# PRATIBHA

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# Ergonomic Survey In Garment Manufacturing Industry;
# A Research Introduction

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## ABSTRACT

**Purpose –** The purpose of this paper is to describe some of the key areas that influence in garment manufacturing industries, sewing machinists suffer from several health problems, like musculoskeletal disorder of neck and shoulder which have been attributed to poor working postures as well as to the repetitive hand and arm movements. It causes increment in sick leaves, mental disturbances on the working time, less productivity. The modifications to the sewing workstation of garment manufacturing industries have great potential for improving the operator's working postures. These can be done by studying the ergonomic issues in industry. Hence the investigation of ergonomic issues becomes a need in a sewing machine workstation of garment manufacturing industries.

**Design/methodology/approach –** The study includes improvement in work design, machine layout and working conditions with the objective of providing maximum comfort to workers to enhance their health and well-being.Also study supports to MSD(Musculoskeletal disorders) prevention efforts for garment industry workers.This paper basically deals with the some research work related with this design and analysis.

**Findings –** A literature review identified gaps in the research and a set of investigative questions were derived from the review. These questions help define the premise behind the research approach outlined in the paper. Investigative questions were further grouped to identify specific issues and/or areas of concern. Finally, the paper constructs a generic research problem, a tentative research methodology, probable outcomes of the research.

**Practical implications -** India has carved a name for itself as a hub for export oriented garment manufacturing centre globally. Reports reveal that garment industry is the largest manufacturing sector in India. The textiles and garments sector alone employed 20% of the workforce in the manufacturing sector. Women constitute 80% of the workforce in the industry. This paper provides contemporary researchers in the areas of ergonomics in Garment manufacturing industries with knowledge that will help them in improvement in manufacturing aspects and reduce the fatigue of the workers.

**Originality/value -**Initially, the paper proposes a framework for understanding the techniques of the ergonomics used in sewing machine workstation and various Garment manufacturing industries. Subsequently, the paper introduces the software supported by various calculations and designs from the literature. The paper offers guidance to researchers in developing, defining and presenting their research (especially in the case of Ergonomics ) in a systematic and convincing manner.

*Keywords- Ergonomics, Garment Industry, MSD Musculoskeletal disorders.***Paper type** - Conceptual paper

## I. INTRODUCTION

Article of clothing producing enterprises (fitting, cutting material, settling catches, getting done with, checking, pressing, packing) has dreary and repetitive requiring solid visual requests, inappropriate postural prerequisites, including extended periods sitting or remaining in one position. A large portion of the ladies labours whined of spinal pains and breathing issues connected to their work. Ergonomics assumes a key part in zones where clashes amongst man and machine emerges. It manages fitting the man to the activity by meshing the diverse parts into a solitary framework to such an extent that every segment work in synchronized way with the others. These parts incorporate the specialist, the workplace both physical and hierarchical, the errand and the workspace. In this manner perceiving ergonomic hazard factors in the working environment is a basic initial phase in redressing dangers and enhancing

specialist protection.[1,2]Ergonomics can be characterized as the utilization of learning of human qualities to the outline of frameworks. Individuals in frameworks work inside a domain and ecological ergonomics is worried about how they connect with nature from the point of view of ergonomics. Despite the fact that there have been numerous investigations, more than several years, of human reactions to the earth (light, commotion, warm, cool, and so on.) and much is known, it is just with the advancement of ergonomics as a teach that the one of a kind highlights of ecological ergonomics are starting to emerge.[3] Also it can characterized as a train in its own particular appropriate, as the hypothetical and crucial comprehension of human conduct and execution in deliberate cooperating socio-specialized frameworks, and the utilization of that comprehension to plan of collaborations with regards to genuine settings. This definition is defended in the money related, specialized, lawful, authoritative, social, political and proficient settings in which ergonomists work. Based on the historical backdrop of ergonomics and contemporary commitments, it is recommended that it is one of the advanced sciences, drawing as much from the field as from the lab, and including components of a craftsmanship and a specialty too. Support for the new definition is given by looking at the communicating frameworks which are predominant in the cutting edge. At long last various difficulties for ergonomics are recognized. So there is have to rethink the ergonomics.[4]

The sewing undertaking includes moving the material through the machine utilizing the left hand, holding and nourishing the material utilizing the correct hand, controlling the speed of the machine by utilizing a foot pedal and review the work point while additionally performing different controls of the material. These exercises affect the work pose. Seating and workstation measurements likewise seriously oblige the administrator's stances. A few investigations have demonstrated beforehand that alterations to sewing machine workstation courses of action could enhance the administrator's postures.[5,6,7]. Rotator sleeve tendinitis demonstrated a higher level of steadiness than myofascial torment disorder. The two issue exceptionally affected the view of general wellbeing. [8] Some investigations universally have featured musculoskeletal hazard factors related with the material business and piece of clothing making employments on account of profoundly redundant work in clumsy work poses Back, neck and shoulder distress are exceedingly pervasive among these sewing machine operators.[9] People who work inside a move work plan are more powerless to the worry between this kind of working time association with circadian and social rhythms, and subsequently, to endure an assortment of wellbeing and prosperity issues, for example, incessant weariness, stomach related and rest issue, work disappointment and work-family strife because of this they can misfortune their age and life by revealed that expanding on-move number of days was altogether connected with occurrences prompting a word related damage or accidents.[10] The mediation procedures including the overhaul of the workstations and seating and the arrangement of preparing in essential ergonomics standards for enhancing the work life of these administrators. [11]

It is a need to comprehend the diverse procedures in a piece of clothing industry with an ergonomic approach. Ergonomics intercessions can be successful and taken a toll advantageous from an organization viewpoint. The ergonomic issues which are predominant in the ventures and attempts to distinguish their consequences for the wellbeing of the workforce and create essential ergonomic intercessions. The advancements in Sewing machines and its segments like brace for holding designs, scissors, standing office is to be needed.[13,14] Algorithms and heuristics create in cutting and pressing issue then again, interest for more precise arranging quicker yield and bigger cost sparing has driven attire makers to receive new devices and abilities in texture cutting. To enhance profitability programmed spreading machines and automated cutting frameworks were present in 1980s.[15] For enhancing the bundling sap exchange shaping (RTM) is to be presented effectively in composite assembling industry. The stacking succession was observed to be more viable approach to impact permeability.[16] Discrete Optimization for Finding great mixes of layouts and explaining spread out problems.[17] Many specialists have focus towards tackling planning and line adjusting of sewing lines in the article of clothing industry.[18,19] Optimization of spreading and cutting sequencing model are set up for simple working.[20]

A portion of the essential uses of these product devices in working environment configuration are examinations of workspace region, achieving, seeing, leeway, act, quality ability and biomechanics. The primary reasons why these instruments have been picked are on the grounds that they spare cost and time and are exceptionally viable, especially in the beginning times of the plan procedure. The imperative advance arranging in this

method is determination of part and instrument canisters and their courses of action in the workstation with monetary and ergonomic contemplations. To beat every one of these issues a few scientists make another recreation models for arranging new work station changes, postures.[21] The various leveled robotize sewing with two utilizes are available in a few enterprises for simple working .[22] In this study there are the investigations regarding the ergonomic issues and the dis-comfortness of the operators are described. Also identify and describe possible ergonomics deficiencies in the workstation of sewing machine operators in a textile industry.

Suggested research approach is shown in the diagram,
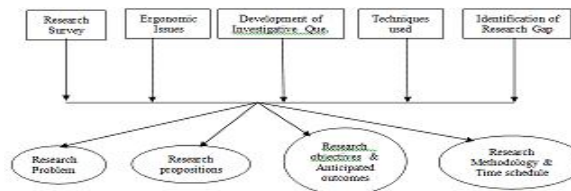


Fig.1: Research Process

## II. Research Survey :Techniques used for Ergonomic Investigations

The use of ergonomics in workplace designing or workstation designing has been started way back in industries. Ergonomics should be regarded as one of the "first truly multi-, inter- and cross-disciplinary subjects that the world requires if we are to understand and improve the lives of people and societies going into the 21st century. The role of ergonomics as the holistic approach to understanding complex interacting systems involving people. The ideas and expertise from different disciplines interested in the effectiveness of human performance (anatomy, physiology, psychology, industrial medicine, industrial hygiene, design engineering, architecture and illumination engineering), and re-design of workstations may define this as physical ergonomics. To reduce workplace health risk exposures through redesign of processes, tools and equipment to improve the musculoskeletal health of workers. In the industries some models are design for dealing with worker according to ergonomics. Some of introducing human software tools for investigating the postural behaviour at sewing machine work stations with the help of ergonomics changes.

The earlier research on methods used in garment industries are as follows:-

1. Introduced SPSS version 20.0 software program for analysis of associated risk factors of work related musculoskeletal disorders.[2]
2. Make prototype sewing machine and check the ergonomic postures. [6]
3. Statistical analysis were performed with computer software to analyse the working conditions of shift workers. [10]
4. NASA Task Load Index (NASATLX) questionnaire to identify and describe possible ergonomics deficiencies. [11]
5. Use of a Computer aided engineering (CAE) system such as DESIGN to create and modify a product structured data base. [12]
6. Introducefuzzification scheme for genetic optimization procedure. [15]
7. Create IP(Integer programming) model for solving layout problems. [17]
8. A discrete event simulation model was developed for process durations, task allocations. [18]
9. Used Heuristic methodology and grouping genetic algorithm (GGA) for to complete the task with balance load. [19]
10. Prepare spreading and cutting sequencing SCS model using GA to solve the sequencing problem. [20]
11. Analyze& new work station design with using ERGO Plan software package. [21]
12. Used intelligent hierarchical controller for the robotized sewing of two plies of fabrics, Fuzzy logic and neural networks. [22]
13. Prepare Mathematical Model for ergonomic design using well-established methods in optimization and workspace analysis. [23]
14. A genetic optimization approach using adaptive ESs is developed. [24]
15. Questionnaire and rapid upper limb assessment (RULA).[25]
16. Software tools like JACK, RAMSIS, SAFEWORK, SAMMIE for investigating the postural behaviour at sewing machine work stations. [26]
17. The discomfort analysis by Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) and also the Rapid Entire Body Assessment (REBA) was carried out.[27]

## III. Research Problems : Ergonomic Issues

I1. Improper work postures - Musculoskeletal disorders
I2.Difficult Work station - logistical weaknesses

I3.Long hours sitting or standing in one position - backaches and breathing problems.

I4.Too short break – More Absenteeism

I5. Working conditions of shift workers -  accident severity, low productivity

I6.Completion of target within time - Signs of psychological problems, low quality

I7. Working in traditional frameworks -  fatigue of workers

I8. Vibrations and noise on the work station – Severe Headeque among the workers.

## IV.  Identification of Research gap

Table No.1: Identification of research Gap

| Research Gap Issues | Views Reported |
|---|---|
| 1. Understanding of ergonomic postures | Visualize the limb's workspace envelope in 3D abdelmalek<br>A Study of the principles, methods and models used in environmental ergonomics is provided in terms of the effects of heat and<br>cold, vibration, noise and light on the health.k.c.parsons(2000)<br>Working posture and workers' perceptions were measured.Nico(2002)<br>Design of new workstation with simulation models. fulder(2005)<br>This study analyzed the relationship of age and tenure with occupational accident severity of 156 male shiftworkers at an industrial plant, Statistical analysis.Angel(2009)<br>Study the sewing machine workstation of garment manufacturing industry.Mukund(2014)<br>Identifed the prevalence of musculoskeletal symptoms and ergonomic Risks.Nilufer(2011) |
| 2. Traditional working methods | High occurrence of musculoskeletal complaints<br>and neck and shoulder disorders havebeen  studied of women sewingmachine operators Annette(2000)<br>To identify possible ergonomic deficiencies in the standing modular workstation of sewing machine operators.Sakthi(2017) |
| 3. Absence of performance measurements | A model of a woman custom-built in JACK is used inthe analysis. Asyraf(2003) fuzzify thestatic standard time so as to incorporate some uncertainties, in terms of both job-specific and human related factors,into the fabric-cutting scheduling problem. Mok(2006) |
| 4. Poor Strategic vision | Minimize the fabrication time and the idle time of the computerized cuttingmachine.w.k.wong(2000)<br>study was to identify and describe possible ergonomics deficiencies in the workstation of sewingmachine operatorssealsetsa(2010) |
| 5. Improper worker and manager relationship | Work accidents among shift workers in Industry. Nag(1996) |
| 6. Improvements in performance | data collection about worker satisfaction.Narayan(2013)<br>Economic evaluation is done for cost benefit by considering the ergonomic factors. Emile (2013)<br>The planning is done to assign the task to the workstation so as to complete the task with balance load.James(2012) |

## V.  Research Investigative Questionnaire

Table No. 2: Research Investigative Questionnaire

| Research Gap leading to RQs | Research Question (RQ) Leading to Investigative Questions | Investigative Questions (IQ) |
|---|---|---|
|  |  |  |

| RG1 | At present is there a proper arrangement between work station and human posture? | What are the factors to be considered for man machine relationship? |
|---|---|---|
| RG2 | Are they implement the newly design working methods? | Which methods are identified for comfort of the workers? |
| RG3 | Is the work design on the basis of performance measurement? | Shift workers are capable for doing their work in given time? |
| RG4 | Working strategy is in favour of workers or not? | Are the workers liable for punishment due to non completion of target? |
| RG5 | Working environment is friendly or not? | What factors should be needed to improve the worker and manager relationship? |
| RG6 | Are they measure the improvement in performance? | Which performance parameters should be measure for improvement? |

## VI. Research Propositions

For any industry it is very much important that their employee should get work satisfaction as they are the main asset of the plant. For increasing productivity and smooth running of the plant, workers should get good comfort while working because worker plays vital role in the industry. To get this, study of the ergonomic conditions is needed. The parameters need to be identified related to the ergonomics in sewing machine workstation are as follows.

➢ Study of sewing machine workstation in detail.
➢ Study of ergonomics involved in sewing machine workstation of garment manufacturing industry.
➢ Identify various parameters affecting sewing machine operator and productivity related to ergonomics in sewing machine workstation.
➢ Identify factors affecting overall working and quality output of the garment manufacturing industry.
➢ Study of effects of light, noise, vibration, and thermal environments on the health.
➢ Correlate various parameters with anthropometric data of sewing machine operator and various measures of sewing machine workstation.
➢ Prepare mathematical model to optimize various parameters related to workplace design of sewing machine workstation.
➢ Recommendations for re-dimensioning of the workstation.
➢ Recommendations on workstation adjustment and modifications needed to minimize the load on the musculoskeletal system and health.
➢ Recommendations for Computer aided work station design with skilled operator and lot of knowledge of ergonomic design.

To achieve these objectives there are some barriers as well as the enablers. Also after achieving all the goals the work station might have some benefits. Objectives, barriers and the expected benefits are tabulated here.

Table No.3: Prepositions with barriers

| Objectives | Barriers | Enablers | Benefits |
|---|---|---|---|
| Study of sewing machine workstation | *Response from the company people* | Literature Survey | Problem Identification |
| Study of Ergonomic factors in work station | *Un willingness of the entrepreneur* | Instruments | Collection of anthropometric data |
| Identify the factors affecting overall working & quality | *Building a trust among workers* | Quest ionnaire | Easy to find the solution |
| Study the effect of light,noise, Vibration& Thermal environment | *Availability of feasible conditions* | Quest ionnaire | Identify the factors affecting productivity |
| Correlate various parameters with anthropometric data | Lack of the data | Relat ed software | Suggestions for modifications |

| Prepare mathematical model | Lack of the data | Calculations | Optimization of various parameters |
|---|---|---|---|
| Recommendations for re-dimensioning of the Workstation | | Co-relation of data | Human comfortness During working |
| Recommendations for Computer aided work | | Analysis of data | Smooth working &Improve quality |

Correlation between the Research gaps, arising research and investigative questions, issues and objectives presented in following pictorial view as a Research process:-



Preposition 1: Study of ergonomics involved in sewing machine workstation of garment manufacturing industry.
Preposition 2: Identify various parameters affecting operator and productivity & quality related to ergonomics.
Preposition 3: Study of effects of light, noise, vibration, and thermal environments on the health.
Preposition 4: Correlate various parameters with anthropometric data.
Preposition 5: Prepare mathematical model to optimize various parameters related to workplace design.
Preposition 6: Recommendations for re-dimensioning of the workstation.
Preposition 7: Recommendations for modifications needed to minimize the load on health.
Preposition 8: Recommendations for Computer aided work station design with skilled operator.

Fig.2: Correlation of Processes

## VII. Research Methodology and Time schedule: Future Directions in Research

Indian Garment manufacturing industries are failing to achieve their business potential due mainly to myopic viewpoints which results in weak quality processes and products, late deliveries due to health issues among the sewing machine operators. Increased manufacturing and delivery lead times influence the Indian Garment Industries. The proposed research framework will help redefine the Sewing machine work station, which is mainly focused on studies about Ergonomics. For the purposes of the proposed approach, an exploratory multiple case study would be conducted. In addition, the outcomes of such research are expected to identify causal relationships between Factory owners and workers which will further help to prioritize decision making in the growth of Productivity.

1. Literature Review 18
2. Industry visits and situational analysis 6
3. Questionnaire development 6
4. Data collection and preparation 4
5. Model formulation and development 10
6. Model results interpretation 4
7. Analysis and interpretation 2
8. Report Writing 4

Improved quality of work and reduced fatigue of workers at the sub-assembly level can surely bring value to the customer. The proposed research framework is also anticipated to offer benefits for the garment manufacturing sector. A better understanding of ergonomic postures and their logistical weaknesses, which were until recently, considered to be routine. This understanding may improve the productivity, reduced fatigue and improvements in the quality of products. . A better understanding of the factors those produce a strategic fit between workers and the work place. This will highlight the necessary changes required in present practices, performance measurement and

organizational structures.In sum, this paper is informative in nature. It has documented key issues related to the ergonomic investigation in sewing machine work station in India and the difficulties it faces in the manufacturing. At this stage, we consider that research projects that follow the framework advocated above and take account of the anticipated outcomes, knowledge about ergonomic comfort of workers in India will be expanded. The below references also provide pathways for developing insightful understandings about the many problems faced by textile industries.

## VIII.Conclusion

Over all specialists gives the thought regarding outlining of the sewing machines work stations. It clarifies about the different worries to be considered while working in piece of clothing fabricating businesses. Likewise the majority of the scientists utilized the diverse programming's for examination.
a.The research ponder discoveries may give the ergonomic solace to the administrators by embracing reasonable working environment plan and working conditions.
b. The ergonomic changes in the sewing machine workstation spares the season of assembling.
c. Because of the right ergonomic stances MSD (Musculoskeletal disorders)can be avoided.
4.Productivity may increment with the ordinary working conditions.

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# Green Supply Chain Management (GSCM) - A Literature Review and Conceptual Framework

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**Abstract: - The purpose of this paper is to provide the Green Supply Chain Management (GSCM) practices and to briefly review the recent literatures of the GSCM and also determine the new direction area of this emerging field. The literature is needed to focus on aspects like Practices, implementation of GSCM In industry, its performance, and analysis etc. Based on the literature the review is constructed to find the key research topics, interrelations and alliance patterns. The work involves the study of practices, implementation and the recent development in the field of GSCM, to get the areas where the GSCM can be applied. The study also identifies barriers to a sustainable Green supply chain.**

**Keywords:-***GSCM, GSCM implementation, , GSCM Framework, Research area in GSCM.*

## 1 INTRODUCTİON

Environmental disturbance and the deterioration of the naturalresources have become the topic of concern to various government bodies and organizations due to increased high levels of industrialization. High environmental risk industries, including chemical, plastic, automotive, and heavy engineering, have always considered improvements in environmental performance as one of the basic competitive priorities, alongside lower costs, manufacturing lead-time, and quality. The European Union passed the Restriction of Hazardous Substance and the Waste Electrical and Electronic Equipment regulations demanding compliance with the relevant regulatory laws of product recycling and prohibiting the use of hazardous substances in products for sale in the market. In this development, the supply chain manager plays a key role of selection and development of green strategies with the objective of improving environmental, economic, and social performance.The Supply chain manager can interact the firm with the environment in four ways, which include; the firm and its survival, the immediate business environment, the society in which it operates and the natural environment which is the source of its livelihood.Green supply chain management can be proved as an important strategy management in overcoming the environmental problems caused due to waste produced in industries. In addition to the greening of internal processes, an organization needs to integrate green strategies into its entire span of supply chain activities, which is called green supply chain management (GSCM). Though sustainability is the major concern in today's organisations, very little research has been done to investigate the GSCM practices in Indian Industries and their Environmental Performance. Many large companies globally that focus on sustainable strategies has launched green supply chain programs designed to promote environmental management practices throughout their supply chain network.

## 2 LITERATURE REVIEW

### 2.1GSCM- A brief background

There are various definition of GSCM exists in the literature. They all aims to improve design of product, selection of material, manufacturing process as well as the end to end life management of the raw material and final finished product after its useful life. It include reduction of energy use, using renewable alternatives, Cutting water volumes, countering contamination ,reducing, scrubbing or sequestering green house gas(GHS),decreasing quantities of waste recycling packaging, materials,etc. Considering the importance of green design Navin Chandra's first presented literatureon green design suggesting importance of reducing the product waste [8]. Concept of Green Supply Chain (GSC) was firstly proposed by the Manufacturing Research Consortium (MRC) of Michigan State University

in the U.S. in 1996, for comprehensively considering environmental impacts and resources optimization of manufacturing supply chains [3, p.387]. The aims were to minimize the impacts on environmental i.e. related to the products end-of-use by tracking and controlling the raw material procurement, in order to ensure compliance with environmental rules and regulations starting from the stage of product R&D. The literature shows researchers have studied the GSCM adoption and implementation in developed countries but still limited studies have examined in developing countries like India. Green Operations in terms of reverse logistics was an important concept that came out of the GSCM Walton et al. (1998) conducted a GSCM study based eco design, green manufacturing and packaging, environmental participation, green marketing, stock and suppliers. Many researchers (Zhu et al., 2005, 2007; Ninlawan et al., 2010;) studied Green supply chain management: pressures, practices and performance within the Chinese automobile industry and Thailand electronics industry. They observed that increasing pressures from a variety of directions improve both their economic and environmental performance. Zhu et al., (2005, 2007) also focused on different dimensions of practices including green procurement, internal environmental management, eco design, customer cooperation, and investment recovery. Hsu, and Hu (2008) studied the green supply chain management in the electronic industry in which they mentioned various approaches for implementing green supply chain management practices, nevertheless no investigation on reliability and validity of such approaches. Shang et al. (2010). The researcher (Mudgal et al., 2009, 2010; Sarode, and Bhaskarwar, 2011) has identified the various variables which help in greening the supply chain of Indian manufacturing sector. They merely focused on top management commitment, societal concern for protection of natural environment, regulations, supplier involvement, customer satisfaction, EMS, employee involvement/empowerment, green product development, green procurement practices, availability of clean technology, green disposal, green transportation, 3R- reduce/ remanufacture/ recycle, lean manufacturing practices, economic interests, eco labelling of products, reverse logistics practices, competitiveness and corporate image. The researcher ( Ajchara et al. , 2016) investigates the procurement process effecting green-supply chain management in manufacturing industry in Thailand.

