should be installed with backpressure monitors that would alert the operator when the backpressure exceeds some pre-set level. With some insight into the state of the particulate filter

(PF), the operator can avoid potentially costly failures. Some active systems may collect and store PM over the course of a full day or shift and can be regenerated at the end of the day or shift with the vehicle or equipment shut off. A number of the filters used in stationary like applications operator can be trained to remove and regenerate externally at a "regeneration station" for achieving complete regeneration with ease. Because they can have control over their regeneration and may not be much dependent on the heat carried in the exhaust. Careful analysis of application environment and more stress is required for the fulfillment of durability requirements, mainly on catalyst reactivation or replacement techniques development.[10]

## 3. Criteria for Design and Development of Exhaust System

During past studies, more stress has been given to engine design aspects of Compression Ignition engines for their performance analysis. Enhance design, operational and maintenance aspects specifically related to C.I. engine exhaust system that is backpressure on engine, needs to be focused. Backpressure on engine is the pressure that tries to force the exhaust back in to the engine. In extreme cases too much backpressure can damage the engine. In most of literature reviewed back pressure rise is a common phenomenon observed for after-treatment strategies utilization in exhaust system of C.I. engines. Possible causes and their remedies required to be controlled for exhaust backpressure phenomenon plays vital role, so this work would be useful for automotive sector to understand this important controllable backpressure as an engine operating variable. All the feasible ways are to be studied for keeping the backpressure value at minimum level, irrespective of engine type and operating conditions.

Finally it is decided to have an experimental investigation for energy efficient exhaust diffuser system design and development for C.I. engine performance enhancement in the following manner. In this complete process, three crucial steps viz. planning, operation and data analysis should be adopted, in experimental planning step study of instruments to be used for precision and accuracy errors should be done.[3]

## 4. Methodology

The analysis has been carried out on three designs an existing one that is EDS – I with $0^{\circ}$ inlet cone angle, EDS – II with $45^{\circ}$ inlet cone angle and a modified one that is EDS – III with $90^{\circ}$ inlet cone angle, results are subsequently compared. It was observed that the brake thermal efficiency improved drastically upon modification in exhaust geometry. Physical models of the same these two systems are subsequently manufactured and exhaustive experiments are carried out on them. The results obtained through CFD analysis are experimentally confirmed.

In CFD analysis two major flow characteristics back pressure and engine performance are studied.

Study I: The change in pressure of structure was studied. This study offered to find the change in pressure difference in inlet and outlet of exhaust diffuser system. The models which produce the higher pressure difference are selected for further studies.

Study II: The models which had the higher pressure difference are studied for the flow pattern. The back- pressure characteristics of the models are modelled and the model having the lesser backpressure was taken for experimental analysis of engine performance. [4]

## 5. Three Dimensional CFD Study

A three- dimensional model of exhaust diffuser system is generated in CFD Fluent for the analysis.

*A. Modelling and Meshing*

The geometry of the element is made as tetrahedral mesh, with a refined mesh near the wall. The K-E turbulence model is used, with standard wall functions for near-wall treatment for analysis of Exhaust system.

*B. Boundary Conditions*:

Boundary conditions used at inlets mass flow rates and Temperatures of Fluid are applied and at outlets pressure outlet is applied. Domain surface is used as a wall with 'No Slip condition' and heat transfer coefficient of 45 w/m2 $^{o}$k and wall surface roughness as 0.00508 mm is used. [5]

## 6. CFD Results and Discussion

The primary aim of this CFD analysis is to find out the right shape of catalytic converter for the exhaust manifold which can offer minimum back pressure.[6]

It is observed that the back pressure at inlet of EDS- I is found to be 1659 Pa, as shown in Figure 1and 2. The back pressure is found to be increase with the increase in length of EDS for the same inlet pressure.

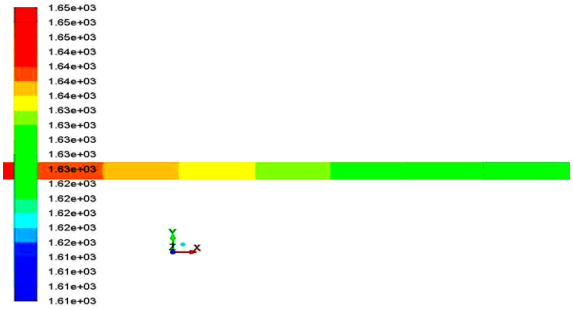



Fig 1: This depicts the Pressure Contour which indicates the change on Pressure along the X- Axis for EDS – I at Constant Load 5 Kg.

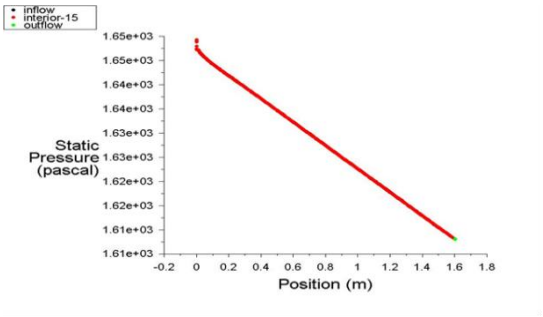



Fig 2: This depicts that variation in backpressure on engine during the flow through EDS – I along its length at Constant Load 5 Kg

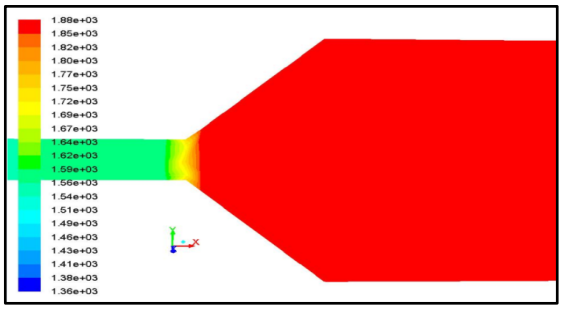


Fig 3: This depicts the Pressure Contour which indicates the change on Pressure along the X- Axis for EDS – II at Constant Load 5 Kg.

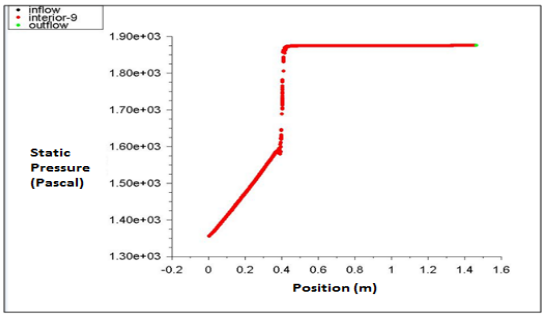



Fig 4:This depicts that variation in backpressure on engine during the flow through EDS – II along its length at Constant Load 5 Kg.

The back pressure analysis is carried out for other EDS – II is found to be 1632 Pa, as shown in Figure 3 and 4. The back pressure is found to be decrease with the increase in inlet cone angle of EDS for the same inlet pressure.

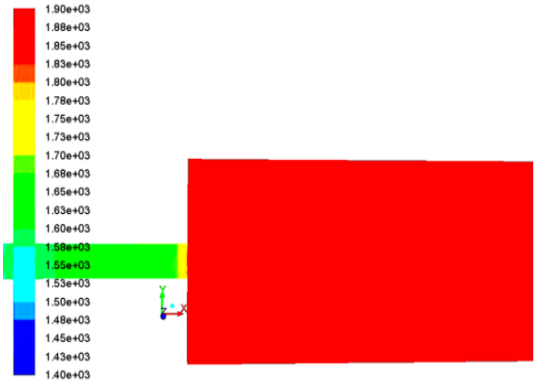


Fig5: This depicts the Pressure Contour which indicates the change on Pressure along the X- Axis for EDS – III at Constant Load 5 Kg.

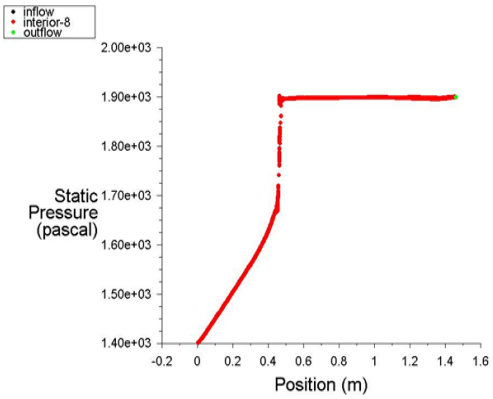
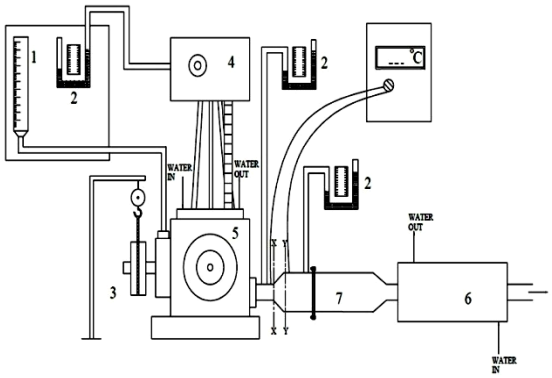



Fig 6:This depicts that variation in backpressure on engine during the flow through EDS – III along its length at Constant Load 5 Kg.

Similarly the back pressure analysis is carried out for other EDS – III is found to be 1585 Pa, as shown in Figure 5 and 6. The back pressure is found to be decrease with the increase in inlet cone angle of EDS for the same inlet pressure. [7]

## 7. Experimental Result and Discussion

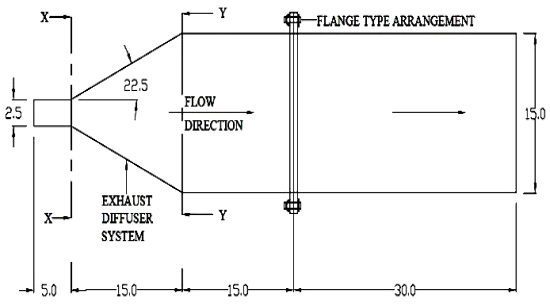
The experimentation was conducted with the EDS - I and EDS – II in single cylinder four stroke diesel engines. The exhaust system was fitted on the engine exhaust flange. Then the performance study was conducted and plotted against the brake thermal efficiency. [8], [9]




1 Fuel Flow Measurement
2 U- Tube Manometers
3 Dynamometer
4 Air Flow Meter
5 C.I. Engine
6 Exhaust Gas Calorimeter
7 Exhaust System

X-X: Inlet to Exhaust Diffuser System
Y-Y: Inlet to Exhaust Diffuser System

Fig 7: Schematic view of experimental set up




All dimensions are in CM

Fig 8: Schematic view of exhaust diffuser system

The figure 9 shows that the variations in the brake thermal efficiency. Considerable increase in brake thermal efficiency is observed while using the EDS – II. There is 9 to 14% of brake thermal efficiency increased.

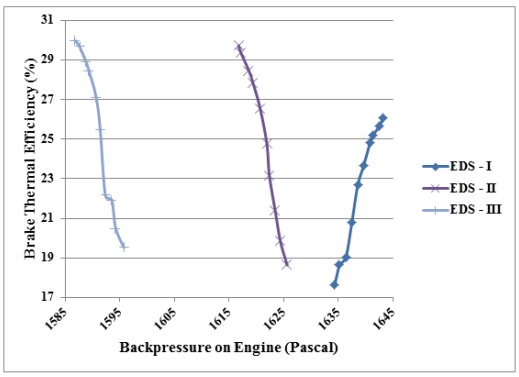



Fig 9: Variation in brake thermal efficiencies vs. backpressure on engine for different load conditions using exhaust diffuser systems.

The figure 10 shows that the variations in heat carried away by exhaust gases Vs. backpressure on engine for different load conditions using exhaust diffuser systems depicts that when the load is kept constant load at different level viz. 0.5 to 5 kg the backpressure on engine decreases and heat carried away by exhaust gases decreases. Value for heat carried away by exhaust gases for EDS – I is decreasing as load increasing. It is also found that for EDS – III backpressure on engine decreases and heat carried away by exhaust gases decreases. Heat carried away by exhaust gases decreases approximately 4% for EDS – III system as compared to EDS – I.

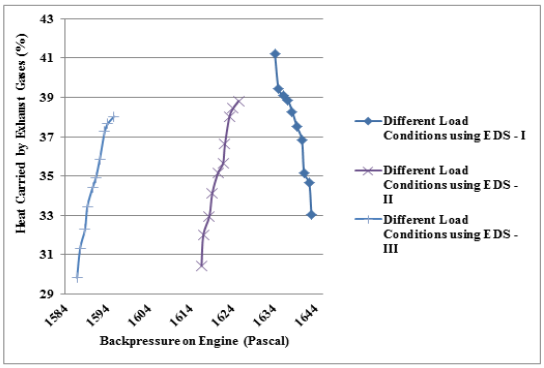



Fig 10: Variation in heat carried away by exhaust gases in % vs. backpressure on engine for different load conditions using exhaust diffuser systems.

The figure 11 shows that the variations back pressure on engine using values observed during experimentation Vs. different load conditions with exhaust diffuser systems; when the load is kept constant load at different level viz. 0.5 to 5 kg the backpressure on engine is decreases. Value for backpressure on engine for EDS – I is increasing as load increasing. It is also found that for EDS – III backpressure on engine decreases. Backpressure on engine decreases which results increase in brake power of engine.

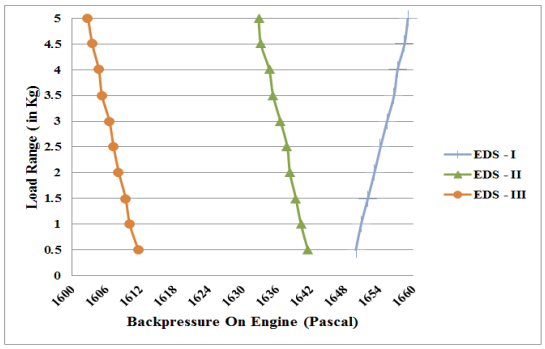



Fig. 11: Variation in backpressure on engine using experimentation vs. different load conditions for exhaust diffuser systems.

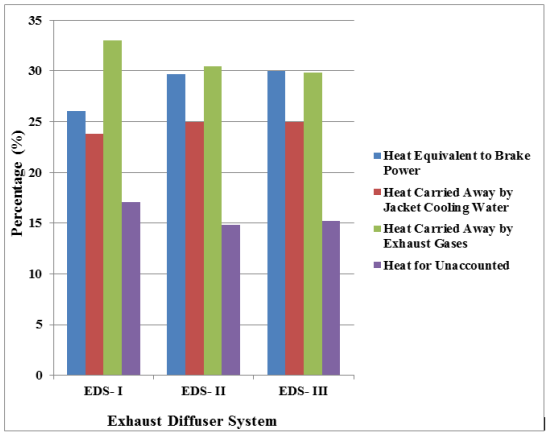



Fig 12: Heat balance sheet for Exhaust Diffuser Systems at constant load 5 Kg

It is observed from the Fig. 12, heat balance sheet for different Exhaust diffuser systems at constant load 5 kg; the heat balance sheet parameters that are heat equivalent of brake power, heat carried by the jacket cooling water, heat carried by exhaust gases and heat unaccounted for. When the exhaust diffuser systems are varies during the change of EDS - I to EDS – III the heat equivalent of brake power increases and heat carried by exhaust gases decreases. After testing it is observed that around 30 to 40%of fuel energy is wasted, this part is of great concerned so as to maximize utilization of exhaust energy. It is important to utilize the exhaust energy through proper exhaust system design.[11]

## 8.Conclusion

The following conclusions may be drawn from the present study. The Exhaust system is successfully designed. Through CFD analysis, the backpressures of various Exhaust diffuser systems are studied. The increase in inlet cone angle increases the pressure of the flow which leads to reduce the recirculation zones. Experimental setup of the diffuser with different angles i.e.22.5, 45, 90 degree is design and fabricated. With the help of C.I. engine test rig and suitable instrumentation different parameters pressure, temperature, mass of exhaust gases is determined. The exhaust gases from an optimal sized engine currently used, to convert available Kinetic energy and enthalpy of exhaust gases into the pressure energy for useful after treatment of exhaust gases. This pressure is being used and sent through diffuser which reduces the back pressure. Installation of the EDS – III increases the brake thermal efficiency and decreases the backpressure.

This paper provides the experimental values obtained during test for backpressure on engine and the value obtained using CFD analysis for backpressure on engine gives authenticity of data for development of energy efficient exhaust system. This was only made possible by the approach adopted in this investigation.

## Acknowledgments

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# IMPROVING EFFICIENCY OF SOLAR WATER HEATER USING PHASE CHANGE MATERIALS

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**Abstract: The present work has been undertaken to study the feasibility of storing solar energy using Phase Change Materials (PCMs) and utilizing this energy to heat water for domestic purposes during nighttime. This ensures that hot water is available throughout the day. The system consists of two simultaneously functioning heat-absorbing units. One of them is a solar water heater and the other a heat storage unit consisting of PCM (paraffin). The water heater functions normally and supplies hot water during the day. The storage unit stores the heat in PCMs during the day supplies hot water during the night. The stainless steel water tank has a capacity of about 30 litres, with an internal diameter of 28 cm and a height of 48 cm, it houses the 9 kg PCM inside the square tank having length 40 cm & width 28cm and allows for heat transfer between the surface and the water. Experiment results show with using PCM cooling rate during the night decrease & efficiency and heat storage capacity increases.**

**Abbreviations**

| | |
|---|---|
| SWH | Solar Water Heater |
| PCM | Phase Change Material |
| FPC | Flat Plate Collector |
| MS | Mild Steel |
| PVC | Poly Vinyl Chloride |
| ICS | Integrated Collector Storage |
| SHS | Sensible Heat Storage |
| TES | Thermal Energy Storage |
| LHTES | Latent Heat Thermal Energy Storage |
| HTF | Heat Transfer Fluid |

## 1 Introduction

1.1 Phase Change Material

These materials can store energy by the melting at a constant temperature. No material has all the optimal characteristics for a PCM, and the selection of a PCM for a given application requires careful consideration of the properties of various substances. Over 20,000 com-pounds and/or mixtures have been considered in PCM, including single component systems, congruent mixtures, eutectics and peritectics [3]. The isothermal operating characteristics (i.e. charging/discharging heat at a nearly constant temperature) during the solidification and melting processes, which is desirable for efficient operation of thermal systems [9].

The value of the latent heat is very important, because the higher latent heat results higher storable heat quantity. According these aspects we can choose from several materials. We have to mind the chemical properties, the thermal expansion and the aspects of safety. PCMs in the 50 to 1000 temperature range have been proposed to water heating and o -peak electrical heater applications.

Wax is the most commonly used commercial organic heat storage PCM [10]. Paraffin waxes are cheap and have moderate thermal energy storage density but low thermal conductivity and, hence, require large surface area [10]. In our current project we are considering the same PCM.

## 2 Experimental Investigations

### 2.1 Experiment setup

Photographs of the experimental setup shown with the solar collector connected to the water tank are shown in Figures 1. The setup consists of a cylindrical water tank which holds the PCM inside inner square tank, solar flat plate collector. The stainless steel water tank has a capacity of about 30 litres, capable of supplying water for a family of four members. With an internal diameter of 28 cm and a height of 48 cm, it houses the PCM inside the square tank having length 40 cm & width 28cm and allows for heat transfer between the surface and the water. The

tank is insulated with 5 cm of Rock wool and is provided with an aluminium cladding. The PCM storage tank contains 9 kg of paraffin wax. RTDs are provided at inlet & outlet.

Fig 1: Experimental setup

**2.2 Experiment trial**

During the charging process the water is circulated through the tank and the solar collector unit continuously. The water absorbs solar energy sensibly, and exchanges this heat with the PCM in the PCM storage tank, which is initially at room temperature. The PCM slowly gets heated, sensibly at first, until it reaches its melting point temperature. As the charging proceeds, energy storage as Latent heat is achieved as the Paraffin wax melts at constant temperature (62±2°C). After complete melting is achieved, further heat addition from the water causes the PCM to superheat, thereby again storing heat sensibly. The charging process continues till the PCM and the water attain thermal equilibrium. Temperatures of the PCM and water at the outlet are recorded at intervals of 3 hours. The PCM is charged through the day, whenever hot water is not demanded by the user.

The discharging process used is termed as batch wise process. In this method, a certain quantity of hot water is withdrawn from the water tank and readings are taken. This is then repeated for intervals of 3 hours, in which time transfer of energy from the PCM would have occurred. This procedure is continued till PCM reaches a temperature of $56^0$C.

First of all we have taken the trial on the Solar Water Heater without using phase change material (WAX).

Phase 1

We calculated the cooling rate of the water in the water tank after heating the water for 6hrs sunlight.

The analysis is shown in the Table 2.1

Table 1: Cooling rates of Water in General SWH

| Time elapsed (hrs) | Temperature$^0$C |
|---|---|
| 0 | 75 |
| 3 | 70 |
| 6 | 66 |
| 9 | 62 |
| 12 | 59 |
| 15 | 56 |
| 18 | 54 |
| 21 | 52 |

Phase 2

In this phase we were calculating the efficiency of Solar Water Heater. The parameter s for calculating the efficiency of Solar water heater as shown in Table 2.2.

Table 2: Efficiency Parameters

| **Parameters** | **Symbol** | **Value** |
|---|---|---|
| Volume of water | V | 20liter |
| Initial Temperature of water | Ti | 360C |
| Heat radiated in day | Pin | 1170 Watts |
| Time elapsed | t | 6hrs |
| Final Temperature of water | Tf | 750C |

We know the standard formula for efficiency calculation

$$\text{Efficiency, } \eta = \frac{\text{Heat Enrgy Output}}{\text{Heat Energy Input}}$$

$$= Qout / Qin$$

Now, to calculate output Heat energy Qout = Heat energy absorbed by water

$$\rho \times V \times C_{pw} \times ( T_f - T_i )$$

let's calculate heat supplied by solar radiation Average heat radiated in a day, Pin = 1170 W/$m^2$

Hence, Qin = Pin ×area of panel× Δ t

The absorption of radiated heat is only 96% effective. So, effective heat radiated on panel

$$Q_{in,effective} = 0.96\ Qin$$

Now, calculating efficiency of general solar water heater without using phase change material

$$\eta = Qout / Q_{in,effective}$$

Now, calculating cooling rate and the efficiency of the solar water heater by adding PCM (Wax).

We added 9kg PCM (wax) in PCM tank as 100 liter water requires 36kg of PCM. Phase 1

We calculated the cooling rate of water in the water tank by adding PCM and heating water for 6 Hrs.

The analysis is shown in the Table 2.3.

Table 3: Cooling rates of Water in SWH with PCM Phase 2

| Time elapsed (hrs) | Temperature of water$^0$C |
|---|---|
| 0 | 68 |
| 3 | 65 |
| 6 | 63 |
| 9 | 61 |
| 12 | 60 |
| 15 | 59 |
| 18 | 57 |
| 21 | 56 |

Then calculate the efficiency of solar water heater.

The parameters for calculating the efficiency of solar water heater are shown in Table 2.4.

Table 4: Efficiency Parameters

| **Parameters** | **Symbol** | **Value** |
|---|---|---|
| Volume of water | V | 20liter |
| Initial Temperature of water | Ti | 400C |
| Heat radiated in day | Pin | 1170 Watts |
| Time elapsed | t | 6hrs |
| Final Temperature of water | Tf | 680C |

Now, specification of PCM,

Initial temperature of PCM = $36^0$C
Temperature of fusion = $60^0$C
Final temperature of PCM = $65^0$C
Specific heat of solid PCM = $2.5\frac{KJ}{KgK}$

Specific heat of molten PCM =$215\frac{KJ}{Kg\ K}$
Heat of Fusion=$2.13\ \frac{KJ}{Kg\ K}$

Now, calculating efficiency of solar water heater,

Efficiency, $\eta$ = = Qout / Qin

Now, calculating heat accumulated in the solar collector, which is sum of energy gained by water and same by PCM.

Energy gained by water =$\rho \times V \times C_{pw} \times ( T_f - T_i )$

Energy gained by water = Energy accumulated by solid PCM + Heat of fusion + Energy accumulated by molten PCM

$Q_{out}$ = Energy gained by water + Energy gained by PCM

$\eta$ = Qout / Qin;eff

**3 Results and Discussion**

The temperature distributions of water and the PCM in the water tank for different time intervals are recorded during charging and discharging processes. The cumulative heat stored and system efficiency of process is studied in detail during the discharging process.

### 3.1 Charging Process

#### 3.1.1 Temperature histories of water and PCM

The temperature histories of water and PCM are noted as follows:

Table 5: Charging Process

| Charging without PCM | | Charging with PCM | |
|---|---|---|---|
| Time elapsed (hrs) | Temperature of water $^0$C | Time elapsed (hrs) | Temperature of water $^0$C |
| 0 | 36 | 0 | 40 |
| 1 | 38 | 1 | 42 |
| 2 | 42 | 2 | 44 |
| 3 | 47 | 3 | 47 |
| 4 | 55 | 4 | 55 |
| 5 | 61 | 5 | 61 |
| 6 | 65 | 6 | 63 |
| 7 | 70 | 7 | 66 |
| 8 | 75 | 8 | 68 |

The graphical representation is as follows:

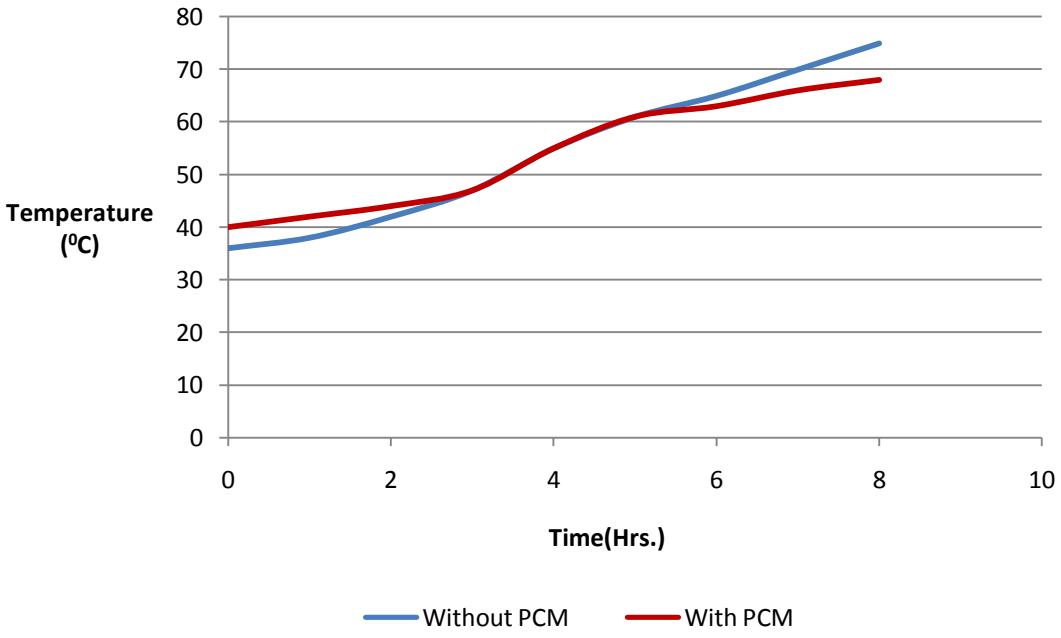


Fig. 2 Charging Process in SWH

### 3.1.2 Instantaneous heat stored

Fig 5 graphically represents the instantaneous heat stored in the storage tank during the charging process of PCM. This is estimated based on the instantaneous inlet and outlet temperatures of the water. It is observed that during the initial period of charging the heat stored is high, but decreases there on end. During the phase change period of PCM, the drop in heat stored is less drastic, almost a constant. This is a major advantage of the PCM system where a uniform rate of charging and discharging is possible for a longer period, which will be useful for practical applications.

