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Table of Contents

Volume 3, No. 2, June, 2015

PRATIBHA: INTERNATIONAL JOURNAL OF SCIENCE, SPIRITUALITY, BUSINESS AND TECHNOLOGY (IJSSBT), Vol. 3, No. 2, June 2015
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Leverage Analysis: Measuring impact on return on equity

Sarang S. Waykole[1], Mukesh B. Ahirrao [2], Dr. V.S.Rana [3]

[1]Management Student, M.B.A Dept,
S.S.B.T's College of Engineering & Technology, Bambhori, Jalgaon, MS, India.
[2]Asst. Prof., M.B.A Dept,
S.S.B.T's College of Engineering & Technology, Bambhori, Jalgaon, MS, India (Corresponding Author),
[3] Associate Prof. & HOD, M.B.A Dept,
SSBT's College of Engineering & Technology, Bambhori, Jalgaon, MS, India.
Email:[1]samwaykole77@gmail.com

Abstract: Leverage analysis is an important tool in the hands of business firm. Through leverage analysis firm can analyze the impact of fixed cost expenses on return to equity share holders during fluctuating revenue.
This is a case study measuring the impact of fixed cost expenses on return to equity share holders. Data is retrived from the financial statements of the concern for three years and accordingly the current status of operating leverage, financial leverage and combined leverage is analyzed and it's impact on return to equity is concluded.
During the period of study, operating leverage, financial leverage and combined leverage is not favorable due to decline in revenue.

Keywords: Trading on Equity, Operating Leverage, Financial Leverage, Combined Leverage, Leverage Analysis.

I. Introduction:

The concern is a midcap firm listed in NSE & BSE stock exchanges. It is a company limited by shares. It is a pioneer firm in the manufacturing of irrigation system in Asia.
During the last consecutive years company disclosed lots of fluctuation in sales. Such fluctuation in sales is short term in nature and caused by the extreme whether condition and decline in oil and polymer prices (Press Release, 2014).
In such prevailing condition, it is desirable to undertake the leverage analysis and ascertain impact of fluctuating sales on return to share holders.

II. Literature Review:

A] Leverage Analysis:

Dictionary meaning of leverage refers "the act of using a lever to open or lift something; the force used to do this" (Hornby, 2005). In financial term leverage analysis refers to "influence of one financial varable over other financial variable" (Monga).
Leverage analysis involves analysis of impact of fixed cost on return to share holders. It involves mainly three types of Leverages as under.

a] Operating Leverage:
It is defined as the firm's ability to use fixed operating cost to magnify effects of changes in sales on its earnings before interest and taxes. Operating leverage occurs when a firm has fixed operating costs which must be met regardless of volume of sales. It is ratio between percentage change in EBIT divided by Percentage change in sales.

b] Financial Leverage:
It is defined as the ability of a firm to use fixed interest charges to magnify the effects of changes in EBIT /Operating Profits, on the firm's earning per share. Financial leverage occurs when a firm's capital structure contains obligation of fixed financial charges i.e. interest cost. It is ratio between percentage change in EPS divided by Percentage change in EBT.

c] Combined Leverage:
Operating leverage explains the operating risk and financial leverage explains the financial risk of firm. However, a firm has to look into overall risk or total risk of the firm i.e., combined risk which is measured by combined leverage. It is ratio between percentage change in EPS divided by Percentage change in sales.

Importance of Leverage Analysis:

- Operating leverage helps to analyze the impact of fixed operating cost on return to equity share holders.
- Financial leverage helps to analyze the ability of firm to raise the borrowed money in order to maximize the return on equity. It analyze impact of fixed Interest cost.
- Combined leverage helps to analyze the overall risk firm is exposed to i.e. operating risk and financial risk (Monga).

III. Objectives of the Study:

- To Analyze the prevailing status of three leverages.
- To ascertain the impact of changes in these leverages on return to equity share holders.
- To identify the strength and weakness in leverages of the concern.

IV. Research Methodology:

A] Research Type:
It is an analytical research based on the secondary data. It investigates the financial figures of the concern using theoretical framework of leverage analysis. financial statements of 3 years i.e. 2011-12, 2012-13 & 2013-14 is comparatively analyzed to indentify strength and weakness in leverage analysis.

B] Type of Data: Secondary Data
Secondary data involves figures relating to income statements reported in annual report of the business firm for three years i.e. 2011-12, 2012-13 & 2013-14. Also some important information is collected by various sources of secondary data such as books, websites, and official release of business firm.

C] Analysis tools and techniques:
Figures are analyzed using basic mathematical tools like average and percentage etc. and it is interpreted using various kinds of charts and graphs.

V. Data Analysis & Interpretation:

1. Degree of Operating Leverave

Table 1: Degree Operating Leverage (Fig. In Crores)

Year	2011-12	2012-13	2013-14
Contribution	1236.439	986.064	1085.083
EBIT	696.086	490.871	360.758
Ratio	1.78	2.01	3.01

(Source: Annual Report of the Concern)

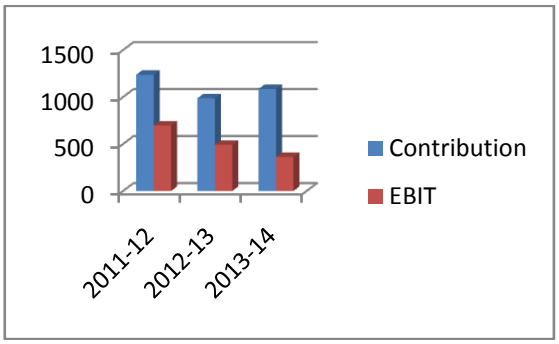

Figure 1: Degree of Operating Leverage

Interpretation: Figure 1 denotes that contribution is marginally declined during 2012-13 and marginally increased in 2013-14 due to fluctuation in sales turnover. EBIT on the other hand is declined throughout these three years. Such decline in EBIT is result of incresing degree of operating leverage i.e. 1.78, 2.01 and 3.01 during these three years.

2. Degree of Financial Leverage

Table 2: Degree of Financial Leverage (I in Crores)

Year	2011-12	2012-13	2013-14
EBIT	696.086	490.871	360.758
EBT	272.609	48.674	-30.085
Ratio	2.55	10.08	-11.99

(Source: Annual Report of the Concern)

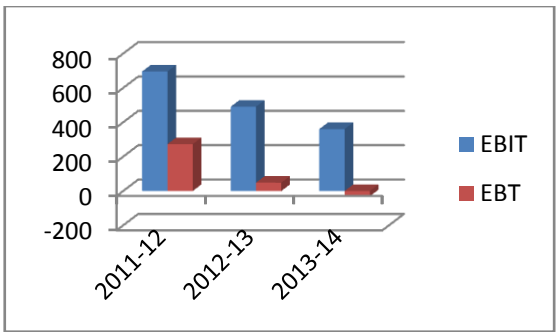

Figure 2: Degree of Operating Leverage

Interpretation: Figure 2 denotes that EBIT is declining during these three years but EBT is declining sharply if compared with EBIT. This is because degree of financial leverage is increased tremandously in 2012-13 i.e. 10.08. that reflects existence of finance fixed cost causes negative impact on the return if there is decline in EBIT.

Percentage change in EBT is more than percentage change in EBIT.

3. Degree of Combined Leverage:

Table 3: Degree of Combined Leverage (In Crores)

Year	2011-12	2012-13	2013-14
Contribution	1236.439	986.064	1085.083
EBT	272.609	48.674	-30.085
Ratio	4.54	20.26	-36.07

(Source: Annual Report of the Concern)

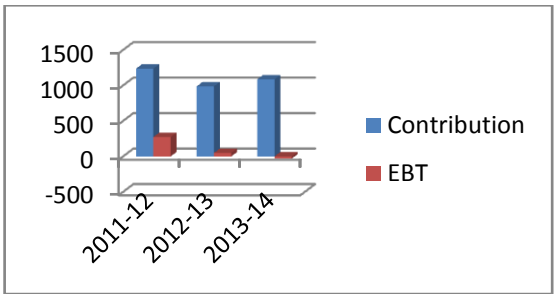

Figure 3: Degree of Combined Leverage

Interpretation: Figure 3 denotes that degree of combined leverage is very haigh and firm is exposed to high risk.

4. Analysis of Return on Equity Share Holder's Fund:

Table 4: Return on Equity Fund (In Crores)

Year	2011-12	2012-13	2013-2014
Net Income After Tax	268.299	30.106	3.903
Share Holder Fund	1911.957	2336.662	2352.869
Ratio (%)	14.03	1.29	0.17

(Source: Annual Report of the Concern)

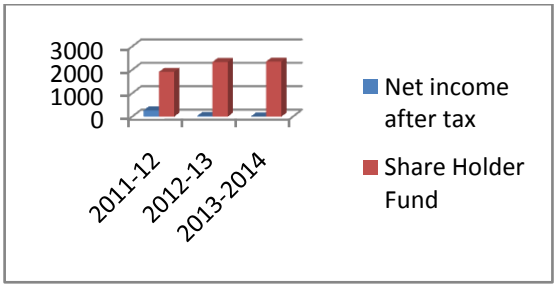

Figure 4: Return on Equity

Interpretation: Figure 4 denotes that earnings available to equity share holders is declining during these three years. This is the evident that due to increasing degree of operating, financial leverage, return on equity is declining.

5. Analysis of EPS:

Table 5: EPS (In Crores)

Year	2011-12	2012-13	2013-2014
EPS	6.62	0.7	0.09

(Source: Annual Report of the Concern)

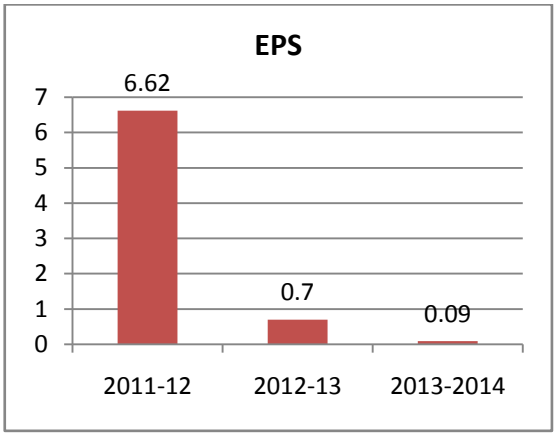

Figure 5: EPS

Interpretation: Figure 5 denotes that as a result of increased operating and financial leverages Earning per share is declined every years i.e. 6.62, 0.70 and 0.09 respectively.

VI. Key findings of the study:

A. Status of Leverages:

- Degree of operating leverage, financial leverage and combined leverage is increased during the period of study.

B. Impact on Return on Equity:

- During the period of study operating leverage, financial leverage and combined leverage is increased. On the other hand return on equity is declined every years.

C. Strength And Weakness:

- During the period of study sales turn over is declined.
- The burden of fixed operating cost is very high in the income statement of the concern. That is small decline in sales resulted high decline in return on equity.

- As well as burden of fixed financial cost is also high in the income statement of the concern. Due to this very small portion of earning is availabe to equity share holders.

VII. Conclusion & Suggestions:

- Leverage analysis is very important to those firm which are exposed to high fixed operating and finance cost. It can suggest the impact of these cost on return to share holders in fluctuating revenue conditions.
- The operating leverage, financial leverage and combined leverage are not favourable due to fluctuation in sales during these three years. As well as it is reflecting increasing trend.
- The concern hereby recommended that it should try to increase it's overall sales so that it can minimize the impact of increased operating and financial leverage.

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A Review on Causes for Damaged Sorghum and Corn Grains

Sheetal B. Gawande[1], *Dr. I. D. Patil*[2]

[1]Research Student, SSBT`s, COET, Bambhori, Jalgaon (MS), India
[2]Professor and Head, Department of Biotechnology, SSBT`s, COET, Bambhori, Jalgaon (MS), India
[1]sheetal_deshmukh11@rediffmail.com
[2]Idp72@yahoo.co.in

Abstract:
In this paper exhaustive review of literature is carried out for determination of main causes and type of sorghum and corn grains damages. It is found that the best possible remedy for damaged sorghum and corn grains is to utilize it for ethanol production. Since sorghum and corn grains is having highest potential ethanol production. Major causes of sorghum and corn grains damages are briefly discussed in this paper. It is revealed that grain gets damaged during harvesting, handling, and storage due to breakage. This cause reduction in grain size and protective shield of grains becomes weak. On these weak grains an insect infestation is able to reduce its chemical or nutritional value which is very important for its further utilization. The intensity of grain damage is difficult to quantify accurately but it can measured with the help of physical and chemical tests. Physical parameters of grains like length, width and Moisture content are discussed here.

Keywords
Breakage, Ethanol, Harvesting, Handling, shield

1. Introduction

The edible parts of plants and animals that are produced or harvested for human consumption but that are not ultimately consumed by people is called as food loss and waste. Food loss and damaged grain have many negative economic and environmental impacts. Based on weight the Food grain and Agriculture Organization of the United Nations (FAO) observed that in the world, Out of all food produced 32 percent food is lost or wasted in 2009. Approximately 24 percent of all produced food is waste or lost when converted to calories. Farmers' incomes can be reduced economically because of waste investment in production of damaged food grain. Particularly food loss is defined as food that gets lost before it reaches the consumer or spills, spoils, incurs an abnormal reduction in quality such as bruising or wilting [1].

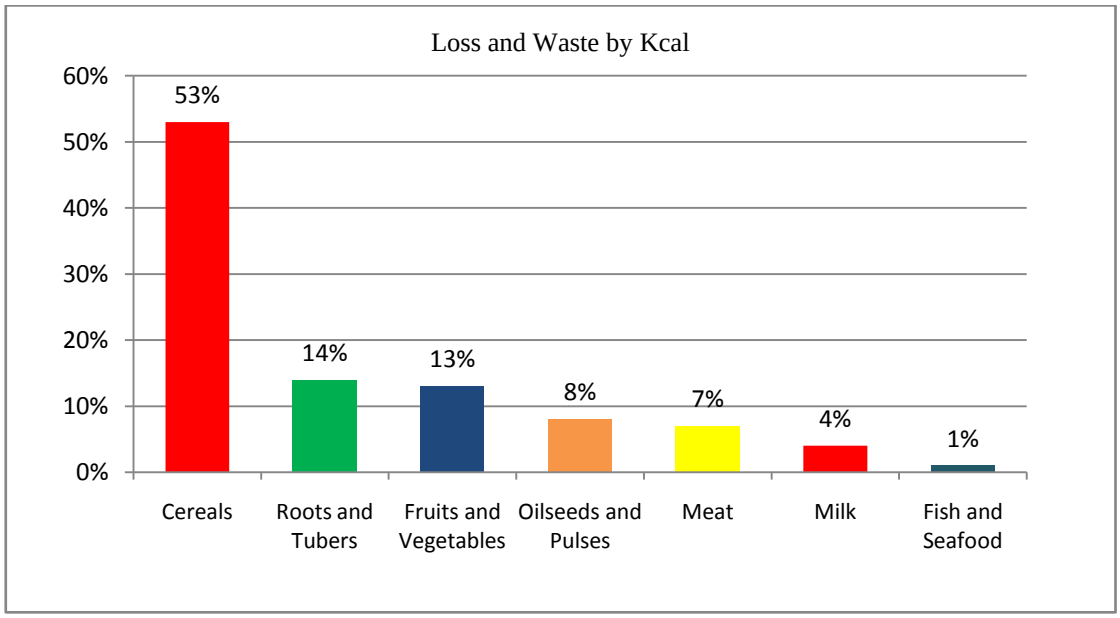


Figure No1:- Food Loss and Waste by Kcal [1]
[Source: WRI analysis based on FAO. 2011. Global food losses and food waste—extent, causes and prevention. Rome: UN FAO]

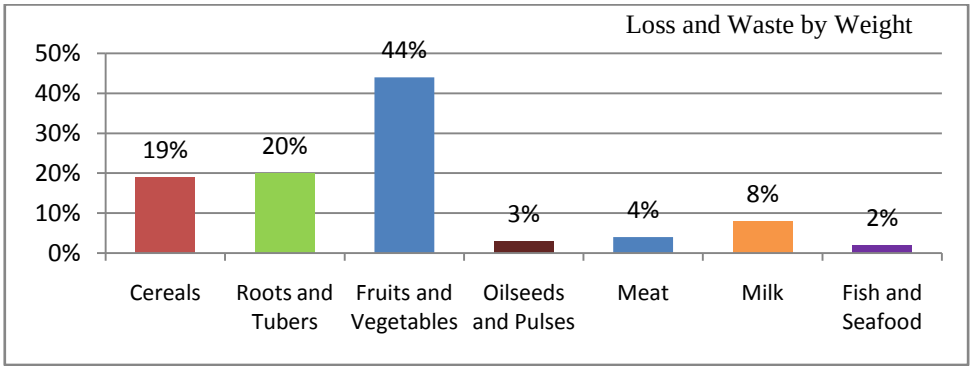


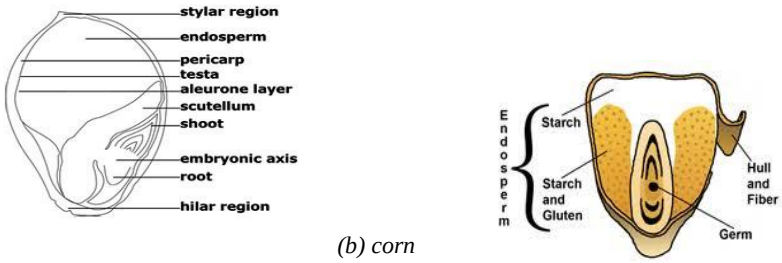
Figure No 2:- Food Loss and Waste by weight [1]
[Source: WRI analysis based on FAO. 2011. Global food losses and food waste—extent, causes and prevention. Rome: UN FAO]

Food loss is because of agricultural process or technical limitation in storage, infrastructure, packaging, and marketing. Food waste is a food which is discarded either before or after it spoils though it has a good quality and fit for human consumption. Food loss and waste increase consumers' expenses economically. The utilization of the waste food is need of the world to reduce the farmer's loss. These damaged or waste food grains can be utilized for the effective production of ethanol using fermentation process. Nutritional qualities of grains are as given below

Table No1:- Nutritional qualities of grains

Grain	Protein (g/kg)	Fat (g/kg)	Carbohydrate (g/kg)	Crude Fiber (g/kg)	Energy (Mcal/kg)
Sorghum	108	31	720	21	2.0
Wheat	125	17	720	18	2.1
Corn	92	45	716	27	2.1

The general Grain structure and composition of sorghum and corn are given below



(a) Sorghum *(b) corn*

Figure No 3:- The general Grain structure

Table No1:- The general average composition of sorghum and corn

	Average % Mass (Dry Basis)	
Quantities	Sorghum Grain	Corn Grain
Starch	74.1	71.7
Protein	11.1	9.5
Fat	3.7	4.3
Ash	1.5	1.4

Types of sorghum and corn grains damage:-

Grain Damage: - agriculture based food grains like sorghum and corn grains are not suitable for to be used as food and if these grains are consumed by human being or animals, it will badly affect their health. Grain damage quality can be measure with the help of physical and chemical tests. Out of many common methods for determining grain damage some type of visible inspection can carried out with minimum amount of error. All factors that cause grain damage are difficult to recognize and measure them accurately.

Types of the sorghum and corn grains damage are discussed are as follows:-

Broken/Cracked Kernels

A broken or cracked kernel is a one of the most common form of grain damage. This type of damage occurs during handling process and moving grain anytime from one place to another. During further handling, deterioration of the grain more quickly through accelerated insect and fungal infestation and a faster propensity to breaking because of cracks in kernel. The increase in mechanical damage decreases the allowable of storage time.

Figure No 3:- Kernels with zero to multiple stress cracks as placed from left to right. [3]

Stress cracks can form within the kernel, in addition to exterior cracks. Combination of thermal and mechanical handling processes like drying usually causes the stress cracks in the grain. Kernels can break more rapidly during further handling because of internal stress cracks which have greater breakage vulnerability. Percentage losses also turn into large quantities of useless grains by contaminating them with their droppings, webs and odors apart from damage due to insect pests. Quantitative as well as qualitative losses in grains take place significantly during storage [3].

Fungal and Insect Infestation

Figure No 4:- Kernels which contain any mold on the exposed part of the kernel are considered damaged [3]

Dry matter losses may be because of Fungal and insect infestations make the grain less valuable. Grain damage as well as loss the actual weight of the grain result due to grain Insect infestations.
An insect infestation is able to reduce the chemical or nutritional value of the grain which is very important for the end use. Moisture, mechanical damage, storage temperature, and other factors can be trigger mold growth. Weight or quality losses because of insect during storage are not accurately measured though it is estimated around 35% of total production [4].

Heat Damage

Figure No 5:-Heat damaged maize kernels

Heat damage mostly arises from drying of grain. USDA recognized heat damage as new type of damage though it is a sub type of damage including broken or cracked kernels. Heat damaged kernels may have seed coats which are peeling off or have a discolored, wrinkled, and blistered, be puffed and/or swollen. It is undesirable effects due to elevated temperatures used to eliminate moisture by drying process. Breakage/cracks, discoloration, and shrinkage are the most common signs of heat damage. Interior and exterior stress cracks on the kernels are caused because of temperature and moisture gradients in the grain during the drying process. Grain qualities problems arise due to cracks are listed in the two earlier grain damage types. Brown et al. explained that for multiple types of drying, the percentage of stress-cracked kernels increases as moisture content increases [5]

Causes of damaged sorghum and corn grains:-

1. Damage during Harvest

Grain damage between field and its end use is discussed in this article. Hence harvesting is first cause of grain damage itself. In some growing environment, Grain quality is might be majorly affected by harvest timing. Mechanical damage occurring during threshing process is a huge cause of grain damage. Threshing is a process of stripping the grain from the plant and can frequently cause cracks as well as other damage. Severe kernel damage during threshing can cause due to grain harvesting at too high moisture. An attempt to find methods to minimize grain damage without decreasing harvest productivity has been made by many researchers. Among the many harvest factors affecting the grain damage during the harvest some factors are uncontrollable by

operator like moisture content. The damage increases exponentially with the increase in rotor speed and it has a largest effect on grain damage. Actually decrease in forward speed or ground speed of machine, increases the grain damage [6]. If the gap of the concave is too narrow or as the length of the concave increases then grain damage also increases that implies its dependence on setting of concave [7].

Damage during Handling

Grain undergoes free fall during many handling processes. Usually grain is conveyed and dropped in to storage devices such as semi or grain cart and it also undergoes free fall during unloading. Anytime free fall can be cause grain damage. The grain damage due to free fall is depends on many factors like height of travel, contact surfaces, discharge size, impact angle, and type of grain. The quantity of mechanical damage occurred during impact increases with the increase in drop height. The increase in number of handling process, increase the grain damage.

Damaged due to insecticides:-

The insect damages are ranging from 5 – 30% of the world's total agricultural production [8]. Before few weeks of crop harvest in the field, insects starts infestation frequently and could be Reach to the storage facility [9]. Weight or quality losses because of insect during storage are not accurately measured though it is estimated around 35% of total production [4]. Greenbugs are pear shape of aphids with approximately 1/16 inch long. small grains and sorghum damaged by Greenbugs in three ways: (1) Copious amounts of sap are extracted with their piercing- sucking mouthparts, thereby depriving the plant of water and nutrients; (2) A chemical is injected during the feeding process and this causes enzymatic destruction of cell walls which leads to chlorosis (reddening and yellowing) and eventually necrosis (browning) of leaf tissue; (3) Devastating viruses such as barley yellow dwarf virus in small grains and maize dwarf mosaic virus (MDMV) in sorghum may be transmitted, or the plants may be predisposed to other diseases like charcoal rot of sorghum. Greenbugs may infest and injure host crops at almost any stage of plant development from seedling stage to heading or later. Seedling plants are very susceptible to greenbug injury, which may result in plant loss, stunting and delayed maturity. Injurious infestations on larger plants cause stunting and reduced kernal size and quality.

Determination of Physical Parameters of the Grain

Length and width: The length and width of 10 randomly selected from each sorghum and corn variety were individually measured using a Vernier caliper.

Moisture content: Grain moisture content is expressed as a percentage of moisture based on wet weight (wet basis) or dry matter (dry basis). Wet basis moisture content is generally used. Dry basis is used primarily in research.

$$M_w \text{ (wet basis)} = (w - d)/w \times (100)$$

$$M_d \text{ (dry basis)} = (w - d)/d \times (100)$$

w = wet weight
d = dry weight

M = moisture content on a percent basis

Assessment of Grain Damage

A change in moisture content will also change in test weight of grain. The test weight is the weight per bushel based on volume. Since grain volume changes with a change in moisture content and since water and dry matter do not weigh the same, the test weight is changed. The grain damage was determined by using the formula:

% Grain Damage = (Initial Grain Weight – Final Grain Weight)/ Initial Grain Weight x 100

Utilization of damaged corn and Sorghum grain:-

Germination, or sprouting, is a common problem for grain when weather is moist during harvest or the environment is humid during storage. The most important issues in industrial ethanol production are yield, efficiency, and energy consumption. Laboratory results in terms of ethanol yield and ethanol fermentation efficiency from artificially germinated high-tannin sorghum suggest that huge potential energy savings exist in production of ethanol from germinated sorghum grain. Using germination-damaged sorghum for industrial ethanol production might benefit the producer and end user by expanding market uses of what has been historically considered a low-value commodity. Germination not only causes compositional changes in the sorghum grain but also initiates a series of biochemical and physiological changes. Intrinsic enzymes such as amylases, proteases, lipases, fiber-degrading

enzymes, and phytases are activated. Current fuel ethanol research and development deals with process engineering trends for improving biotechnological production of ethanol. This paper gives a overview of the current ethanol production processes from cereal grains and effect of sorghum grain sprouting on fermentation for sustainable fuel energy production. [10]

Conclusion:-

In this paper various causes of sorghum and corn grain damages are briefly discussed. Main causes of grain damages are mechanical damages during harvesting and handling grain size reduces due to breakage. Moisture content and due to insecticides deterioration of grain occurs heavily. Measurements of grain quality for determination of grain damage are also briefly discussed in this paper. After identification of sorghum and corn grain in damaged condition, that is these grains are not usable as food or feed. The next best option for its utilization is as fuel energy production.

Acknowledgment:

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An Overview of Dynamic Voltage Restorer employed for Voltage Stability of Doubly Fed Induction Generator Wind Turbine System during Faults

Sagar P. Joshi[1], Dr. P. J. Shah[2]

[1]Student, SSBT's COET, Jalgaon.
[2]Professor & Head, Department of Electrical Engg, SSBT's COET, Jalgaon
[1] sagarpj7@gmail.com, [2] pjshahj@yahoo.com

Abstract − This paper describes the dynamic voltage restorer for the fault ride through the doubly fed induction wind turbine system. Because of extended power handling properties of power electronics devices, it is been used widely in the Electrical Devices. The extensive usage of power electronic devices has raised the problem of power quality issues, resulting into the problem of voltage sag/swell etc. The system to be designed will face the problems of voltage sag/swell & will keep the system healthy throughout the symmetrical & unsymmetrical fault conditions. This will also avoid the nuisance tripping of highly sensitive relays & will also maintain synchronism of power system. The use of doubly fed induction generation system is done to maintain the constant voltage & frequency output irrespective of wind velocity.

Keywords − Power quality, doubly fed induction generation, dynamic voltage restorer, control techniques.

I. INTRODUCTION

The recent trends in technology has invented many sophisticated electrical and electronic equipments, such as computers, programmable logic controllers and variable speed drives, which are non-linear loads and are very sensitive to disturbances. The use of recent power electronics devices create power quality problems like voltage sags, swells and harmonics and the purity of sine waveform is lost. Voltage sags are considered to be one of the most severe disturbances to the industrial equipments [6].

Power systems, ideally, are bound to provide their customer with an uninterrupted power flow at smooth sinusoidal voltage at the contracted magnitude level and frequency. A momentary disturbance for sensitive electronic devices causes voltage reduction at load end leading to frequency deviations which results in interrupted power flow, scrambled data, nuisance tripping, unexpected plant shutdowns and equipment failure. Voltage lift up at a load can be achieved by reactive power injection at the load point of common coupling (PCC) [1].

Use of Dynamic Voltage Restorer (DVR) is an electronic solution to the voltage regulation. DVRs are custom power devices for providing reliable power quality [3]. It has a series of voltage boost technology using solid state switches for compensating voltage sags/swells. The DVR applications are mainly for sensitive loads that may be drastically affected by fluctuations in system voltage level [4].

The doubly fed induction generation (DFIG) system helps to improve the performance of the power generation system during variable wind velocities [1].

II. DOUBLY FED INDUCTION GENERATOR (DFIG) SYSTEM

The DFIG wind turbine is the wound rotor Induction Generator that is useful for generation of electric power during variable wind speeds giving out constant voltage & frequency output. It has two windings i.e. Stator Winding & Rotor Winding. The system is so constructed that it has Stator Side Converter (Line Side Converter) & Rotor Side Converter [1]. The rotor is rotated with the wind velocity through Wind Turbine. But the amount of speed with which the rotor is rotating is not fixed depending upon the wind velocity, so if the rotor speed is not as per the rating then the supply frequency of rotor winding is varied to maintain the constant frequency & in order to maintain the output voltage, the amplitude of the supply to the rotor is changed as per the requirement [1]. This special supply arrangement gives us the fulfilment of the grid codes.

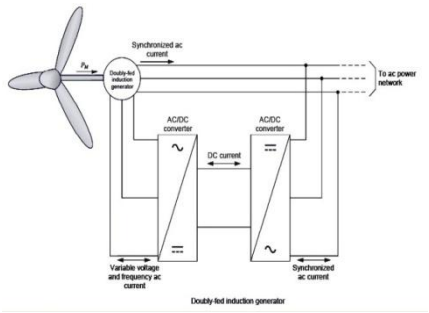

Fig.1 DFIG wind turbine block representation

For DFIG system the output frequency control is done as per the following expression,

$$f_{stator} = \frac{n_{rotor}}{120} \times P + f_{rotor} \quad (1)$$

So, in order to maintain the synchronism of system with the grid, we supply the rotor with the AC supply as per following expression,

$$f_{stator} = \frac{n_{rotor}}{120} \times P - f_{rotor} \quad (2)$$

The construction of DFIG system consists of rotor with the converter unit that is nothing but the back to back connection of the converters separated by the DC link & the capacitor unit so that to reduce the harmonic component produced by the converters [1].

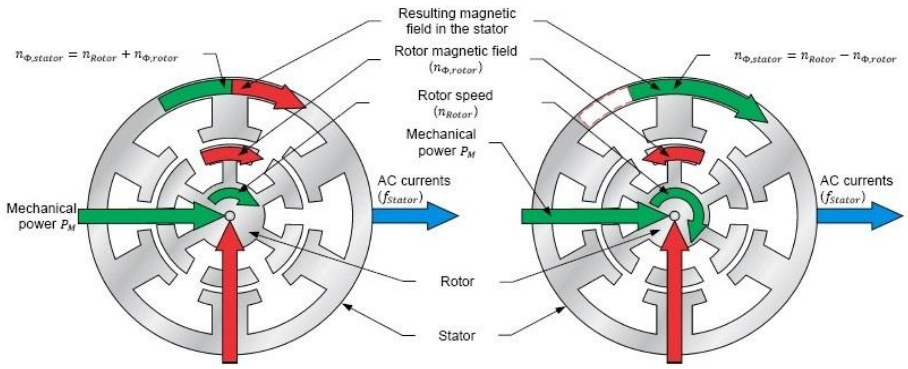

Fig.2 DFIG wind turbine rotating magnetic field representation

As the voltage disturbance last for the short duration & there is no any arrangement of increase in the turbine input, which is air, the system should ride through that condition.

A. Rotor Voltage Dynamics

As far as rotor voltage dynamic is concerned the main focus comes on the voltage & frequency that is given to the rotor.

Let us consider the equivalent per phase circuit of DFIG stator circuit, the expression for the voltage is given as follows:

$$v_s = R_s i_s + \frac{d\phi_s}{dt} \quad (3)$$

$$v_r = R_r i_r + \frac{d\phi_r}{dt} - jf\phi_r \quad (4)$$

$$\phi_s = L_s i_s + L_h i_r. \quad (5)$$

$$\phi_s = L_r i_r + L_h i_s. \quad (6)$$

Where ϕ, v, & i represent the flux, voltage & current respectively. Subscript s & r denote the stator & rotor respectively.

$L_s = L_{s\sigma} + L_h$ & $L_r = L_{r\sigma} + L_h$represent stator & rotor inductances R_s & R_r are the stator & rotor resistances &f is the electrical rotor frequency.

By introducing the leakage factor
$\sigma = 1 - (L_h^2/L_s L_r)$ the rotor flux can be described in dependence of rotor current & stator flux

$$\phi_r = \frac{L_h}{L_s}\phi_s + \sigma L_r i_r \quad (7)$$

By substituting (5) in (2) equation for the rotor voltage can be obtained as follows

$$v_r = \frac{L_h}{L_s}\left(\frac{d}{dt} - jf\right)\phi_s + \left(R_r + \sigma L_r\left(\frac{d}{dt} - jf\right)\right) i_r \quad (8)$$

The expression shows the rotor induced voltage that depends upon the magnitude of the flux of the stator & the rotor induced currents.

B. Rotor Side Converter Control (RSC)

This rotor side converter unit acts as controller to control the amount of active & reactive power flow from the stator. The system is so designed to have stator voltage oriented control, for that

purpose, the decomposition in *d* & *q* components is done. i.e. (V_{sq}=0)
Neglecting the stator voltage drop, the stator output active & reactive powers can be expressed as,

$$P_s \approx \frac{3L_h}{2L_s} V_{sd} I_{rd} \quad (9)$$

$$Q_s \approx -\frac{3V_{sd}}{2L_s}\left(\frac{V_{sd}}{\omega_s} + L_h I_{rq}\right) \quad (10)$$

Thus the active & reactive power flow can be controlled with the control on *d* & *q* components of the rotor.

C. Line Side Converter Control (LSC)

The main feature of the line side control is that it provides the required DC voltage V_{dc} along with the reactive power back up to the system. A voltage oriented cascade vector control is shown in the fig no. 2. The line current I_l can be controlled by the adjustment of the line inductance L_l as shown below

$$V_s = R_l I_l + L_l \frac{dI_l}{dt} \quad (11)$$

The equation (9) is used to design the current controller, while DC dynamics can be expressed by following expression,

$$C_{dc} \frac{dV_{dc}}{dt} = I_{dc} - I_{load} \quad (12)$$

Where C_{dc} is the DC capacitance while I_{dc} & I_{load} are the DC currents of LSC & RSC respectively.

III. DYNAMIC VOLTAGE RESTORER (DVR)

Dynamic Voltage Restorer is a static VAR [3] device having a voltage source converter along with energy storage device. This is a series compensation device that protects the sensitive electrical loads from the power quality problems like voltage sag, voltage swell, voltage unbalance & distortion. A coupling transformer is used in series to inject the exact amount of voltage to restore the voltage of the load to normal operating value & also performs the function of correction of deteriorated line voltage.

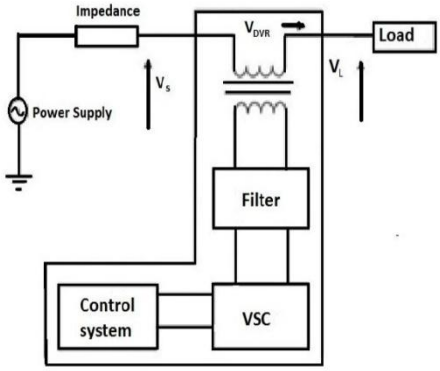

Fig.3 DVR block diagram

Generally the solid state electronic switches are used in pulse width modulation structure. DVR can generate or absorb independently controllable real & reactive power at the load side. In other words, DVR is made up of solid state DC to AC switching power converter that injects a set of three phase AC output voltage line voltages in series & synchronism with the general configuration of DVR consists of following blocks as shown in fig no. 3 [2] [3].

A. Injection Transformer/ Boosting Transformer

This transformer is a special purpose transformer that attempts to limit the coupling of noise & transient energy from the primary side to the secondary side. The HV winding of the transformer is connected to the power system that injects the compensating voltages generated by voltage source converter in the transmission line. To compensate the voltage by DVR dc voltage this transformer ratio should be properly chosen [8]. This transformer must have the higher rating to avoid saturation effects & high inrush current protection.

B. Harmonic Filter

The use of harmonic filter provides the filtration from the distorted waveforms coming out of semiconductor devices present inside the DVR itself. So if we are not connecting Harmonic Filter in series with DVR then it may add some harmonics in the system instead of removing it [8].

C. Voltage Source Converter

This is a power electronic switching cum storage device which generates the sinusoidal voltage at required frequency, amplitude & phase angle. The scheme used for the voltage generation is with the help of PWM technique [3]. It is used

for conversion of the DC voltage into sinusoidal AC voltage. It is also possess the control mechanisms so as to have precise control over the energy sent to the network [6].

D. Control System/ Energy Storage Device

The control system consists of energy storing devices such as DC capacitors, batteries, super capacitors, superconducting magnetic storage device etc. These devices store the energy & supply it with the exact required amount so as to bridge up the gap of voltage Sag/Swell with the reference.

IV. VOLTAGE INJECTION METHODS

The rating of the DVR system depends mainly on the depth of the fault voltage that is to be compensated. For voltage sag & swells with zero phase angle jump, the requirement of active power of the DVR is given by

$$P_{DVR} = \left(\frac{V_1 - V_2}{V_1}\right) P_{load} \quad (13)$$

Where V_1 &V_2 are normal & faulty line voltages respectively. The faults having phase angle jump along with the voltage variation, the active power flowing into DVR charges the DC link. For full compensation of full voltage dip, the rating of the DVR must be as same as that of the DFIG.
There are four voltage injection methods that are normally used as follows.

A. Pre Sag Compensation

This method is constant tracking method, here the supply voltage is consistently kept under observation & if any disturbance in supply voltage detected, it injects the value of voltage which is equal to difference between the supply voltages & sag voltage, so that the load voltage is restored back as that of pre fault voltage [3] [4] [5] & [6].