## 2.2 Critical areas of GSCM

Critical areas and the main driving forces behind the green strategy chosen were analyzed. A closer look at the selected studies indicated that these studies can be categorized into four main areas of focus as shown in Table No. 1.

Table No. 1 Main Driving Force of Green Supply Chain

| SSr. No | Description of area of case study | End goals |
|---------|-----------------------------------|-----------|
| 1 | Use of performance standards, prescribing basic environmental requirements across the supply chain | Waste (of all types): minimization of waste; Energy usage: minimize energy consumption; and Resource usage or material consumption: optimize resource usage. |
| 2 | Integrating operational efficiency and waste reduction alongside supply chain objectives | |
| 3 | Use of environmental friendly technologies and innovations and their transfer across the supply chain | |
| 4 | Supply chain collaboration, development of remanufacturing and recycling systems | |

### 2.3 Implementation and Frame works

The conceptual framework from the literature review is shown in Figure 1. The causal relationship between GSCM drivers, Green SCM practices and Environmental performance has been found in literature.



Fig. No. 1 Key Indicators of Supply Chain Management

In the previous article we understand the main practices of GSCM. Now to implement the GSCM there is a need a driver their different drivers and their framework according to the industry. There are two main drivers [26,p.98].External drivers are those that are not from the organization they may be stakeholders that posit pressure on organization, government bodies that means the set of regulations and act that exert pressure on the organization. Customer pressure, NGO's pressure and environmental societies pressure to form the green product [27,p.389], [28,p.124]. Internal drivers are the practices done internally that is cost saving from waste, recycling and reusing of materials with lower consumptions of energy and efficient resource [28,p.123]. To use standards like ISO 14001 and to generate the good publicity for the organization. To emanates mainly from prevalent green culture and awareness in the organization and its supply chain members. This lead these organizations to assume responsibility over product reuse and recycling as an element of environmental management.
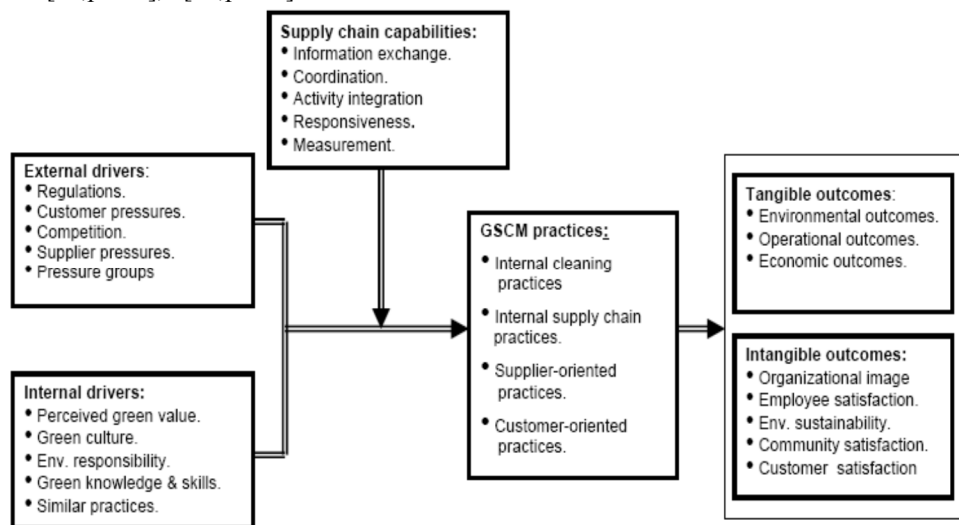


Fig. No. 2 Conceptual Framework of the study (Source; Tarig Eltayeb [6] p-7)

The use of TQM may encourage the firms to implement GSCM. Since these are the drivers which integrate in the firms to reduce the impact on the environment asstrategic initiatives [20,p.87], [10,p.1708].The framework listed above shows that the external drivers act as primary motivators and internal drivers as stronger motivator and supply chain capabilities as catalyst or mechanism for higher level implementation. The organization must understand the importance of internal drivers.

## 3 DISCUSSION AND CONCLUSION

The paper has discussed the importance of implementing GSCM in Indian industry through study of the relevant literature. The paper also study the model incorporated previously and elements,capabilities,driver,and outcomes involvement in GSCM life cycle. These practices are new as compared to traditional methods of supply chain management. Green supply chain is a panacea to environmental degradation. Green engineering will produce green products, which can be recycled and disposed off without harming the environment. The awareness of GSCM is needed for each employee and customer also then and only then the GSCM can be fully implemented. The paper tries to explain few concepts with the help of some framework developed by some researchers. There are theories by which we can developed the framework that are porter's theory, RBV, TCT etc.

Researchers focus on various sectors but very few work is done in the indian small scale industries (that means on supplier) sector. More effort has to be taken to empower GSCM.in the area of Designing of products, production, material purchase, packaging, ware housing and reverse logistics.

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# Identification of Variables and Formulating Approximate Generalized Field Databased Mathematical Model in Investigation of Thermoelectric Generator System for its Performance Enhancement

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**Abstract:**

**Dimensional Analysis is an focus tool for analyzing fluid flow problems. This mathematical technique can be used for solving several engineering problems. Each physical phenomenon can be expressed as an equation giving relationship between different quantities such quantities are dimensional and non- dimensional. Dimensional analysis helps in determining a systematic arrangement of variable in physical relationship, combining dimensional variables to form non dimensional parameters. It is specifically useful in presenting experimental results in a concise form. In present work it was studied the basic theory and operation of thermoelectric systems developed. Considering the modeling based on the experimentation to eliminate number of independent variables and to generalized the results. On the basis of experimentation identified independent and dependent variables from thermoelectric generator system and developed the three relevant dimensionless independent Pi terms and one dependent Pi term as current. It helped to focus influencing performance of Thermoelectric Generator system (TEG)**

*Keywords: Field Data based Mathematical Modeling, Dimensionless analysis, TEG module*

## I. INTRODUCTION TO TEG

The basic theory and operation of thermoelectric based systems have been developed for many years. Thermoelectric power generation is based on a phenomenon called Seebeck effect discovered by Thomas Seebeck in 1821 [5]. When a temperature difference is established between the hot and cold junctions of two Dissimilar materials (metals or semiconductors) a voltage is generated, i.e., Seebeck voltage. In fact, this phenomenon is applied to thermocouples that are extensively used for temperature measuremen
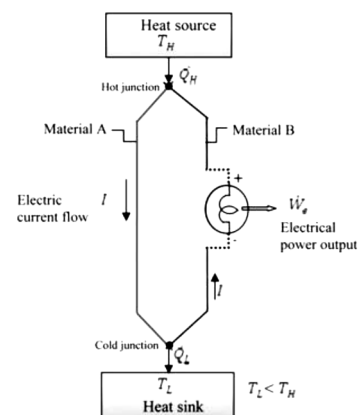


Fig.1. Schematic diagram showing the basic concept of a simple thermoelectric power generator operating based on Seebeck effect. [5]

In above figure heat is transferred at the rate of QH from a high temp. Heat source maintained at TH to the hot junction, and rejected heat rate of QL to low temp. sink maintained at TL. Due to the heat supplied at hot junction, causes the electric current to flow in the circuit to produced electrical voltage [5]

### i) COMPONENTS OF THE THERMOELECTRIC GENERATOR:

as foundation mechanical integrator & electrical insulator for n-type (to create electron) and p-type (to create excess holes) semiconductors elements. The thermoelectric material operates as the charge carriers & electron carriers. The sizes of conventional thermoelectric devices vary from 3mm$^2$ by4 mm thick to 75 mm$^2$ by 5 mm thick. Due to mechanical consideration the length of most of the module not exceeds more than 50 mm [5].

Fig 2: Schematic diagram showing components and arrangement of a typical single stage thermoelectric power generator [5]

Fig.2. shows a illustrating diagram of components & arrangement of a conventional single stage thermoelectric power generator It consist of two ceramics plates, which are used

## II. EXPERIMENTAL SET UP FOR INVESTIGATING THE PERFORMANCE OF TEG MODULE
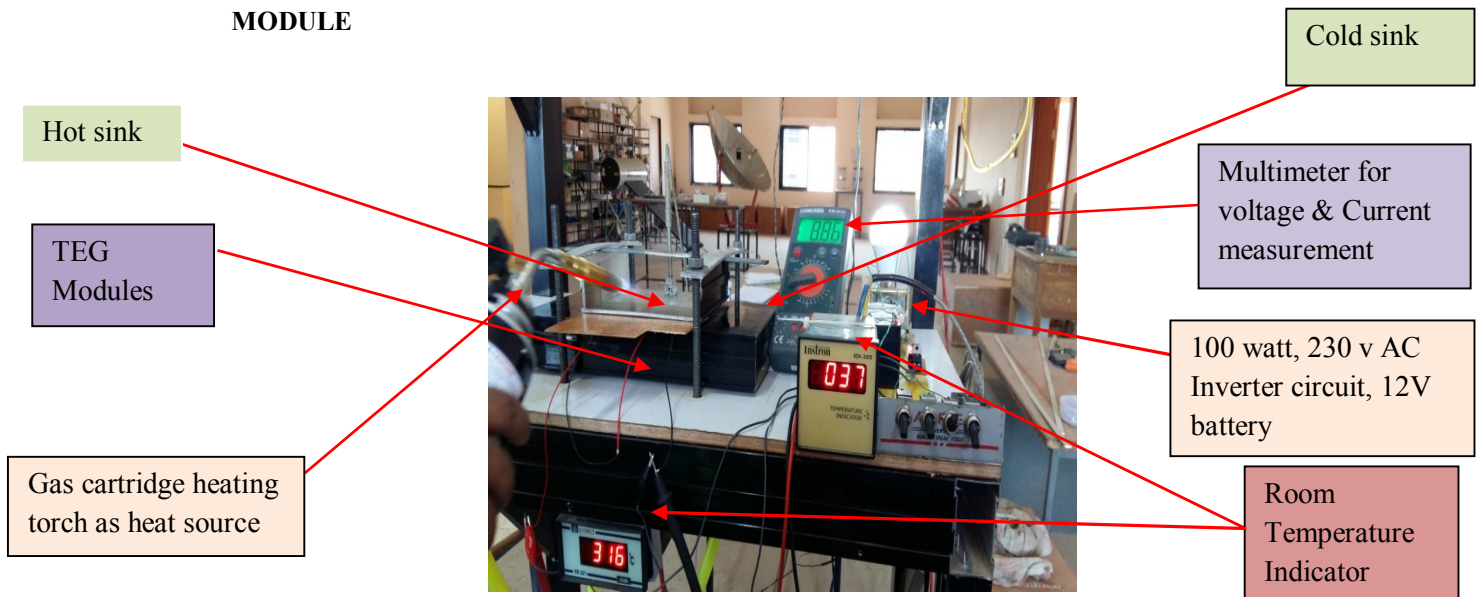


Fig. 2 Picture of TEG experimental setup with Gas cartridge heating torch as heat source [11]

**Working:**

Fig. 2 shows TEG experimental setup with Gas cartridge heating torch as heat source is developed and tested [11]. TEG module is placed into a system, whereby the hot side has a higher temperature than the cold side, DC power will be produced. The greater the ΔT (difference in temperature across the module the greater the power produced) . During testing hot side temperature is maintained at 300 °C by using Gas cartridge heating torch as heat source and cold side temperature at 30 °C

by cold water as source [5]. TEG module terminal connected to multimeter for measurement of voltage and current. and these modules can be placed in parallel and series to produce a workable larger voltage. After testing results were obtained as power output of both TEG modules (TEG Module 1268-4.3 and TEG Module 4199-5.3) is measured 5.0925 W and 6.256 W respectively [11]

### III. Identification of Independent and Dependent Variables:

**a). Independent Variables in the form of LMTθ**

**a.i)** Variable related to Butane gas portable gas cartridge used as heat source

| Pi Term | Code | Name of Independent Variables | LMTΘ | Type of Variables | Rem. |
|---|---|---|---|---|---|
| | A1 | Mass of butane (m) (Kg) | $M^1 T^0 \theta^0$ $L^0$ | Independent | |
| | A2 | Volume of butane gas (V) (m3) | $M^0 T^0 \theta^0$ $L^3$ | Independent | $\pi 1 =$ |
| | A3 | Pressure of butane gas (Pb) (N/m2) (Kg/mS2) | $L^{-1} M^1 T^{-2} \theta^0$ | Independent | $\dfrac{A6 \, x \, A9 \, x \, A19}{(A7 \, xA8)}$ |
| | A4 | Density of butane gas ($\rho_b$) (kg/m³) | $M^1 T^0 \theta^0$ $L^{-3}$ | Independent | $\dfrac{A2}{(A12 \, xA13 \, xA14)}$ |
| π1 | A5 | Kinematic viscosity of butane gas (m²/s) | $M^0 T^{-1} \theta^0$ $L^2$ | Independent | $x$ $\dfrac{A16 \, x \, A15}{(A17 \, xA18)}$ |
| | A6 | Sp heat at constant pressure (Cp) (J/KgK) | $M^0 T^{-2} \theta^{-1}$ $L^2$ | Independent | $\dfrac{A4 \, xA12 \, xA13 \, xA14}{(A1)}$ |
| | A7 | Sp. heat at constant volume (Cv) (J/KgK) | $M^0 T^{-2} \theta^{-1}$ $L^2$ | Independent | $x \dfrac{(A3 \, xA2)}{A11} x$ $\dfrac{(A5 \, xA5 \, xA1)}{(A11 \, xA14 \, xA15)}$ |
| | A8 | Enthalpy (h) (J/Kg) | $M^0 T^{-2} \theta^0$ $L^2$ | Independent | $x \dfrac{(A10 \, xA19 \, xA20xA}{(A8 \, xA1)}$ |
| | A9 | Entropy (s) (j/Kg-K) | $M^0 T^{-2} \theta^{-1}$ $L^2$ | Independent | |

| | | | | | |
|---|---|---|---|---|---|
| 10 | A | Thermal conductivity (W/mK) | $M^1$ $L^1$ $T^{-3}$ $\theta^{-1}$ | Independent | |
| 11 | A | Total Enthalpy (H) (Joule) (N-m) (Kgm²/S²) | $M^1$ $L^2$ $T^{-2}$ $\theta^0$ | Independent | |
| 12 | A | Height of gas cartridge (He) (m) | $L^1$ $M^0$ $T^0$ $\theta^0$ | Independent | |
| 13 | A | Diameter of gas cartridge (D1) (m) | $L^1$ $M^0$ $T^0$ $\theta^0$ | Independent | |
| 14 | A | Length of pipe attached to gas cartridge (L1) (m) | $L^1$ $M^0$ $T^0$ $\theta^0$ | Independent | |
| 15 | A | OD of pipe attached to gas cartridge (D2) (m) | $L^1$ $M^0$ $T^0$ $\theta^0$ | Independent | |
| 16 | A | Length of nozzle (L2) (m) | $L^1$ $M^0$ $T^0$ $\theta^0$ | Independent | |
| 17 | A | Tip diameter of nozzle (D3) (m) | $L^1$ $M^0$ $T^0$ $\theta^0$ | Independent | |
| 18 | A | ID of pipe attached to gas cartridge (D4) (m) | $L^1$ $M^0$ $T^0$ $\theta^0$ | Independent | |
| 19 | A | Temp of gas inside (θ1) (0K) | $L^0$ $M^0$ $T^0$ $\theta^1$ | Independent | |
| 20 | A | Time (t1) (s) | $L^0$ $M^0$ $T^1$ $\theta^0$ | Independent | |

Table: 1 Variables in the form of LMTθ

**a. ii)Variable related to Heat sink (water) used as Cold source**

| Pi Term | Code | Name of Independent Variables | LMTθ | Type of Variables | Rem. |
|---|---|---|---|---|---|
| π2 | B1 | Length of tank (Lt) (m) | $L^1$ $M^0$ $T^0\theta^0$ | Independent | $\pi2 = \frac{B7}{B8}x$ |

| | | | | | |
|---|---|---|---|---|---|
| B 2 | Height of tank (Ht) (m) | $L^1$ $M^0\,T^0\theta^0$ | Independent | $\dfrac{B5}{B9}$ | |
| B 3 | Width of tank (Wt) (m) | $L^1$ $M^0\,T^0\theta^0$ | Independent | $x\dfrac{B6}{B10}$ | |
| B 4 | Volume of tank (Vt) (m³) | $L^3$ $M^0\,T^0\theta^0$ | Independent | $x\dfrac{B12}{B14}$ | |
| B 5 | OD of discharge pipe (D5) (m) | $L^1$ $M^0\,T^0\theta^0$ | Independent | $x\dfrac{B15}{B16}$ | |
| B 6 | ID of discharge pipe (D6) (m) | $L^1$ $M^0\,T^0\theta^0$ | Independent | $x\dfrac{(B17xB4)}{B19}$ | |
| B 7 | Length of discharge pipe (Ld) (m) | $L^1$ $M^0\,T^0\theta^0$ | Independent | $x\dfrac{B11}{B13}$ | |
| B 8 | Length of suction pipe (Ls) (m) | $L^1$ $M^0\,T^0\theta^0$ | Independent | $x\dfrac{(B18xB20xB20)}{B3}$ | |
| B 9 | OD of discharge pipe (D7) (m) | $L^1$ $M^0\,T^0\theta^0$ | Independent | $x\dfrac{B1}{B2}$ | |
| B 10 | ID of discharge pipe (D8) (m) | $L^1$ $M^0\,T^0\theta^0$ | Independent | $x\dfrac{(B21xB20xB20x}{B19}$ | |
| B 11 | Velocity of water flowing in discharge pipe (ϑ1) (m/s) | $L^1$ $M^0\,T^{-1}\theta^0$  17 | Independent | $x\dfrac{B22}{B23}$ | |
| B 12 | Flow rate of water (Q1) (m³/s) | $L^3$ $M^0\,T^{-1}\theta^0$ | Independent | | |
| B 13 | Velocity of water flowing in suction pipe (ϑ2) (m/s) | $L^1$ $M^0\,T^{-1}\theta^0$ | Independent | | |
| B 14 | Flow rate of water in suction pipe (Q2) (m³/s) | $L^3$ $M^0\,T^{-1}\theta^0$ | Independent | | |
| B 15 | PE of water in supply tank (P.E.) (Kgm²/s²) | $M^1$ $L^2T^{-2}\theta^0$ | Independent | | |
| B 16 | KE of water in supply tank (K.E.) (Kgm²/s²) | $M^1$ $L^2T^{-2}\theta^0$ | Independent | | |

| | | | Name | LMTθ | Type | Rem. |
|---|---|---|---|---|---|---|
| | B 17 | | Density of water ($\rho_w$) (kg/m³) | $M^1 L^{-3} \theta^0$  $L^0$ | Independent | |
| | B 18 | | Acceleration due to gravity (g) (m/s²) | $M^0 T^{-2} \theta^0$  $L^1$ | Independent | |
| | B 19 | | Mass of water (m) (kg) | $L^0 M^1 T^0 \theta^0$ | Independent | |
| | B 20 | | Time required to reach water to TEG module ($t_2$) (s) | $M^0 T^1 \theta^0$  $L^0$ | Independent | |
| | B 21 | | Pressure of water (Pw) (Kg/ms²) | $L^{-1} T^{-2} \theta^0$  $M^1$ | Independent | |
| | B 22 | | Temperature of water at discharge pipe ($\theta_2$) (0K) | $M^0 T^0 \theta^1$  $L^0$ | Independent | |
| | B 23 | | Temperature of water at suction pipe ($\theta_3$) (0K) | $M^0 T^0 \theta^1$  $L^0$ | Independent | |

Table: 2 Variables in the form of LMTθ

**a.iii).Variable related to Thermoelectric Generator Module (TEG)**

| Pi Term | Code | Name of Independent Variables | LMTθ | Type of Variables | Rem. |
|---|---|---|---|---|---|
| π3 | C1 | Length of thermo element in TEG module (Lte) (m) | $L^1 M^0 T^0 \theta^0$ | Independent | $\pi 3$ $=\dfrac{(C12 x C15)}{C18}$ $x\dfrac{C17}{(C14 x C4)}$ $x\dfrac{(C13 x C11 x C5?)}{C19}$ $x\dfrac{C19}{C20}$ $x\dfrac{C1}{C2}$ $x\dfrac{C3}{C6}$ $x\dfrac{C7}{C8}$ $x\dfrac{C9}{C10}$ |
| | C2 | Width of thermo element in TEG module (Wte) (m) | $L^1 M^0 T^0 \theta^0$ | Independent | |
| | C3 | Height of thermo element in TEG module (Hte) (m) | $L^1 M^0 T^0 \theta^0$ | Independent | |
| | C4 | Length of TEG module (Lm) (m) | $L^1 M^0 T^0 \theta^0$ | Independent | |
| | C5 | Width of TEG module (Wm) (m) | $L^1 M^0 T^0 \theta^0$ | Independent | |
| | C6 | Height of TEG module (Hm) (m) | $L^1 M^0 T^0 \theta^0$ | Independent | |

| | | | | | |
|---|---|---|---|---|---|
| C7 | Area of hot side surface (Ah) (m$^2$) | $M^0 T^0 \theta^0$ $L^2$ | Independent | | $xC16$ |
| C8 | Area of cold side surface (Ac) (m) | $M^0 T^0 \theta^0$ $L^2$ | Independent | | |
| C9 | Hot side surface temperature (Th) ($^0$C) | $M^0 T^0 \theta^1$ $L^0$ | Independent | | |
| C10 | Cold side surface temperature (Tc) ($^0$C) | $M^0 T^0 \theta^1$ $L^0$ | Independent | | |
| C11 | Temperature difference across the TEG module ($\Delta t$) ($^0$C) | $M^0 T^0 \theta^1$ $L^0$ | Independent | | |
| C12 | Room temperature around TEG module (Tr) ($^0$C) | $M^0 T^0 \theta^1$ $L^0$ | Independent | | |
| C13 | Thermal conductivity of TEG module (K) (W/mK) (KgmS$^{-3}$K$^{-1}$) | $L^1 M^1 T^{-3} \theta^{-1}$ | Independent | | |
| C14 | Total internal electric resistance for module (R) ($\Omega$) | $M^1 T^{-3} A^{-3}$ $L^2$ | Independent | | |
| C15 | Seebeck coefficient ($\sigma$) (V/K) | $M^1 T^{-3} \theta^{-1} A^{-3}$ $L^2$ | Independent | | |
| C16 | Figure of merit (ZT) | $M^0 T^0 \theta^0$ $L^0$ | Independent | | |
| C17 | Electrical resistivity ($\Omega$ m) | $M^1 T^{-3} A^{-2}$ $L^3$ | Independent | | |
| C18 | Voltage of TEG module (v) (V) | $M^1 T^{-3} A^{-1}$ $L^2$ | Independent | | |
| C19 | Heat liberated at hot junction (Qh) (W) (Kgm$^2$/s$^3$) | $M^1 T^{-3} \theta^0$ $L^2$ | Independent | | |
| C20 | Heat absorbed at cold junction (Qc) (W) (Kgm$^2$/s$^3$) | $M^1 T^{-3} \theta^0$ $L^2$ | Independent | | |

Table: 3 Variables in the form of LMTθAmp

## IV. PROCEDURE FOR FORMULATING THE MATHEMATICAL MODEL BY DIMENSIONLESS ANALYSIS TECHNIQUE.

Dimensional analysis involves a dimensional model analysis of acting quantities in the investigated process. It enables one to determine, in a simple algebraic way, dimensionless similarity criteria and functional relations, represented amongst them by a criterion equation. Further, it enables the conversion of physical quantities into other various fundamental sets of measuring units, the conversion of measuring units and other procedures. In modeling and experiment, its main function is to reduce the amount of independent variables, to simplify the solution and to generalize the results thereof. It can become an effective method, especially if a complete mathematical model of the investigated process is not known. This is a method, simple from the practical point of view, which does not enable either solving a problem completely or revealing important inner couplings of an investigated phenomenon. However, it is an extraordinarily effective means of obtaining an idea about the behavior of a phenomenon if neither its complete mathematical nor physical descriptions are known. Usually, it is an important physical tool in every more complicated physical, scientific or industrial experiment. The main functions of dimensional analysis are the following.