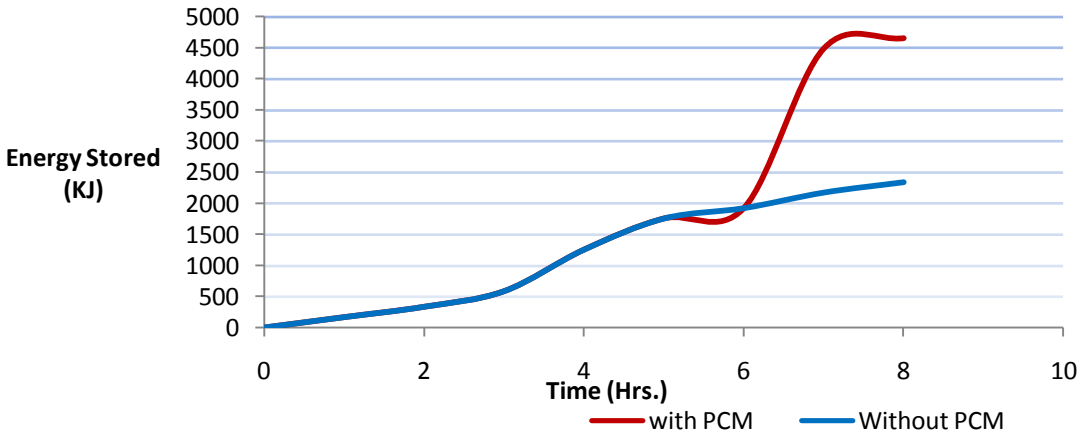


Fig. 3 Heat Stored in SWH Tank

### 3.1.3 System Efficiency

System efficiency is defined as the ratio of the amount of energy stored by the water tank to the heat energy available from solar radiation. The system efficiency of the SWH with & without PCM is as shown. It is seen that the system efficiency increases with time during the sensible heating of solid PCM, remains nearly constant during phase change period and then further increases during sensible heating of liquid PCM.

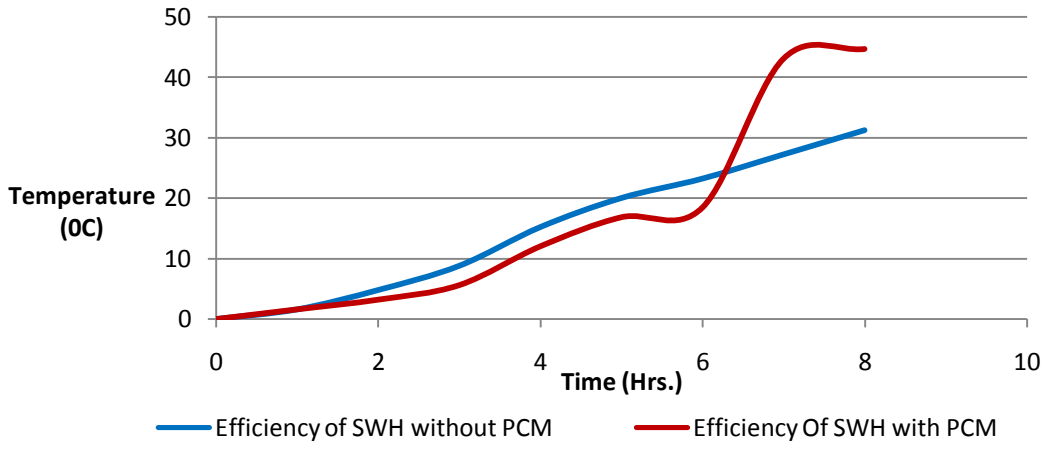


Fig. 4 Efficiency of SWH without PCM

### 3.2 Discharging process

The present work is an effort to evaluate the cooling rates of water with and without PCM.

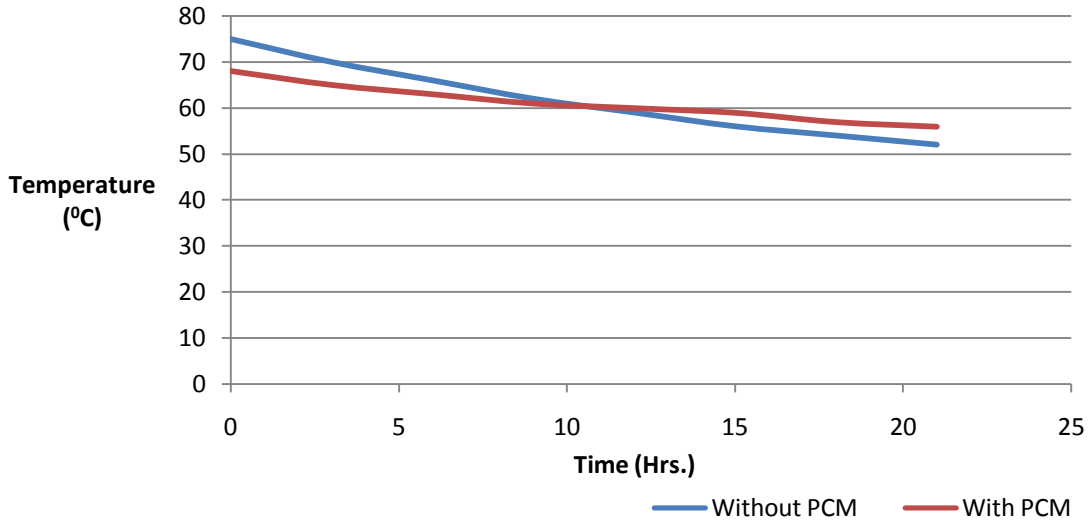


Fig 5 Discharging Process in SWH

### 4 Conclusions:

The use of PCM in solar water heater helps to reduce cooling rate of water, thus it enhance the maximum utilization of solar energy and hence improves efficiency of system. In this research with use of PCM efficiency of solar water heater increase from 31.25% to 44.63% and also heat storage capacity increase from 3260.4 kJ to 4656.5 kJ.Hence with using PCM material efficiency & heat capacity of solar water heater increases at reduced initial heating rate because PCM take heat to get heated. As PCM based solar water heater store maximum solar energy, it reduces the size of tank and hence can reduce cost of Solar Water Heater. The use of PCM in solar water heater helps to reduce cooling rate of water, thus it enhance the maximum utilization of solar energy and hence improves efficiency of system. In future this project will also help to find the suitable PCM and provide the various designs for solar water heating systems to store the solar thermal energy.

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# Recent Trends in Banana By-Products and Marketing Strategies: A Critical Review

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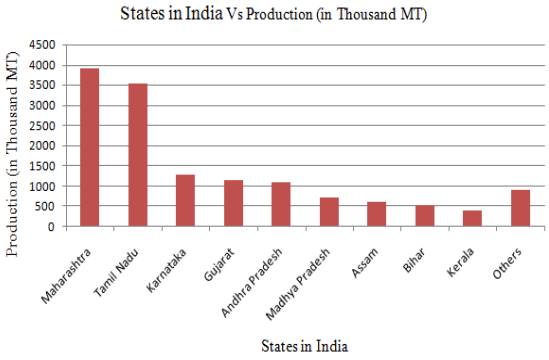
**Abstract: Recent trend in Banana processing and by-products are reviewed for utilizing it in a better way. Since problem of malnutrition exists almost in the world. While fruits are excellent food supplements, their agricultural production is specific to meteorological conditions and soil type. Fruit processing is a boon of science and technology with multiple benefits. It has made it possible to transport the fruit overseas in the form of products. It has made them all season available. Apart from this it is a potential source of employment generation. For developing countries like India fruit processing has bright prospects. Banana is the major fruit of India having world largest production. However a nominal 2% of it is processed. Hence there is a tremendous scope for enhancing its processing. In fact Banana processing can play vital role in Indian economy. The present paper highlights the major products of banana processing and global marketing potentials.**

***Key words: Banana, fruit processing, economy***.

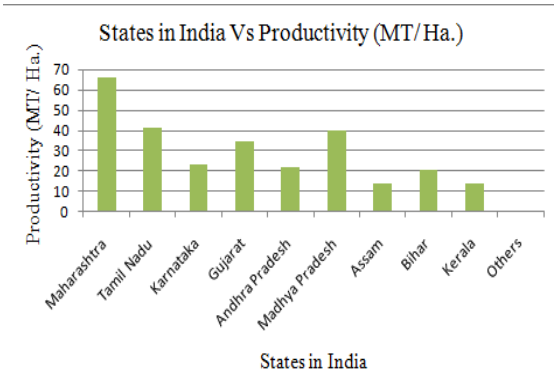
**Introduction:**

In modern days food preservation has become of a science based on latest developments in science and technology and food processing is a growing industry in many countries including India.

Fruits and vegetables are important supplements to the human diet as they provide the essential minerals and vitamins and fiber required for maintaining health. India ranks first in production of fruits and second in production of vegetable in the world. However, this abundance of production is not fully utilized and about 25-30% of wastages occur at various stages of fruit handling and distribution (Patil et al 2009). India produced about 62.86 million tons of fruits and 122.25 million tons of vegetables in 2006-07 (UNCTAD 2010; Narayana et al 2007).

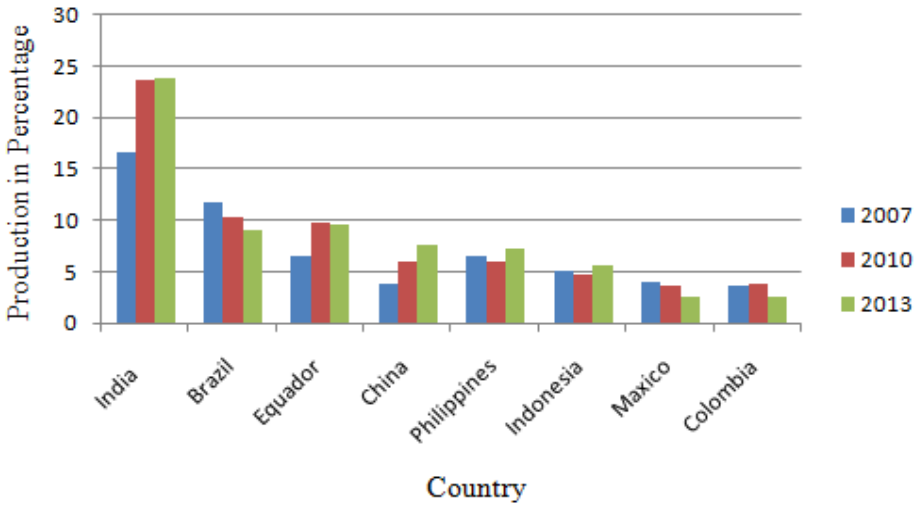



Graph No.1:- States in India Vs Production (in Thousand MT)




Graph No.2:-States in India Vs Productivity (MT/ Ha.)

Though India is the largest producer of fruits and vegetables in the world, only less than 2% of the total production is processed. In other countries the percentage of processed fruits are very high. Thailand processes (30%), Brazil and USA (70%). Philippines (78%) and Malaysia (83) (www. ikisan.com).




Graph No.3:- Country Vs Production (in Percentage)

There is a tremendous scope for export of processed value added products of fruits and vegetables. During 2006-07, around 797481.55 MTS various processed fruits and vegetables valued at Rs. 2502 crores were exported from India (Babhulkar N N 2009). The prime position of India in the production of fruits and vegetables provides us an unlimited potential to capture the vast export market of the world in the processed fruits and vegetables. The enormous Indian population also constitutes the potential consumers of processed foods (Roy et al 2000). With increasing urbanization, rise is middle class purchasing power, change in food habits and dying out of the practice of making preserves and pickles in homes, there is an increasing demand for factory made jams, jellies, fruit beverages, dehydrated foods, pickles etc. in the domestic market.

Therefore, it is needless to say that food processing sector in general and fruit processing industry in particular is still a sunrise area which holds tremendous potential both for revenue generation and for employment opportunity (Tripahti et al 2000).

India is the largest producer of banana in the world with a production of approximately 20.86 million tons from an area of 6.00 lakh hectares (www.ikisan.com). Out of this amount only 3-4% of banana is processed. The most popular processed product is Nendran chips, which is still in cottage scale while some bigger manufactures are processed banana puree for export. However, there is scope for converting banana into several other processed products like figs, jam, jelly, powder, Flour, baby food, health drink, RTS beverages, wine, alcohol, sauce, pickles, chutneys, animal feed, fiber etc. several processing technologies for value added banana products have been developed at National Research Center for Banana, Trichy. Some of the common banana products are discussed below (Rethinam 2008):

**A. By- Products from Banana:**

**1. Chips/Crisps:** Nendran fruits of approximately 80% maturity are harvested and demanded. The fingers are peeled, treated with 0.1% potassium metabisulphite and cut into slices of 1.2-0.8 mm thickness and deep fried in suitable cooking oil, preferably coconut oil. Upon frying this will yield crisp, yellow colored chips, which are sprinkled with common salt and packed in polyethylene bags. Generally they have a storage life of 30-35 days under ambient conditions. Packing the chips in laminates with nitrogen gas can extend its life up to 4 months. Several other verities of banana chips like flavored, sweet, sweet and sour, tomato flavored, with pepper, etc. are also catching up in the market.

**2. Banana Fruit Candy/Stem Candy:** Banana fruit candy made from nendran with jiggery and ginger are widely sold in market in Kerala state. Banana stem (true stem) can also be made into candy through osmotic dehydration process followed by sun drying.

**3. Banana Fig:** Banana figs are dried or dehydrated banana fruits with sticky consistency and very sweet taste. Fully ripe banana fruits of variety 'Karpuravalli' or 'Dwarf Cavendish' are peeled, treated with 0.1% potassium metabisulphite solution and dried either in sun or oven at 50$^{o}$C. These figs are packed in polyethylene bags or any other suitable containers.

They have a shelf life of about 3-4 months under ambient conditions.

**4. Banana Flour:** Banana flour is prepared from mature green bananas, which have a high starch content. It can be used as nutritious adjuvant in several food preparations like bread, cakes, biscuits, health drink and baby food formulations. It can also be blended with other cereal flours for making chapaties and roties. It has some medicinal property to cure ulcers. Under cool and dry conditions it can be stored up to one year without any adverse change in their composition.

**5. Banana Powder:** Banana powder is prepared from fully ripe banana fruits either through drum drying or spray drying process. The moisture content of final product should be around 2-4%. This product has got high market value as it is extensively used in confectionary industry, ice cream preparations and baby food making. When suitably packed it will have a shelf life of more than 6 months.

**6. Banana Juice:** Since banana puree is very thick, juice cannot be directly obtained from it. Therefore, the puree is treated with pectolytic enzyme and clear juice is obtained through filtration or centrifugation. After pasteurization and bottling it can have a shelf life of a minimum of 6 months under ambient conditions.

**7. Banana Fruit Bar:** Banana Fruit Bar is confectionary item prepared from ripe banana fruit of any variety. It is made by homogenizing banana pulp, sugar, citric acid and pectin in suitable proportions and dehydrating the mass in ghee coated ray at $70^{o}$ C in an oven till sets into a sheet. It is then cut into suitable size and packed in polyethylene pouches.

**8. Banana Biscuits:** Banana biscuits are made by mixing 60% banana flour and 30% maida. The dough is made using flour mixture and suitable proportions of sugar, saturated fat, baking powder, milk powder and essence. These biscuits are very tasty and highly nutritious.

**9. Banana Jam & Jelly:** Banana jam is made by cooking the fruit pulp with sugar along with pectin and citric acid in right proportions till gives a good set. Several varieties of banana are suitable for making jam. This is product, which has good commercial value and good market.

Banana jelly is a semi solid product prepared by boiling clear strained fruit extract free from pulp after addition of required amount of sugar, citric acid and pectin. A perfect jelly should be transparent, attractive and sparkling in color with strong flavor of fruit.

**10. Banana Wine:** Banana wine is produced by fermenting the enzyme treated clear banana juice with wine yeast viz . Saccharomyces cerevisae var. ellipaoiswua. The fermentation is carried out for about 3 weeks followed by filtration, clarification, and bottling. The pasteurized wine is stored in bottles for aging. The alcohol content of banana varies from 9-12%.

**11. Health drinks and Baby food:** A highly nutritious and tasty health drink formulations and baby food formula has been developed by NRCB using banana flour/powder after supplementing with suitable natural source of proteins ,minerals ,vitamins and fat . It has got a shelf life of about 6 months and suitable is for children and adults.

**12. Banana Fiber:** Banana fiber is extracted from the pseoudostem, peduncles and dried petioles and of banana plant . The banana fiber can be used for manufacture special kind of papers, ropes, threads, baskets, toys and several fancy items. The yarn made form banana fiber is much in demand for making textiles.

**Conclusions:**

It is quite obvious from the forgoing discussion that there is a vast scope for developing by-products of banana. The post globalization world economy gives more weightage on processing and value addition. This industry can play a vital role in the economic uplifting of the country specially the agricultural section. In fact this is going to be the second phase of green revolution. Thus, food preservation and proper low cost consumption to reduce malnutrition problem is possible through banana fruit. and it's by-products.

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# EFFECTS OF GROUNDING SYSTEM ON POWER QUALITY

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**Abstract—The purpose of this paper is to present the importance and affects of grounding and harmonics to the quality of power. The power quality conditions significantly depends on the every aspect in electrical system such as voltage, current, frequency, power, power factor and so on. As the result of this analysis, the grounding conditions used in the data center was found to have no signs of severity in power quality conditions. However, there were some issues of improper wiring and grounding found in the systems. On the other hand, the harmonic distortion in data center was discussed in terms of the source of harmonics effects of harmonic on the performance of data center. In order to identify the cause of such orders of harmonics in this system, the most non linear load is identified. Therefore, some recommendations and mitigations of the harmonics were discussed.**

***IndexTerms— Grounding, Harmonics , Power Quality, data center, Voltage Levels.***

## I.INTRODUCTION

Power quality issues can be very high-speed events such as transients, harmonic, high frequency noise, faulty wiring of grounding system, voltage swells and sags and total power loss. In this analysis, grounding and harmonics will be discussed in terms of power quality. Grounding may not be complicated but when a lack of understanding mixes with folklore and tradition, it may become exceedingly complex. It has been reported that 80 to 90% of power quality problems are mostly caused by improper wiring and grounding. Grounding is defined as a conducting connection, whether intentional or unintentional by which an electric circuit or equipment is connected to the earth or to some conducting body relatively large that serves in place of the earth. Grounding system designs and operations are completely depends on the applications in particular requirements. By specializing the grounding techniques can evolve the complexion of grounding system topic to meet the perceived grounding requirements of electronic equipment. The assessments include representation of grounding systems with linear and nonlinear parameters to produce a better representation of the overall electrical system at abnormal operating conditions [1].

Another power quality issue is harmonic [2]. Harmonic is defined as sinusoidal component of a periodic waveform having a frequency that is an integer multiple of having fundamental frequency. It is also a mathematical model that used to analyzed distorted waveforms and can be generated by non linear electronic loads[3]. The harmonic related losses reduce system efficiency, cause apparatus overheating, and increase power and air conditioning costs. The harmonic currents can have a significant impact on electrical distribution systems and the facilities they feed.

## II. BASIC ON HARMONICS

The basic harmonic theory which according to Fourier theorem, periodic non-sinusoidal or complex voltage (Figure 2) or current waveforms can be represented by the sum of a series of multiple frequency terms of varying magnitudes and phases as shown in equation (1).

$$f(t) = a_0 + \sum [a_n \cos(n\omega t + q_n)] \qquad (1)$$

where: $a_n$ is the magnitude of the n$^{th}$ harmonic frequency

$a_o$ is the d.c. component

$q_n$ is the phase angle of the n$^{th}$ harmonic frequency

ωis the fundamental frequency . $n$=1,2,3,…

Harmonic is measured using total harmonic distortion (THD) which is also known as distortion factor and can be applied to current and voltage. It
is a square-root of sum of all harmonic magnitudes over the fundamental. Equation (2) shows the calculation for voltage total harmonic distortion ($THD_v$).

$$THD_V = \frac{\sqrt{\sum_{n=2}^{\infty} V_n^2}}{V_1} \qquad (2)$$

where: $V_1$ is the magnitude of fundamental frequency voltage.

$V_n$ is the magnitude of n[th] harmonic frequency voltage.

## III. PROBLEM STATEMENT

Data center today are designed with systems and redundacies to minimize the loss of power [4]. However, the important issue to be emphasized is the quality power. Grounding of the data center is one of the ways to make sure the performance of the data center is always maintained at the acceptable level. Data center is dealing with many electronic equipments that often run into harmonic issues and the it should be taken care of by mitigating the harmonics[5].

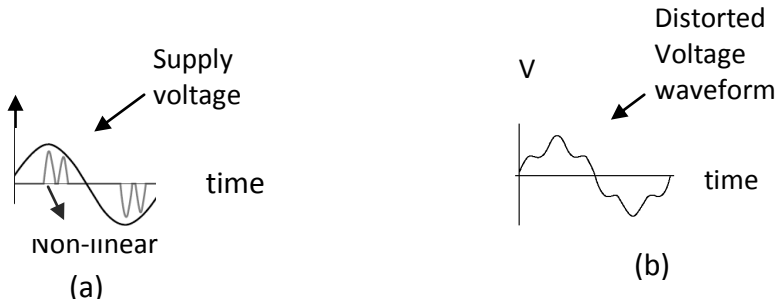



Fig. 2 Harmonic Current and Voltage Distortion

Table 1 categories of power quality events with durations and voltage magnitude

| S. No. | Categories | | Duration | Voltage Magnitude |
|---|---|---|---|---|
| I | *Short Duration Variation* | | | |
| (a) | Sag | Instantaneous | 0.5-30 cycle. | 0.1-0.9 pu. |
| | | Momentary | 30 cycles-3 sec. | 0.1-0.9 pu. |
| | | Temporary | 3sec-1min. | 0.1-0.9 pu. |
| (b) | Swell | Instantaneous | 0.5-30 cycle. | 1.1-1.8 pu. |
| | | Momentary | 30 cycles-3 sec. | 1.1-1.4 pu. |
| | | Temporary | 3sec-1min. | 1.1-1.2 pu. |
| (c) | Interruption | Momentary | 0.5cycles-3sec. | <0.1 pu. |
| | | Temporary | 3sec-1min. | <0.1 pu. |
| II | *Long Duration Variation* | | | |
| (a) | Interruption, Sustained | | >1min | 0.0 pu. |
| (b) | Under-voltage | | >1min | 0.8-0.9 pu. |
| (c) | Overvoltage | | >1min | 1.1-1.2 pu. |
| III | *Transients* | | | |
| (a) | Impulsive | Nanosecond | <50nsec. | |
| | | Microsecond | 50-1msec. | |
| | | Millisecond | >1msec. | |
| (b) | Oscillatory | Low frequency | 0.3-50msec. | 0-4 pu. |
| | | Medium freq. | 20µsec. | 0-8 pu. |
| | | High freq. | 5µsec. | 0-4 pu. |
| IV | *Voltage Imbalance* | | Steady state | 0.5-2% |
| V | *Waveform Distortion* | | | |
| (a) | Harmonics | | Steady state | |
| (b) | Notching | | Steady state | |
| (c) | Noise | | Steady state | |

## IV. SOME CASE STUDIES IN POWER QUALITY

### A.VOLTAGE TRANSIENTS CAUSING DIODE FAILURES

**Environment -** A plastic extrusion manufacturer in the mid-West had a 480V delta feeding a plastic extrusion machine. The ASD-driven synchronous motor in the extruder had a half-wave bridge rectifier circuit to provide excitation voltage to the pole coils.

**Problem -**Diodes on the half-wave bridge exciter circuit were blowing out, and the filters to the SCRs were being damaged.

**Monitoring Survey -** Three channels of the voltage supply feeding the extruder were monitored for just two seconds before enough data was collected to determine the cause of the failures. A burst of transients would occur three times a second. The RMS voltage did not change significantly during these transients. Closer examination of the waveforms showed that the transients were actually a repetitive series of voltage transients, occurring six times a cycle on all three phases. An example of the voltage waveforms for one phase is shown in Figure 1.

These repetitive voltage transients are referred to as voltage notches. The maximum voltage of the transient could produce damage, and the voltage notches that cross the zero axis could result in zero crossing errors. Closer examination of the transients is shown in Figure 2.