Compensation in both phase angle & amplitude sensitive loads is achieved. The amount of voltage fed to the system is determined by following expression

$$V_{DVR} = V_{prefault} - V_{sag} \quad (14)$$

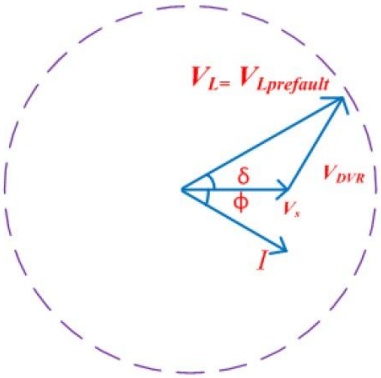

Fig.4 Pre Sag Compensation

B. In Phase Compensation Method

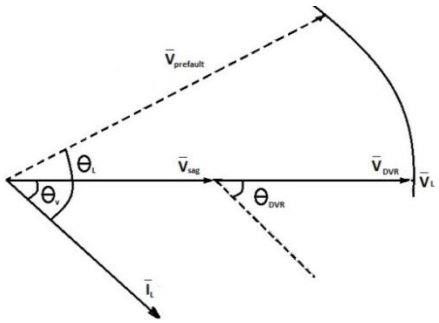

Fig.5 In Phase Compensation Method

The voltage that is to be injected is in phase with the supply voltage irrespective of the pre sag value. By this method the constant amplitude of the load voltage is maintained. The advantage with this method is that the amplitude of DVR injection voltage is minimum for the voltage sag condition, as compared with other strategy [3] [4] [5] & [6].

C. In Phase Advanced Compensation

In previous two methods, the active power is injected into system during disturbances where as this method is based on the phase angle compensation. The phase angle of voltage sag & the load current is minimized to control the real power supplied. The active power supplied by the DVR is the energy stored in DC link. The values of load current & voltages are fixed the change is done in only phase angle of the voltage sag. So reactive power is being used by this method, but not all voltage sags are mitigated by this system hence it is suitable for only limited range of voltage sags [3] [4] [5] & [6].

D. Voltage Tolerance Method With Minimum Energy Injection

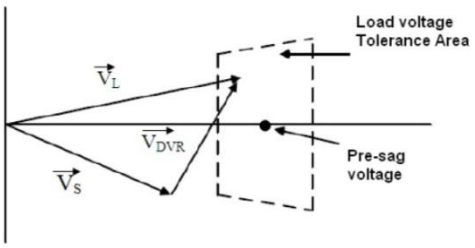

Fig.6 Voltage Tolerance Method

There always exists some tolerable limit in the system. Similarly, small amount of voltage drop & phase angle jump is allowable in the system. If the voltage magnitude lies in between the range of 90-110% of nominal voltage & 5-10% of nominal state that will not affect the performance characteristics of the load. Hence both magnitude & phase are the control parameters, which can be achieved by this method of small energy injection. That means this method of operation of DVR is going to control the Voltage up to some desired accepted value so that the system will not change the load performance characteristics, [3] [4] [5] & [6] as shown in the fig no. 6.

V. CONTROL TECHNIQUES

The performance of DVR depends upon the controller used to initiate the DVR. Controller plays the vital role of controlling the power electronic switches in order to meet the demand of the load. The control techniques of the DVR consist of the two different methods depending up on the type of controller used [3]. They are classified as below.

A. Linear Controllers

The linear controllers are made up of designing of circuit by the use of linear components. There are three main types of voltage controllers such as Feed Forward, Feedback & Multi loop controllers.

Among these three controllers Feed Forward is the basic controller chosen for the DVR operation due to its simplicity & fastness. The supply voltage is continuously monitored & compared with the reference voltage signal, if the difference exceeds the certain tolerance; DVR injects the positive or negative amount of voltage.

In feedback control scheme, load voltage is measured & compared with the reference voltage; the differential voltage is supplied by DVR to bus in feedback loop. This controller has accurate response, but has some time delay.

The Multi loop is used with an outer voltage loop to control the DVR voltage & an inner loop to control the load current. This is most useful than other two methods.

B. Non Linear Controller

The non linear components are used for the design of these controllers. The use of nonlinear controller is most suitable than the linear controller, as it contains semiconducting devices which has higher order of switching frequency. Mostly used non linear controllers are Artificial Neutral Networks (ANN) [3], Fuzzy Logic (FL) [3] and Space Vector Pulse Width Modulation (SVPWM) [3].

The ANN method is adaptive & can give improved performance by the use of interpolation method. When mathematical formulation is not possible at that time it uses the FL controllers. The use of FL controllers reduces the transient overshoot of the PWM. The SVPWM scheme is adopted space vector of the inverter voltage to get the better performance in low switching frequencies.

VI. CONCLUSION

The paper focuses on the basics, operating principles, mathematical statistics & control strategies related to the DFIG wind turbine & DVR. The DVR is effective device for enhancing the power quality problems related to the voltage due to its less acting time, precise response & high reliability. This paper also explains about the effectiveness of the DFIG wind turbine system over conventional wind turbine, by providing precise control over the voltage & frequency irrespective of the wind speed. DVR has advantage of low cost, less computational efforts & simple control as compared to other FACTS devices. DVR gives the simple implementation for voltage profile improvement by voltage sag/swell compensation.

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Cash Flow Statement: Comparative Analysis of Financing, Operating and Investing Activities.

Ajay G. Paliwal[1] Mukesh B. Ahirrao [2],Dr. V.S.Rana [3]

[1]Management Student, M.B.A Dept,
S.S.B.T's College of Engineering & Technology, Bambhori, Jalgaon, MS, India.
[2]Asst. Prof., M.B.A Dept,
S.S.B.T's College of Engineering & Technology, Bambhori, Jalgaon, MS, India (Corresponding Author),
[3] Associate Prof & HOD, M.B.A Dept,
SSBT's College of Engineering & Technology, Bambhori, Jalgaon, MS, India.
Email:[1]ajaypaliwal97@gmail.com

Abstract: Cash flow statement is an important tool to analyze the cash position of business firm. It can denote changes in cash position during two financial years. Concern is the world's second largest manufacturer of micro irrigation system and the business model of concern is loaded with heavy working capital as huge fund is blocked in trade receivables. Recently, the concern has reported fluctuating turnover for last three years in its annual reports. Hence it is necessary to judge the sufficiency of the cash position to support the success story of company. This study is based on financial figures disclosed by company in three consecutive years. Study involves comparative analysis of cash flow from three business activities i.e. operating, financing and investing. Accordingly the sufficiency of cash position is concluded and some recommendation is made to overcome the scenario.

Keywords: Cash flow Analysis, Financing Activities, Investing Activities, Operating Activities.

I. Introduction:

The concern is the listed midcap company limited by shares. it is the largest micro irrigation company in Asia and second largest in world. The company's revenue model is said to be loaded with heavy working capital as major part of revenue is linked with Govt. subsidies.
Recently the company has disclosed its Q3 (December 2014) financial result in press release reporting that turnover is declining and overall receivable level stands around 137 days.
It reported that the decline in business is short term in nature and caused by the extreme whether condition and decline in oil and polymer prices [6].
Such 137 days as overall age of receivables denotes that majority of revenue is noncash in nature. Considering such current business scenario, it is necessary to undertake the in-depth analysis of cash flow statements.

II. Literature Review:

A] Cash Flow Statement Analysis:

Cash flow statement provides information about the cash receipts and payments of an enterprise for a given period. It provides significant information that compliments the profit and loss account and balance sheet. A cash flow statement is a statement which provides a detailed explanation for the change in a firm's cash during a particular period by indicating the firm's sources and uses of cash during that period. Cash flow statement classifies cash flow during the period from operating, investing and financing activities.

a] Cash Flow from Operating Activities:

Cash generated by production and sales of business is reflected under this head. It comparatively denotes inflow of cash from operating activities and outflow of cash for business operating expenses. E.g. cash from operation is the revenue net of expenses.

b] Cash Flow from Financing Activities:

This section of Cash flow statement denotes cash generated from activities to finance the business operation. E.g. cash receipt on account of issue of equity shares or debentures etc. and cash paid to such stake holders. Dividend to equity shares or interest on debenture etc.

c] Cash Flow from Investing Activities:

This section denotes cash invested in long term assets e.g. purchase of machinery and other long term assets as well as other current assets such as purchase of equity shares of other company etc. and cash receipts from such investing activities e.g. dividend received, interest received sales of machinery and scrap etc [5].

III. Objectives of the Study:

- To ascertain the sources of cash and uses of cash.
- To ascertain the net changes in cash indicating the difference between sources and uses of cash by three activities during the period of study.
- To measure the weight of such sources and uses of cash against cash profit position of the firm.
- To identify the strength and weakness in cash flow position of the firm.

IV. Research Methodology:

A] Research Type:

It is an analytical research based on the secondary data. It investigates the financial figures of the concern using theoretical framework of cash flow statement analysis. Figures of cash flow statement of 3 years i.e. 2011-12, 2012-13 & 2013-14 is comparatively analyzed to indentify strength and weakness in cash flow of the business.

B] Type of Data: Secondary Data

Secondary data involves figures denoted regarding cash inflow and cash outflow in cash flow statement reported in annual report of the business firm for three years i.e. 2011-12, 2012-13 & 2013-14. Also some important information is collected by various sources of secondary data such as books, websites, and official release of business firm.

C] Analysis tools and techniques:

Figures are analyzed using basic mathematical tools like average and percentage etc. and it is interpreted using various kinds of charts and graphs.

V. Data Analysis & Interpretation:

6. Analysis of Revenue

Table 6: Net Revenue in Million

Particulars	2011-12	2012-13	2013-14
Sales	37810.92	35109.48	41331.12

(Sources: Annual Reports of the Concern)

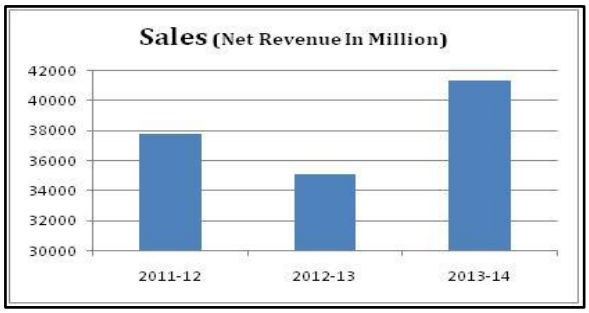

Figure 6: Sales (Sources Annual Reports)

Interpretation: Figure 1 denotes fluctuation of sales during the three years that is 2011-12, 2012-13 & 2013-14. As well as according to the press release of concern (10th Feb 2015) domestic business is declined by 12.7 % and export business is marginally declined by 3.4 % in the current quarter. This reflects that currently firm is operating in a uncertain business environment. Farmers are the customers of firm and during current financial year unexpected rainfall has affected the agriculture sector throughout the year and throughout the country. This suggests a tough time ahead and it can lead the concern towards the insufficient cash position to support the breakeven point.

7. Analysis of Operating Activity:

Table 7: Analysis of Operating Activity (In Millions)

Particulars	2011-12	2012-13	2013-14
Cash from Operations	2393.24	3727.94	5199.01
Cash Operating Expenses	34390.55	33931.51	38798.59

(Source: Annual Reports)

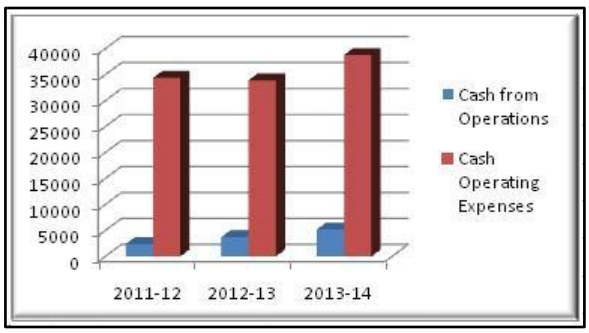

Figure 2: Operating Activity (Source: Annual Report)

Interpretation: Figure 2 denotes comparative weight of cash generated from operating activity and total cash operating expenses. Total cash

operating expenses is total operating expenses net of depreciation and amortization. Total cash operating expenses includes unpaid expenses. This figure reflects that total cash operating expenses is 14.36, 09.10 and 07.46 times more than cash from operation during 2011-12, 2012-13 & 2013-14 respectively. It is very large if compared with cash from operation. As well as in Q3 2015 firm has suffered loss of Rs. 29.9 Crores. It denotes that cash earning is not sufficient.

8. Analysis of Working Capital Changes:

Table 8: Changes in Working Capital (In Millions)

Current Assets	2011-12	2012-13	2013-14
Inventories	8011.96	11570.43	11730.81
Debtors	20286.08	15986.79	14846.96
Cash & Bank	2811.73	1716.94	1219.41
Other Assets	2849.72	3245.44	3400.83
Loans & Advances	2402.39	3951.68	5852.14
Total	**36361.88**	**36471.28**	**37050.2**
Current Liabilities	**2011-12**	**2012-13**	**2013-14**
S/Term Borrowings	15800.03	14211.91	14968.58
Trade Payables	11744.54	11688.86	11000.39
Other Current Liabilities	4198.75	4202.66	4597.56
S/Term Provision	509.85	329.5	354.73
Total	**32253.17**	**30432.93**	**30921.3**
Particulars	**2011-12**	**2012-13**	**2013-14**
Working Capital	**4108.71**	**6038.35**	**6128.89**

(Source: Annual Reports)

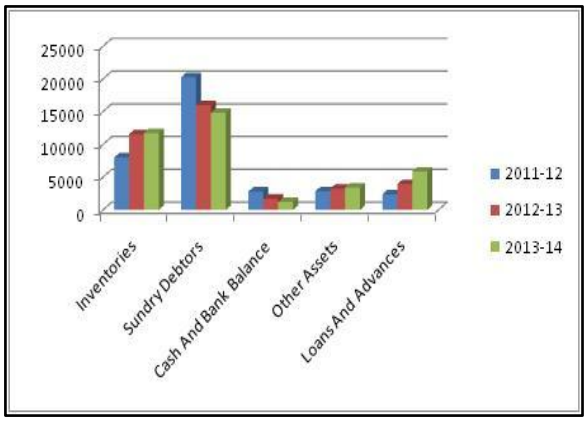

Figure 3: Changes in Current Assets

Figure 4: Changes in Current Assets

Interpretation: Table 3 denotes working capital is increased in 2012-13 as compared to 2011-12 and there is no change in 201314. Figure 3 reflects that sundry debtors are the major part of current assets which is improved in 2013-14. And figure 4 denotes that trade payables and short term borrowings are major part of current assets. High weight of sundry debtors, trade creditors and borrowings denote that large volume of the business transitions are credit transactions indicating insufficient position of cash.

9. Analysis of Investing Activities:

Table 9: Analysis of Investing Activity (in Millions)

Particulars	2011-12		2012 – 13		2013-14	
	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow
Purchase Of Fixed Assets		4352.50		2072.98		1752.35
Sale Of Fixed Assets	5.65		18.42		692.45	
Purchase Of Investment		274.61		2998.50		559.80
Sale Of Investment (Net)			303.98		252.08	
Loan Given To Subsidiaries	53.37		632.76			696.65
Share Application Money Paid				556.25		
Interest Received	145.72		233.01		150.64	
Dividend Income	0.01		0.01		0.03	
Total	**204.75**	**4627.10**	**1188.20**	**5627.70**	**1095.20**	**3008.80**

(Source: Annual Reports)

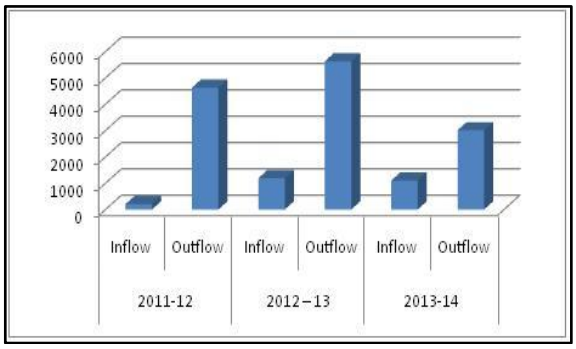

Figure 5: Inflow & Outflow from Investing Activities

Interpretation: Figure 5 denotes the comparative weight of cash inflow and cash outflow from investing activities. During the three years of 2011-12, 2012-13 & 2013-14 cash inflow is 22.60, 04.74 & 02.75 times more than cash inflow. In 2011-12, Cash outflow is associated with purchase of fixed assets. In 2012-13, cash outflow is associated with purchase of fixed assets and investments. And in 2013-14 cash outflow is associated with purchase of fixed assets, purchase of investments and loan given to subsidiary.

10. Analysis of Financing Activity:

Table 10: Cash flow from financing activities (In Millions)

Particulars	2011-12		2012 - 13		2013-14	
	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow
Proceed By Issue Of Equity Share	14.13		3903.03		647.25	
Proceed By Issue Of Share Warrants			161.81			161.81
Proceed From Term Loan Borrowings	4880.95		5893.88		2496.55	
Repayment Of Term Loan		2677.82		4176.95		3341.9
Incr. / Decr. In W.C. Borrowings	2789.53			1602.61	756.67	
Int. And Fin. Charges Paid		3534.01		4121.96		3903.76
Div. & Div. Distribution Tax Paid		448.19		468.74		265.24
Total	**7684.61**	**6660.02**	**9958.72**	**10370.26**	**3900.47**	**7672.71**

(Source: Annual Reports)

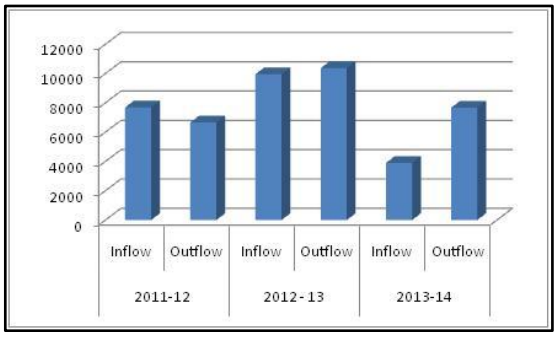

Figure 6: Financing Activities

Interpretation: Figure 6 denotes the comparative weight of cash inflow and cash outflow from financing activities. During the year of 2011-12 cash inflow is more than cash outflow. Both inflow & outflow in 2011-12 is attributed to borrowings and repayments of borrowings. Both are at par in 2012-13 and cash inflow is attributed to issue of equity shares and term loan borrowings as well as cash outflow is primarily associated with repayment of term loan, working capital loans and interest on the same. In 2013-14 cash outflow is twice as compared to cash inflow. Cash inflow is marginally attributed to issue of equity shares and primarily term loan borrowings as well as cash outflow is primarily associated with repayment of term loan and interest on the same.

11. Analysis of cash flow from all 3 activities.

Table 11: Cash flow from 3 Activities (In Millions)

Particulars	2011-12	2012-13	2013-14
Net Cash From Operating Activities	2393.24	5199.01	3727.94
Net Cash Flow Used in Investing Activities	4422.36	4439.55	1913.60
Net Cash Used in Financing Activities	1024.59	411.54	3772.24
Net Decrease in Cash Position	1004.53	1123.15	486.83

(Source: Annual Reports)

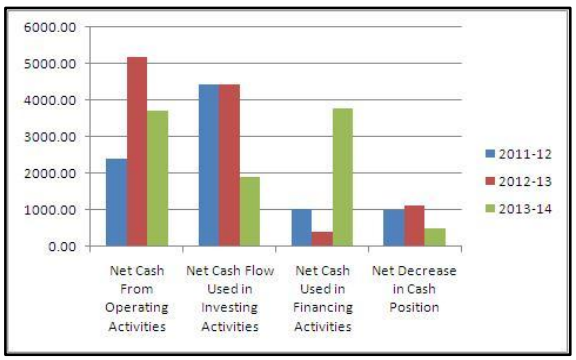

Figure 7: Cash flow from 3 activities

Interpretation: Figure 7 denotes the comparative weight of cash flows all 3 activities i.e. financing activities, operating activities and investing activities. The net cash from operating activities is increased in 2012-13 by 2.17 times and again it is declined in 2013-14 by 01.39 times. Net cash flow used in investing activities is almost at par in 2011-12 & 2012-13 but in 2013-14 it is declined by 02.33 times. Similarly net cash used in financing

activities is declined by 59.83 % and inclined by 89.09 % in 2013-14. Net cash balance is increased by 11.80 % in 2012-13 and declined by 56.65 % in 2013-14.

VI. Key findings of the study:

D. Sources of Cash & Uses of Cash:

- The said business firm during the period of Analysis has raised the additional fund from issue of equity shares marginally and short term and long term commercial borrowings to finance the working capital and expansion of business.
- Most of the fund is utilized for purchasing & modernizing fixed assets for increasing the installed capacity of plastic processing and tissue culture. And increase in other investments is investment to new sustainable agro commercial finance Ltd.
- Also big part of cash flow is absorbed by loss in current period.

E. Net Changes in Cash & its distribution in 3 business activities.

- The net position of cash is almost decreased in 2013-14. That is 50 % against previous year cash position.
- Fund used in investing activities during 2013-14 is almost 51.33 % and fund used in financing activities is at par with cash from operation.
- Most of the cash flow is associated with external borrowings and its repayment with interest cost that is excessive in nature.

F. Strength And Weakness In Cash Flow Position:

- The sales of the concern are fluctuating during these three years. The external environment is quite uncertain due to unexpected rainfall and decline in oil and polymer prices.
- During the period of analysis business firm is facing a liquidity crunch indicating sufficient cash is not earned to support the established capacity. This is evident from the fact that majority of revenue is blocked in trade receivables for near about 6 month. To meet this gap, burden of outside fund and its interest cost is associated with cash inflow and outflow.

VII. Suggestions:

- The concern hereby recommended that it should try to increase its overall sales by promoting sales of fruit processing and onion dehydration and consolidating the operations in plastic division for short term purpose until uncertainty is get over.
- The burden of external borrowings is excessive and company should get it repaid through raising the equity fund from employee stock options.
- Company can also think to more diversify its business in cash based business model. This will provide the firm long term stability in coping with adverse impact of trade receivables.

VIII. Conclusion:

- Cash flow analysis is important to identify weaknesses in business operation that can lead the firm towards liquidity crunch. Through cash flow analysis, company can identify the unproductive use of fund as well as to ascertain and plan future cash flow.
- The business model of the firm is geared with heavy working capital but still it is sustainable in long term period. But currently it is facing a short term uncertainty in plastic division.
- In spite of decline in cash position in current period, it is quite sufficient to support established capacity.
- The burden of external borrowed fund and its interest cost is increased in cash flow of the firm in recent years.
- Management responded this situation very positively by establishing a non banking financial institution that will take care of the burden of trade receivable of micro and plastic divisions. As well as management has well aligned and diversified the business model of firm.

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Design Considerations for Flat Plate Solar Water Heater System

[1*]*P. P.Patil,* [2]*Dr.D.S.Deshmukh.*

[1*] Assi. Prof., Mech. Engg. Department, SGDCOE Jalgaon.MS India
[2] Professor, Mech. Engg. Department, SSBT'S. COET Jalgaon MS India,
[1*]prasadppatil1@yahoo.co.in, [2]deshmukh.dheeraj@gmail.com

ABSTRACT: This paper deals with design consideration for the solar water heater to obtain hot water for the domestic and industrial applications. Solar energy is unconventional energy source at comparatively low cost and high capacity. Design of solar water heating system is important to assure maximum benefit to the users, especially for a large system. Research work is in progress continuously in the field of cover materials, absorber plate materials, absorber and glazing coating along with the changes in the design. Designing a solar water system involves appropriate selection of each component for the desired capacity and location of installation for solar water heater to produce hot water. Various factors and correlations for design of collector, storage tank and insulating material are briefly discussed in this paper.

Keywords: ***Unconventional Energy, Solar water*** **heater,** ***Collectors, Design Parameter.***

1. INTRODUCTION:

Solar energy has always been a viable option for the energy problems faced by the world. Solar energy is the radiation resulted by nuclear fusion reactions in the sun. Toe 30% of the solar power actually reaches the Earth, every 20 minutes the sun produces enough power to supply the earth with its needs for an entire year. This solar radiation can be directly converted into heat. Many different kinds of equipment are available for this conversion. These can help lessen the impact of domestic sector on the environment. Flat plate collectors have been service for a long time without any significant charges in their design and operational principles.

Simple flat plate collector consists of an absorber plate in an insulated box covered with transparent sheets. The most important part of a solar collector is the absorber. 'Which usually consists of several narrow metal sheets aligned side-by-side. The fluid used for heat transfer generally flows through a metallic pipe, which is connected to the absorber strip. In plate-type absorbers, two sheets are sandwiched together alloying the medium to flow between the two sheets. The outer easing which provides mechanical strength to the equipment is insulated to reduce the heat losses from back and sides of the collector

The collector can reach temperatures up to 20^0 when no liquid flows through it and therefore all the materials used must be able to resist these high temperatures. The absorber is usually made of metallic materials such as copper, steel or aluminum. The collector housing can be made of plastic, metal or wood and the glass front cover must be sealed so that heat does not escape, and the collector itself is protected from dirt. Insects or humidity. The collector housing is highly insulated at the back and sides to reduce the heat losses. Still *the* heat losses due to the temperature difference between the absorber and ambient air result in convection and radiation losses. The convection tosses are caused by the angle of inclination and the spacing between the glass cover and the absorber plate, while the radiation losses are caused by the exchange of heat between the absorber and the environment.

Solar Collector-

Solar collectors are the key component of active solar-heating systems. They gather the sun's energy, transform its radiation into heat, then transfer that heat to a fluid (usually water or air). The solar thermal energy can be used in solar water-heating systems, solar pool heaters, and solar space-heating systems.

There are a large number of solar collector designs that have shown to be functional. These designs are classified in two general types of solar collectors:

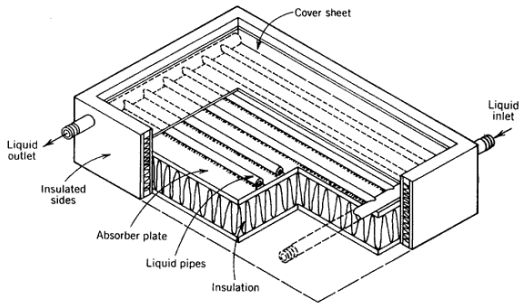
- **Flat-plate collectors** – the absorbing surface is approximately as large as the

overall collector area that intercepts the sun's rays

- **Concentrating collectors** – large areas of mirrors or lenses focus the sunlight onto a smaller absorber.

Flat Plate Collector-

Flat-plate collectors are the most common solar collector for solar water-heating systems in homes and solar space heating. A typical flat-plate collector is an insulated metal box with a glass or plastic cover (called the glazing) and a dark-colored absorber plate. These collectors heat liquid or air at temperatures less than 80°C.



Flat-plate collectors are used for residential water heating and hydronic space-heating installations.

Constructional Elements of a Plate Solar Collector

- **Absorber Plate or selective surface**- Is a metal, glass or plastic surface, mostly black in color. it absorbs and converts radiation into thermal energy
- **The Transparent Cover**- Is the upper part of the collector covering the tide absorber plate. It is made from glass or transparent plastic sheet to permit penetration of solar beams.
- **The Collector Insulator**- Consists of a material with very low thermal conductivity. It is installed in the bottom and around the sides of the collector, in order to minimize heat loss.
- **The heat transfer medium**- Flowing through the collector to transfer the heat from absorber to the utilization system. Can be either air or liquid, usually water.

2. DESIGN CRITERIAS:

A. Solar Water Heater Design Consideration-

Following Points should be considered for the design of a solar water heater system.

For the purpose of designing we make following Assumptions.

- Daily Water Consumption
- Water inlet Temperature
- Since water is required for general purpose we have to design the water heater on following parameter,
  a) Ambient Temperature
  b) Inclination of Collector
  c) Wind Speed
  d) Fluid to the heat transfer Coefficient.

For the Design the flat plate solar water considering the following design parameter discuss in design part.

B. Theoretical Background-

Operational Characteristics of the Collector-

Collector efficiency (η) Is the ratio of useful gained thermal energy for period of to the incident solar radiation onto the collector for the same time period.

Thermal Capacity of the Collector (C) : It is the amount of heat that can be stored per surface collector area and per unit of temperature change

Pressure Drop (ΔP) Is the difference in pressure between the inlet to the collector the outlet due to circulation friction

Stagnant Conditions is characterized by no fluid circulation inside the collector the period in which the absorbing surface area receives a considerable incident radiation

Incidence Angle Coefficient (kθ) the ratio of the optical efficiency of a solar with a fixed beam angle of incidence to the optical efficiency of the collector at its normal

The cover reflectance (ρc)

Cover Transmittance (τc)

Cover Absorptance (αc)

Coefficient of cover Emissivity (εc)

Coefficient of Absorber Emissivity

Collector Efficiency Factor (F): It is the ratio of the real energy output of the collector to the energy output in the case when the total absorber area was at the average fluid temperature with the same fluid quantity of flowing water.

Collector Flow Factor (F"): It is the ratio of the energy that the collector can deliver at the average temperature of the fluid to the energy that the collector can supply at the inlet collector temperature.

Collector Heat Removal Factor (FR): It is the ratio of the energy collector output to the energy output of the collector in temperature of the inlet fluid. It is temperature dependent.

Collector Heat Loss Coefficient (UL): Coefficient of thermal loss of a collector is defined as the ratio of the temperature difference per unit area of the cover to the ambient temperature.

Incidence Angle Coefficient (kθ) : The ratio of the optical efficiency of a solar collector with a fixed beam angle of incidence to the optical efficiency of the collector at its normal.

Several parameters are used to describe solar collectors. Following are brief descriptions for some of these parameters:

The *aperture area (*Aa) is the area of the collector that intercepts solar radiation.

Acceptance angle is defined as the angle through which a source of light can be moved and still converge at the receiver (Hsieh, 1986). A concentrator with small acceptance angle is required to track the sun continuously while. a concentrator with large acceptance angle needs only seasonal adjustment.

Absorber area (A_{abs}*)* is the total area of the absorber surface that receives the concentrated solar radiation. It is also the area from where useful energy can be extracted.

*Concentration ratio (*C) is defined as the ratio of the aperture area to the absorber area i.e.

$$C=\frac{Aa}{Aabs}$$

The *optical efficiency* is defined as the ratio of the energy absorbed by the absorber to the energy incident on the concentrator aperture (Garg and Prakash, 2000). It includes the effect of mirror/lens surface, shape and reflection/transmission losses, tracking accuracy, shading, receiver-cover transmittance, absorptance of the absorber and solar beam incidence effects. The optical efficiency is given as

$$\eta_o = \frac{Pabs}{Aa\ Id}$$

The optical efficiency of most solar concentrators lies between 0.6 and 0.7. In a thermal conversion system a working fluid is used to extract energy from the absorber. The thermal performance of solar concentrator is determined by their thermal efficiency.

The *thermal efficiency* is defined as the ratio of the useful energy delivered to the energy incident at the concentrator aperture:

$$\eta_{th} = \frac{\rho VCpf\ (T2-T1)}{Ib\ Aa}$$

The incident solar radiation consists of beam (direct) and diffuses radiation. However, the majority of concentrating collectors can utilize only beam radiation.

The *instantaneous thermal efficiency* of a solar concentrator may be calculated from an energy balance on the absorber. The instantaneous thermal efficiency is dependent on two types of quantities, namely the concentrator design parameters and the parameters characterizing the operating conditions. The optical efficiency, heat loss coefficient and heat removal factor are the design dependent parameters while the solar flux, inlet fluid temperature and the ambient temperature define the operating conditions.

3. NOMENCLATURE:

Aa – aperture area
A_c -- Collector area
Aabs – absorber area
A_{st} -- Surface Area of the tank
C – concentration ratio
Ib – beam radiation
Pabs - rate of energy absorbed by the absorber
T1 – temperature of heat transfer fluid entering the collector
T2 – temperature of heat transfer fluid leaving the collector
$Q_{i\ th}$ – instantaneous thermal efficiency
h - Heat transfer coefficient W/m^2
H - Heat Loss watts
T_a - Average ambient temperature
T_s - Desirable/Actual insulation surface temp
T_h - Hot temperature surface.
Q_u - rate of useful heat gain
F_R - Heat removal factor.
S - sunshine hour per day
U_t - Top loss coefficient
T_{fi} - Temperature transfer coefficient
T_a - Average ambient temperature
F - fin efficiency
C_b - bond resistance
C_w - wall resistance
U_L - overall loss coefficient
D_i - inner diameter of tube, m

h_{fi} - heat transfer coefficient on inside surface of tube
W - pitch of tubes

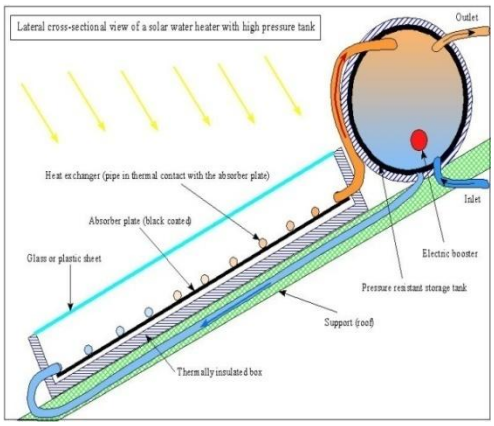


Fig-Basic Structure of SWH

4. DESIGN CALCULATION:

To Carry out design procedure of solar water heater system, that have from the condition, assumptions and values of design parameter were calculated. The parameter Considered for the Calculations are,

- Length of Collector
- Width of Collector
- Length of Absorber Plate
- Plate cover specification
- Thermal Conductivity of Plate Material
- Plate Thickness
- Outer and inner diameter of tubes
- Glass Cover emissivity
- Insulation thickness
- Values of Latitude and Longitude
- Hourly Beam Radius.
- Hourly Diffuse Radiation.

❖ Design Input-

- Volume of hot water required per day
- Temperature of hot water required
- Temperature of Inlet water(Ambient Temperature)
- Material of Storage Tank
- Overnight temperature drop.

❖ Design Output-

Diameter of the tank,
Shell Volume required,
Length of tank shell is calculated by

$$V = \pi r^2 L$$

Thickness of the cylinder is calculated by

$$\text{Design Stress}=\frac{Pd}{2tn}$$

Required Collector area is calculated by

$$Q = m\ Cp\ \Delta T$$

The surface area of the tank

$$\text{Ast} = \pi DL + \frac{\pi DL}{2}$$

Collector Area Required

$$A_c=\frac{Q}{I \times Y}$$

Calculation of insulation thickness-

$$H=h*A*(T_h-T_a)$$

Useful Heat Gain-

$$Q_u=F_R\ A_P\ [S - U_t\ (T_{fi} - T_a)\ ]$$

Collector efficiency factor-

$$=\frac{\frac{1}{UL}}{W[\frac{1}{UL\ [\ D+(W-D)F]}]} + \frac{1}{Cb} + \frac{1}{Cw} + \frac{1}{\pi Di\, hfi}$$

5-CONCLUSION:

Design considerations for solar water heating system are revealed in this paper. Procedure or steps of solar water heating system development is discussed so as to design manufacture and operate the system optimally. Solar energy as a renewable source is having vast potential for its utilization in water heating application foe domestic and industrial purposes. Factors to be considered for design and development of solar water heater are well presented in this work.

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Design Considerations for Thermoelectric Generator Performance Improvement: A Critical Review

Dipak C. Talele[1], Dr. Dheeraj S. Deshmukh[2], Pradeep M. Solanki[3]

[1]Assistant Professor, S.S.B.T.'s, College of engineering & Technology, Bambhori, Jalgaon
[2]Professor & Head, S.S.B.T.'s, College of engineering & Technology, Bambhori, Jalgaon
[3] Assistant Professor, S.S.B.T.'s, College of engineering & Technology, Bambhori, Jalgaon
[1]taleledeepak190687@gmail.com, [2]deshmukh.dheeraj@gmail.com, [3]p_msolanki@rediffmail.com

ABSTRACT:High-efficiency Thermoelectric Generators are designed to convert waste heat energy into electrical energy which is an important direct conversion method for power-generation. To handle current challenge for developing alternative energy technologies design considerations for thermoelectric Generator are discussed in this paper. Further to reduce dependence on fossil fuels and reduce greenhouse gas emissions both can be achieved with the help of the direct conversion of waste heat into electrical energy. Performance of thermoelectric devices is governed by the properties of the thermoelectric material as well as by the geometrical design and thermal matching of the materials. The efficiency of thermoelectric generators is strongly affected by the contacts quality and legs length. In this paper the effect of heat transfer law, legs lengths, contact resistance the temperature dependency of the material properties and design parameters like thickness of generator, size of hot & cold side substrate and size of P-leg section on the performance of thermoelectric generator are critically reviewed. It is observed that important design considerations for Thermoelectric Generator are Figure of Merit that is dependent on material properties, available temperature difference; it decides the power output or capacity of Thermoelectric Generator and manufacturing processes to be used for pair of materials.

Keywords: - Heat transfer, Contacts resistance, Figure of Merit, Substrate

Introduction

The efficient usage of energy at all stages along the energy supply chain and the utilization of renewable energies are very important elements of a sustainable energy supply system. Especially at the conversion from thermal to electrical power a large amount of unused energy ("waste heat") remains. The concept of the thermoelectric (TE) defines the direct transformation between thermal energy and electrical energy. This transformation is performed by the TE semiconductors most efficiently [1] Thermoelectric generators is used to convert waste heat into electricity or electrical power directly as they are solid-state energy converters having combination of thermal, electrical and semiconductor properties. In past few years, many efforts have been taken considerably to enhance the performance of thermoelectric generators. In designing high performance thermoelectric generators, the system analysis, optimization of thermoelectric generators and improvement of the thermoelectric material and module have equal importance. Generally performance of one or multiple-element single-stage thermoelectric generators is analyzed with the help of conventional non-equilibrium thermodynamics. Modifying the geometry of the thermo-elements, a significant increase in the power output from a module can be achieved.