1. Determination of the number and form of dimensionless quantities which represent the similarity criteria.
2. Reduction of the numbered independent variables in an experiment, simplification of the solution and generalization of its results.
3. Conversion of the basic set of units of the measurement.
4. Conversion of physical quantities into another basic set of units of measurement.
5. Determination of functional relations in cases where the solver does not know more detailed information of the physical principle of the investigated phenomenon and no complete mathematical description of the phenomenon is known.

In application of dimensional analysis, the highest efficiency is reached in its combination with general physical ideas obtained by a solver directly from experiments. The depth of previous knowledge of the physical principles of the investigated phenomenon can influence and extend considerably the possibilities of the dimensional analysis.

## V. MODEL FORMULATION
## a. i) INTRODUCTION

The data of the independent and dependent parameters of the process has been gathered during the experimentation. In this case there are three independent and one dependent pi terms. It is necessary to correlate quantitatively various independent and dependent pi terms involved in the process. This correlation is nothing but a mathematical model as a tool for every process. The optimum values of the independent pi terms can be decided by optimization of these models for maximum output. This section describes the procedure for development of experimental data based mathematical models.

## a.ii) DEVELOPMENT OF EXPERIMENTAL DATABASED MATHEMATICAL MODEL

Three independent pi terms (viz. $\Pi 1$, $\Pi 2$ and $\Pi 3$) and one dependent pi terms (viz. $\Pi D1$,) have been identified in this formulation. Each pi term is assumed to be the function of the available independent pi terms.

Independent pi terms = $(\Pi 1, \Pi 2, \Pi 3)$

Dependent pi terms = $(\Pi D1)$

Each dependent pi is assumed to be function of the available independent pi terms,

ΠD1, First dependent pi term = f (Π1, Π2, Π3)

Where, "f = function of". A probable exact mathematical form for this phenomenon could be the empirical relationships in between dependent dimensionless ratio and independent dimensionless ratio are assumed to be exponential.

**a.iii) DEVELOPMENT OF MODEL FOR DEPENDENT PI TERM ΠD1**

The observation table considered for development of model for dependent pi term ΠD1 is as follows.

| ∏1 | ∏2 | ∏3 | ∏D1 |
|---|---|---|---|
| 2.36E-07 | 2.00069E+11 | 3.27736E-13 | 0.75 |
| 2.49E-05 | 1.15139E+11 | 4.59496E-13 | 0.75 |
| 0.002143 | 2.3167E+11 | 3.73604E-13 | 0.75 |
| 0.000168 | 3.54288E+13 | 5.54163E-13 | 0.77 |
| 0.000219 | 1.82083E+13 | 7.24272E-13 | 0.83 |
| 0.000191 | 3.31785E+13 | 7.64754E-13 | 0.86 |
| 0.000245 | 4.73493E+13 | 8.6838E-13 | 0.89 |
| 0.000238 | 1.25386E+14 | 9.64705E-13 | 0.94 |
| 0.000409 | 1.87834E+14 | 8.23227E-13 | 0.97 |
| 0.000342 | 2.78134E+14 | 9.63624E-13 | 0.97 |
| 0.00033 | 3.44048E+14 | 8.29951E-13 | 0.97 |
| 0.000189 | 4.28816E+14 | 1.11694E-12 | 0.97 |
| 9.76E-05 | 4.94894E+14 | 1.29771E-12 | 0.97 |
| 6.17E-05 | 4.67858E+14 | 8.67803E-13 | 0.97 |
| 2.11E-05 | 6.40949E+14 | 1.07671E-12 | 0.97 |
| 1.38E-05 | 5.40417E+14 | 1.05555E-12 | 1.01 |
| 5.55E-06 | 7.85816E+14 | 6.50758E-13 | 1.03 |
| 2.3E-06 | 9.27444E+14 | 5.72014E-13 | 1.04 |
| 4.14E-07 | 8.29089E+14 | 5.6054E-13 | 1.05 |
| 4.27E-08 | 8.01428E+14 | 5.67991E-13 | 1.06 |
| 1.22E-09 | 8.16144E+14 | 5.79333E-13 | 1.07 |

For the dependent pi term ΠD1, we have,

ΠD1 = f (Π1, Π2, Π3)

Where 'f' stands for "function of" and a probable exact mathematical form for this phenomenon could be

$$\Pi D1 = k2 * (\Pi 1)^{a2} * (\Pi 2)^{b2} * (\Pi 3)^{c2} \text{ ------- (1)}$$

There are four unknown terms in the equation, viz. constant of proportionality k2 and indices a2, b2, c2. It is decided to solve this problem by curve fitting technique (Spiegel

1980). To follow this method it is necessary to have the equation in the form as under

$$Z = a + b * x + c * y + d * z + \ldots \quad (1.1)$$

The equation (1) can be brought in the form of equation (1.1) by taking the log of both sides of the equation (1). By taking the log of both the sides of theses equation,

$$\text{Log } \Pi D1 = \log [k2 * \Pi 1^{a2} * \Pi 2^{b2} * \Pi 3^{c2}]$$

$$\text{Log } \Pi D1 = \log k2 + \log \Pi 1^{a2} + \log \Pi 2^{b2} + \log \Pi 3^{c2}$$

$$\text{Log } \Pi D1 = \log k2 + a2 \log \Pi 1 + b2 \log \Pi 2 + c2 \log \Pi 3 \text{ --------- (1.2)}$$

Let, log $\Pi D1 = Z2$,

Log $k2 = K2$, Log $\Pi 1 = A$, Log $\Pi 2 = B$, Log $\Pi 3 = C$,

Then equation (1.2) can be written as

$$Z2 = K2 + a2 * A + b2 * B + c2 * C \text{ ---- (1.3)}$$

Equation (1.3) is a regression equation of Z2 on A, B and C in a 'n' dimensional coordinate system. This represents the regression hyper plane. To determine the regression hyper plane we determine a2, b2 and c2 in equation (1.3) by multiplying coefficients of a2, b2, and c2, individually as,

Multiply by A

$$A * Z2 = A * K2 + a2 * A^2 + b2 * AB + c2 * AC$$

Multiply by B

$$B * Z2 = B * K2 + a2 * AB + b2 * B^2 + c2 * BC$$

Multiply by C

$$C * Z2 = C * K2 + a2 * AC + b2 * BC + c2 * C^2$$

Above set of equations are valid for number of reading taken during experimentation, therefore taking summation of these n values. The equation becomes,

$$\Sigma Z2 = n * K2 + a2 * \Sigma A + b2 * \Sigma B + c2 * \Sigma C \text{ -- (1.4)}$$

$$\Sigma A * Z2 = K2 * \Sigma A + a2 * \Sigma A^2 + b2 * \Sigma AB + c2 * \Sigma AC \text{ -------- (1.5)}$$

$$\Sigma B * Z2 = K2 * \Sigma B + a2 * \Sigma AB + b2 * \Sigma B^2 + c2 * \Sigma BC \text{ --------- (1.6)}$$

$$\Sigma C * Z2 = K2 * \Sigma C + a2 * \Sigma AC + b2 * \Sigma BC + c2 * \Sigma C^2 \text{ -------- (1.7)}$$

Where n is the number of sets of the values.

Above equations are called normal equations and are obtained as per the definition. In the above sets of equations the values of the multipliers of K2, a2, b2 and c2 are substituted to compute the values of the unknown's (viz. K2, a2, b2 and c2).

Now Consider, equation as

$$\Sigma Z2 = n * K2 + a2 * \Sigma A + b2 * \Sigma B + c2 * \Sigma C$$

In this equation

| $\Sigma Z2 = \Sigma \log \Pi D1 = -0.69$ | $\Sigma A = -97.65$ |
|---|---|
| $\Sigma B = \Sigma \log \Pi 2 = 293.21$ | $\Sigma C = \Sigma \log \Pi 3 = -255.029$ |

Consider equation as

$$\Sigma A * Z2 = K2 * \Sigma A + a2 * \Sigma A^2 + b2 * \Sigma AB + c2 * \Sigma AC$$

In this equation we know

| $\Sigma A * Z2 = 2.57$ $\Sigma A = -97.65$ | $\Sigma A2 = 502.51$ |
|---|---|
| $\Sigma AB = -1372.21$ | $\Sigma AC = 1187.86$ |

Consider equation (c) as

$$\Sigma B * Z2 = K2 * \Sigma B + a2 * \Sigma AB + b2 * \Sigma B^2 + c2 * \Sigma BC$$

In this equation we know

| | |
|---|---|
| ΣB * Z2 = -203.71 | ΣB2 = 222.36 |
| ΣB = 293.21 | |
| ΣAB = -132.90 | Σ BC = -182.47 |

Consider equation as

$\Sigma C * Z2 = K2 * \Sigma C + a2 * \Sigma AC + b2 * \Sigma BC + c2 * \Sigma C^2$

In this equation we know

| | |
|---|---|
| ΣC * Z2 = 8.52  ΣC = -255.029 | ΣC2 = 3097.64 |
| ΣAC = 1187.86 | Σ BC = -3558.35 |

Thus, by putting all the values the above set of equations can be rewritten as

-0.69476 = K2 *22 + a2 * (-97.65) + b2 * 293.21 + c2 * (-255.029)

2.57315 = K2 * (-97.65) + a2 * 502.514 + b2 * (-1372.21) + c2 * 1187.86

-203.716 = K2 * 293.219 + a2 * (-132.90) + b2 * 222.36 + c2 * (-182.47)

8.5205 = K2 * (-255.029) + a2 * 1187.86 + b2 * (-3558.35) + c2 * 3097.64

The above equations can be verified in the matrix form and further values of K2, a2, b2, c2, can be obtained by using matrix analysis.

X2 = inv (W) x P2     ----------  (1.8)

The matrix method of solving these equations using 'MATLAB' is given below.

W = 4 x4 matrix of the multipliers of K2, a2, b2, and c2.

P1 = 4 x 1 matrix of the terms on L H S and

X1 = 4 x 1 matrix of solutions of values of K2, a2, b2, and c2.Then, the matrix obtained is given by matrix as,

$$Z_1 \quad x \quad \begin{bmatrix} 1 \\ A \\ B \\ C \end{bmatrix} = \begin{bmatrix} n & A & B & C \\ A & A^2 & BA & CA \\ B & AB & B^2 & CB \\ C & AC & BC & C^2 \end{bmatrix} \quad x \quad \begin{bmatrix} K2 \\ a_2 \\ b_2 \\ c_2 \end{bmatrix}$$

P1 = W1 x X1

In matrix form the equation can be written as

| -0.69476 | 22 | -97.65 | 293.21 | -255.025 | k2 |
|---|---|---|---|---|---|

| 2.57315 | -97.65 | 502.51 | -1372.21 | 1187.86 | a2 |
| -203.716 | 293.21 | -132.90 | 222.36 | -182.47 | b2 |
| 8.5205 | -255.029 | 1187.86 | -3558.35 | 3097.64 | c2 |

Then, equation type, [P1] = [W1] [X1], gives the unique values of K2, a2, b2 and c2 and antilog of K2 will be the solution for the equation (1). Using Mat lab, X1= W1\ P1, after solving X1 matrix with K2 and indices a2, b2, c2, are as follows,

| K2 | -0.758 |
| --- | --- |
| a2 | 0.4275 |
| b2 | 2.7125 |
| c2 | 2.892 |

Hence the model for dependent term pi term is $\pi_{D2}$

$$\text{Model}: (\pi_{D1}) = K2 . \{(\pi_1)^{a2} . (\pi_2)^{b2} . (\pi_3)^{c2}\}$$

$$(\pi_{D1}) = -0.758 \{(\pi_1)^{0.4275} . (\pi_2)^{2.7125} . (\pi_3)^{2.89}\}$$

## VI. DISCUSSIONS OF RESULTS

In this study a generalized experimental data based mathematical models using dimensional analysis and Buckingham's Pi theorem are developed to simulate dependent process parameters voltage, current, power and efficiency. The approach to formulate a generalized mathematical model is to provide simple way to analyze the process occurred in Thermo Electric Generator (TEG) where the impact of experimental data is the measure of performance. The experimental data has been converted into the interpretable form. It is now necessary to analyze this data to draw some logical conclusions. Keeping this in view studies have been made under the following heads.

- Quantitative analysis of space curve
- Performance of model

In order to interpret the mathematical models formed earlier, the models are analyzed quantitatively using appropriate techniques. Detail analysis is presented in this section. The general points are as follows.

1. The mathematical models obtained from experimental data based mathematical modeling approach are in exponential form.

2. The interpretation of models gave extent of influence on output of the model by any pie terms or any variables.

3. By comparing the indices of the models with positive and negative sign one can find most influencing variables.

## VII. MODEL INTERPRETATION:

### a. i) Performance of the Models by Analysis of Indices of the Models

The present work gave an illustration of how dimensional analysis (DA) can be applied to significantly reduce the number of independent variables used to optimize the dependent process parameters of the current, as response variable using experimental data based mathematical modeling. Using dimensional analysis around 63 numbers of independent variables has been reduced to 03 dimensionless pi terms and 1 number of dependent pi terms

treated as 01 dimensionless pi terms. This can greatly help in formulation of approximate, generalized experimental data based mathematical model in easier manner. Thus in this way the dimensional equations established in reduced or compact models made the complete experimentation process less time taking having generation of optimum data. The conclusion in the form of interpretation of model is being reported in terms of several aspects viz. (1) Order of influence of various inputs (causes) on outputs (effects) (2) Relative influence of causes on effect (3) Interpretation of curve fitting constant K.

The value of curve fitting constant in the model for ($\Pi D1$) is -0.758. This collectively represents the combined effect of all variables such variables related with heat source, heat sink and specifications of TEG module used. Further, as it is negative, this indicates that these causes have less influence on the dependent process parameter current ($\Pi D1$). The absolute index of $\pi 1$ is the highest Viz. 0.4257. Thus, this is term related to specifications related with parameters of heat source which is the most influencing $\pi$ term in this model. The absolute index of $\pi 3$ is 2.89, which is related with specification of TEG module used. This indicates that pi term $\pi 3$ is less influencing term than $\pi 1$ in this model. The absolute index of $\pi 2$ is positive viz. 2.7125. This pi term is related with heat sink parameter of thermoelectric generator. This negative index indicating that pipe dimensions are directly proportional to heat sink parameters of thermo electric generator.

## CONCLUSION:

The experimental data based model are established with reduce or compact mode in order to the complete experimentation process less time taking having generation of optimum datafor making and formulation of the mathematical model. Also dimensionless $\pi$ terms provide the idea about combined effect of process parameters.

## ACKNOWLEDGEMENT

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# Impact of Training Programs on Student Performance: A case study of Management Students of SSBT's College of Engineering & Technology, Jalgaon.

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**ABSTRACT:**

**In present competitive era, nothing is stable as technology is changing day by day; we are the witnesses of various innovations, innovative practices. To remain competitive and to cope with this constant change, organizations are focusing on providing essential training to their workforce which may result in increase in productivity, performance of employee and increasing organizational stability. In this regard organization especially HR departments are always very keen while recruiting the suitable candidates.**

**Considering the growing importance and seriousness about training a pilot study has done on 100 Management students of SSBT's College of Engineering & Technology, Jalgaon. The focus of this study was to review the impact of Training on performance of MBA students. In this study, the primary data were collected by using Likert's Scale tool from MBA students and researcher used convenient sampling method. The present study reveals that, training and development programs have significant impact on improving performance of M.B.A. students.**

*Keywords: Training, Performance, Education, Technology.*

## I.  INTRODUCTION

Training constitutes a basic concept in human resource development. It is concerned with developing a particular skill to a desired standard by instruction and practice. Training has specific goals of improving one's capability, capacity, productivity and performance. Training and Development is very important aspect to nurture and strengthen the skill set of individual. It is fact that proper training can improve skills, knowledge, and ability of an individual. Also a person, student or employee who receives necessary training is obviously more able to perform his job and responsibilities. In present competitive era, organizations though small, medium or large scale are very conscious in hiring multidimensional personalities as well as they are focusing on providing essential trainings and overall development of their existing employees as this is important to enhance organizations effectiveness, strengths and overall growth.

Considering the importance of training programs, and for overall development of students the universities are very keen in framing the practical curriculum. So far as the M.B.A curriculum of North Maharashtra University is concerned the objectives of present M.B.A course are:

1) To equip the students with requisite knowledge, skills and right attitude necessary to provide effective leadership in a global environment.
2) Enhance the ability of students to understand the importance of an organizational perspective of different functional areas through the course

Hence, with an object to make management students industry ready and to know the impact of training on performance of students, a pilot study has done.

## II.BASIC REASON OF STUDENT TRAINING

The appropriate student training is always required for:

- Globalization & New Technology
- Need of Leadership
- For increasing student confidence level.
- For increasing Morale and for refining their decision making ability and their skills.

- For development of positive attitude among students.
- For overall development and performance of students.

## III.   OBJECTIVES OF THE STUDY

- To study the importance of Training.
- To study the impact of Training on student performance.
- To know students view about Training.

## IV.   RESEARCH METHODOLOGY

The present study is descriptive in nature.The researcher collected primary data through structured questionnaire. The responses were randomly collected from 100 management students of SSBT's College of Engineering & Technology. The period covered for the study is A.Y.2017-18. The collected data has been carefully tabulated and analyzed with the help of graphical representation.

## V.   REVIEW OF LITERATURE

- P.Nischithaa and M V A L.Narasimha Rao (April-June 2014) in their research paper highlighted that, employee morale and satisfaction, company productivity and service quality can be improved through training. They further opined that, specific training programs should be organized by Hotels with its business objectives, core values.

- Raja Abdul Ghafoor Khan, Furqan Ahmed Khan, Dr.Muhammad Aslam Khan (2011), in their research paper highlighted that, there is significant impact of training and development, on the job training on organizational performance. The paper also focuses that on the job training is very effective and saves time and cost.

## VI. IMPORTANCE OF THE STUDY

In present competitive era, it is very difficult for organizations to make their employees ready for accepting the change. It is true that, due to constant changing technology and trends, the personnel departments of most of the organizations are continuously engaged in either hiring the well trained person or rather providing the training to their existing employees. This is because the well trained employees are considered as assets of any organizations.

The present study is a case study of management students where an attempt has been made to study the impact of training on student's performance as well as to find the gap which can be filled by providing practical trainings to students for better performance. In academic year 2017-18, the M.B.A. students came across few training programs provided by M.B.A. department and later a feedback have been taken to study the effectiveness of training programs. So far as the scope of the study is concerned the present study will be helpful to both i.e College as well as students.

## VI.   DATA ANALYSIS, INTERPRETATION

1. Are training programs essential for management students?
   A) Yes     B) No
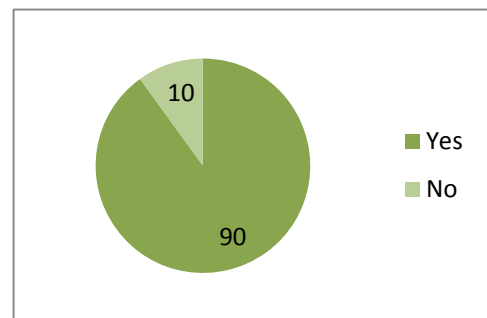


**Inference** -from the above pie chart, it is found that according to 90% students, training is very important whereas 10% respondents opined that training programs are not important.

2. Do Training programs enhance the skill of students?
   A) Strongly agree     B) Agree     C) Disagree
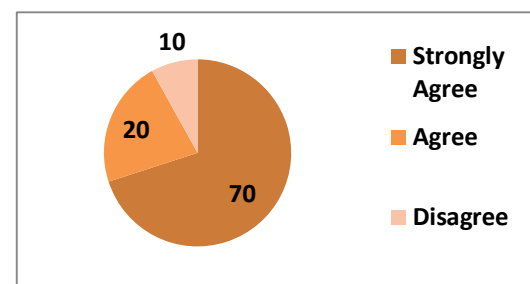
**Inference**-from the above pie chart it is found that 70% students strongly agree that, training programs enhances the skills of students.

3. Do you think that training programs add value to curricular studies?
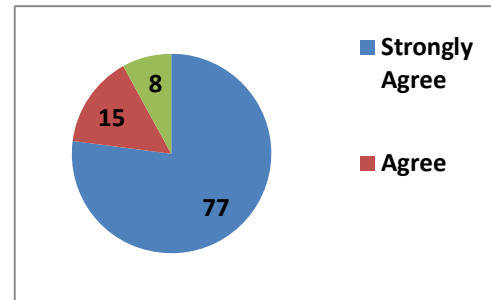   A) Yes    B) No
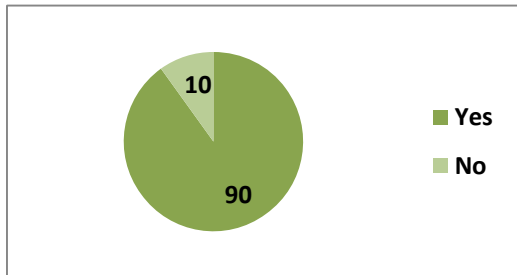


**Inference**-The above pie chart depicts that 90 % respondents felt that training programs add value to curricular studies whereas 10 % respondents do not agreed with the above statement

4. How much do you think training ignites one's hidden talent?
   A) 0-40 %    B) 50-80 %    C) 90-100 %
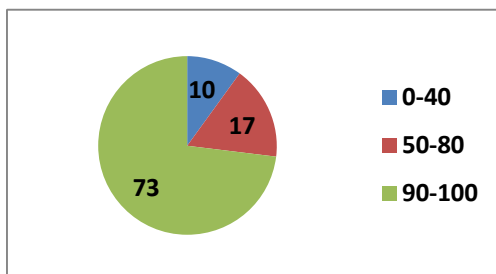


**Inference**-From the above pie chart it is revealed that 73% studentsfeel that training ignites one's hidden talent in between 90-100 % whereas 17 % students fill that training can ignite one's hidden talent only 50-80 %.

