All India Conference on

SMART GRID

17th - 18th August 2018

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Department of Electrical Engineering

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Dr. S.P. Das
Professor, IIT Kanpur

2nd Session

Er. P.K. Upadhyay
GM, BHEL Bhopal

3rd Session

Dr. R.K. Nema
Professor, MANIT Bhopal

4th Session

Er. R.N. Soni
Addl. SE, MPPKVVCL, Indore

Resource Persons

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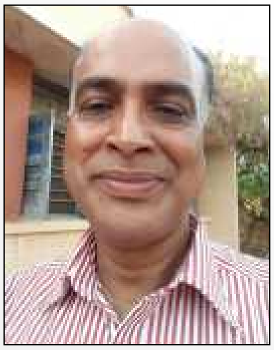
Rajkiya Engg. College
Atarra, Banda (U.P.I)



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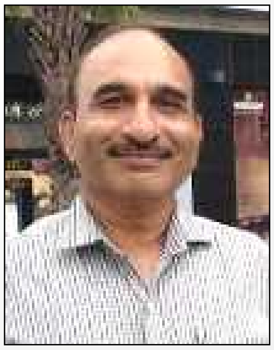
GEC, Rewa



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THE UNIVERSITY WITH DIFFERENCE

MESSAGE

I am extremely happy to know that the Department of Electrical Engineering, AKS University, Satna, M.P. is organizing All India Conference on Smart Grid during 17-18 August, 2018 at AKS University premises.

Power system stability is one of the key problems in India. Hence the 2-day Conference on energy efficient Smart Grid is need of the hour. The Conference will be enriched by contributions from reputed Resource Persons and interaction between experts, faculty members, students and industry personnel.

I am sure that the Department of Electrical Engineering will take responsibilities for creating a synergy amongst all stake holders. I extend my best wishes for the success of the Conference.

Prof. P K Banik
Vice Chancellor

Sherganj, Panna Road, SATNA-485001 (M.P.) INDIA ✆09981124776, 08889537776, Fax : 07672-404776 Website-www.aksuniversity.ac.in

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AKS University, Satna (M.P.)

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Er. Anant Kumar Soni
Chairman

Date: August 14, 2018

It is the matter of great pleasure for me that A.K.S. University Satna is organizing the All India Conference on "Smart Grid" during 17th 18th August 2018. I hope that the conference will provide a platform to the young researchers from in and around Madhya Pradesh state to show case their achievement in the various fields of Technology. This platform will provide them with a chance to meet the researcher's, academicians as well technocrat of the industries from different parts of the country. Such conference provide our academic fraternity with a chance to widen their sphere of knowledge and know-how

I wish this conference a great Success

(Signature)

Sherganj, Panna Road, SATNA-485001 (M.P.) INDIA ✆ 09981124776, 08889537776, Fax : 07672-404776 Website-www.aksuniversity.ac.in

Shyama P Das
Professor
Department of Electrical Engineering
IIT Kanpur

Message

I am very happy to learn that Department of Electrical Engineering, Faculty of Engineering and Technology of A K S University, Satna is organising an All India Conference on Smart Grid during 17-18 August 2018. The concept of power grid has undergone changes during the past one and half decades. Power demand of the country has increased. More and more renewable sources of energy are being integrated into the grid. There has been an increased need to have secured energy metering. The automation of source as well the load has taken place. Micro-grids and nano-grids have been deployed at remote and isolated areas. These small grids, at times, are integrated to the main power grid for high reliability. The digital technology has made the two way communication between the customer and utility possible. The "Smart Grid" includes Controls, Communication and Automation to respond digitally to the quickly changing electric demands, both in the source and load sides. Thus, the theme of the conference is very relevant to the modern Power Systems.

I hope these two days of conference will bring the academicians and people from industry together and will be beneficial to the working engineers, policy makes, faculty members and students.

I convey my best wishes for the conference.

(Shyama P Das)

Dr. Harshvardhan
Pro-Vice Chancellor (Development)
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To,

HOD,
Electrical Engineering Department
AKS University, Satna.