The finite time thermodynamic model of an irreversible multi-element thermoelectric generator with external heat transfer is shown in figure 1. The thermoelectric generator consists of P-type and N-type semiconductor legs. The number of thermoelectric elements is N. The junctions of the thermoelectric elements are fixed at a thermal conducting and electrical insulting ceramic plate. The thermoelectric elements are insulated, both electrically and thermally, from its surroundings. The internal irreversibility is caused by Joule loss and Fourier heat conduction loss through the semiconductor between the hot and cold junctions. K is the thermal conductance of the thermoelectric element, T_h is the hot junction temperature and T_c is the cold junction temperature. The heat source and heat sink temperatures are T_H and T_L . The heat flow rates through the hot and cold junctions of the thermoelectric elements are Q_h andQ_c, The heat flow rate absorbed from the heat source of the thermoelectric generator is Q_H . The heat flow rate

dissipated from the thermoelectric generator to the heat sink is Q_L respectively. The electrical resistance of the P- and N- type semiconductor leg are R_p and R_n . The output electrical current and load resistance are I and R_L [2] .

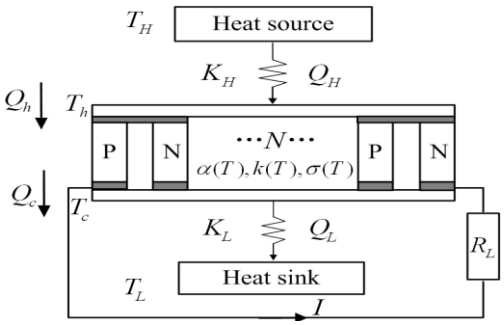

Figure 1:- The finite time thermodynamic model of an irreversible multi-element thermoelectric generator with external heat transfer. [2]

Effects of temperature dependence of thermoelectric properties:-

The performance of the thermoelectric devices is influenced by the allocation of thermal conductance of heat exchangers between the hot and cold sides when the external heat transfer is considered [33, 34]. The allocation is described by a ratio of thermal conductance allocation which is defined as $f = K_H/(K_H + K_L)$. The effect of output electrical current, length of thermoelectric element and ratio of thermal conductance allocation on power and efficiency of thermoelectric generator are studied with the help of numerical calculations.

The power and efficiency will always improve with increase in temperature difference if the temperature dependence of thermoelectric properties is not considered. On the other hand the power improves very slowly whereas the efficiency decreases after its maximum with the increase of temperature difference, considering the influence of temperature dependence of thermoelectric properties.[1] Effects of temperature dependence on power versus electrical current and Effects of temperature dependence on efficiency versus electrical current are shown in figures below

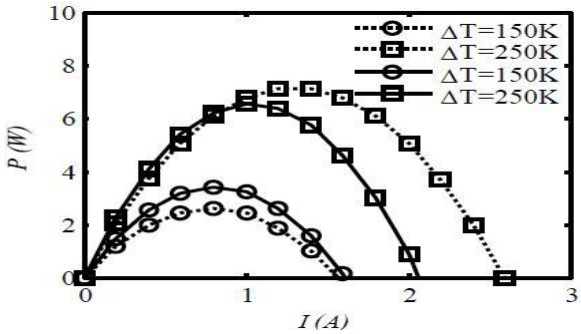

Figure No.1: Effects of temperature dependence on power versus electrical current [1]

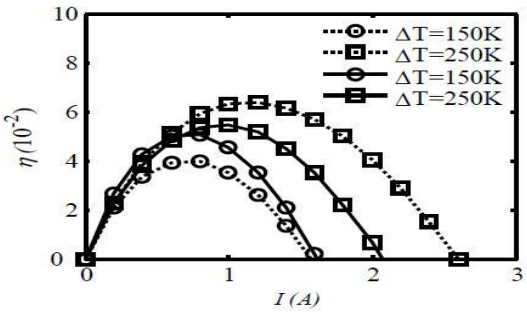

Figure No.2: Effects of temperature dependence on efficiency versus electrical current [1]

Effect of heat transfer law

The heat transfer law represents the characteristic and regularity of the transfer. The characteristics of the thermoelectric device are influenced by the external heat transfer law. The external irreversibility is caused by the finite rate heat transfer between the thermoelectric generator and its heat reservoirs. When the heat transfer law is nonlinear then there are optimal working electrical currents and optimal ratio of thermal conductance allocations corresponding to the maximum power output and maximum efficiency. Since there are a variety of heat exchangers for thermoelectric device, the heat transfer laws are various and different from each other. By experiment or from empirical formula, one can find out the exponents n and m. The heat leakage through the lateral face can be neglected in a commercial thermoelectric generation module because they are thermal insulation packaged. At a steady work state, the temperature distribution of the air gap is the same with the thermoelectric elements, so the heat transfer of the whole device can be treated as one dimensional heat transfer approximately. The increment rate of inner energy of an infinitesimal is zero at steady-state. [2]

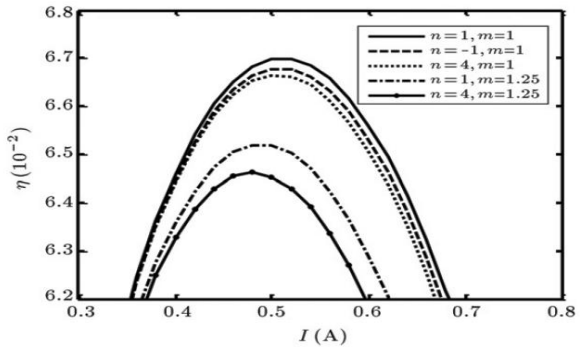

Figure No.3: Effect of heat transfer law on efficiency versus working electrical current. [2]

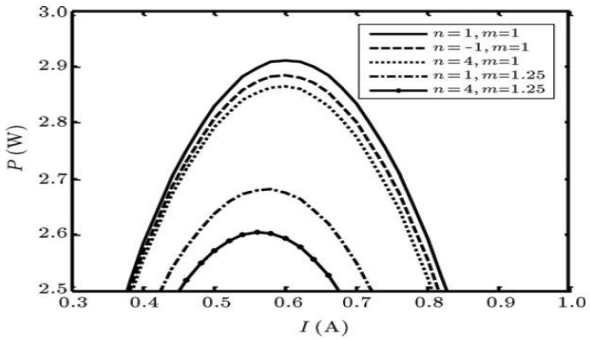

Figure No.4: Effect of heat transfer law on power output versus working electrical current. [2]

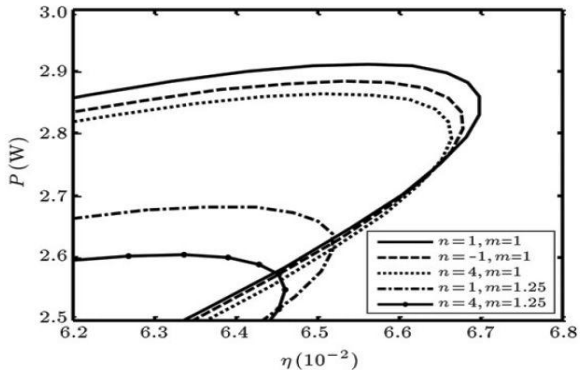

Figure No.5: Effect of heat transfer law on power output versus efficiency. [2]

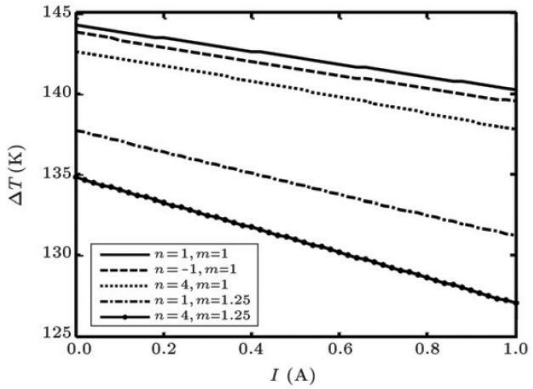

Figure No.6: Effect of heat transfer law on temperature difference versus working electrical current. [2]

Effects of contact resistance & Leg lenght:-

Good thermoelectric material properties are inevitable requirements for a thermoelectric module exhibiting high efficiency. Rowe et al. [11] describe the impact of the module's contact resistance on the performance of thermoelectric generators. Even with very good thermoelectric material, the device performance can be rather poor, if the contact resistances of the module are too large. The figure of merit *ZT* of a thermoelectric generator is a measure of the performance and is closely related to the efficiency of a module [3]. It is strongly affected by the modules resistance and is given by:

$$ZT_{Module} = \frac{\alpha^2 T}{K_{Module}\, R_{Module}}$$

Where α denotes the Seebeck coefficient of the thermoelectric material [12], T the averaged temperature of the module, and K_{Module} and R_{Module} are the heat conductance value and total resistance of the module, respectively. They are given by:

$$K_{Module} = \frac{\lambda_n A_n}{l} + \frac{\lambda_p A_p}{l}$$

$$R_{Module} = R_{legs} + R_C = \frac{\rho_n l}{A_n} + \frac{\rho_p l}{A_p} + R_C$$

Here, A and *l* denote the cross-section area and the lengths of the legs, and λ and ρ are the thermal conductivity and specific electric resistance, respectively. The resistance of the legs is given by R_{legs}, and the contact resistance is denoted by R_C. The subscripts n and p denote the ntype and p-type doping of the legs. Now, the modules *ZT*-value can be rewritten to:

$$ZT_{Module} = ZT_{mat}\ \frac{1}{1 + \frac{R_C}{R_{legs}}}$$

Where ZT_{mat} denotes the *ZT*-value of the material without contact resistance. For non-vanishing contact resistances of the module its *ZT*-value is always smaller than what would be reachable given the material's *ZT*-value. However, the influence of the contact resistance *R*c vanishes for increasing leg's resistance *R*legs. This suggests the possibility to minimize the effect of contact resistances by increasing the size *l* of the thermoelectric legs, since the module's resistance *R* scales with *l*.

Figure no. 7 shows impact of the contact resistance on the *ZT*-value of the module for modules with different leg sizes, calculated at room temperature. For vanishing contact resistance, the *ZT*-values of the modules approach the maximum value of ~0.57 of the material applied. Modules with larger legs have a higher *ZT*-value than modules with smaller legs [3].

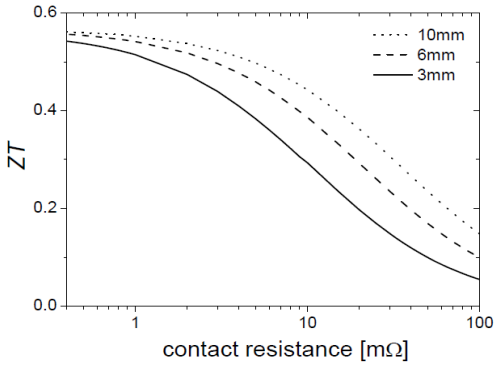

Figure no. 7:- Impact of the contact resistance on the *ZT*-value of the module for modules with different leg sizes, calculated at room temperature [3].

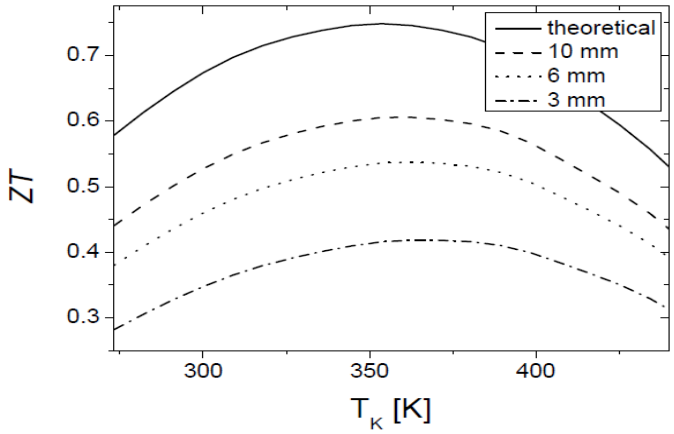

Figure no. 8:- The modules *ZT*-values versus the cold-side temperatures *T*k for different leg sizes. The simulations predict, that modules with longer legs show a better performance [3].

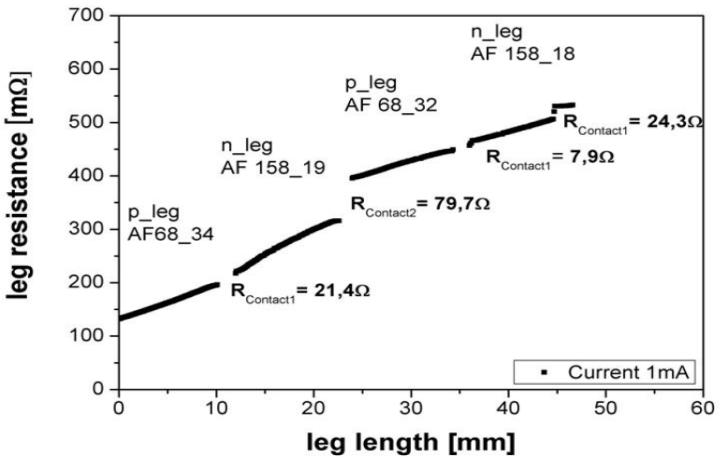

Figure no. 9:- The discontinuities represent the contact resistances, the linear slopes the resistance of the thermoelectric legs [3].

Design Consideration:-

The Major limitation of performance of thermoelectric generator is high heat transfer coefficient of heat sink. The heat spreading from the generator element to the heat sink can reduce the heat flux through some degrees, from generator to heat sink. The solution of heat flux reduction is properly increasing the thickness of generator and it has also advantages like output power and efficiency can be enhancement due to increase of temperature difference across the elements. [13] To extract maximum energy from thermoelectric generator, the thickness of hot side substrate must

be minimized and that of cold side substrate must be maximized. The thinning of hot side substrate causes rapid heating of the substrate which increases the response speed of the active layer. [9] With bigger p-leg cross-section, the output current and power on the load increase due to the reduced generator internal resistance. Increase in p-leg cross-section size, decreases the actual temperature difference between the hot and cold junctions. This decrease in temperature difference is less compared to internal resistance reduction. Efficiency is maximized at optimum p-leg cross-section. [7]

Conclusion: -

In this paper the exhaustive study effects of temperature dependence of thermoelectric properties, heat transfer laws, contact resistance and leg length is discussed. All the above mentioned parameters affect the performance of thermoelectric generator significantly.

Increasing the temperature difference will always improve the power and efficiency if the temperature dependence of thermoelectric properties is not considered. On the other hand the power improves very slowly whereas the efficiency decreases after its peak value with the increase of temperature difference, considering the influence of temperature dependence of thermoelectric properties. The external heat transfer law does influence the characteristics of the thermoelectric device. When the heat transfer law is nonlinear, there are Optimal working electrical currents and optimal ratio of thermal conductance allocations corresponding to the maximum power output and maximum efficiency. The module performance increases with the length of their legs, could not be supported by the experiments as per the review of scholars work. The heat flux reduction is done by increasing the thickness of generator to enhance output power and efficiency. The thickness of hot side substrate must be minimized and that of cold side substrate must be maximized to maximize energy output. Big size P-leg section reduces internal resistance due to which the performance of the generator enhanced. Further analysis showed that heat loss along the thermoelectric legs by convection and radiation is mainly responsible for this deviations.

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An empirical study on Blood Types and Personality

Dr. Parag Arun Narkhede

Assistant Professor, KCES's Institute of Management and Research, Jalgaon
Email: paragnarkhede@yahoo.com

Abstract— In Japan, a superstition similar to horoscopes, but based on blood type is very common. People strongly believe that the blood type influences one's personality, weaknesses and strengths. The belief was started in 1927 by Takeji Furukawa in a series of articles and books. The tradition is less popularized after Furukawa's death in 1940, but it was revived in 1970 by journalist Masahiko Nomi by a series of books that sold millions of copies, and that new popularity has lasted until today.
The basic idea of this paper is based on the same line. Primary data has been collected randomly from 100 people through questionnaire to reveal the similar linkages in India. The result shows that each blood group have distinct characteristic similar to Japanese perception.

Keywords- Blood Group, Personality, Traits, India

I. INTRODUCTION

Beginning in approximately 1930, the Japanese embraced the idea of matching personality traits with one's blood type. This phenomenon is as popular in Japan as the idea of matching horoscope with personality is in the United States. Almost all Japanese are aware of their blood type. The idea began when some in the west were touting the idea that the Asian peoples were more closely related to animals then humans, or lower on the evolutionary chain, since type B blood was the predominant blood type in Asians and animals. Almost every Japanese person knows their blood type due to physical examinations in school, and while even those who believe in it (mostly teenage girls) don't take it very seriously, the superstition is everywhere: people use it as a conversation starter and especially to determine compatibility of lovers and friends. As ludicrous and unscientific as this idea was, it was insulting to say the least. Modern science disproves this obviously faulted idea. In the 1930's Furukawa Takeji (1891-1940) set out to disprove this notion and a new idea was born (Shintaku, 2013).However, the idea of personality traits being influenced by blood type remains. Companies in Japan even had divided workers by blood type. Interest in this lore tapered off after Furukawa's death in 1940, but it was revived in 1970 by journalist Masahiko Nomi by a series of books that sold millions of copies, and that new popularity has lasted until today.

II. LITERATURE REVIEW

The history of the theory that blood type determines personality is actually a dark one. In 1900, Austrian scientist Karl Landsteiner discovered the four blood types. Like 19th-century scientists who used brain size (the larger the brain, the more advanced) to propagate theories of racial and gender superiority, many (white) scientists used the blood type theory as a way to push forward their own ideas of racial supremacy. Scientists from the west suggested (falsely, obviously) that Asians were inferior and sub-human since the vast majority of them like animals had type B blood. In 1927, Takeji Furukawa, a Japanese professor, introduced the theory to the Japanese public in a paper entitled, "The Study of Temperament through Blood Type." Even though he lacked the proper credentials and backed up nothing scientifically, the public embraced the idea of blood type as a determination of personality. The Japanese government even commissioned a study to determine if they could breed better soldiers. In the 1970s, a book by Masahiko Nomi revived the idea, which is still popular with the general Japanese public. In 2008, four books on the topic have hit Japan's top ten bestseller lists (Josef, 2012).

III. BLOOD TYPE & PERSONALITY

Each blood type has a personality profile (Masahiko, 2012). These profiles which are found with the literature available on World Wide Web, the Rh factor plays no role in the blood type/personality idea. The general belief of each blood type along with their traits according to Masahiko (2012) are-

Type A: People with blood type 'A' have a deep-rooted strength that helps them stay calm in a crisis Situations when everyone else is panicking. However, they tend to avoid confrontation, and

feel very uncomfortable around people. Type A's are the most artistic of the blood groups. ‘’ types are shy and sometimes withdrawn. They seek harmony and are very polite, but all the same feel that they never really fit in with others. ‘A’ types are very responsible. If there is a job to be done, they prefer to take care of it themselves. These people crave success and are perfectionists. They are also very creative, and the most artistic of all the blood types, most likely because of their sensitivity. People with blood type A are also likely to be considered classic "type ‘A's": stressed and conscientious (Masahiko, 2012).

Type B: People with blood type B are the most practical of the blood groups. They are specialists in what they do. They are Goal oriented and strong minded. When they start a project, they spend extra time understanding and trying to follow directions than others might. When they are doing something, all of their attention is focused on it. They tend to stick to a goal and follow it through to the end, even if it seems impossible. They tend to be less than cooperative, as they like to follow their own rules and their own ideas. Type B's are individualists of the blood group categories and find their own way in life. B type people pay attention to their thoughts a little more than their feelings, and therefore can sometimes seem cold and serious. People with blood type B are often considered more relaxed, freewheeling, and unconventional than other types, although not necessarily to an unacceptable degree (Masahiko, 2012).

Type O: People with blood type O's are outgoing, energetic, and very social. They are the most flexible of the blood types. They are initiators; they easily start up projects but often have trouble following through because they give up easily. They are flighty and not too dependable. O types always say what's on their mind. They value the opinion of others and like to be the center of attention. Also, people with O blood are extremely self-confident. Creative and popular, they love to be the center of attention and appear very self confident. Type O, the most "average" blood type, is considered the best type in Japan (Masahiko, 2012).

Type AB: People with blood type AB are hard to categorize, they are the split personalities of the blood groups. They can have characteristics on both ends of the spectrum at the same time. For instance, they are both shy and outgoing. They easily switch from one opposite to another. AB people are trustworthy and responsible, but can't handle it when too much is asked of them. They don't mind doing favors or helping out, as long as it is on their own conditions. People with this blood type are interested in art and metaphysics.
AB is considered the worst blood type. In predictability-loving Japan, they're loose cannons. They also like to set their own conditions and reserve the right to drop out when things don't meet their expectations. They're known to be sensitive and considerate at times but it just isn't enough to balance out the flaws in this blood type. For a while, some companies tried dividing their employees into work groups based on blood type, and no one wanted to work with the AB group (Masahiko, 2012).

IV. METHODOLOGY

The basic intention of this paper is to correlate & compare this Japanese philosophy with Indian Blood Traits. As a pilot study Questionnaire was prepared considering different traits of personality along with annual income, Blood group and occupation of respondents. The questionnaire is distributed among 100 respondents to take their feedback out of which 90 responses have taken into consideration for further analysis. The data analysis has been done with the help of IBM PASW software using cross tabulation.

V. FINDINGS AND DISCUSSION

Around 62% respondents are doing job while 38% are respondents are doing business. 26 respondents belong to ‘O’ blood group while 22,24,18 respondents belong to ‘A’, ‘B’, & ‘AB’ blood group respectively. Majority of Respondents from ‘O’ & ‘A’ blood group have preferred Job as their profession similarly, most of respondents from ‘B’ & ‘AB’ doing business.
Respondents belongs to ‘B’ type are reserved to talk freely with others. Most of respondents from ‘B’ & ‘AB’ always feel comfortable with people around, while respondents from ‘O’ & ‘A’ are only sometimes, they prefer privacy.
‘AB’ & ‘B’ type people are always ready to make social contacts, ‘A’ are quite choosy & ‘O’ prefer some times.
A person belongs to ‘AB’ Blood type adapts well in changing situations.
Respondents from ‘B’ blood type like to expressing ideas and feeling openly compared to other types while ‘O’ type prefer rarely.
Respondents belongs to ‘O’ & ‘A’ group always like to work hard.
‘A’ blood group people are perfectionist they always prefer to complete the task in their hand.
‘O’ type people always prefer to take initiative while performing task in a group, Similar

characteristics are also observed in Blood Type 'B', 'A' type are quite lazy in taking initiative while 'AB' type are not interested in taking initiative.

Blood type 'O'are always prefers to help people, 'B' people are quite choosy in helping people, 'A' are moody in helping people, while 'AB' are extremist.

In response to the question on 'Do you like to take help from others', 'O' type people rarely take help from others, 'AB' people are willing to take help from others, 'B' type people take help whenever necessary, 'A' type people sometimes take help from others.

'O' blood group respondents generally never jealous with competitor, 'A' type are generally jealous with competitor, 'B' people are rarely jealous with competitor, 'AB' people have very diverse opinion about jealousy.

Most of the time 'O' blood type are creative, sometimes 'B' are also creative. 'AB' people are angry birds; they get angry immediately, 'B' type people frequently get angry.'A' & 'O' Sometimes get angry.

'A' blood type people are mostly punctual in their work, 'B' are average in punctuality, while 'O' and 'AB' are sometimes punctual.

'O' Blood group holders forgot things easily, 'B' blood type people have sharp memory.

'B' type blood group people are forgiver in case of others mistakes, 'A' type are quite tough to forgive others, 'O' and 'AB' are quite social they hold optimum mixture of forgiveness.

'A' blood type holder are high risk taker, 'B' blood type are moderate risk taker while 'O' and 'AB' are low risk taker.

People belongs to 'A' blood type are controlled by head than heart, 'B' and 'AB' are quite emotional, 'O' blood type people are situational.

'A' Blood group holder have very high patience while performing certain task, 'AB' blood type people have low patience, 'O' have moderate patience while performing certain task while 'B' blood type people's patience depends on intensity of task importance.

'O' blood holder rarely love animals; 'A' blood holders have high affections towards animals, 'B' and 'AB' possesses moderate affection towards animals.

'B' blood type people have good people readings; immediately trust people most of the times with their first impression, whereas 'AB' blood holder will trust people most of the time only after confirmation that they are trustworthy, 'O' and 'A' have similar responses regarding trust on people; most of the time they trust people after confirmation.

'B' and 'O' blood type holders prefer to live in peaceful or friendly environment, 'AB' are flexible an any environment, 'A' blood type people also like friendly or peaceful environment but sometimes expect lonely environment.

'O' type people are social butterflies; basically believes on hardwork, 'A' Blood type people are hardworking but somewhat shy. 'AB' blood people are social as well as hard worker, and 'B' blood group holders are blended mixture of social, shy, lazy & hard work; they seems to be a moody people.

Table showing frequency distribution of data Collected is attached in Annexure.

VI. CONCLUSION

The findings shows that each blood group have distinct characteristic, the finding may somehow differs from Japanese studies, but Indian culture, regional diversity, religion characteristic and poor family conditions have significant contributions in shaping individual personality. The characteristic of blood group with respect to personality as per the findings are -

Type O: A person belongs to 'O' blood type are the social butterflies. Often popular and self-confident, very creative personalities and always seem to be the center of attention. Always make a good impression on people and you're often quite attractive. Organized and determined, their persistence will helps to reach their goals. These people are good leaders & prefer to live in peaceful or friendly environment.

Type A: 'A' person belongs to 'A' blood type has very high patience but quite shy, basically controlled by head than heart. Perfectionist, hardworking & punctual; always prefer to complete the task in their hand but, quite lazy in taking initiative. High affections towards animals. Usually introverted personalities, jealous with competitor& choosy.

Type B: Type 'B' is impulsive individualists who often create their own path in life. They are very strong and optimistic & like to live in pleasant & peaceful environment. Moody, Outgoing and very charming, they are good at reading people and providing support.

Type AB: Not surprisingly, AB's can be quite dualistic, possessing both A and B traits. They are Hard worker but not interested in taking initiative, quite emotional & low risk taker. They are social personalities, always ready to make social contacts. Usually trustworthy and like to help

others. Comfortable with people around & adapts well in changing situations. AB blood type people may have low patience; they trust people most of the time only after confirmation that they are trustworthy.

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Annexure: Tables showing frequency distribution of data Collected

		Blood Group			
		O	A	B	AB
Occupation	Job	18	14	14	10
	Business	8	8	10	8
	Farm	0	0	0	0
	Industry	0	0	0	0
Do you like communicating freely with others?	Always	18	14	10	14
	Sometimes	8	8	10	2
	Rarely	0	0	4	2
	Not at All	0	0	0	0
Are you comfortable if more people are present around you?	Always	8	6	12	12
	Sometimes	14	12	8	4
	Rarely	4	4	2	2
	Not at All	0	0	2	0
Do you like making social contacts?	Always	8	10	16	14
	Sometimes	16	10	4	4
	Rarely	2	2	4	0
	Not at All	0	0	0	0
Do you adapt well to the changing situation?	Always	10	8	10	8
	Sometimes	14	8	14	10
	Rarely	2	6	0	0
	Not at All	0	0	0	0
Do you like expressing your ideas and feeling openly?	Always	6	8	12	6
	Sometimes	8	10	8	6
	Rarely	12	4	4	4
	Not at All	0	0	0	2
Do you like working hard?	Always	24	20	18	12
	Sometimes	2	2	4	4
	Rarely	0	0	2	2
	Not at All	0	0	0	0

		Blood Group			
		O	A	B	AB
Do you complete the work that you take in your hand?	Always	20	18	16	12
	Sometimes	6	4	4	6
	Rarely	0	0	2	0
	Not at All	0	0	2	0
Do you like taking initiative while performing any task in group?	Always	14	12	12	4
	Sometimes	12	6	12	12
	Rarely	0	4	0	2
	Not at All	0	0	0	0
Do you like helping people?	Always	22	18	16	16
	Sometimes	2	0	8	0
	Rarely	2	4	0	0
	Not at All	0	0	0	2
Do you like taking help from other peoples?	Always	0	0	2	2
	Sometimes	6	10	10	8
	Rarely	20	10	12	6
	Not at All	0	2	0	2
Do you fell jealous of your competitors?	Always	0	4	2	2
	Sometimes	2	10	10	4
	Rarely	6	2	8	6
	Not at All	18	6	4	6
Are you creative?	Always	10	6	6	8
	Sometimes	10	12	18	8
	Rarely	6	4	0	2
	Not at All	0	0	0	0
Do you get angry easily?	Immediately	2	4	4	6
	Frequently	6	2	6	8
	Sometimes	14	12	14	4
	Not at All	4	4	0	0

		Blood Group			
		O	A	B	AB
Are you punctual in your work?	Always	14	14	12	10
	Sometimes	12	8	8	8
	Rarely	0	0	4	0
	Not at All	0	0	0	0
Do you forget things easily?	Always	4	2	2	2
	Sometimes	16	10	8	10
	Rarely	6	8	8	6
	Not at All	0	2	6	0
Do you forgive people easily for their mistake?	Immediately	4	2	8	4
	Frequently	6	4	2	0
	Sometimes	16	14	14	14
	Not at All	0	2	0	0
What kind of risk taker you are?	High	2	8	6	2
	Moderate	20	8	10	8
	Low	2	4	4	4
	Not at all	2	2	4	4
Are you controlled by your head than your heart?	Always	2	10	8	6
	Sometimes	18	6	10	6
	Rarely	6	4	4	4
	Not at All	0	2	2	2
Do you keep	Always	14	16	10	4

patient white performing certain task?	Sometimes	12	6	12	12
	Rarely	0	0	2	2
	Not at All	0	0	0	0
Do you love animals?	Always	4	14	12	8
	Sometimes	10	6	4	4
	Rarely	10	2	4	4
	Not at All	2	0	4	2

		Blood Group			
		O	A	B	AB
How you trust people?	Immediately	10	8	10	4
	After Confirmation	16	14	12	14
	Dont Trust	0	0	2	0
	Not at All	0	0	0	0
Which environment you like the most?	Peaceful	8	6	10	4
	Crowdies	0	0	0	2
	Friendly	18	12	14	10
	Lonely	0	4	0	2
What kind of person you are?	Social	12	2	10	8
	Shy	0	4	2	0
	Lazy	0	0	2	0
	Hardworking	14	16	10	10

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A Study of Consumer Preferences & Attitude towards Passenger cars of Maruti Suzuki & Hyundai Motors in Marathwada Region of Maharashtra

Dr.Vishal S.Rana [1],Dr.M.A.Lokhande[2]

[1] Associate Prof & Head, M.B.A Dept, S.S.B.T's College of Engineering & Technology, Bambhori, Jalgaon, MS (Corresponding Author)
[2] Professor, Department of Commerce, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad, MS, India.
Email: vishal.rana1980@yahoo.com, murlidhar_lokhande@yahoo.com

***Abstract*— Companies today are becoming customer centric & highly focusing on satisfying their customers as they realized that in present cut throat competition, satisfying & delighting the customers is very crucial. Because of the constant change in needs, expectations and lifestyle of customers, most of the companies are in dilemma that how to satisfy the customers and which strategy should be adopted. The same problems have witnessed by Indian automobile industry. Even Maruti Suzuki and Hyundai Motor- the two leading automobile giants in India are very much conscious about understanding the needs & expectations of the customers. The present study throws light on various factors related to consumer behavior & satisfaction. The objective of this research paper is to know the preferences and opinions of Maruti & Hyundai customers regarding after sales service, resale value, and fuel efficiency along with customer preferences while buying Maruti & Hyundai brands.**

The present study is descriptive in nature & convenient sampling technique has been adopted for selecting the consumers. The primary data has been collected with the help of structured questionnaire. The study reveals that the customer's preferred Maruti cars on parameters like fuel efficiency, after sales service, resale value, availability of spare parts whereas in view of Hyundai customers they preferred vehicles on parameters like comfort & convenience, exterior, technology etc. The study concludes that proper customer care strategy plays vital role in satisfying & delighting the customers.

Keywords-
Maruti Suzuki, Hyundai Motors, after sales service, fuel efficiency, customer satisfaction.

I. INTRODUCTION

Indian automobile sector is one of the heart industries of Indian economy. Till early 1980s, there were very few players in the Indian automobile sector & was suffering from obsolete & substandard technologies. After 1991 the India government released tedious norms and opened the Indian market for all. Currently the Indian automobile market is crowded with lot of Indian as well as multinational brands like Maruti, Honda, Chevrolet, Skoda, Renault, BMW, Hyundai, Nissan, Audi, Fiat, Toyota & General Motors etc.In India, the automobile industry provides direct employment to about 5 lakh persons. It contributes 4.7 per cent to India's GDP and 19 per cent to India's indirect tax revenue.

India's auto market remains dominated by passenger cars in the small segment (segment-A) and compact segment (segment-B), which jointly account about 65 percent of sales. The Indian passenger vehicle industry has been progressing continuously since a last decade except the recessionary phase witnessed during FY 2009. Despite the recession in 2009, the Indian automobile market has captured the major market share in domestic as well as in international markets. In recent years the Indian automobile industry has achieved splendid achievement. India is 11th largest passenger vehicle market and is largest three wheeler market in world.

II. CUSTOMER SATISFACTION

Customer satisfaction is defined as the number of customers, or percentage of total customers, whose reported experience with a firm, its products, or its services (ratings) exceeds specified satisfaction goals. In a competitive marketplace where businesses compete for customers, customer satisfaction is seen as a key differentiator and increasingly has become a key element of business strategy. Presently gaining high levels of customer satisfaction is very important to a business or any

company because satisfied customers are most likely to be loyal and to make repeat orders and to use a wide range of services offered by a business. There are many factors which lead to high level of customer satisfaction which includes:

- Products and services which are customer focused
- Customer service giving personal attention to the needs of individual customers
- After sales service- following up the original purchase with after sales support such as maintenance and updating

It is obvious that the consumer generally experiences satisfaction when the performance level meets or exceeds the minimum performance expectations. Similarly, when the performance level far exceeds the desired performance level, the consumer will not only be satisfied but will most likely are delighted. Such an outcome tends to reduce the consumers' decision making efforts on future purchase occasions of the same product or service to accomplish need satisfaction.

III. OBJECTIVES OF THE PAPER

- To get the opinion of respondents regarding Maruti & Hyundai brands in Marathwada region with respect to after sales service, resale value, fuel efficiency, vehicle satisfaction, opinion about price, source of information.
- To study the preferences of respondents while buying Maruti & Hyundai brands.

IV. REVIEW OF LITERATURE:

Menon Balkrishnan & Dr.Jagathy Raj V.P, (May 2012) in their research paper, "Model development and validation for studying consumer preferences of car owners" highlighted on various consumer purchase behavior patterns of passenger car owners in the state of Kerala. Their findings indicate that customer focus is a major differentiator in the passenger car industry, wherein the customer looks for personalized care for his after sales service with the manufacturer. The study also reveals that for the youths, peer group is the greatest influencing factor, of their car purchase decision. Manmohan N & Dr. Ganapathi R, (May 2012) in their research paper, "Customer preferences and attitudes towards Maruti cars in Pollachi taluk" highlighted on customer preferences, attitude and satisfaction regarding Maruti cars. The authors stated that Maruti 800, Omni, Zen and Wagon R are popular models of Maruti Suzuki. The authors suggested that Maruti Suzuki should concentrate and enhance their services like timely delivery, after sales service, handling customer enquiries etc. They also suggested that the company should launch its car with some added features with competitive prices. Suganya R, (Jan 2012) in her research paper highlights the effect of brand equity on consumer purchasing behavior on car. The paper speaks that brand plays vital role in car sales, not only to attract but also to retain customers. The author concluded that brand awareness and perceived quality proved to influence the brand loyalty. Also brand loyalty and brand association affect customers' attitudes towards brand. Phule Mohan, (2012) in his Ph.D thesis, "Exploring Marketing strategies and customer satisfaction in automobile industry: a comparative study of Aurangabad and Pune city" found that telephone, internet are the most preferred sources of collecting feedback. He also suggested that the company should use advanced technology and try to increase the efficiency of car. He also suggested that with an object to minimize the complain of car regarding after sales service, the automobile companies should have direct linkage with the customers through email, and the company should focus that whether the customers are really satisfied with after sales service or not. Vidyavathi K, (April 2012) in her research paper, "Consumer lifestyle influence of consumer behavior with reference to automobile industry in Chennai", throws light on growth of Indian automobile industry along with various features that the manufacturers should concentrate on to attract the prospective buyers. The author also suggested that the automobile manufacturers should find out the needs, wants, tastes and preferences of the consumers in order to design the products. The study reveals that the middle class population has risen to 13 percent of the total population. Hence the brand image and brand loyalty could be boosted by selling quality automobiles at a reasonable price to suit the needs of the middle income group. As far as after sales service is concerned, the author lastly suggested that the services rendered or to be rendered should be properly explained, friendly approach and reliability in service are to be further improved.

V. RESEARCH HYPOTHESIS

The hypotheses are as follows:
$H_{0\ 1}$: There is no association between price and customer satisfaction of the auto products of both the auto companies' i.e Maruti & Hyundai.

H0 2: The Demand of vehicle not depends upon Resale value.

VI. RESEARCH METHODOLOGY

This paper is mostly prepared with the help of primary data collection.

Sampling Design and Data Collection:

- The universe of the study consists of all Maruti & Hyundai customers' in the Marathwada region.
- Sample Size: 500
- Sampling Method: Convenient Sampling Method
- Data Type: Primary & Secondary Data
- Data collection Tool: Structured Questionnaire
- Survey Method

VII. HYPOTHESIS TESTING

H0 1: There is no association between price and customer satisfaction of the auto products of both the auto companies' i.e Maruti & Hyundai.