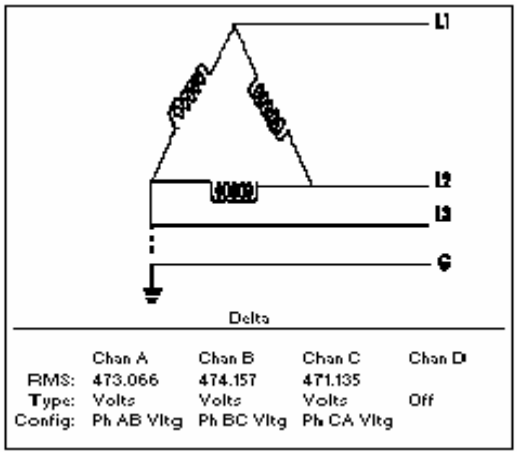



Fig. 1

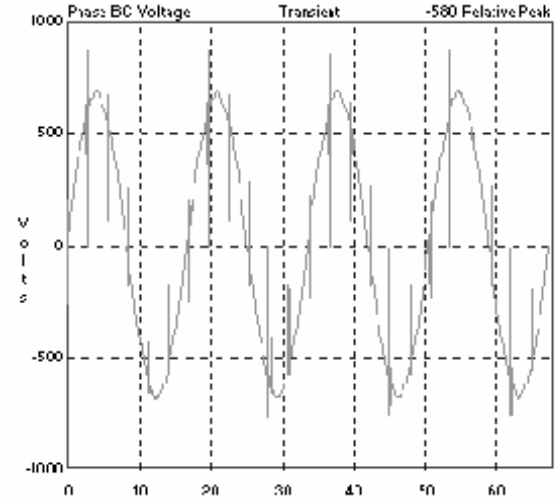



Fig. 2. Single Transient Waveform

**Analysis**

The following were calculated values of this voltage disturbance monitoring period: Number of transients: 192 Amplitude: -580 volts. Worst Absolute amplitude (from zero crossing): 864. Rise time: 1.0851 microseconds Frequency (1/4*rise): 230.4kilohertz. Number of zero crossing errors this frame: 146. Worst zero crossing width: 61440 microseconds. Worst zero crossing delta voltage: 168 volts. Worst notch area: 0.021475 volt-seconds.

**Transient Analysis**

The absolute amplitude value confirmed the cause of the damage to the diodes, as this voltage exceeded the ratings of the diodes in the half-wave bridge. The very fast rise time and equivalent frequency greater than 100 KHz of the transient indicates that the source of the transient is relatively close to the measuring point.This would indicate that the origin of these transients was an electronic switching load such as a bridge rectifier used on many electronic motor drives. The transients on other phase voltage channels were not the same polarity, but occurred at relatively the same time, as shown in Figure *3*. Zero crossing errors can cause timing problems with phase controlled and electronic loads. Clocks can run faster and power electronics, such as SCRs and switching diodes, can misfire and be damaged. Notching can also trip protective relaying, stress power electronics, and cause excessive heat in motors and transformers.

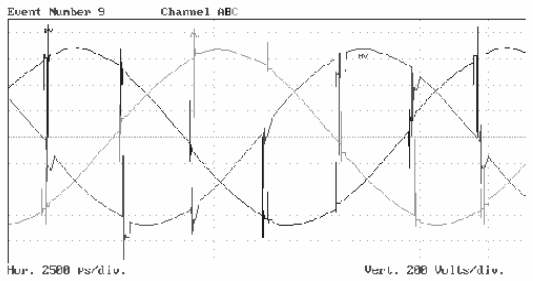


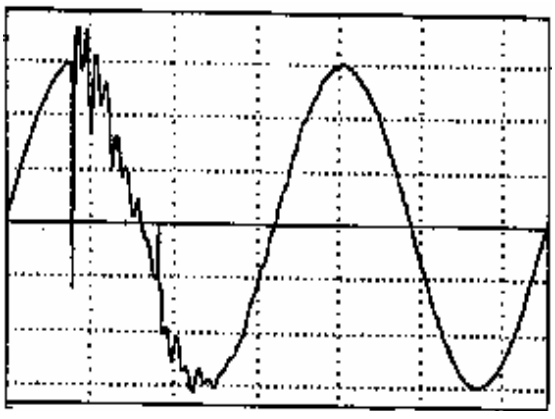

Fig 3. Three Phase Voltages Overlaid.

## B. UTILITY POWER FACTOR CAPACITOR BANK SWITCHING PROBLEM

**Environment -** A medical clinic in Las Vegas, Nevada, employing sensitive computed tomography (CT Scan) system. Power was brought to the system from a 480 volt service feeding a 480-to-208 volt isolation transformer.

**Problem -** CT Scan system was experiencing repeated computer lockups and component failures.

**Measurements -** The medical equipment service company installed a power monitor on site to analyze the power to the system. A single day of monitoring was enough to identify the case of the failures. Figure 1shows the disturbance on the line caused by a utility power factor correction capacitor bank located just one block away. Figure 2shows the attenuation effect of the isolation transformer, still not enough to protect the CT Scan .



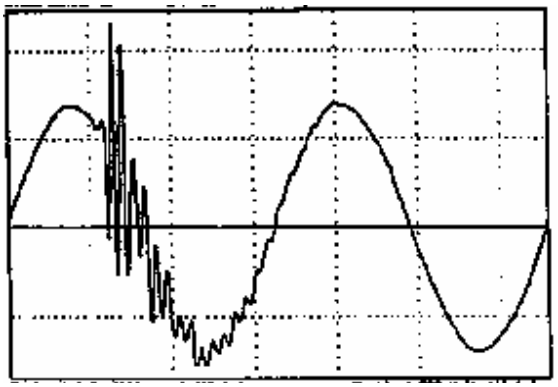


Fig 4.Disturbance caused by utility capacitor bank

Solution

Expansion of the waveform data, Figure 3, revealed the ringing frequency of the system, when energized by the capacitor bank, was between 1 kHz and 1.5 kHz. This allowed the specification of a treatment device to mitigate the problem. The medical equipment company recommended the use of an active-tracking filter specifically designed for this type of disturbance around 1 kHz. The filter was installed on the 480 -volt line to protect all of the downstream equipment. Figure 4shows the difference between the input (Channel C) and output (Channel B) of the filter during a subsequent capacitor bank switching operation

## IV.CONCLUSION

This work has been involved with investigations associated with the various systems modelling and its influence on the final reports about equipment damage analysis[6],[7].

If this condition occurs, the grounding representation by linear model, although its simplicity, indicates great disadvantages and strong effects on the final voltage and current results. Moreover, the model that includes non-linear parameters, allowing the inclusion of the previous phenomena, is linked with equations, information and complex parameters that are quite difficult to be obtained[8]. This has motivated the idea of a ground representation here proposed. The advantages of this is given by a combination of a good response to disturbances and the need for more simple data.

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# USE OF RGB COLORS AND CRYPTOGRAPHY FOR COULD SECURITY

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**AbstractCloud computing is a parallel and distributed computing system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing which is based on service level agreement. In cloud computing data security and privacy is one of the most challenges. So secure delivery of data to and from the cloud is however a serious issue that needs to be addressed. This paper describes or fulfills the current scenario of cloud computing by using combination of both colors and Homomorphic encryption technique simultaneously.**

***Keywords- Cloud Computing, Cloud Security, Data Security, Homomorphic encryption.***

## 1. INTRODUCTION

According to NIST (National Institute of standard and Technology) Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. There are many problem related with cloud computing traffic, security and resource management. We can provide security in cloud by many ways like on data, network and storage. Homomorphic encryption method provides more security on data because provider is not involving in key management. I have use proxy re-encryption technique and colors technique that prevents ciphertext from chosen cipher text attack. This system is more secure than existing system.

By Cloud Computing we mean: The Information Technology (IT) model for computing, which is composed of all the IT components (hardware, software, networking, and services) that are necessary to enable development and delivery of cloud services via the Internet or a private network. This definition has no notion of security for data in the cloud computing even if it's a very new. Cloud providers like: IBM, Google and Amazon use the virtualization in their Cloud platform, and in the same machine can coexist the storage space and treatment virtualized which belong to the concurrent enterprises.

In cloud computing, everything is delivered *as a Service* (*XaaS*), from testing and security, to collaboration and Meta modeling [8]. The cloud was rapidly becoming a conflagration of buzzwords "as a service". Today there are three main service models, which are agreed on and defined in the NIST document [9].

1. *Software as a Service* {*SaaS*} - this simply means delivering software over the Internet. It is the most widely known model of cloud computing. *SaaS* has been around since early 2001 when it was commonly referred to as the Application Service Provider (ASP) Model [8]. Software as a Service consists of software running on the provider's cloud infrastructure, delivered to (multiple) clients (on demand) via a thin client (e.g. browser) over the Internet. Typical examples are Google Docs and Salesforce.com CRM.

2. *Platform as a Service* {*PaaS*} - this gives a client (developer) the flexibility to build (develop, test and deploy) applications on the provider's platform (API, storage and infrastructure). *PaaS* stakeholders include the *PaaS* hosted who provides the infrastructure (servers etc), the *PaaS* provider who provides the development tools and platform and the *PaaS* user [10]. Examples of *PaaS* are Microsoft Azure and Google AppEngine.

3. *Infrastructure as a Service* {*IaaS*} - rather than buy servers and build a datacenter from ground up, and consequently having to worry about what happens when the 1. *Software as a Service* {*SaaS*} - this simply means delivering software over the Internet. It is the most widely known model of cloud computing. *SaaS* has been around since early 2001 when it was commonly referred to as the Application Service Provider (ASP) Model [8]. Software as a Service consists of software running on the provider's cloud infrastructure, delivered to (multiple) clients (on demand) via a thin client (e.g. browser) over the Internet. Typical examples are Google Docs and Salesforce.com CRM.

Depending on infrastructure ownership, there are four deployment models of cloud computing each with its merits and demerits. This is where the security issues start.

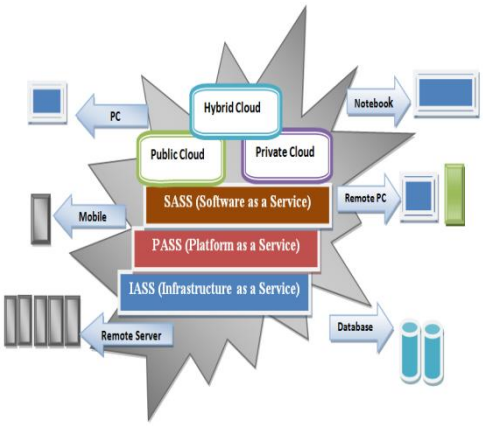


Fig 1 Architecture of cloud computing

1. *The Public Cloud* - this is the traditional view of cloud computing in every day lingua. It is usually owned by a large organization (e.g. Amazon's EC2, Google's AppEngine and Microsoft's Azure). The owner-organization makes its infrastructure available to the general public via a multi-tenant model on a self-service basis delivered over the Internet. This is the most cost-effective model leading to substantial savings for the user, albeit with attendant privacy and security issues since the physical location of the provider's infrastructure usually traverses numerous national boundaries.

2. *The Private Cloud* - refers to cloud infrastructure in a single tenant environment. It defers from the traditional datacenter in its predominant use of virtualization. It may be managed by the tenant organization or by a third party within or outside the tenant premises. A private cloud costs more than the public cloud, but it leads to more cost savings when compared with a datacenter as evidenced by Concur Technologies (est. savings of $7million in 3 years from 2009) [11]. The private cloud gives an organization greater control over its data and resources. As a result, the private cloud is more appealing to enterprises especially in mission and safety critical organizations.

3. *The Community Cloud* - according to NIST, the community cloud refers to a cloud infrastructure shared by several organizations within a specific community. It may be managed by any one of the organizations or a third party. A typical example is the Open Cirrus Cloud Computing Tested, which is a collection of Federated data centers across six sites spanning from North America to Asia [12].

4. *The Hybrid Cloud* - comprises of a combination of any two (or all) of the three models discussed above. Standardization of APIs has lead to easier distribution of applications across different cloud models. This enables newer models such as "Surge Computing" in which workload spikes from the private cloud is offset to the public cloud.

## 2. HOMOMORPHIC ENCRYPTION

Homomorphic encryption alludes to encryption where plain texts and cipher texts both are treated with an equivalent algebraic function. Homomorphic Encryption allows server to do operation on encrypted data without knowing the original plaintext. Homomorphic encryption allows complex mathematical operations to be performed on encrypted data without using the original data. For plaintexts X1 and X2 and corresponding ciphertext Y1 and Y2, a Homomorphic encryption scheme permits the computation of X1 Θ X2 from Y1 and Y2 without using P1 Θ P2.The cryptosystem is multiplicative or additive

Homomorphic depending upon the operation Θ which can be multiplication or addition.

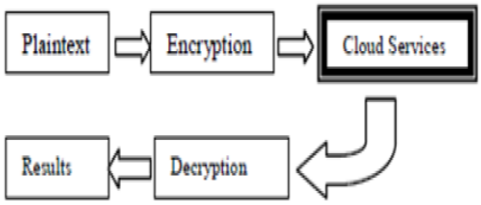


Fig. 2 A framework for data protection over Cloud

## 3. CRYPTOGRAPHY

Cryptography, to most people, is concerned with keeping communications private. Encryption is the transformation of data into some unreadable form. Its purpose is to ensure privacy by keeping the information hidden from anyone for whom it is not intended. Decryption is the reverse of encryption; it is the transformation of encrypted data back into some intelligible form. Encryption and decryption require the use of some secret information, usually referred to as a key. The data to be encrypted is called as plain text. The encrypted data obtained as a result of encryption process is called as cipher text. Depending on the encryption mechanism used, the same key might be used for both encryption and decryption, while for other mechanisms, the keys used for encryption and decryption might be different.

### Types of Cryptographic Algorithms

There are several ways of classifying cryptographic algorithms. In general they are categorized based on the number of keys that are employed for encryption and decryption, and further defined by their application and use as in. The three types of algorithms are depicted as follows

1) *Secret Key Cryptography (SKC):*Uses a single key forboth encryption and decryption. The most common algorithms in use include Data Encryption Standard (DES), Advanced Encryption Standard (AES).

2) *Public Key Cryptography (PKC):* Uses one key for encryption and another for decryption. RSA (Rivest, Shamir, and Adleman) algorithm is an example.

3) *Hash Functions:* Uses a mathematical transformation to irreversibly "encrypt" information. MD (Message Digest) algorithm is an example.

### RGB Color Model

Any color is the combination of three primary colors Red, Green and Blue in fixed quantities. A color is stored in a computer in form of three numbers representing the quantities of Red, Green and Blue respectively. This representation is called RGB representation which is used in computers to store images in BMP, JPEG and PDF formats. Here each pixel is represented as values for Red, Green and Blue. Thus any color can be uniquely represented in the three dimensional RGB cube as values of Red, Green and Blue. The RGB color model is an additive model in which Red, Green and Blue are combined in various ways to produce other colors. By using appropriate combination of Red, Green and Blue intensities, many colors can be represented. Typically, 24 bits are used to store a color pixel. This is usually apportioned with 8 bits each for red, green and blue, giving a range of 256 possible values, or intensities, for each hue. With this system, 16 777 216 (256^ 3 or 2^24) discrete combinations of hue and intensity can be specified.

## 4. EXISTING SYSTEM

### Additive Homomorphic encryption

A Homomorphic encryption is additive, if:
Enc(x +y) = Enc(x) +Enc(y)

Table 1: Paillier Cryptosystem (1999):

| Key Generation: KeyGen(p,q) | Encryption: Enc(m, pk) | Decryption: Dec(c, sk) |
|---|---|---|
| Input: p , q ϵ P | Input: m ϵ $Z_n$ | Input: C ϵ $Z_n$ |
| Compute: n=p*q, and λ=lcm(p-1)(q-1)<br>Choose g ϵ $Z_n$ such that Gcd(L(g^λ mod $n^2$), n)=1<br>With L(u)=(u-1)/n | Choose r ϵ $Z_n$<br>Compute: c= $g^m * r^n$ mod $n^2$ | Compute:<br>m= mod n [L(c^λ mod $n^2$)/L(g^λ mod $n^2$)] |
| Output: (pk , sk)<br>Public key: pk=(n, g)<br>Secret key: sk=(p,q) | | Output: m ϵ $Z_n$ |

Suppose we have two ciphers C1 and C2 such that:
C1=gm1. r1 n mod n2
C2=gm2.r2 n mod n2
C1. C2= gm1.r1 n.gm2.r2 nmod n2= gm1+m2(r1r2)n mod n2
So, Paillier cryptosystem realizes the property of additive Homomorphic encryption. An application of an additive Homomorphic encryption is electronic voting: Each vote is encrypted but only the "sum" is decrypted.

### Multiplicative Homomorphic Encryption

A Homomorphic encryption is multiplicative, if:

Enc(x *y) = Enc(x) *Enc(y)

Table 2: RSA Cryptosystem (1978)

| Key generation KeyGen(p,q) | Encyption: Enc(m,pk) | Decryption: Dec(c, sk) |
|---|---|---|
| Input: p,q ∈ P | Input: m∈ Zn | Input: c ∈ Zn |
| Compute: n=p*q, and Ø(n)=(p-1)(q-1) | Compute: $c = m^e \bmod n$ | Compute: $m = c^d \bmod n$ |
| Choose e such that Gcd(e,Ø(n))=1 Determine d such that e * d≈1mod Ø(n) | Output: c ∈ Zn | Output: m ∈ Zn |
| Output: (pk ,sk) Public key: pk=(e,n) Secret key: sk=(d) | | |

Suppose we have two ciphers C1 and C2 such that:
C1= m1e mod n
C2= m2e mod n
C1. C2= m1e m2e mod n= (m1m2)e mod n

So, RSA cryptosystem find the properties of the multiplicative Homomorphic encryption, but does not satisfied good notions of security, Because if we assume two ciphers C1, C2 corresponding to the messages m1, m2, respectively, so :
C1= m1 e mod n
C2= m2 e mod n

The transmitter sends the pair (C1, C2) to the Cloud server; the server will perform the calculations requested by the client and sends the encrypted result (C1XC2) to the customer. If the attacker intercepts two ciphers C1 and C2, which are encrypted with the same key, it will be able to decrypt all messages exchanged between the two communications because the Homomorphic encryption is multiplicative, i.e. the product of the ciphers equal to the cipher of the product.

## 5. Problem in Existing System

Suppose we have two ciphers C1 et C2 such that:

C1 = m1e mod n
C2 = m2e mod n
C1.C2 = m1em2e mod n = (m1m2)e mod n

RSA cryptosystem is working with property of multiplicative Homomorphic encryption, but it has a lake of security, because if we have two ciphers C1, C2 corresponding respectively to the messages m1, m2 so:

C1 = m1e mod n
C2 = m2e mod n

The client sends the pair (C1, C2) to the Cloud server and server performs the calculations requested by the client and sends the encrypted result (C1 × C2) to the client. If the attacker intercepts two ciphers C1and C2, which are encrypted with the same private key, so they are able to decrypt all messages exchanged between the server and the client. Because the Homomorphic encryption is multiplicative, i.e. the product of the ciphers equals the cipher of the product. The basic RSA algorithm and Paillier Cryptosystem is vulnerable to chosen ciphertext attack (CCA).CCA is defined as an attack in which adversary chooses a number of ciphertext and is given the corresponding plaintext, decrypted with the target's private key. Thus the adversary could select a plaintext, encrypt it with the target's public key and then be able to get plaintext back by having it decrypted by private key. So attacker will know the entire data in-between client and cloud server.

## 6. Proposed System

To prevent cipher data from CCA (chosen ciphertext attack) I propose Proxy Re- Encryption algorithm with paillier and RSA Cryptosystem. At initial level receivers are identified by assigning of unique color. Each color is represented with a set of three values for example violet red color is represented in RGB format as (238,58,140) after then in next step assign a set of three key values to each receiver. Detail description of proposed system model is shown in above figure:-

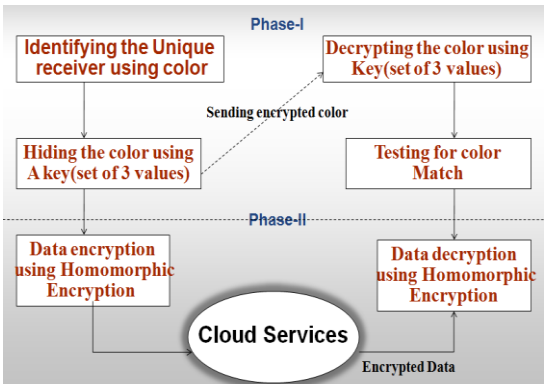


Fig. 3 Proposed System Model

**Step 1**: *Encryption: L*et us assume that the data has to be sent to a receiver (say A) who is assigned the color raspberry (135, 38, 87). Let the Unique key values to be added with this color value be (-10, +5, +5).

**Step 2:** Initially the sender knows the required receiver to be A. So the key values are added with the color values assigned for receiver A.

135 38 87
-10 5 5
---
125 43 92

**Step 3:** Convert the above old color value and new create color value data into a matrix as follows

$$A = \begin{Bmatrix} 135 & 125 \\ 38 & 43 \\ 87 & 92 \end{Bmatrix}$$

**Step 4:** Consider an encoding matrix...

$$B = \begin{Bmatrix} 1 & 5 & 3 \\ 1 & 25 & 9 \\ 1 & 125 & 27 \end{Bmatrix}$$

**Step 5:** After multiplying the two matrices (B X A) we get

$$c = \begin{Bmatrix} 779 & 890 & 742 \\ 3071 & 3598 & 2834 \\ 13427 & 16082 & 1290 \end{Bmatrix}$$

The data 779, 890, 742, 3071, 3598, 2834, 13427, 16082, 1290

**Step 6:** After then this data is encrypted using public key cryptography system.

**Step 7:** In this step the encrypted data is sent to the receiver as well as for the next phase of the system

**Step 8:** Input data of the previous phase and data of the phase-II are added simultaneously and perform the Homomorphic encryption techniques

Key Generation -keygen (p,q)
1. Take two prime number p and q.
2. Compute n=p.q, Φ(n)=(p-1)(q-1) and choose e such that gcd(e, Φ(n)))=1.
3. Determine d such that e.d=1 mod Φ(n).
4. The Proxy public key (Rpk) is (e,n) is generated.
5. The proxy Secret key (Rsk) is (d) is generated.

Encryption: Enc (c,Rpk)
6. Let m be a message to be encrypted where m Є Zn.
7. Compute ciphertext as: rc=me mod n.

Decryption: Dec (rc,Rsk)
8. Ciphertext c Є Zn.
9. Compute message m=cd mod n.

**Step 9**: Proxy Re-Encryption Algorithm:
Key generation:
1. Choose two large prime numbers p and q randomly and independently of each other such that gcd (pq ,(p-1)(q-1))=1.
2. Compute n=pq and λ=lcm (p-1, q-1).
3. Select random integer g where g Є Z*n2
4. Ensure n divides the order of g by checking the existence of the following modular multiplicative inverse: μ=(L(a λ mod n2))-1 mod n, where function is defined as L(u)=u-1/n.
5. The public (encryption) key is. (n,g)
6. The private (decryption) key is (λ, μ)

Encryption: Enc (m, pk)
1. Let m be a message to be encrypted where m Є Zn.
2. Select random where r Є Zn*.
3. Compute ciphertext as: c=gm .rn mod n2.

Proxy Re-Encryption(c)
1. Compute Private and Public key.(Rsk,Rpk).
2. Re Encrypt Ciphertext generated and send Public key (Rpk) to cloud server.

Decryption: Dec(c,sk)
3. Ciphertext c Є Zn2*.
4. Compute message: m=L(c λ mod n2)/ L (g λ mod n2).

Mod n

**Step 10:** After then data is decrypted with the help of unique key, unique color value, public key and public key of phase-II

## 7. CONCLUSION

The above combination of secret key and public key cryptography can be applied mainly at initial level called phase–i to identifying the receiver. at the phase–ii i provide homomorphic encryption technique which is a new concept of security on the cloud that enables proving results of calculations on encrypted data without knowing the row data. in this paper i have proposed rsa and paillier algorithm for homomorphic encryption with rgb color model that prevents cipher data from choosen cipher text attack (cca). So this system is more secure than existing system.

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# Utilization of Cereal Grains for Bioethanol Production: A Critical Review

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**Abstract: Bioethanol produced from renewable biomass, such as sugar, starch, or lignocellulosic materials. Bioethanol is one of the alternative energy resources; this is both renewable and environmentally friendly. Although, the priority in global future ethanol production is put on lignocellulosic processing, which is considered as one of the most promising second-generation bio-fuel technologies, cereal grains for fuel ethanol is still underutilized. Sugar-based that is molasses, sugar cane, sugar beet and starch-based that is corn, wheat, triticale, potato, rice, etc., feed stocks are still currently predominant at the industrial level. They are, so far, economically favourable compared to lignocelluloses. Currently, approximately 80 % of total world ethanol production is obtained from the fermentation of simple sugars by yeast. In this paper, a review of the state of the art in bio ethanol production and availability is discussed. Pointing out the progress possibilities on starch-based production are discussed, in the respect of feedstock choice, pre-treatment, optimization of fermentation and process integration. It is observed that utilization of cereal grains for bioethanol production is the best option after food application.**

***Key words: Cereal grains, Bio-ethanol, amylose, amylopectin.***

## 1. Introduction:

Cereal grains are used mostly for food and feed. Due to overproduction of cereals and advanced technology in seed production, tillage, sowing, harvesting and storage, cereals can be used as energy source. In recent decades, plant-breeding activities have made good progress in increasing grain yields and improving the genetic make-up of crops to increase nutrient utilization efficiency and to improve their adaptability for better environmental condition. As per estimates provided by Food Corporation of India (FCI) huge quantities of cereal grains are getting spoiled every year due to unfavourable climate condition, and become unfit for human and animal consumption; and these are very cheap. There are about one million tonnes of damaged grains lying unutilised in FCI stores **(Suresh et al, 1999).** The damage includes discoloration, breakage, cracking, attack by fungi, insect damage, chalky grain, partial softening by being damp, dirty and bad smell etc., The damaged grains used for ethanol production are ten times cheaper than fine quality.

High starch contents in cereal grains make them good feed stocks for conversion into bio-fuels and other bio-based products. Ethanol is the only bio fuel that has been produced commercially from these feed stocks in large quantities. The amount of grain utilised neither for food, nor for feed purposes has grown in recent years. There has been an annual increase of around 10% from 2006 to 2008. Prior to that, the increase has been smaller and the amount was fairly stable prior to 2004 (C. Wrigley, I.L. Batey, 2010). The main industrial use of grains is to isolate the starch component and then process it further. Starch comprises 60 to 80 % of dry matter in most cereal grains. It is isolated industrially from maize and wheat, and to a lesser extent from rice. The resulting starch may be utilised or may be processed further. Modified starches (anionic, cationic and cross linked) have wide range of purposes in food and non food applications. A significant amount of starch is digested by enzymatic or acid/enzymatic treatment to produce glucose. Some of this glucose is converted to high fructose syrups for use as a sweetener. The starch may also be subjected to fermentation to ethanol. This use has traditionally been for production of alcoholic beverages, but high oil prices have caused the amount of grain being converted into automotive fuel production. Much of increase in amount of grain being used for purposes other than food and feed that is for ethanol production. The two main types of liquid biofuels are biodiesel and bioethanol. Biodiesel can be blended with diesel and bioethanol is primarily blended with petrol. Currently, the majority of vehicle engines are designed to run on

blends of at least 5 percent biofuel. At present, bioethanol is produced from sugar beet or cereal grain. In future, it may become possible to produce sugar, hence alcohol from plant biomass, which is much cheaper and plentiful. Using crops, to produce fuel will help to meet targets for reducing greenhouse gas emission such as ($CO_2$).Cereals for combustion or for fermentation may be produced in the same manner as for food or fodder use.