Sub. :- All India conference on **Smart Grid** (17-18 August, 2018)

Madam,

It is a matter of great pleasure that Electrical Engineering Department is organizing a National Conference on **Smart Grid** which should be very useful for the student of electrical department. As we all know that **Smart Grid** concept is based on efficient utilization of generation, transmission and distribution facilities, to be understood by all concerned of this country.

I wish a grand success of this endeavour of your department in the interest of the student and by and large all the participants shall be benefitted by this conference.

With warm regards.

Satna
11.08.18

Harshvardhan
Dr. Harshvardhan
Pro-VC (Develop)

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Date: 06th August, 2018

Message

I am very glad to be a very small part of this conference. Electrical energy in India has great potential to develop the nation. The country must capitalize on its own strengths and experiences. Now the need of the time is skilled and innovative thinking youths.

Such conferences are really very much useful to prepare the skilled and innovative youths who are the future of this country.

I extend my best wishes for the great success of this conference.

(Prof. R. N. Tripathi)
Dean, Basic Science & O.S.D
AKS University, Satna

To,

Er. Rama Shukla
Head
Department of Electrical Engineering
AKS University, Satna

Sherganj, Panna Road, SATNA-485001 (M.P.) INDIA ✆09981124776, 08889537776, Fax : 07672-404776 Website-www.aksuniversity.ac.in

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Dr G.K.Pradhan
Dean
Faculty of Engineering & Technology

14th August 2018

Message

Department of Electrical Engineering of our University is holding this 'All India Conference on Smart Grid', during 17-18 August 2018. At a time when every engineering segment is set to get 'smart', electrical engineering being the prime mover of any economic activity is far ahead of others.

In order to deliberate on various aspects of electrical energy distribution and transmission, this conference on 'Smart Grid', will benefit the industry, academia and also the students immensely.

I wish the Conference all success.

GKPradhan

Prof G.K.Pradhan

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Index

S. No.	Title	Page No.
1.	Carbon Sequestration by Enhanced Oil Recovery Method	8
2.	Effect of PV Panel Surface Temperature on Its Performance	9
3.	Impact of Lightning Overvoltage in Transformer	16
4.	Conservation of Lightning Energy: A Case Study of University Campus	19
5.	Impulse Voltage Generation Using MATLAB/Simulink	27
6.	Energy Saving in the Cement Manufacturing with different reliable ways	33
7.	Characterization of Fiber Optic Communication link for Digital Transmission System	47
8.	Calculation of Losses for Transformer Life Assessment	48
9.	Grounding Protection Methods for Grid-connected Hybrid Power Systems	58
10.	Energy Conservation for Sustainable Clinker Manufacturing and emission of CO_2 In Cement Industry	59
11.	Hot Spot Temperature measurement and Aging of A Transformer	65
12.	Fault Diagnosis of Power Transformer Bushing Using SFRA and DGA as auxiliary tools	73
13.	Size Calculation the Vertical Earth Grounding Using Nomograms	81
14.	Design of Earthing System Using Two Layer Model	82
15.	Promoting Renewable Source of Energy to Reduce Dependability on Fossil Fuels	85

CARBON SEQUESTRATION BY ENHANCED OIL RECOVERY METHOD

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Abstract - *The purpose of Carbon Capture and Storage (CCS) is to reduce emissions of greenhouse gases to the atmosphere as a climate change mitigation activity. However, given the relatively high costs currently associated with CCS, coupling CCS with Enhanced Oil Recovery (EOR) could provide a critical financial incentive to facilitate development of CCS projects in the near term. One issue is that projects to enhance oil production are primarily implemented to increase oil production with (tertiary recovery methods and any long term storage of CO2 is considered a potential ancillary benefit. When projects are designed as CCS from the start, there is typically a site evaluation process to review the storage formation according to best practice criteria for CCS. In EOR, the formation where CO2 would be stored is predetermined by the existing oil bearing reservoir, raising potential questions about monitoring, long-term CO2 storage liabilities, potential, leakage, permanence and other issues that must be addressed in CCS projects but may fall outside the boundaries of a typical EOR project.*

CONCLUSION

I. This technique uses CO2 both naturally occurring as well as byproduct of industrial process, to increase production of oil from existing oil fields.