The Hypothesis has been tested in SPSS using ANOVA test as mentioned below:

ANOVA

	Sum of Squares	Df	Mean Square	F.	Sig.
Bet[n] Group	573990551626.3	4	143497637906.586	3.27	.012
With[n] Group	2066485 3608037.5	471	43874423796.258		
Total		475			

In this case, the final column labeled sig. indicates how likely it is that an F ratio of that size would have occurred by chance. There is a probability of 0.012 that an F ratio of this size would have occurred by chance (that's less than a 5% chance). Hence, because the observed significance value is less than .05, the hypothesis was rejected & it can say that there is positive association between Price and Customer Satisfaction of the auto products of both the auto companies.

H0 2: The Demand of vehicle not depends upon Resale value.

The above hypothesis tested with the help of Cross Tabulation as follows:

Cross Tabulation

The cross tabulation shows the frequency of each response from the car owners with respect to resale value & demand of vehicle.

		Demand of Vehicle is depend on Resale Value		Total
		Yes	No	
Do you think that there is good resale value of your vehicle	Yes	118	283	401
	No	11	64	75
Total		129	347	476

Chi Square Test

	Value	Df	Asymp.Sig (2- sided)
Pearson Chi Square	6.967	1	.008
Likelihood Ratio	7.730	1	.005
Fisher's Exact Test Linear-by-Linear Association	6.952	1	.008
N of Valid Cases	476		

Here the two-sided asymptotic significance of the chi-square statistic is 0.008 (Pearson Chi-Square, Fisher's Exact Test (0.008) Likelihood Ratio (0.005) < significance value i.e 0.05). Hence the null hypothesis is rejected and it is concluded that the demand of vehicle depends upon resale value.

VIII. ANALYSIS & FINDINGS:

Table 1: Annual Income of Respondents

Factor	Frequency	Percent
< 2lakhs	19	4.0
2-5 Lakhs	241	50.6
> 5 lakhs	216	45.4
Total	476	100.0

Source: Field Survey

From the above table it was revealed that, the annual income of 50.6 percent of the respondents are in between 2-5 lakh whereas 216 respondents i.e 45.4 percent respondent's annual income are above 5 lakh. Also there are only 19 respondents whose annual income is less than 2 lakh which is 4 percent as compare to other respondents.

Table 2: Opinion about Price of Vehicle

Factor	Frequency	Percent
Lower	9	1.9
Affordable	188	39.5
Excessive	86	18.1
Competitive	193	40.5
Total	476	100.0

Source: Field Survey

The above table depicts that in view of 40.5 percent respondents the price of their vehicle is competitive whereas 18.1 percent respondents opined that the price of their vehicle is excessive. Only 1.9 percent i.e 9 respondents thought that the price of their vehicle is lower whereas in view of 39.5 percent respondents, the price of their vehicle is affordable.

Table 3: Overall Vehicle Satisfaction on 1-5 Scale

Factor	Frequency	Percent
Not Satisfied	1	.2
Least Satisfied	5	1.1
Satisfied	177	37.2
Good Satisfied	53	11.1
Highly Satisfied	240	50.4
Total	476	100.0

Source: Field Survey

It was disclosed from above table that, 37.2 percent respondents are overall satisfied with their Vehicle, 50.4 percent i.e 240 respondents opined that they are highly satisfied with their vehicle, 0.2 percent respondent is not satisfied with their vehicle whereas 1.1 percent i.e 5 respondents stated that they are least satisfied with their vehicle.

Table 4: Problem about After Sales Service

Factor	Frequency	Percent
Yes	36	7.6
No	440	92.4
Total	476	100.0

Source: Field Survey

The above table disclosed that, 7.6 percent respondents have faced problems regarding after sales service whereas 92.4 percent i.e 440 respondents opined that they have not faced any problem regarding after sales service. During survey it was found that, few Maruti respondents are not satisfied regarding after sales service provided by Maruti Suzuki dealers.

Table 5: Demand of Vehicle is depend on Resale Value

Factor	Frequency	Percent
Yes	129	27.1
No	347	72.9
Total	476	100.0

Source: Field Survey

From the above table it was disclosed that, in view of 27.1 percent i.e 129 respondents, the demand of vehicle depends on resale value whereas 72.9 percent i.e 347 respondent opined that the demand of vehicle not depends on resale value.

Table 6: Source of Information

Factor	Frequency	Percent
TV advt.	91	19.1
News papers	91	19.1
Magazines	102	21.4
Internet	30	6.3
Friends /Relative	156	32.8
Others	6	1.3
Total	476	100.0

Source: Field Survey

The above table illustrates that 32.8 percent i.e 156 respondents' came to know about their vehicle through source of their friends and relatives', it means that this source of information is considered as most reliable source according to customer's point of view. Also in view of 19.1 percent respondents, TV advertisement is the effective source of information for them.

Table 7: Customer Preferences while buying vehicle

Parameter	Maruti	Hyundai
a	95	38
b	199	145
c	83	15
d	36	1
e	229	127
f	52	87
g	225	74
h	119	15
i	112	141
j	133	139
k	14	0
l	118	43
m	115	74

Source: Field Survey

The details of above parameters (a…h….m) are indicated as follows:

a) Easy availability of Vehicle, b) Comfort & Convenience, c) Competitive Price and Discount, d) Financing Options, e) Fuel efficiency, f) Safety features g) Better after sales service, h) Availability of Spare parts, i) Interior, j) Exterior, k) Resale Value, l) Demand of Vehicle, m) Image of Company

During survey the customers were asked about their preferences while buying vehicle and it was noticed that every respondent preferred his/her vehicle on the basis of various parameters i.e more than one parameters. In view of Maruti Suzuki respondents, it was disclosed that, 229 respondents preferred Maruti vehicles on the basis of fuel efficiency while 225 respondents preferred Maruti vehicles because of better after sales service. It was found that there are only 14 customers who agreed that they have preferred Maruti vehicles because of its good resale value and 115 customers opined that they have preferred Maruti vehicles because of good Image of company.

In case of Hyundai respondents the above table illustrates that there are 145 respondents who have preferred their Hyundai vehicles because of comfort and convenience & 141 respondents opined that they have preferred Hyundai vehicles because of its nice Interior. The above table also highlighted that 87 respondents have preferred Hyundai vehicle because of its Safety features whereas 74 customers have preferred their Hyundai vehicle because of its better after sales service.

IX. FINDINGS

- The occupation pattern of respondents is a mixture of servicemen, businessmen, self employed person, students, farmers and retired.
- The annual income of 50.6 percent respondents is in between 2-5 lakhs per annum where as the annual income of 45.4 percent respondent is above 5 lakhs.
- It was found that, 66.6 percent respondents own Maruti Suzuki vehicles whereas remaining 33.4 percent respondents own Hyundai Motor vehicle.
- The majority i.e 98.3 percent respondents agreed that their vehicles were delivered with all features promised at the time of sales whereas remaining respondents told that their vehicles were not delivered with all features promised at the time of sales.
- In a survey it was found that, as far as Maruti vehicles are concerned, the respondent preferred Maruti cars on vital parameters like Fuel efficiency, better after sales service, comfort and convenience, exterior, availability of spare parts.
- In case of Hyundai Motors it was noticed that, the respondents preferred Hyundai cars because of comfort and convenience, interior, exterior, fuel efficiency.
- As far as opinion about price of vehicle is concerned, 40.5 percent respondents stated that, the price of their vehicle is competitive, 39.5 percent respondents stated that, the price of their vehicle is affordable.
- So far as after sales service problem is concerned, 92.4 percent respondents reported that they have not faced any problem regarding after sales service whereas 7.6 percent respondents agreed that they faced problem regarding after sales service.
- It was disclosed that, in view of 70.8 percent respondents, the dealer provided them good services, 22.1 percent respondents opined that the dealer offered them very good service, 3.2 percent respondents agreed that the dealer provided them excellent service.
- In opinion of 27.1 percent respondents it was disclosed that, demand of vehicle depends on resale value whereas 72.9 percent respondents agreed that the demand of vehicle not depends on resale value.

X. CONCLUSION

Customer satisfaction is crucial for business performance, as it is the driver of customer loyalty and consecutive retention. One could say that it is much more expensive to acquire new customers than retain current ones, as the costs associated with the customer recruitment are higher than those connected with customer retention.

It is obvious that satisfied customers, satisfied employees and satisfied shareholders all have one common characteristic– they are positive and enthusiastic about the company they are dealing with. The automobile companies if wants to retain their customers for long should focus on appropriate marketing mix. Similarly the automobile companies should develop an efficient system of receiving complaints and encourage consumers to record their complaints as soon as they occur, and efficiently resolve their complaints. For this constant meeting with customers, dealers, telephone enquiry can be a good option. Automobile companies should periodically conduct meetings with marketing & sales managers, Production managers, and customer care officers to frame innovative strategies.

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Extraction of lycopene by supercritical fluid extraction

Mr. R.B. Tupe[*1], *Mr. S.M. Patil*[2], *Dr. B.K. Sakhale*[3]

[*1]Institute of Chemical Technology, Mumbai-400019, India.
[2]Laxminarayan Institute of Technology, Nagpur-440033, India.
[3]University Department of Chemical Technology, Aurangabad-431001, India.
swapnil.udct@gmail.com

Abstract: Tomatoes are rich in lycopene, it used as antioxidant, anti-cancer,ant-aging, sun protective and infertility. The extracted lycopene from four different particle size 297, 251, 178, 152µby supercritical fluid extraction (SFE) and examine on spectrophotometer and HPLC. Maximum yield was obtained 50.10% at 152 µ in supercritical fluid extraction, observed that particle size decreases the concentration of lycopene increases.

Keywords: Lycopene, Supercritical Fluid Extraction, Spectrophotometer, HPLC

Introduction

Over the past decade, certain plant substances, which have come to be known as photochemical, have been the focus of considerable attention because of their potential health benefit. Lycopene is one such substance, which belongs to a broad class of lipophilic compounds referred to as the carotenoids. Lycopene is an open chain pigment of unsaturated carotenoid, which occurs naturally, imparts red color to fruit and vegetable. Tomatoes (*Lycopersion esculentum*) are rich in lycopene and, in lower concentration also contain β-carotene, phytoene, pytofluene, lutein, γ-carotene, ξ-carotene and neurosporene**.**

Lycopene is a symmetrical tetra terpene having 8 isoprene units. It is a member of the carotenoid family of compound consists entirely of carbon and hydrogen. Naturally it is all-trans form; the molecule is long and straight constrained by its system of eleven conjugated double bond in this extended Π electron system reduces the energy required for electron to transition to higher energy states, allowing the molecule to absorb visible light of longer wavelength but not the longest hence appear red.

Lycopene is not an essential nutrient for humans, but it is commonly found in the diet mainly from dishes prepared from tomatoes. When absorbed from the intestine, lycopene is transported in the blood by various lipoproteins and accumulates primarily in the blood, a dipose tissue, skin, liver, and adrenal glands, but it can be found in most tissue.

Materials & Methods

Materials

Fresh, sound, fully ripe deep red color quality tomatoes of local cultivator were procured from the market.

Reagents

All chemicals used for the extraction purpose were of the analytical grade which includes acetone, petroleum ether. For HPLC analysis all chemicals were of HPLC grade including acetone, methanol and water. Standard lycopene was procured from Sigma chemical (St. Louis, MO, USA) with 99 % purity.

Sample preparation

Tomatoes brought from local market were carefully washed, cleaned so that outer surface should be free from soil and dust particles.

Sieve separation

The tomato powder obtained was subjected to sieve analysis. First it put on top sieve and then it was shaken for 20 min manually, in order to get the fine powder of different particle size viz. 297, 251, 178, 152µ.

Extraction of Lycopene

The powder of tomato was subjected to lycopene extraction by using supercritical fluid extraction (SFE) in order to study, method of extraction and effect of particle size on the yield of lycopene.

Supercritical Fluid Extraction

The Supercritical fluid chromatography extraction unit (JASCO make, Japan) was used for lycopene extraction which consist assembly of PU-2080 plus CO_2 (CO_2 delivery pump), BP-2080 plus (automatic backpressure regulator), MD-2010 plus (multi wavelength detector), CO_2 -2060 plus

(integrated column thermostat). Supercritical fluid (CO_2) extraction.Four particle sizes were selected for the supercritical extraction method.
The extraction vessel was having the capacity up to 5.5 gm of tomato powder. It was filled externally according to volume of the specific powder of various particle sizes. The CO_2 pump was switched on and it was allowed for cool stable stage which was attended within 45 min. After that CO_2 flow was allowed slowly to increase up to 3 ml/min. And then oven temperature at 70^0C was set and UV was at 472 nm. Lastly back pressure regulator was at 330 atm then samples allowed for injection.

Analysis by Spectrophotometer

All solutions were prepared under subdued light and kept at freezing temperature (-18^0C). A double beam spectrophotometer of JASCO makeV-630 was used for the analysis of sample. Standard sample concentrations were made first and by taking the spectra analysis max that obtained at 472 nm. Other peaks were obtained at 444 nm and 503 nm which are cis-isomer and di-cis isomer respectively. The absorbance of all extracted sample by supercritical fluid extractionwere taken at 472 nm, which shows that as particle size decreases the optical density increases.

Analysis by HPLC

An isocratic system (JASCO make) was used for the analysis of samples with C-18 column (250 mm*4.6 mm I.D., particle size 5 µm) were used for separation of lycopene and its cis-isomers. Standard sample was have concentration of 100 µg/ml was made. Mobile phase used was methanol/water (80:20). Before analysis all samples were filtered through whatman filter paper (125 mm). The two co solvent acetone and hexane were used. The column temperature was maintained at 20^0C temperature and UV detector was set at 472 nm wavelength. The flow rate was maintained at 1ml/min.

Results and Discussion

Sieve analysis of tomato powder

The dried tomato powders were subjected to sieve analysis for getting the fine powder of different particle size. The powder obtained having different particle sizes were classified in to eight sizes as per the B.S.S standard. The quantity of powder having different particle sizes are given in following table.

Table 12: Sieve analysis of tomato powder

BSSStandard	Particle size (µ)	Wt. obtained(gm)/ Kg	Percent powder(%)
36	422	6.84	16.67
44	354	2.16	5.26
52	297	4.90	11.94
60	251	4.58	11.16
85	178	10.8	26.32
100	152	8.14	19.84
120	125	3.0	7.31
150	104	0.60	1.46

Effect of particle size on extraction of lycopene by SFE

The samples extracted by supercritical method were analyzed by spectrophotometer which gives absorbance after dilution of 1:50 whose spectra analysis is given below. Standard lycopene graph was shown in fig 1, which gives very much closer resemblance with extracted sample of lycopene, which give confirmation of lycopene in extracted sample at 472 nm.

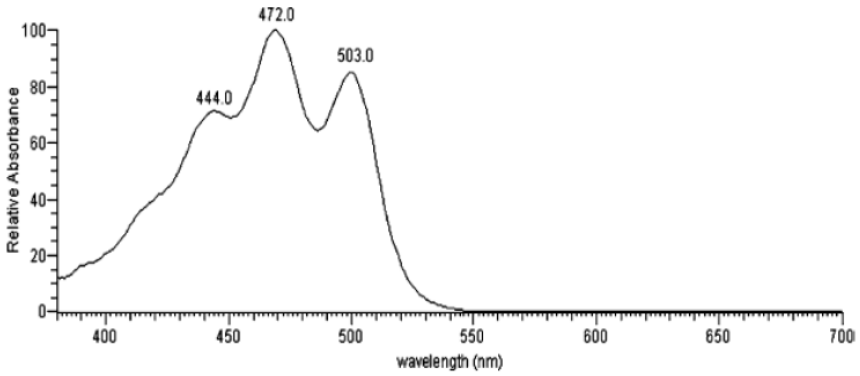


Figure 1: Standard lycopene curve

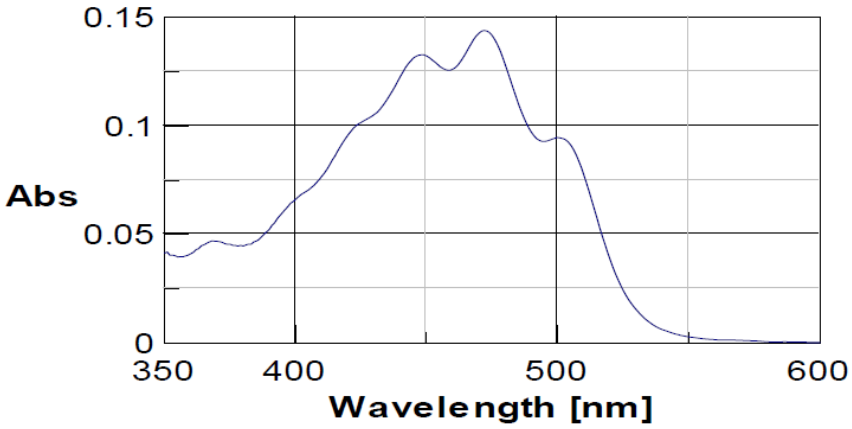


Figure 2: Spectra analysis for particle size (297 micron, 52BSS)

Peak executed – 472 nm, Absorbance – 0.14411

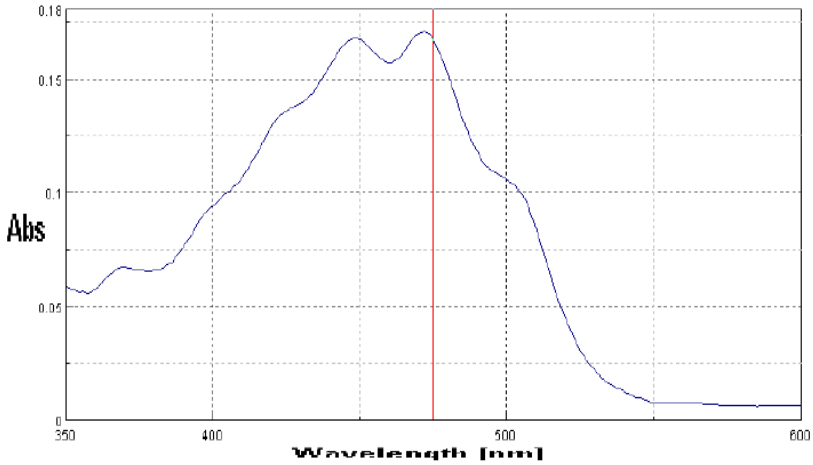


Figure 3: Spectra analysis for particle size (251 micron, 60 BSS)

Peak executed – 472 nm, Absorbance – 0.17058

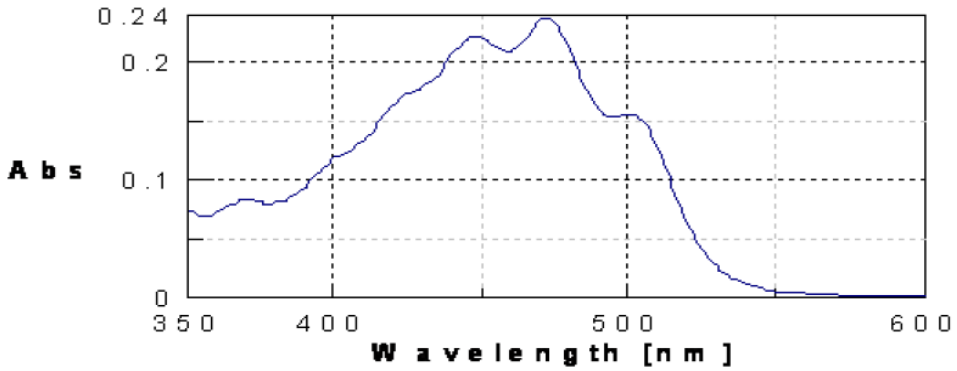


Figure 4: Spectra analysis for particle size (178 micron, 85 BSS)

Peak executed – 472 nm
Absorbance – 0.23745

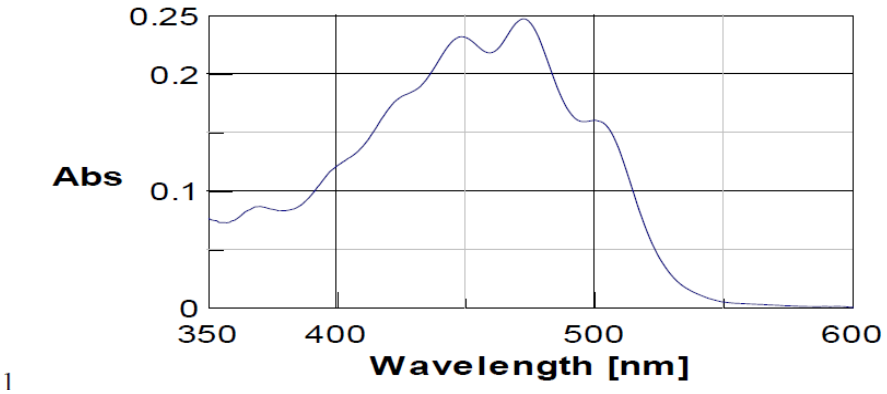


Figure 5: Spectra analysis for particle size (152 micron, 100 BSS)

Peak executed – 472 nm
Absorbance – 0.24787

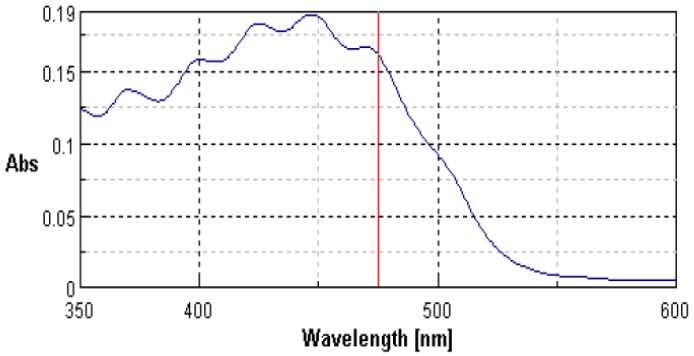


Figure 6: Spectra analysis for particle size (125 micron, 120 BSS)

Peak executed – 472 nm
Absorbance – 0.18927

In fig. 6 showed the spectra analysis for particle size of 125µ, but it did not match with graph of standard lycopene graph it might be due to very fine powder, which facilitated for extraction of various components along with other cis and di-cis isomers, which was undesirable.

Table 13: Effect of particle size on yield of lycopene by supercritical fluid extraction

ParticleSize (µ)	BSS Standard	Sample in extraction vessel(gm)	Optical density	Lycopene concentration(mg)/ gm
152	52	5.3	0.24787	50.10
178	60	5.3	0.23785	48.08
251	85	4.2	0.17058	43.51
297	100	4.1	0.14411	37.65

Analysis by HPLC

By mentioned above method, HPLC analysis is done for standard lycopene sample whose results with co solvent acetone and hexane are respectively shown below.

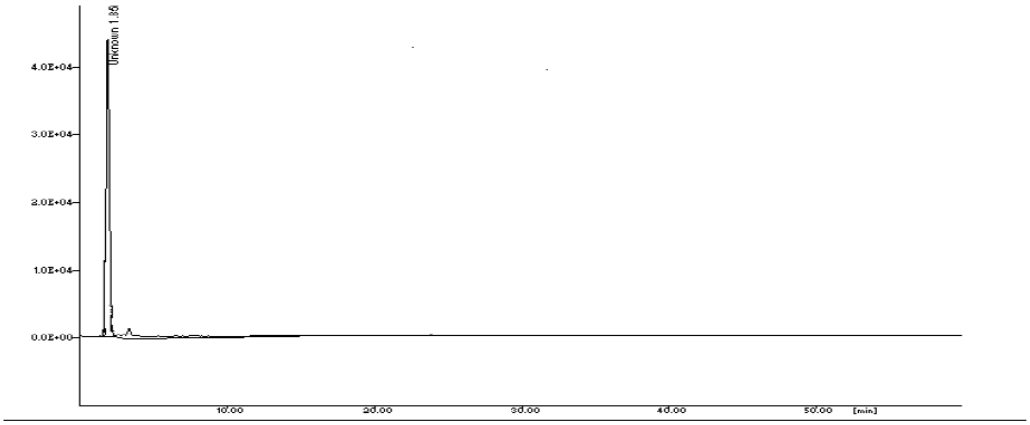
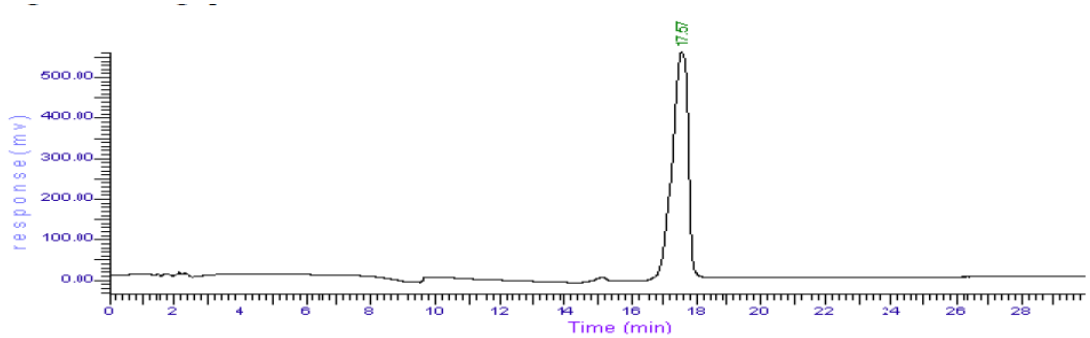


Figure 7: HPLC graph with co-solvent acetone

Retention time = 1.850
Area under curve 73.25



Peak #	Time [min]	Area [µV·s]	Height [µV]	Area [%]	Norm. [%]	BL	Area/Height [s]
1	2.155	10670.93	4520.31	0.06	0.06	BB	2.3607
2	4.018	213714.47	581.26	1.18	1.18	BB	367.6773
3	9.770	45986.65	3008.64	0.25	0.25	BB	15.2849
4	17.567	17779107.90	552595.67	98.50	98.50	BB	32.1738

Figure 8: HPLC graph with co-solvent hexane

From above both graph unknown concentration can be found out using the area under curve relationship.

Conclusion

This study confirms the suitability of supercritical fluid extraction as an alternative to any other conventional methods. Essential data on the kinetics of lycopene extraction by supercritical carbon dioxide has been provided. The maximum yield was obtained at 152µ particle size below that particle size was not suitable because of various isomers were coming with all trans- isomer. The SFE technique was environmentally friendly because, no need of organic solvent and if it is required then it is used in very small amount, as modifier. In future more attention needs to be paid to the stabilization of the extracted compound and antioxidant activity.

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A Critical Review on Operating Variables of Solar Thermoelectric Power Generator

P.M.Solanki[1]
[1]Assistant Professor, Mechanical Engineering, SSBT`s COET, Bambhori, Jalgaon, (M. S.), India
[1]p_msolanki@rediffmail.com

Dr. D.S. Deshmukh[2]
[2]Professor & Head, Mechanical Engineering, SSBT`s COET, Bambhori, Jalgaon, (M. S.), India
[2]deshmukh.dheeraj@gmail.com

Dipak C. Talele[3]
[3] *Assistant Professor, S.S.B.T.'s, College of engineering & Technology, Bambhori, Jalgaon*
[3]taleledeepak190687@gmail.com

ABSTRACT: Recently, an increasing concern of environmental issues of emissions, in particular global warming and the constraints on energy sources has resulted in extensive research into innovative technologies of generating electrical power. Thermoelectric power generation has emerged as a promising alternative green technology. In summer season heat collected in the solar water heater is mostly wasted, can be utilized in thermoelectric generator efficiently. Direct solar thermal power generation has been a gorgeous electricity generation technology using a concentrator to gather solar radiation on a heat collector. Then directly converting heat into electricity through a thermal electric conversion element is possible. Instead of steam power generator system direct conversion of solar heat into electricity is having higher potential of electric power generation.

Keywords: Solar Energy, Two Stage Concentrator; Thermal Analysis; Thermoelectric Power Generation

Introduction:

Thermoelectric power generation is one of the current wellbeing in clean energy research in view of direct solar power generation. Thermoelectric power generation becomes an striking application. Recent research analyses were proposed in the open literature to cover the various aspects of energy generation [2-10]. Efforts have been devoted to investigate the thermoelectric power conversion theory and practical applications. Maximizing the temperature difference between two sides of thermoelectric devices by increasing the heat flow through thermoelectric devices with methods such as raising the solar concentration ratio. Enhancing material thermoelectric characteristic. Seeking more suitable thermoelectric materials, such as nanometer materials, is the most useful and effective way to improve thermoelectric conversion efficiency at present. Implementing effective heat dissipation on the cold side, so that thermoelectric materials can work in the most suitable temperature range. This review is intended to present an account of the recent advances in developing the thermoelectric technologies specially, for direct solar thermal power generation.

Thermoelectric Applications :

Thermoelectric applications are vast. Thermoelectric materials had their first vital long-term test with the start of demanding deep-space research. During the Apollo mission, thermoelectric materials were responsible for the power supply, and currently, radioisotope thermoelectric generators (RTEGs) are the power supplies (350 W) used in deep-space missions beyond Mars. Recently, the Cassini satellite was launched with three RETGs using 238Pu as the thermal energy source and Si-Ge as the thermoelectric conversion material. Smaller self-powered systems such as thermoelectric-powered radios were first mentioned in Russia around 1920; a thermoelectric climate-control system in a 1954 Chrysler automobile shows the scope of this technology. Currently, millions of thermoelectric climate-controlled seats that serve as both seat coolers and seat warmers are being installed in luxury cars. In addition, millions of thermoelectric coolers are used to provide cold beverages. Even wristwatches marketed by Seiko and Citizen and biothermoelectric pace-makers are being powered by the very small temperature differences within the body or between a body and its surroundings.
Thermoelectric materials were previously used primarily in niche applications, but with the advent

of broader automotive applications and the effort to utilize waste-heat-recovery technologies; thermoelectric devices are becoming more prominent. The rising costs of fossil fuels have helped spawn a program between the Energy Efficiency and Renewable Energy office of the US Department of Energy and several automotive manufacturers to incorporate thermoelectric waste-heat-recovery technology in the design of heavy trucks. Indeed, without such systems, more than 60% of the primary energy of fossil fuels is lost worldwide as unusable waste energy; the loss is as high as 70% in some automobiles [12].

Thermoelectric power generation is one of the current interests in clean energy research. Thermoelectric power generation technology has been widely used for many years power generation, heating and cooling applications. Although recent developments in nanotechnology have helped to improve the efficiency of the thermoelectric generators, they are not yet competitive with other electrical energy generation technologies from the efficiency perspective. Thermoelectric efficiency of these generators has generally been limited to about 5% - 6% [2, 11]. However, they are easy to operate, compact, longer-

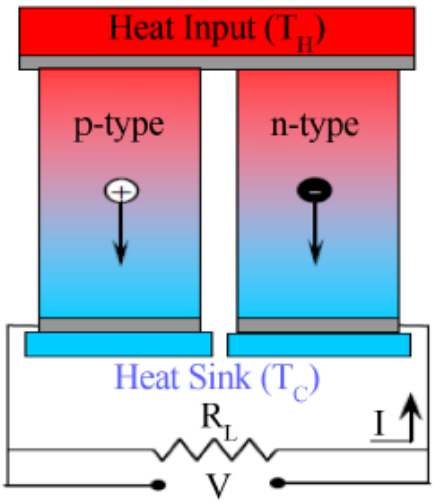

Fig. Arrangement of thermoelectric module for power generation by seeback effect

Fig shows that when the junctions of two dissimilar materials are held at different temperatures (ΔT), a voltage (V) is generated that is proportional to ΔT. The proportionality constant is the Seebeck coefficient or thermo power: $\alpha = -\Delta V/\Delta T$. When the circuit is closed, this couple allows for direct conversion of thermal energy (heat) to electrical energy. The conversion efficiency, ηTE, is related to a quantity called the figure of merit, ZT that is determined by three main material parameters: the thermo power α, the electrical resistivity ρ, and the thermal conductivity κ. Heat is carried by both electrons (ke) and phonons (κph), and k = ke + kph. The quantity ZT itself is defined as

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

where S is the Seebeck Coefficient, σ is electrical conductivity, T is the temperature at which these properties are measured, and κ is thermal conductivity [18].

Solar Thermoelectric Power Generation (STEG):

The rising demand for energy throughout the world has caused great significance to be attached to the exploration of new sources of energy. Among the unconventional sources, solar energy is one of the most promising energy resources on earth and in space, because it is clean and infinite. Applications of solar thermoelectric generator are gorgeous. The use of the solar thermoelectric generator usually combines a solar thermal collector with a thermoelectric generator, which delivers the electric energy. Tirtt et al. [5] reported that the infrared (IR) region of the solar spectrum can supply the needed hot temperature, TH. With regard to solar energy conversion, thermoelectric devices will likely utilize the IR spectrum of solar radiation as shown in Figure 2.

Telkes [7] gave a brief summary of the work in STEGs before 1954, and reported STEGs constructed of ZnSb and Bi-Sb alloys. The maximum efficiency achieved of a flat-panel STEG was 0.63%. Fewer than 50 times optical concentration, the efficiency reached 3.35%. However, these efficiencies may be inaccurate; Telkes

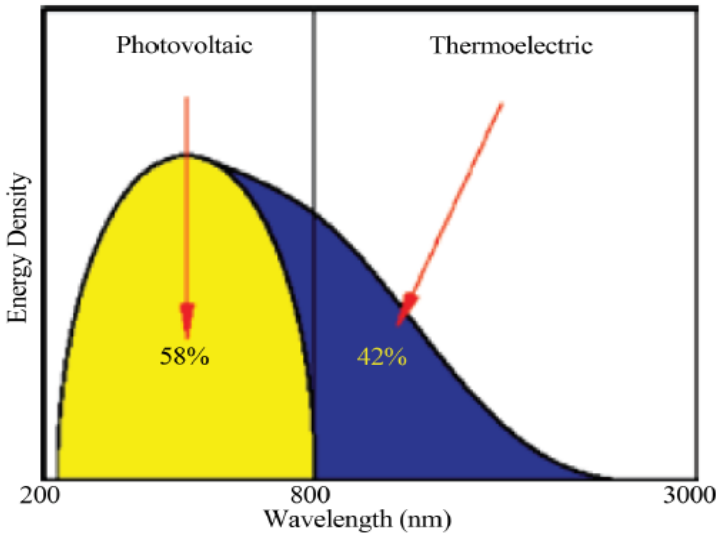

Figure 2. Sun radiates energy as a 6000 K blackbody radia-tor with part of the energy in the ultraviolet (UV) spectrum and part in the infrared (IR) spectrum [3].

A thermodynamic analysis is presented by Amatya et al. [6] for predicting the therm sion efficiency for the generator. With solar concentration of 669 suns, a system efficiency of 3% was measured for a commercial Bi2Te3 module with output power of 1.8 W. Using novel thermoelectric materials such as n-type ErAs: (InGaAs)1-x(InAlAs)x and p-type (AgS-bTe)x(PbSnTe)1-x, a conversion efficiency of 5.6% can be achieved for a STG at 120× suns. Recently, Li et al. [8] proposed an experimental prototype concentration solar thermoelectric generator with improved total conversion efficiency. They developed a theoretical model of the concentration solar thermoelectric generator system to predict system performance based on the best available properties of different bulk thermoelectric materials found in the literature, including Bi2Te3, skutterudite, and silver antimony lead telluride alloys. They showed that the highest possible efficiency of the concentration solar thermoelectric generator can attain 9.8%, 13.5%, and 14.1% for Bi2Te3, skutterudite, and silver antimony lead telluride alloys, respectively. al-to-electrical conver-

Chen [9] investigated the theoretical efficiency of solar thermoelectric generators (STEGs). A model was established including thermal concentration in addition to optical concentration. Based on the model, the maximum efficiency of STEGs is a product of the opto-thermal efficiency and the device efficiency. The device efficiency increases but the opto-thermal efficiency decreases with increasing hot side temperature, leading to an optimal hot-side temperature that maximizes the STEG efficiency. For a given optical concentration ratio, this optimal hot-side temperature depends on the thermoelectric materials' nondimensional figure-of-merit, the optical properties of wavelength-selective surface and the efficiency of the optical system. Operating in an evacuated environment, STEGs can have attractive efficiency with little or no optical concentration working in the low temperature range (150°C - 250°C) for which Bi2Te3- based materials are suitable.

A model of a two-stage semiconductor thermoelectric- generator with external heat-transfer is built by Chen et al. [13]. Performance of the generator, assuming New-ton's heat-transfer law applies, is analyzed using a combination of finite-time thermodynamics and non-equilibrium thermodynamics. The analytical equations about the power output versus the working electrical current, and the thermal efficiency versus working electrical-current are derived. For a fixed total heat-transfer surface-area for two heat-exchangers, the ratio of heat-transfer surface area of the high-temperature side heat-exchanger to the total heat-transfer surface-area of the heat-exchangers is optimized for maximizing the power output and the thermal efficiency of the thermoelectric-generator. For a fixed total number of thermoelectric elements, the ratio of number of thermoelectric elements of the top stage to the total number of thermoelectric elements is also optimized for maximizing both the power output and the thermal efficiency of the thermoelectric-generator. The effects of design factors on the performance are analyzed.

Omer et al. [12] presented a design procedure and thermal performance analysis of a two stage solar energy concentrator suited to combined heat and thermoelectric power generation. The concentrator is comprised of a primary one axis parabolic trough concentrator and a second stage compound parabolic concentrator mounted at the focus of the primary. The thermoelectric device is attached to the absorber plate at the focus of the secondary. A cooling tube is fitted to the cold side of the thermoelectric device to extract the waste heat and maintain a high temperature gradient across the device to improve conversion efficiency. The key requirements of the concentrator design are to be tolerant of tracking misalignment, maintain temperature gradients to suit thermo- electric generation and minimize heat losses. A design methodology is presented which allows interception of rays within an angular region (±δ). The results in a wider receiver for the parabolic trough concentrator would usually be used for a similar concentration ratio. The role of the second stage concentrator in limiting heat losses from the absorber plate is evaluated. Results indicate that in addition to improving the concentration efficiency, the second stage compound parabolic concentrator of the proposed design also inhibits convective air movement and, consequently, improves the overall performance of the solar concentrator.