## 2. Bioethanol production from cereal based feedstock and progress possibilities:

Production of bioethanol, whether it may be for beverages or other use, grains are usually fermented without prior isolation of starch components. Starch contents and theoretical ethanol yield of cereal grains which are relevant to ethanol production are summarized in Table 1. Theoretical yield of ethanol is 0.51 kg ethanol per kg glucose. Upon hydrolysis, 1 kg starch produces 1.11 kg glucose.

Table-1:Starch and Theoretical Ethanol Yield of Relevant Cereal Grains (Dry Basis)

| Feed grain | Starch (%) | Theoretical ethanol yield | |
|---|---|---|---|
| | | (L/Kg) | (gal/MT) |
| Corn | 72 (65-76) | 0.52 | 125 |
| Wheat | 77 (66-82) | 0.55 | 132 |
| Barley | 57 (55-74) | 0.41 | 98 |
| Sorghum | 72 (68-80) | 0.52 | 125 |
| Oat | 58 (45-69) | 0.42 | 101 |
| Rice | 79 (74-85) | 0.57 | 137 |

Source: Adapted from Dairy Research and Technology Centre (http://www.afns.ualberta.ca/Hosted/DRTC/Articles/Barley_Dairy.asp) and Juliano, 1993.
MT: metric ton

Starch is a polymer of glucose and consists of two main structural components, Amylose and Amylopectin. *Amylose* is essentially a linear polymer in which the glucose residues are connected by the α-1, 4 linkages. The other main component of starch is *amylopectin*, which is a larger and branched molecule with both α-1, 4 and α-1,6 linkages. Most common starch contains about 25 percent amylose and 75 percent amylopectin. Starch in waxy grain varieties contains amylopectin almost exclusively (greater than 98 percent). Percent of amylose and amylopectin in starches from variety of crops is given in Figure no.2.

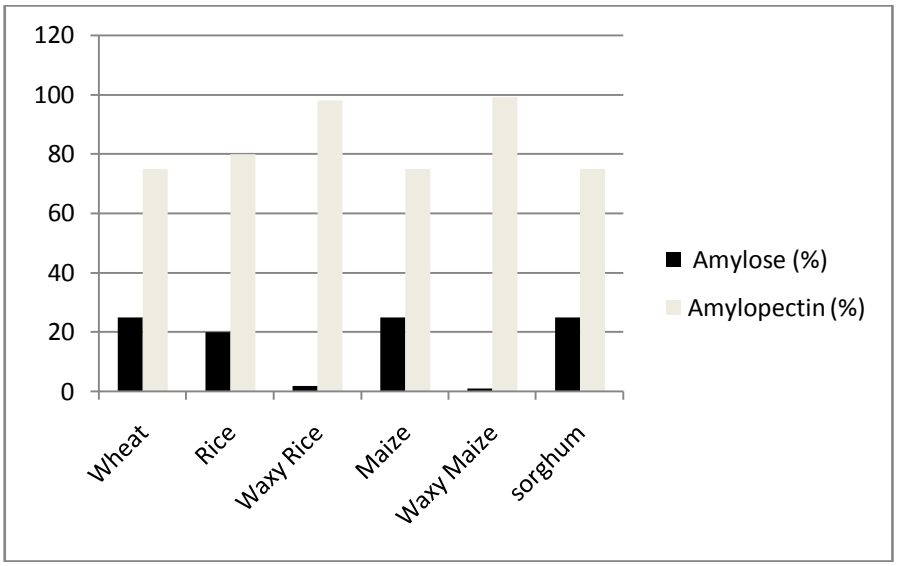


Fig2: Percent of Amylose and Amylopectin in starches from variety of crops (Power 2003).

Bioethanol is produced by fermentation of simple sugars present in cereal grains and the sugars obtained by prior chemical or enzymatic treatment of the cereal grains. The fermentation is performed by micro organisms, traditionally by yeasts, although some types of bacteria such as Zymomonasmobilis could also be used. After the fermentation, the ethanol is being separated from the fermentation broth, conventionally by means of distillation and rectification or by using more efficient separation technologies such as pervaporation, membrane filtration or molecularsieves. A schematic of bioethanol production on corn starch is presented in Figure 3.

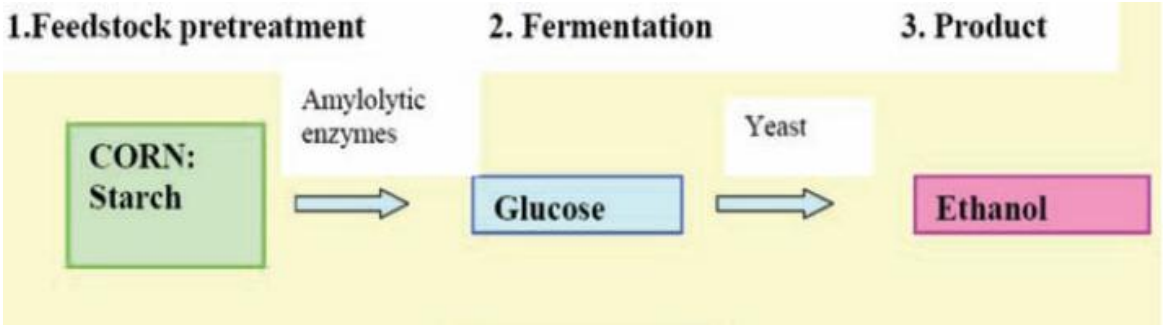


Fig. No: 3 Flow chart

2.1 **Hydrolysis of starch -** The hydrolysis of starch may be considered as a key step in the processing of starch-based feedstock for the bioethanol production. Starch can be hydrolyzed by enzymes to produce the monomeric sugar glucose, which is readily metabolized by the yeast *Saccharomyces cerevisiae* to produce ethanol at high yields. Starch processing is a mature industry, and commercial enzymes required for starch hydrolysis are available at low costs. In addition to starch cereal grains also contain other components, which can be recovered into value-added co-products in the ethanol fermentation process. Sales of these high-value co-products play an important role in determining the process economics of fuel ethanol production.The hydrolysis may be performed by acids, an older process which is now mainly abandon and replaced by more efficient enzymatic process. The starch-based bioethanol industry has been commercially viable for about 30 years; in that time, tremendous improvements have been made in enzyme efficiency, reducing process costs, and time, increasing hydrolysis and bioethanol yields. Recent advances in the development of thermo stable α-amylases, the starch liquefying enzymes which catalyze the hydrolysis of internal α-D-(1-4)-glucosidal linkages in starch, in a random manner. Effective glucoamylases, the starch saccharifying enzymes which catalyze the hydrolysis of α-D-(1-4) and α-D-(1-6)-glucosidal bonds of starch from the non-reducing ends giving glucose as final product, have led to commercial establishment of so called “the two-step enzymatic cold process”. The main advantages of this process are lower energy consumption and a lower content of non-glucosidal impurities, and thus much better suitability for the ethanol production. The mode of action of α-amylase and glucoamylase is presented in Figure No 4.The amount of endogenous enzymes for the hydrolysis of starch-based feedstock and the parameters of hydrolysis such as pH, temperature, substrate concentration, process time etc. depends upon the type of feedstock; its chemical composition, presence of the native auto-amylolytic potential as well as on the origin of endogenous enzymes and their activity.The employment of additional, mainly physical treatments, such as grinding, micronionization, cooking and steaming, microwave, ultrasound etc., improves the starch gelatinization process, the substrate susceptibility to enzymes and can greatly influence and improve the effects of hydrolysis and subsequent ethanol fermentation.

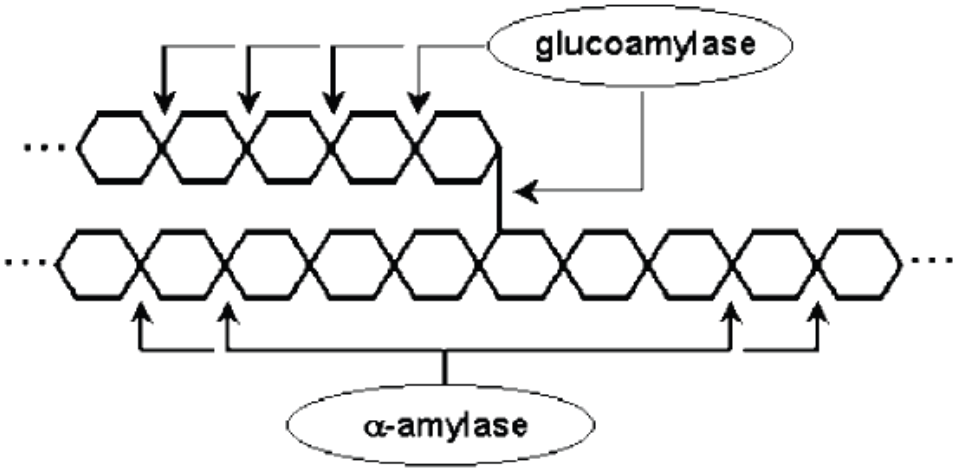


**Fig 4**

2.2 **Fermentation-** Efficient bioethanol production requires a rapid fermentation leading to high ethanol concentrations. Therefore, a yeast strain must have a good specific growth rate and specific ethanol production rate at high osmotic pressure and ethanol concentration. An important issue for the efficient ethanol production is to optimize the fermentation step regarding following main parameters: temperature, pH, media, composition, mixing, aeration, elimination of infection etc. The choice and development of the efficient production microorganism is of crucial importance. As a result, lot of research is currently going to produce a microorganism with a resistance to higher substrate and ethanol concentrations. Review of literature has revealed that the ability of yeast strains to achieve high level of ethanol strongly depends on the nutritional conditions and protective functions that some nutrients can provide. The immobilization of yeast or the fermenting organism for the bioethanol production has been greatly explored as a strategy to overcome the substrate and product inhibition and to improve the ethanol tolerance **(Ljiljanamojović et al., 2009).**

2.3 **Process integration-** Besides the optimization of individual process steps of the ethanol production, an overall process design and integration is also of great importance and may vastly influence the production efficiency and economy. Various process dynamics and fermentation regimes such as batch, fed-batch and continuous could be chosen and certain production steps could be integrated in order to minimize the production costs. It is generally accepted that the integration of the enzymatic saccharification step and fermentation step which are carried out in one vessel in so called simultaneous saccharification and fermentation (SSF) process could reduce the production cost and process time compared to conventional separate hydrolysis and fermentation (SHF) process. The presence of yeast or bacteria along with enzymes minimizes the sugar accumulation in the vessel because the fermenting organism immediately consumes the released sugar. Since the sugar produced during starch breakdown slows down α-amylase action, higher rates, yields and concentrations of ethanol are possible using SSF rather than SHF, at lower enzyme loading. Additionally, the presence of ethanol makes the mixture less vulnerable to contamination by unwanted microorganisms, which is a frequent burden in case of industrial processes. Also, capital investments are lower in this process as the total reactor volume is decreased due to higher productivity. On the other hand, the critical problem with SSFis that it operates at non-optimal hydrolysis temperature since optimal temperatures for the yeast and the enzymes differ. Other promising integration alternative for starchyfeedstock is the inclusion of pentose fermentation in the SSF, process known as simultaneous saccharification and co-fermentation (SSCF). In this configuration, it is necessary that both fermenting microorganisms are

compatible in terms of operating pH and temperature.

2.4 **Bioethanol economy-** The cost of bioethanol as a fuel is also an important issue. In order to ensure the market, bioethanol must be competitive with other biofuels and with mineral fuels such as petrol and diesel. Currently, the cost of bioethanol is still higher than the cost of fossil gasoline supply. Because of that, national governments have to enact special policies such as agricultural subsidies and taxation free polices in order to encourage the production and use of bioethanol in the transportation sector. Nevertheless, at sustained high oil prices and with a steady progression of more efficient and cheaper technology, bioethanol could be a cost-effective alternative in the near future in many countries. The price of raw material used for the bioethanol production plays a major role on the total production costs. It represents 60–75% of the total bio-ethanol production cost. The seasonal production pattern due to the harvest period of various agricultural feedstock used for bioethanol production is another important factor on the final price of the fuel on the market. The estimates of the costs of the bioethanol production from different feedstocks are shown in Table 2.

**Table 2:** Parameters for the assessment of the suitability of various feedstocks for bioethanol production [7, 8]

| Type of feed sock | Annual yield t/ha | Specific conversion rate to ethanol, l/t | Annual ethanol yield, l/ha· | Output/input ratio | Cost, US$/kg | Cost of production of anhydrous ethanol US$/l |
|---|---|---|---|---|---|---|
| Sugar cane | 70-122 | 68-70 | 5345-9381 | 2.5-10.2 | 0.0100 | 0.1980 |
| Sugar beet | 66-78 | 80-100 | 5000-6600 | 1.9 | 0.170 | 0.4910 |
| Corn (USA) | 6-10 | 350-460 | 6600 | 1.34-1.53 | 0.076 | 0.2325 |
| Wheat | 1.5-3.0 | 340-370 | 1020-3214 | 2.24-2.84 | 0.188 | 0.402 |
| Potato | 17-20 | 100 | 1700-2000 | - | 0.020 | 1.330 |
| Sorghum | 1-6 | 340 | 340-2040 | - | 0.149 | 0.386 |
| Sweet sorghum | 25-35 | 68-86 | 1700-9030 | - | - | - |
| Cassava | 20 | 180 | 3600 | - | - | - |
| Straw | 1.93-3.86 | 170-261 | - | - | - | 0.651 |

**3. Bioethanol production from Maize (Corn or *Zea mays* L.)-** During the last three decades, maize production in India has markedly increased; largely driven by the growing demand from the feed industry.Maize is considered a promising option for diversifying agriculture in upland areas of India. It now ranks as the third most important food grain crop in India. The maize area has slowly expanded over the past few years to about 6.2 million ha (3.4% of the gross cropped area) in 1999/2000. **Paroda and Kumar (2000)** predicted that this area would grow further to meet future food, feed, and other demands, especially in view of the booming livestock and poultry producing sectors in the country. Maize in India is grown in diverse environments–from the cool, dry area of Chitradurga, Karnataka, to the warm, wet plateau of Chindwara, Madhya Pradesh. The production of ethanol from corn for use as a transportation fuel is mature technology. It was first introduced in the United States in the early 1900s. Today, most fuel ethanol is produced from corn either by the dry grind (67%) or the wet mill (33%) process. The wet milling process is more capital- and energy intensive, as the grain must first be separated into its components, including starch, fibre, gluten, and germ. The germ is removed from the kernel and corn oil is extracted from the germ. The remaining germ meal is added to fibre and the hull to form corn gluten feed. Gluten is also separated to become corn gluten meal, a high-protein animal feed. In the wet milling process, a starch solution is separated from the solids and fermentable

sugars are produced from the starch. These sugars are fermented to ethanol. Wet mill facilities are true "biorefineries", producing a number of high-value products. In the dry grind process, clean corn is ground and mixed with water to form a mash. The mash is cooked and enzymes are added to convert starch to sugar. Then yeast is added to ferment the sugars, producing a mixture containing ethanol and solids. This mixture is then distilled and dehydrated to create fuel-grade ethanol. The solids remaining after distillation are dried to produce distillers' dried grains with protein and are sold as an animal feed supplement.

4. **Bioethanol production from Sorghum-** Sorghum is an important drought-resistant cereal crop, originally from Africa. Sorghum is ranked as the fifth largest produced cereal in the world after wheat, rice, barley and corn **(Shewale and Pandit, 2009)**. In Africa, China and India, sorghum is a staple food, while in the United States, Australia and South America it is used for animal feed **(Belton and Taylor,2004).** In some areas of Brazil, sorghum has been increasingly planted during the dry season between crops of soybeans or cotton. Sorghum is valued because of its ability to grow in areas with marginal rainfall and high temperatures i.e., in semiarid tropical and subtropical regions of the world, where it is difficult to grow any other cereal. Also, because of its relatively short growing season requirements, it is suitable for double cropping and crop rotation systems **(Smith and Frederiksen, 2000).** Sorghum has a relatively low cash value if sold directly as feed grain **(Fang and Hanna, 2002)**. To enhance the value of sorghum crops, new industrial utility needs to be developed. Sorghum grain is one of the most important sources of carbohydrates. Carbohydrates and fibres comprise approximately 72% of sorghum grains. Its starch component has similar properties to corn starch, and can be used almost interchangeably. Since there are hundreds of sorghum hybrids available commercially, if these feed stocks are option for bioethanol production. The large variations in their composition will surely affect the hydrolysis and fermentation performance **(Wang *et al*., 2008)**. Thus, it is important for the ethanol industry and sorghum producers to have appropriate methods that accurately predict sorghum ethanol yields and conversion efficiencies **(Zhao *et al*., 2009)**.

## 5. Conclusion

A significant progress and enhancement in the economy of bioethanol production on starch--based raw materials may be obtained by the process optimization of feedstock pretreatment and ethanol fermentation itself, and by an adequate utilization of the process byproducts. The introduction of new pre-treatments such as microwave and ultrasound can improve the starch gelatinization process, the substrate susceptibility to enzymes and greatly influence and improve the effects of hydrolysis and subsequent ethanol fermentation. In the domain of fermentation the choice of the production microorganism, media optimization, and the choice of the most appropriate process flow sheet (simultaneous saccharification and fermentation, utilization of immobilized yeasts, etc.) are significant for the development of an efficient production process. Thus, utilization of especially damaged cereal grains for bioethanol production is the best option for fossil fuel shortage.

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# A Critical Review on Low Temperature Solar Water Heater Collectors

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**Abstract: Energy application from the sun to heat water is well known.The solar radiation incident on the surface of the earth can be conveniently utilized for the benefit of human society. One of the popular devices that harness the solar energy is solar hot water system (SHWS).A solar water heater consists of collector to collect solar energy and an insulated storage tank to store hot water. The re-circulation water through absorber panel in the collector help to raises the temperature to $80^0$C in a good sunny day. This communications presents comparative study of Flat plate collectors and Evacuated tube collectors used in solar water heating system. This indicates that the Evacuated tube collector is more efficient than flat plate collector.**

***Keywords: Solar hot water system (SHWS), absorber panel, solar collector.***

## I. INTRODUCTION

The sun is responsible for all of the earth energy. Plants use the sun's light to make food. Decaying plants hundreds of millions of years ago produced the coal, oil and natural gas that we use today.Solar energy is created by light and heat which is emitted by the sun, in the formof electromagnetic radiationand now days we are able to capture this radiation and turn it intousable forms of solar energy such as heating or electricity [1].

Solar energy is the sun's nuclear fusion reactions within the continuous energygenerated. Earth's orbit, the average solar radiation intensity is 1367kw/$m^2$.Circumference of the Earth's equator is 40000km, thus we can calculate theenergy the earth gets is up to 173,000 TW. At sea level on the standard peak intensity is 1kw/$m^2$, a point on the earth's surface 24h of the annual averageradiation intensity is 0.20kw/$m^2$, or roughly 102,000 TW of energy [1], [2].

The total amount of solar energy resources isten thousand times of the energy used by humans, but the solar energy densityis low, and it is influenced by location, season, which is a major problem ofdevelopment and utilization of solar energy [4].

Solar energy can be used by four technological processes, Chemical, Electrical, Thermal and Mechanical energy [13].Chemical process, through photosynthesis, maintains life on earth by producing food and converting $CO_2$ to $O_2$. Electrical process, using photovoltaic converters, provides power for spacecraft and is used in many terrestrial applications. Thermal process can be used to provide much of the thermal energy required for solar water heating and building heating. Another one form of convertedsolar radiation is mechanical energy as wind and water steams [14].

The most important and most expensive single component of an active solar energy system is thecollector field, which may be performed in a several versions, as from constructions of solar collectors, as of collector configuration. Solar collectors are the heart of most solar energy systems. The collector absorbs thesun's light energy and changes it into heat energy.

Solar hot water systems function as heat exchangers. They receive solar radiant energy and transfer it to the flowing fluid. The performance of solar systems varies as the design variables change, so it is therefore necessary to identify the parameters affecting this design and the operational variables.Solar water heating has been around for many years because it is the easiest way to use the sun to save energy and money. One of the earliest documented cases of solar energy use involved pioneers moving west after the Civil War. They would place a cooking pot filled with cold water in the sun all day to have heated water in the evening.

The first solar water heater that resembles the concept still in use today was a metal tank that was painted black and placed on the roof where it was tilted toward the sun. The concept worked, but it usually took all day for the water to heat, then, as soon as the sun went down, it cooled off quickly because the tank was not insulated.

The roles of thermal collectors are simple sit in the sun, absorb and transfer heat, and do it reliably for decades. But to fill their roles efficiently, collectors need to absorb a high level of solar radiation, while minimizing losses from

reflection and heat loss to the surrounding environment.

## II. SOLAR WATER HEATING SYSTEM

Solar water heating systems can be broadly divided into three main parts:

1. Solar collector that receive and transfer the sun's radiant energy into thermal energy in the working fluid.
2. System of working fluid channel or pipe diverter, which is the part that connects the collector to the storage.
3. Fluid storage tank that is part of the store and hold hot water.

Classifications of solar collectors according to concentration degree are as given bellow [5].

Table No. 1 Classifications of solar collectors according to concentration degree

| Category °C | Example | Temperature range, | Efficiency, % |
|---|---|---|---|
| No concentration | Flat-plate Evacuated tube | up to 75 up to 200 | 30 – 50 |
| Medium | concentration | Parabolic cylinder 150 - 500 | 50 – 70 |
| High concentration | Parabodial | 1500 and more | 60 - 75 |

The majority of solar thermal collectors for low temperature water heater are Flat plate solar thermal collector andEvacuated tube solar thermal collector.

## III.TYPES OF SOLAR THERMAL COLLECTOR FOR LOW TEMERATURE RANGE

### 1. The Flat Plate Solar Collector

A Flat plate solar collector is required to absorb solar radiation and to transfer the absorbed energy into a heat transfer fluid with a minimum of heat loss. In assessing the performance of a collector it is therefore important both to determine its ability to absorb solar radiationand to characterise its heat losses [3]. The principal components and losses are shown in Figure.

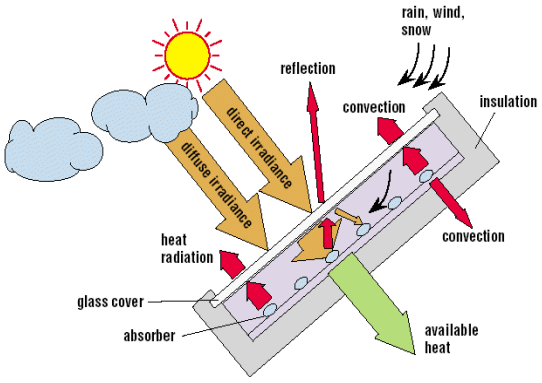


Fig No.1 Solar Radiation Process.

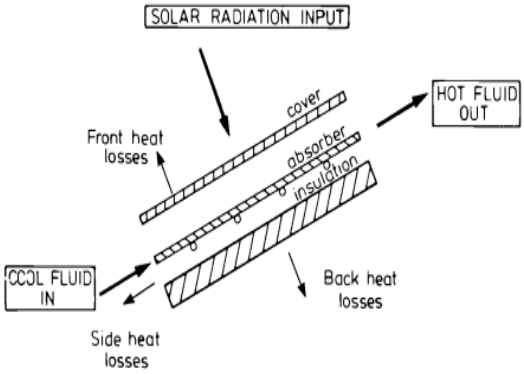


Fig No.2 Flat plate collector.

The ability of a collector to absorb solar radiation is largely determined by the optical properties of its cover and absorber surface. However, there are also losses, which may be considered as input losses, associated with the transfer of heat from the absorber surface into the heat transfer fluid. These are influenced by the design of the absorber fluid passageways.

A collector loses heat from its front, its back and its sides. The back and side losses from a flat plate collector can be minimised by the use of insulation. The heat losses from the front of a flat plate collector are usually the largest component of the overall heat losses. They occur in the form of convection and thermal radiation from the front cover to the environment and can be reduced by designing thecollector in such a way that the temperature of the front cover is kept low. This can be achieved by minimising the heat transfer between the absorber and the outer cover. The convective heat transfer between the absorber and the outer cover can be reduced by using a multiple glazing system or by evacuating the space over the absorber. The radiative heat transfer from the absorber to the cover can be reduced by the use of selective surfaces.The main advantage of flat plate solar thermal collectors is their low equipment cost. Under the current market, the cost of a flat

plate solar thermal collector is about 1/3 to 1/2 that of an evacuated tube solar thermal collector [6]. In low temperature applications, since the temperature gradient between the thermal fluid and the surrounding is small, the efficiency may surpass that of evacuated tube solar collector.

## 2. Evacuated tube collector

Evacuated tube collectors are made from glass and have a double wall construction, the outer tubeis transparent allowing light rays to pass through with minimum refection. Theinner tube is coated with aselective coating which has good solar radiation absorption [7]. The top of the two tubes are fused together and the air contained in the space between the two layers of glass is pumped out. The vacuum greatly reduces heat loss from convection and conduction.The only heat loss mechanism remaining is radiation.Each pipe is a sealed unit with a large heat tip at the top. Heat transfer liquid is heated and rises within the tube, which releases heat energy at the condensing tip transfers the heat to a condenser located in the manifold of the solar system [8].

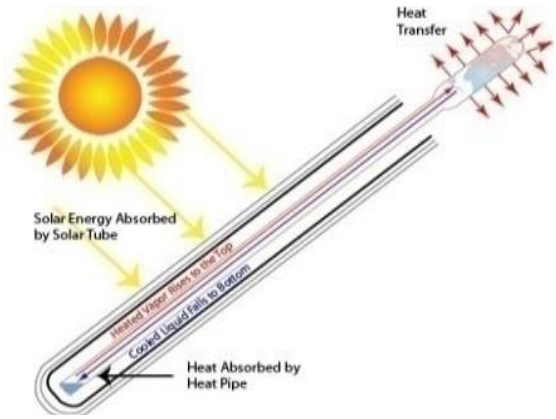


Fig.3 Evacuated Tube collector.