5. Do you agree that, training programs make an individual smart to survive in competitive world?



**Inference**-The above pie chart depicts that 77 % respondents strongly agreed that training programs make an individual smart whereas 8 % respondents neither agreed nor disagreed with the above statement.

6. In your opinion, does training program develop Skills, Attitude & Performance of students?
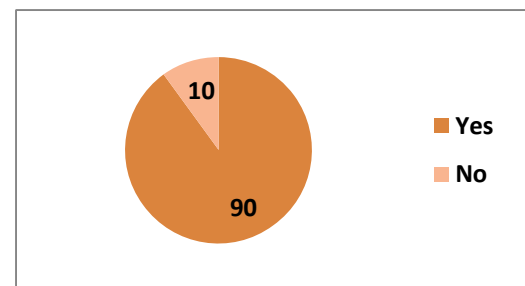


**Inference:** It is revealed from above chart that, in view of 90 % students, training program develops skill, attitude & performance of students whereas 10 % students are not agreed with the statement.

**VIII.    HYPOTHESIS TESTING**

1. Ha = 90 % students agree that training programs helps to improve the curricular studies.
   H0 = 90 % students does not agree that training programs helps to improve the curricular studies.
   Ha: $P = 0.90$ & H0: $P \neq 0.90$.

   - Expected Probability of success (p0) = 0.90
   - Expected Probability of failure (q) = 0.10
   - Sample Size (n) = 100
   - Observed frequency of success = 90
   - Observed frequency of failure = 10
   - Level of significance = 5 %

- $P^\wedge$ = Proportion of success. $(P^\wedge)$ = 90/100 = 0.90
- The H0 is one sided
- Z Test Statistics (Z) = $(P^\wedge - P0)/\sqrt{P0}$ (1-P0)/n……… (Single sample Z Test)
- = 0. 90 – 0.10 / $\sqrt{0.10}$ (1 – 0.10) / 100 = 26.66666667
- The P Value is < 0.00001. And the result is significant at P < 0.05.
- In this case the P value is less than significance value, hence we reject the null [H0] hypothesis and accordingly, we conclude that, 90 % of students agree that training programs helps to improve the curricular studies.

2. Ha = According to 90 % students, training program develop Skills, Attitude & Performance of students.
   H0 = According to 90 % students, training program does not develop Skills, Attitude & Performance of students.
   [Ha: P = 0.90 & H0: P ≠ 0.90.]

- Expected Probability of success (p0) = 0.90
- Expected Probability of failure (q) = 0.10
- Sample Size (n) = 100
- Observed frequency of success = 90
- Observed frequency of failure = 10
- Level of significance = 5 %
- $P^\wedge$ = Proportion of success. $(P^\wedge)$ = 90/100 = 0.90
- The H0 is one sided
- Z Test Statistics (Z) = $(P^\wedge - P0)/\sqrt{P0}$ (1-P0)/n……… (Single sample Z Test)
- = 0. 90 – 0.10 / $\sqrt{0.10}$ (1 – 0.10) / 100 = 26.66666667
- The P Value is < 0.00001. And the result is significant at P < 0.05.
- In this case the P value is less than significance value, hence we reject the null [H0] hypothesis and accordingly, we conclude that, According to90 % students training program develop Skills, Attitude & Performance of students.

## IX. CONCLUSION

Discloser of study shows that,providing essential training to students is really fruitful.

Institutions and colleges by conducting various kinds of training programs may contribute to the overall development of students. There are numbers of training programs which is really beneficial to develop the student's skills and to refine their decision making ability which will also results in developing the innovative skills, attitude, values, confidence level and behavior of students. No doubt it will be an added advantage to the students as well as to organizations also. Considering the present competitive scenario, continuous training programs should be organized for students to make them industry ready.

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# Internet of Things and its indestructible Security

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**A**BSTRACT-

**The paper focuses on the Internet of Things i.e ranging from humans to every object to every creature being provided with unique identifiers, and having the ability to interact without requiring interaction of humans with personal computers or humans interacting with humans. The conveyance of technologies related to set ups provide wireless technology and mechanization. The object referred in the 'Internet of Things' maybe aperson which is being treated for theParkinson'sdisease in order to effect the posture of the body, smart devices, sensors that work during various situations that provide indications for the checkup of devices – simple as well highly advanced - ranging to sensors that help cars to move back and collide with any object. Thus, all these serve as auditor that may help out the person in his daily life work. The paper also cynosures around the most important issue these days i.e., dealing with the security of the Internet of Things.**

*Keywords: Sensors, IOT, metasploit,exploit, Uconnect*

## I. INTRODUCTION

This paper basically deals with the Internet of Things and its inherently embedded security that goes with all such electronic-based high value technologies. The computers with all the smart devices included are dependent on human being for information or for gaining access. Most of the data available on the internet is being captured via typing by human beings searching for information pushing a record button, etc. The IoT represents an emerging area of net working that connects a variety of appliances to one another and interaction through them becomes possible.

The applicable areas that the IoT enfolds is receiving pollution warnings, stop driving in circles, sharing findings, maintaining quality and consistency, getting advanced warnings via sensors, thus using the internet as an scaffold to support and transmit its sensations.

Thus the successful involvement of the IOT involves extensive security providing accurate results and consistency since in case not provided may lead to destructions. The paper enfolds how the IOT helps in various circumstances with main focusing on its security and how to hack IoT by exploiting the Zigbee Technology. The security of android devices is also a concern since these provide a range of sensors such as an accelerometer, Gyro, Video, Proximity, GPS, compass etc since the devices can be accessed by sending payloads to a victim machine. The payloads can be sent via various social engineering techniques.

The most concerned security breach of the IOT is that the data can be sniffed out such as the Flying Drone which is a custom made tracking tool capable of sniffing out data [1] from devices connected to the internet. Illegal access of IOT is because of vulnerability prevailing with the development of smart phones, cities and even cars.

With the IOT engulfing us into its folds with days passing its mandatory to exclude the vulnerabilities so that the flaws can't be exploited by an outside hacker. To provide security as well as to grasp with the rest of the Internet the IOT nodes get tangled in a conglomeration with a variety of security mechanisms such as Diffie Hellman Key Exchange[2],SSL that confirm to performing various cryptographic operations. A node in an IOT may be more involved in resource strained rather than a host in a network. When Iot nodes communicate over the wireless protocol called Zigbee which is opened at the network layer they send out beacon requests through which data can be captured.

## II. RELATED WORK

Issues in high speed Internet Security [4] (Peder Jungck,Simon S.Y Shim) that focused on how an SQL Slammer, one of the first flash worms released around the world with spreading in an instant and doing damage almost before administrators could accustom deference against the attacks causing widespread damage infecting almost 75000 servers around the world with just a single 384-byte packet penetrating the net work. Thus network administrators find it quite difficult to achieve fast and safe networking. Low Energy Security: Limit and opportunities in the internet of things [5] (Wade Trappe, Richard Howard, Robert S. Moore) which focused on the low end future of the world's wireless Internet Faces would pose the possible threats such as integrity or availability where a wireless communication is gullible for message content. As the messages are sent from one end to another and oppugner could conveniently interlope them.

The attacker can bombard denial of service attacks on RF specific devices or reprogramming wireless devices to operate with expeditive duty cycles thus increasing channel utilization or flooding back end servers [5]. Security for the Internet of Things [6]: A survey of Existing Protocols and open research issues (Joge Granjal, EdmundoMonteiro, Jorge Sa Silva) focused on extant protocols and contrivance to impregnable communications on the IoT.

An early Application of the Bell Labs Security Framework to Analyze Vulnerabilities in the Internet Telephony domain [7] (Vijay K.Gurabani, AndrewR. McGee) provided and discursive matrix that could be used to guesstimate the security of a service. It aimed to appraise where in the framework security attacks on Internet telephony framework appear. It evaluated Internet telephony vulnerabilities in the frame of reference of Bell Labs Security Framework. It also dealt with Amplication Vulnerability in SIP Proxies that rendered inoperable by sending a single message to set of proxies that had that vulnerability thus stealing the VOIP service to which studies stated that VOIP service providers were being circumvent of over US $1 million in revenue.[7]

The illegal access of systems can salvage important statistics, data, and thus can yield information that may cause harm to the person using it. The advantage of our research paper is that it would provide effective measures and protections against these malicious activities. We would deal with the security issues of some IoT devices with main focus on webcams and automobiles. The work done so far is stills less and the discussion on security of the IoT keeps pointing out on the latest vulnerabilities and how to combat with these.

## III.    SECURITY BREACH OF WEBCAMS

Webcams are generally video cameras that feed or stream its images in real time to or through a computer to computer network according to Wikipedia definition [8]. When these videos or images are captured they can be saved on personal computers or can be sent via email or social networks to locations via a computer network.

The security of the webcams should be taken into consideration, since these webcams can be accessed by a person sitting on a remote location via RAT's i.e., Remote Access Trojans. The Trojan horses attacks take control of the Victim's machine. The malicious links that contain malwares are generally sent via social engineering techniques that get executed when a person clicks on it and thus the hacker is able to take control of the PC functions. We reviewed the architecture of webcams and found that their security could be breached by meterpreter, which is a part of metasploit and the victim's webcam can be remotely accessed. The figure below is architecture of a webcam.
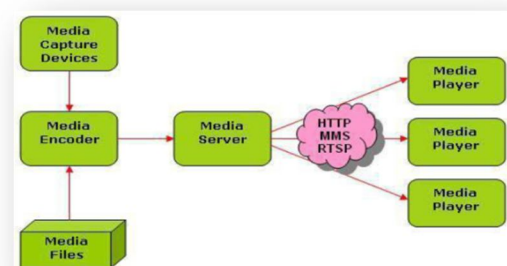


**Figure 1: Webcam Architecture.**

The webcam could be exploited due to controlling the victim's machine by using metasploit creating a session via links or payloads accepted by the victim. through numerous ways. The meterpreter has a feature in it that can control the remote system's

webcam. When we have built a session via metasploit or created a backdoor we first install meterpreter on the victim's machine. Then using the commands we capture the snapshot from the webcam of the victim's computer. The snapshot taken is after we have installed meterpreter to the victim's machine. [9]

After we have installed the meterpreter we check whether the victim's computer has a webcam by the following commands.

Meterpreter>webcam list.

This thus comes out with a list of webcams if the victim's machine has webcam on it. If further we want to now take the photo using the webcam we can type in the following command.

Meterpreter>webcam_snap

Which could then take the screenshot of the person sitting in the front of the webcam. The screenshot so taken would be saved in the metasploit console directory which could be accessed by the person accessing illegally into the webcam. Thus the vulnerability prevailing is an important issue that is to be taken into consideration.

## IV. PROTECTING ILLEGAL ACCESS OF WEBCAMS

Suspicious attachments and links that reflect to be malicious should not be opened since they may contain malwares. Email attachments should be properly scanned and then opened since these may start a session into the victim's computer [10]. Firewalls should be used which may turned on in windows. Wireless connections should be secured, online chats must be avoided on Internet messengers to strangers. A strong antivirus software can work wonders thus avoiding illegal access of webcams.

## V. SECURITY BREACH OF AUTOMOBILES

With the advent of smart cars, the security of automobiles has become an important issue these days. Features such as steering, dashboard functions, brakes and transmission etc can be accessed from a remote location thus questioning the security of smart cars such as Jeep Cherokee, Ford Escape, Toyota Prius [11]. These provide the attacker access to the car ,via the Internet, to wireless control, via the Internet. The car can be compromised, accelerating and breaking functions disabled thus leading to high emergency conditions. The smart cars are generally hacked by building up exploits that run on msf console. The car's GPS coordinates, speed control and even the route entered by the user to approach his destination can be be collected. Uconnect which is found in thousands of smart cars connects to the internet and control all the major functions of the cars such as the entertainment system, providing locations, destination routes, enabling phone calls etc. Uconnect provide wireless access inside cars, the car can be accessed from anywhere via the IP address of the car.

The firmware executes commands through the car's internal computer network, by which physical components can be controlled. Thus we reviewed the exploits that are currently present on exploiterzdb, hackforums, 1337xday, and found that the Uconnect feature was not much difficult to exploit. Some changes made in the exploit could yield more physical features of the car and could lead to extremly dangerous situations. To combat with the vulnerability a patch was being provided, and the owners of the vehicle were being provided with an update. However the Uconnect feature still remains vulnerable to exploit. According to a survey it was found that there are almost 471000 hackable automobiles. Uconnect computers are linked to the internet by cellular network, thus the set of GPS coordinates, with the vehicle identification number and its IP address is displayed. The information so revealed of the car in a country, its incorrect use can lead to high emergency. The figures shown below shows the update of Uconnect which can be updated by entering the vehicle's 17 digit Vehicle Identification Number (VIN) and the vulnerabilities prevailing in the website of Uconnect, the results i.e the screenshots are shown below which can be exploited to gain access into an automobile that is being powered by Uconnect.
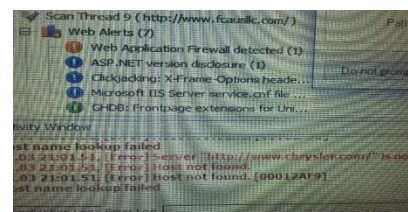
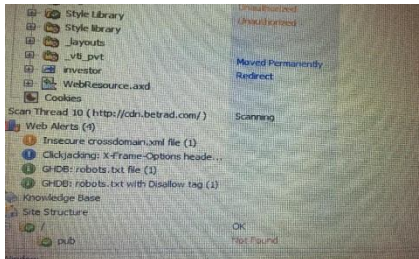**Figure 2: Vulnerability list of Uconnect via Acutenix Scanner**



**Figure 3: Vulnerability list of Uconnect.**

Smart car can be protected from attacks by continuously scanning for vulnerabilities, thus applying patches. Also the Uconnect should be regularly tested against exploits so as to prevent illegal access and regular patches and updates must be provided to protect Uconnect from illegal access.

**CONCLUSION**

The ongoing article illustrates how through webcams and other vulnerabilities, the smart car can be controlled. In course of time other smart devices' security can be breached rendering them prone to disastrous consequences. This article heralds a warning to strengthen the security and introduce personal anti-hacking mechanism of the software upon which the system works. Above that the actual user may be sounded about the alert so that he may be in a position to shut the mechanism or take a detour circumventing the problem to neutralize it in a manner the Patriot Anti-Missile does – shoot the problem.

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# Necessity for Future Smarter Nation with a Sustainable Trend - Smart Grid

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*Abstract :*

**This paper briefly discusses need and gradual evolution of Smart Grid and its development. Smart Grid is important as it leads us to energy independence and of course a sustainable economic growth. Growth of Smart Power Grid in India will slowly but surely take us towards fulfilling the dreams of former President Dr. A.P.J. Abdul Kalam, "Energy for all and Energy forever". According to its outlook, the smart grid is an upgrade of the common existing electricity grids that operate mostly to provide one-way power from several major power plants to a huge number of consumers but being friendly to both the utility as well as the consumers. This upgrade is expressed in the ability to operate in conditions of uncertainty in order to route the power supply in an optimal way that responds to a wide variety of situations, to encourage users in off-peak hours and charge premium rates from consumers who use energy during peak hours. The key to this capability is quick, accurate and two-way transmission of information between all parts of the grid. Situations that require fast response can occur at all parts of the grid – at the chain of production, transmission and consumption.**

*Keywords: Smart home,intelligrid, harmonics , SmartGrid, FACTS, IC.*

## I. INTRODUCTION

A smart grid (SG), also called smart electrical/power grid, intelligent grid, intelligrid, futuregridintergrid, or intragrid, is an advancement of the 20th century power grid. In India bulky electrical power distribution system is used which is complex and growing rapidly at an alarming rate. Rate of GDP would lead the rise in demand by 3 times in next decade and 66% of which would be on-grid only [1]. By 2032, the expected demand of the Power would be 900GW [2], and this demand would be met significantly by renewable sources besides the conventional resources. The expected potential of renewable energy would be 183GW by the same time [4]. Along with the availability of power, the reliability and efficiency also become prime concerns for the Indian power systems.

The increase in demand would not only consists of conventional domestic and industrial type loads, but also few new unique loads like electric vehicle and power electronics loads which would contribute to a major part in demand growth.The source of the event could be in the environment (sudden cloudiness that decreases solar power, or a very hot day that increases the demand for air conditioning), in parts of the grid itself (sudden failures, the need for proactive maintenance) or in the demand (work hours compared to hours of rest).].Power Quality (PQ) disturbances include those from short to long duration variations,harmonics, flickers, increased downtime, etc. and poor power quality would result in incurring high operationexpenditure (Opex)cost. By monitoring and analyzing power quality, the cause of power system disturbance can beidentified and improved before they cause interruptions

Power generation and distribution the real-time information on costs, demands and supplyof power will provide control at every level of the system. Consumers will both receiveand contribute power to the smart grid from ultimately anywhere in the world.Large appropriations are being spent around the world to advance smart grid. In theU.S., bills have the smart grid will add monitoring, analysis, control and communication capabilities been passed nationally and at the state level to mandate renewableenergy standards, funded by both government and industry.In The need for cross-industry research is immense. Smart grid queries of IEEE dataresources have increased. Collaborations have begun between experts in diversefields—electricanalysis systems engineers with software developers, communications firmsand the computer systems experts—to develop technologies for new applications in distribution, communication, analysis and control. Millions of new products and devices will be required.

## II. LITERATURE SURVEY

What is smart grid? The initial concept of SG started with the idea of advancedmetering infrastructure (AMI) with the aim of improving demand-side management and energy efficiency, and constructing self-healing reliable grid protection against malicioussabotage and natural disasters [13]. However, new requirementsand demands drove the electricity industries, research organizations, and governments to rethink and expand the initially perceived scope of SG. The U.S. Energy Independence and Security Act of 2007 directed the National Institute ofStandards and Technology (NIST) to coordinate the research and development of a framework to achieve interoperability of SG systems and devices.

### A. Build future smart grids- Motivation

We are facing energy deficiency in some countries which not only impacts economics, society and development of the country, but also results in the global warming. The drivers for change are both external to the network, like preparing for a low-carbon future by reducing greenhouse gas, as well as internal, like the need for replacement of an ageing infrastructure. Recently, energy saving and energy security have become major issues. One of the main external drivers is the European Union (EU) Energy and Climate Package, which has set out ambitions targets for year 2020 and beyond as [7]: - 20% reduction of greenhouse gas emissions (compared to 1990 levels) - 20% of RES in the EU 27 energy mix (today 6.5%) - 20% reduction in the primary energy used (saving 13% compared to 2006 levels). The EU's triple commitment to reduce $CO_2$ emissions by 20%, sourcing 20% of its total energy (transport, heating, lighting and electricity) from renewable sources and improving energy efficiency by 20%, all by year 2020; represent a considerable challenge for today´s energy sector. A set of recent developments are about to change this picture and put the electricity networks under pressure to change. For the electricity grid, the triple commitment is even more challenging as it means that approximately 35% of all electricity will be generated from renewable sources. In addition, more electricity applications will appear in the future, such as the electrical vehicles and heat pumps coming into use today. This will have a considerable impact on the electricity grid. Generation of electrical energy, however, is currently the largest single source of carbon dioxide emissions, making a significant contribution to climate change.

### B. Smart grid pilot for Power quality analysis

According to report from the International Energy Agency (IEA) onTransmission and Distribution (T&D) losses in different countries during year 2010-11, the T&D losses in India are 23.65% against 9.8% average throughout the world [10].India would be having six million electric vehicles on road by 2020in [6] [7]. Further, in current scenario, distribution system in India is facing high Aggregate Technical andCommercial (AT&C) losses [2].To evaluate the real benefits and to identify suitable technologies/models of the smart grid, Ministry of Power, Govt. of India proposed 14 pilotprojects across the country with different functionalities of smart grid. At present all these pilot projects are underinitial stage of implementation. Pondicherry smart grid project [3] is one of the proposed pilots which are beingdeveloped jointly by Power Grid Corporation of India Limited (POWERGRID) along with open collaborators andPondicherry Electricity Department (PED).The introduction of more power electronic devices gives increase inharmonic distortion [4]. Further the PV integration into the network influences both the voltage and network lossespositively [5][6].Power Quality (PQ) disturbances include those from short to long duration variations,harmonics, flickers, increased downtime, etc. and poor power quality would result in incurring high operationexpenditure (Opex)cost. By monitoring and analyzing power quality, the cause of power system disturbance can beidentified and improved before they cause interruptions. Various standards like IEEE-1547, IEEE-519, and IEEE-1159 etc. are laid down to monitor and control the quality of power supply.The indexes to monitor power quality arefrequency variations, voltage variations, harmonics, flicker, power factor, etc. [7]

## III. WORLD WIDE SCENARIOCURRENT STATE

We will now discuss the current state of various advanced components, as well as the core technologies upon which they depend. We must keep in mind, however, that while all of these technologies and components are needed for a modern grid, the timetable of expected availability varies as Power Electronics in Transmission and Distribution Systems
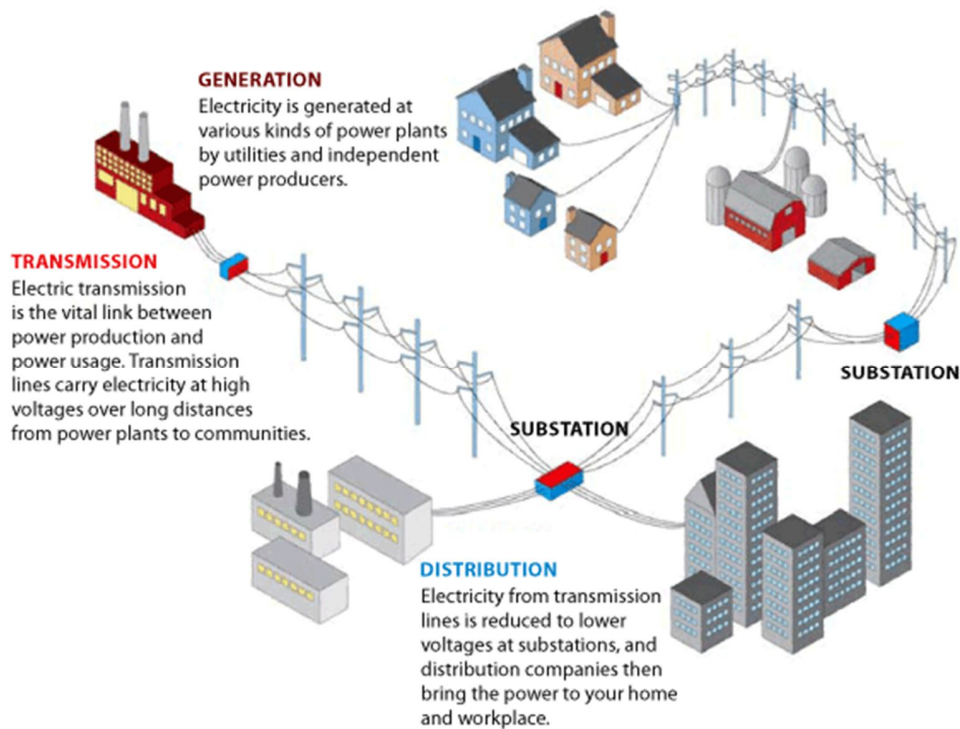
Fig.1 Power Electronics in Transmission andDistribution Systems