Thermoelectric Materials :

Thermoelectric material which greatly affects the efficiency is of huge importance for solar thermoelectric power generation. Apart from the large Seebeck coefficient, good electrical conductivity, and small thermal conductivity, the thermoelectric materials must present excellent thermal and chemical stability at high temperature when used under the concentrated solar radiation. A great deal of research on thermoelectric material has been conducted over the past 50 years, and the literature is rich. The three factors α, σ and k are interrelated and make it quite challenging to optimize ZT. High Seebeck coefficients are essential for a good thermoelectric material. Nevertheless, an increase in α is almost always accompanied with a de-crease in σ. Typically semiconductors and semimetals have higher α but lower σ than metals because of their rather lower carrier concentrations At room temperature, T = 300 K, desired values for the thermoelectric parameters are α = 225 μV/K, σ = 105 Ω−1·m−1, and k = 1.5 W/m·K, which results in a ZT ≈ 1. These values are typical for the best TE materials such as Bi2Te3 and Sb2Te3 alloys, which are presently used by industry in devices that operate near room temperature and are well investigated. Current TE devices operate at an efficiency of about 5% - 6%. By increasing ZT by a factor of 4 predicted efficiencies can increase to 30% [4].

In order to achieve a sufficient conversion efficiency η at the given temperature, values of at least ZT ~ 1 are required. The maximum conversion efficiency is ther-modynamically limited by the Carnot efficiency. As was shown by (Yang and Caillat [15]), a figure of Merit in the range of 2 < ZT < 3 results in conversion efficiencies of ~50% of the Carnot efficiency. The real conversion efficiency depends not solely on the materials properties, but also on the construction and geometry of the TE de-vice, as well as on the macroscopic heat and electronic transport. Commercial thermoelectric devices are based on Bi2Te3 because this material exhibits a relatively high figure of Merit. Disadvantages of Bi2Te3 compounds are their limited chemical stability at high temperatures in air and their toxicity.

Current thermoelectric materials, as shown in Figure 3 [5], have ZT = 1, and new materials with ZT values of 2 - 3 are required to provide the desired conversion efficiencies. The current materials exhibit conversion efficiencies of 7% - 8% depending on the specific materials and the temperature differences involved. With regard to solar energy conversion, thermoelectric devices will likely utilize the IR spectrum of solar radiation. For example, a thermoelectric power conversion device with ZT = 3 operating between 500°C and 30°C (room temperature) would yield about 50% of the Carnot efficiency.

Tirtt et al. [16] proved that a value of ZT > 4 does not significantly increase the conversion efficiency over that of a material with ZT = 2 - 3.5 Therefore, they believed that the “Holy Grail” of thermoelectric materials research is to find bulk materials (both n-type and p-type) with a ZT value on the order of 2 - 3 (efficiency = 15% - 20%) with low parasitic losses (e.g., contact resistance, radiation effects, and inter diffusion of the metals) and low manufacturing costs. With respect to solar energy, these materials would need to operate at about 1000 K (≈700°C).

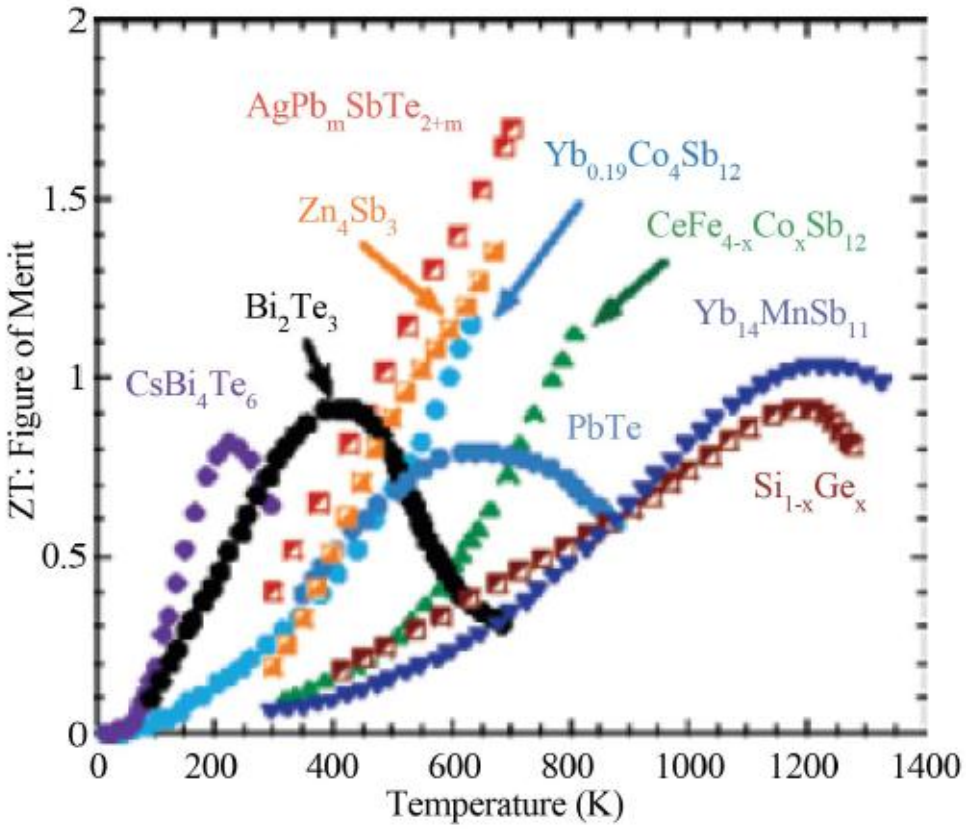

Figure 3. Figure of merit (*ZT*) as a function of temperature for several high-efficiency bulk thermoelectric materials [14].

The Future of Thermoelectric Materials :

The future growth of thermoelectric energy conversion technologies is tied primarily to enhanced materials performance along with better thermal management design. The best thermoelectric material should behave as a so-called phonon-glass-electron-crystal; that is, it should minimally scatter electrons, as in a crystalline material, whereas it should highly scatter phonons, as in an amorphous material. Materials researchers are now investigating several systems of materials including typical narrow-band gap semiconductors (half-Heusler alloys), oxides, and cage-structure materials (skutterudites and clathrates). More exotic structures that exhibit reduced dimensionality and nanostructures have been the focus of much recent research, including super lattices, quantum dots, and nanodot bulk materials. Also, recent progress in nano composites, mixtures of nano materials in a bulk matrix, has generated much interest and hope for these materials. The emerging field of these thermoelectric nano composites appears to be one of the most promising recent research directions. Such nano composites could allow for higher ZT values by reducing thermal conductivity while maintaining favorable electronic properties. With new higher efficiency materials, the field of harvesting waste energy through thermoelectric devices will become more common.

The most stable, long-term, and readily available worldwide energy source is that of solar energy. The issue has always been low-cost transformation and storage. Other alternative energy technologies such as fuel cells, wind energy, and thermoelectric will provide some assistance in meeting our future energy needs. Many hybrid systems will be needed, and thermoelectric is able to work in tandem with many of these other technologies, especially solar as it can use the heat source provided by solar radiation. Over the past decade, thermoelectric materials have been developed with ZT values that are a factor of 2 larger than those of previous materials. An-other 50% increase in ZT (to ZT ≈ 3) with the appropriate material characteristics and costs will position thermoelectric to be a significant contributor to our energy needs, especially in waste heat or solar energy conversion. The likelihood of achieving these goals appears to be within reach in the next several years. Furthermore, some contribution from many of these alternative energy technologies

such as thermoelectric will be needed in order to fulfill the world's future energy needs.

Conclusion:

It is observed that more concentrated efforts are required to develop direct solar thermal power generation technologies, for practical utilization of direct conversion of solar heat into electricity more research & development activity should be planned & implemented, further technological enhancement in the field of thermoelectric. There is immense potential of thermoelectric potential for converting waste heat produced from steam condenser furnaces and solar water heater in summer season.

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Operating variables- Temperature difference between hot junction and cold junction,
Temperature range at input or thermoelectric material melting point, temperature or sustainable temperature limit of materials, Variation in material properties electrical as well as heat transfer as per temperature change, Design heat input source variation such as hot water, hot gases, and direct flame and heat sink at cold junction using cold water, cold air and direct contact with ice. Effect of humidity variation at hot junction and cold junction. Effect of variation in figure of merit as per the operating temperature range, manufacturing techniques used to design and development of hot & cold junction.

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Design of Experiment for Solar Water Heater Performance Analysis

Mr. M.V. Kulkarni[1], Dr. D. S Deshmukh[2],

[1] Asst. Professor, Department of Mechanical Engineering,
SSBT'S COLLEGE OF ENGINEERING AND TECHNOLOGY,
BAMBHORI, JALGAON - 425 001 (MS)

[2]H.O.D., Mechanical Engineering,
SSBT's COLLEGE OF ENGINEERING AND TECHNOLOGY,
BAMBHORI, JALGAON - 425 001 (MS)

ABSTRACT: There are several studies carried out by scholars to improve the performance of the solar water heater collector in the recent times. The specific objective of this paper is to design performance parameters measuring and testing technique for solar water heater and method that can improve the efficiency of the solar water heater collector. There are number of collector models available in the market for improving the efficiency of solar water heating system requires some unified approach or testing method that will compare and determine the performance of different solar water heating collector models under similar climatic and operating conditions. In this paper more concentration is given on factors affecting the performance of solar water heater collector such as temperature difference, solar radiation, and incoming cold water temperature. Available techniques to reduce different thermal losses are briefly discussed in this work.

Abbreviations

SWH	Solar Water Heater
FPC	Flat Plate Collector
Q	The energy absorbed by the collector
G	Total solar radiation intensity
η	Collector efficiency
T_a	ambient temperature
TES	Thermal Energy Storage
m	The fluid flow rate
T_i & T_o	The fluid inlet and outlet temperature of collector The principle
V	Wind speed

INTRODUCTION

A solar water heater consists of a collector to collect solar energy and an insulated storage tank to store hot water. The solar energy incident on the absorber panel coated with selected coating transfers the heat to the riser pipes underneath the absorber panel. The water passing through the risers get heated up and is delivered the storage tank. The recirculation of the same water through absorber panel in the collector raises the temperature to 80 C (Maximum) in a good sunny day. The total system with solar collector, storage tank and pipelines is called solar hot water system.

Broadly, the solar water heating systems are of two categories. They are : closed loop system and open loop system. In the first one, heat exchangers are installed to protect the system from hard water obtained from borewells or from freezing temperatures in the cold regions. In the other type, either thermosyphon or forced circulation system, the water in the system is open to the atmosphere at one point or other. The thermosyphon systems are simple and relatively inexpensive. They are suitable for domestic and small institutional systems, provided the water is

Treated and potable in quality. The forced circulation systems employ electrical pumps to circulate the water through collectors and storage tanks.

The choice of system depends on heat requirement, weather conditions, heat transfer fluid quality, space availability, annual solar radiation, etc. The SHW systems are economical, pollution free and easy for operation in warm countries like ours. [1]

Based on the collector system, solar water heaters can be of two types.

- **Flat Plate Collectors (FPC) based Solar Water Heaters**

The solar radiation is absorbed by Flat Plate Collectors which consist of an insulated outer metallic box covered on the top with glass sheet. Inside there are blackened metallic absorber (selectively coated) sheets with built in channels or riser tubes to carry water. The absorber absorbs the solar radiation and transfers the heat to the flowing water.

Solar water heating is now a mature technology. Wide spread utilization of solar water heaters can reduce a significant portion of the conventional energy being used for heating water in homes, factories and other commercial and institutional establishments. Internationally the market for solar water heaters has expanded significantly during the last decade. [2]

INTRODUCTION TO COLLECTOR TESTING

The performance of solar heating systems depends largely on the performance of the solar collectors employed, and it is therefore particularly important for researchers to know how well a collector will perform. The measurement of collector efficiencies has been shown to require specialized facilities and careful experimental practices if it is to be performed accurately. As a result to develop Standards in the field of solar collector testing.

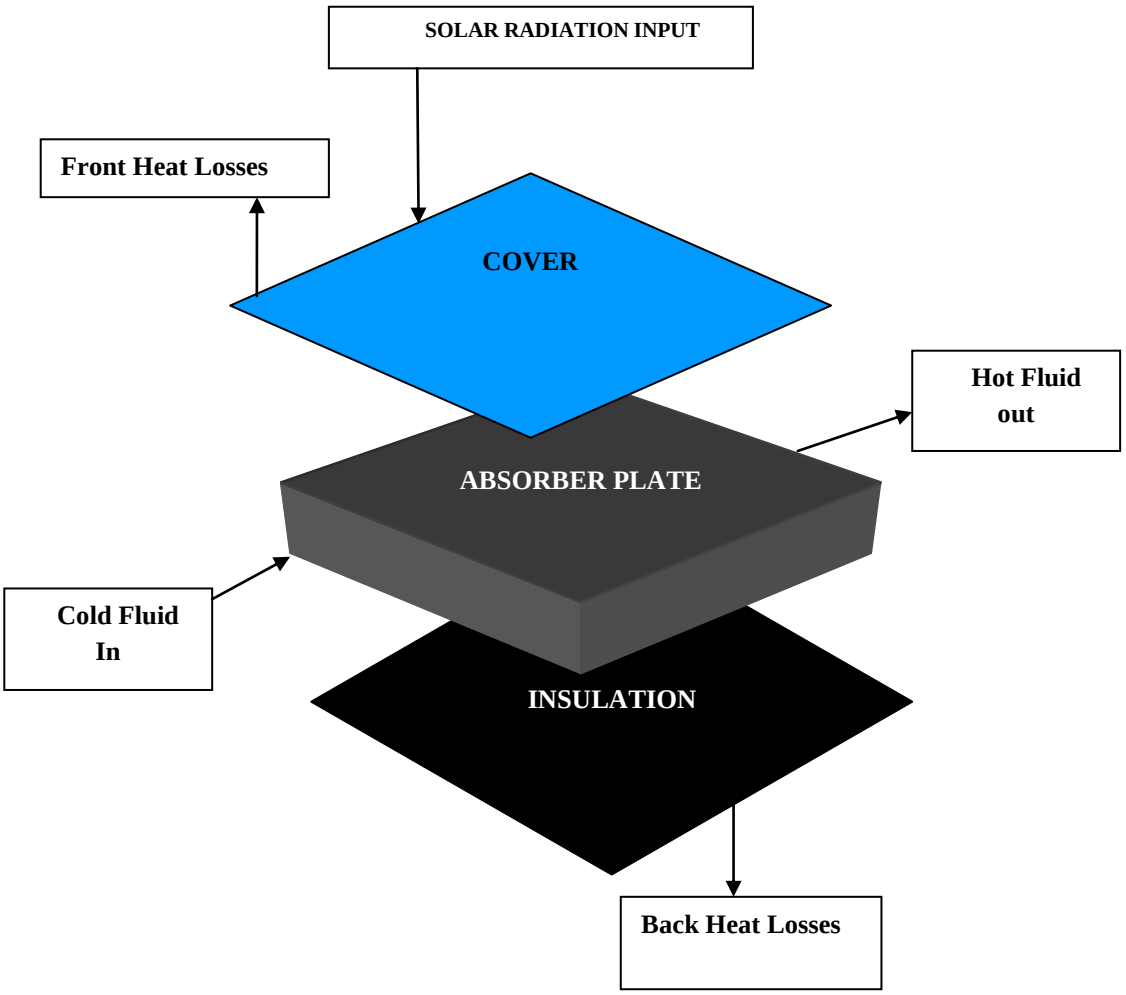

Figure 1: The Flat Plate Solar Collector

A solar collector is required to absorb solar radiation and to transfer the absorbed energy into a heat transfer fluid with a minimum of heat loss. In assessing the performance of a collector it is therefore important both to determine its ability to absorb solar radiation and to characterise its heat losses. The principal components and losses are shown in Figure 1.

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

FACTOR AFFECTS EFFICIENCY OF A FLAT PLATE COLLECTOR

Efficiency of flat plate collector can be improve by

1. Increase transmission of energy through the collector to the working fluid by
   a. Improve transparent covers
   b. Improve absorber plate to incident solar radiation
   c. Improve heat transfer coefficient from absorbing surface to the working fluid

2. Reducing thermal losses from absorber plate to outside air. This can be minimize by reducing conductive, convective and radiation losses

   a. Conduction losses: A collector loses heat from its front, its back and its sides. The back and side losses from a flat plate collector can be minimized by the use of insulation.
   b. Convection & Radiation losses: The heat losses from the front of a flat plate collector are usually the largest component of the overall heat losses. They occur in the form of convection and thermal radiation from the front cover to the environment and can be reduced by designing the collector in such a way that the temperature of the front cover is kept low. This can be achieved by minimizing the heat transfer between the absorber and the outer cover. The convective heat transfer between the absorber and the outer cover can be reduced by using a multiple glazing system or by evacuating the space over the absorber. The radiative heat transfer from the absorber to the cover can be reduced by the use of selective surfaces.

3. The heat loss coefficient of a collector increases with collector operating temperature and with the local wind speed

TESTING PROCEDURE

Standardized testing and rating procedure provides a basis for comparing the efficiency of different type of collector also it is basis for selection of a solar collector for given application as well as their design improvement. The main functions of collector testing are

1. To get requisite data for predicting the performance of solar collector system in given meteorological condition.
2. To get requisite data to study and develop the design of solar water heater collector
3. To compare performance of different design solar collector for their better commercial use
4. To get performance standard.

Test set up consisting of flat plate collector under test, a liquid pump, a heat exchanger with a cooling coil and a storage tank with an electric immersion heater. A bypass is provided for control mass flow rate. The purpose of heat exchanger with a cooling coil is to remove heat. Thus the combination of storage tank with electric heater and heat exchanger provides a mean for adjusting the fluid inlet temperature to collector to a desire value.

There are number of collector models appearing in the market for improving the efficiency of solar water heating system requires some unified approach or testing method that will compare and determine the performance of different solar water heating collector models under given climatic and operating conditions.

On any given day data is recorded under steady state condition for fixed value of m and $T_{i,}$ for each set of fixed value number of test be conducted symmetrically. The principle measurements made in each data set are the fluid flow rate m, the fluid inlet and outlet temperature of collector (T_i & T_o), the solar radiation incident on the collector plane (G), the ambient temperature T_a and wind speed V. The efficiency of solar collector is given by

Collector Efficiency Collector panel efficiency is the ratio between the rates of heat (Q) is transferred to a fluid divided by solar radiation on the cover plate.

$$\eta = \frac{Q}{A\,G}$$

$$\eta = \frac{mC_p(T_{out} - T_{in})}{A\,G}$$

Description: Q = The energy absorbed by the collector, (W/m^2)
A = Area of the collector, (m^2) , G = Total solar radiation intensity (W/m^2)
T_{in} & T_{out} = The temperature of the incoming & outgoing water (^0C)

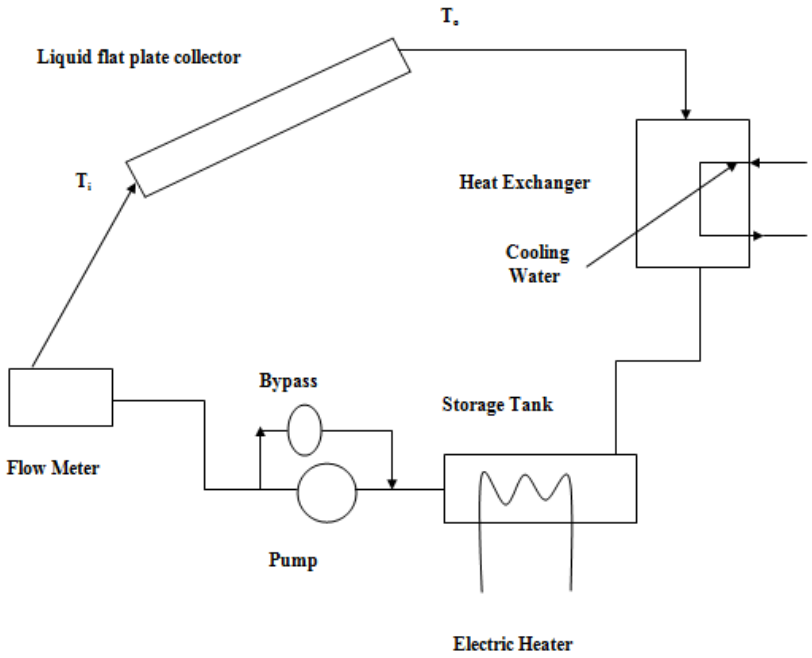

Figure 2 Closed loops set up for testing flat collector

INSTRUMENTATION FOR USE IN COLLECTOR TESTING

Solar Radiation Measurement

Pyranometer

A pyranometer is an instrument for measuring the solar irradiance from a solid angle of 2π on a plane surface. When the solar radiation coming from the solid angle of the sun's disk is obscured from the instrument, a pyranometer can be used to determine the diffuse solar irradiance on a plane surface.

Thermal Radiation Measurement

Thermal radiation measurements are less important than solar radiation measurements for the determination of collector efficiencies, and are usually neglected outdoors. However, in solar simulators and indoor heat loss testing it is often necessary to make performance corrections for excess thermal irradiance when comparing results with those from outdoor testing.

Pyrgeometer

Thermal irradiance (wavelengths > 4 um) from a hemispherical field of view may be measured using a pyrgeometer. This is an instrument rather like a pyranometer, but protected by a dome which is transparent only to thermal radiation in place of the glass domes used on a pyranometer.

Angle of Incidence of Direct Solar Radiation

Required Accuracy
The angle of incidence of direct solar radiation at the collector plane should be determined to ensure that it is less than 40° during the collector test period. For most purposes an accuracy of ± 5° is adequate although ± 1° is desirable when measuring incidence angle modifiers.

Temperature Measurement

Three temperature measurements are required for solar collector testing. These are the fluid inlet temperature of the collector, the fluid temperature difference between the outlet and inlet of the Collector and the ambient air temperature. The required accuracy and the environment for these Measurements are different and hence the transducer and associated equipment may be different.

Mercury in Glass Thermometers

Mercury in glass thermometers are required mainly for calibration purposes and are available graduated at 0.1°C or 0.05°C intervals. The range of calibration reference thermometers is usually

small (typically 30°C), and hence more than one thermometer may be needed.

Measurement of Heat Transfer Fluid Temperature Difference (ΔT)

The temperature difference between the collector outlet and inlet needs to be measured to an accuracy of ± 0.1 K in order to achieve ±1% accuracy for temperature differences of 10 K. Accuracies approaching ±0.02 K can however be achieved with modern well matched and calibrated transducers, and hence it is possible to measure temperature differences down to 1 or 2 K with a reasonable accuracy.

Transducer Arrangements and Calibration Checks

Platinum Resistance Thermometers Platinum resistance thermometers (PRTs) may be arranged Differentially to measure temperature difference. A matched pair of PRTs is required with some instruments, whilst in others the matching can be accomplished during calibration by a simple adjustment to the equipment. A zero check for PRTs should be performed regularly by placing both PRTs in a well stirred fluid bath at several temperatures spaced over the operating range.

Measurement of Surrounding Air Temperature (Ta)

Required Accuracy

The ambient or surrounding air temperature should be measured to an accuracy of ±0.5°C.

Mounting of Sensors

For outdoor measurements the transducer should be shaded from direct and reflected solar radiation by means of a white painted, well ventilated shelter, such as a meteorological screen, or by two concentric vertical metal pipes. The shelter should be placed at the mid-height of the collector but at least 1 metre above the local ground surface to ensure that it is away from the influences of ground heating. The shelter should be positioned to one side of the collector within 10 metres of it.

Fluid Flow rate Measurement

Weighing Devices

A simple and accurate method of determining the fluid flow rate is to divert the fluid, downstream of the collector, into a vessel and to measure the mass of fluid delivered during a measured time period. When performing such measurements at high temperature, weighing vessels should be covered to minimize errors caused by evaporation.

Air Speed Measuring Instruments

Cup Anemometers

A cup anemometer is a device for measuring the total horizontal component of air speed and is suitable for outdoor collector testing when no forced air movement is employed. A cup anemometer does not indicate the direction of the air movement.

Table no. 1: List of Instruments to be used in Collector Testing

Sr. No.	Experimental Variable	Units	Precision
1	Global Radiation on collector plate	W/m^2	± 50 W/m^2
2	Angle of Incidence (measured or calculated)	Degree	± 5 Degree
3	Thermal Irradiance	W/m^2	± 10 W/m^2
4	Surrounding Air Speed	m/sec	± 0.5 m/sec
5	Fluid Inlet Temperature	^{0} C	± 0.1^0 C
6	Ambient Air Temperature	^{0} C	± 1^0 C
7	Difference between Fluid Outlet Temperature and Fluid Inlet Temperature	^{0} C	± 0.1^0 C
8	Mass Flow rate of Heat transfer fluid	kg/sec	± 1 %

CONCLUSION

Solar water heater performance is a topic of never-ending discussion in the solar renewable energy field. While the performance of solar water heater systems is at par, still there is scope of performance improvement. In order to assure certain quality for solar water heater systems, it is necessary to design standards, conduct tests to verify compliance of these standards. In this paper solar water heater performances parameters are discussed which would be useful to optimize and compare various solar water collectors. It would provide information to consumers regarding performance of the solar water heater. There is wide scope in research and development of solar water heater to enhance performance by increase transmission of energy through the collector to the working fluid also reduces thermal losses.

Evacuated tube collectors have lower thermal losses as compared to flat plate collector and hence are less affected by ambient conditions. Instead of conducting the tests for the whole year, the tests can be conducted for about fifteen days and the results should be extrapolated to obtain annual performance.

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Modeling and Evaluation of Interline Dynamic Voltage Restorer for Distribution System

Gauri S. Sarode
ME scholar, SSBT's COET
Jalgaon-425001
Ph. No.-7875088293
sgauri.sarode@gmail.com

Dr. Paresh J. Shah
Professor, SSBT's COET
Jalgaon-425001
Ph. No.-8237466370
pjshahj@yahoo.com

Dr. Rakesh K. Saxena
Professor, SGSITS
Indore-452003
Ph. No.-9425068030
rakeshsaxena@hotmail.com

ABSTRACT: In this paper, a new topology based on a space vector pulse width modulation inverter is proposed for three phase interline dynamic voltage restorer (IDVR). This topology generates less harmonic distortion in both output voltage and current and provides a more efficient use of the supply voltage in comparison with other modulation techniques. SVPWM provides a constant switching frequency as a result of this switching frequency can be adjusted easily. The control topology is properly able to compensate voltage sag and swell. The IDVR consist of several DVRs connected with common DC-bus. When one of the distribution feeder inverter are subjected by voltage sag/swell then this feeder inverter operates on voltage control mode and other feeders inverter operates on power flow control mode. It is obvious that the proposed topology would not face any difficulties in long duration compensation due to the fact that it provides the required energy directly from other feeder. The proposed system has been validated through detailed simulation studies in MATLAB/SIMULATION software.

Key words- DVR, IDVR, SVPWM, DC-link

I. INTRODUCTION

Power quality is define as any power problem manifested in voltage, current, or frequency deviations that results in failure or misoperation of customer equipment [1]. Power Quality issues often arise in distribution networks due to the presence of a non-negligible number of large loads as a result of this it is necessary to use high quality of power. High quality of power is achieved by compensating the various power line disturbances like voltage sag/swell, harmonics, interruption and unbalance [2]. For compensation the various devices such as static synchronous compensator, flywheel, uninterruptable power supplies (UPS), dynamic voltage restorer, tap changing transformer are used. DVR is one of the technically advance device to compensate voltage disturbances in distribution system.

DVR is economically feasible device in voltage sag/swell compensation in distribution system. DVR is series compensation device it inject the voltage in series with three phase source voltage. Basically the voltage sag compensation involves real and reactive power injection to the distribution system. For injection of real power DVR required energy storage device [3]. This energy storage device is necessary to meet real power requirement of the system. Capability of the DVR is decided by this energy storage device. Its limits the capability of DVR during long duration voltage sag. This limitation is overcome in proposed system.

Interline dynamic voltage restorer proposed in this paper works in long duration voltage disturbances [4]. In IDVR system when one of the DVR is operated in voltage control mode, then other DVR is operated on power flow control mode to replenish the energy in the common dc-link energy storage dynamically.

II. OPERATING PRINCIPLE OF IDVR

Interline dynamic voltage restorer is a power electronic converter based series compensator that can protect sensitive loads from all supply side disturbances other than outages. Interline dynamic voltage restorer (IDVR) playing a most significant role in mitigating long duration voltage sag in distribution system. The IDVR system consists of several DVRs in different feeders sharing a common dc link [5].

Fig.1 illustrated IDVR system for two independent feeders originating from two grid substation. These two independent feeders can be of the same voltage magnitude or different voltage magnitude level. When one of the DVRs compensates for voltage sag, then the other DVR in IDVR system operates in power-flow control mode to refill dc link energy storage which is exhausted due to the real power taken by the DVR working in the voltage-sag compensation mode. Due to larger electrical distance between the two feeders it is realistic to assume that the voltage sag in Feeder 1 would have a lesser impact on Feeder 2 [6].therefore the two independent sourcesV1 and

V2 having impedances as Z1 and Z2 respectively are show in Fig. 1. It is very unusual to occur fault on both feeders simultaneously. Each DVR are capable of working in both power and voltage control mode. When one of the feeder experience voltage sag then only one DVR is in active mode and the inverter operating in voltage control mode. By comparing the reference load voltage (Vref) and desired set point voltage.

The injected reference voltage is generated by voltage controller in control system along with phase and magnitude. These generated reference voltage is injected to line one and other DVR replenish the DC link voltage to maintain the energy capability of the unit constant. Consider a load connected across feeder 2 while feeder 1 is at its normal level, once voltage sag experienced by feeder 2 reference signal is generated from feeder 2 and fed it to controller, inverter 2 is switched to voltage control mode to compensate the voltage sag and same time feeder 2 draw a power from DC link during injection of power to feeder 2 DC link voltage is maintained constant by the inverter 1. This can be accomplished by using proportional integral derivative (PID) controller [8-10]. These controller help to calculate the error value as the difference between measured process voltage and desired set point voltage.

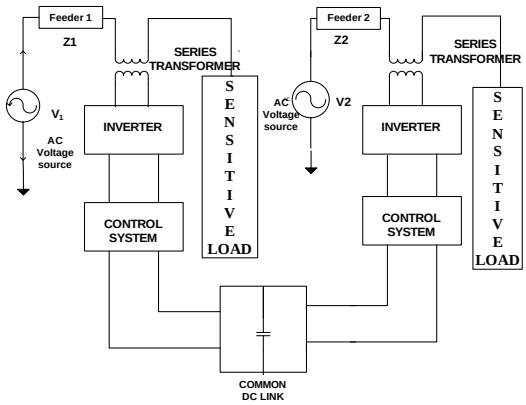


Fig.1. Interline dynamic voltage restorer

III. SPACE VECTOR PULSE WIDTH MODULATED INVERTER

Space Vector pulse width modulation (SVPWM) is the admired PWM method and the advantageous in all the PWM techniques as it generates higher voltages with low total harmonic distortion. Space Vector Pulse width Modulation generates the suitable gate drive waveform for each PWM cycle. The inverter is treated as one single unit and also combines different switching states. For each of these states unique switching time calculations is provided by the SVPWM. The sector that form one triangle will provide duty cycle time for each of them, giving the desired voltage vector (Vref).

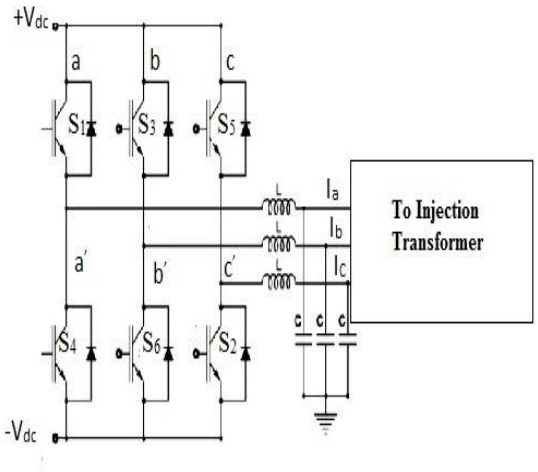


Fig.2. Three-leg voltage source inverter

The schematic diagram of three phase voltage source inverter is as shown in Fig. 2, having six switches, these are classified as 1, 3, 5 are positive grouping switches and 2, 4, 6 are negative grouping switches [11, 12]. These switches forms eight different states in which two are null or zero state and other 6 are active states used to control inverter output and frequency. The main function of space vector PWM technique is to approximate the reference voltage vector Vref using the eight switching states as shown in Fig. 3.

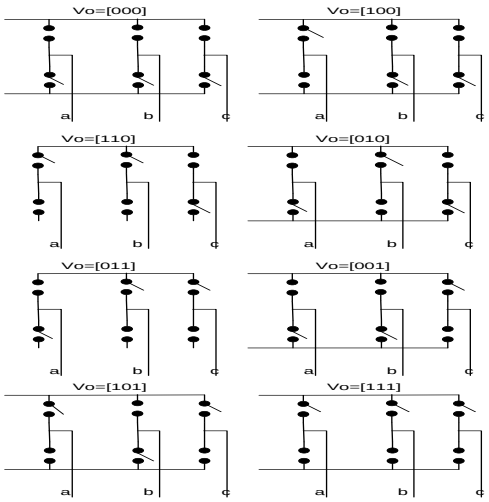


Fig.3. eight switching states of inverter

By generating the average output of the inverter in a small period one can approximate the reference voltage vector, which is equal to time duration T in the same period. Therefore, space

vector PWM can be implemented by the following steps:
Step 1: determination of V_d, V_q, V_{ref} and angle
Step 2: determination of time duration T_1, T_2, T_0
Step 3: determination of switching time of each transistor

The very important point will using SVPWM method is that the use of dq0 transformation or αβ transformation is necessary for obtaining information regarding phase shift. The dq0 transformation is illustrated in equation 1

$$\begin{bmatrix} Vd \\ Vq \\ Vo \end{bmatrix} = \begin{bmatrix} \cos\theta & \cos\left(\theta - \frac{2\pi}{3}\right) & 1 \\ -\sin\theta & -\sin\left(\theta - \frac{2\pi}{3}\right) & 1 \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix} \begin{bmatrix} Va \\ Vb \\ Vc \end{bmatrix} \quad (1)$$

All six sectors in SVPWM forms hexagon are shown in Fig. 4. A set of three vectors that forms triangle are used to defined instantaneous space vectors of the voltages and currents at the input and output of the inverter [13].

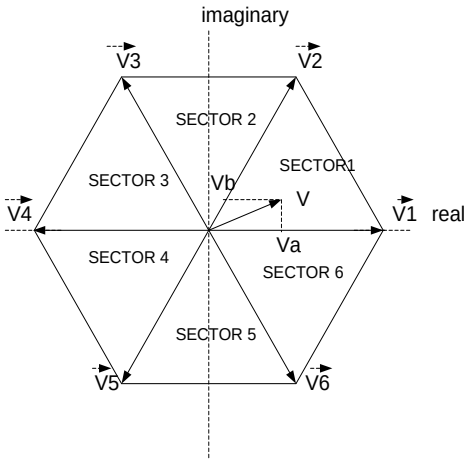


Fig.4 Hexagonal representation of vector

The eight voltage vector V_0=[000],…….V_7=[111] are corresponding to S_0,……,S_7 respectively. The length of the vectors V_1 to V_6 are unity and V_0 and V_7 are zero. Important rules while using space vector are given in equation 2.

$$V_1 = -V_4$$
$$V_2 = -V_5$$
$$V_3 = -V_6$$
$$V_0 = V_7 = 0$$
$$V_1 + V_3 + V_5 = 0 \quad (2)$$

The output voltage vector in one sampling interval is given by equation 3

$$V(t) = \frac{t0}{Ts} Vo + \frac{t1}{Ts} V1 + \cdots + \frac{t7}{Ts} V7 \quad (3)$$

Where,
t0, t_1,……, t_7 are the turn on time of the vectors V_1, V_2,…,V_7.

Sampling time equation is,

$$\sum_{i=0}^{7} ti = Ts$$

Where t_0,t_1,…...,t_7>0.

Vector V_a and V_b determine by equation 4.

$$V_b = \frac{T2}{TS} \quad , \quad V_a = \frac{T1}{Ts} \quad (4)$$

Where the V_a and V_b is shown in Fig. 5

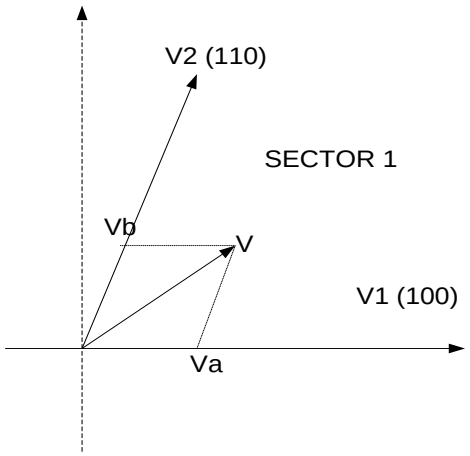


Fig.5. Reference voltage generation in sector one space vector

Where, T_s is half of PWM period, T_1 and T_2 are the duration of vector V_1 and V_2 respectively in half PWM period. The rest of the period (T_s-T_1-T_2) is the duration for the zero vectors. By using reference voltage V_{ref} the values of T_1 and T_2 are calculated.

Vector V for one sampling time is expressed in equation 5.

$$V = \frac{T1}{TS} V1 = \frac{T2}{Ts} V2 + \frac{To}{Ts} Vo \quad (5)$$

VI. SIMULATION AND RESULTS OF IDVR SYSTEM

The IDVR system is designed using MATLAB/SIMULINK software in Fig.8. IDVR system design using feeders, two DVRs with

different ratings, control system, inverters. The dq0 transformation is used to calculate angel α for selection of space vector. This angle α selects the useful sectors. Selection of sector is useful in calculation of the switching time and the switching pulses. This will give the triggering signal to inverter gate terminal. Output signal of inverter is injected in series with the three phase AC supply to compensate voltage sag with the help of injection transformer.