Evacuated tube solar thermal collectors are more expensive than flat plate solar thermal collectors. However, they are more efficient for applications with higher temperature difference between the thermal fluid and ambient air [9], [10]. Other advantages lie in the maintenance issue because the thermal fluid is not running through the whole panel area. This reduces the chance of pipe blockage or leakage.

## IV RESULT AND DISSCUTION

The amount of energy a collector can gain throughradiation decreases, as its temperature increases abovethe ambient air temperature. The graph indicates the efficiency of typical modern Evacuated tubeand Flat plate collectors at gaining energy at differenttemperatures above ambient.

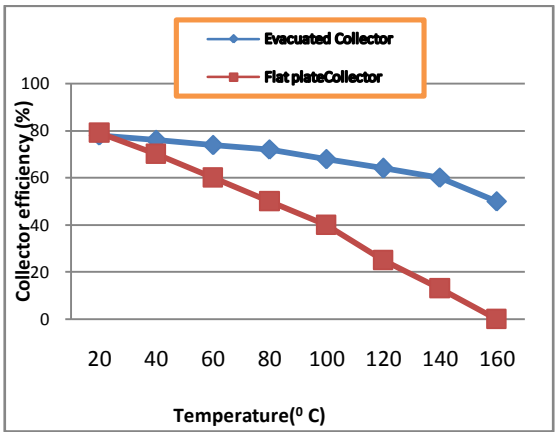


*Figure no.4* Efficiency Vs Temperature.

It is important to compare theefficiencies at the particular water temperature trying tobe achieved. If we assume that we are trying to heat domestic water to 60°C above the ambient temperature then the Evacuated Tube system is 78% efficient, where as the efficiency of the Flat Plate system has fallen to just 63%.

Tests have performed throughout the year, anda high quality Evacuated tubesystem produces twice energy than Flatplate system. The 4m²Flat plate systems produced the same amount of energy as a 2m² Evacuated tube systems, the vast majority of the energy producedduring the summer months [11]. The blue shaded areain the graph on the right indicates the amount ofhot water required throughout the year. Figure no.5 indicates contribution various systems in colored lines. Any energy produced in excess of the hot water requirement is wasted,so as there is limited benefit of installing an oversized Flat Plate System.

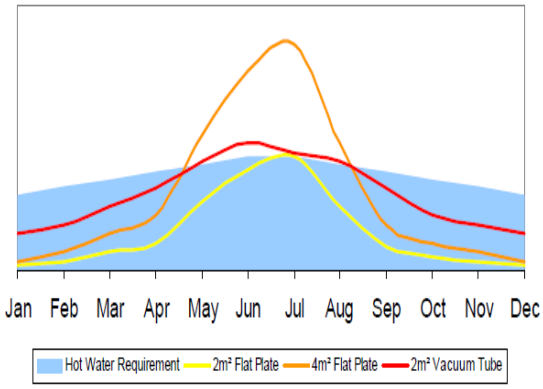


Fig.5 Comparison of Flat plate collectors and Vacuum (Evacuated) tube collector.

It is seen from the Figure no.6 initially the efficiency of Flat plate collector with respect to the

Evacuated tube collector is high when the difference between the inlet and outlet temperature of the fluid is small. When the difference between the inlet and outlet temperature reach at $100^0$ C then the efficiency of flat plate collector and evacuated tubecollector will be same and it is approximately 35%. Flat plate collectors easily attain temperatures of 40 to 70ºC [12]. As the temperature difference increase the efficiency of the flat plate collector is goes on decreases and the efficiency of the evacuated tube collector is high as compared to the flat plate collector [6].

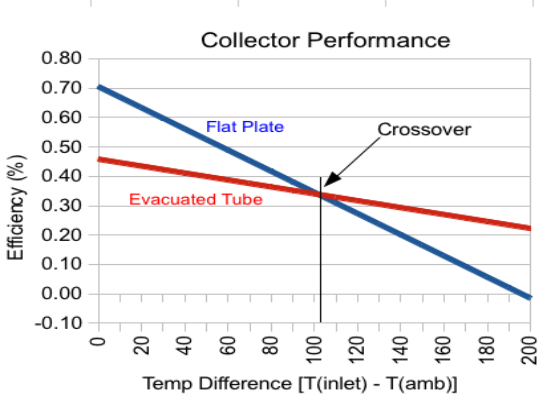


Fig. 6 Efficiency Vs Temperature Difference.

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## CONCLUSIONS

The review indicates that comparison of the Flat plate collectors and Evacuated tube collectors are use in their maximum temperature level, Evacuated tubes are superior over flat plate collector.Collectors operate most efficiently when the inlet fluid temperature is same or less than the ambient air temperature. When Inlet fluid temperature equals with ambient air temperature, flat-plate collectors are efficient about 75%, while evacuated tubes has 50% efficient. As the inlet temperature increases, the potential for heat transfer from the absorber to the surrounding air increases, heat lost to the atmosphere instead of transferred to fluid in the collector which results in less efficiency. Because of the superior insulation in Evacuated tubes, their efficiency curve which shows the loss in efficiency as the difference between inlet and ambient temperature is an increase which isless steep compared to flat plates.

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# Comparative analysis of Multilayer Perceptron and Radial Basis Function ANN for prediction of cycle time of Structural subassembly Manufacturing

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**Abstract: This paper examines and compares two novel methods of Artificial neural network models used for the prediction of cycle time to manufacture structural subassemblies predominantly in batch processing mode. At the outset individuality of structural subassembly manufacturing and associated independent and dependent variables are investigated. Then, models for cycle time prediction based on Multivariate Products using Multilayered Perceptron and Radial Basis function based neural network methods are presented and compared. The parameter estimates for the training of the neural network are completed with field process generated array, and the performances of the two models are studied. The neural network model based on MLP is found to seize better performance than the RBNF model for cycle time prediction under convoluted multivariate datasets.**

***Keywords: Multilayer perceptron, Neural Network, Structural subassembly, Radial Basis Function***

## 1. Introduction:

During last decade models have emerged to estimate and predict various parameters of manufacturing industry using ANN approach .Current study depicted in this paper is primarily focuses on batch processing multivariate production of structural subassemblies of tractors.Strucural subassemblies are the mounting on the main body of the tractor such as assembly quadrant mounting bracket,PC lever and hub subassembly, DC slider, Lever draft control upgradation, Latch bottom support bracket etc. With the present scope of study combine model using database of all five products are taken into consideration for generation of field process generated array .Field process generated array consists with collection of field data related to 35 participating independent variables for total eight workstations. No of experiments were planned and conducted on actual scene of manufacturing ,600 for all products combine,168 for product I ,144 for product II,48 for product III ,120 for product IV and 144 for product V.Neural networks are the preferred tool for many predictive data mining applications because of their power, flexibility, and ease of use. Predictive neural networks are particularly useful in applications where the underlying process is complex.Neural networks used in predictive applications, such as the multilayer perceptron (MLP)Radial Basis Function (RBNF) networks, are supervised in the sagacity that the model-predicted results can be compared against known values of the target variables. The Neural Networks option allows us to fit MLP and RBNF networks and save the resulting models for scoring.

Computational intelligence techniques that include ANNs, genetic algorithms, simulated annealing, and fuzzy logic have shown promise in many areas including industrial engineering where the use of neural networks, genetic algorithms, and fuzzy logic is quite prominent. The capability of ANNs to learn complex relationships well has made them a popular methodology for modeling the behavior of complex systems. Computationally, ANNs in their most common form of a multilayer perceptron (MLP) are distributed parallel-processing systems capable of

a fault tolerant and efficient learning and are resistant to noise and disturbances. They are connectionist structures composed of nodes called neurons and arcs connecting the neurons with weights associated with the arcs. Weights are adaptable and are the main learning parameters of the network. The network learns typically by using a backpropagation learning algorithm (Rumelhart, Hinton, & Williams, 1986) that updates the weights. The network has generally three types of layers called input, output, and hidden layers. The information is presented in a preprocessed or raw format into the input layer of the network and the predictions are obtained at the output layer of the network.

## 2. Literature Review:

[Timothy James Stich, Dr. Julie K. Spoerre & Dr. Tomás Velasco,2000] In their paper on "The Application of Artificial Neural Networks to Monitoring and Control of an Induction Hardening Process" systematically investigated thorough literature, according to them ,Artificial neural networks (ANNs) are excellent tools for complex manufacturing processes that have many variables and complex interactions. Neural networks have provided a means of successfully controlling complex Processes [(Toosi and Zhu 1995, Hubick 1992,Hoskins and Himmelblau 1992,Coit and Smith 1995, Fan and Wu 1995,and Chovan, Catfolis and Meert 1996)].Other applications of neural networks include bearing fault classification [Spoerre, 1997], turning, tapping, and welding comparisons [Du, Elbestawi, and Wu 1995],acoustic emission for tool condition monitoring [Toosi and Zhu 1995], temperature control in a continuous-stirred-tank reactor [Hoskins and Himmelblau 1992], and monitoring of chip production and cutting-tool wear [Hubick 1992]. [Pham and Oztemel (1994)] used an integrated neural network-based pattern recognizer and expert system for analyzing and interpreting control charts. In another application, artificially intelligent process control functions based on a unique combination of rule-based expert systems and neural networks were developed to control a complex pulp and paper process [Beaverstock 1993].

[Smith, A. E., & Mason, A. K. 1997]A new method of estimating cost is through the use of artificial neural networks or ANNs. One major benefit of using a neural network is its ability to comprehend and conjure up multifarious functions. However, one of the current drawbacks to such use is that as the complexity of the function increases, more training data becomes necessary if the function is to be implicit as well as possible. This meticulous disadvantage is a factor for any method but is especially present with neural networks as it requires the data to be split into multiple subsets.Neural networks are used to simulate more complex functions than older methods, such as linear regression, making the amount of data available increasingly important. Production data, part designs, and part costs from a large aircraft engine manufacturer were used to train and test a neural network. Two different part families, shafts and cases, were evaluated, which represent two different levels of part complexity [John D. Dowler, 2008].Little work has been published on using real world data to train and test a neural network that can produce a cost estimate. To date, those studies available show ANNs promising ability to understand complex models and provide a superior cost estimate when compared to estimation methods such as linear regression [Smith, A. E., & Mason, A. K. 1997].

[Marco Garetti, Marco Taisch, 2010] in their paper mentioned mottled applications cover a great number of industrial engineering domains with different degrees of innovation. Examples range from production scheduling to process control [ Currie and Leclair 1993, Rogers and Dagli1996] , from image recognition [ Huang *et al*. 1992] to signal processing [ Widrow *et al* . 1994] , from system identification [ Pollard *et al* . 1992] to metal cutting [ Nagasaka *et al*. 1995, Yan *et al* . 1995] , from inspection [ Hou *et al*.1993] to forecasting, from product design [ Venugopal and Narendran 1992, Wu 1993] to plant design and location [ Shtub and Zimerman 1993, Vaithyanathan *et al* . 1996] , from robot control to system diagnosis [ Huang and Wang 1993, L in *et al*. 1995] .

As mentioned and discussed by [Brad Warner and Manavendra Misra, 1996] several authors have done comparison studies between statistical methods and neural networks [Hruschka 1993; Wu and Yen 1992]. These works have a propensity to focus on performance comparisons and use specific problems as examples. There are a number of good introductory articles on neural networks, usually located in various trade journals. For instance, [Lippmann (1987)] provides an excellent overview of neural networks for the signal processing community. There are also a number of good introductory books on neural networks, with [Hertz, Krogh, and Palmer (1991)] providing a good mathematical description,[ Smith (1993)] explaining backpropagation in an applied setting, and [Freeman (1994)] using examples and code to explain neural networks. There have also been papers relating neural networks and statistical methods [Buntine and Weigend 1991; Ripley 1992; Sarle 1994; Werbos 1991]. One of the best

for a general overview is [Ripley (1993)]. [Frans Vainio, Michael Maier, Timo Knuutila, Esa Alhoniemi, 2009]According to cited literature of this paper when considering possible methods for estimating the operation times of manufacturing machines, one can rely on statistical techniques. Common nonlinear regression methods are well known in the classical statistics literature [Hald (1967)].In recent years; neural networks have gained much esteem due to their flexibility, resourcefulness and simplicity. There are many different types of neural networks supporting nonlinear regression, e.g. MLP (multi-layer perceptron), RBF (radial basis function) and SVM (support vector machine)[Bishop (1995)]. Each of these methods has strengths and weaknesses. It turns out that conventional learning methods are prone to overfitting when the number of hidden units of the network is large in relation to the number of training cases.

In particular multiple regression (MR) analysis (Edwardset al., 1999c). The great advantage of regression is that it has an established confirmation of use within the edifice research community (Akintoye and Skitmore, 1994; Akinsola, 1997). More recent studies have utilized the artificial intelligent forecasting technique ``neural networks'' (more specifically, the multilayer perceptron) (Edwards and Holt, 1999). This was similarly successful in the prediction of the hourly maintenance cost of tracked hydraulic excavators operating in the open cast mining industry (Edwards et al., 1999b). However, in order to weigh the success (or otherwise) of either technique, a comparative analysis of prediction performance must be made (Hua, 1996). For the case, (Brass 1994) and (Smith and Mason 1997) used multiple linear regressions to estimate the product costs. However, their analysis did not consider multicollinearity, heteroskedasticity, and specification error and did not discuss the possibility of adopting other regression models. Davim (2003) established correlations between the response and process parameters using multiple linear regression analysis (RA) technique. [Dr Maria Karanika, 2009] Elaborate the center of attention of the work- health relationship using neural network and regression analysis and prime focus was to establish whether artificial neural networks would provide better fit than the time-honored multiple linear regression analysis in modelling the relationship between work characteristics and work-related health. According to author there would be differences in (1) variance explained between the linear regression models and the neural networks, and (2) the relative positioning of the predictors in the architecture of the models. Inference models used in industry can be broadly classified as parametric models, analogous models and detailed models. Parametric estimation is the generation and application of equations that describe relationships between cost schedules and measurable attributes of a system that must be brought forth, sustained and retired [Dean, 1995]. [Zhang, 1992] investigated a model in which the input of each stage consists of a vector of m quality characteristics, X=(x1, x2. . . xm)$^{T}$, whose output is the preferred quality characteristic or quality of the product Y. To control such a process, Zhang proposed an expansion of the univariate cause-selecting chart, which he named the multivariate cause-selecting chart (MCSC).

Cook and Chiu [1998] used the radial basis function (RBF) neural networks trained by the least-mean squares algorithm for statistical process control of correlated processes. The trained RBF neural networks were used to separate the shifted and unshifted correlated papermaking and viscosity data in literature. The neural networks successfully identified data that were shifted 1.5 and 2 standard deviations from non shifted data for both the papermaking and viscosity processes. The network for the papermaking data was able to also classify shifts of one standard deviation, while the traditional statistical process control (SPC) technique cannot achieve this because it requires a large average run length. Above mentioned literature shows insightful porch of ANN and regression for diversified domains.

Baillie and Mathew [1994]‟s results in diagnosing faults of rolling element bearings indicated that backpropagation (BP) neural networks generally outperformed the radial basis functions (RBF). McCormick and Nandi [1996] used multi-layer perceptron and radial basis function neural networks to classify the condition of a small rotating machine. It was found that both networks achieved similar success in fault classification. However RBF networks could be trained in a significantly shorter length of time. Multilayer perceptrons (MLP) however required fewer neurons and were faster in recall operation. Meesad and Yen [2000] applied MLP and Learning Vector Quantization (LVQ) classifiers to diagnosing faults in gears, bearings, and shafts. It was proven that these two neural networks were successful while they required off-line training and iterative presentation of the training data. They were cumbersome when applied to pattern classification problems that needed fast, on-line, real-time, incremental learning.

## 3. Field experimentation:

Representation of the actual corporeal system for structural subassembly manufacturing

with various workstations might be a tedious task for large dataset. Scenario would be, more complex with various product mix and various factors which must be taken into consideration for modeling. With the present scope of this paper five different products are selected for modeling process. Selection of independent variable is done based on the actual working scenario .Predominantly independent variables related to ergonomic consideration, workstation parameters, product specification and parameters, worker personal data and environmental conditions have been identified for the data collection form the actual scene. Table 1 shows the list of independent variable for modeling and their analogous grouping based on logical thinking.

Altogether 35 independent variables are well thought-out for modeling for the prediction of cycle time and human energy input. Number of experiments were planned and executed on the actual panorama of manufacturing ,related cycle time of the operation and then total cycle time required to manufacture a product is premeditated which will serve as experimental value .Experimental value will be serviceable for comparison and fitting of the mathematical model with different recital index.

Fig.1 Experimental setup for field data collection

## 2. ANN modeling using Multilayer Perceptron:

### 2.1 Neural Network Structure

Although neural networks impose nominal demands on model structure and assumptions, it is useful to understand the general network architecture. The multilayer perceptron (MLP) network is a function of predictors (also called inputs or independent variables) that minimize the prediction error of target variables (also called outputs). This structure is known as feedforwardarchitecture because the acquaintances in the network flow forward from the input layer to the output layer without any feedback loops. In this figure:

- The input layer contains the predictors.
- The hidden layer contains unobservable nodes, or units. The value of each hidden unit is some function of the predictors; the exact form of the function depends in part upon the network type and in part upon user-controllable specifications.
- The output layer contains the responses. Since the history of default is a categorical variable with two categories, it is recoded as two indicator variables. Each output unit is some function of the hidden units. Again, the exact form of the function depends in part on the network type and in part on user-controllable specifications.

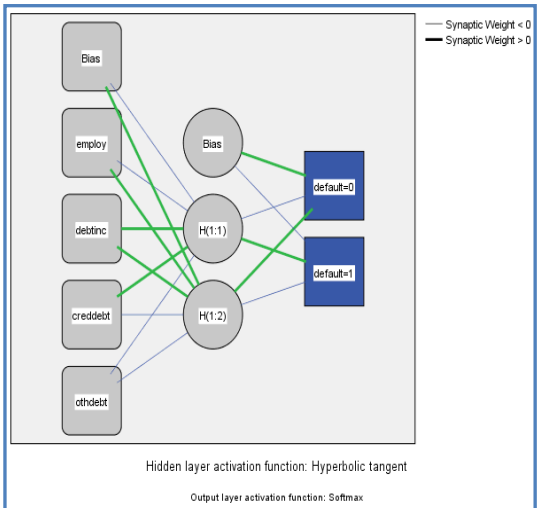



Fig.2.Multilayered Feedforward Network
[Source: IBM SPSS 20]

**2.1.1 Number of Hidden Layers.** A multilayer perceptron can have one or two hidden layers. For the case presented in this paper all models are fitted well with one hidden layer

**2.1.2 Activation Function.** The activation function "links" the weighted sums of units in a layer to the values of units in the succeeding layer.

**Hyperbolic tangent:** This function has the form: $\gamma(c) = \tanh(c) = (e^{c}-e^{-c})/(e^{c}+e^{-c})$.

It takes real-valued arguments and transformsthem to the range (–1, 1). When automatic architecture selection is used, this is the activation function for all units in the hidden layers.Hypebolic tangential function is utilized as activation function for present study [Handbook of SPSS 20, IBM].

### 2.2 Multilayered perceptron modeling

#### 2.2.1 Sample ANN model with base variable as input and cycle time output for all products:

ANN equation for basic variables as input and production cycle time as output is formulated as follows:

$X_{1,1}= (e^{1*sum(Layer1Cell0)} - e^{-1*sum(Layer1Cell0)}) / (e^{1*sum(Layer1Cell0)} + e^{-1*sum(Layer1Cell0)})$
Where sum (Layer1cell0) $=0.24*X_{0,1}-0.43*X_{0,2}-0.307*X_{0,3}+0.17*X_{0,4}+0.1888*X_{0,5}-0.4*X_{0,6}+0.24*X_{0,7}+0.4*X_{0,8}+0.02*X_{0,9}-0.074*X_{0,10}-0.023*X_{0,11}+0.15*X_{0,12}+0.099*X_{0,13}+0.02*X_{0,14}+0.33*X_{0,15}-0.421*X_{0,16}+0.29*X_{0,17}-0.009*X_{0,18}+0.04*X_{0,19}+0.077*X_{0,20}+0.471*X_{0,21}-0.146*X_{0,22}-0.363*X_{0,23}-0.417*X_{0,24}+0.163*X_{0,25}-0.237*X_{0,26}-0.329*X_{0,27}+0.389*X_{0,28}+0.196*X_{0,29}+0.18*X_{0,30}-0.359*X_{0,31}+0.04*X_{0,32}-0.096*X_{0,33}-0.0321*X_{0,34}-0.228*X_{0,35}-0.421$

$X_{1,2}= (e^{1*sum(Layer1Cell1)} - e^{-1*sum(Layer1Cell1)}) / (e^{1*sum(Layer1Cell1)} + e^{-1*sum(Layer1Cell1)})$
Where sum (Layer1cell1) $= 0.24*X_{0,1}-0.43*X_{0,2}-0.307*X_{0,3}+0.17*X_{0,4}+0.1888*X_{0,5}-0.4*X_{0,6}+0.24*X_{0,7}+0.4*X_{0,8}+0.02*X_{0,9}-0.074*X_{0,10}-0.023*X_{0,11}+0.15*X_{0,12}+0.099*X_{0,13}+0.02*X_{0,14}+0.33*X_{0,15}-0.421*X_{0,16}+0.29*X_{0,17}-0.009*X_{0,18}+0.04*X_{0,19}+0.077*X_{0,20}+0.471*X_{0,21}-0.146*X_{0,22}-0.363*X_{0,23}-0.417*X_{0,24}+0.163*X_{0,25}-0.237*X_{0,26}-0.329*X_{0,27}+0.389*X_{0,28}+0.196*X_{0,29}+0.18*X_{0,30}-0.359*X_{0,31}+0.04*X_{0,32}-0.096*X_{0,33}-0.0321*X_{0,34}-0.228*X_{0,35}-0.433$

$X_{1,3}= (e^{1*sum(Layer1Cell2)} - e^{-1*sum(Layer1Cell2)}) / (e^{1*sum(Layer1Cell2)} + e^{-1*sum(Layer1Cell2)})$
Where sum (Layer1cell2) $=0.24*X_{0,1}-0.43*X_{0,2}-0.307*X_{0,3}+0.17*X_{0,4}+0.1888*X_{0,5}-0.4*X_{0,6}+0.24*X_{0,7}+0.4*X_{0,8}+0.02*X_{0,9}-0.074*X_{0,10}-0.023*X_{0,11}+0.15*X_{0,12}+0.099*X_{0,13}+0.02*X_{0,14}+0.33*X_{0,15}-0.421*X_{0,16}+0.29*X_{0,17}-0.009*X_{0,18}+0.04*X_{0,19}+0.077*X_{0,20}+0.471*X_{0,21}-0.146*X_{0,22}-0.363*X_{0,23}-0.417*X_{0,24}+0.163*X_{0,25}-0.237*X_{0,26}-0.329*X_{0,27}+0.389*X_{0,28}+0.196*X_{0,29}+0.18*X_{0,30}-0.359*X_{0,31}+0.04*X_{0,32}-0.096*X_{0,33}-0.0321*X_{0,34}-0.228*X_{0,35}+0.459$

$X_{1,4}= (e^{1*sum(Layer1Cell3)} - e^{-1*sum(Layer1Cell3)}) / (e^{1*sum(Layer1Cell3)} + e^{-1*sum(Layer1Cell3)})$
Where sum (Layer1cell4) $=0.24*X_{0,1}-0.43*X_{0,2}-0.307*X_{0,3}+0.17*X_{0,4}+0.1888*X_{0,5}-0.4*X_{0,6}+0.24*X_{0,7}+0.4*X_{0,8}+0.02*X_{0,9}-0.074*X_{0,10}-0.023*X_{0,11}+0.15*X_{0,12}+0.099*X_{0,13}+0.02*X_{0,14}+0.33*X_{0,15}-0.421*X_{0,16}+0.29*X_{0,17}-0.009*X_{0,18}+0.04*X_{0,19}+0.077*X_{0,20}+0.471*X_{0,21}-0.146*X_{0,22}-0.363*X_{0,23}-0.417*X_{0,24}+0.163*X_{0,25}-0.237*X_{0,26}-0.329*X_{0,27}+0.389*X_{0,28}+0.196*X_{0,29}+0.18*X_{0,30}-0.359*X_{0,31}+0.04*X_{0,32}-0.096*X_{0,33}-0.0321*X_{0,34}-0.228*X_{0,35}+0.021$

$X_{1,5}= (e^{1*sum(Layer1Cell4)} - e^{-1*sum(Layer1Cell4)}) / (e^{1*sum(Layer1Cell4)} + e^{-1*sum(Layer1Cell4)})$
Where sum (Layer1cell5) $=0.24*X_{0,1}-0.43*X_{0,2}-0.307*X_{0,3}+0.17*X_{0,4}+0.1888*X_{0,5}-0.4*X_{0,6}+0.24*X_{0,7}+0.4*X_{0,8}+0.02*X_{0,9}-0.074*X_{0,10}-0.023*X_{0,11}+0.15*X_{0,12}+0.099*X_{0,13}+0.02*X_{0,14}+0.33*X_{0,15}-0.421*X_{0,16}+0.29*X_{0,17}-0.009*X_{0,18}+0.04*X_{0,19}+0.077*X_{0,20}+0.471*X_{0,21}-0.146*X_{0,22}-0.363*X_{0,23}-0.417*X_{0,24}+0.163*X_{0,25}-0.237*X_{0,26}-0.329*X_{0,27}+0.389*X_{0,28}+0.196*X_{0,29}+0.18*X_{0,30}-0.359*X_{0,31}+0.04*X_{0,32}-0.096*X_{0,33}-0.0321*X_{0,34}-0.228*X_{0,35}-0.001$