II. CO2-EOR has direct environmental benefits as very little new land for production use.

III. Large volume of commercially available CO2, captured from industrial and power plant sources have the potential to produce billions of additional barrels of trapped oil.

IV. After completion of CO2-EOR activities, the CO2 use in oil recovery is permanently sequestrated in former oil formation

EFFECT OF PV PANEL SURFACE TEMPERATURE ON ITS PERFORMANCE

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Abstract. The panel surface temperature is a key environmental parameter that affects the performance of PV panel by changing its electrical parameters, such as open circuit voltage, short circuit current, maximum power output and fill factor. In the present study, an experimental work was carried out to investigate the effect of PV panel surface temperature on its electrical parameters. The results obtained from this experimental study show a significant reduction in the performance of PV panel with an increase in panel surface temperature. A 5W PV panel experienced a 0.39% decrease in open circuit voltage for every 1ºC increase in panel surface temperature. Similarly, there was 0.72% and 0.49% decrease in maximum power output and in fill factor, respectively, for every 1ºC increase in panel surface temperature. On the other hand, the short circuit current increases with the increase in surface temperature at the rate of 0.10%/ºC. Over and above, this study also showed that the maximum power point (MPP) in the P-V curve moves towards the lower output voltage as the surface temperature of PV panel increases.

1 Introduction

The use of energy plays a very vital role in one's life. Thus, it's supply and generation should be secure and sustainable. At the same time, it should be environmentally friendly, socially and economically acceptable. The present scenario of energy generations are neither secure nor sustainable and depends on fossil fuels, nuclear and renewable energy sources. Among these, the renewable energy could be considered as a source of secure and sustainable energy source [1]. There are different types of renewable energy sources, such as hydro, geothermal, biomass, wind and solar. Among all available renewable energy sources, solar energy experienced a rapid growth and popularity in the last one decade. Therefore, solar energy is the most promising and vital energy source to produce electricity in a present scenario [2-4].

In solar energy, photovoltaic (PV) panel is a device that converts sun radiation (solar energy) into electrical energy with the help of photovoltaic effect [5]. Photovoltaic effect is a process in which PV panel generates electric power, when it is exposed to sunlight. Sun light consists of the bundle photons, which are simply absorbed by a PV panel and when a suitable wavelength of photon incident on the panel surface, the energy of the photon is transferred to the electron of the PV material. This causes the electron to move towards a higher energy state (i.e. conduction band) from a lower energy state (i.e. valence band). This movement of electron is the main cause of generation of an electric current in the PV device [6-8].

The performance of PV panel is highly depended on the environmental parameters, such as solar radiation, wind speed, humidity, dust and atmospheric temperature. The panel surface temperature is a key environmental parameter that influence the performance of PV panel by changing its electrical parameters, such as open circuit voltage (V_{OC}), short circuit current (I_{SC}), maximum power output (P_M) and fill factor (FF) [9-10].

In general, PV panels are made of silicon semiconductor material and like all semiconductor material, PV panels are also temperature sensitive. Hence, temperature of PV panel is an important environmental parameter, which affects its performance. The panel surface temperature depends on the encapsulating material, solar radiation, atmospheric temperature, humidity and wind speed [11]. As the temperature of PV panel increases its V_{OC}, P_M and FF decreases. Moreover, the I_{SC} of PV panel experiences a very small increment with the rise in its surface temperature. As a result of this, the overall performance of PV panel reduces due to increase in its surface temperature [12]. The rise in panel temperature for c-Si PV panel decreases its V_{OC} at the rate of -0.45%/K [13]. Similarly, the decrease in power output and fill factor of the PV panel to increase in panel surface temperature are at the rate of -0.65%/K and -0.2%/K, respectively [14]. A study has shown that the 9% increments in panel efficiency due to 20% reduction in the panel surface temperature [15]. Similarly, one more study reported that with the 22ºC reduction in the panel surface temperature, its power output experienced a gain of 10.3% [16]. The available literature shows that the surface temperature of PV panel is a vital parameter that affect its performance. Therefore, in this paper, an attempt was made to understand the influence of surface temperature on PV panel performance.