### A.    In Japan

Japan is investing to renew the energy architecture, smart meters and smart gridJapan's work in the energy field is based on a unique combination of a solid scientific base combined with deep experience in Japan's energy business sector. Japan's electricity has undergone major overhaul, including the dissolution of vertically-integrated utilities, the creation of a nationwide grid operator, and incentives for distributed generation and demand response. Sustained reforms will drive the pace and scope of new opportunities for U.S. suppliers. Japan already has a highly reliable grid compared with the US, which needs more reliable and distributed networks across the nation to develop its smart grid system. Japan is developing its smart grid at a steady pace and has already been investing in grid projects for almost 20 years; over this period, there have been many developments. With proper security controls, smart grids can prevent or minimize the negative impact of attacks by hackers and thus increase the reliability of the grid, thereby gaining the trust and meeting the satisfaction of users [10].

a) Participation of various players such as system operators, retails, consumers, resource aggregators
b) Realization of secure, safe, and comfortable Smart Society by realizing the Smart Grid through the digital integration
c) Whole optimization and high value-added creation
d) High reliable inter-convertibility of systems and Standardization of data structure
e) Utilizing Big Data
f) Cyber security
g) Cooperation and optimization with centralized power plants, distributed power plants, and electricity apparatus of customers

Flexible alternating current transmission system devices (FACTS devices include UPFC, DVAR, SVC, etc.) are good examples of advanced components that are based on power electronic technologies. FACTS have already demonstrated their worth in a number of transmission and distribution (T&D) applications, including the following Voltage control at various load conditions

a) Power quality enhancement

b) Reactive power balance
c) Stability problems with energy transfer over long distances
d) High voltage direct current (HVDC), a mature technology, also relies on power electronics to resolve many issues involving the power grid, such as these:
e) Coupling of asynchronous systems
f) Stability problems with energy transfer over long distances
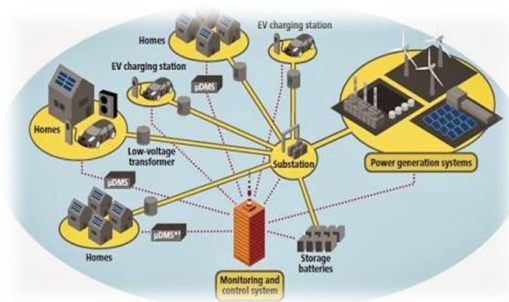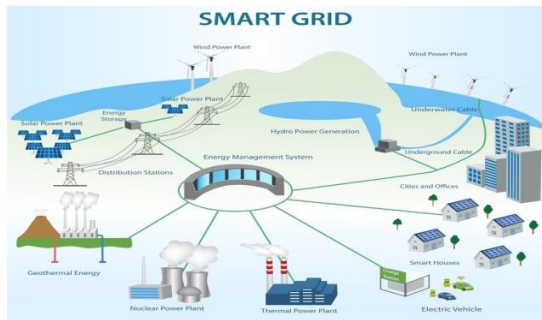g) Increase of short-circuit currents in meshed systems



Fig.2 Smart grid in Japan



Fig.3 Smart grid shutter stock

### B. In Usa

The U.S. Department of Energy (DOE) is charged under the Energy Independence and Security Act of 2007 (EISA 2007) with modernizing the nation's electricity grid to improve its reliability and efficiency. As part of this effort, DOE is also responsible for increasing awareness of our nation's Smart Grid. Building upon The Smart Grid: An Introduction, a DOE-sponsored publication released in 2008 and available online at www.smartgrid.gov, this publication is one in a series of books designed to better acquaint discrete stakeholder groups with the promise

and possibilities of the Smart Grid. Stakeholder groups include Utilities, Regulators, Policymakers, Technology Providers, Consumer Advocates and Environmental Groups.

Support for the smart grid in the United States became federal policy with passage of the Energy Independence and Security Act of 2007[11]. The law set out $100 million in funding per fiscal year from 2008–2012, established a matching program to states, utilities and consumers to build smart grid capabilities, and created a Grid Modernization Commission to assess the benefits of demand response and to recommend needed protocol standards. The law also directed the National Institute of Standards and Technology to develop smart grid standards, which the Federal Energy Regulatory Commission (FERC) would then promulgate through official database.

The Department of Energy (DOE) issued a Notice of Intent and a draft Funding Opportunity Announcement (FOA) that will lay the groundwork for providing nearly $4 billion in American Reinvestment and Recovery Act funds to support smart grid projects. The Notice of Intent was issued for DOE's Smart Grid Investment Grant Program, which will provide grants of $500,000 to $20 million for smart grid technology deployments and grants of $100,000 to $5 million for the deployment of grid monitoring devices. The program will provide matching grants of up to 50% of the project cost, and the total funding for the program is $3.375 billion. In addition, the draft FOA paves the way toward an offer of $615 million to support demonstrations of regional smart grids, utility-scale energy storage systems, and grid monitoring devices.

### C. In India

The present power grid using the technology of 1970, but are connected to increase with the progress in different concept of power generation, problems with the power outages and theft, and also due to the demand, we need a modernized grid to fit the needs of the customers even in the to take the situation in claim hype, what can be called "Smart Grid".The Smart Grid performs various functions, so that it increases network stability, reliability, efficiency and ultimately reduces the processing power conduction losses. The Smart Grids are the two-way of the consumers who may have distributed generation. Various technologies such as sensors and measurement, use of advanced components are used for the successful functioning of

the network. Confronted in this paper, Smart Grid, its features, technologies in smart grid used, implementation and challenges of Smart Grid in India are discussed.

A "smart grid" is a concept for transforming a power grid, with the modern communication, automated checks and other forms of information technology. It integrates new, innovative tools and technologies of generation, transmission and distribution to home appliances and equipment. The urgency for Smart Grids in India arises from the challenges that the industry is currently in front. India operates the third largest transmission and distribution network in the world, still faces a number of challenges, such as: inadequate access to electricity supply shortages (peak and energy)

## IV. WORLD WIDE SCENARIO – FUTURE STATE

The mix of generation will include large central power plants having a range of characteristics (e.g., heat rates, emissions, inertia, ramp rates, etc), in addition to distributed energy resources (many of the green variety) having a different set of performance characteristics. The combination of generation types will operate in a coordinated manner so as to optimize cost, efficiency and reliability and minimize environmental impact. Transmission capacity and reliability will be enhanced through the application and retrofitting of a variety of advanced components, many based on advanced power electronics and new types of conductors. Distribution systems will incorporate many new storage devices and sources and will employ new topologies, including micro grids.

The modern grid will employ a range of advanced components that will greatly enhance the performance of transmission and distribution systems.

TABLE I
A BRIEF COMPARISON BETWEEN THE EXISTING GRID AND THE SMART GRID [15]

| Existing Grid | Smart Grid |
|---|---|
| Electromechanical | Digital |
| One-way communication | Two-way communication |
| Centralized generation | Distributed generation |
| Few sensors | Sensors throughout |
| Manual monitoring | Self-monitoring |
| Manual restoration | Self-healing |
| Failures and blackouts | Adaptive and islanding |
| Limited control | Pervasive control |
| Few customer choices | Many customer choices |

Power quality will be improved through new technology and by seeking an optimal balance between grid and load characteristics Economical FACTS devices will make use of new low-cost power semiconductors having far greater energy-handling capacity than today's semiconductors. Distributed generation will be widely deployed and multiple units will be linked by communications to create dispatch able virtual machines. Superconductivity will be applied to fault current limiters, storage, low loss rotating machines, and lossless cables. Advanced metering and communications will enable a suite of demand response (DR) applications, including the integration of GFAs and plug-in hybrid electric vehicles (PHEVs). New energy storage technologies will be deployed as DER and as large central

## CONCLUSION

The smart protection system involves the work related to system reliability, failure protection mechanism, security and privacy in SG. It is obvious that with this revolution within the advanced infrastructure framework of SG, new management services and applications would emerge and eventually ease consumers' daily lives. For the smart management system, most of the existing works aim to improve energy efficiency, demand profile, utility, cost, and emission, based on the smart infrastructure by using optimization, machine learning, and game theory. . The needs and changes present the power industry with one of the biggest challenges it has ever faced [14].

Due to the potential importance of SG, this survey comprehensively explores the technologies used in SG. The surveys reveal the major SG projects/programs/trials and three major technical systems in SG: the smart infrastructure system, the smart management system, and the smart protection system. The paper outlined challenges and future research directions worth exploring for each of these three systems. It also divided the smart infrastructure into three subsystems: the smart energy subsystem, the smart information subsystem, and the smart communication subsystem. For the smart energy subsystem, we have reviewed the work on power generation, transmission, and distribution. The paper has also described two important new grid paradigms: micro grid and G2V/V2G. For the smart information subsystem, and reviewed the work on information metering, measurement, and management. For the smart communication subsystem, the wireless and wired communication technologies, and the end-to-end communication management has also been considered. In brief, in the transition from the conventional power grid to the SG, thus will replace a physical infrastructure with a digital one Hence it leads to successful comparison and one can find all the technical specifications in one paper. The paper may appear quite simple but it requires tough survey of various papers and technical articles. This paper also allows the reader to understand the hidden potential of all the energy sources and allows a wide future scope about what all can be done. So one needs to primarily focus upon the new developing trends in this field and help the government to complete its proposed projects.

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# Non Convective Zone as a Critical Parameter in Determination of Thermal Performance of Salt Gradient Solar Pond:-A Review

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**Abstract:**
Solar pond technology plays an important role as an alternative source of energy. Solar pond is an artificially constructed pond in which desired temperature rises are caused to occur in the lower regions by preventing convection. To prevent convection, salt is added in the water. Those ponds are called ''salt gradient solar pond'' (SGSP).Thermal performance of the pond is very much depend on different parameters, likebrine transparency , the storage zone temperature, Design and maintenance of the salinity profile, internal convective zones, Optimum size of non convective zone .Also the meteorological factors affect the thermal performance of the SGSP. Among all the parameters size of the non convective zone is one of the most prominent and critical parameter which decide the thermal performance of the SGSP.The non convective gradient zone of a salt gradient solar pond is prominently responsible for effective transmission of incident solar energy to the storage brine below as its thickness is reduced. However, that same gradient zone tends to more effectively reduce heat loss from the warm brines as its thickness is increased. Therefore, there exists an optimum gradient zone thickness for which the net rate of energy collected and retained is a maximum.

## 1 . INTRODUCTION :

Solar ponds are excellent medium for collection and storage of solar energy. Thereby the energy can be extracted for any suitable thermal application. Working of a solar pond is quite simple .Salts like magnesium chloride, sodium chloride or sodium nitrate are dissolved in the water with the concentration varying from 20% to 30% at the bottom to almost zero at the top .In order to maintain the salt gradient, fresh water is added at the top of the pond, while slightly saline water is run off, at the same time, concentrated brine is added at the bottom of the pond. Three zones, namely upper convective zone (UCZ), non-convective zone (NCZ) and lower convective zone (LCZ) are being maintained in the solar pond. Salinity in UCZ is very less and close to fresh water. In NCZ, salinity increases with the depth .As there is no natural convection in this zone, it is called as NCZ.

The solar radiation transmits this zone and increases the temperature uniformly with the depth. LCZ is dense and has a uniform and high density of salt (close to saturated brine). This zone is acting as a storage zone. Maintenance of depth of the gradient zone is essential for the efficient use of solar ponds. Besides various factor influencing on the salt gradient solar pond performance one of the important and critical parameter is non convective zone. Thickness of NCZ very much affect over the thermal performance of the pond.[1], [2],[13]
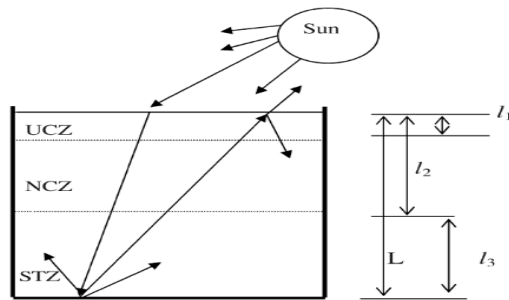


Figure No.1:- Schematic diagram of salt gradient solar pond [4]

## 2. Thermal performance of salt gradient solar pond

The thermal performance of a solar pond can be represented in a form similar to that used for conventional flat plate collectors. Assuming a steady state condition,

$$Q_u = Q_a - Q_e$$

where $Q_u$, = useful heat extracted, $Q_a$ = solar energy absorbed, $Q_e$ = heat losses. The thermal efficiency of a solar pond can be defined as $\eta = (\frac{Q_u}{I})$ where I is the solar energy incident on the pond. Thermal efficiency can be written as $\eta = \eta_o - \frac{Q_e}{I}$, where $\eta_o$ is called the optical efficiency of the pond $(\frac{Q_a}{I})$. We express $Q_e = U_0(T_s - T_a)$ , where $T_s$ is the pond storage-zone temperature, $T_a$ is the ambient temperature and $U_0$ is

the overall heat-loss coefficient. If we neglect heat losses from the bottom and sides of the pond and assume that the temperature of the upper mixed layer is the same as the ambient, then $U_0 = \frac{K_w}{b}$ where $K_w$ is the thermal conductivity of water and b is the thickness of the gradient zone.

Kooi (1979) has compared the efficiency of a solar pond with those of conventional flat plate collectors.. He find that the thermal efficiency of a solar pond is higher than that of a flat plate collector when the operating temperatures are higher, and is in the range of 20 to 30% when the temperature difference is around 60°C. The thermal efficiency is strongly dependent upon the transparency of the pond which is influenced by the presence of algae and dust. Even if the solar pond is free of dust and algae, the absorption properties of pure water influence the transmission of solar radiation in the pond.. He observes that about half the solar radiation is absorbed in the first 50cm of water. This is on account of strong infrared absorption bands in water. At a depth of 2 meters the transmission is about 40%. This sets the upper limit on the thermal efficiency of a solar pond. The thickness of the gradient zone must be chosen depending on the temperature at which thermal energy is needed. If the thickness of the gradient zone is too high the transmission of solar radiation is reduced while if it is too small it causes high heat losses from the bottom to the top of the pond. The optimum value of the thickness depends on the temperature of the storage zone of the pond. Nielsen (1980) has provided a steady state analysis of a solar pond and has included the effect of solar radiation absorption in the gradient zone on the temperature profile. In the steady state, the energy equation becomes

$$K\left(\frac{d^2T}{dZ^2}\right) = I\left(\frac{d\tau}{dZ}\right)$$

Where K is the Thermal conductivity of water, and $\tau$ is Fraction of solar radiation I reaching a depth Z.[7,12]

## 3. Controlling parameters for thermal performance of salt gradient solar pond

The successful operation of a solar pond requires several things: the brine must be kept as clear as possible to maximize the amount of radiation reaching the storage zone; the storage zone must be prevented from overheating; the formation of convective zones within the gradient must be prevented; and upper surface layer deepening due to wind stirring and penetrative convection must be controlled. The latter two effects both reduce the effective thickness of the gradient zone, sharpening the salt and temperature gradients which in turn increases the transport of heat and salt from the heat storage zone to the surface of the pond. Both upper surface layer deepening and overheating of the storage zone will also decrease the stability of the gradient zone by sharpening the temperature gradient.

### 3.1 Maintaining brine transparency

Salt gradient solar ponds are identical to large lakes. They are open to atmosphere and are recipient of impurities. The impurities decrease the clarity of its liquid content and consequently the thermal performance of the pond is degraded. Clarity of water is an important concern in salt gradient solar ponds for better performance. The importance of clarity is recognized by many researchers. The clarity is expressed in various ways by them. Researchers have identified the various sources of water clarity loss. Most of the previous studies on turbidity accumulation

rates are lab scale studies. Such information is of extreme importance to the pond researchers for carrying out realistic thermal performance analysis of the pond. It is also important to be noted that the rate of turbidity accumulation is specific to the geographic conditions including prevailing meteorology and the surrounding landscape. It is important to assess the rate of turbidity accumulation in salt gradient solar ponds under natural environmental conditions.

### 3.2 Maintaining the storage zone temperature

Overheating of the heat storage zone can reduce the stability of the gradient in two ways. Firstly, any increase in heat storage zone temperature will strengthen the destabilizing temperature gradient. Secondly, thermal rising from the bottom of the pond may entrain fluid from the gradient into the heat storage zone, decreasing the thickness of the gradient. It is therefore essential to extract enough heat to maintain the storage zone temperature within the desired range .Heat extraction can also be used to control the thickness of the heat storage zone by producing a layer of cooler brine at the bottom of the pond, in effect stratifying the storage zone. The thermals produced by the heating of the bottom of the pond must expend energy to mix through the introduced stratification before they can entrain fluid from the bottom of the gradient. Usually, the energy remaining after mixing the cooler fluid into the storage zone will be insufficient to cause any erosion of the gradient zone boundary .Nielsen observed that by extracting heat at the Ohio State University's solar pond, the top of the heat storage zone was lowered to within 5 cm of the extraction level.

### 3.3 Controlling the upper surface layer

In a solar pond, sudden deepening events usually result from either strong surface cooling or strong wind stirring. Deepening by seiche-induced shear production at the base of the mixed layer may occur if a pond is long enough, but Schladow has shown that this mechanism is unimportant for ponds less than a few hundred meters in length and so it is not a concern at Alice Springs. However, sustained high winds have been observed to generate surface drift currents at Alice Springs that produce enough shear to cause mixing at the base of the upper surface layer. Double-diffusion on the other hand, will cause a slow downward migration of the upper gradient zone boundary but this effect is generally small compared to the entrainment caused by wind stirring and penetrative convection. Observations at Alice Springs show a typical downward boundary migration rate of about 5 mm/day for an internal convective zone located near the top of the gradient while the upper surface layer deepens at a rate of 10 mm/day under average weather conditions. This compares with meteorologically forced mixing events that can deepen the surface mixed layer by up to 5-10 cm in a single day. Sudden deepening events can be controlled by adjusting the potential energy of the water column above the top of the gradient zone, i.e., by increasing the amount of energy required to entrain fluid from the top of the gradient prior to the encounter of a strong wind. This requires the operator to anticipate the possibility of an event; numerical solar pond models that include upper surface layer dynamics are valuable in this respect. Double-diffusive erosion of the top of the gradient cannot be prevented and must be compensated for by occasional brine injections into the surface layer to reestablish the lost stratification. The potential energy of the upper surface layer is most easily altered by either floating a layer of freshwater on top of the pond or by injecting brine to form a layer that will settle on the top of the gradient. Both techniques increase the amount of energy required to deepen the upper surface layer by lowering the center of mass relative to the surface, and hence the potential energy, of the fluid above the gradient. Schladow has shown numerically that the depth of the upper surface layer can be effectively controlled by varying the surface washing rate and Nielsen has observed a reduction in upper surface layer thickness as a result of rain adding a layer of fresh water to the top of a solar pond. The method that should be chosen will depend on the circumstances at the time, such as the mean upper surface layer salinity and the salinity gradient at the base of the mixed layer.

### 3.4 Design and maintenance of the salinity profile

To prevent the formation of internal convective zones it is essential to maintain a sufficiently high level of stability within the gradient. A well-designed initial salt gradient is required to ensure that $Rp$ remains greater than 5 throughout the gradient. Using a numerical model to simulate the dynamics of the Alice Springs solar pond, Sherman used observed weather data to predict the quasi-steady temperature distribution during the peak summer heating period. This distribution depended on the relative initial thicknesses of the upper surface layer, the gradient zone and the heat storage zone as well as the meteorological forcing. Because the absorption of the sun's shortwave radiation follows an exponential decay with depth, the quasi-steady temperature distribution displayed similar depth dependence with $\delta T/\delta Z$ much sharper at the top of the gradient than at the bottom. The minimum stability always occurred on

summer nights near the base of the upper surface layer where the temperature gradient was the strongest, typically about 70°C/m. [13]

### 3.5 Removing internal convective zones

A method for the elimination of internal convective zones is required because these zones can form duringthe initial construction of the gradient. To do this at Alice Springs, the discrete brine injection concept has been retained but a new diffuser has been designed. The new diffuser produces several small (8-mm diameter) turbulent jets which produce thorough mixing of the injected fluid within an internal convective zone. The flow rate through the diffuser is adjusted to minimize any disturbance of quiescent fluid beyond the boundaries of the convective zone. The technique allows much more accurate control of the resulting stratification. [3, 10, 11]

### 4. Optimum size of non convective zone for improved thermal performance

After discussion of different parameters affecting the thermal performance of SGSP it is found that NCZ is a critical and that much important parameter responsible for thermal performance of SGSP. Different researcher has done the study on the same .J.R.Hull (1989) performed the study of steady state analysis of rising solar pond and concluded An analytical expression has been derived for the steady-state salinity profile of a rising solar pond when the solutal diffusivity has a linear temperature dependence .The analysis includes the possibility of injection in the interior of the gradient. Salinity gradients at the upper boundary can be calculated in the large Φ limit, evaluating Φ for the diffusivity at the upper boundary .In a rising pond using NaCI, a profile can be

established that is stable in the interior of the gradient zone and has a gradient at the surface that is strong enough to resist erosion, with a bottom temperature of 85°C and a surface temperature of 25°C. If a nearly saturated brine source is used for the bottom injection, then for some operating conditions no fluid needs to be extracted from the lower zone to maintain salinity. M.Husain et.al.(2003) with reference to Kooi(1979) proposed analytical approach to determine the size of the NCZ for a faster warm-up rate in the pre-maturation (transient) phase of a pond. Its value is found to be dependent upon other vertical dimensions of the pond, insulation of the bottom, reflectivity of the bottom, the pond solution properties, the desired (target) temperature of the STZ and meteorological parameters. It is observed that the NCZ size strongly influences the warm-up time as well as the cumulative heat collected in the short- and long-term. The pond is a system that requires a very long warm-up time, hence its warm-up time decides the payback period of the financial investment. The steady state optimum size of the NCZ given by Kooi results in the highest rate of heat collection, but after a very long time.