The IDVR model in fig.8 is designed for two line system with different rating. The first feeder is designed for 33KV, 50Hz and second feeder is designed for 66KV, 50 Hz. In simulation model 27% voltage sag is created in feeder 1 then with the help of reference generator the information regarding voltage is send to SVPWM model where the reference voltage time period and phase shift information is calculated with the help of switching time generator and switching pulse generator. The output of this SVPWM block is given to inverter which converters output DC in to AC. After that inverter output can be injected in series with incoming AC supply voltage. To maintain load voltage constant at the same time feeder 2 helps to maintain dc-link voltage constant. In simulation model the dc-link storage of 35 KV is used to compensate voltage sag of both the feeders.

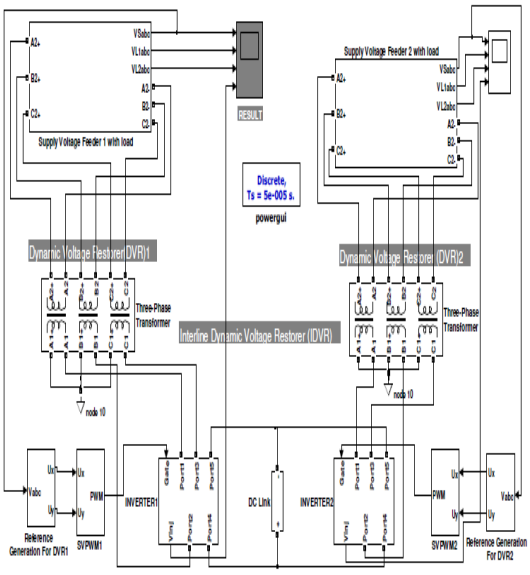


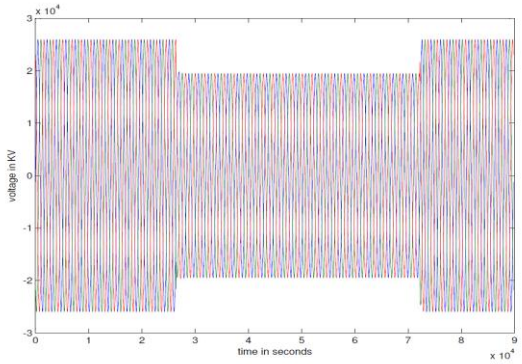
Fig.6. Simulation of IDVR system based on SVPWM technique

To study the efficiency of suggested control strategy, the system parameters and constant value are listed in table I. the results of most important simulation are represented in fig.9

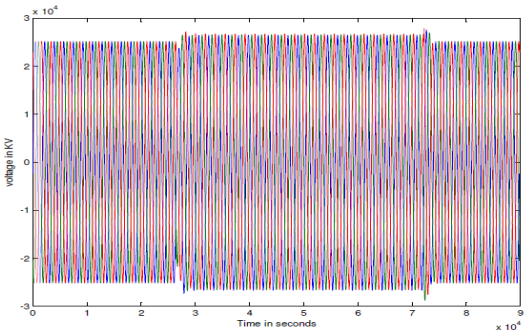
Table I. System parameter and constant values

supply voltage of feeder1(ph-ph)	33000V
Supply voltage of feeder 2(ph-ph)	66000V
dc-link capacity	35000V
Injection transformer turn ratio	1:1
Frequency	50 Hz
resistance of feeder1	0.1Ω
inductance of feeder1	1.0001e-6
Line resistance	4Ω
Line impedance	110e-3
Resistance of feeder 2	500Ω
Impedance of feeder2	800e-3
Voltage sag on feeder1	27%

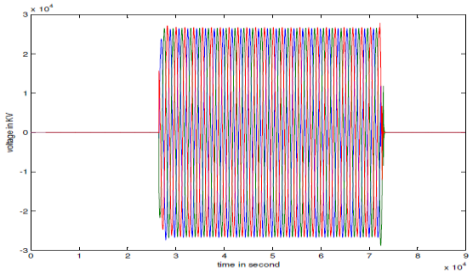
Fig.9. shows the voltage sag compensation by IDVR system. Fig. 9(a) shows the 27% of voltage sag initiated at 300ms and it is continuing up to 800ms. Fig. 9(b) shows that the voltage sag is compensated by IDVR system successfully and the system load voltage is kept constant. Because of injection of voltage in series with the supply voltage through injection transformer the output load voltage at load terminal is constant. Injected load voltage is shown in Fig. 9(d) and fig. 9(c) shows the replenishment of voltage by DVR 2 in the DC- link.



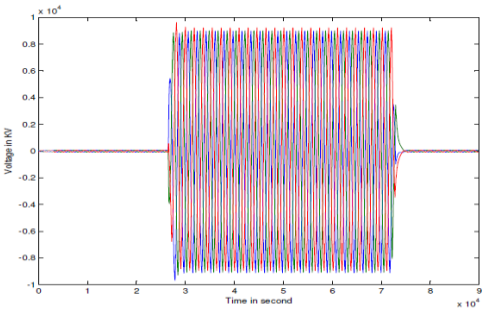
(a) Uncompensated voltage



(b) Compensated voltage



(c) Voltage across load 2



(d) Injected voltage

Fig.7.Voltage sag compensation by using IDVR system

CONCLUSION-

The modelling and simulation of IDVR system using MATLAB/SIMULIK has been presented. The simulation results showed clearly the performance of the DVR in mitigating voltage sags. The IDVR handled multi-feeder voltage sag without any difficulties and injected the appropriate voltage component to correct rapidly any anomaly in the supply voltage to keep load voltage balanced and constant at nominal value. The proposed topology mitigates the voltage sag of about 27% efficiently.

The efficiency and the effectiveness in voltage sags compensation showed by the IDVR system makes it an interesting power quality device compared to other custom devices. The results of the MATLAB/SIMULINK simulation and experimental verification also verify the proposed control algorithm based on space vector pulse width modulation technique to generate the pulses for mitigating voltage sag.

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Over Head Transmission Lines Live Line Maintenance Techniques Based on Condition Monitoring in Indian Power Scenario

P. P.Mawle ,
Assistant Director, National Power Training Institute (WR), Nagpur, (M. S.), India, Email: ppmawle@yahoo.com,

Dr. K.B.Porate,
Associate Professor, Priyadarshini College of Engg. Nagpur, (M. S.), India, Email: kporate@yahoo.com

Dr. P.G.Burade,
Associate Professor, Associate Professor, ITMCOE, Nagpur,(M.S.)India. Email: prakash.burade@gmail.com

ABSTRACT: This paper presents a Live Line Maintenance Technique (LLMT) for overhead lines based on condition monitoring to maintain system reliability. Owing to rising global electricity consumption, population growth, access to better standards of living, rising to industrial production, power grid must be expanded and strengthened to accommodate these needs. A quantitative relationship between the condition monitoring data and failure rate of overhead lines is established. Indian power system is characterized by continuous expansion of the grid in the range of 35- 40% per year for meeting the rising energy demands. Many new technologies have been implemented by POWERGRID in India to ensure preventive maintenance and quick restoration of faulty system. Condition monitoring & data monitoring gives the location, situation and quantified the severity of maintenance for each line. Some of major technologies are Regular Inspection and Preventive Maintenance, Condition Based Monitoring and Diagnostic Techniques. Maintenance in ranking order is created using the benefit/cost ratio index. The proposed strategy can provide better reliability at the lowest maintenance cost. In India LLMT maintenance strategy depending on data monitoring is decided for continuity of supply without failure by maintaining safety, as no shut down/outages required. LLMT improves the dielectric strength of insulators and insulator strings, this increases the life of insulators, transmission line and substation equipments. The paper presents possible works in live technologies for OHLs. All Live methods included in maintenance to avoid the outages of the line. The new tools and technologies developed are briefly discussed.

KEYWORDS: Live Line Maintenance Technique, Condition monitoring data, reliability centred maintenance,* overhead lines*, and unscheduled interchange.

I. INTRODUCTION:

Increasing grid connectivity is accompanied with various factors viz. wide variation in generation as well as loads on daily/seasonal basis, spread of the grid geographically, multi direction flow of power, open access, unscheduled interchange (UI) and the need for economic dispatch. Thus it is necessitates reliable and secure grid with continuous quality power supply [8]. Extra and ultra high voltage transmission lines have been developed worldwide and are successfully being operated in developed nations. Recent trends in Indian transmission scenario are progressing towards establishing 765 KV lines to strengthen its transmission infrastructure. Massive expansion of inter-state transmission system is under way to cater to the transmission requirement of new generation projects. With rising global electricity consumption – population growth Grid strive to maximize supplies, minimize energy losses and keep costs down through energy efficiency and continuous R&D programs [11].Grid meets these energy needs with a full range of solutions and services for long-distance transmission at voltages up to 1200Kv. Transmitting electricity at high voltage & extra high voltages reduces the fraction of energy lost to resistance, which varies depending on the specific conductors, the current flowing, and the length of the transmission line.

In India Having a large amount of old aging transmission system life & aging equipment results in higher probabilities of failure, higher maintenance cost & higher replacement cost.

Aging equipment will have to be replaced; this replacement should be planned in coordination with capacity additions [13]. Dynamic state of the grid on real-time basis in terms of i) Angular and voltage stability ii) Level of increase in transfer capacity of various transmission elements a different instances iii) Control and regulation of power flow to maintain grid parameters iv) Remedial Action Scheme (RAS) and System Integrated Protection Scheme (SIPS) in the event of severe contingency in the grid must be known. Smart Grid technology is used to achieve advanced asset management (AAM) [1], with the development of computers, sensors and other advanced monitoring technologies, conditions of overhead lines can be consistently monitored and condition-based maintenance (CBM) can be implemented. The condition of each item will impact the overall condition of system equipments. This can enhance asset utilization efficiency and improve system reliability. Scheduling of maintenance will greatly affect reliability and economy of power system [2].An overhead line includes tower foundations, tower structures, conductors, insulators, fittings, grounding devices, auxiliary facilities and surroundings. The monitoring technologies for all the items of overhead lines have been developed and successfully applied. Many items (such as insulators, conductors and fittings) can be continuously monitored online [3]–[7]. Although the conditions of foundations, tower structures, auxiliary facilities and surroundings still basically rely on human's inspections, various hand-carrying instruments can be utilized during inspection tours [9]. Actually, aerial inspections have been applied widely in utilities. The monitoring and inspection for individual items of overhead line can provide the useful information on the condition of different parts of overhead line. Various Live line maintenance works were done using Live technologies from insulators replacement to complex reparation works were on 400KV and 220KV OHL [10]. New technologies were developed in the last period, such as replacement of insulators, mounting of monitoring systems, mounting of line arresters etc. Live Line Maintenance consists of Hotline maintenance, Live Line insulator washing & Emergency Restoration Systems (ERS) presently. In India Live Line Maintenance Technique introduced in 1958 & Hot Line Training Centre for voltage levels up to 400 kv established at NPTI, Bangalore.

II. INDIAN POWER SCENERIO:

The vision statement of the Ministry of Power as per the RFD document follows: "Reliable, adequate and quality power for all at reasonable prices". All India installed capacity (in MW) of is 258701.45MW as on 31.01.2015[11].

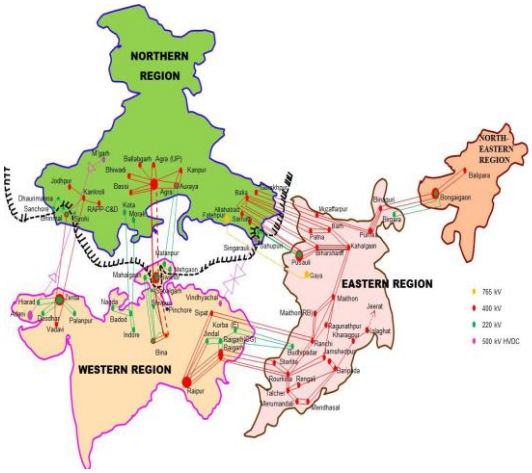

Fig.1: Map indicating the IR links between NR, WR, ER and NER [11].

The amount of electricity available to end users depends on four parameters: installed capacity; operational efficiency of the plants; transmission / distribution efficiency; and reach / penetration of transmission and distribution network[13]. Operational efficiency can be measured through plant utilisation metrics such as plant availability and Plant Load Factors. Transmission and distribution efficiency can be measured through AT&C loss and system reliability metrics. Uniform reach and penetration of the distribution network ensures that all segments of population have access to electricity [12]. Improvement of reliability of distribution sector is dependent upon 24x7availability of power and adequate T&D system, optimal loading of network elements, preventive maintenance of distribution network and prompt action to rectify faulty network[8]. In the urban areas infrastructure/ equipment such as RMUs, auto reclosures and SCADA will be put in place in identified towns having population of more than 4 lakhs and input energy of 350MU as a part of R-APDRP. An analysis of these factors helps in understanding the strengths, weaknesses, opportunities and threats that we must consider in the strategy [13]. About 2,000km long; -+800kV, 6000 MW HVDC Bi-pole connecting Biswanath Chariali in Assam to Agra in Uttar Pradesh is under implementation, and shall be amongst the longest such lines in the world. Similarly, highest voltage level in the world, 1200 kV UHVAC Single Circuit (S/c) and Double Circuit (D/c) test lines were successfully test charged along with one 1200 kV Bay at 1200kV UHVAC National Test Station at Bina, Madhya Pradesh and field tests are currently undergoing [14]. The IEP report by the

Planning Commission, released in August 2006, forecasts India's total energy requirements to be 1,425B units by FY17 while the International Energy Agency (IEA) projects 1,332B Ministry of Power: Strategic Blueprint [11]. SWOT Technology also acts as an enabler towards improving reliability, security as well as efficiency of the transmission network.

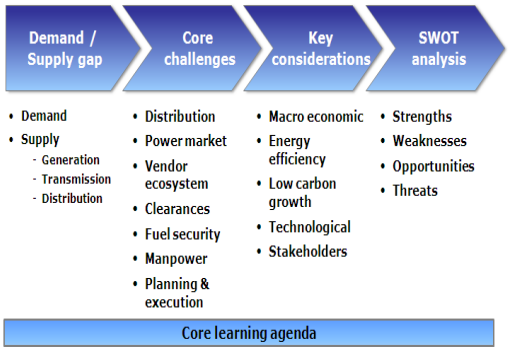

Fig.2: SWOT Technology of the transmission work [14].

III. INDIAN TRANSMISSION SCENERIO:-

As on December 31, 2014, the PGCIL owns & operates transmission network of about 1, 13,587 ckm of transmission lines and 188 nos. of EHVAC & HVDC substations with transformation capacity of about 2,19,579 MVA. The Company continues to wheel about 50% of total power generated in the Country through its transmission network at an availability of over 99% consistently.

Table:1. Executive summary of Target and Achievement of Transmission Lines during 2014-15, [13].

(All figures in circuit kms.)

Programme / Achievement		HVDC						765 kV				400 kV						220 kV						Total Central, State & JV/ Private Sector					
		±800 kV			±500 kV							Central Sector			State/ Private Sector			Central Sector			State/ Private Sector			Central Sector			State/ Private Sector		
		Central Sector	State Sector	Total Sector	JV/Private Sector	Total	Central Sector	State Sector	JV/Private Sector	Total	PGCIL	DVC	Total CS	State Sector	JV/Private Sector	Total	PGCIL	DVC	Total CS	State Sector	JV/Private Sector	Total	PGCIL	DVC	Total CS	State Sector	JV/Private Sector	Grand Total
Programme 2014-15		0	0	0	0	0	4988	0	2463	7451	2995	0	2995	4403	1442	8800	0	361	361	5169	0	5530	7843	361	7424	9572	3905	21682
Feb, 2015	Programme	0	0	0	0	0	1074	0	0	1074	0	0	0	0	0	0	0	37	37	0	0	37	1074	37	1111	0	0	1111
	Achievement	0	0	0	0	0	268	0	263	531	39	0	39	345	0	384	19	0	19	298	0	317	286	0	286	543	263	1132
Upto Feb, 2015	Programme	0	0	0	0	0	3844	0	2463	6307	2113	344	2457	4443	1442	8242	0	37	37	4206	0	4243	5957	381	6338	8351	3905	18594
	Achievement	0	0	0	0	0	4666	3	1058	5727	3822	0	3822	3906	1713	9441	19	74	93	5449	20	5542	7507	74	7581	7408	2791	17780

The way to the future for bulk transfer of power from generation centres to demand centres spanning long distances is the use of hybrid technology deploying a combination of 765kV AC and HVDC transmission technology along with dynamic compensation for voltage control.

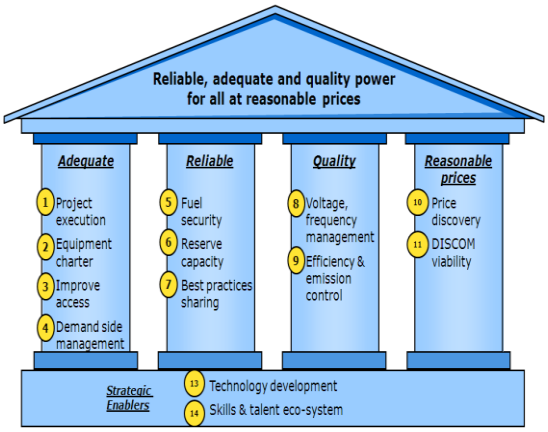

Fig.3: Strategic imperatives for Generation, Transmission and Distribution, [11].

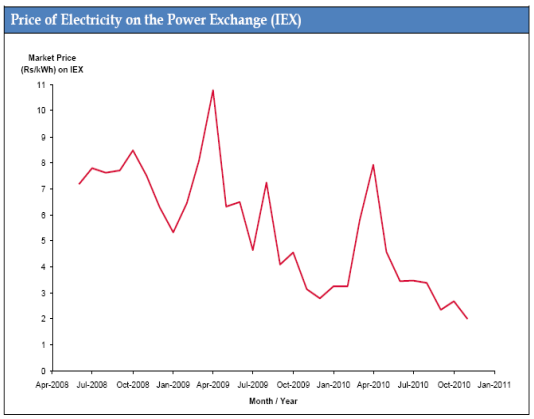

Fig.4: Price of electricity on the Power Exchange (IEX), [11].

Technologies like increasing the voltage levels-765kV AC, +/-800 kV HVDC, multi circuit towers to reduce ROW requirements, High temperature low sag conductor, GIS substation to reduce land requirement, remote operation & automation of substations, FACTS devices to enhance transfer capacity of the existing corridors is already integrated into transmission network. However, it is necessary to develop skill set to upkeep the above state-of-the-art technologies. Smart Grids to support utilities in making optimal usage of the transmission grid capacity and to prevent the spreading of disturbances are also being considered. Benefits of Transmission 1.Efficient bulk Power Markets.2.Hedge against generation outages.3.Hedge against fuel price changes.4.Low –cost access to renewable energy.5.Operational flexibility [2]. Conserving Right-of-Way (RoW), minimizing impact on natural resources, coordinated development of cost effective transmission corridor, flexibility in up gradation of transfer capacity of lines matching with power

transfer requirement are major areas of concern in development of transmission network in the country. In this direction, the Company is now working on higher transmission voltages of ±800kV HVDC & 1200kV 1200 KV UHVAC.

IV. TYPES OF MAINTENANCE:

A) PREDICTIVE MAINTENANCE:

The aim of predictive maintenance is to predict when equipment failure might occur, and secondly, to prevent occurrence of the failure by performing any required maintenance. The task of monitoring for future failure allows maintenance to be planned before the failure occurs. Predicting failure can be done with one of many techniques. The chosen technique must be effective at predicting failure and also provide sufficient warning time for maintenance to be planned and executed.
The techniques include vibration analysis, oil analysis, thermal imaging, and equipment observation. These are described in detail in Condition Based Maintenance [1].

This brings several cost savings

- minimizing the time the equipment is being maintained
- minimizing the production hours lost to maintenance, and
- minimizing the cost of spare parts and supplies.

B) PREVENTIVE MAINTENANCE:-

The care and servicing by personnel for the purpose of maintaining equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of incipient failures either before they occur or before they develop into major defects. Maintenance, including tests, measurements, adjustments, and parts replacement, performed specifically to prevent faults from occurring. Maintenance at fixed intervals is the most frequently used approach, and strategies based on reliability-centered maintenance (RCM) are increasingly considered for application. This can be observed recently in some applications of RCM in transmission systems approach to an optimal maintenance strategy in transmission systems using a genetic algorithm [12].

V. METHODS OF CONDITION MONITORING :-

1. INSPECTION :

The inspection of a overhead line (ORL) is performed by taking actions that consist in evaluating the conformity from a helicopter. Line Inspection Basically, the common inspection systems for OHL consist in:- foot patrol; climbing inspection; standard visual inspection from a helicopter, detailed visual, infrared and ultraviolet inspection other obstacles under lines;- Line components;- Foundations state;- Towers state (crossheads, main legs, crossbars, anchorage, insulating strings);- Active conductors state; Protection conductors state; State of the earthlings; The inspection goal is the condition assessment of all line components[10].
Inspection tasks:- General aspect of the line;
The state vegetation in the protection corridor of the line; Crossings (telecommunication lines, transport or distribution electric lines, roads, railroads, rivers)
Access;- Buildings and through observation, measurement or comparison with a standard of the equipments, installations.
Localization of hot spots; Corona activity;

2. INSULATOR TESTER:

Insulator tester is used to get information on voltage distribution along the insulator strings which can be useful for the design of future power transmission lines. The working principle of this new device is based on the automatic measurement and recording
of the electric field along the insulator string which decreases considerably in front of an internally-shorted insulator.

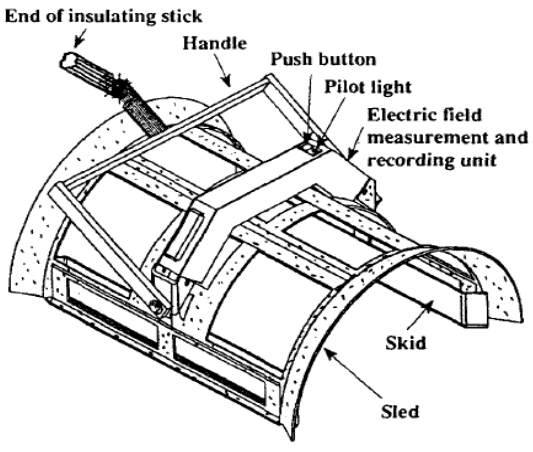

Fig: 5 Insulator tester [10].

The tester is slid along the string while the insulators are counted automatically. The information from tests on up to 200 strings can be stored in the device to be later transferred in a host computer for interpretation and/or permanent

storage Plots of the logarithm of the electric field along a 32 insulator string, with and without short circuited elements. These curves were obtained from tests done in a high voltage laboratory using the new tester, the short- circuits were placed in position 7, 9,15,16,23 and29 along the string. The short- circuits locations appear as minima in the field value.

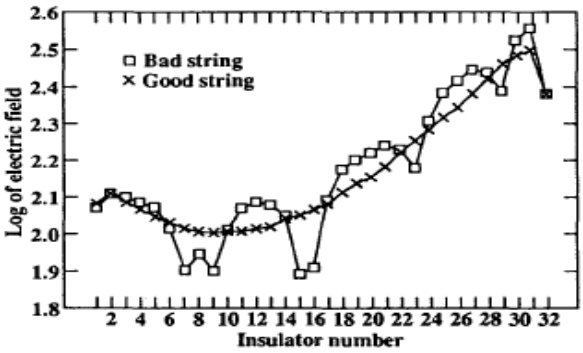

Fig: 6 Log of electric field Vs Insulator no. [10]

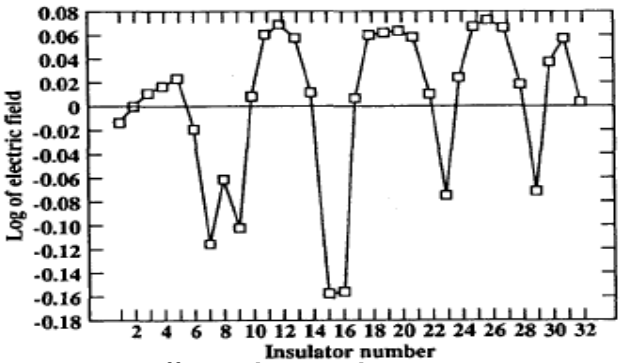

Fig 7: Difference between the two Logs of electric Field [10].

3. REAL TIME MONITORING SYSTEM – RETMOS:

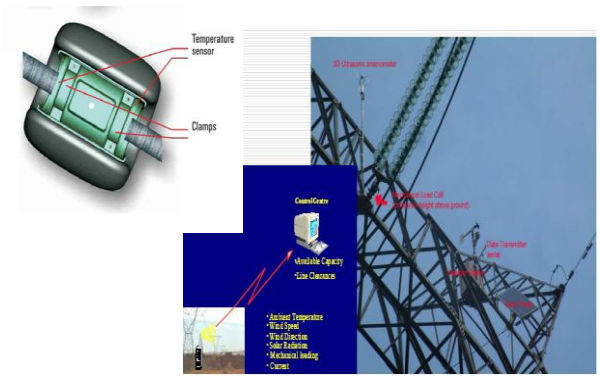

Fig:8 Monitoring System version 2 (OTLM) Monitoring system provides real-time monitoring of temperature and current on OHL [10].

4. SERVER AND CLIENT SOFTWARE:

The server software is responsible for data transfer between the central unit on the tower and the server in the transformer station. It is also responsible for calculating the prospective conductor temperature. The client software shows the calculated conductor temperature on a graphical interface using a three-color code. The maximum permissible temperature must previously be stated by the customer. The client software can also be used to graphically display the temperature at individually defined intervals.

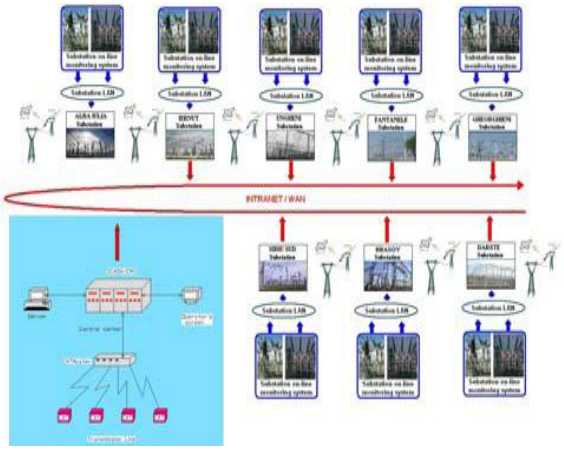

Fig: .9 The architecture of on-line monitoring systems for high voltage electrical equipment in the substations [10].

VI. LIVE LINE MAINTENANCE:

A policy for overhead line maintenance must evolve from the overall maintenance policy, setting particular direction for overhead lines in the form of specific Key Performance Indicators [2] .Nowadays the Live Maintenance technologies have a constant development in Smart Grid. By live working the switching cycles of switchgears can be reduced and considering the age of equipment, it can help to reduce the incident risks [4].

This includes

i) Replacement of broken glass cap and pin disk insulators and re insulation with composite insulators (NCI's).We experience a large number of broken glass disks due to vandalism in populated rural areas. Insulator replacements account for approximately 80 % of live line maintenance activity in Indian Transmission

ii) Bird pollution and bird streamer faults are responsible for around 30 % of the line faults experienced and flashed over insulator strings have to be replaced on a regular basis.

iii)The majority of transmission lines have bundled conductors (2, 3, 4 and 6) and spacer/damper

replacement account for a considerable proportion of preventative maintenance work.
iv) Conductor repairs, fitting of bird diverters and aviation spheres make up the rest of the day to day maintenance activities.

VII. MAINTENANCE REQUIREMENTS:

Highly skilled trained manpower required for live lines planned maintenance activities such as replacement of insulator, spacer dampers, hardware etc and thereby avoiding outages. PGCILs are using a wide range of Tools manufactured by USA (Chance) & Brazil (Ritz) companies [4-7].

VIII. MAINTENANCE IN A TRANSMISSION COMPANY SHOULD BE PLANNED, EXECUTED AND CONTROLLED WITH THE AIMS OF:

- Optimising maintenance costs,
- Ensuring high levels of assets availability,
- Extending assets life,
- Ensuring an adequate quality of supply,
- Ensuring the safety of staff and the public,
- Contributing to the long-term viability of the company
- Reduce the damage to agricultural flora because the maintenance can be planned considering the vegetation period [7].

IX. THE FOLLOWING OPERATIONAL FACTS ARE CONSIDERED DURING THE LIVE LINE MAINTENANCE:

i. Auto reclose devices on the line being worked on are inhibited to eliminate switching over voltages.

ii. Live work is not performed when thunder or lightning activity is present because of TO V's.

iii. Series capacitor banks are bypassed as these have found to have an effect of p.u. overvoltage along the line during line faults and switching.

iv. Closing resistors are generally used on EHV circuit breakers to reduce p.u. switching over voltages.

v. Where specific values for variables have not been determined by measurement and/or simulation, the values suggested in the respective tables in IEC 6 1472 [2] are utilised.

vi. Worst case scenarios (e.g. altitude) are used to determine one set of clearances applied throughout the transmission network.

X. METHODS OF LIVE LINE MAINTENANCE:

1. HOT STICK METHOD (HSM):

In this method the lineman will be at ground potential, working with Hot Sticks (tools) keeping safe clearance from the line.

i) HOT LINE MAINTENANCE TOOLS:

S. N	TOOLS	Application/properties
1	EPOXY GLASS STICKS	➢ Higher insulation value.(100kv/foot / 5 min) ➢ Mechanically stronger, ➢ No moisture absorption. ➢ Orange colour for easy identification. ➢ No effect on the sticks due to sudden changes in Temp. or atmospheric condition. ➢ No effect of chemically polluted atmosphere. ➢ Superior than wooden sticks. ➢ Handling easy because of light in weight. ➢ Maintenance is easy.
2	Hot Clamp	Used to prevent movement of conductor cover /guard over the conductor.
3	Conductor cover, insulator cover, cross arm cover	IR Value from 35.5 KV – 49 KV.
4	Utility Plat Form	750 lbs .Available in 36” & 42”.It will be used on poles with the safer distance for working of line men.
5	Epoxy glass rail plat form with the provision to tie the safety rope.	800 lbs
6	Hand gloves	20 KV / feet. Can be used up to 11 KV.

ii) SAFE WORKING DISTANCE FOR HOT LINE OPERATIONS AS PER OSHA STANDERDS

Voltage rage phase to phase in kv	Metres	FEET
2.1 to 15	0.61	2
15.1 to 35	0.71	2’4”
35.1 to 46	0.76	2’6”
46.1 to 72.5	0.91	2’
72.6 to 121	1.02	3’4”
138 to 145	1.07	3’6”
161 to 169	1.12	3’8”
230 to 242	1.52	5’
345 to 362	2.13	7’
500 to 552	3.35	11’
700 to 765	4.57	15’

Fig.10: Changing of insulator on 220 KV Suspension Point [10].

Fig.11:Changing of insulators on 220 KV‘V’ String [10].

Fig.12: Changing of insulators on 220 KV Dead End [10].

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2. BARE HAND METHOD (BHM):

In 1937, Michel Faraday proved that electricity between two points at the same potential is same. If a Lineman can be shielded in a Faraday Cage, and the cage is bonded to an energized conductor, he may work on the conductor and associated hardware without shock or discomfort Here the lineman will be working at line potential keeping safe clearance from ground. For this conductive suits made of 25% microscopic stainless steel and 75% nomex will be provided.

Fig.13 Changing of insulator string on 400 KV Dead End [10].

Fig.14 insulator string replacement on 400KV line [10].

3. COMBINATION:

Generally a combination of above two methods is used in practice as HSM & BHM are complimentary and supplementary to each other. Insulated ladders, insulated aerial platforms, rope hoisting methods and helicopters are utilised to gain access to live conductors and structures. Tools and techniques have been developed and optimised for local conditions and designs, based on maintenance requirements and available resources [10].

XI. LIVE WORK RISKS AND GOVERNANCE:

While electrical flashover due to insulating tools failure is a risk in live working, our experience and risk assessment has shown that mechanical failure of tools and equipment is a greater risk. Mechanical failure of tools and equipment ultimately lead to electrical flashover, both of which cause damage to equipment and injury to staff. Live work standards and procedures are based on international norms and best practices as documented by the various authorities such as IEC [2, 3, and 4], IEEE [6] and work by EPRI [7&8] and CIGRE [9].

XII. LIVE LINE MAINTENANCE TECHNIQUE AND AVAILABILITY STUDY:

Outage rate (the availability of energy, which is the ratio of ENS to available energy) and the unavailability indicator for transmission lines (which is called unavailability indicator of transmission lines) are used as the availability indicators of the network. In addition to the outage rate SAIDI, SAIFI and CAIDI indicators are considered for distribution systems [1].Since this kind of regulation of supply continuity appeared, it plays important role as an economic driver in development of live working technology because the application of this maintenance technology can radically decreases the number of interruptions. Therefore transmission and distribution companies have become more and more motivated to invest in live work maintenance technology.

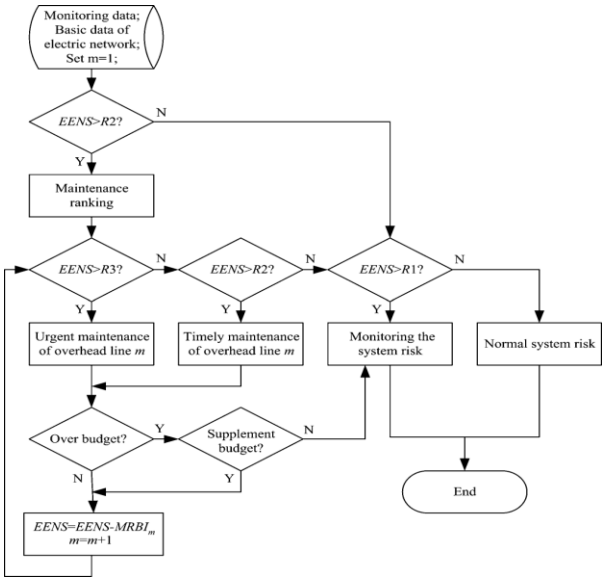

Fig.15.Flow Chart of Maintenance strategy of OHL monitoring [1].

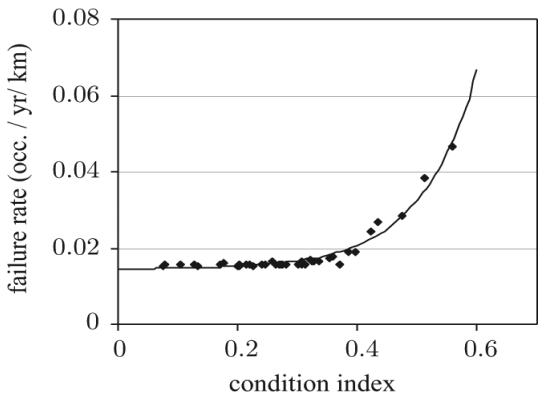

Fig.16: Relation of condition index and failure rate of overhead lines [1].

XII. CONCLUSION :

This paper reveals the importance of Live - Line Maintenance Techniques for Indian grid. Maintenance strategy of overhead lines based on monitoring data gives actual information regarding fault location, situation, quantified the severity of maintenance of each line & reason thereon. Thus maintain continuous supply to consumers by

avoiding interruption due to the maintenance. Therefore this maintenance technology directly improves the quality of service, saves equipment and its associated surrounding. Live work is extremely dangerous for untrained workers and especially it is directly affects human life. Before doing LLMT several technological study should be done such as the electrical influence on workers near the T/L, development of live-line facilities, guarantee of safety, the technical rules of live-line work and safe method of live-line work. Hence it is proposed that Live Line Maintenance Technique using Bare Hand Method is most suitable and technically suited for over head transmission line.

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Analysis of Self Piercing Riveting Process by Numerical Methods

[1]Mr.Akhilesh V. Rajput, [2]Er.Navneet K. Patil, [3]Mr. Pawan S. Nandanwar

[1]akhileshvrajput@gmail.com, [2]navneetkpatil@gmail.com, [3] nandanwarpavan10@gmail.com

Abstract: Self-Piercing Riveting (SPR) is a technique used for joining of two sheet metals and it does not required preparatory hole. Now a days in automotive industry is rapidly increasing the use of material's alternative to the steel that are very difficult and impossible to join with traditional techniques. Owing to favorable weight/strength ratio polymer material are vital in use.

Today, different technologies are available in the market to construct automobiles. The most common method for connections of sheets is resistant spot welding. The production process is optimized by adhesive or rivets joints. This is proved by different researchers. It is essential to ensure a cost saving and time optimized car development to reduce the required number of experiments by using precise simulation.

In this paper, SPR process has been numerically simulated by using FEA software. Also some experimental analysis is done and proved that SPR process is more economical, fast and better than other joining processes.

Key Word:- Self Piercing Riveting, resistant spot welding, sheet metals, simulation

I. INTRODUCTION

The fabrication of lightweight products is a primary objective for most manufacturers. A well-known example is the automotive industry, where a reduction on the total vehicle weight of 10 % translates into a reduction of fuel-consumption and polluting emissions of around 8-10 %. A common practice is to manufacture lightweight products by using alternative materials. However, a common limitation to these innovative. Materials are the joining methods, since spot-welding is impossible to apply to plastics and expensive and difficult to apply to metallic non ferrous alloys [1]. The most commonly used in automotive industry, spot welding still has severe limitations when applied for joining the mentioned types of materials. One of the ways to overcome the problem is to look for other fastening methods and/or adhesive bonding as competitive and complementary processes. Recently mechanical joining methods are under serious consideration. Among them, the most promising appears to be self-piercing riveting – SPR [3].