2 EXPERIMENTAL SET-UP AND METHODOLOGY

A 5W polycrystalline PV panel was used to carry out the present investigation. The detail technical specifications of PV panel considered are given in Table 1. The PV panel was mounted on the flat frame with zero inclination and subjected to a constant solar radiation of 1182W/m^2. This range of solar radiation was generated by using a set of solar simulators and measured by TM-207 solar power meter. The experimental setup used in this study is presented in Figure 1. The PV panel was connected to a variable rheostat of 320Ω rating through the ammeter (connected in series) and a voltmeter (connected in parallel). A Digital Multimeter Fluke 178+ and DT830B were used as a voltmeter and ammeter in the circuit, which is given in Figure 2. To increase the surface temperature of PV panel a set of infrared dryer bulbs were used and a digital pyrometer was also used to measure the panel temperature of PV panel. The panel temperature was increased from 35ºC to 65ºC and the readings of electrical parameters (i.e. current and voltage) were taken at every increase of 10ºC of panel surface temperature. Based on the obtained reading the other electrical parameters of PV panel, such as power output and fill factor were calculated. The equation used for calculating the fill factor (FF) of PV panel is given in equation 1.

$$FF = \frac{V_m \times I_m}{V_{OC} \times I_{SC}}$$

where,

V_{OC} = open circuit voltage (volt)

I_{SC} = Short circuit current (amp)

I_m = Maximum current (amp)

V_m = maximum voltage (volt)

Table 1. Technical Specification of 5W PV panel.

Sl. No.	Specification	Rating
1	Maximum power	5 watt
2	Maximum voltage	9.64 volt
3	Maximum current	0.52 amp
4	Open circuit voltage	11.57 volt
5	Short circuit current	0.57 amp
6	NOCT	(47±2) ºC
7	Tolerance level	0 to 3%

(a) Heating of PV panel (b) Electric measurement of PV panel

Fig.1. Experimental set-up.

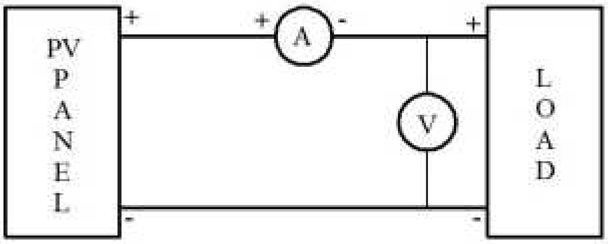

Fig.2. Circuit diagram.

3 Results and Discussions

The recorded electrical parameters of PV panel, such as V_{OC}, I_{SC}, P_M and FF under varying panel surface temperature are given in Table 3. Based on the recorded electrical parameters the current (I)-voltage (V) and power (P) -voltage (V) characteristics of PV panel are plotted. The plotting of characteristic curves was done w.r.t. only three temperatures (i.e. 35ºC, 55ºC and 75ºC) because by plotting characteristic curve for all the five temperature, the graph looks very clumsy and the characteristic curve at three different surface temperatures (i.e., 35ºC, 55ºC and 75ºC) are presented in Figure 3 and Figure 4. As depicted in Figure 3 and Figure 4, surface temperature of PV panel has a significant impact on its I-V and P-V characteristic. The current is almost same in lower voltage range but as the voltage increases a fast reduction in the current is observed for the all four defined surface temperature conditions. As presented in Figure 3 the deformation in the I-V characteristic gets increases with the panel surface temperature. There is a significant reduction in the V_{OC} of the PV panel with increases in the panel surface temperature, whereas a very small increment in I_{SC} is observed. Due to this significant reduction in V_{OC} the other electrical parameters (i.e., maximum power output and fill factor) of PV panel also reduces. Therefore, the overall performance of PV panel reduces with the rise in its surface temperature. Moreover, as presented in Figure 4 the maximum power point (MPP) in the PV curve moves towards the lower output voltage with the increase in panel surface temperature. Due to this, the maximum power point tracker algorithm would not be able to operate at a particular maximum power point, which reduces the performance of solar charge controller. Hence, the shifting of MPP in the PV curve directly affects the effective operation of the whole PV systems (i.e., PV panel and charge controller).