Also M.Husain et.al (2012)proposed technique of creating an additional interface above the NCZ (0.5 Xm),xm optimum thickness of NCZ for rapid warm-up (m), a higher STZ temperature of 90 ºC may be obtained yet maintaining stability of NCZ. But all the present work develops a rational analytical insight for judicious selection of NCZ size considering optimum thermal performance as well as stability aspects. The feasibility of the proposed technique needs to be further examined experimentally [5, 6, 8, 9]
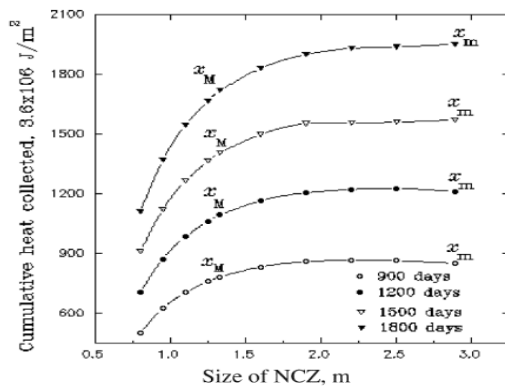
Figure No.2:-Effect of NCZ size on heat retrieval by pond

## Conclusions

SGSP is one of the promising and sustainable technology for future alternative source of energy. For effective utilization of SGSP its thermal performance must be improved which is depend upon various factors. One of the important factor is the size of the non convective zone. Various researchers proposed the different techniques for the same but they suggested the analytical as well as simulation techniques. The feasibility of the proposed technique needs to be further examined experimentally.

## Acknowledgements

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# Optimization of roller burnishing process for improving surface quality

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## Abstract

Improving the surface characteristics of roller burnishing process is one of the effective approaches to decrease the machining cost and time. This paper systematically investigates the nonlinear relationships between machining parameters and surface characteristics, including surface roughness and hardness of the exterior roller burnishing using response surface method (RSM) model. Four process parameters considered include burnishing speed, feed rate, depth of penetration and number of passes. A set of physical experiments was carried out with EN-19 alloy steel on a computer numerical control (CNC) lathe machine using the roller burnishing tool. Using the experimental results, a regression model has been developed to predict surface hardness.

Keywords: Roller burnishing, Response surface methodology, Optimization technique, CNC lathe, ANOVA analysis

## Introduction

Roller burnishing is a cold working process in which surface asperities get plastically deformed due to pressure applied by the hard roller. This process is an efficient chip less surface, compared to other treatment techniques such as, grinding, polishing, lapping, and honing. Plastic deformation on the work piece surface will occur as the peaks flow into the valleys under the burnishing pressure. The surface of the metallic material will be smoothed out and because of the plastic deformation the surface is work hardened and the material is left with a residual stress distribution compressive on the surface. The changes in surface characteristics due to burnishing will cause improvements in surface roughness and surface hardness.

The realization of surface integrity improvement via burnishing parameter optimization has considered by many researchers. Surface roughness and surface hardness of the burnished material are two priority criteria in terms of machined part quality.

It has been observed by Klocke and Liermann [1] that improvement in the surface finish between 30 and 50% can be achieved by roller burnishing process using ceramic balls. Hassan et al. [2] optimized the ball burnishing parameters, mainly the burnishing force and number of passes using response methodology. El-Axir [3] developed a mathematical model for roller burnishing operation using response surface methodology under lubricating conditions.

They predicted surface micro-hardness and roughness of steel-37 with the help of their model. Nemat and Lyons [4] investigated and reported that by choosing proper burnishing conditions, burnishing process could decrease surface roughness up to 70% on A113 grade A of mild steel and AA6463 E of Aluminium alloy using the lathe. Hamadache et al. [5] investigated the effect of ball and roller burnishing process on Rb40 steel in lathe. The effect on the material surface by the change in the burnishing force, feed, speed and number of passes was studied. El-Tayeb et al. [6] investigated the impact of burnishing speed, burnishing force and burnishing tool dimensions on the surface qualities and tribological properties. The investigations were carried out by varying speed, feed and number of passes using Taguchi method to examine the surface finish and microhardness [7]. Qureshi et al. [8] investigated ball and roller burnishing processes on EN8 steel by varying burnishing parameters like speed, feed, depth of cut and number of passes on surface roughness. Roller burnishing parameters were optimized in an effort to

improve the surface roughness in terms of aluminium alloy [9]. Similarly, the relationships between machining parameters and the surface performances, including the surface roughness and hardness were developed for titanium alloy [10], 2017A-T451 aluminum burnishing [11].

Most of the researchers have studied only the effects of burnishing parameters for burnishing process but did not use any statistical method to optimize the results. Hence, this paper deals with RSM optimization technique for roller burnishing process parameters on tool steel under different burnishing parameters such as burnishing speed, feed rate, depth of penetration and number of passes against surface hardness.

**Experimental Details**

Work piece material chosen is 'EN-19 Grade Alloy Steel' which is widely used in automobile industries. Chemical composition of the material is given in table 1.

Table 1 Chemical Composition of EN 19 alloy steel used for experimental investigation

| Element | C | Mn | Si | S | P | Cr | Ni | Mo |
|---------|------|------|------|------|------|------|------|------|
| Wt (%) | 0.441 | 0.789 | 0.185 | 0.028 | 0.014 | 1.063 | 0.081 | 0.276 |

All the burnishing tests were conducted on ACE Designers make CNC lathe (Junior Jobber) having Fanuc controller. The work pieces are cylindrical in shape with 32 mm diameter and 200 mm length. The work pieces are then turned to the desired diameter of 30 mm and length 183 mm. The following machining parameters are used for rough turning: speed 2000 rpm, feed 0.2 mm/rev, depth of cut 1 mm, cutting speed 120 mm/min and tool insert TNMG160408. The following machining parameters are used for finishing turning: speed 2500 rpm, feed 0.1 mm/rev, depth of

cut 0.25 mm. Small grooves of 2 mm each are machined at equal intervals of 40 mm to divide the turned work piece into four parts. Entire understanding of the process needs more number of experiments to be performed, which is very time consuming and expensive. This can be overcome by adopting the experimental layout plan based on the design of experiments using different levels defined for each of the process variables. In the present study burnishing speed, burnishing feed, depth of penetration and number of tool passes were identified based on the past

investigation. To investigate the effect of process parameters on the performance of output parameter, the experiment was designed and conducted by considering surface hardness as a main response. The

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considered process parameters were varied from lowest to highest levels for each factor as summarized in Table 2

Table 2 Factors and levels for CCD

| Coded levels | -2 | -1 | 0 | 1 | 2 |
|---|---|---|---|---|---|
| Burnishing Speed, rpm (A) | 1000 | 1100 | 1200 | 1300 | 1400 |
| Burnishing Feed, mm/rev B) | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 |
| Depth of Penetration, mm C) | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 |
| Number of Passes ( D) | 1 | 2 | 3 | 4 | 5 |

Designed and manufactured roller burnishing tool assembly photographic view is given in Figure1.
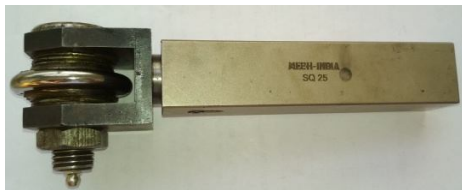


Figure 1 Photographic view of roller burnishing tool

The burnishing tool was mounted on the CNC turret. The work piece was clamped by using the tailstock center and lubricant was used during burnishing as shown in figure 2.



Figure 2 Experiment setup of roller burnishing process

Surface hardness values were measured using Rockwell hardness measurement device. For each sample, three surface hardness values were measured and the arithmetic mean of the measured values was

taken as result. In this study, the design expert software package was used to develop RSM model. RSM is a collection of mathematical and statistical techniques that are useful for the modeling and analysis of problems in which a response of interest is influenced by several variables and the objective is to optimize this response. RSM consists of a group of techniques used in the empirical study of relationships between one or more measured responses and a number of input factors. It works following these steps: designing a set of experiments, determining a mathematical model and determining the optimal value of the response for a better understanding of the overall system behavior.

**Experimental Design and Analysis**

Instead of using one factor at a time for experimentation, Design of experiments is used for conducting experiments. It reduces number of experiments and time for conducting experiments. Total 30 experiments were carried out based on central composite design (rotatable design) and output response in terms of surface roughness were measured. The arrangement and the results are given in table 3. Design Expert-8 software was used to analyse and decide mathematical model which will be

adequate for the output responses. Regression analysis indicates quadratic model is adequate for surface roughness. The regression model for surface hardness is expressed in coded factors using equation no 1.Surface hardness values are measured at using standard surface roughness tester as shown in figure 3.



Figure 3 Rockwell hardness tester machine

Table 3 CCD designed matrix and experimental results

| Run | A:Speed (rpm) | B:Feed (mm/rev) | C: Depth of Penetration (mm) | D: Number of Passes | Surface Hardness (HRC) |
|---|---|---|---|---|---|
| 1 | 1100 | 0.05 | 0.2 | 4 | 32.66 |
| 2 | 1200 | 0.06 | 0.3 | 3 | 32.33 |
| 3 | 1100 | 0.07 | 0.2 | 4 | 32.33 |
| 4 | 1200 | 0.08 | 0.3 | 3 | 32.33 |
| 5 | 1200 | 0.06 | 0.3 | 3 | 32.66 |
| 6 | 1200 | 0.04 | 0.3 | 3 | 33 |
| 7 | 1000 | 0.06 | 0.3 | 3 | 32.66 |
| 8 | 1100 | 0.07 | 0.4 | 2 | 32.33 |
| 9 | 1300 | 0.05 | 0.2 | 2 | 33.33 |
| 10 | 1300 | 0.07 | 0.2 | 4 | 32 |
| 11 | 1200 | 0.06 | 0.3 | 3 | 33.66 |
| 12 | 1200 | 0.06 | 0.1 | 3 | 32.33 |
| 13 | 1100 | 0.05 | 0.2 | 2 | 33.66 |
| 14 | 1100 | 0.07 | 0.4 | 4 | 32.66 |
| 15 | 1200 | 0.06 | 0.5 | 3 | 34.33 |
| 16 | 1400 | 0.06 | 0.3 | 3 | 32 |
| 17 | 1100 | 0.05 | 0.4 | 4 | 34.66 |
| 18 | 1200 | 0.06 | 0.3 | 1 | 34.66 |
| 19 | 1300 | 0.05 | 0.2 | 4 | 32 |
| 20 | 1300 | 0.07 | 0.4 | 2 | 32.33 |
| 21 | 1300 | 0.05 | 0.4 | 4 | 35 |
| 22 | 1200 | 0.06 | 0.3 | 5 | 33.66 |
| 23 | 1200 | 0.06 | 0.3 | 3 | 32.33 |
| 24 | 1300 | 0.05 | 0.4 | 2 | 34 |
| 25 | 1200 | 0.06 | 0.3 | 3 | 32.66 |

| 26 | 1100 | 0.07 | 0.2 | 2 | 33.66 |
| 27 | 1300 | 0.07 | 0.2 | 2 | 33.66 |
| 28 | 1300 | 0.07 | 0.4 | 4 | 33 |
| 29 | 1100 | 0.05 | 0.4 | 2 | 32.66 |
| 30 | 1200 | 0.06 | 0.3 | 3 | 32.33 |

Table 4 ANOVA for response surface quadratic model

| Source | Sum of squares | df | Mean Square | F Value | p-value Prob > F | |
|---|---|---|---|---|---|---|
| Model | 16.37 | 10 | 1.64 | 29.32 | < .0001 | significant |
| A-Speed | 4.00E-03 | 1 | 4.00E-03 | 0.072 | 0.7918 | |
| B-Feed | 2.07 | 1 | 2.07 | 37.08 | <0.0001 | |
| C-depth of penentration | 2.02 | 1 | 2.02 | 36.24 | <0.0001 | |
| D-passes | 0.36 | 1 | 0.36 | 6.49 | 0.0196 | |
| AC | 0.54 | 1 | 0.54 | 9.74 | 0.0056 | |
| BC | 2.04 | 1 | 2.04 | 36.49 | <0.0001 | |
| BD | 0.54 | 1 | 0.54 | 9.74 | 0.0056 | |
| CD | 5.1 | 1 | 5.1 | 91.25 | < .0001 | |
| C2 | 0.54 | 1 | 0.54 | 9.75 | 0.0056 | |
| D2 | 3.4 | 1 | 3.4 | 60.92 | <0.0001 | |
| Residual | 1.06 | 19 | 0.056 | | | |
| Lack of Fit | 0.74 | 14 | 0.053 | 0.84 | 0.6366 | not significant |
| Pure Error | 0.32 | 5 | 0.063 | | | |
| Cor Total | 17.43 | 29 | | | | |

The model F-value of 6.78 shows that the model is significant. The values of "prob>F" less than 0.0500 indicates that model terms are significant. Depth of penetration, burnishing feed and quadratic term of number of passes are the most significant terms. In this case signal to noise ratio is 10.232 indicates an adequate signal. Value of R square is coming 0.7363. So we can say that other parameters are not significant to depth of penetration as shown above table 4.

**Models, Results and Discussion**

Experimental results are used to decide which mathematical model can be applied. Regression analysis indicates that the quadratic model adequately represents surface hardness. The regression equation can be expressed by equation (1) in terms of coded factors.

Surface Hardness (HRC) $= 32.66 - 0.31*B + 0.31*c - 0.37*B*C + 0.58*C*D + 0.37*D*D$       (1)

Burnishing parameters whose effect is negligible are not considered in above equation. Validation of

mathematical model is done and it is observed that average results are correct up to 90%. So, we can say that model is effective.

Results: As seen in Table 4, feed rate and depth of penetration are the most significant parameters, speed and numbers of passes are the non significant parameters. The effect of the depth of penetration and burnishing feed on the surface hardness is shown in figure 4. It can be realized that the combination between nominal feed rate and high depth of penetration results in considerable increase in burnished surface hardness.
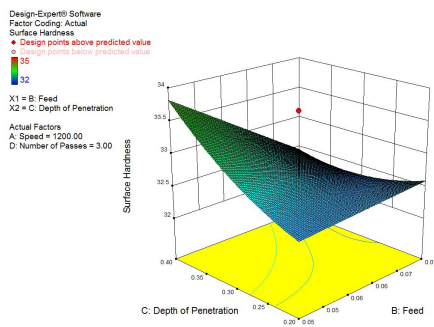


Figure 4 Effect of Depth of penetration and feed on surface hardness

The effect of the depth of penetration and number of passes on the surface hardness is shown in figure5. It can be realized that the combination between high

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number of passes and high depth of penetration results in considerable increase in burnished surface hardness
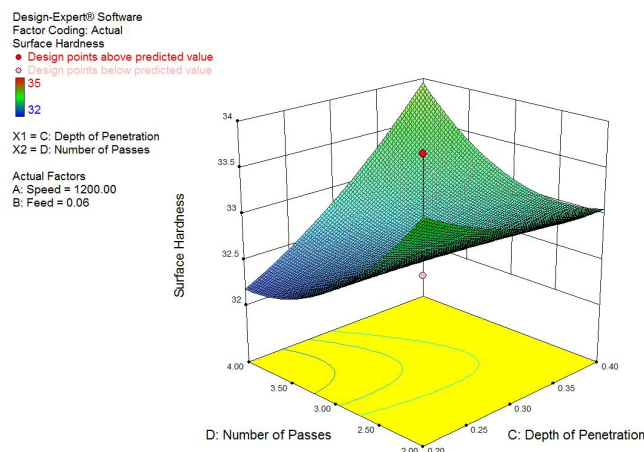


Figure 5 Effect of number of passes and Depth of penetration on surface hardness

The normal probability plot of the residuals is shown in figure 6. The predicted values were found to be statistically similar to the actual measured values, based on the plotted probability plot. A check of the

plot in figure 6 revealed that the residuals generally fall on a straight line implying that the errors are distributed normally.
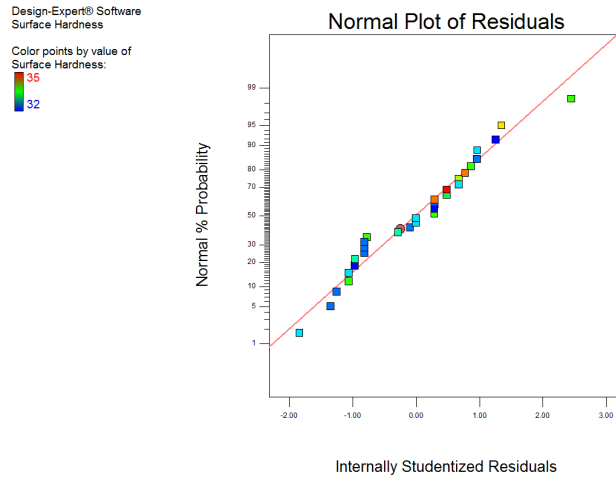


Figure 6 Normal probability plot of the residuals

Figure 7 indicates that it has no obvious pattern and unusual structure. This implies that the model proposed is adequate. The comparison of experimental results with the RSM predictions is presented in figure 8.
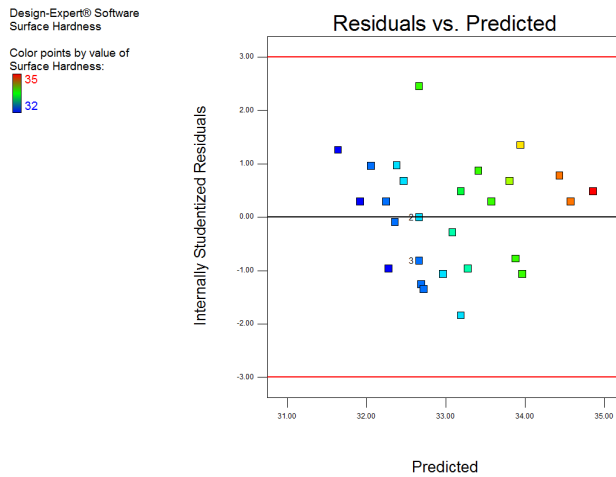


Figure 7 Standardized residual versus observation order plot

As seen in figure 8, the agreement between experimental surface hardness values and model surface hardness values is high. The value of the multiple coefficient of $R^2$ between experimental results and predictive values is obtained as 73.63 %. This value showed that the empirical model fits well with experimental results.
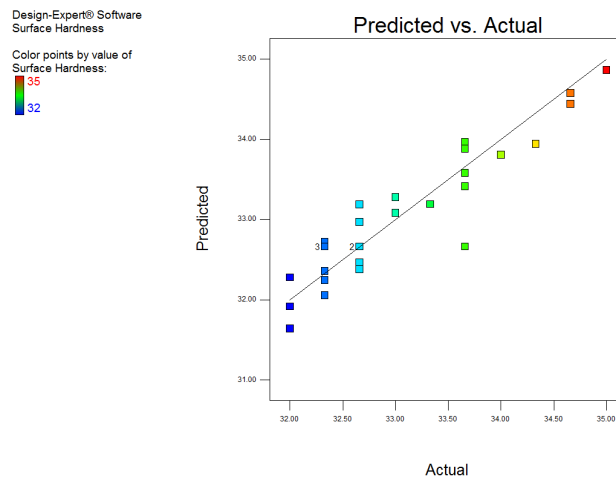
## Conclusion

In this experimental study, a quadratic model was developed for the prediction and analysis of the relationship between the burnishing parameters and surface hardness of EN 19 alloy steel by using a RSM based approach. The significant factors on the surface hardness were determined as depth of penetration, burnishing feed and number of passes. As a result, the model from CCD was considered to be accurate and reliable for predicting the surface hardness in single roller burnishing process.

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# Review of Electrical conductivity properties of Conducting Polymers based electronics application

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**Abstract :**

In this paper, the review of conductivity properties of conducting polymers is carried out based on electronics application. The electrodes of various electronics applications play an important role it has received much attention in both fundamental and practical studies because they have good electrical properties to those of both traditional semiconductors and metals. Also it has simple synthesis and processing conditions, chemical and structural diversity, tunable conductivity, and structural flexibility. Considering these strength the paper highlights the importance of conductivity, enhancement of conductivity and their use in various applications.

**Keywords:** Conducting polymer, Conductivity, Electronics application.

## I. Introduction

Polymers are typically utilized in electrical and electronic applications as an insulator where advantage is taken of their very high resistivity. A polymer is composed of many repeated subunits. It shows broad range of properties for natural and synthetic polymers, it play essential and ubiquitous roles in day today life. Natural polymers are insulators, with conductivities lies between $10^{-6}$ to $10^{-20}$ $\Omega^{-1}cm^{-1}$. Conducting polymers (CPs) is a subclass of polymers that are electronic conductors. Generally, conducting polymers are insulators in their neutral state and conductivity is achieved by oxidizing or reducing (doping) the polymer chain. They are organic polymers that conduct electricity and have metallic conductivity or can be semiconductors. It is of economical importance, electrical conductivity and good environmental stability as well as due to their useful electronic, optical and mechanical properties. It exhibits good conductive, electronic, magnetic, wetting, mechanical, optical and microwave-absorbing properties due to which it has high range of applications such as ion extraction, actuators, electromagnetic radiation shielding, smart windows, organic light-emitting diode (OLED) displays, and sensors. They are also be used as the active material in energy storage and solar cell applications. This paper is discussing the importance of electrical and conducting properties of conducting polymers in electronics application.

## II. Conductivity

The conductivity is defined by Ohms Law. It is stated as V= IR, Where R is the resistance, I the current and V the voltage present in the material. The conductivity of a material depends on both the density of charge carriers (number of charges per unit volume) and how fast they can move in the material or on its mobility µ. A simple relationship between mobility of the charge carriers and the electrical conductivity σ exist. Mobility of negative charges µe and positive charges µp will move with the velocity vector µeE and µpE in the electric field E. The total current density is then

$$\sigma = e\,(ne\,\mu e + np\,\mu p)$$

where *e* is the elementary charge, and *ne* and *np* are the number density (concentration) of negative charges (electrons) and positive charges (holes). The conductivity is temperature dependent for metals it decreases with increasing temperature, whereas for semi-conductors like conducting polymers it increases.

## III. Role of electrical conductivity in electronics application

In terms of electronics and electrical applications the electrical conductivity of conducting materials the plays major role. It has a measure of how an electrical current moves within a substance. Higher conductivity gives greater current density for a given applied potential difference. The doping percentage, arrangement of polymer chains, conjugation length and the purity of the samples are considered in conductivity measurement. The structure, conductivity, energy gap, type of doping of the conducting polymers like poly(acetylene), poly(thiophene), poly(pphenylene vinylene) (PPV), poly(pyrrole) and poly(aniline) are discussed in table 1.