Self-pierce riveting (SPR) has a number of advantages as compare to more other traditional methods of sheet metal joining. It is a fast and clean technique to join dissimilar materials with no need for pre-drilled holes. Although, SPR is inappropriate for brittle substrates, SPR can be used to join fiberglass composite panels and aluminium blanks if the composite laminates are placed at the top of the joint. In this study, semi-tubular self-pierce riveting joints between carbon fiber reinforced laminates (T700SC/RIM935) and aluminium alloy sheets (AlMgSi0,5 T6) were investigated experimentally to study the mechanical behavior in dependence of the fiber orientation. For a better understanding of the inward phenomena, finite element simulations have been carried out and have been verified by the experiments [4]. Self-pierce riveting (SPR) is used for high speed mechanical fastening of sheet material components. In this process, a semi-tubular rivet is pressed by a punch into two or more substrates of materials that are supported on a die. The die shape causes the rivet to flare inside the bottom sheet to form a mechanical interlock as shown in Fig. 1 [5].

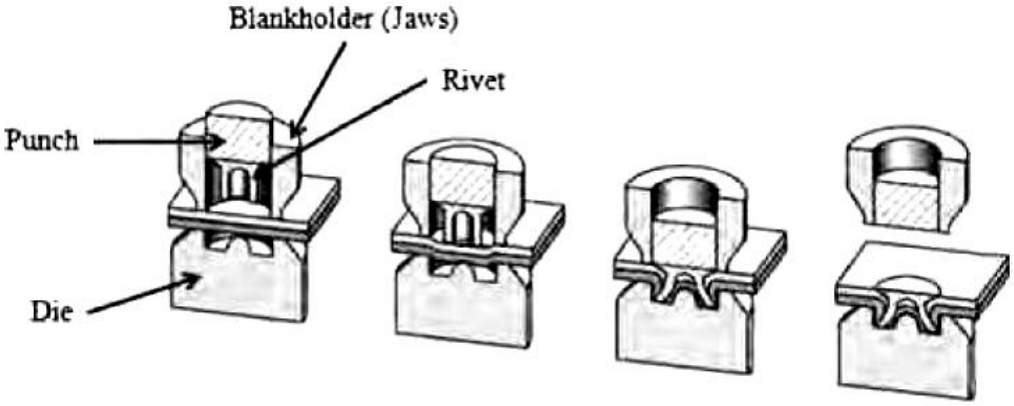


Fig.1.SPR Operation with semi tubular Rivet

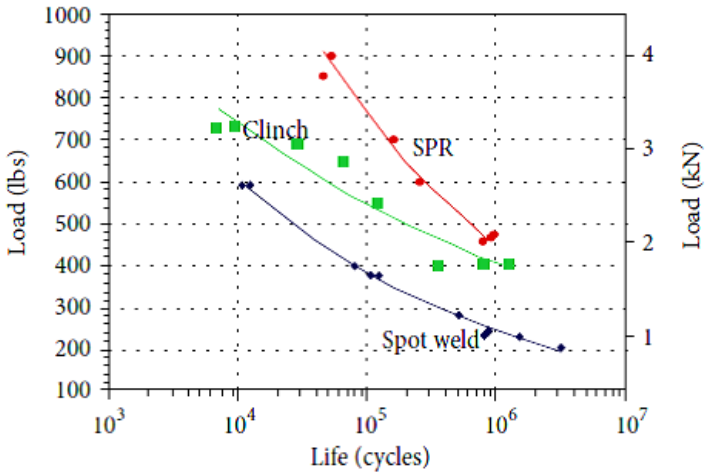
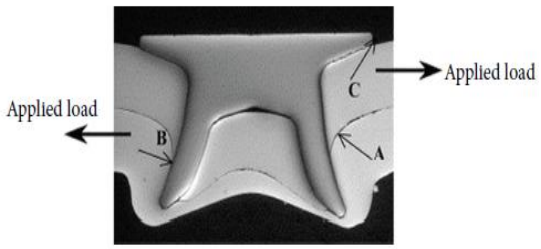


Fig.2 Fatigue behavior comparison of SPR, clinch, and spot-weld joints

SPR is a high-speed mechanical fastening technique used to fasten two or more sheets of material by driving a semi tubular rivet through the top sheet(s), piercing the bottom sheet and spreading the rivet skirt under the guidance of a suitable die. As the process relies on a mechanical interlock rather than fusion, SPR can be used for a wide range of advanced materials. The fatigue behavior of the SPR joints has been investigated by a number of authors for a number of materials. All agree that the fatigue strength of SPR joints is superior to that of the spot-welded joints [6]. Fig. 2 compares the fatigue behavior of SPR and clinching with spot welding.

Sun et al.'s paper [6] summarized the fatigue test results of SPR joints between similar and dissimilar sheet metals. Fatigue test results indicated that SPR joints have superior fatigue strength than resistance spot weld (RSW) joints for the same material combinations. It was also found that different piercing directions (from thinner sheet to thicker sheet or from thicker sheet to thinner sheet) for SPR joints have a noticeable effect on the static and fatigue strength of the joints. Figure 3 shows the typical lap-shear fatigue failure modes of SPR joints.



A: interface between the two riveted sheets
B: interface between the rivet shank and the locked sheet
C: interface between the edge of the rivet head and the pierced sheet

Fig. 3: Three fretting positions in a SPR joint [6].

A study was conducted by Han et al.[6] to characterize fretting fatigue in SPR single-lap joints of aluminium alloy 5754 sheets. The experimental results showed that fretting occurred at three different positions in a SPR joint, as shown in Figure 4. It was established that fretting led to surface work-hardening and crack initiation as well as early-stage crack propagation. The fretting behavior of SPR aluminium alloy joints with different interfacial conditions was investigated by Han et al. [6]. The fatigue life of the joints was observed to be dependent on the fretting behavior under different interfacial conditions, as also shown in Figure 4. They found that the presence of a wax-based solid surface lubricant on the surface of the aluminium alloy sheet could delay the onset of fretting damage.

II. Mechanical Clinching

Mechanical clinching is a mechanical joint for fastening sheet metal components, and it is widely used in automotive industry. The clinching process is a method of joining sheet metal or extrusions by localized cold forming of materials. The result is an interlocking friction joint between two or more layers of material formed by a punch into a special die.

Depending on the tooling sets used, clinched joints can be made with or without the need for cutting. By using a round tool type, materials are only deformed. If a square tool is used, however, both deformation and cutting of materials are required. The principle of clinching is given in Figure 5. Although the static strength of clinched joints is lower than that of other joints, the fatigue strength of clinched joints is comparable to that of other joints, and the strength of the clinched joints is more consistent with a significantly lower variation across a range of samples. In Mizukoshi and Okada's study, tensile-shear strength and fatigue strength of riveting joints, clinching joints, and rivet-bonded joints for aluminium auto body sheets were investigated and compared with those of spot-welded joints. Moreover corrosion performances have also been investigated [6].

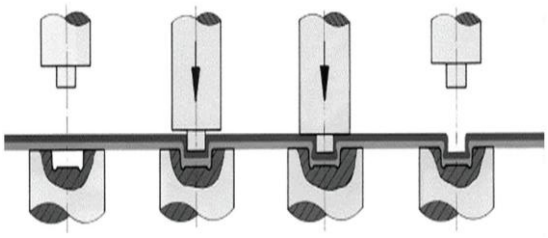


Fig.4: Principle of mechanical clinching

III. Comparison of Self piercing riveting with other joining processes

Nowadays aluminium is highly used in vehicle bodies to reduce the body mass hence to reduce the emissions. The joining of aluminium parts can be carried out with the help of number of technologies like MIG welding, Laser welding, Self piercing rivet etc. These technologies are used according to their individual characteristics.

In case of Laser welding, heat applied requires low heat input and relatively easy to undergo. One-sided welding is also possible with the help of laser welding. Laser welding is used to join exterior panels and floor panels. But the opening between panels requires strict control during laser welding.

Joining without preparing holes in advance is carried out with the help of Self piercing rivets. It does not require heat input. Also opening between the panels can be controlled with the help of clamping panels. So this technology is relatively easy to undergo compared to MIG welding and Laser welding. It can be also used to join extrusions and castings. Tensile-Shear strength comparison of Spotwelding and SPR is shown fig. 5.

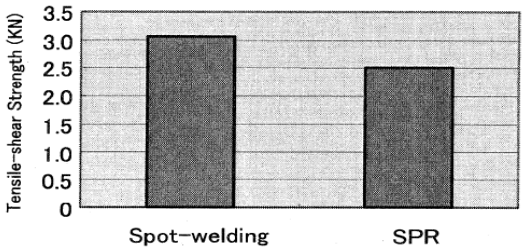


Fig.5- Tensile-Shear strength comparison of Spotwelding and SPR

Hiroyuki Iguchi and Yasuaki Ohmi suggested some improvements in his paper for the self-piercing rivet to get an improved performance like changing rivet material, modifying materials and their shapes, modifying joining technologies. It is been found out that die that satisfied shape characteristics requirements should be selected according to the characteristics of the material to be joined. Rivet legs and driving characteristics are improved by using the sliding die which enables the improvement of the joining process. By changing the rivet material to aluminium improvement in recycling is found. Two new types of aluminium rivets are resulted from this study which enables good performance.

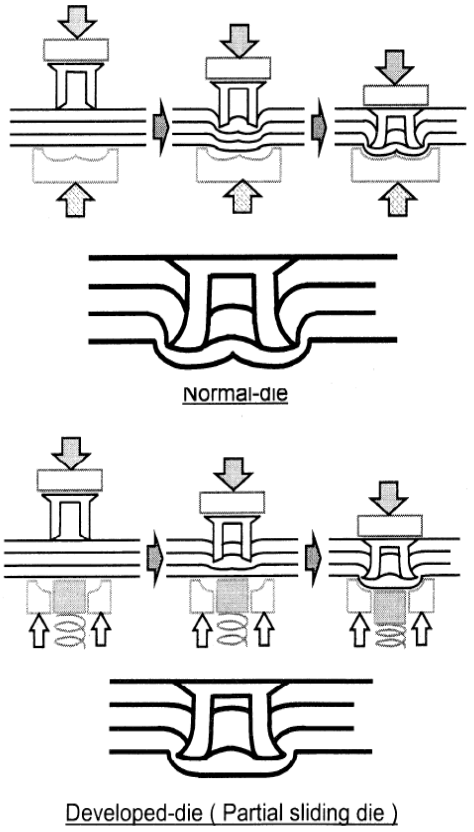


Fig6. Developed Partial Sliding Die

Hiroyuki Iguchi and Yasuaki Ohmi suggested that to prevent cracks from forming and to join number of panels or when panels are thick then partial sliding die is used. It maintains the appropriate length after the rivet legs are driven in as shown in fig.6.
Hence because of this study, the self piercing rivet is easier to apply for joining of aluminium alloys than MIG welding and Laser welding.

IV. Simulation of Self Piercing Riveting-

Xiaocong He, Baoying Xing, Kai Zeng, Fengshou Gu and Andrew Ball studied the numerical and experimental investigations of self-piercing riveting. SPR process is numerically simulated using FE simulator LS-Dyna. In order to avoid numerical problems due to mesh disturbances, the efficacious approach is to use an erosion or element kill technique, where elements are simply removed from the mesh in accordance with a failure criterion.

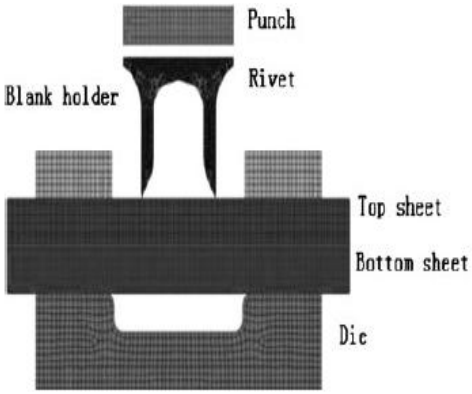


Fig.7.- FE model of SPR process

Simulation time can be reduced by smoother surface and reducing the no. of elements. To get such smooth surface, an implicit solution technique with the Lagrange method and r-self-adaptivity has been used. The window technique was used in the tests for evaluating the quality of SPR joints as shown in fig. 7

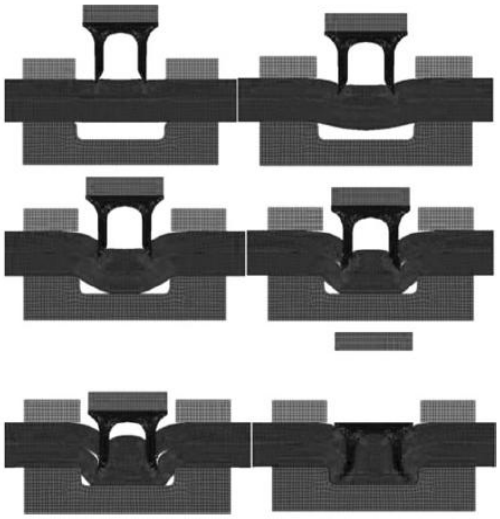


Fig.8 Simulation of SPR process

In this case online window monitoring of the SPR process was carried out by measuring the actual SPR setting force through a force sensor and punch travel through a position sensor. SPR setting force reflects the deformation force on the sheet materials and the punch travel indicates the geometric change of the sheets during the SPR process as shown in fig.8.

V. Simulation Model Geometry-

The SPR process has been numerically simulated using the commercial FEA software LS-

Dyna. A 2D axisymmetric model was generatedas shown in fig. 11. An implicit solution technique with Lagrange method and r-self-adaptivity was used. R-adaptivity is recommended in this study as the case of 2-d axisymmetric is maintained for the following reasons.

- R-adaptivity preserves the logical structure of the grid.
- R-adaptivity remeshing is the only option for 2-d axisymmetric.
- Completely new mesh will be initialized from the old mesh using least square approximations.

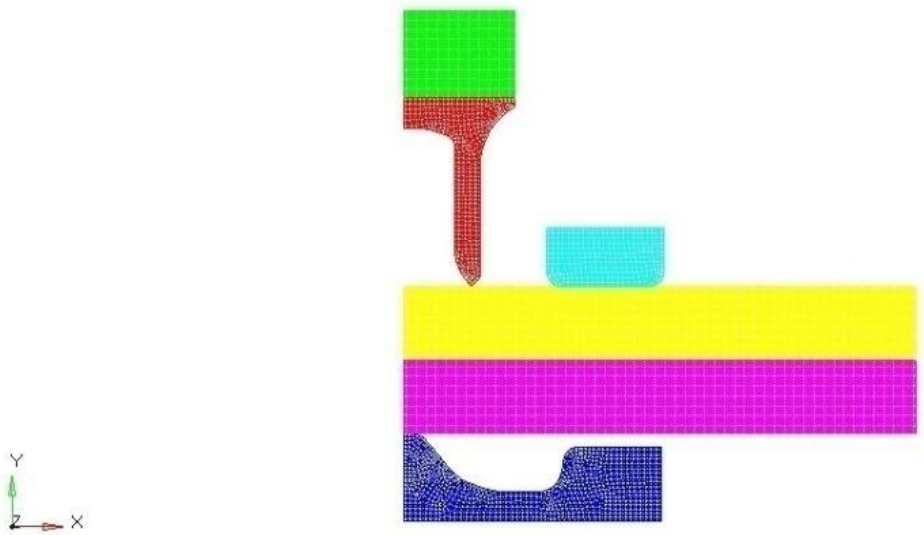


Fig. 9– FE Model for SPR Process

I. Punch-

Finite element model of punch with mesh size of 0.09mm × 0.1mm and dimensions of 3.77mm × 3mm. As shown in fig.10, FE model of punch is generally created as it is a rigid body.

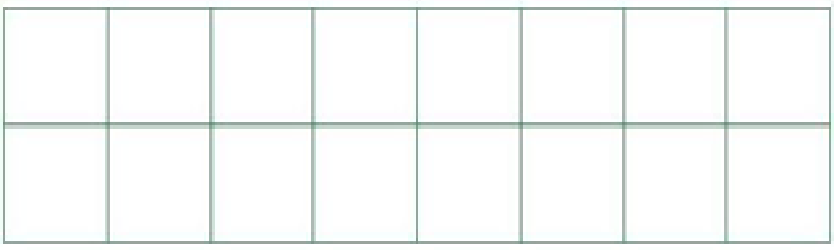


Fig.10. Simulation model for punch

II. Blank Holder-

Finite element model of blank holder with mesh size 0.1mm × 0.1mm and dimensions 4mm × 2mm. As shown in the fig. 11 , FE model of blank holder is developed considering a rigid body.

Fig. 11. Simulation geometry of Blank holder

III. Sheet Metal blank-

Finite element model of Sheet metal blank with mesh size 0.1mm × 0.1mm with dimensions 17.5mm × 2mm. As shown in fig. 12, a single blank design with fine mesh size in order to understand the better sensitivity of mesh density.

Fig. 12. Simulation geometry of Sheet metal blank

IV. Rivet-

Finite element geometry of Rivet with mesh size 0.1mm × 0.1mm . As shown in fig. 13 , mesh density is maintained to get the cylindrical profile of the rivet according to the standards.

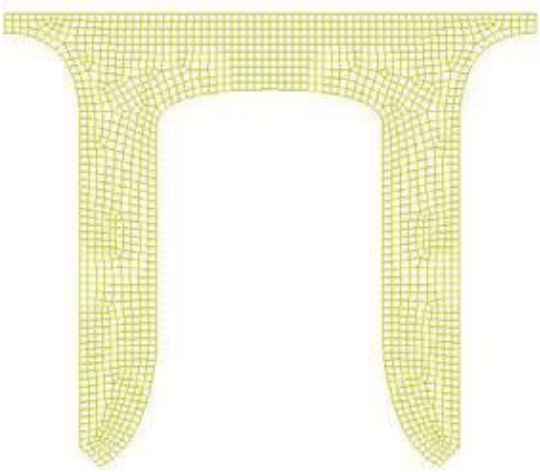


Fig.13 – Simulation geometry of Rivet

V. Die-

Finite element geometry of Die with mesh size 0.1mm × 0.1mm . As shown in fig. 14 , an axisymmetric die profile is generated with fine mesh and considered as a rigid body.

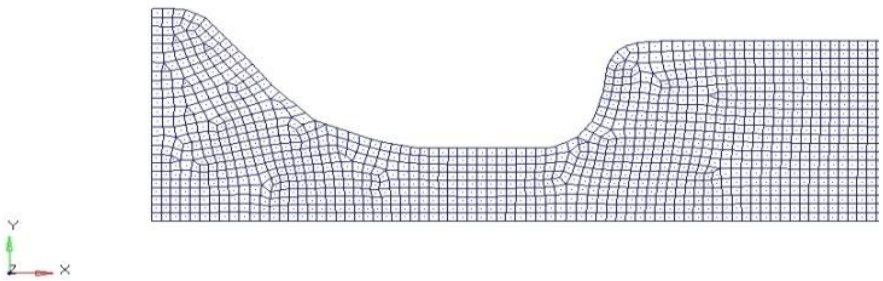


Fig. 14.Simulation of Die

VI. Element formulation-

As the problem is 2D axisymmetric calculations, element formulation type EQ.14: Axisymmetric solid (Y-axis of symmetry)- area weighted was used. It is default shell element formulation in LS-DYNA. It is a computationally efficient element formulation used as common for all the axisymmetric geometric tools.

The type of element formulation for each part is specified in the *SECTION_SHELL card under ELFORM options.

VII. RESULTS

Comparison of force-deformation curve-

The numerical simulated model was validated against the experimental test results as shown in Fig. 15 and 16. A visual comparison is carried on between the numerical simulation and test results of force-deformation curves from the riveting process. The force-deformation curves have shown oscillations during the process, which is due to high value of penalty scale factor. We can absorb that at displacement length after 1.5mm, the force has increased higher consistently than experimental result. The segment penetration between the mesh of rivet and top sheet was managed with high value of penalty scale factor than default value.

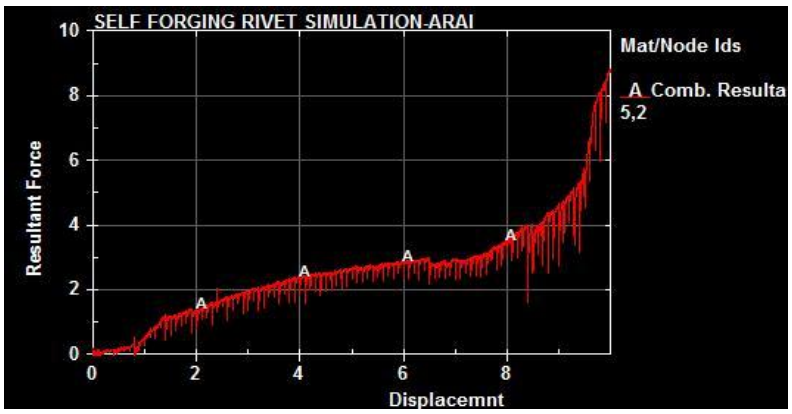


Fig.15. - Force Vs Displacement curve from simulation

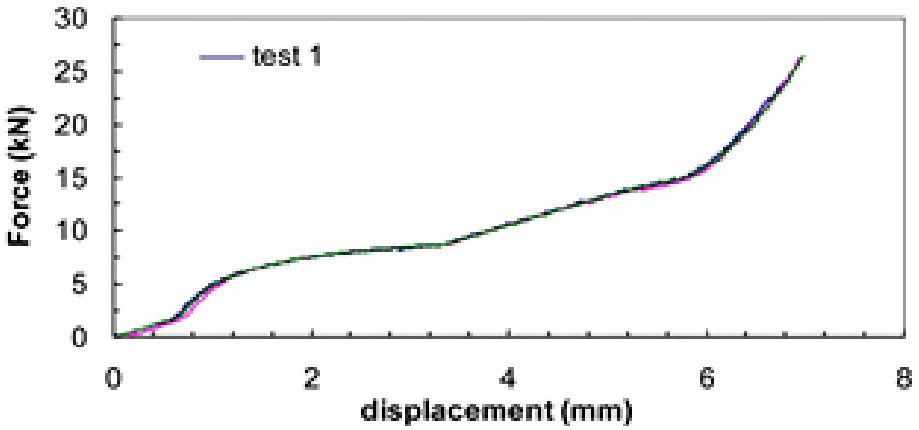


Fig.16. - Force Vs Displacement curve

The riveting test results from literature survey were used as a database to validate a 2D-axisymmetric model generated in the explicit commercial LSDYNA finite element code. Simulations were performed using an explicit solution technique. An r-adaptive method together with a mesh size of 0.1 mm × 0.1 mm was used to deal with the element distortion problem encountered during the riveting process. The simulation results were in good agreement with the experiments, with respect to the force–displacement curves

The following conclusions were drawn from report.

- In the SPR process, the force variation could be divided into two main stages: the rivet penetration region and the rivet-setting region.
- The penetrating force required to deform and penetrate the aluminium sheets was analyzed through explicit analysis.
- Explicit approach is an efficient tool to study the joining process and predict the mechanical strength and failure mechanism of the SPR joints. Force-deformation values were predicted from rivet being riveted.

VIII. CONCLUSION-

Here from literature survey the riveting test results are used to validate a 2D-axisymmetric model generated in the explicit commercial LSDYNA finite element code. The simulation results are in good agreement with the experimental results, with respect to the force–displacement curves. Simulations are performed using an explicit solution technique. An r-adaptive method together with a mesh size of 0.1 mm × 0.1 mm is used to deal with the element distortion problem encountered during the riveting process.

To predict the mechanical properties of SPR process numerical simulation technique is used.

The following conclusions are drawn-

- In the SPR process, the force variation could be divided into two main stages: the rivet penetration region and the rivet-setting region.
- The penetrating force required to deform and penetrate the aluminum sheets was analyzed through explicit analysis.
- Explicit approach is an efficient tool to study the joining process and predict the mechanical strength and failure mechanism of the SPR joints. Force-deformation values are predicted from rivet being riveted.

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Comparative Stress Analysis using Ansys Software for Different Tires Performance Evaluation

Krunal Girase [1], Mr. Navneet Patil [2], Dr. Dheeraj Deshmukh[3]

[1]P.G. Student, Department of Mechanical Engineering, SSBT"s COET, Jalgaon, Maharashtra, India
[2] Associate Professor, Department of Mechanical Engineering, SSBT"s COET, Jalgaon, Maharashtra, India [3]Head, Department of Mechanical Engineering, SSBT"s COET, Jalgaon, Maharashtra, India

ABSTRACT: In this paper Comparative Stress Analysis using Ansys 12 software is used for different tires of same material with different structured threads in the same operating condition. Three different structured threads are used as Plane threaded tire, line threaded tire and Cross threaded tire for stress analysis. Operating conditions are kept constant as 300RPM, Plane concrete road profile, pressure on all tires are same and rubber material is used for all three tires. During this evaluation two geometries are modeled in solid-edge tool as three different tires and the road profile. In Ansys 12 Load and rotation is provided on tire models and road profile is fixed. It is observed during the simulation analysis minimum stress as well as minimum deformation occurs in Plane threaded tire as compared to line threaded and cross threaded tire.

Keywords – solid-edge, Ansys, Road profile, Tire threads, Frictional Analysis

I. INTRODUCTION

Road friction, its measurement and relation to traffic accident risks, is a problem that has engaged thousands of road engineers throughout the world. In many countries there exist specified road friction threshold values that define the lowest acceptable road friction [1]. If the friction level is below this threshold value, then the risk of accidents may increase. And this all depend on stress and deformation in tire in running conditions. These stress and total deformation in tire are the result of research into the relation between road friction and accident risks.

Friction is the resistance an object encounters in moving over another object. Often the force needed to move the object, the frictional force and if the stress is maximum then friction also increases and hence the wear in both contacting surfaces and it's undesirable.

In a friction measurement, often three bodies are involved; the measuring tire, the road surface and some kind of contaminant interacting with both tire and road like for example water (wet friction), dust or wear particles etc. The friction values measured depend to a great extent on all three bodies, their material properties, the local contact pressures, relative velocities etc. A summary of the important factors influencing the road surface friction is given in following table –

Table-Factors influencing the road surface friction and stress

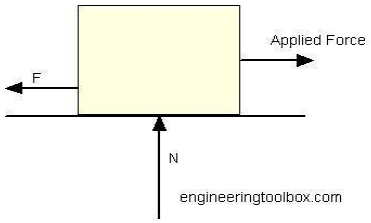
Road	Contaminant (fluid)	Tire
Macro texture	Chemical structure	Tread pattern design
Micro texture	Viscosity	Rubber composition
Chemistry of materials	Temperature	Rubber hardness
Temperature	Thermal conductivity	Load

A Tire

A tire (U.S. English) or tyre (British English) is a ring -shaped covering that ts around a wheel's rim to protect it and enable better vehicle performance. Most tires, such as those for automobiles and bicycles, provide traction between the vehicle and the road while providing a flexible cushion that absorbs shock.

Frictional force

As frictional force is directly proportional to stress on moving body, it's important to take frictional force in consideration, Frictional force can be expressed as, F = N



where,

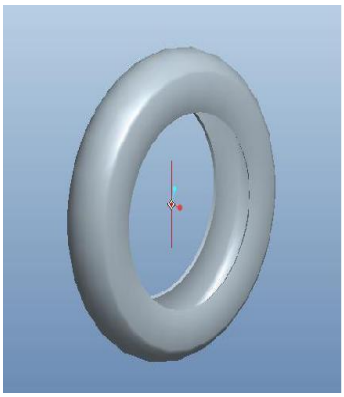
F= Frictional Force N = normal force

II. Objectives

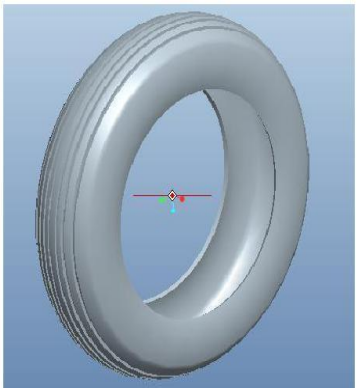
- To carry out, or procure research into all factors affecting the safe use of public roads.
- To find optimum thread pattern for optimum stress and hence friction in between road surface and tire.

III. Modeling and Analysis of tire Modeling of Tires

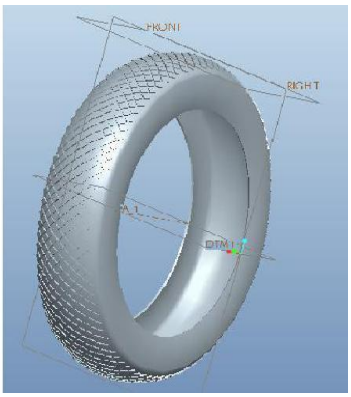
For modeling of tire Solid Edge software tool is used. Three types of tires are considered for the study, with identical geometries but different thread.



(a)

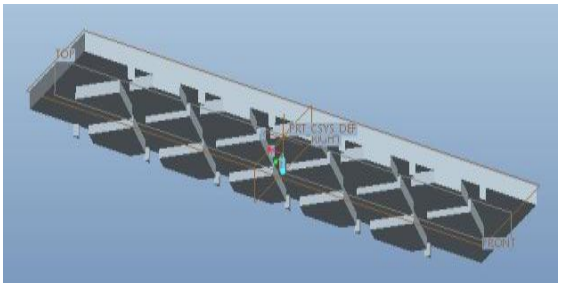


(b)



(c)

Being a more complicated shape, for cross threaded tire meshing is very time consuming. Hence it was decided to consider a small segment tire that will be in contact with road surface for analysis. The segment under consideration is shown in following figure.



Analysis of Tires

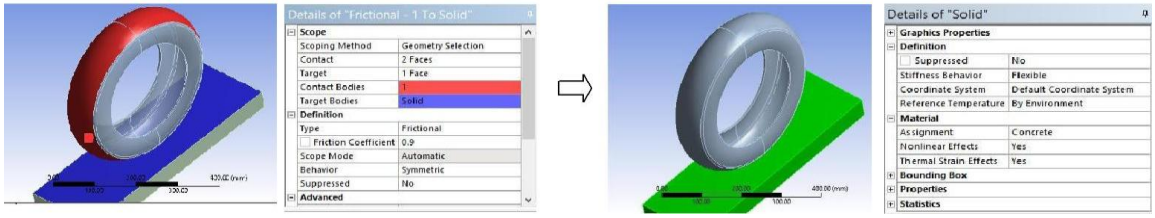
The structural analysis has been performed using ANSYS -12.0. ANSYS supports three contact models: node-to-node, node-to-surface, and surface-to-surface. Each type of model uses a different set of ANSYS contact elements and is appropriate for specific types of problems.

Steps in a Contact Analysis

The basic steps for a typical surface-to-surface contact analysis are as follows,

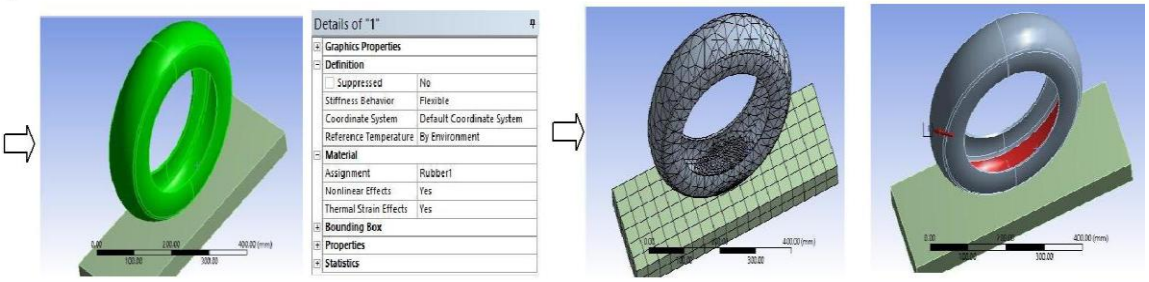
1. Create the model geometry and mesh
2. Identify the contact pairs
3. Define the contact surface
4. Set the element key options and real constants
5. Define/control the motion of the target surface (rigid -to- flexible only)
6. Apply necessary boundary conditions
7. Define solution options and load steps
8. Solve the contact problem
9. Review the results

Analysis of pain tire



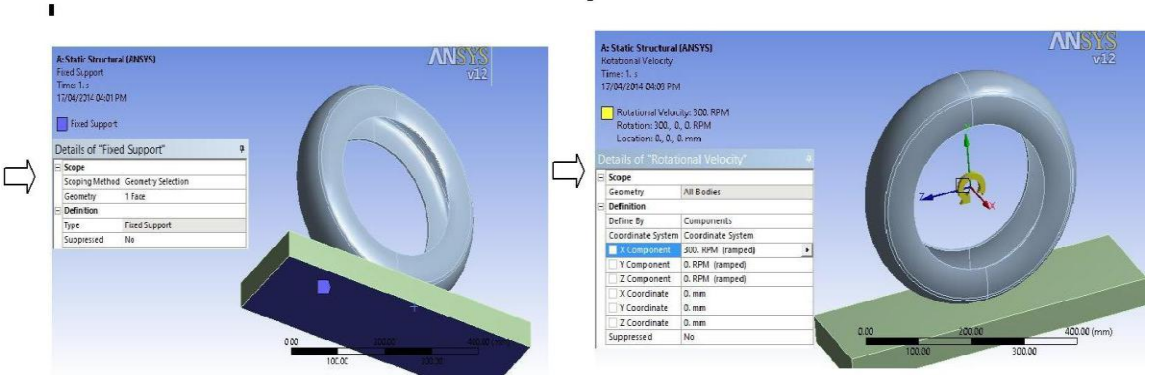
Defining contacting surfaces

Details road surfaces



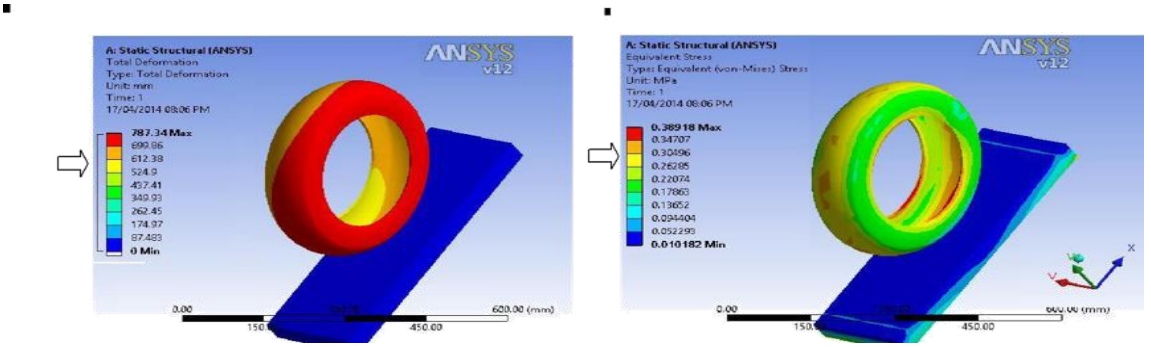
Details tire surfaces

Meshing of tire and road surface
Pressure application



Fixing of road surface

Applying Rotational Velocity

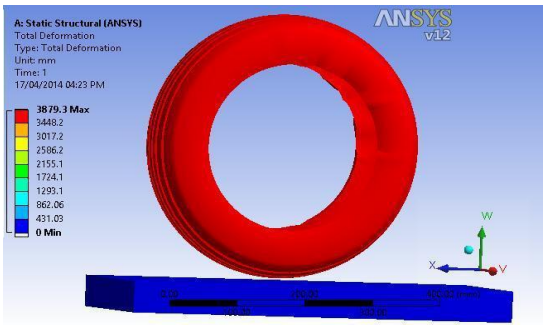


Total Deformation

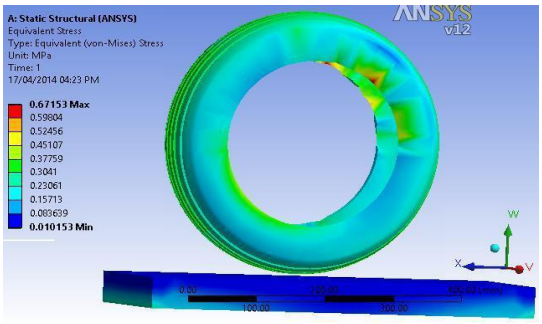
Von-mises stress

Similarly , we can have Analysis of Two remaining tire threads by going through same steps.

Analysis of line threaded tire

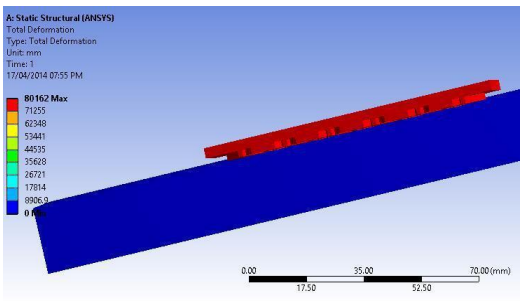


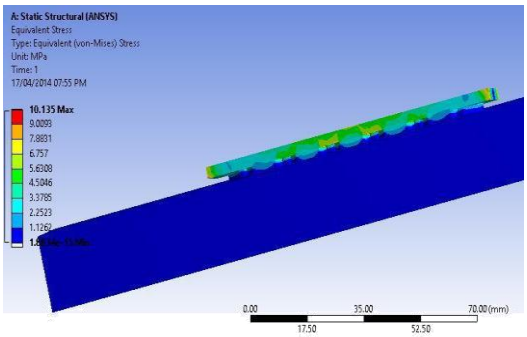
Total Deformation



Von-mises stress

Analysis of Cross threaded tire





Von-mises stress

IV. Result

The three types of threads of tire for stress analysis between road and tire surface are considered. They are Plane, Line threaded and cross threaded tire. At a constant speed of 300 m/s, all the tires are analyzed for total deformation. The Von-Mises stresses and total deformation for all of three tires as shown below,

Type of Tire	Total Deformation (mm)	Maximum Stress (MPa)	Minimum Stress (MPa)
Plane Tire	787.34	0.38918	0.010182
Line Threaded tire	3879.3	0.67153	0.010153
Cross Threaded tire	80162	10.135	0.0000018834

V. Conclusion

For identical operating conditions, three tire thread profiles are analysed. Comparing the maximum stresses and total deformation for the tires it is observed that the tire having no threads that is Plane tire have minimum stress in it and also the total deformation as compared to other two structured tires. Contact area of plane threaded tire is more than other tires and area of contact is directly proportional to friction, so sriction will be maximum in this tire. By considering all the aspect as stress, total deformation and friction the line threaded tire is optimum to use for vehicles.