Table 3. Recorded electrical parameters of PV panel.

Panel surface temperature (^{0}C)	Open circuit voltage (volt)	Short circuit current (amp)	Maximum power output (watt)	Fill factor
35	9.70	0.360	2.476	0.709
45	9.30	0.360	2.202	0.657
55	8.90	0.365	2.050	0.631
65	8.55	0.370	1.950	0.616
75	8.20	0.375	1.755	0.570

As indicated in Table 3, the reduction in V_{OC} is 15.46% with the increase in panel surface temperature from 35ºC to 75ºC. Similarly, the reduction in P_M and FF are 29.12% and 19.60%, respectively, due to increase in panel surface temperature. The P_M and FF are found to decrease with increase in panel surface temperature due to change in respective current and voltage. The reduction in P_M and FF with the increase in panel surface temperature are presented in Figure 5 and Figure 6. The maximum power output and fill factor of PV panel decreases linearly with the increase in panel surface temperature. From the Table 2, the temperature coefficient for V_{OC}, I_{SC}, P_M and FF are calculated with the help of Equations (3), (4), (5) and (6). The temperature coefficient for V_{OC}, I_{SC}, P_M and FF are -0.39%/ºC, 0.10%/ºC, -0.72%/ºC and -0.49%/ºC, respectively.

$$\text{Temperature Coefficient of } V_{OC} = \frac{\Delta V_{OC}}{V_{OC} \times \Delta T} \ (\%/^{o}C) \quad (3)$$

$$\text{Temperature Coefficient of } V_{OC} = \frac{\Delta I_{SC}}{I_{SC} \times \Delta T} \ (\%/^{o}C) \quad (4)$$

$$\text{Temperature Coefficient of } P_{M} = \frac{\Delta P_{M}}{P_{M} \times \Delta T} \ (\%/^{o}C) \quad (5)$$

$$\text{Temperature Coefficient of FF} = \frac{\Delta FF}{\Delta FF \times \Delta T} \ (\%/^{o}C) \quad (6)$$

ΔT = Change in panel surface temperature (ºC)

V_{OC} = Open circuit voltage of PV panel (volt)

ΔV_{OC} = Change in open circuit voltage (volt)

P_M = Maximum power output of PV panel (watt)

ΔP_M = Change in maximum power output of PV panel (watt)

FF = Fill factor of PV panel

ΔFF = Change in fill factor

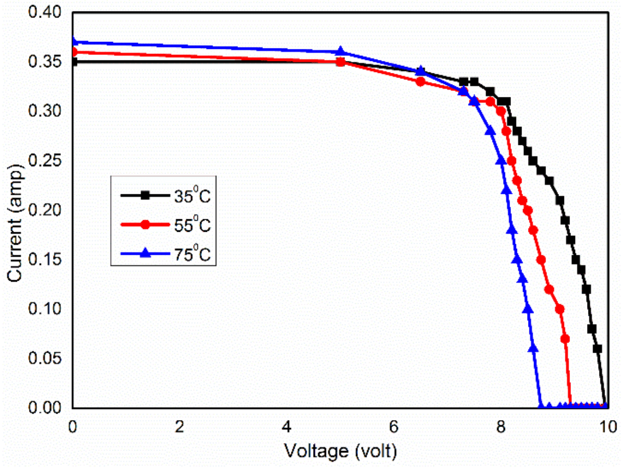

Fig. 3. Current-voltage characteristic of PV panel.