Table 1: conducting polymers in electronics application

| Conducting polymers (Discover year) | Structure | Conductivity (S/cm) | Energy Gap (eV) | Type of Doping |
|---|---|---|---|---|
| Polyacetylene (PA) (1977) | | 103 – 1.7×105 | 1.5 | n, p |
| Polypyrrole (PPy) (1979) | | 102 – 7.5×103 | 3.1 | p |
| Polythiophene (PTh) (1981) | | 10 – 103 | 2.0 | p |
| Polyphenylene (1979) | | 102 – 103 | 3.0 | p |
| Poly(p-phenylene vinylene) (PPV) (1979) | | 3 – 5×103 | 2.5 | p |
| Polyaniline (PAn) (1980) | | 30 – 200 | 3.2 | n, p |

## IV. Conducting Polymer Electronics Application

Even though several conducting polymers have been prepared, it was soon realized that they cannot compete with metals in traditional electrical applications, like electric wiring, transmission cables etc. Researchers have, therefore, focused on other applications that exploit the existence of extended conjugation in these polymers. A few attractive possibilities are mentioned below
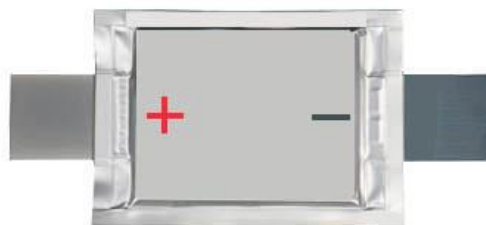
1. **Supercapacitor**



Fig 1 radial style and flat style super capacitor for electronics and mobile application

A supercapacitor is a high-capacity capacitor with capacitance values much higher than other capacitors (but lower voltage limits) that bridge the gap between electrolytic capacitors and rechargeable batteries. As compare to electrolytic capacitors it store 10 to 100 times more energy per unit volume, can accept and deliver charge much faster than batteries, and tolerate many more charge and discharge cycles than rechargeable batteries. Fig 1 shows radial style and flat style supercapacitor for electronics and mobile application. Many researchers have shown their interest in the design and fabrication of supercapacitor electrode using conducting polymers.

Table 2 review of supercapacitor with various parameter

| Material | Electrolyte solution | Maximum specific capacitance | Current density/ sweep rate | Power density (kW/kg) | Electric resistance (Ω) | Reference |
|---|---|---|---|---|---|---|
| PAN-based CNFs | 6M KOH | 134 F/g | 1 mA/(cm2 ) | – | – | 1 |
| PAni nanofibers | 1M H2SO4 | 548 F/g | 0.18 A/g | 0.127 | 0.76 Ω | 2 |
| PAni/MWCNTs | 1M H2SO4 | 360 F/g | 2 mA | – | 0.48 Ω/(cm2 ) | |
| PPy/MWCNTs | | 200 F/g | | | 0.86 Ω/(cm2 ) | 3 |
| PAni nanotube/TNT | 1M H2SO4 | 740 F/g | 3 A/g | 3 | – | 4 |

## 2. Light emitting diodes

A light-emitting diode (LED) is a two terminal semiconductor light source. It emits light when activated with a suitable current is applied between the p and n terminal. The electrons are able to recombine with electron holes within the device, it releases energy in the form of photons.

The flow into the junction from electrodes with different voltages. Due to recombination of electron and hole, at the junction point energy level falls and releases energy in the form of a photon. The semiconducting material doped with impurities to create a p-n junction. As compare to other diodes, the current flows easily from the p-side, or anode, to the n-side, or cathode, but not in the reverse direction. The charge carriers electrons and holes
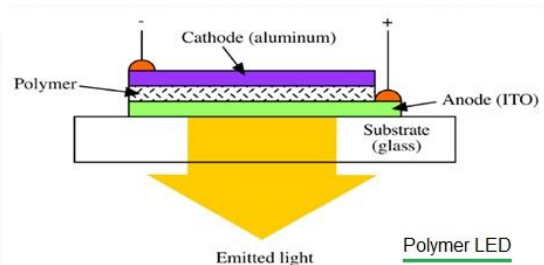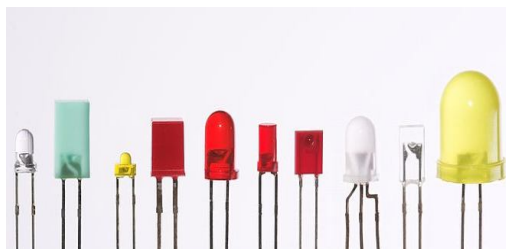


Fig 2: LED and constructional detail of polymer LED

Table 3: review of light emitting diode with various parameters

| Polymer | Dopant | E.Q.E. (%) | C.E. (cd/A) | P.E. (lm/W) | Ref |
|---|---|---|---|---|---|
| PVK | Ir(ppy) | 16.1 | 53.8 | 13.3 | 5 |
| PVK | Ir(ppy) | 3.4 | 12.3 | -- | 6 |
| PVK | Ir(ppy) | 8.5 | 30.1 | -- | 7 |
| PVK | Ir(mppy) | -- | 23.0 | -- | 8 |
| PVK | Ir(mppy) | -- | 33.7, 32.0 | 19.6 ,15.9 | 9 |
| PVK | Ir(ppy) | -- | 63.2 | 12.2 | 10 |
| PVK | Ir(mppy) | -- | 50 | 41 | 11 |

Note :- External Quantum Efficiency (EQE), Current Efficiency (cd/A) and Power Efficiency (lm/W)

### 3. Solar Cells

In contrast with existing variety of solar cells, flexible solar cells (like polymer solar cells) create a number of application possibilities because they are potentially inexpensive, flexible, lightweight, semi-transparent, variable in color, environmentally friendly and provide portable solar

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energy. These technology-specific factors, in many ways, represent market opportunities as well as threats. Portable solar energy has been a dream since solar energy was discovered – and, admittedly, possesses interesting possibilities if the solar cell is cheap enough, and if the PCE matches the portable application – which is a key point. External limiting factors are the need for energy and the storage of energy, i.e. the available application and battery capacity coupled with the PCE of the solar cell
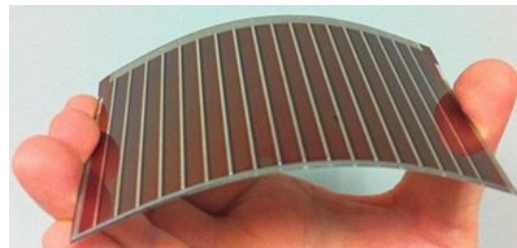


Fig 3: solar cell

Table 4: review of solar cell material and efficiency

| Solar cells | Materials | Efficiency | Refs. |
|---|---|---|---|
| Polymer | P3HT, IC60BA, PBDTT-DPP,PC71BM | 8.60% | 12 |
| Polymer | Same as above | 10.60% | 13 |

### 4. Transistors and data storage

Fig 4: transistor and data storage

In terms of electronics application a various kinds of transistor plays an important role as switching, amplification, storage etc. The conductivity property has ability to improve the in-situ and gate module channel conductance. Many researchers quoted their research for structural, morphological, synthesis, homogenous allocations properties using conductive polymers.

Table 5: review of transistor and data storage

| Material | Innovation | Application | Ref |
|---|---|---|---|
| P3HT | structural and morphological modifications | organic field effect transistor | 14 |
| PTh | synthesized and characterized sandwich-type apparatus conductance switching by calculating capacitance | Storage and switching | 15 |
| Poly(methyl methacrylate) (PMMA) | flexible polymer light-emitting transistors using Ag nano wires electrodes | light-emitting transistors | 16 |
| Polymer variant survey | porous reticular morphology and homogenous allocations | energy storage solid-state rechargeable | 17 |
| polypyrrole | lithium ion batteries as anode materials | Batteries | 18 |
| Polyaniline and polypyrrole | single nanowires conducting polymer field effect transistor | Field effect transistor | 19 |

**5. Sensors**

The application of CPs in sensor technologies includes the CPs as an electrode modification in order to enhance sensitivity, to impart selectivity, to suppress interference and to give a support matrix for sensing materials. Few sensors employing CPs are discussed below:
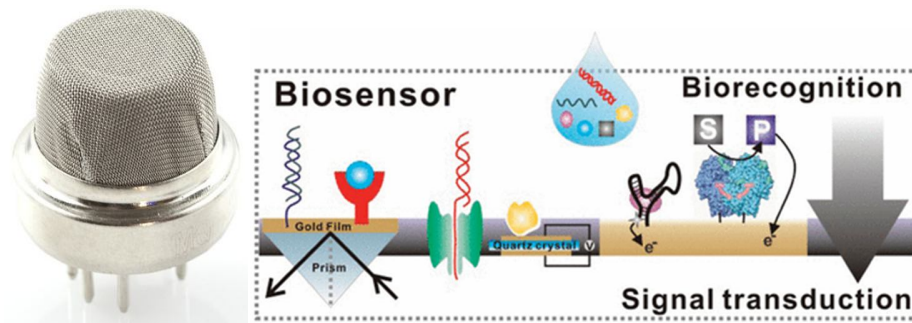
Fig 5: Typical Sensors

**a. Gas sensors:**

The liberation of gaseous impurities like SO2, nitrogen oxide and toxic gases from associated industries has become a severe ecological concern.

Sensors are essential to identify and evaluate the concentration of such gaseous pollutants. PANI, PPY and PTh have generally been used in fabrication of gas sensor apparatus.

Table 6: Review of Gas sensor

| Material | Uses | Ref |
|---|---|---|
| poly N-(2-pyridyl) pyrrole | Sensing | 20 |
| PEDOT doped with poly (styrene sulfonic acid) | sensing | 21 |
| PEDOT: PSS | | 22 |
| PPy | CO2 gas sensor | 23 |
| PPy and PANI | conductimetric acetone gas sensor | 24 |
| CuO/Multi walled nanotubes thin film | ethanol sensing | 25 |
| metallopolymer | LPG sensors | 26-28 |

**b. Bio Sensors**

Bio sensor is a device which uses a living organism or biological molecules, especially enzymes or antibodies, to detect the presence of chemicals. It captures the biological signal and convert it into a detectable electrical signal. Biosensors are employed in the fields of environment, biomedical and food industries to detect and remove certain contaminants, weather non-living or living entities. Optical, Amperometric, Surface Plasmon Resonance, enzymatic, DNA, Phage, and bacterial sensors are the common sensors being employed today. They are used for the detection of the broad spectrum of biological analytes and have shown greater responses and success in medical laboratories, food bioanalysis, microbial detection

etc. The glucose in body, microbial invasion in body and food, heavy metals detection in soil, water and air-borne microbes, pesticides in water and soil and number of harmful chemicals produced by body, can be easier and real time approach based monitoring with high precision using the different types of biosensors with few modifications.

Mahrotra et al showed the latest progress in biosensors and their uses in food investigation, environmental control, clinical detection, medicinal and farming industries, etc.[29] Adhikari et al. examined several materials for sensor applications and stated the use of CPs either in sensing mechanism or in immobilizing the ingredient responsible for sensing the analyte.[30] Freire reported the development of electrochemical

biosensors by direct transfer.[31] The films synthesized by electrochemical co-deposition of enzymes on CP or conductive substrates have been used to produce biosensors.[32]

### c. Humidity Sensors
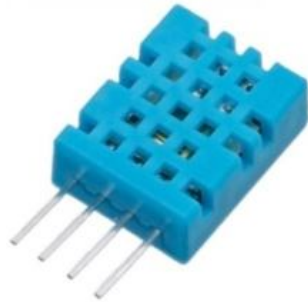


Humidity sensors are needed for industrial and medical fields and they are competent for the detection of the humidity in different environments with respect to electrical [33-36], optical [37-39] and other physical parameters.[39-42]. To compute and control humidity is a crucial task in several regions such as food and electronic industry, domestic atmosphere, medical, etc.

Fig 6: Humidity sensor

Similarly the hydrophilic properties of polymer, polymer composites and modified polymers have been used in devices.

Jain et al reported the PANI doped humidity sensor[43]. Choa et al shows the behavior of PPy humidity sensor for change in temperature. As the initial impedance of the sensor was increased with enhancement in humidity and decrement of temperature. Similarly the repeatability rate of the sensor was outstanding at different humidity circumstances[44]. Parvatikar et al studied the electrical and humidity sensing properties of nanocomposites [45]. Zenga reported the PANI nanofibres based sensor, it respond to low relative humidity (<50% RH) generally by decreasing electrical resistance with enhancing humidity.[46]

### d. Actuators

An actuator is a kind of device that is dependable for controlling a system and it is operated by a source of energy, usually electric current, hydraulic fluid pressure and changes that energy into action.

Table 7: Review of Actuators

| Method and material / Type of actuator | Reference |
|---|---|
| conducting inter penetrating polymer arrangements for actuator | 47 |
| tubular linear actuator using PPy | 48 |
| new self-sensing ion CP metal composite actuator | 49 |
| bilayer and trilayer actuators | 50 |
| Temperature dependence of water vapour absorption and electro-active polymer actuating | 51 |
| bending actuators | 52 |
| compared displacement study of bilayer actuators including of CPs | 53 |
| location control | 54 |
| electrochemical actuator | 55 |
| tri-layer PPy micro actuators | 56 |

### V.Conclusion

We have described the electrical properties of conducting polymer that have become significant. Accepting these properties key importance in the development of CP's for application in various fields. In this paper the review highlight that the doping concentration, temperature, inherent structure affects the mobility of charge carriers; it results improvement in the conductivity of conducting polymer. Conductivity of CP has much scope for improvement. Conducting polymers

offers many electronics applications, as the conductivity of polymeric material varies with different metal. In future conducting polymer will be strong candidates for a diverse range of future applications.

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# Small Scale Solar PV For Residence: A Critical Review

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**ABSTRACT :** Utilization of solar PV system in residential houses started increasing worldwide due to economical beneficial and increasing environmental awareness of people. Due to increase of use of solar PV the CO2 emission is decreased which helps in reducing the green gas effect. This paper reviews the small solar PV system in residential house in economical as well as environmental way. India receives sun's energy over 300 days a year most of the time. About 5000 trillion kWh per year sun's energyis incident over India's land area.Using consumer-level data, theeffects of installing a PV system on the electricity demand are estimated in terms of the impact of thetechnological performance which was a direct contributor to a reduction in the electricity demand. This paper presents also the impacts of PV home systems on the electric gridrepresented in decreasing the losses, raising the voltage level and decreasing the power factor. It presents alsothe effect of PV systems on the environment and a simulation supported method for improving the annual energyproduction of such PV home systems at no additional cost.

*Keyword ---* Solar PV, Residence

## 1.INTRODUCTION :

One of the greatest renewable energy sources of energy is solar energy, abundant, environmental friendly and can be harnessed for domestic uses. A photovoltaic device converts solar energy into electric potential. The application of photovoltaic technologies resolves the problems like greenhouse gas emissions and climate change. Also, solar energy is secure, clean and suitable. Problems of energy shortage and environmental pollution have become more prominent, leading to worldwide attention on solar PV energy.Governments worldwide have included strategies to stimulate the growth of micro renewable energy systems at the residential level as part of their overall energy policy aimed at combatting climate change. Governments have used a variety of support mechanisms to achieve their targets which include Feed-in Tariffs (Fit), point of sales rebates including Renewable Energy Certificates (REC), and tax benefits.

The solar radiations reaching the earth's surface vary from 0.06kW/m2 athighlatitudesto0.25kW/m2 at lowlatitudes. It is given that the total globalise-free land is around 13,000MHa, from this theoretically power collected from the solar source is about 1,840TW.Inparticular,solar PV possesses a huge potential both in technical and sustainable solutions to the energy demands.

It is project edthattheelectricitygeneratedfromsolarenergywillbe increasedto402TWhby2030, while electricity generationfromPVwillbe280TWh.Itisestimatedthat during the past five years, the total capacityofsolarPVgrewwithaverageratesof60%annu allyfollowedbyCSP43%andwind 25%.
This shows that utilization of solar PV system on small scale in residential is necessary to meet global demand of energy from solar PV. To fulfil this demand the solar PV system will be required to available in minimum cost so that it will be economical for the every person.

## 2. Literature Review

**Eric O'Shaughnessya, Dylan Cutlera, Kristen Ardania, Robert Margolisa**

We find that solar plus – a more integrated approach toPV optimization using batteries and load control devices – improvescustomer economics relative to standalone solar. We build on a growingbody of literature by showing that the economics of solar plus dependon grid export rates as well as other rate structure components. We findthat the solar plus approach is well suited to address some of the ratestructure challenges facing future PV deployment. We provide a newmethod for evaluating, selecting, and sizing solar plus technologies,allowing our model to choose amongst a suite of candidate technologies.

**Bikash Kumar Sahu**

In the present paper, the global renewable status, regional renewable energy status as well as country wise renewable energy status have been analyzed. Among all renewable energysources, solar energy has a tremendous potential across all the countries and it is the mostprominent energy source. Similarly, the solar PV developments at global levels, regional levels and national levels are also discussed. This paper has given the main focus on recent developments of solar energy and the effective policies in the top ten countries. In the present scenario, the countries such as Germany, Italy, Japan, Spain, USA, China, France, Belgium, Czech Republic and Australia are the top ten global solar power producers. The per capita values of these leading countries are also taken for consideration.

**Nelson Sommerfeldt, HatefMadani**

Techno-economic analyses are a critical input to the decisionmaking process for investment in building energy systems. Presentedin this work is a modeling framework for use in studying prosumerinvestments in PV systems in deregulated markets and a review ofcomponent models and uncertainty analysis which can work to meetthe model's objective. State of the art methods from finance arebeginning to be used in solar PV studies, but the majority of literaturecontinues to use traditional engineering economic methods. This study
is useful as a reference to solar energy analysis and motivates the needfor an increase in more comprehensive and market based PV investmentanalysis in published scientific literature.

**S. Manju, NetramaniSagar**

This paper discusses the scenario, progress, applications and prospects of PV industry in India. In order to keep pace with the rapid economic growth in India and face the threat of climate change, some policies are developed by the central and the state governments tobooostthe use of RE in all possible sectors. The declining PV system prices combined with the higher incentives provided by the government ramps up the use of PV in future India. The progress in PV industry can be followed in a translucent and reliable manner since the price of PV system continues to reduce. The purchasing power of the people will increase due to an increase of 5% annual GDP rate resulting from the developing Indian economy, which accelerates the installation of RE technologies to increase the availability of green power. As manufacturing pricing reduces along with the growing shipments, the higher productivity creates an optimistic prospect for PV industry in India.

## 3. Methodology

### 3.1 PV home system components

Each PV system consists mainly of a PV generator, support structure,one On-Grid single phase inverter, protection features (circuit breakers,fuses, surge arrestors, lightning protection and grounding system), ACkWhmeter for measuring the total kWh produced by the PV system anda meter for measuring kWh injected into the grid and the total kWhconsumption of the load as well as monitoring and measuring system.

### 3.2 PV Generator

The maximum peak power required for grid connected PV system is limited to 5 kWp. Thislimitation is fixed at this value because the annual energyconsumption of most residence houses doesn't achieve or exceed theannual production of a PV generator rated at 5 kWp.Therefore, allinterested residents like to install 5 kWp on their roofs to obtain thehighest possible income. Furthermore, no specific standards, policy orspecifications are available to enforce selecting PV modules, but thewhole PV modules in the local market are of polycrystalline andmonocrystalline types where each consists of 60 or 72 PV cellsconnectedin series and rated at a peak power in the range of 260–340 Wp.
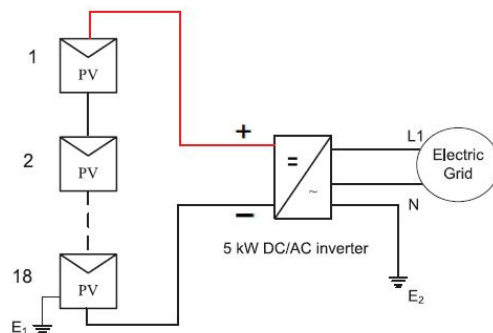


Fig.1Block diagram of the PV power home system rated at 5 kWp.

The three PV systems selected for this study are similar to eachother, where each is rated at 5 kWp and consists of one string consistingof 18 polycrystalline PV modules connected in series, each moduleconsists of 72 cells connected in series and rated at 280 Wp. The output of the PV generator is connected to a grid-tied inverter as illustrated in Fig.

### 3.3 Support structure

The support structure consists of hot galvanized steel tubes, barsand angles with different dimensions constituting a front surface facingsouth with a tilt angle of 32°.

### 3.4 Invertor

The selected inverter should fulfill the waveform requirements ofthe load or grid and should be with high efficiency in order to reducethe loss of energy generated by PV modules. The inverters used in allhouses are single phase and of grid tied type. Its rated power at 230 V

and 50 Hz is 5 kW, its maximum efficiency is 98% and its maximuminput voltage is 800 V.

### 4. PV energy production and performance evaluation

Performance evaluation of grid connected PV systems requiresanalysing the obtained measuring results to compute the mainparameters as annual energy produced by the PV system, the final annual yield, final monthly yield and final daily yield. These parameters are obtained according the following equations:

Final annual yield= $\dfrac{Yearly\ energy\ generated\ by\ PV}{Peak\ power\ generated}$

Final monthly yield= $\dfrac{Monthly\ average\ energy\ generated\ by\ PV}{Peak\ power\ generated}$

Final daily yield= $\dfrac{Daily\ average\ energy\ generated\ by\ PV}{Peak\ power\ generated}$

The yield, which is the ratio of kWh generated to peak watt of thePV system (kWh/kWp) is used to normalize the output.

The produced output energy of the PV system is usually negativelyaffected by the operational deficiencies represented mainly in PV-celltemperature losses, resistive wiring losses and inverter losses.The PV- cell temperature has the highest negative effect and causeespecially in summer months a considerable reduction in the outputenergy of the system.

### 5. Orientation and tilt angle of the PV systems

To maximize the collection of the daily and seasonal solar energy, PV modules should be oriented geographically. The optimum orientationfor a PV module is the geographic true south.The simulation software package PVSYST is used to compute theoutput power of 1 kW peak PV-system with different tilt angles, theobtained results are illustrated in the following table,
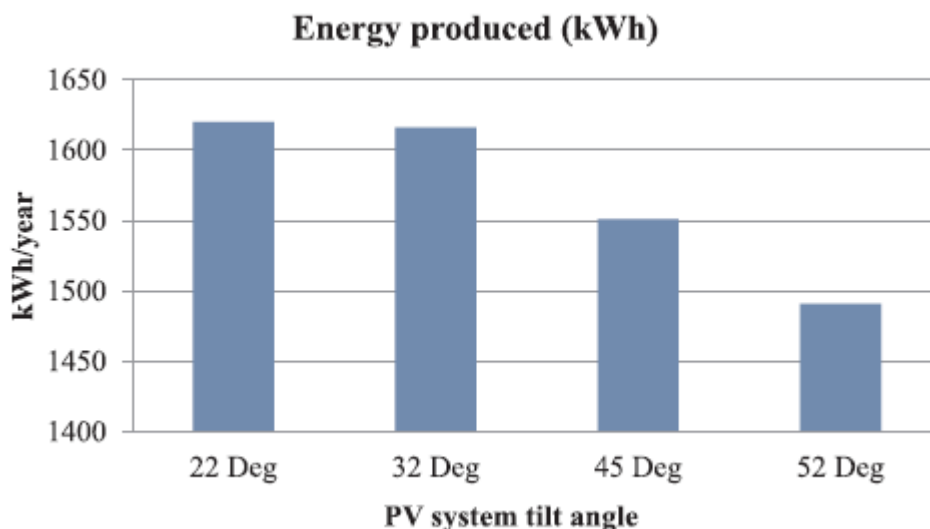


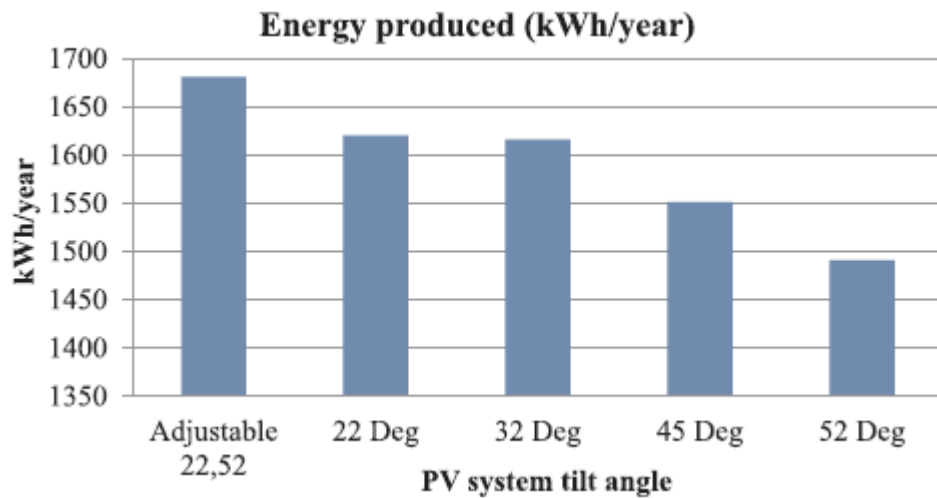Fig.2 Annual energy produced by 1 kWp-PV system (kWh/year) with different tilt angles.