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Analysis of smart grid with superconducting fault current limiters

Priyanka Mahajan[1], Paresh J. Shah[2], Rakesh Saxena[3]

[1 *] M.E. scholar, Electrical department, SSBTs COET Jalgaon, Maharashtra, India-425001, ph +91940325502
[2] H.O.D., Electrical department, SSBTs COET, Jalgaon, Maharashtra, India-425001, ph +918237466370
[3] Professor, Electrical department, SGSITS, Indore, Madhya Pradesh, India-452003,ph +919425068030
[*] peehumahajan@gmail.com, pjshahj@gmail.com, rakeshsaxena@hotmail.com

Abstract: One of most important application of superconducting fault current limiters for upcoming smart grid is related to its effect on fault current reduction. SFCL reduce fault current within the period of 1st cycle only. This paper first presents a resistive type SFCL model by integrating in Simulink-Matlab and then simulates different types of fault in smart grid and analysis is done with SFCL and without SFCL. The designed SFCL model could be utilized for determining an impedance level of SFCL according to the fault current limitation. SFCL is most attractive solution to reduced fault current. The resistive type SFCL model provides quick protection to grid. A system study shows that SFCL not only limit the fault current to an acceptable level, but also transient recovery voltage could damp. And improve the power system transient stability. SFCL also improves power system reliability and power quality by reducing the fault current instantaneously. Thus in recent power system, fault current reduction research has been directed towards the superconducting fault current limiters. The result shows that SFCL modules reduces fault current instantaneously and improve power system transient stability and power quality.

Keywords: SFCL, Smart grid, Power quality, transient recovery voltage, symmetrical faults.

I. INTRODUCTION

Now days there is increase in demand, consumption of electric energy is increase. As a result there is increase in size of generating station and interconnected network called power grid [1]. Due to increase in size of power grid and interconnection, abnormal condition is also increase. There may sudden decrease in impedance of network, which leads to increase in current known as fault current. Due to abnormal condition, high fault current flows from network. Which may damage the equipment installed, system configuration might need to change and some time get blackout also. As the equipment of power system is very expensive, their protection from such large fault current is very important. It is not possible to eliminate the fault from power system but it is possible to lower the effect of fault system. For fault reduction, there are various methods available such as: circuit breaker, shunt reactor, pyrotechnic current limiters, and numeric fuses. But the above methods having lot of disadvantages such as, circuit breaker cut the fault current at its zero crossing only and sometimes its fail to activate, if the fault current is very high in magnitude. Also it takes 3-5 cycle to cut the current. Shunt reactor have fixed impedance so they introduce fixed load, which reduce system efficiency and stability. Fuses and pyrotechnic limiters have to replace after each operation and available only for low voltage [2].

SFCL overcomes above disadvantages. It limits fault current within 1st half cycle only [3]. It have the capability of rapidly increase their impedance and limits high short circuit current. It made up of superconducting material. Superconducting materials have a highly non-linear behavior and it is ideal for the application as fault current limiters [4]. SFCL are very attractive solution for reducing high short circuit current from the technical and economical point of view. In addition, considerable economical benefits can be achieved by using SCFCLs [5].

The organization of this paper is as follows: Section II describes SFCL technology. Section IV describes the Resistive SFCL module. Section V describes modeling of resistive type SFCL.VI describes the proposed SFCL system. Section VII describes simulation results and discussion. Finally, section VIII provides conclusions regarding this paper.

II. FAULT CURRENT & SFCL ADVANTAGES

The general formula of short circuit current is describe by equation(1).

$$I = Ip\sin(\omega t + \alpha - \varphi) + [Im\sin(\alpha - \varphi') - Ipsin(\alpha - \varphi)]e^{\left(-\frac{\omega R}{X}\right)t} \quad \ldots.(1)$$

Fault current is consisting of symmetrical component and asymmetrical component [6]. It is clear that maximum fault current appears within first half cycle. So the SFCLs is available to limit the maximum fault currents within milliseconds SFCL have following advantages [7] over other current limiting devices.

a) It limits high fault current within 1st half cycle.
b) Low impedance during normal operation.
c) High impedance during fault condition.
d) It is very compatible to existing protection device.
e) It has smooth change in impedance from normal region to fault region.
f) It has low impact on environment.
g) It operates before circuit breaker recloses.

Above advantages makes SFCL best and attractive solution to reduce fault current.

III. SFCL TECHNOLOGY

Superconducting Fault Current Limiter (SFCL) have ability to reduce short circuit fault current problems. SFCL suppress the fault current within first half cycle only. Main current carrying element of SFCL is made up of superconducting material [8].fig.1 shows the fault current waveform with SFCL and without SFCL.

Fig.1 shows SFCL limits fault current within 1st half cycle only and steady state condition is achieving rapidly. The principle of SFCL is based on superconductivity. It states that "Any superconducting material is in superconducting stage as long as temperature, current and magnetic field density below to their critical limit." When these three parameters get exceed their critical limit, material lost superconductivity and quench into normal stage. This is known as quenching characteristics of SFCL [9].

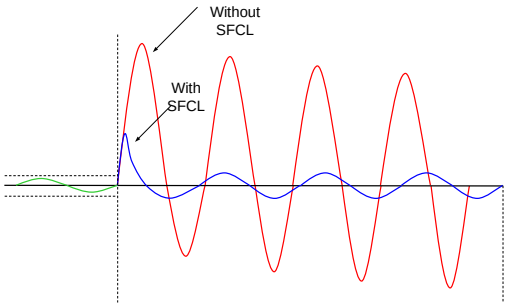


Fig.1: Fault current waveform with SFCL and without SFCL

In superconducting stage resistance of material is zero and when it quenches into normal stage resistance is very high. If there is no fault in power system, that time resistance of SFCL is very low or zero. But if any fault occurs in power system and if current exceeds their critical limit that time superconducting material quenches into normal stage and shows high resistance and instantly limit fault current. quenching process of SFCL results in heats that must be carried away from superconducting element by cryogenic cooling [10]. Fig.2 shows the principle of SFCL.

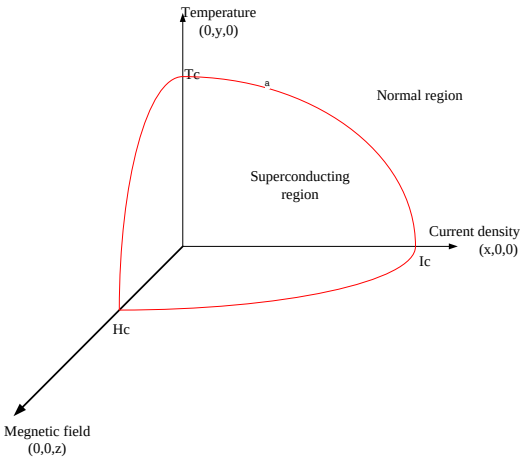


Fig.2 Principle of SFCL

There are various types of SFCLs, which can be classified in three types such as: Resistive type SFCL, Inductive type SFCL, Iron core type SFCL. In this paper resistive type SFCL is model. Resistive SFCL have following advantages over other two types of SFCL:

a) It has compact and simple size.
b) It performs resistive limiting action.
c) It has no triggering so it is intrinsically safe.

There are two types of resistive type SFCL: purely resistive RSFCL and hybrid type RSFCL. Resistive SFCL requires less cooling if hybrid type RSFCL is use in design.

IV. MODELING OF POWER SYSTEM WITH SFCL MODULE

The resistive type SFCL model developed in the Matlab-Simulink using SimPowerSystem block set. The parameters used to design such model are as: (i) Transition or response time = 2ms, (ii) maximum impedance = 20Ω, (iii) minimum impedance = 0.01Ω, (iv) Recovery time = 10ms and (v) Triggering current = 550 Amp. Figure 3 shows the Resistive SFCL model, in which RMS block is used to calculate the RMS value of incoming current which then fed to subsystem of SFCL characteristic table block. The SFCL characteristic table block is used to decide whether the impedance level goes maximum or minimum. The comparison concludes the value of resistance of SFCL as: (a) if the incoming current is below the triggering current level, then the SFCL resistance is minimum. (b) if the incoming current is exceeds above the triggering value, then its resistance is maximum close to the impedance level [11]. This results in the reduction (limit) of the short circuit fault current. Figure 4: shows the characteristic table of SFCL. In which step input and transport delay are used to set the transition, response and recovery time of SFCL [12].

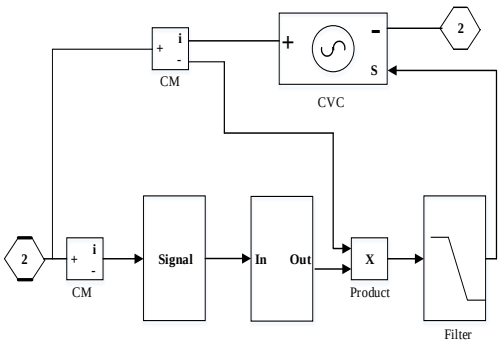


Fig. 3: SFCL Model

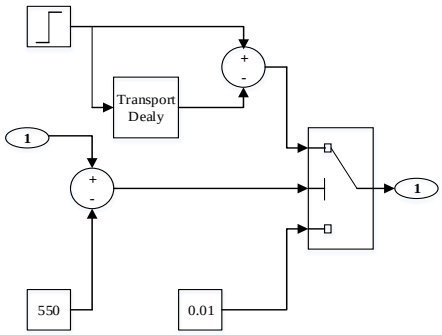


Fig. 4: Characteristic table of SFCL

The switch block is used to set the value of impedance to minimum or maximum [13]. After SFCL characteristic subsystem there is an filter block and controlled voltage source block. These are used to reduce the harmonics and to compensation of voltage sag[14] respectively.

V. PROPOSED SFCL SYSTEM

Fig. 5 shows the three phase system which is considered for the transient stability system.

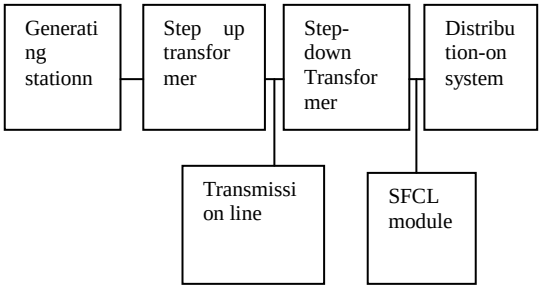


Fig. 5: Proposed 3-Phase system

The generating voltage is 11 kV. A step up transformer is used to step the voltage which will provide the voltage to the load and further distribution network. The step up transformer rated 11/33 kV.

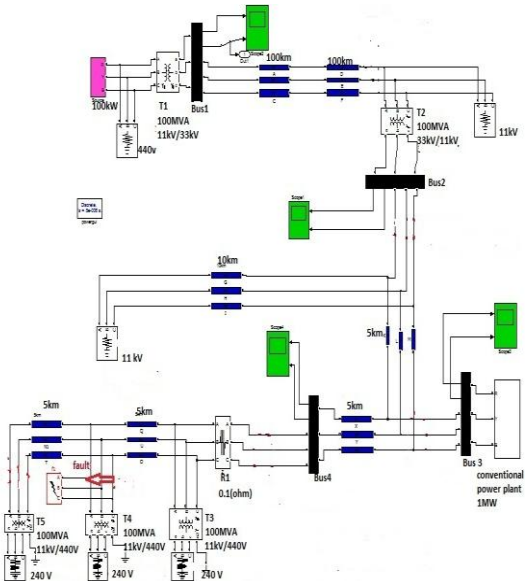


Fig.6: proposed SFCL system without SFCL

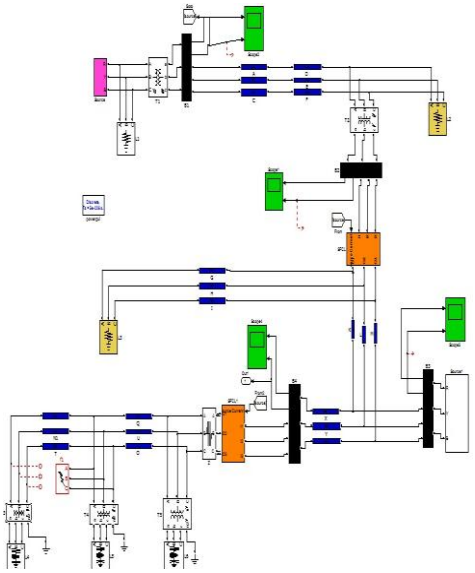
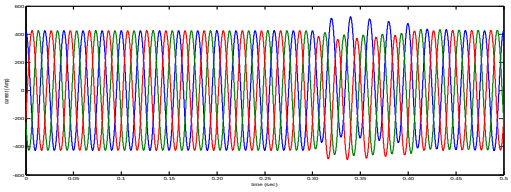


Fig. 7 proposed SFCL system with SFCL

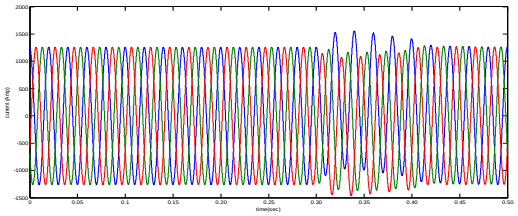
In above model wireless signal transmission is use. Source current from bus 1 is wirelessly transmitted to SFCL. The output current of all buses is analyzed in section VI.

VI. RESULTS AND ANALYSIS

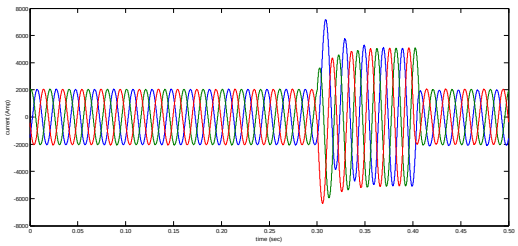
The simulation results are presented for the L-L-L-G fault simulating on distribution line. Fig.8 shows the simulation output of short circuit current without SFCL corresponding to all buses.



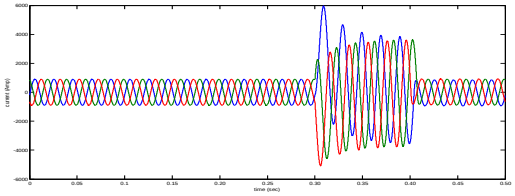
a) Bus 1



b) Bus2



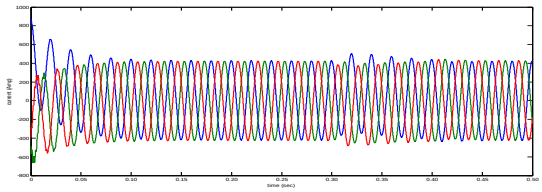
c) Bus 3



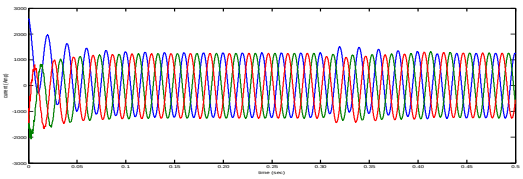
d) Bus 4

Fig.8 Fault current compensated in all buses(bus1-bus4) without SFCL

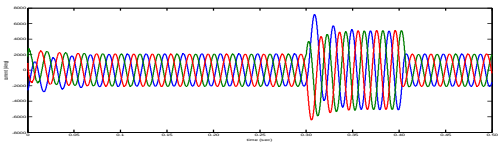
From fig.8 it is clear that when fault occurs at network, fault current exceeds their rated capacity and it may damage the equipment. But when SFCL installed in network this high fault current limits up to possible value. Fig.9 simulation output of short circuit current with SFCL corresponding to all buses.



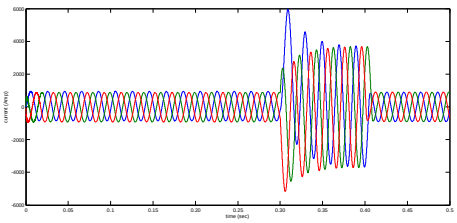
a) Bus1



b) Bus 2



c) Bus 3



d) Bus 4

Fig.9 Fault current compensated in all buses(bus1-bus4) with SFC

Fig.9 shows reduction in fault current with installation of SFCL. Numerical results are shown in table.1. it is clear from table1 and fig.9(a) that, in 1st overshoot 16A reduction in fault current with SFCL, in 2nd overshoot 27A reduction, and in 3rd overshoot 37A reduction in bus 1. Which shows that with the use of SFCL reduction of fault current is increase with overshoot. And steady state condition is achieved earlier with SFCL.

From fig.9 (b) it is clear that in 1st overshoot 34A reduction in fault current with SFCL, in 2nd overshoot 77A reduction, in 3rd overshoot 79A reduction in fault current.

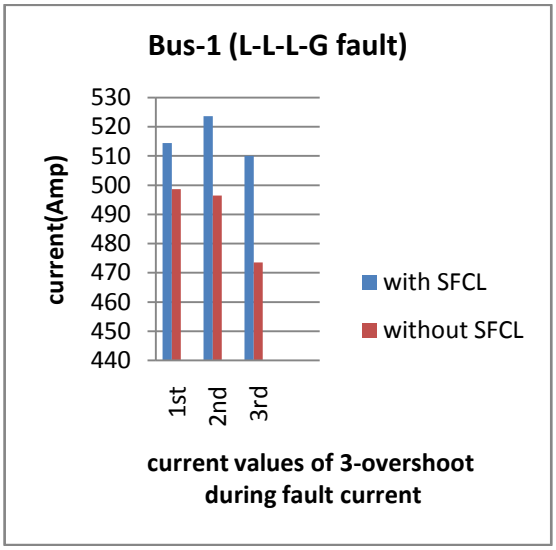
From fig.9(c) and table1 it is clear that in 1st overshoot 17A reduction in fault current, in 2nd overshoot 51A reduction, in 3rd overshoot 58A reduction in fault current.

Table 1: Values of Fault Current without and with SFCL

Faut type	Symmetrical fault (L-L-L-G fault)					
	Without SFCL (Amp.)			With SFCL (Amp)		
Bus no.	1st overshoot	2nd overshoot	3rd overshoot	1st overshoot	2nd overshoot	3rd overshoot
B1	514.4	523.6	510	498.7	496.5	473.5
B2	1530	1560	1520	1496	1483	1441
B3	7187	5777.5	5282	7170	5726	5224.5
B4	5957	4672.5	4161	5935	4568.5	4010

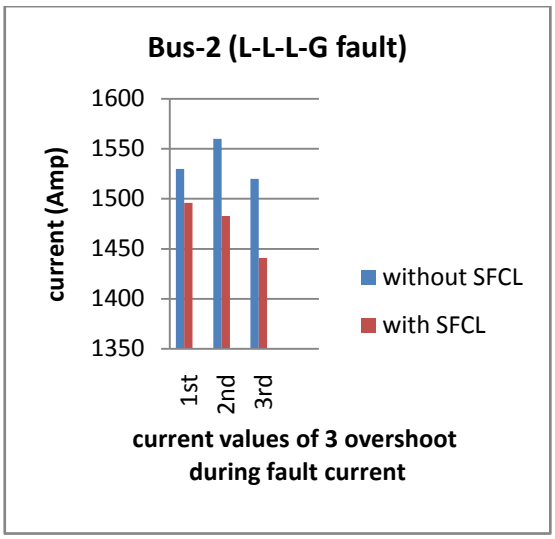
Also from fig.9(c) it is clear that in first overshoot 22A reductions in fault current, in 2nd overshoot 104A reduction, in 3rd overshoot 151A reduction in fault current.

This all results are tabulated in graphs 1-graph 4.

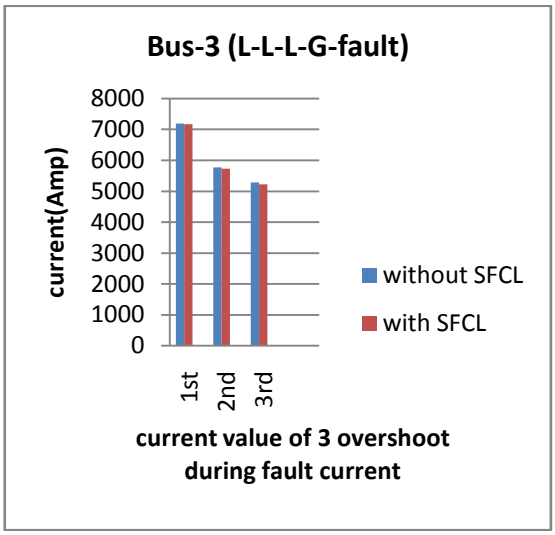


Graph.1: Fault current at bus 1 with SFCL and without SFCL

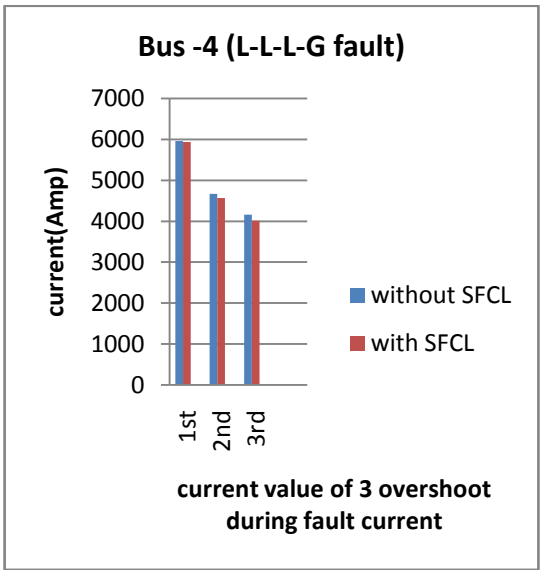
From graph.1 it is clear that when fault occurs in power system up to, 37A reduction occurs in fault current with SFCL in bus1 and 79A reduction occurs in fault current with the installation of SFCL in bus 2 in graph.2.



Graph2: Fault current at bus 2 with SFCL and without SFCL



Graph.3: Fault current at bus 3 with SFCL and without SFCL



Graph.4: Fault current at bus 4 with SFCL and without SFCL

Also From graph.3 it is clear that when three phase to ground fault occurs in power system, upto 50A reduction occurs in fault current in bus3 after installation of SFCL in network and up to 151A reduction occurs in fault current with SFCL.

VII. CONCLUSION

This paper shows the design of resistive SFCL module and the results are carried out for three phase to ground fault in transmission line as well as in distribution line. The results are tabulated in table which shows that, using SFCL module the transient rise in fault current are suppressed or limit to a desired value using SFCL. From table also conclude that, the resistive SFCL module have ability to limit the sudden rise in fault current by providing the sufficient value of resistance.

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Analysis of Reference Current Generation for Shunt Active Power Filter Using SRF Algorithm to Compensate Harmonic Current

Mr. S. M. Shembekar[1], Mr. K. L. Deshmukh[2],

[1]Assistant Professor, [2]M.E (EPS) (Pursuing),[1,2]Department of Electrical Engineering,
[1,2]S.S.B.T's COET Bambhori, Jalgaon, India,
[1]smshembekar@gmail.com
[2]deshmukh_kalpesh@ymail.com

Abstract – Number of power electronic devices used in the power system to control the equipment. These power electronic devices are responsible to produce Harmonics in the system. These harmonics may pollute the entire power system. So it is necessary to develop the system for solving these harmonic problems. At the beginning LC filter, Passive filter and Active filter has been developed. But due to the drawback of passive filter and LC filter they are less in use. So importance is being given to the Active Power Filters to solve these problems of harmonics. Amongst them shunt active power filter is used to eliminate voltage and load current harmonics and for reactive power compensation. The shunt active power filters have been developed with a controlled strategy like p-q theory, PI controller, Sliding mode control. In this paper reference current is determined for compensation of harmonics source current with the help of Synchronous Reference Frame Algorithm Method. Park transformation is used to determine the reference current. Hysteresis band current control (HBCC) technique is used for the generation of firing pulses to the inverter. This system is simulated using MATLAB and results are obtained.

Key words: Shunt Active Power Filter, harmonics, Synchronous Reference Frame Algorithm, Hysteresis current control, Reference current.

I. INTRODUCTION

The wide use of power electronics based controller technology for non linear loads, industrial machines and automation devices in industries, in commercial and households appliances, have led to a significant increase in disturbances, which affect power quality in power systems. Therefore, it is necessary to develop and implement solutions to improve power quality in electrical power systems [1-2]. Conventionally passive L-C filters were employed to reduce harmonics and capacitors were used to improve the power factor of the loads. But passive filters have the demerits of fixed compensation, large size and resonance. The increased severity of harmonic pollution in power distribution network has attracted the attention to develop dynamic and adjustable solutions to the power quality problems giving rise to active filter [3]. Now days, shunt active power filters have appeared as an effective method to solve the problem of harmonics, with reactive power compensation. Active power filters are connected to 3 phase AC transmission lines in order to eliminate voltage distortion and harmonic components. Shunt active power filter are used to eliminate the current harmonic components working as a source with only the harmonic components and power factor correction, so that only the fundamental component is supplied in the 3 phase AC lines [4-7].

The Shunt Active Power Filter is connected in parallel with the line through a coupling inductor. Its main power circuit consists of a three phase three-leg current controlled voltage source inverter with a DC link capacitor. An active power filter operates by generating a compensating current with 180 degree phase opposition and injects it back to the line so as to cancel out the current harmonics introduced by the nonlinear load. This will thus suppress the harmonic content present in the line and make the current waveform sinusoidal. So the process comprises of detecting the harmonic component present in the line current, generating the reference current, producing the switching pulses for the power circuit, generating a compensating current and injecting it back to the line. [12]

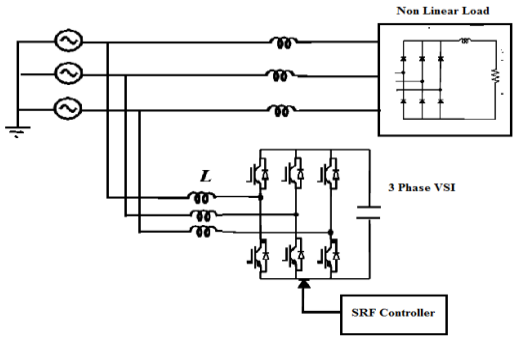

Fig No.1 3- phase shunt active power filter with SRF controller

II. SYSTEM DESIGN

A. Synchronous Reference Frame Algorithm

Various control strategies has been developed for the determination of reference currents in shunt active power filters namely Instantaneous Reactive Power Theory (p-q theory), sliding mode control strategy, Unity Power Factor method, One Cycle Control, Fast Fourier Technique etc. Here, SRF theory is used to evaluate the three-phase reference currents (i_{ca}*, i_{cb}*, i_{cc}*) by the active power used filters by targeting the source (i_{ca}, i_{cb}, i_{cc}) current Fig.2 shows the block diagram which explains three-phase SRF-theory, used for harmonic component extraction. Here in SRF theory Park transformation is used.

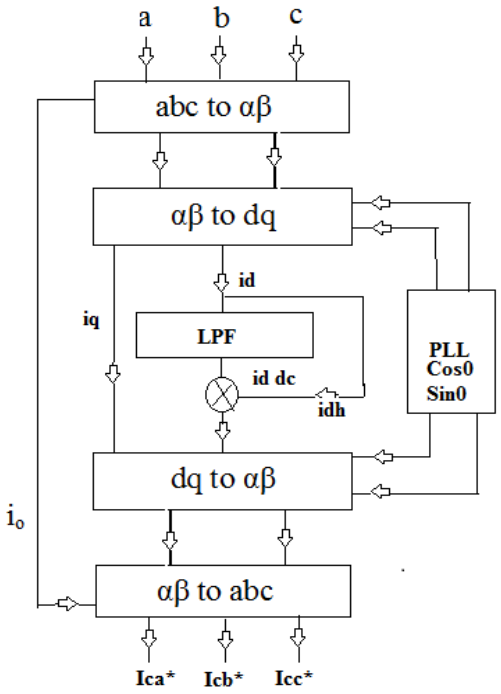

Fig No.2 Block diagram of SRF based algorithm

In this method, the source currents (ia, ib, ic) are first detected and transformed into two-phase stationary frame (αβ-*0*) from the three-phase stationary frame (a-b-c), as per equation (1).

$$\begin{bmatrix} i_\alpha \\ i_\beta \\ i_0 \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & \frac{-1}{2} & \frac{-1}{2} \\ 0 & \frac{\sqrt{3}}{2} & \frac{-\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} \quad (1)$$

Here two directand inverse parks transformation is used which allows the evaluation of specific harmonic component of the input signals and a low pass filtering stage LPF. Now, the two phase current quantities iα and iβ of stationary αβ-axes are transformed into two-phase synchronous (or rotating) frame (d-q-axes) using equation (2), where Cosθ and Sinθ represents the synchronous unit vectors which can be generated using phase-locked loop system (PLL).

$$\begin{bmatrix} i_d \\ i_q \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} i_\alpha \\ i_\beta \end{bmatrix} \quad (2)$$

The d-q currents thus obtained comprises of AC and DC parts. The fundamental component of current is represented by the fixed DC part and the AC part represents the harmonic component. This harmonic component can be easily extracted using a high pass filter (HPF), as implemented in Fig 2. The d-axis current is a combination of active fundamental current (id dc) and the load harmonic current (ih). The fundamental component of current rotates in synchronism with the rotating frame and thus can be considered as dc. By filtering id, the current is obtained, which represents the fundamental component of the load current in the synchronous frame. Thus, the AC component id_h can be obtained by subtracting id dc part from the total d-axis current (id), which leaves behind the harmonic component present in the load current. In the rotating frame the q-axis current (iq) represents the sum of the fundamental reactive load currents and part of the load harmonic currents. So the q-axis current can be totally used to calculate the reference compensation currents.

Now inverse transformation is performed to transform the currents from two phase synchronous frame d-q into two-phase stationary frame α-β as per equation (3).

$$\begin{bmatrix} i_\alpha \\ i_\beta \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} i_{dh} \\ i_q \end{bmatrix} \quad (3)$$

Finally the current from two phase stationary frame αβ0 is transformed back into three-phase stationary frame abc as per equation (4) and the compensation reference currents ica*, icb* and icc* are obtained.

$$\begin{bmatrix} i_{ca}^* \\ i_{cb}^* \\ i_{cc}^* \end{bmatrix} = [T_{abc}] \begin{bmatrix} i_\alpha \\ i_\beta \\ i_0 \end{bmatrix} \quad (4)$$

Where,

$$[T_{abc}] = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & 0 & \frac{1}{\sqrt{2}} \\ \frac{-1}{2} & \frac{\sqrt{3}}{2} & \frac{1}{\sqrt{2}} \\ \frac{-1}{2} & \frac{-\sqrt{3}}{2} & \frac{1}{\sqrt{2}} \end{bmatrix} \quad (5)$$

B. Hysterisis Band Current Control

The hysteresis band current control (HBCC) technique is used for pulse generation in current controlled VSIs. The control method offers good stability, gives a very fast response, provides good accuracy and has got a simple operation. The HBCC technique employed in an active power filter for the control of line current is shown in Fig.3. It consists of a hysteresis band surrounding the generated error current. The current error is obtained by subtracting the actual filter current from the reference current. The reference current used here is obtained by the SRF method as discussed earlier which is represented as Iabc*. The actual filter current is represented as I_f abc. The error signal is then fed to the relay with the desired hysteresis band to obtain the switching pulses for the inverter.

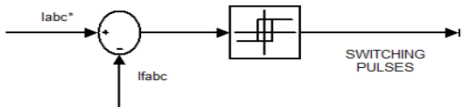

Fig No..3 Hysteresis Band Current Controller

The operation of APF depends on the sequence of pulse generated by the controller. Figure 4 shows the simulation diagram of the hysteresis current controller. A band is set above and below the generated error signal. Whenever this signal crosses the upper band, the output voltage changes so as to decrease the input current and whenever the signal crosses the lower band, the output voltage changes to increase the input current. Accordingly switching signals are generated.

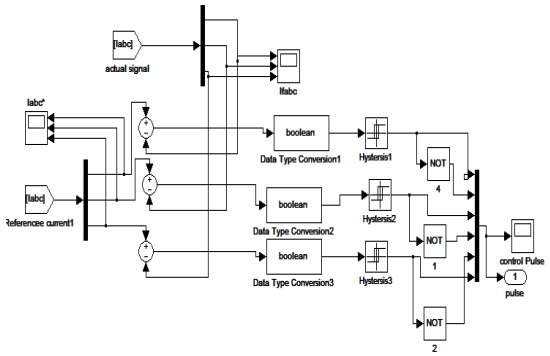

Fig No. 4 Simulation diagram of hysteresis current control

The switching signals thus generated are fed to the power circuit which comprises of a three phase three leg VSI with a DC link capacitor across it. Based on these switching signals the inverter generates compensating current in phase opposition to the line current. The compensating current is injected back into the power line at the PCC and thus suppressing the current harmonics present in the line. The overall simulation block diagram is shown in Fig 5.

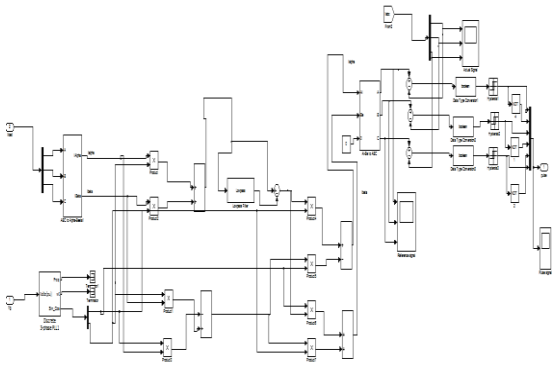

Fig No.5 Overall simulation diagram.

II. SIMULATION RESULTS AND DISCUSSION

In this paper simiulation of SRF algorithm using park transfomation hass been done which is shown in fig 5.from this the referencee signal Iabc* is produceed from SRF algorithm which is shown in fig 6. Then this refrence current is compared with actual current signal from which error signal is developed shown in fig 7. which is fed to the hystersis band control harmonic current. This developed the pulsee signal for VSI shown in fig 8.

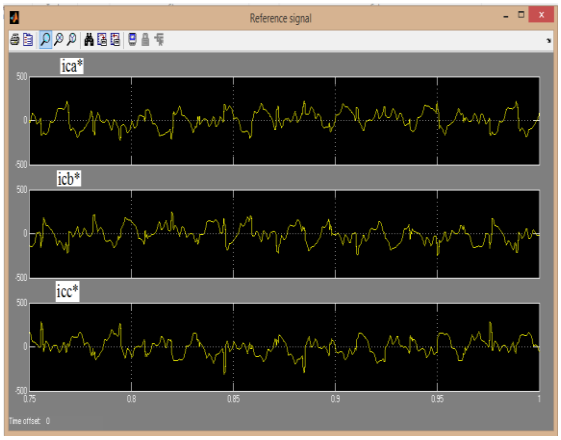

Fig No.6 Refrence current from SRF Algorithm

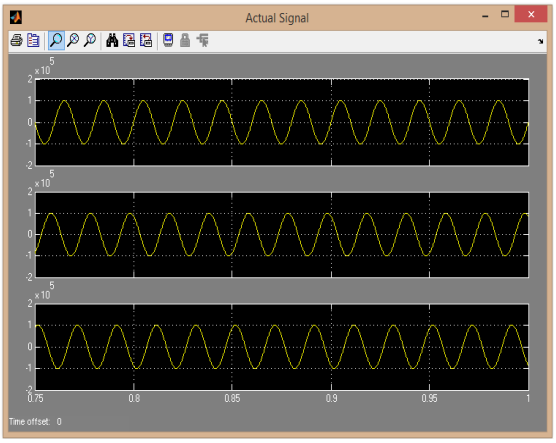

Fig No.7 Error Signal

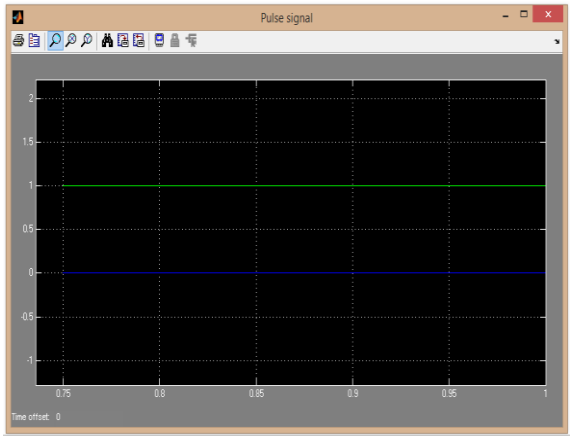

Fig No.8 Pulse signal for VSI

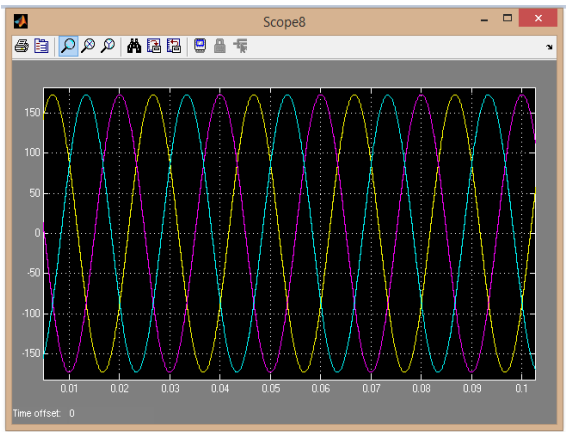

Fig No.9 VSI output

III. CONCLUSIONS

This paper describes compensation process for the line current harmonics generated due to nonlinear loads in the system. Using Synchronous Reference Frame Algorithm three phase reference current is generated, this is compared with the actual filter current and resultant signal is given to the HBCC, it provides control signal to three phase voltage source inverter. HBCC technique used for the switching pulse generation is found more effective and gives fast response.

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SHRAM SADHANA BOMBAY TRUST's
COLLEGE OF ENGINEERING & TECHNOLOGY,
BAMBHORI, JALGAON (INDIA)

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