$X_{1,6}= (e^{1*sum(Layer1Cell5)} - e^{-1*sum(Layer1Cell5)}) / (e^{1*sum(Layer1Cell5)} + e^{-1*sum(Layer1Cell5)})$
Where sum (Layer1cell6) $=0.24*X_{0,1}-0.43*X_{0,2}-0.307*X_{0,3}+0.17*X_{0,4}+0.1888*X_{0,5}-0.4*X_{0,6}+0.24*X_{0,7}+0.4*X_{0,8}+0.02*X_{0,9}-0.074*X_{0,10}-0.023*X_{0,11}+0.15*X_{0,12}+0.099*X_{0,13}+0.02*X_{0,14}+0.33*X_{0,15}-0.421*X_{0,16}+0.29*X_{0,17}-0.009*X_{0,18}+0.04*X_{0,19}+0.077*X_{0,20}+0.471*X_{0,21}-0.146*X_{0,22}-0.363*X_{0,23}-0.417*X_{0,24}+0.163*X_{0,25}-0.237*X_{0,26}-0.329*X_{0,27}+0.389*X_{0,28}+0.196*X_{0,29}+0.18*X_{0,30}-0.359*X_{0,31}+0.04*X_{0,32}-0.096*X_{0,33}-0.0321*X_{0,34}-0.228*X_{0,35}+0.498$

$X_{1,7}= (e^{1*sum(Layer1Cell6)} - e^{-1*sum(Layer1Cell6)}) / (e^{1*sum(Layer1Cell6)} + e^{-1*sum(Layer1Cell6)})$
Where sum (Layer1cell7) $=0.24*X_{0,1}-0.43*X_{0,2}-0.307*X_{0,3}+0.17*X_{0,4}+0.1888*X_{0,5}-0.4*X_{0,6}+0.24*X_{0,7}+0.4*X_{0,8}+0.02*X_{0,9}-0.074*X_{0,10}-0.023*X_{0,11}+0.15*X_{0,12}+0.099*X_{0,13}+0.02*X_{0,14}+0.33*X_{0,15}-0.421*X_{0,16}+0.29*X_{0,17}-0.009*X_{0,18}+0.04*X_{0,19}+0.077*X_{0,20}+0.471*X_{0,21}-0.146*X_{0,22}-0.363*X_{0,23}-0.417*X_{0,24}+0.163*X_{0,25}-0.237*X_{0,26}-0.329*X_{0,27}+0.389*X_{0,28}+0.196*X_{0,29}+0.18*X_{0,30}-0.359*X_{0,31}+0.04*X_{0,32}-0.096*X_{0,33}-0.0321*X_{0,34}-0.228*X_{0,35}-0.166$

$X_{1,8}= (e^{1*sum(Layer1Cell7)} - e^{-1*sum(Layer1Cell7)}) / (e^{1*sum(Layer1Cell7)} + e^{-1*sum(Layer1Cell7)})$

Where sum (Layer1cell8) $=0.24*X_{0,1}-0.43*X_{0,2} - 0.307*X_{0,3}+0.17*X_{0,4}+0.1888*X_{0,5}-0.4*X_{0,6} +0.24* X_{0,7}+0.4* X_{0,8}+0.02* X_{0,9}-0.074* X_{0,10}-0.023* X_{0,11}+0.15* X_{0,12}+0.099* X_{0,13}+0.02* X_{0,14}+0.33* X_{0,15}-0.421* X_{0,16}+0.29* X_{0,17}-0.009* X_{0,18}+0.04* X_{0,19}+0.077* X_{0,20}+0.471* X_{0,21}-0.146* X_{0,22}-0.363* X_{0,23}-0.417* X_{0,24}+0.163* X_{0,25}-0.237* X_{0,26}-0.329* X_{0,27}+0.389* X_{0,28}+0.196* X_{0,29}+0.18* X_{0,30}-0.359* X_{0,31}+0.04* X_{0,32}-0.096* X_{0,33}-0.0321* X_{0,34} -0.228* X_{0,35}-0.047$

$X_{1,9}= (e^{1*sum(Layer1Cell8)} - e^{-1*sum(Layer1Cell8)}) / (e^{1*sum(Layer1Cell8)} + e^{-1*sum(Layer1Cell8)})$

Where sum (Layer1cell9) $=0.24*X_{0,1}-0.43*X_{0,2} - 0.307*X_{0,3}+0.17*X_{0,4}+0.1888*X_{0,5}-0.4*X_{0,6} +0.24* X_{0,7}+0.4* X_{0,8}+0.02* X_{0,9}-0.074* X_{0,10}-0.023* X_{0,11}+0.15* X_{0,12}+0.099* X_{0,13}+0.02* X_{0,14}+0.33* X_{0,15}-0.421* X_{0,16}+0.29* X_{0,17}-0.009* X_{0,18}+0.04* X_{0,19}+0.077* X_{0,20}+0.471* X_{0,21}-0.146* X_{0,22}-0.363* X_{0,23}-0.417* X_{0,24}+0.163* X_{0,25}-0.237* X_{0,26}-0.329* X_{0,27}+0.389* X_{0,28}+0.196* X_{0,29}+0.18* X_{0,30}-0.359* X_{0,31}+0.04* X_{0,32}-0.096* X_{0,33}-0.0321* X_{0,34} -0.228* X_{0,35}+0.328$

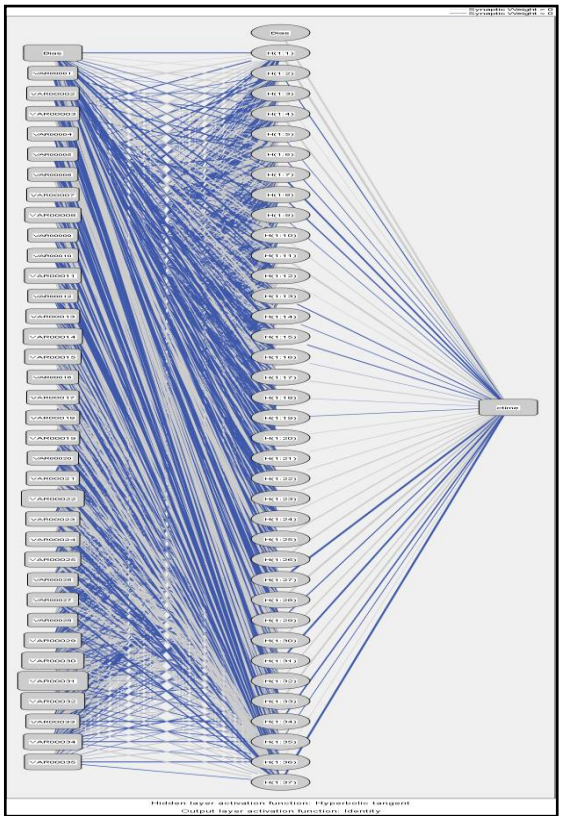


Fig 3. ANN network topology for cycle time with multilayered perceptron

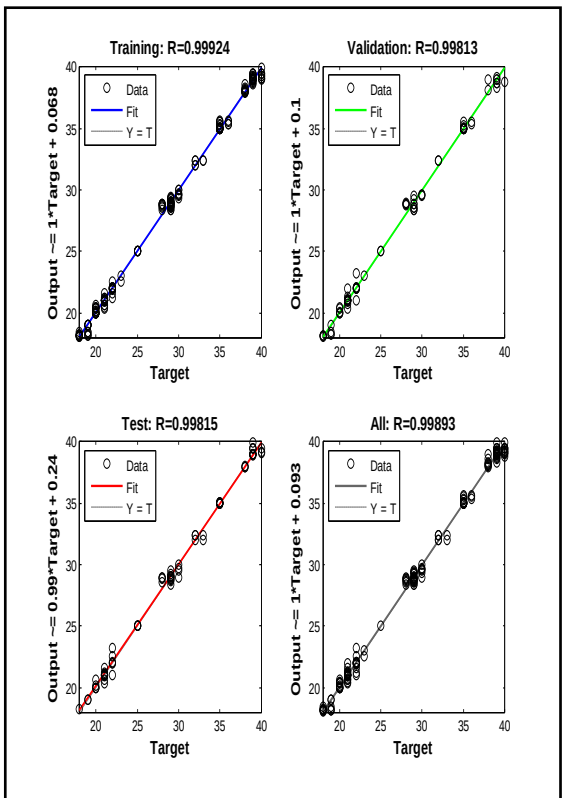



Figure 4: Regression plot for training, testing and validation of all products ANN model

**Goodness of fit for the all variables Cycle time model**

| Coefficient of correlation( R) | $R^2$ | SSE | | RMSE | Relative Error | |
|---|---|---|---|---|---|---|
| | | Training | Prediction | | Training | Prediction |
| 0.9989 | 0.997 | 0.0896 | 0.272 | 0.197 | 0.003 | 0.005 |

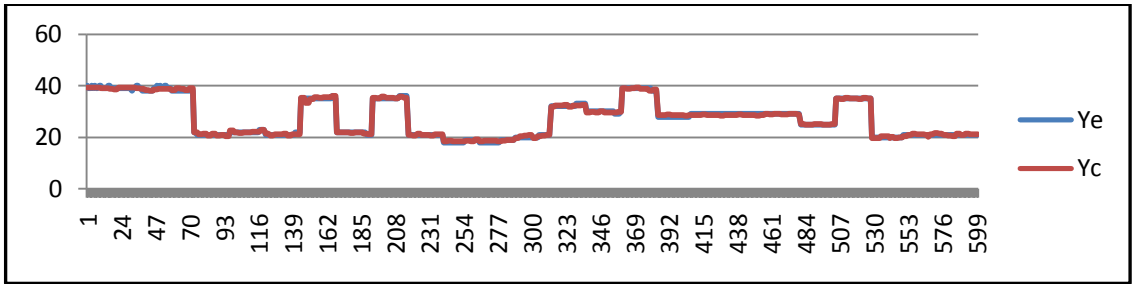



Fig 5: Experimental and computed values of Ctime for all products in ANN all variable model

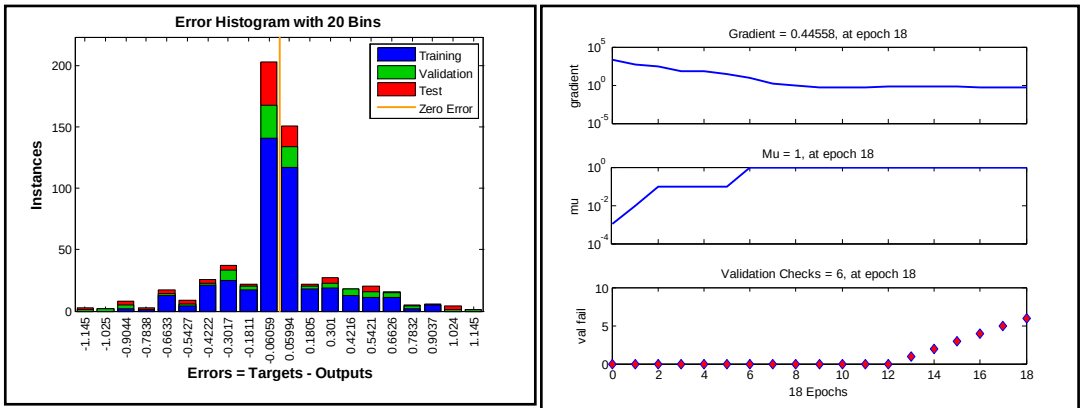



Fig 6: Error histogram and gradient plot of all products ANN models

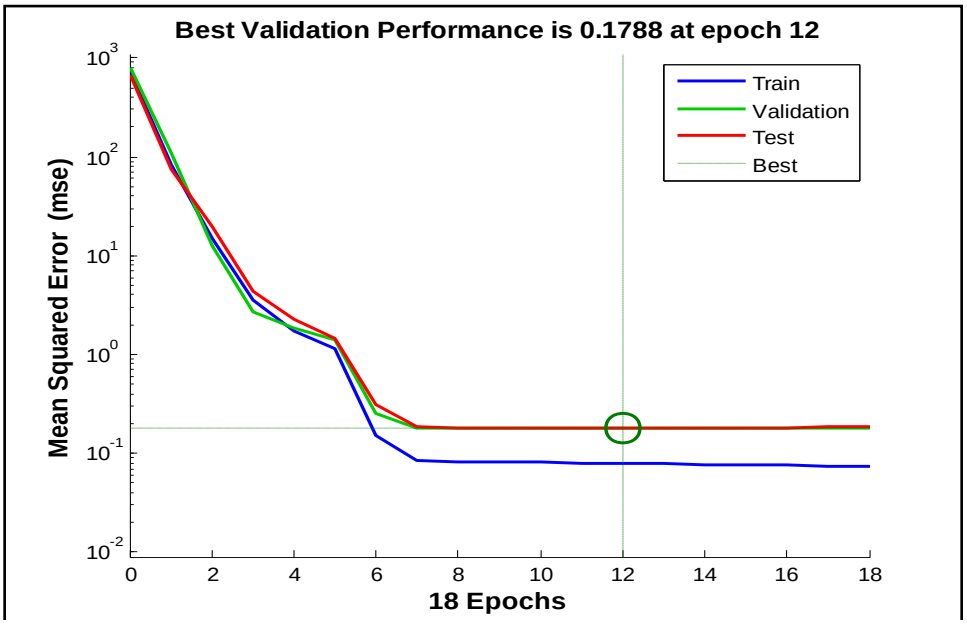



Fig 7: Validation performance graph of all products ANN models

## 4. ANN modeling using Radial Basis Function

The radial basis function network consists of a layer of units performing linear or non-linear functions of the attributes, followed by a layer of weighted connections to nodes whose outputs have the same form as the target vectors. It has a structure like an MLP with one hidden layer, except that each node of the the hidden layer computes an arbitrary function of the inputs (with Gaussians being the most popular), and the transfer function of each output node is the trivial identity function. Instead of "synaptic strengths" the hidden layer has parameters appropriate for whatever functions are being used; for example, Gaussian widths and positions. This network offers a number of advantages over the multi layer perceptron under certain conditions, although the two models are computationally equivalent.

These advantages include a linear training rule once the locations in attribute space of the non-linear functions have been determined, and an underlying model involving localised functions in the attribute space, rather than the long-range functions occurring in perceptron-based models. The linear learning rule avoids problems associated with local minima; in particular it provides enhanced ability to make statements about the accuracy of the probabilistic interpretation of the outputs.

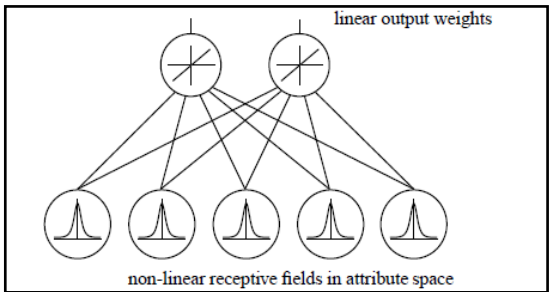



Fig 8. A Radial Basis Function Network.

Figure 8. shows the structure of a radial basis function; the non-linearities comprise a position in attribute space at which the function is located (often referred to as the function's centre), and a non-linear function of the distance of an input point from that centre, which can be any function at all. Common choices include a gaussian response function $\exp(-x^2)$ and inverse multiquadrics ( $[z^2+c^2]^{-1/2}$ ..), as well as non-local functions such as thin plate splines ($z^2\log z$¨) and multiquadrics ($[z^2+c^2]^{1/2}$. ..). Although it seems counter-intuitive to try and produce an interpolating function using non-localised functions, they are often found to have better interpolating properties in the region populated by the training data. The Radial Basis Function network approach involves the expansion or pre-processing of input vectors into a high-dimensional space. This attempts to exploit a theorem of Cover (1965) which implies that a classification problem cast in a high-dimensional space is more likely to be linearly separable than would be the case in a low-dimensional space.

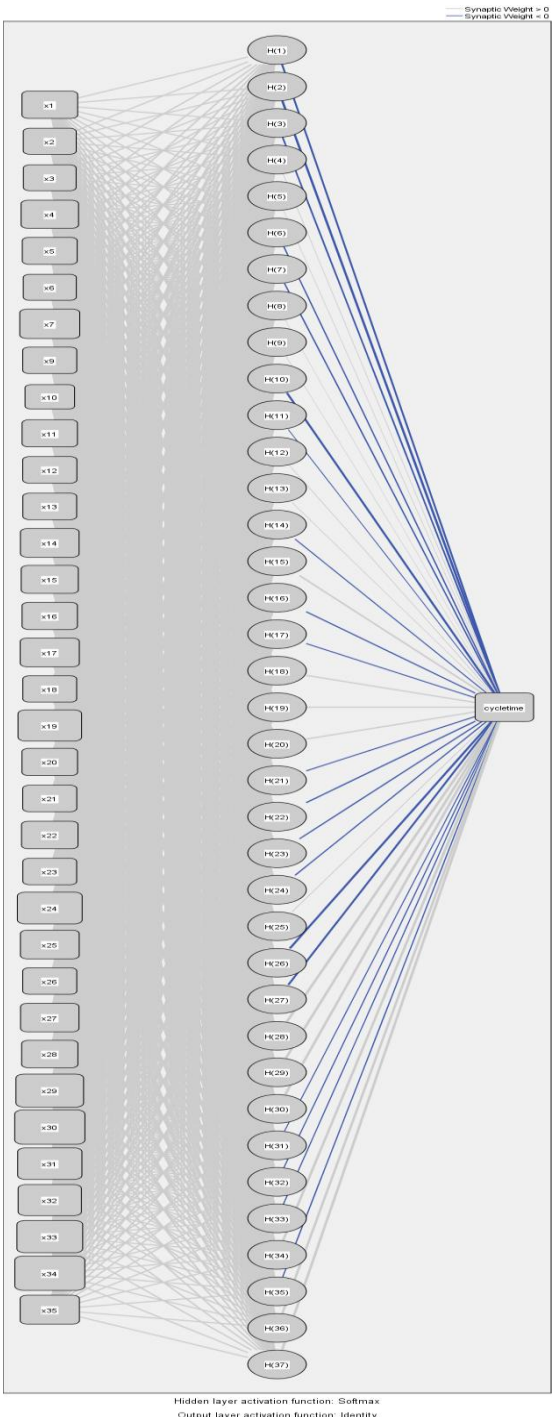



Fig 9. ANN network topology for cycle time with Radial Basis Function

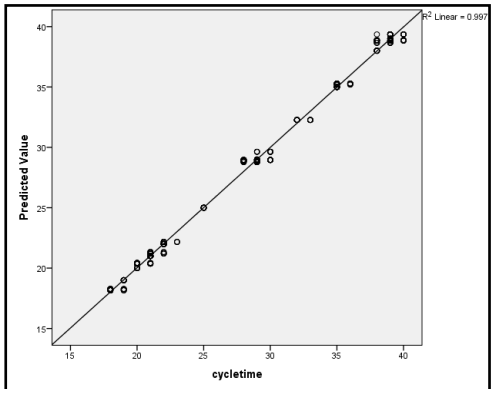



Fig 10

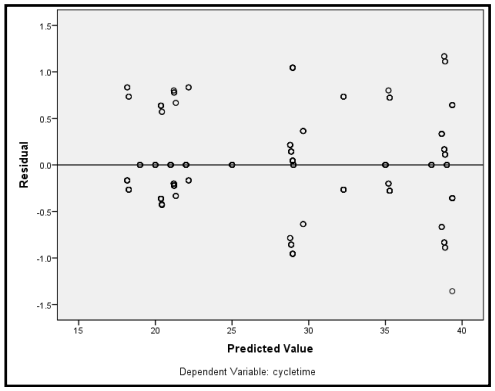



Fig 11

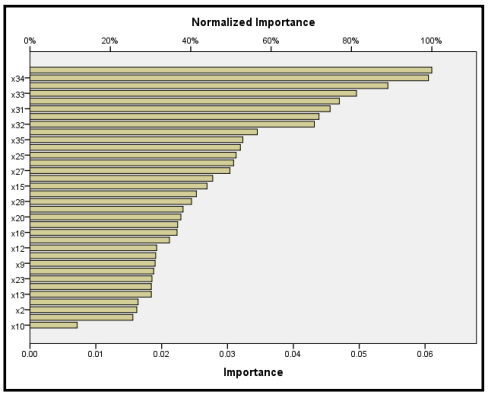



Fig 12

Fig 10-12 Predicted by observed chart, Residual by predicted chart, Variable importance chart for Radial Basis Function

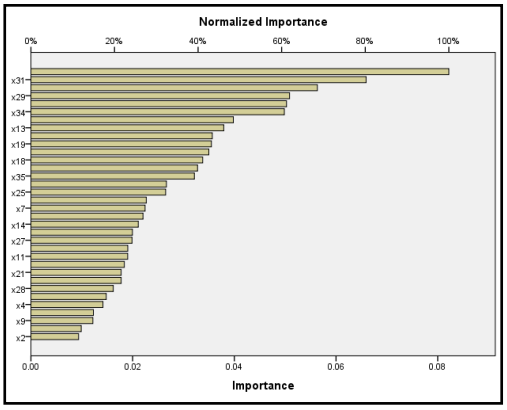
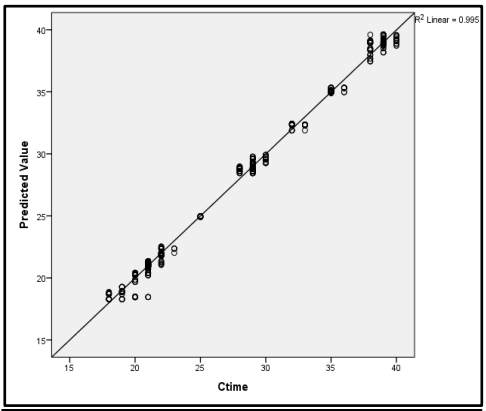
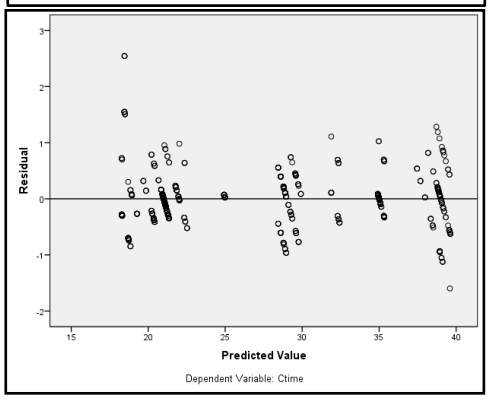



Fig 13-15 Predicted by observed chart, Residual by predicted chart, Variable importance chart for Multilayer Perceptron model



## 5. Result and Discussion

Table 1: Performance of Radial Basis Neural Network

| ANN Network Topology | R | $R^2$ | Relative Error | | Sum of Square Error | |
|---|---|---|---|---|---|---|
| | | | Training | Testing | Training | Testing |
| 35-10-1 | 0.613 | 0.376 | 0.608 | 0.663 | 122.248 | 60.033 |
| 35-15-1 | 0.794 | 0.631 | 0.333 | 0.476 | 71.230 | 36.780 |
| 35-20-1 | 0.879 | 0.773 | 0.194 | 0.299 | 39.394 | 27.685 |
| 35-25-1 | 0.948 | 0.899 | 0.108 | 0.088 | 22.328 | 8.804 |
| 35-30-1 | 0.985 | 0.971 | 0.008 | 0.078 | 1.688 | 6.905 |
| 35-31-1 | 0.994 | 0.990 | 0.010 | 0.011 | 2.053 | 0.957 |
| 35-32-1 | 0.994 | 0.990 | 0.007 | 0.018 | 1.372 | 1.635 |
| 35-33-1 | 0.994 | 0.990 | 0.008 | 0.015 | 1.638 | 1.312 |
| 35-34-1 | 0.988 | 0.977 | 0.004 | 0.073 | 0.888 | 6.040 |
| 35-35-1 | 0.982 | 0.996 | 0.004 | 0.361 | 0.785 | 0.361 |
| 35-36-1 | 0.982 | 0.996 | 0.004 | 0.004 | 0.848 | 0.374 |
| 35-37-1 | 0.998 | 0.997 | 0.003 | 0.003 | 0.637 | 0.288 |

Table 2: Performance of Multilayer Perceptron Neural Network

| ANN Network Topology | R | $R^2$ | Relative Error | | Sum of Square Error | |
|---|---|---|---|---|---|---|
| | | | Training | Testing | Training | Testing |
| 35-10-1 | 0.998 | 0.997 | 0.003 | 0.004 | 0.247 | 0.169 |
| 35-15-1 | 0.998 | 0.997 | 0.003 | 0.004 | 0.245 | 0.129 |
| 35-20-1 | 0.993 | 0.988 | 0.017 | 0.017 | 1.435 | 0.670 |
| 35-25-1 | 0.997 | 0.996 | 0.004 | 0.005 | 0.320 | 0.202 |
| 35-30-1 | 0.998 | 0.997 | 0.003 | 0.003 | 0.228 | 0.115 |
| 35-31-1 | 0.996 | 0.993 | 0.007 | 0.007 | 0.656 | 0.244 |
| 35-32-1 | 0.998 | 0.997 | 0.002 | 0.003 | 0.217 | 0.129 |
| 35-33-1 | 0.997 | 0.995 | 0.004 | 0.006 | 0.367 | 0.208 |
| 35-34-1 | 0.998 | 0.997 | 0.003 | 0.004 | 0.269 | 0.122 |
| 35-35-1 | 0.997 | 0.996 | 0.004 | 0.005 | 0.369 | 0.166 |
| 35-36-1 | 0.998 | 0.997 | 0.003 | 0.003 | 0.265 | 0.125 |
| 35-37-1 | 0.997 | 0.995 | 0.004 | 0.005 | 0.405 | 0.171 |

Data from field process generated array is considered as a input for neural network modeling .Two diversified approach of Multilayered perceptron and Radial basis function is used to fit neural network model .The corresponding transfer function used for Radial basis function model is softmax on the contrary transfer function for Multilayered perceptron model is hyperbolic tangential function for input layer and hyperbolic tan for output layer.

The topologies which envisaged for ANN model generation are implemented purely on trial and error basis. Started with by default 10 number of hidden neurons in hidden layer number 1 to maximum 37 hidden nodes in hidden layer have been tried . Radial basis function yielded with low coefficient of correlation at early stage of function fitting with 10 hidden nodes with relatively large SSE (122.248, 60.033) for training and testing samples. Though relative error doesn't shows large difference which indicated that the network is not overstrain. Radial basis function performs well with 37 hidden nodes with very minimum SSE as well as relative error.

Multilayered Perceptron network performs relatively well even with 10 hidden nodes .Overall range of SSE and relative error is predominantly well placed in multilayered perceptron model. It fits well with topologies of 35-10-1, 35-15-1, 35-30-1, 35-34-1, 35-37-1. Coefficient of correlation is well closed to 1 which indicated that multilayered perceptron is able to predict cycle time better than anticipation.