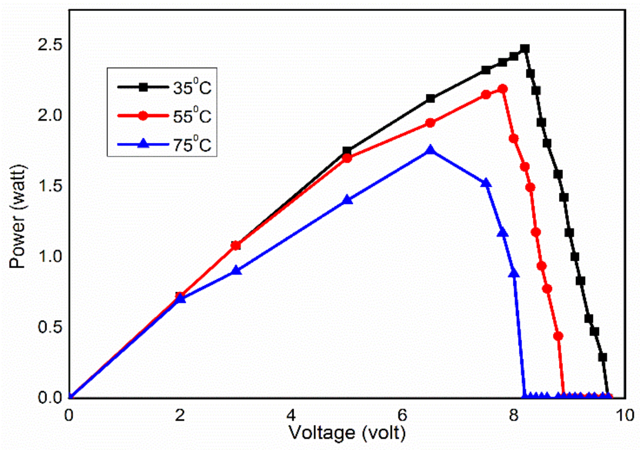

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Fig. 4. Power voltage characteristic of PV panel.

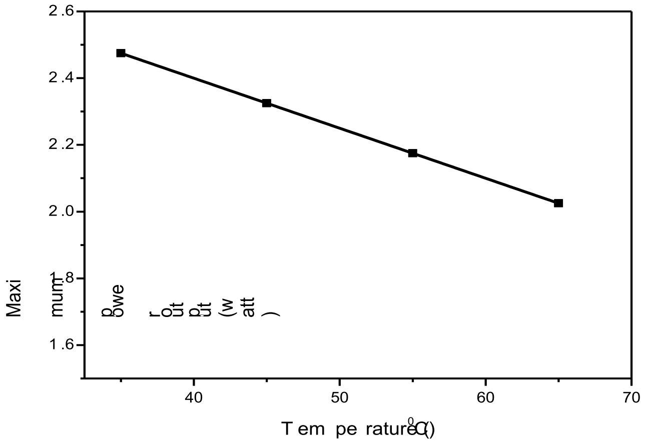

Fig.5. Variation of maximum power output with panel surface temperature.

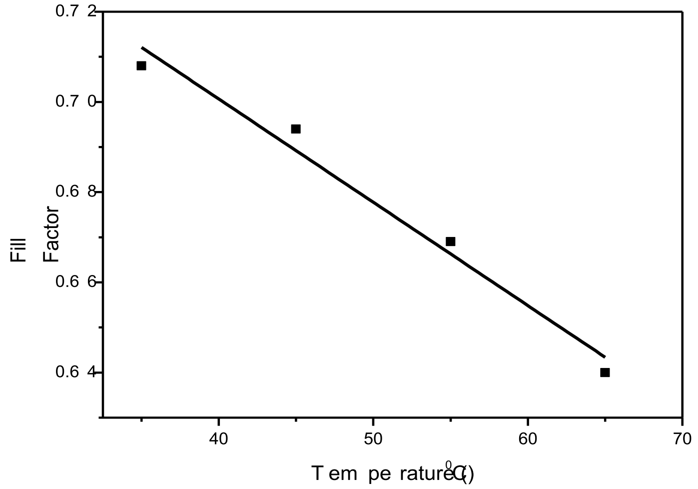

Fig.6. Variation in fill factor of PV panel with panel surface temperature.

405060700.640.660.680.700.72Fill FactorTemperature (0C)

4 Conclusions

The performance of PV panel depends on the temperature at which the panel is operating. In this study, the performance analysis of PV panel was evaluated under its varying surface temperature condition. The performance of PV panel was calculated in terms of its electrical parameters, such as V_{OC}, I_{SC}, P_M and FF. The results showed that the P_M and FF of PV panel have a negative linear relation with the panel surface temperature. According to obtained results, the reduction in V_{OC}, P_M and FF are respectively 15.46%, 29.12% and 19.60% of the increase in panel surface temperature from 35ºC to 75ºC (i.e. 40ºC increase in panel surface temperature). On the other hand, short circuit current of PV panel experiences very slight increments of 4.17% with the 40 ºC increase in panel surface temperature. Over and above, this study also demonstrates that the maximum power point (MPP) in the P-V curve moves towards the lower output voltage as the surface temperature of PV panel increases. This movement of MPP disturbs the operation of solar charge controller, which reduces the overall performance of whole

PV systems.