Fig.3 Annual energy production of 1 kWp-PV system at different fixed tilt angles compared with the output at adjustable two tilt angles.

## 6. The impacts of PV home systems on the electric grid

The advantage of installing the PV system near the electrical loadshas both technical and economical benefits represented in reductionof feeder's losses and improvement of voltage level in the grid.The losses in distribution systems are mainly related to transformerlosses.

The copper losses in the distribution transformers will be reduced asthe net current (I-net) will be reduced because a part of the load currentwill be supplied by the PV system.

## 7. Economic evaluation of PV power home systems
### 7.1 Net present value

The NPV of an investment project at time t=0 is the sum of thepresent values of allcash inflows and outflows linked to the investment:

$$NPV = -I_0 + \sum_{t=0}^{T} (R_t - I_t)q^{-t} + L_T \times q^{-T}$$

$$q^{-t} = \left(1 + \frac{i}{100}\right)^{-t}$$

Where I0 is the investment cost at the beginning (t = 0), T is the lifetime of the project in years, Rt is the return in time period t, It is theinvestment in time period t, $q{-t}$ is discounting factor, i is the discountrate and LT is the salvage value.

## 7.2 Internal rate of return

IRR computes for what interest rate the NPV will be zero, so it expressesthe achievable interest tied-up in the investment.

$$0 = -I_0 + \sum_{t=1}^{T} R_t \times \left(1 + \frac{\text{IRR}}{100}\right)^{-t} + L_T\left(1 + \frac{\text{IRR}}{100}\right)^{-T}$$

## 7.3 Cost annuity

CA converts all costs into a series of annual payments of equalamount, it can only be used for evaluating the relative favorability ofinvestment projects on the basis of costs per annum or per unit production.

$$CA = \left[\left(\sum_{t=1}^{T} k_0 \times q^{-t}\right)RF(i, T)\right] + (I_t - L_T) \times RF(i, T) + L_T \times i$$

$$RF = \frac{q^t(q-1)}{q^t - 1}$$

$$\text{kWh} - \text{cost} = \frac{CA}{\text{Total yearly kWh produced}}$$

## 7.4 Dynamic payback period

The purpose of calculating DPB is to determine the time point atwhich the capital invested in a project will be recovered by annualreturns, within its service time. The acceptable DPB must be shorterthan the service life time of the project.

$$DPB = \frac{I_0}{[(\sum_{t=0}^{T} (R_t - I_t)/T)}$$

|  | NP V (USD) | IR R (%) | DP B (Year) | Co st Annuity | PV annual | k Wh cost |
|---|---|---|---|---|---|---|
| Hou se 1 | 157 10 | 25 .1 | 4.9 16 | 10 71 | 9018.9 2 | 0.1 2 |
| Hou se 2 | 156 69 | 25 .1 | 4.9 26 | 10 72 | 9004.9 07 | 0.1 2 |
| Hou se 3 | 155 27 | 24 .9 | 4.9 58 | 10 71 | 8956.2 27 | 0.1 2 |

Table1.Results of economic parameters for the three PV home systems

## 8. Economic evaluation results

Inspecting the obtained results in table,we found that the NPV is positive and exceeds than 15,000 USD for all houses, the IRR is around25%, the dynamic payback period is around 5 years which represents aquarter of the life time, The cost annuity, which represents the cost ofeach kWh produced by PV system, is around 0.12 USD/kWh. Comparingit to the price of sold kWh produced from the PV system amounting to 0.30 USD/kWh, it represents a gain of 0.17USD/kWh for each kWh sold to thegrid. This result represents an evidence for the high economic feasibilityof such grid connected PV home systems.

## 9. Environmental impacts of PV power home systems

Harmful carbon dioxide and methane emissions from fossil fuels, our traditional energy source, are leading contributors to global warming and decreased air quality. But generating electricity with solar panels produces no greenhouse gasses whatsoever. In fact, the solar capacity currently installed across the United States is expected to offset as much as 16.8 million metric tons of carbon dioxide a year. That's a huge step towards mitigating the human impact of climate change.

The environmental impacts of PV energy generation is representedmainly in reducing the emission of $CO_2$. According to different internationalenvironmental references [14] the $CO_2$ reduction obeys theratio 0.7 kg $CO_2$/kWh-generated. Thereby, the obtained results for thethree PV home systems are presented in fig.
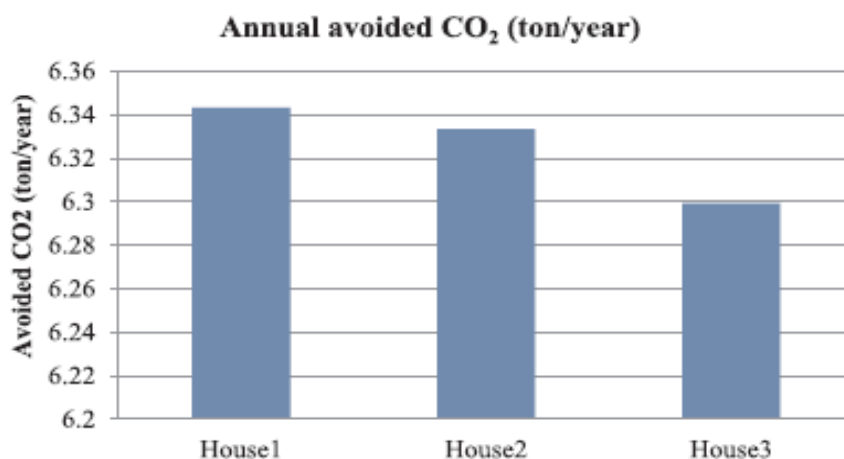


Fig.4 Annual amount of CO2 avoided by installing PV systems.

Solar energy is renewable. The sun is the world's most abundant energy source, producing an amazing 173,000 terawatts of solar energy every second. That's more than 10,000 times the world's total combined energy use, and it can be used over and over again. In contrast, fossil fuels are non-renewable and while they may seem in abundance today, there will come a time when the world will run out. Or, the cost of finding and extracting these sources will become too expensive. By that time, the resulting damage to our financial infrastructure and environment may be unrepairable. Switching to solar today is the best way to hedge against the reality of finite fuel resources.

## 10. Conclusion

Based on the above review it can be concluded that the impacts of PV home systems on the associated electric grid arepresented mainly in reducing the resistive losses, raising the gridvoltage level and decreasing the power factor.The most appropriate tilt angle of PV array is equal to the latitude of its location to capture the highest input solar energy.Using a PV support structure with adjustable two tilt angles($22°$ and $52°$) would result annually 4% higher energy yield.

Finally we can conclude that by using the solar PV we can avoid the $CO_2$ emission reducing the greenhouse gas effect.

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# An Introductory Overview of Support Vector Machine for Image Classification

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**Abstract :**

Support Vector Machine (SVM) is a type of training method which is used to separate extracted features by creating a separating hyper plane. SVM have been proven to overcome the local minimum that happens in Neural Networks (NN) training algorithms. Thus, SVM provides a better performance in terms of accuracy for classification and regression. In imaging, SVM is modified to do several classification tasks, such as pattern recognition in edge detection ,in texture classification and in video classification SVM serves as complement for image segmentation methods. This paper gives the overview of Support vector machine for classification of features of segmented image.

**Keywords-** SVM, hyper plane, Image classification, Kernel function

## I. Introduction

In the context of supervised classification, machine learning and pattern recognition is the extraction of regularity as texture features .or some sort of structure from a collection of data. Neural networks (NN) and Bayesian classifiers are the typical examples to learn such organization from the given data observations. Support Vector Machines (SVM) is a relatively new classifier and is based on strong foundations from the broad area of statistical learning theory [4]. Since its inception in early 90s, it has found applications in a wide range of pattern recognition problems, to name a few: handwritten character recognition, image classification, financial time series prediction, face detection, bioinformatics, biomedical signal analysis, medical diagnostics, and data mining.

SVM has become, in practice, the classifier of choice of numerous researchers and practitioners for several real-world classification problems. This is because SVM is capable of generalizing well (predicting the unseen or unknown samples with a good degree of accuracy) as compared to many traditional classifiers (NN, etc.) It offers several advantages which are typically not found in other classifiers: These areas follows

• Computationally much less intensive (especially in comparison to NN)

• Performs well in higher dimensional spaces (a factor which limits many efficient classifiers)

• Lack of training data is often not a severe problem

• Based on minimizing an estimate of test error rather than the training error (structural risk minimization)

• Robust with noisy data (noise can severely degrade the performance of NN)

• Does not suffer as much from the curse of dimensionality and prevents over fitting

It is the first author's observation that research activity in pattern recognition areas, at the national level, has missed out so far on this powerful classification method. Therefore, an introductory

overview of SVM is presented in the remainder of this section.

## II. Support Vector Machines

A binary class supervised classification problem is usually formulated in the following way: given $n$ training samples ($< x_i > y_i$) where $< x_i > = (x_{i1}, x_{i2,.....} x_{im})$ is an input feature vector and $y_i \in \{-1, +1\}$ $i$ $y$ is the target label, the task of the discriminate function or a classifier is to learn the patterns in the training samples in such a way that at a later stage it can predict reliably a $y_i$ for an unknown $x_i$. SVM is fundamentally developed for such binary classification case and is extendable for multi-class situation.

Like other linear classifiers, it attempts to evaluate a linear decision boundary (assuming that the data is linearly separable) or a linear hyper plane between the 2-classes (Figure 1.a) Theoretically, when the data is linearly separable, there exist possibly an infinite number of hyper planes (Figure 1.b) which can correctly classify the training data. SVM, unlike other classifiers of its kind, strives to find out an optimal hyper plane (Figure 1.c). It is commonly believed that points belonging to the two data classes often lie in such a way that there is always some 'margin' between them. SVM attempts to maximize this margin ($2\gamma$ in Figure 3) by considering it as a quadratic programming problem, see [4, 5] for mathematical formulation and derivation of the solution.



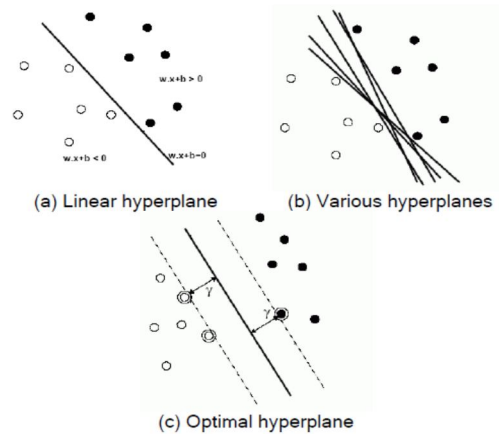**Figure 1.**: Evaluation of an optimal hyperplane.

## III. Statistical learning theory – Key to generalization for SVM

SVM foundations are strongly rooted in the statistical learning theory(SLT): an area of study which addresses the issue of how to control the generalization ability of a classifier. Vapnik and Chervonenkis [4] developed this theory for creating classifiers or discriminant functions that can generalize well. Normally, classifiers like NN try to minimize the training error (called empirical error) but, statistically, there is no guarantee that such a classifier (with zero empirical error) will perform well on the test data. SLT, in contrast, provides an estimate of the test error (called *risk*):

$$Er \leq Ee + c\sqrt{\frac{V(F)}{N}} \quad \text{-----3.1}$$

where $Er$ is the risk, $Ee$ is the empirical error, $c$ is a constant, $V(F)$ is the VC-dimension (the Vapnik-Chervonenkis dimension, denoting the maximum number of samples that can be shattered by a set of functions) and $N$ is the number of training samples. This equation describes the basis of the structural risk minimization principle. Thus the SVM, in practice, is based on the minimization of this risk estimate which often leads to efficient classifiers.

## IV. Kernel function – The kernel-trick

The concepts above are presented for a linear classification case. These are generalizable to a nonlinear case where a mapping function $\varphi(x_i)$ is used to map the input space into a higher dimensional feature space such that the non-linear hyper plane becomes linear,

(Refer Fig 2)

To avoid the increased computational complexity and curse of dimensionality, a kernel-trick or kernel function $K(x_i, x_j)$ employed which, in essence, computes an equivalent kernel value in the input space such that no explicit mapping is required[7].
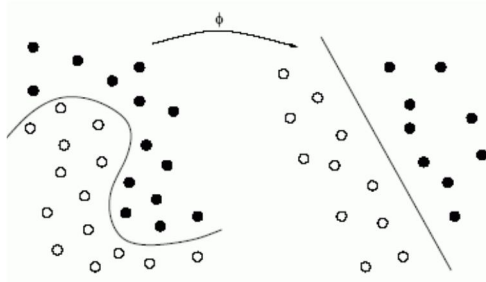


**Figure 2.**: Feature mapping

A few popular kernels are:

Linear:- $K(x_i, x_j) = <x_i, x_j>$

Gaussian:- $e^{-\gamma \|x_i - x_j\|^2}$

Polynomial:- $(\gamma <x_i, x_j> + a)^d$

-----2.1

Thus, the support vectors give, in some sense, a compact representation of the data. The SVM ignores non-informative data and considers only informative data points from point of view of the optimal hyper plane, that is, points lying on the hyper planes which have unit functional distance from the optimal separating hyper plane.
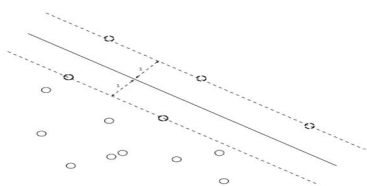


**Figure 3:**

The idea of ignoring data without losing the quality of the estimate is very useful, especially when very large datasets are considered. Of course, this property can be used to classify previously unseen vector $x^{'}$ only after the optimal hyperplane has been found and training must be done using the whole dataset.

Support Vector Machines (SVM) is a relatively new classifier and is based on strong foundations from the broad area of statistical learning theory [6] similar to other binary classification approaches, the main goal of SVM is to map from feature vectors into a higher dimensional feature space, and then creating a separating hyperplane with maximum margin to classify the features.Also

## V Conclusion

From this paper it is concluded that SVM provides a better performance in terms of accuracy for classification and regression. In imaging.SVM helps to provide optimum boundaries, reveal texture patterns, and reduce noise. The more iteration in the SVM training process, the more accurate result we can obtain. A more detailed tutorial is contained in [5], which is oriented for researchers working in pattern recognition. . Current research issues and links can be found.SVM can be considered as a modern classification approach which features a lot of benefits, such as kernel trick and soft-margin classifiers. A large number of software implementations of SVM with distinctive features have been developed by researchers in the machine learning area. A nice and efficient one is the LIBSVM developed in C++, whereas its MATLAB variant OSU SVM is also available.

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# Design & Development of Underwater Grass Cutting Machine

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**ABSTRACT:**

In the market, there are various types of grass cutting machines available with different mechanisms but only on land. It is very much necessary to have a grass cutter for underwater cutting because they create a lot of problem in their surroundings. The newly designed and developed machine would be able to trim out these grasses at a very faster rate as well as it is easy to use. This machine will not require any highly skilled labor and it also operates on single phase 240V. It is operated by a 1 hp motor.

*Keywords: Design, Development, Blades*

**INTRODUCTION:**

Fish farming plays one of the most important roles in the Indian economy. It has its own vital importance from the business point of view. India ranks second in the world after China in the fish farming culture and also our country is one of the largest exporters of fresh water fishes. Therefore, the underwater grass cutting machine has a great scope in the Indian market as well as worldwide. The machine consists of a blade and a jaw combination for perfect cutting of the vegetation underwater. The machine is available with depth adjustment ability. The machine does not require a skilled labor; any unprofessional can also use it very easily. A motor is fixed parallel to the blades which is going to provide the motion to the blades. The motor generates enough torque to slice out the grasses. Therefore, the design of the underwater grass cutting machine is suitable for underwater condition.

**LITERATURE SURVEY:**

In the past, aquatic weed cutter vessels have been designed to sever the water plants from their root systems above the surface of the water bed. Also, various types of vessels transporting reapers have been used to gather and remove from the water floating plants and plants severed from their root systems. Prior art vessels are propelled through the water by a first power system and the cutters and reapers are driven by an independent power system.[1] The problems of cutting and derooting of aquatic weeds are overcome by the this invention by providing a sequence of working heads consisting of a cutter bar and an array of water vortex generators, and preferably including a derooting assembly, which are mounted on a tilt correcting pressure and position monitored and controlled frame which is supported by a system of continuously variable, sliding tilt able racks.[2]

**AQUACULTURE IN INDIA[3]:**

India has 14 major rivers, 44 medium rivers and numerous small rivers and streams. It also consists of ponds and tanks which are estimated to be 2.36 million ha. Our country has an eleven fold increase of fish production in the past six decades.

In 1950-51 the production rate was 0.75 million tonnes which increased to 9.6 million tonnes in 2013-14. India is the largest exporter of shrimps to the Netherlands. Especially freshwater fish farming has increased by tenfold in past three decades. About 100 million tonnes of fish are eaten world-wide each year.

**METHODOLOGY:**

*Working principle*: The main objective to design this machine was to make cutting easy of the plants underwater. Initially, a tiller based design was being

considered, but the design had a lot of drawbacks, the main drawback being the excessive drag force.

The construction and operation are simple in nature and is efficient in cutting the various from of weeds underwater. The mechanism used in this project to convert motion to linear motion is by means of links, arranged in a similar manner to that of the quick return mechanism, the difference being the forward and backward strokes have the same speed. The motor used is a 1hp water pump. The primary requirement for the cutting motion of the blades under water is more torque that speed as the required force has to be applied to cut the weeds.

*Basic Units*: While developing the design, the main focus was involved in the design of,

- Cutting blade and jaw
- Supporting unit
- Motor covering
- Main frame

*Assembly:* The jaw is fixed on the lower arm of the main frame whereas the blade is going to slide on the jaws with the help of two links that are connected to it. One link is connected to the shaft of the motor and another is connected to the blade. But both the links are connected to each other with the help of a bolt, some nuts and washers.

The motor is also fixed on the lower arm of one of the sides of main frame. There are two supporting rods which can be easily fixed in the main frame with the help of two 7 shaped angles. All this can be easily attached to the boat walls.

**SPECIFICATIONS:**

The total machine weights just 33kg only. It is far lighter with respect to other heavy aquatic vehicles.

*Cutting Unit:* The material used for the cutting unit is Stainless Steel 304 whose thickness is about 3mm.

There are V-shape teeth on the blade which will easily slice the grasses in the underwater. The blade consists of 17 teeth whose pitch length is 4cm and angle from each other is of 120 degree. The jaw is somewhat straight but pointed at the ends. There are totally 18 teeth in the jaw.

*Main frame:* The main frame is made of mild steel. It is 80cm in length, 45 cm in depth and 45 cm wide also. And it is also painted black with oil paint to make it life longer.

*Supporting Units:* The supporting unit consists of pair of rectangular hollow pipe. It is made of mild steel whose length is around 150 cm. There are two 7 shaped hooks which are made of 15cm hollow rectangular pipe and 32.5cm long and 5mm thick mild steel strip. The rectangular hollow pipes have holes at the distance of 10cm for the adjustment of depth of machine in the water.

*Electric motor:* The motor is of TARO industries. It is a water pumping motor. The torque generated by the motor is 2.48Nm. It requires 220 V three phase to give the best efficiency of the machine.

**CALCULATIONS**

The calculations related to the torque produced at the motor and the torque required must be calculated. The torque at zero load is been calculated for the motor under the conditions of power supply in India.

In India we commercially get 240 Voltage, 2A electricity. Hence at zero load the torque generated by the motor is,

But the torque required to operate the blades depends on the mass it has to move as well as its perpendicular distance,

Force, $F = M_{blade} \times g$

Where,

$Tm = (I \times V \times E \times 60) / (2 \times rpm \times 3.14)$

Where,

Current, $I = 2$ A

Voltage, $V = 240$ V

Efficiency, $E = 0.1$ (used for general calculations)

$Tm = (2 \times 240 \times 0.1 \times 60) / (2 \times 2880 \times 3.14) = 0.15924$ Nm

$M_{blade}$ = Mass of the blade and the long metallic strip

$g$ = acceleration due to gravity

F = 1.9 x 9.81

= 18.639 N

TR= F x R

Where,

R = length of the smaller metallic strip

=0.02m

TR =18.639 x 0.02

= 0.37278 Nm

The torque applied by the motor after applying the load that is after attaching the links.

As the load was applied the speed of the motor reduced to 625 rpm.

Tm = (2 x 240 x 0.1 x 60) / (2 x 625 x 3.14)

= 0.73376 Nm

Since the torque generated by the motor after applying the load is higher that the torque generated at zero load, the design is safe for working.



Figure: Underwater Grass Cutting Machine

**CONCLUSION:**

The machine is ready for use in the field it was made for. It runs successfully. The objective of increasing the productivity is a long term goal so it can be only calculated on long term use of the machine. But the other objectives where achieved by our machine such as

⬜⬜The project makes an effort to contribute towards the cleanliness of water bodies around it and not letting the waterborne parasites prosper which causes number of diseases.

⬜⬜The main action done by the machine, i.e. the cutting of the underwater grasses with the enough speed is achieved.

⬜⬜The death of fishes that was happening due to the collection of garbage and due to the formation of layers if toxic fluids is now has been tackled with the help of this machine.

⬜⬜The oxygen that has to mix in the water naturally now, i.e. after cutting of the grasses can easily be mixed, retaining the oxygen level in the water had saving the lives of aquatic life.

⬜⬜The speed of the cutting depends upon the operators speed. We had done our trial at the speed of 2km per hour.

⬜⬜The design of the machine has been carried in vision with its flexibility of mounting on the boat. It can be mounted either in the front or at the back of the boat easily.

⬜⬜The obstructions or the barrier that was faced by the fishing farmers now has solved. The farmers now without any problem can do the fishing.

⬜⬜The machine is so user friendly that it can be operated by any skilled or unskilled person too.

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