## 6. Conclusion:

This paper ultimately exhibits the comparison of two distinct function fitting processes of Neural network. The overall results reflects that multilayered perceptron outperformed Radial Basis function in terms of stability of network as well as constant performs even with minimum number of hidden nodes. The range of SSE for Radial basis function 0.228 to 122.248 is on higher side compare to Multilayered perceptron. With range of coefficient of correlation (0.993-0.998), multilayered perceptron would be the obvious choice for prediction of cycle time under defined set of conditions.

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# Modeling and Simulation of gate operations of dam for flood management: An approach

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**Abstract: There have been numerous endeavors to use combined simulation-optimization models to decipher reservoir operation problems competently. In many cases, complex simulation models are available, but direct amalgamation of them into an optimization scaffold is computationally exorbitant. To overcome this problem, an approach for modeling and simulation of Dam operation for flood management is suggested in this paper. Traditional mathematical modeling techniques like multiple regression analysis and more sophisticated nonlinear Artifical Neural network technique is discussed for possible solution .This paper also emphasized on state of art literature review for controlling reservoir operations.**

***Key words : Modeling , simulation, Rule - Curves, multilayer perceptron, optimization***

## 1. INTRODUCTION

The problem in reservoir operation is characteristically to resolve the operating policy, which is a specification of how much water is to be released each period, depending on the circumstances of the system in that period, to best conquer a specified objective or goal. Throughout history much of the world has witnessed ever-greater demands for trustworthy, high-quality and inexpensive water supplies for domestic consumption, agriculture and industry. In topical decades there have also been increasing demands for hydrological regimes that support healthy and diverse ecosystems, provide for water-based leisure activities, reduce if not prevent floods and droughts, and in some cases, provide for the production of hydropower and ensure water levels passable for ship navigation. Water managers are challenged to convene these manifold and often disagreeing demands. At the same time, public stakeholder interest groups have shown an increasing desire to take part in the water resources development and management decision making process. Added to all these management challenges bare the qualms of natural water supplies and demands due to changes in our climate, changes in people's standards of living, changes in watershed land uses and changes in technology.How can managers develop, or redevelop and restore, and then manage water resources systems – systems ranging from small watersheds to those encompassing large river basins and coastal zones – in a way that meets society's changing objectives and goals? In other words, how can water resources systemsbecome more integrated and sustainable?

Before engineering projects can be undertaken totackle water management problems or to take advantage prologue of opportunities for increased economic, ecological, environmental and social benefits, they must first be planned. This engrosses identifying various alternatives for addressing the problems or opportunities. Next, the diverse impacts of each proposed alternative need to be estimated and evaluated.

A variety of optimization and simulation models and modelling approaches have been developed to assist water planners and managers in identifying and evaluating plans. This paper introduces the detail review and art of modelling in support of water resources planning and management. Its main emphasis is on the practice of developing and using models to address specific water resources planning and management problems for flood control. This must be done in habits that provide significant, objective and meaningful information to those who are responsible for making informed decisions about specific issues in specific watersheds or river basins.

Human activities commence to increase the benefits obtained from rivers and their floodplains may also increase the potential for costs and damage when the river is experiencing singular or extreme flow conditions, such as during periods of drought, floods and heavy pollution.

These costs and impacts are economic, environmental and social in nature and result from a divergence between what humans anticipate or demand, and what nature (and occasionally our own activities) offers or supplies. Human activities have a propensity to be based on the 'usual or normal' range of reservoir flow conditions. Singular or 'extreme' flow or water quality conditions outside these normal ranges will persist to transpire, and possibly with increasing frequency as climate change experts suggest. Reservoir-dependent, human activities that cannot adjust to these occasional extreme conditions will acquire losses.The planning of human activities involving reservoir and their floodplains must consider certain hydrological essentials. One of these facts is that flows and storage volumes fluctuate over space and time. They are also finite. There are limits to the amounts of water that can be withdrawn from surface and groundwater bodies. There are also limits to the amounts of prospective pollutants that can be discharged into them without causing damage. Once these confines are exceeded, the concentrations of pollutants in these waters may reduce or even eliminate the benefits that could be obtained from other uses of the resource.

Problems and opportunities change over time. Just as the goals of managing and using water change over time, so do the processes of planning to meet these changing goals. Planning processes evolve not only to meet new demands, potential and objectives, but also in response to new insights of how to plan reservoir and gate operation more effectively.

Reservoir operation is a multifarious problem that involves many decision variables, multiple objectives as well as considerable risk and uncertainty (Oliveira and Loucks, 1997). In addition, the incompatible objectives lead to significant challenges for operators when making operational decisions. Traditionally, reservoir operation is based on heuristic measures, embracing rule curves and prejudiced judgements by the operator. This provides general operation strategies for reservoir releases according to the current reservoir level, hydrological conditions, water demands and the time of the year. Established rule curves, however, do not allow a fine-tuning (and hence optimisation) of the operations in response to changes in the widespread conditions. Therefore, it would be valuable to ascertain an analytic and more systematic approach to reservoir operation, based not only on traditional probabilistic/stochastic analysis, but also on the information and prediction of extreme hydrologic events and advanced computational technology in order to increase the reservoir's efficiency for balancing the demands from the different users. Applying modeling and optimisation techniques for reservoir operation is not a new idea. Assorted techniques have been applied in an attempt to improve the efficiency of reservoir(s) operation. These techniques include Linear Programming (LP); Nonlinear Programming (NLP); Dynamic Programming (DP); Stochastic Dynamic Programming (SDP); and Heuristic Programming such as Genetic algorithms, Shuffled Complex Evolution, Fuzzy logic, and Neural Networks etc.

In reservoir operation, LP is well known as the most favoured optimisation technique with many advantages. It is easy to understand and does not require any initial solution.A number of examples of applying LP to reservoir operation are provided by Yeh (1985). Mujumdar and Teegavarapu (1998) developed a deterministic LP model for short-term annual operation of an irrigation reservoir. Duranyildiz et al. (1999) developed a chance-constrained LP model, which takes the random nature of inflows into consideration to optimise the monthly operation of a real reservoir. Unver and Mays (1990) developed a model for real-time flood control operation for a reservoir system and demonstrated that it is possible to link nonlinear optimisation models with unsteady flow routing models to solve large-scale LP problems associated with flood control reservoir operation. In this method the nonlinear optimisation is performed by using the generalized reduced gradient code GRG2. Wang et al. (2004) studied optimisation of short-term hydropower generation and demonstrated that with the development of a direct search procedure, a reformulated problem with only linear constraints of outflow release and storage content can be solved.

Another approach to deal with the reservoir operation problem is the so-called Dynamic programming. In the method, sequential decision problems are divided into a sequence of separate, but interrelated, single-decision sub-problems. In this way, large, complex problems can be solved by combining the solutions of the smaller problems (subproblems) to obtain the solution of the entire problem (Mays and Tung, 2002). It is well suited to deal with short-term operation (hourly or daily) when the hydrologic inputs and water demands are generally considered deterministic. Mujumdar and Ramesh (1997) developed a short-term reservoir operation model for irrigation. The model consists of two components including an operating policy model and a crop water allocation model that were formulated using deterministic dynamic programming. Teixeira and Marino (2002) also

developed a DP model to solve the problem of two reservoirs in parallel supplying water for irrigation districts. In the model, forecasted information including crop evapotranspiration, reservoir evaporation and inflows is updated, which allowed application of the model for real-time reservoir operation andgeneration of a more precise irrigation schedule.

An extension of dynamic programming is stochastic dynamic programming (SDP). This method takes into account the stochastic nature of the hydrological conditions. Kelman et al. (1990) developed a sampling SDP that captured the complex temporal and spatial structure of the streamflow process. Mujumdar and Vedula (1992) developed a model for optimal reservoir operation for irrigation using SDP. In their study, reservoir storage, inflow and soil moisture in the irrigated area were treated as state variables. Yang et al.(1995) combined an autoregressive model with DP to produce a SDP model that was investigated to provide steady-state operation rules taking into account the stochasticity of reservoir inflows.

During the last two decades, heuristic algorithms have been developed for solving reservoir optimisation problems. These algorithms use a set of points simultaneously in searching for the global optimum. Oliveira and Loucks (1997) proposed an approach to identifying reservoir operating rules using genetic algorithms (GA) and argued that the approach overcomes some of the difficulties of many techniques based on more traditional mathematical programming models. Chen (2003) successfully applied real coded GA in combination with a simulation model to optimise 10-day operating rule curves of a major reservoir system in Taiwan. The results showed that the method can be powerfully used to optimise the rule curves, not being limited by the type of the objective function and simulation model used. Moreover, a comparison between binary coded and real-coded GA was exploited in optimising the reservoir operating rule curves (Chang et al., 2005). The results showed that the new operating rule curves obtained from both methods are better than the current operation rule curves, and the real-coded GA is more efficient than the binary-coded GA.

In order to solve the uncertainty of hydrological information as well as define the objectives and constraints, fuzzy set theory has been successfully used. Dubrovin et al. (2002) applied a fuzzy rule-based control model for multipurpose real-time reservoir operation. A comparison between Total Fuzzy Similarity and a more traditional method (the Sugeno method) was done. The results showed that this model can perform generally well and is easy for the operator to understand due to its structure based on human thinking. Akter and Simonovic (2004) combined fuzzy sets and GA for dealing with the uncertainties in short-term reservoir operation. In the paper, uncertainties involved in the expression of reservoir penalty functions and determining the target release value were considered.

Besides the uncertainty of input data, the complexity of physical and hydrological characteristics of a reservoir system often requires the use of computationally expensive simulation models. Thus, the computational time needed for optimisation may be overwhelming, making the optimisation infeasible, especially for real-time applications. A multilevel optimisation procedure that allows for maximum reduction of the time required to solve optimisation problems has been developed by using surrogate models including Artificial Neural Network (ANN). In the optimisation process the ANN model is trained to replace the simulation model. Thus, the requirement of calculation time is minimised without markedly reducing the accuracy of the solution. Neelakantan and Pundarikanthan (2000) applied this approach to improve the policies for reservoir operation.

## 2. LITERATURE REVIEW

Optimization techniques have been often successfully applied in the past to study the operation and the design of reservoirs systems. Available methods include linear programming (LP), dynamic programming (DP) and nonlinear programming (NLP), to be chosen according to the mathematical modelling of reservoir system and availability of data. DP technique has been widely applied because of the possibility to model nonlinear and stochastic features of water resources systems, and to reduce highly complex problems to a multistage decision process.

Definition of operating rules can be carried out by a dynamic programming- regression approach, as proposed by Young(1967). In particular, optimisation technique allows to compute, on the basis of a given inflow series to the reservoir, the corresponding optimalset of releases, i.e. releases which minimise or maximise a given objective function (Yeh, 1985; Simonovic, 1992; Wurbs, 1993). Then, such series of optimal releases are expressed as a function of reservoir state variables and hydrologic input (storage, inflows, etc.) by regression equations, which ultimately allow the water managers to determine the water to be released as a function of available information (Bhaskar and Whitlach, 1980; Karamouz and Houck, 1987; Rossi *et al.*, 1999). Application of regression techniques however

requires the explicit definition of the link between independent and dependent variables. To partly overcome such difficulty, a new interpolation method based on Neural Networks (NN) has been recently applied in several fields of research; it can also be considered as a candidate technique to the determination of operating rules. NN are able to approximate a wide range of multivariate linear and non-linear functions, while maintaining very good generalisation capabilities, and therefore they are ideal candidates if the relationship among the variables is unknown. They have been applied for interpretation, prediction, diagnosis, planning, monitoring, debugging, repair, instruction, and control, but the most successful applications are in categorization and pattern recognition; in fact, they have been shown to perform successfully where other methods do not, recognizing and matching complicated, vague, or incomplete patterns.

Young (1967) derived operating rules using simple linear regression or multiple linear regression from the deterministic optimization results. He derived regression equations using inflows and storages to find optimal releases. Bhaskar and Whitlach (1980) analyzed a single multipurpose reservoir using backward DP algorithm to obtain optimal results. Bhaskar and Whitlach (1980) made use of the procedure of deriving general operating policies from deterministic optimization as initiated by Young (1967). Bhaskar and Whitlach (1980) considered a quadratic loss function and derived monthly policies by regressing optimal set of releases on the input and state variables. They concluded that for two-sided quadratic loss functions performance of linear policies were better than nonlinear policies and for one-sided quadratic loss functions nonlinear policies gave improved performance. Karamouz and Houck (1982) developed reservoir system operating rules by deterministic optimization using the DPR model. The DPR model algorithm had a deterministic dynamic program with a regression analysis. This algorithm also had a simulation model to assess the performance. A hypothetical loss function was used which involved only reservoir release. By considering the recommendations of Bhaskar and Whitlach (1980), Karamouz and Houck (1982) analyzed the DPR model performance with case studies, and suggested that the model can be extended easily to more complex and more practical problems. Wurbs et al. (1985) presented an annotated bibliography for various optimization and simulation models and listed several applications made by various researchers in the reservoir operation problems using LP, DP, NLP, and simulation models. Karamouz and Houck (1987) further compared deterministic DP and regression-based DPR model with stochastic DP (SDP) model. The deterministic DPR model and the SDP model were formulated with the same objective function. As a continuing effort, Karamouz et al. (1992) used an implicit stochastic optimization scheme for multiple reservoir systems. The optimal operations from the deterministic optimization were then analyzed in a regression procedure to obtain a set of operating rules as they did in the single reservoir case. These rules were evaluated using a simulation model and a different set of data. Wurbs (1993) reviewed the reservoir system simulation and optimization models. This review was done with the objective to contribute to ongoing efforts throughout the water management community in sorting through the numerous reservoir system-analysis models. Simonovic (1992) presented a short review of mathematical models used in reservoir management and operation. This review was intended to present conclusions reached by previous state-of-the-art reviews and to provide ideas for closing the gap between theory and practice. Simonovic (1992) presented a simple simulation-optimization model for reservoir sizing and showed how it responded to practical needs of water resources engineers. Yang and Read (1999) developed a constructive DP which is successfully applied to optimize releases in a stochastic two-reservoir model of the New Zealand power system. Takyi and Lence (1999) developed a surface water quality management model using a multiple-realization chance constraint method for more complex systems.

In last years NN have found more and more application in hydraulics and hydrologic field, and also in water management studies. Among the recent state-of-arts on the subject the following are worth to be mentioned. The first part of a study published in ASCE (2000a) focused on setting a conceptual framework for the application of NN to related hydrologic issues, by comparing the modelling capabilities of NN with other traditional modelling approaches. Applications of NN to many nonlinear hydrologic processes such as rainfall-runoff modelling, streamflow forecasting, ground water, precipitation forecasting, and water quality issues, can be found in the second part of the ASCE study (ASCE, 2000b), as well as in Govindaraju and Ramachandra(2000). NN have showed a great potential in prediction problems, although a good understanding of the underlying physical processes seemed to be a key factor for successful applications. The study also pointed out the need for further investigations, to be conducted when applying NN, about the choice of their architecture, the optimal training data set, etc. In

water management, NN have been applied for deriving reservoir operating policies with reference to different types of water supply systems. Raman and Chandramouli (1996) trained neural network by backpropagation algorithm based on a supervised learning for deriving operating rules from optimization results. The suggested model algorithm had three important modules. First was a deterministic optimization algorithm with an objective function to minimize the squared deficit. The results of the DP optimization were printed in a file. The results were treated as training patterns. These training patterns were used to train the neural network. The second module was a neural network with back-propagation algorithm to train the network, and the third module had a reservoir-simulation algorithm that could be used to study the performance. The performance of the DPN model was compared with the SDP model—an explicit stochastic model constructed with the same objective function. Further, the model was compared with standard operating policy which is being practiced in the field. Neelakantan and Pundarikanthan (1999) applied a simulation-optimisation procedure to improve the operation of a municipal water supply reservoir under deficit conditions. The operation policies were based on a hedging rule, able to avoid extreme deficit conditions and to increase the system sustainability. In order to speed up the optimization process, NN were used to replace traditional models in the reservoirs system simulation. This allowed for a more efficient screening of the potential operation policies. Rossi *et al.* (1999) compared the linear regression approach vs the neural network approach, for deriving operating rules of a reservoir supplying an irrigation district. Monthly optimal releases were obtained by DP, assuming the sum of square deficits as objective function. Reservoir storage at the beginning of the current month, streamflow and release during the previous month were selected as independent variables. Results indicated that NN performed better than multiple linear regression.

Jain *et al.* (1999) applied NN for two different tasks. First, NN were used for predicting inflows to a reservoir part of a multipurpose project devoted primarily to irrigation and generation of electric power. Then reservoir operation policies were formulated relating optimal releases with storage, inflow and demand trough linear and nonlinear regressions and NN. Cancelliere *et al.* (2000) analyzed the effects of the presence of severe drought years in the definition of the operating rules of an irrigation reservoir through the use of DP and NN techniques. The selected rules were compared on the basis of reservoir performance indices and crop yield losses. Chandramouli and Raman (2001) made an attempt to extend the DP-NN model, previously applied to a single reservoir, to a multireservoir project. A DP formulation of three reservoirs working in conjunction was developed, and operating rules were derived using regression models and NN. French et al. (1992) developed three-layered NN to forecast rainfall intensity fields in space and time. After training with input patterns, the NN was used to forecast rainfall using the current fields as input. French et al. (1992) showed that NN was capable of learning the complex relationship describing the space-time evolution of rainfall. Ranjithan et al. (1993) used neural network-based screening approach for ground-water reclamation. Saad et al. (1994) described a disaggregation procedure by training an NN. After training, this network gave the storage level of each reservoir of a system when supplied with the value of an aggregate storage level. The training set was obtained by solving the deterministic operation problem of a large number of equally likely flow sequences. Saad et al. (1994) used back-propagation algorithm and the minimization of quadratic error was computed by gradient method. The aggregated storage level was determined by SDP algorithm in which all hydroelectric reservoirs were aggregated to form one equivalent reservoir. Saad et al. (1994) presented a comparison with principal component-analysis disaggregation technique with NN-based technique. Smith and Eli (1995) used ANN to model rainfall runoff process. They used a 5 3 5 grid cell synthetic watershed to generate runoff from stochastically generated rainfall patterns. Smith and Eli (1995) used a backpropagation algorithm for training to predict the peak discharge and the time of peak resulting from single rainfall pattern. Muller (1996) and Babovic and Larsen (1998) reported many applications of decision support and management systems, geographic information systems, and neural networks. Hsu et al. (1999) used artificial neural network for the estimation of physical variables from multichannel remotely sensed imageries for rainfall estimation. In neural network approach a successfully trained network tries to capture the interrelationship between the trained data sets which closely approximate the target values. The application of NNs in water resources showed their usefulness and many applications are reported in literature.

Many successful applications of fuzzy systems were reported in the literature, especially in control and modeling - Fontane et al. 1997; Dubrovin et al. (2002). They are suitable for situations where an exact model of a process is either impractical or very costly to build, but an

imprecise model based on the existing human expertise can do the job. In such situations, fuzzy systems are considered as the best alternative, though they do not perform optimally. Fuzzy sets are an aid in providing information in a more human comprehensible or natural form, and can handle uncertainties at various levels. The knowledge contained in fuzzy systems is transparent to the user. On the other hand, artificial neural networks ANNs are also used successfully for single reservoir as well as Multireservoir operation Raman and Chandramouli 1996; Jain et al. 1999; Chandramouli and Raman 2001. While neural networks are ideal for modeling known or unknown associations that exist between the input and output data, significant data cleaning and preprocessing are usually needed. In other words, input data must be carefully prepared for the network to process. The more input data, the better the training results. The richer the input data, then more accurate is the model. However, training requires substantial time and resources. These difficulties restrict the widespread use of neural networks in many applications - Badiru and Cheung (2002). In many decision-making systems, it is important to be able to explain the process by which the decision is made. The concepts of fuzzy logic clearly compliment those of neural networks. While fuzzy logic provides simple data representation, neural networks provide none. Where fuzzy logic can be used to model a system, neural networks are well suited to provide sophisticated models of diverse type of systems. However, if there is prior knowledge about the underlying system, fuzzy logic can readily encapsulate the knowledge in terms of rules and relations, while it is not particularly easy to preprogram a neural network with prior knowledge. Given a set of training samples, it is not simple to train a fuzzy model, but many algorithms have been developed in the past for training neural networks. The concept of neurofuzzy hybrid systems has emerged as researchers have tried to combine the transparent, linguistic representation of a fuzzy system with the learning ability of an ANN Brown and Harris (1994). A neurofuzzy system uses an ANN learning algorithm to determine its parameters i.e., fuzzy sets and fuzzy rules_ by processing data samples. Therefore, it can be trained to perform an input-output mapping, just as with an ANN, but with the additional benefit of being able to provide the set of rules on which the model is based. Deka and Chandramouli (2003) developed a fuzzy neural network model for deriving river stage-discharge relationship at selected gauging stations of Brahmaputra River in India and found better than other models considered.

Deka and Chandramouli (2005) also found that fuzzy neural network modeling used in routing river flow was better than other models considered. Chaves and Kojiri (2007) developed a conceptual fuzzy neural network(CFNN) for water quality simulation in Barra Bonita reservoir system in Brazil using a genetic algorithm as the training method for finding fuzzy inference and connection weights. They found that the CFNN model showed greater robustness and reliability while dealing with systems for which data are considered to be vague, uncertain, or incomplete.

According to the World Commission on Dams, many large storage projects worldwide are failing to produce the anticipated benefits (Labadie, 2004). Similarly, small storage projects made for local areas in developing countries, like India, are also failing to meet expectations. The main cause identified at various levels of discussion, as reported by Labadie (2004), is inadequate consideration of the more mundane operation and maintenance issues once the project is completed. For existing reservoirs, optimum operation is critical, since all the expected benefits are based on timely water releases to meet the stipulated demand. Real-time operation of a reservoir requires making relatively quick decisions regarding releases based on short-term information. Decisions are dependent on the storage in the reservoir and information available in the form of forecast hydrologic and meteorological parameters. This is especially important duringfloods and power generation, where the system has to respond to changes very quickly and may need to adapt rapidly (Mohan et al., 1991). For reservoir systems operated for irrigation scheduling, real-time operation is not very common because of longer decision steps. Traditionally, the reservoirs meant for irrigation purposes are operated on heuristics and certain rules derived from previous experiences. This defies search capability and near global optimal values. It originated in the mid 1970s (Holland, 1975) and emerged as a powerful optimization approach. An excellent introduction to Genetic Algorithm (GA) is given by Goldberg (1989), and several recent researchers have summarised the essentials of genetic algorithm modelling (Deb, 1995; Wang, 1991; Oliveira and Loucks, 1997; Wardlaw and Sharif, 1999)(Fig. 1). The application of GA to ground water problems (Ritzel et al., 1994; Aly and Peralta, 1999; Reed et al., 2003; Hilton and Culver, 2005; Espinoza et al. 2005), and water distribution network problems (Dandy and Engelhardt, 2001;Wu and Simpson, 2001) has been studied extensively. The application of GA to reservoir operation problems began in the last decade of the 21st century. East

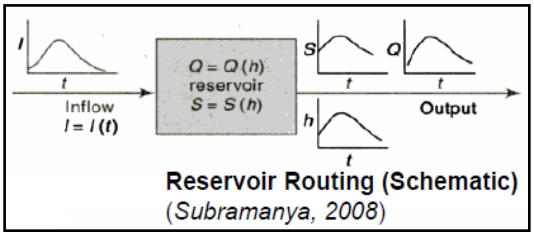
and Hall (1994) applied GA to a four-reservoir problem. The objective was to maximise the benefits from power generation and irrigation water supply, subject to constraints on storage and releases from the reservoirs. Fahmy et al. (1994) compared the performance of GA with that of dynamic programming and found that GA was better. Oliveira and Loucks (1997) used it to evaluate operating rules for multi-reservoir systems, demonstrating that GA could be used to identify effective operating policies. A brief review of GA applications to water resources problems can be found in the work of Wardlaw and Sharif (1999). Sharif and Wardlaw (2000) applied a genetic algorithm for the optimization of a multi-reservoir system in Indonesia (Brantas Basin) by considering the existing developmentsituation in the basin and two future water resource development scenarios. They proved that GA is able to produce solutions very close to those produced by dynamic programming. Kim and Heo (2004) applied multi-objective the concept of water-management; much of the water is lost, which in turn leads to loss of revenue.

## 3. TRADITIONAL METHODOLOGY OF GATE OPERATIONS OF DAM

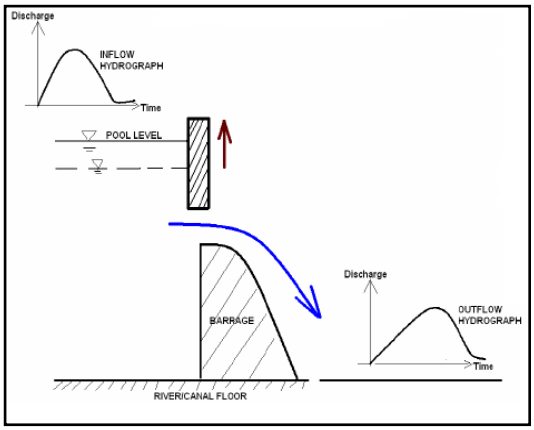
Flow routing is the procedure to determine the time and magnitude of flow (i.e. the flow hydrograph) at a point on a watercourse from known or assumed hydrographs at one or more points upstream (Chow et al., 1988). Reservoir routing is a lumped routing as the flow is calculated as a function of time alone at a particular location.Reservoir routing is also called level pool routing as the water surface is always horizontal. The data required for the method to construct the outflow hydrograph is:

(1) The inflow hydrograph
(2) The capacity – elevation curve of the reservoir
(3) The outflow – elevation curve.