V_m	Maximum voltage
I_m	Maximum current
P_M	Maximum power output
V_{OC}	Open circuit voltage
I_{SC}	Short circuit current
PV	Photovoltaic
FF	Fill factor
ΔV_{OC}	Change in open circuit voltage
ΔP_M	Change in maximum power output of PV panel
ΔFF	Change in fill factor

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IMPACT OF LIGHTNING OVERVOLTAGE IN TRANSFORMER

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***Abstract*—This paper presents a calculation method for voltage transmitted between the windings of the transformer while it is being subjected to the lightning impulse; it describes the reasoning and analytical relations for the predetermination of the transmitted voltage. Software was developed in LabVIEW, in order to make the calculation more efficient and to illustrate the corresponding waveforms of the transmitted voltage determined by calculation. The study was conducted on a 50/67 MVA, TTUS- ONAN, 132/13.8/6.6 kV transformer, and the results achieved by calculation have been validated through experimental tests.**

***Index Terms*— power transformers, software, overvoltage.**

OVERVIEW

THE determination by calculation of the overvoltage transmitted between the windings of the transformer is a current necessity for both transformer designers, for the purpose of insulation sizing and for users of transformers, to correlate the existing protection devices, with voltage levels which can manifest after implementation of the new transformer in the station.

Various designs are proposed in literature for simulation (analysis) of transient phenomena in transformers, each of them using electrical parameters specific for the phenomena under study. Designs based on self-inductance and mutual inductance will be used for modeling of transient phenomena involving magnetic core performance.

Various designs were proposed [1], [2], [3], [4], [5] and [6], with transformer inductance as main component. Another type of design based on leakage inductance is shown in [7], [8] and [9], employing for simulation of short circuit phenomena also the sudden change in transformer load.

Another approach for transient phenomena in transformers was achieved with a design based on duality principle [10], [11], [12], involving time variation of magnetic flux and voltage in windings was applied to assess the time variation of current for sudden energization of transformers and voltage distribution inside the windings undergoing stress by applying switching surge or lightning impulse [13], [14], [15].

In order to obtain an analytical relation of the voltage transmitted between the energized winding of a lightning impulse and the winding with a free terminal and the other terminal with ground potential, the phenomenon was analyzed in two stages:the first stage refers to inductive transmission when the magnetic leakage is negligible and the energy exchange between the capacity and the inductance of the energized winding isnegligible;the second stage relates to the capacitive transmission between the energized winding and the winding towards which the transmission occurs, by analyzing its oscillation through energy exchange between the series capacity and self-inductance of thewinding.

- *Voltage transmission by electromagnetic induction*

The analyzed circuit has the following layout (Fig-1)

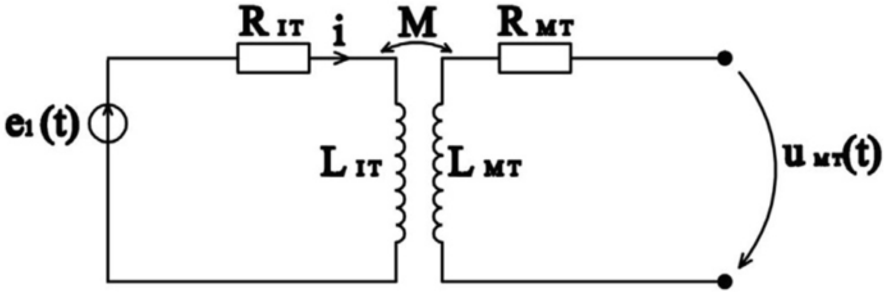

Fig.1. Equivalent circuit of the transformer for assessment of the voltage transmitted through electromagnetic induction

The results of the comparison between the measured signals and the signals resulting from the calculation are as follows:

- the maximum amplitude of the transmitted signals is the same, so is the time after which this value isachieved;
- the frequency of oscillation of the transmitted signals is approximately thesame;
- time damping of the signals is different, determined by the following approximations introduced in the analytical calculation of the signals transmitted between the windings of thetransformer:
- approximation of time variation of transformer winding conductor resistance, as a result of time variation of frequency of electric field determined by the lightningimpulse.
- Form a practical standpoint, the developed mathematical model meets the requirements of both transformer designers and future buyers because:
- dielectric stress in transformer windings can be anticipated,
- this means that can be assessed the levels of electric fields in the insulation between each pair of the turns and also in the insulation from ground of the entirewinding;
- the predetermination by calculation of dielectric stress provides the necessary conditions for optimization of transformer insulationdesign;
- before delivery of transformer it is possible to predict whether the existing protection and signaling in the electric substation are compatible with the levels provided by the technical performance of thetransformer.