The method attempts to get solution of the continuity equation where subscripts 1 and 2 represent the beginning and end of an increment of time

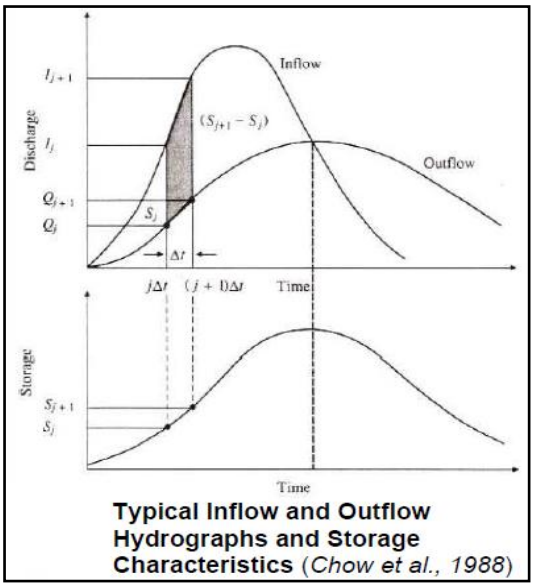


Reservoir Routing (Schematic)
(Subramanya, 2008)




### 3.1 Step by step analytical method ofreservoir routing

1. Divide the inflow hydrograph into steps such that these steps may be taken as straight lines.



Typical Inflow and Outflow Hydrographs and Storage Characteristics (Chow et al., 1988)

   The time interval should be so chosen that the Peak is not missed. Normally it is taken as 3 to 12 h.
2. Fix the level of the reservoir at which the inflow flood hydrograph impinges.
3. Plot the spillway and outlet discharge rating curve.
4. Compute from the inflow hydrograph the value of $[(I_1 + I_2)/2]\ \Delta t$, where I1 is the initial inflow and $I_2$ is after a lapse of $\Delta t$.
5. Assume a trial final reservoir level.
6. Compute the outflow corresponding to the reservoir level of step 5 from the curve of step 3.
7. Compute $[(O_1 + O_2)/2]\ \Delta t$, where $O_1$ is the initial known outflow and $O_2$ the final outflow as obtained in step 6.

8. Compute change in storage by subtracting the value of step 7 from the value of step 4.
9. Compute $S_2$ by adding the value of step 8 to $S_1$, the preflood storage.
10. Find out reservoir elevation corresponding to computed value of $S_2$ under step 9. In case this does not tally with the assumed reservoir level of step 5 assume another trial final reservoir level and repeat from step 5 onward till the reservoir level assumed in step 5 corresponds nearly to the reservoirlevel obtained in this step 10.
11. Continue the process step by step till theoutflow curve crosses the inflow curve. This point gives the peak outflow rate. From this time onwards the rate of outflow begins to fall due to decrease in the inflow rate.
12. The routing process of all the above steps should be continued till the reservoir level reaches to the preflood level.

## 4. CONCEPTUAL FRAMEWORK

### 4.1 Combination of simulation and optimisation models in reservoir operation

Generally, system analysis models used to optimise reservoir operation may be categorized as: simulation models; optimisation models; and combination of simulation and optimisation models. Simulation models are effective tools for studying the operation of complex physical and hydrological characteristics of a reservoir system including the experience and judgment of operators. However, since they are limited to predict the performance of a reservoir for a given operation policy, optimisation models have an advantage in being able to search for the optimum policy from an infinite number of feasible operation policies that are defined through decision variables. In recent years, incorporation of an optimisation technique into a simulation model to execute a certain degree of optimisation has been advocated (Ranjithan, 2005). The framework of the simulation-optimisation process is shown in Figure 1. First, different parameter sets defining the control strategies are generated. For each trial parameter set the simulation model is used to evaluate the performance of the system with respect to different objectives. Then, the parameter set is modified toward optimality by using the optimisation algorithm. The process is continued until one of the termination criteria is satisfied. The common objectives that have been considered are: maximising total energy production; minimising downstream flood risk including flow rate and water level; and maximising minimum downstream discharge for water supply.

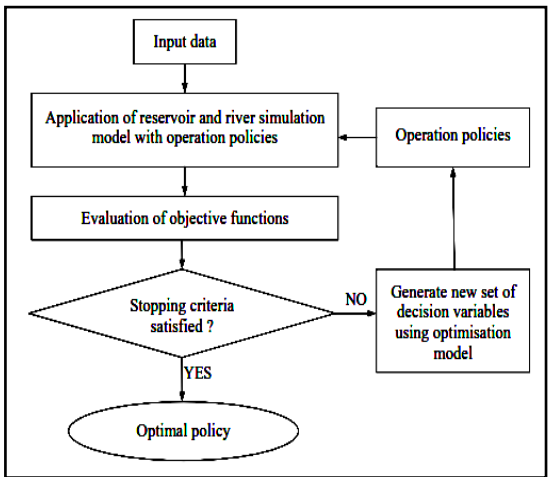



Fig.1General framework of simulation-optimisation modelling approach for reservoir operation

### 4.2 Modeling and simulation approach for flood control

Data sets contain information, often much more than can be learned from just looking at plots of those data. Models based on pragmatic input and output data help us abstract and gain new information and understanding from these data sets. They can also serve as substitutes for more process-based models in applications where computational speed is critical or where the underlying relationships are poorly understood. Models based on data range from the commonly used regression models to models based on, for example, evolutionary or biological processes. This section provides a brief introduction to these types of models. They are among a wide range of data-mining tools designed to identify and abstract information and/or relationships from large sets of data.

Most optimization and simulation models used for water resources planning and management describe, in mathematical terms, the interactions and processes that take place among the various components of the system. These mechanistically or process-based models usually contain parameters whose values are determined from observed data during model calibration. These types of models are contrasted to what are typically called ‘black-box’ models, or statistical models. Statistical models do not describe physical processes. They attempt to convert inputs (e.g. rainfall, inflows to a reservoir, pollutants entering a wastewater treatment plant or discharged to a river) to outputs (e.g., runoff, reservoir releases, pollutant concentrations in the effluent of a treatment plant or downstream from a point of

discharge to a river) using any mathematical equation or expression that does the job.

In statistics, regression analysis is a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps one understand how the typical value of the dependent variable (or 'criterion variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables i.e. the average value of the dependent variable when the independent variables are fixed. Less commonly, the focus is on a quantile, or other location parameter of the conditional distribution of the dependent variable given the independent variables. In all cases, the estimation target is a function of the independent variables called the regression function. In regression analysis, it is also of interest to characterize the variation of the dependent variable around the regression function which can be described by a probability distribution.

Regression analysis is widely used for prediction and forecasting, where its use has substantial overlap with the field of machine learning. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables. However this can lead to illusions or false relationships, so caution is advisable for example, correlation does not imply causation.

Many techniques for carrying out regression analysis have been developed. Familiar methods such as linear regression and ordinary least squares regression are parametric, in that the regression function is defined in terms of a finite number of unknown parameters that are estimated from the data. Nonparametric regression refers to techniques that allow the regression function to lie in a specified set of functions, which may be infinite-dimensional.

The performance of regression analysis methods in practice depends on the form of the data generating process, and how it relates to the regression approach being used. Since the true form of the data-generating process is generally not known, regression analysis often depends to some extent on making assumptions about this process. These assumptions are sometimes testable if a sufficient quantity of data is available. Regression models for prediction are often useful even when the assumptions are moderately violated, although they may not perform optimally. However, in many applications, especially with small effects or questions of causality based on observational data, regression methods can give misleading results.

Regression models involve the following variables:

- The unknown parameters, denoted as β, which may represent a scalar or a vector.
- The independent variables X.
- The dependent variable *Y*.

In various fields of application, different terminologies are used in place of dependent and independent variables.

A regression model relates *Y* to a function of **X** and **β**.

$$Y \approx f(X, \boldsymbol{\beta})$$

The approximation is usually formalized as $E(Y \mid X) = f(X, \beta)$. To carry out regression analysis, the form of the function f must be specified. Sometimes the form of this function is based on knowledge about the relationship between Y and X that does not rely on the data. If no such knowledge is available, a flexible or convenient form for f is chosen.Assume now that the vector of unknown parameters β is of length k. In order to perform a regression analysis the user must provide information about the dependent variable Y:If N data points of the form (Y, X) are observed, where $N < k$, most classical approaches to regression analysis cannot be performed: since the system of equations defining the regression model is underdetermined, there are not enough data to recover β.If exactly $N = k$ data points are observed, and the function f is linear, the equations $Y = f(X, \beta)$ can be solved exactly rather than approximately. This reduces to solving a set of N equations with N unknowns (the elements of β), which has a unique solution as long as the X are linearly independent. If f is nonlinear, a solution may not exist, or many solutions may exist. The most common situation is where $N > k$ data points are observed. In this case, there is enough information in the data to estimate a unique value for β that best fits the data in some sense, and the regression model when applied to the data can be viewed as an overdetermined system in β.In the last case, the regression analysis provides the tools for:

Finding a solution for unknown parameters β that will, for example, minimize the distance between the measured and predicted values of the dependent variable Y (also known as method of least squares).Under certain statistical assumptions, the regression analysis uses the surplus of information to provide statistical information about the unknown parameters β and predicted values of the dependent variable Y.In linear regression, the model specification is that the dependent variable, Yi is a linear combination of the parameters (but need not be linear in the independent variables). For example, in simple linear regression for modeling η data points there is one independent variable: Xi, and two parameters, $\beta_0$ and $\beta_1$:

Straight line: $Y_i = \beta_0+\beta_1 x_i+\varepsilon_i$ , i= 1,...,n

In multiple linear regressions, there are several independent variables or functions of independent variables.Adding a term in $x_i^2$ to the preceding regression gives:

Parabola: $Y_i = \beta_0+\beta_1 x_i+\beta_1 x_i^2 +\varepsilon_i$ , i= 1,...,n

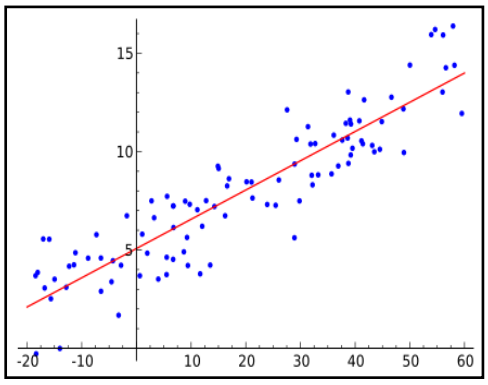



Fig.2 Illustration of linear regression on a data set

### 4.3Modeling approach using Neural Network

Simulation models for reservoir operation studies generally permit detailed and realistic representation of the complex characteristics of a reservoir system. The concepts inherent inthe simulation approach are easier to understand and communicate than other modeling concepts. However, simulation modeling is too timeconsuming to find optimal or near optimalsolutions.

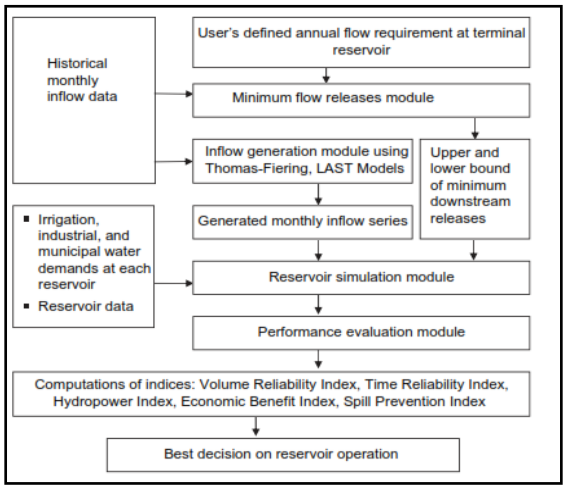



Fig. 3 Simulation model for a multireservoir system.(G.S.Joshi et al. 2009)

Many authors (Gates et al. 1992; Simonovic 1992; Gates and Alshaikh 1993; Alshaikh and Taher 1995) have advocated combined simulation-optimization approaches.

A neural network-based simulation model developed for reservoir system operation is used as a submodel in a Hooke and Jeeves (1961) unconstrained nonlinear programming model for the optimization of management decision variables that define the hedging rule. To enhance the speed of the simulation-optimization process, a backpropagation neural network simulation model is used. Application of artificial neural networks in water resourcessystem analysis is fast growing. An artificial neural network is a model inspired by the structure of the brain that is well suited for complicated tasks such as pattern recognition, data compression, and optimization (Tagliarini et al. 1991). Ranjithan et al. (1993) used neural networks as screening models for a groundwater reclamation problem. Karunanithi et al. (1994) used neural networks for flow predictions. In the work of Rogers and Dowla (1994), optimal management solutions were found by first training a backpropagation neural network to predict the conventional simulation and then using the trained neural network to search through many pumping realizations to find an optimal one for successful remediation of a polluted aquifer. Ranjithan et al. (1995) successfully applied a backpropagation neural network model as a screening model for recognizing particular patterns of spatial distribution of hydraulic conductivity values that constrain the design of groundwater pollution control by means of pumping water. Neural network models are preferred for their high speed. In this study, in the first stage a backpropagation neural network model is trained to simulate

operation of a water supply reservoir system. To train the neural network, exemplars
are required and were obtained through a conventional mass balance simulation model. In the second stage, the neural network simulation model is linked as a submodel with a Hooke and Jeeves nonlinear optimization programming model, and the combined neural network simulation-optimization model is used for screening the operation policies. In the third stage, the operation policy that yields the best objective function value, and the policies that yield objective function values very close to the best value, are selected from the neural networksimulation-optimization analysis, and the results are further refined using the ‘‘conventional simulation-optimization model.’’

To enhance the speed in the screening process, a neural network simulation model is used in place of the conventional simulation model. The optimization procedure followed is iterative in nature; it starts from an initial trial solution and proceeds toward the optimum policy in a sequential manner.

### 4.3.1 Backpropagation Neural Network

The term neural network applies to a loosely related family of models, characterized by a large parameter space and flexible structure, descending from studies of brain functioning. As the family grew, most of the new models were designed for nonbiological applications, though much of the associated terminology reflects its origin. Specific definitions of neural networks are as varied as the fields in which they are used. While no single definition properly covers the entire family of models, for now, considers the following description :
“A neural network is a massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use. It resembles the brain in two respects:

• Knowledge is acquired by the network through a learning process.

• Interneuron connection strengths known as synaptic weights are used to store the knowledge.

By contrast, the definition above makes minimal demands on model structure and assumptions. Thus, a neural network can approximate a wide range of statistical models without requiring that you hypothesize in advance certain relationships between the dependent and independent variables. Instead, the form of the relationships is determined during the learning process. If a linear relationship between the dependent and independent variables is appropriate, the results of the neural network should closely approximate those of the linear regression model. If a nonlinear relationship is more appropriate, the neural network will automatically approximate the "correct" model structure.

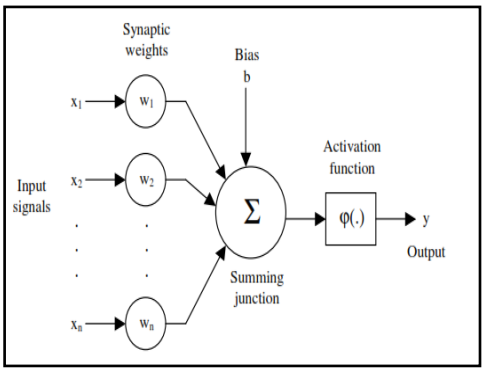



Fig.4 Model of Neuron

The trade-off for this flexibility is that the synaptic weights of a neural network are not easily interpretable. Thus, if you are trying to explain an underlying process that produces the relationships between the dependent and independent variables, it would be better to use a more traditional statistical model. However, if model interpretability is not important, you can often obtain good model results more quickly using a neural network.

**Feed forward neural network:**

Although neural networks impose minimal demands on model structure and assumptions, it is useful to understand the general network architecture. The multilayer perceptron (MLP) or radial basis function (RBF) network is a function of predictors (also called inputs or independent variables) that minimize the prediction error of target variables (also called outputs).

This structure is known as feedforward architecture because the connections in the network flow forward from the input layer to the output layer without any feedback loops. In this figure:

• The input layer contains the predictors.
• The hidden layer contains unobservable nodes, or units. The value of each hidden unit is some function of the predictors; the exact form of the function depends in part upon the network type and in part upon user-controllable specifications.

• The output layer contains the responses. Sincethe history of default is a categorical variable with two categories, it is recoded as two indicator variables. Each output unit is some function of the hidden units. Again, the exact form of the function depends in part on the network type and in part on user-controllable specifications.

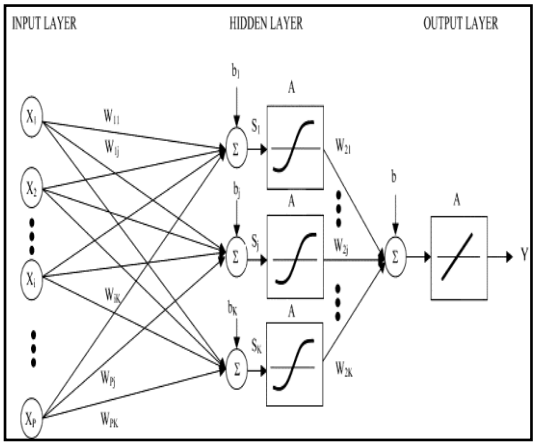



Fig.5 Feedforward network

The MLP network allows a second hidden layer; in that case, each unit of the second hidden layer is a function of the units in the first hidden layer, and each response is a function of the units in the second hidden layer.

**The Back propagation method:**

Backpropagation, an abbreviation for "backward propagation of errors", is a common method of training artificial neural networks. From a desired output, the network learns from many inputs. It is a supervised learning method, and is a generalization of the delta rule. It requires a dataset of the desired output for many inputs, making up the training set. It is most useful for feed-forward networks (networks that have no feedback, or simply, that have no connections that loop). Backpropagation requires that the activation function used by the artificial neurons (or "nodes") be differentiable.

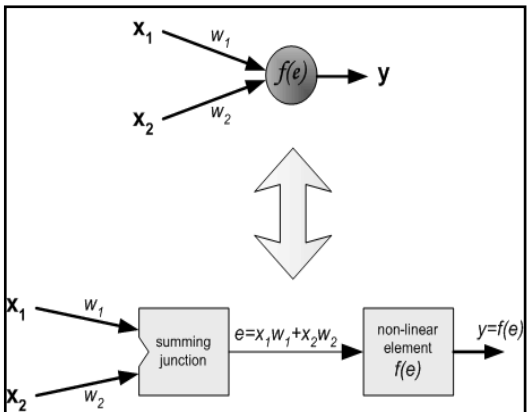



Fig.6 Feedforward structure

As the algorithm's name implies, the errors propagate backwards from the output nodes to the input nodes. Technically speaking, backpropagation calculates the gradient of the error of the network regarding the network's modifiable weights. This gradient is almost always used in a simple stochastic gradient descent algorithm to find weights that minimize the error. Often the term "backpropagation" is used in a more general sense, to refer to the entire procedure encompassing both the calculation of the gradient and its use in stochastic gradient descent. Backpropagation usually allows quick convergence on satisfactory local minima for error in the kind of networks to which it is suited. Backpropagation networks are necessarily multilayer perceptron (usually with one input, one hidden, and one output layer). In order for the hidden layer to serve any useful function, multilayer networks must have non-linear activation functions for the multiple layers: a multilayer network using only linear activation functions is equivalent to some single layer, linear network. Non-linear activation functions that are commonly used include the logistic function, the softmax function, and the Gaussian function.
The backpropagation learning algorithm can be divided into two phases: propagation and weight update.

**Phase 1: Propagation**

Each propagation involves the following steps:

1. Forward propagation of a training pattern's input through the neural network in order to generate the propagation's output activations.
2. Backward propagation of the propagation's output activations through the neural network using the training pattern target in order to generate the deltas of all output and hidden neurons.

**Phase 2: Weight update**

For each weight-synapse following steps are important:

1. Multiply its output delta and input activation to get the gradient of the weight.
2. Bring the weight in the opposite direction of the gradient by subtracting a ratio of it from the weight.

This ratio influences the speed and quality of learning; it is called the *learning rate*. The sign of the gradient of a weight indicates where the error is increasing; this is why the weight must be updated in the opposite direction.

**Threshold in ANN:**

Any cell on neuron network should be viewed as storage media. Whatever it can store is the maximum capacity limited to 1.Storage at any time is called prevailing value of the cell.

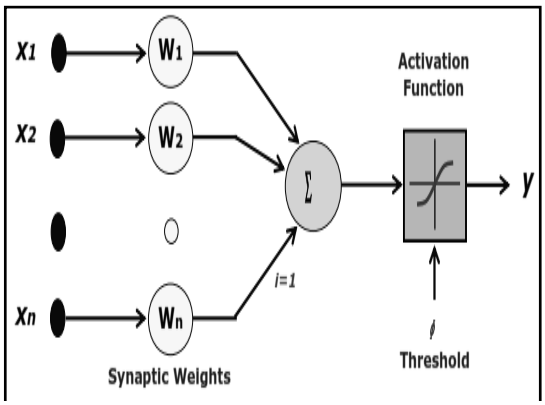



Fig. 7 Threshold in Neural Network

The nodes internal threshold as mentioned in the figure as φ is the magnitude offset.It affects the activation of the node output Y as

$$Y = f(I) = F\{ \sum_{i=1}^{n} xi\ wi - \varphi k \}$$

To generate the final output Y, the sum is passed on to a non-linear filter f called as activation function or transfer function, which releases the output Y.

In practice, neurons generally do not produce an output unless their total input goes above a threshold value .The total input for each neuron is the sum of the weighted inputs to the neuron minus its threshold value. Threshold can dynamically set or altered during the iteration of network solution.Every cell further is insensitive to small fraction of value.

**Activation function:**

A function used to transform the activation level of a unit (neuron) into an output signal. Typically, activation functions have a "squashing" effect. Neural Networks supports a wide range of activation functions. Only a few of these are used by default; the others are available for customization.

Table:1 Different functions in neural network

| Function | Defin -ition | Range | Function | Definition | Range |
|---|---|---|---|---|---|
| Identity | $x$ | -inf,+inf) | Unit sum | $\frac{x}{\sum_i x_i}$ | (0,+1) |
| Logistic | $\frac{1}{1-e^{-1}}$ | (0,+1) | Square root | $\sqrt{x}$ | (0, +inf) |
| Hyperbolic | $\frac{e^x - e^{-x}}{e^x + e^{-x}}$ | (-1,+1) | Sine | sin($x$) | [0,+1] |
| Exponential | $e^{-x}$ | (0,+inf) | Ramp | $\begin{cases} -1 & x \le -1 \\ x & -1 < x < +1 \\ +1 & x \ge +1 \end{cases}$ | [-1,+1] |
| Softmax | $\frac{e^x}{\sum_i e^{x_i}}$ | (0,+1) | Step | $\begin{cases} 0 & x < 0 \\ +1 & x \ge 0 \end{cases}$ | [0,+1] |

The hyperbolic tangent function (tanh): a sigmoid curve, like the logistic function, except that output lies in the range (-1, +1). Often performs better than the logistic function because of its symmetry,ideal for customization of multilayer perceptron, particularly the hidden layers.

## 5. RESULT AND DISCUSSION

Operating rules are often used to provide guidelines for reservoir releases to acquire the best interests of the whole reservoir system, consistent with certain inflow and existing storage levels. They are often predefined at the planning stage of the reservoir construction through simulation techniques. The operating rule curve is one of the most simple and frequently performed operating rules It is usually presented in the form of graphs or tables to direct the release of the reservoir systems according to the tangible storage level, the hydro meteorological conditions and the time of the year .Accordingly, determining how to find the effective operating rules is very essential and can significantly increase the utilization benefits for flood control, energy production, navigation, ecology and water supply. Some reservoir operating rules are typically applicable to reservoir refill. Researchers proposed the space rule, as a special case of the NYC rule, which tried to minimize the total volume of spills. Jain et al. (1998) carried out a reservoir operation study for the India's Sabarmati River System using the historical observed flows, and developed a judicious operation policy for conservation and flood control using simulation techniques. Liu et al. (2006) developed the dynamic programming neural network simplex model using a simulation-based optimizationmethod to derive refill rules for the Three Gorges Reservoir (TGR). They show that it performs better than the original design rule

curves. Ngo et al. (2007) successfully applied the shuffled complex evolution algorithm in combination with the MIKE11 simulation model to optimize the control strategies for the Hoa Binh reservoir operation. The results show that the method can be employed to optimize the rule curves efficiently for reservoir operation in a multi-objective framework. Liu et al. (2011b) proposed a multi-objective refill operation model by combining flood control and conservation together. Although the optimization technique can provide an optimal rule that would maximize the economic benefits as stipulated in many cases, its template rule curves are derived in a fictitious way.

A gap still exists between theoretical model development and practical operation (Panuwat et al., 2009). Labadie (2004) pointed out that it was difficult to make decision on operating policies especially under uncertainty scenario due to the randomness of natural phenomena. Many reservoir system operators feel more comfortable to use predefined operating rules which are easy to comprehend and operate. Therefore, important questions are raised about how such operating rules should be designed and managed to improve the utilization benefits without increasing the flood control risk for a multi-purpose reservoir. The simulation-optimization-test framework and hybrid multiobjective genetic algorithm were used to optimize the rule curves of TGR.

This paper specifically emphasized on the generalized possible approach to control flood using traditional multiple regression model and non linear Neural network model .Variables from the diversified domain regarding flood control will definitely play important role while modeling gate operation for flood control . Most of the multiple objective algorithms such Genetic algorithm, Particle swarm optimization etc. would be the better choice for modeling flood control of reservoir.

## 6. CONCLUSION

The research and approach reported in this paper focused on the simulation of a single multipurpose reservoir for flood management purposes using the traditional and nontraditional approach. Operating rules can be revised for high-flow/flood situation to minimize flooding. Impacts on flood management capacity of the reservoir can possibly be explored by simulating a gated spillway and other gate operations in addition to the existing unregulated spillway. Alternative operating rules may be explored by changing the reservoir storage allocation, reservoir levels at the start of flooding season, and the reservoir outflows. The simulation based approach might be a valuable alternative to conventional simulation techniques. The increased speed of model development, ease of model structure modification, ability to perform sensitivity analysis and effective communication of model results are the main strengths of the reservoir simulation model based on the suggested approach.

However, one limitation is the simplified flood routing as compared with sophisticated hydrodynamic models. Modeling effort can be directed to important tasks such as system conceptualization, data collection, and gaining input from system operators, and involving stakeholders. The entire modeling process should be open, interactive, and transparent. The model needs to be easy to expand and modify in terms of its internal structure and the amount, type, and resolution of data used. Modifications in both structure and values of parameters can be made easily as new information that can affect the model becomes available. The model can then be rerun, the results analyzed, and the model can be improved as necessary. Thus, the entire dynamic modeling process facilitates adaptation of a general model to a particular problem. Numerous simulation scenarios, in addition to what has been discuss in this paper, can be tested using the existing framework. As the current discussion provides information on extent and duration of flooding, another sector can be added to calculate damage to crops or economic losses due to lost opportunity of seeding. The model can be extended from a single multipurpose reservoir to a system of reservoirs.

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