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CONSERVATION OF LIGHTNING ENERGY: A CASE STUDY OF UNIVERSITY CAMPUS

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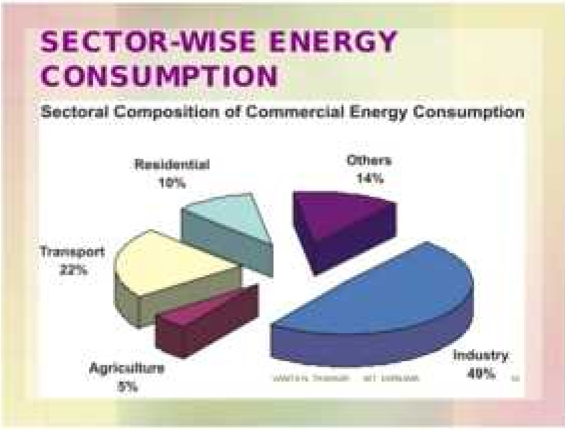
Abstract-*Recent energy scenario shows that trend of energy consumption continuously increases with time but the dependency of different conventional energy sources is remains constant. As we know the crises for these energy sources are continuously increasing so we have to conserve the energy. As we know the most of the electrical energy is generated by thermal power stations which have coal as main energy source. The crisis for coal is continuously increasing so for the optimum utilization of this electrical energy we have to use various energy efficient systems to compensate the energy consumption. As we know a major portion of electrical energy is consumed by different sectors by using different lightning sources hence we have to use different energy efficient lighting system to conserve the energy. This paper deals with the conservation of lightning energy by employing different energy efficient lighting system.*

I. INTRODUCTION

India is significant consumer of energy resources and has over 17% of world's population. As compared to other countries such as Japan, China, Russia and US India has its maximum utilization of energy in different sectors (Residential, Commercial, Agricultural purpose, etc.) [1]. India is the world's third largest producer of electricity about 1,400,800 GWH and third largest consumer followed by China which produces about 6,495,140 GWH, and the United States producing about 4,350,800 GWH. Government of India is going to launch a scheme known as “Power of All” in order to address the lack of adequate electricity supply for all peoples. In 2017-18 India produced about three- fourth of all electricity by fossil fuels, and also by coal which are dominated as India's electricity sector [2]. As we have discussed earlier that in domestic, commercial and industrial sector, lighting system consumes important amount of energy. The total energy consumption in the commercial buildings is about 50% and is about 10% in industries and the rest 40% in residential areas. There are many places where it is found that they have inefficient lightning designs for any particular task. [3] As energy is very much important for every purpose today so to reduce the average demand of the conservation of energy is an important mean. According to the observation the investment done in energy conservation and energy efficiency is highly cost effective. [4]

II. ELECTRICITY SECTOR IN INDIA

Energy plays an important role to have a sustainable growth rate of India, as it is a growing and one of the most populated countries in the world. India has raised its power generation capacity much from the time of independence. [5] The demand for energy is increasing day by day. Since coal and fossil fuel are an important source of energy but it is not very vast and demand increases day by day so it can be a great situation of our future because it may by totally depleted with time and it takes very much time about millions of year to form.



From total generation of energy the different sector uses the energy according to their particular task. The total sectrol composition of commercial energy consumption in industry is about 49%, about 22% in transport, about 10% in residential, about 5% in agricultural and about 14% others. These divisions of energy consumption has been done sector wise.

I. COMPARSION OF DIFFERENT TYPES OF LIGHTNING SOURCES

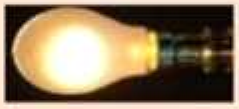
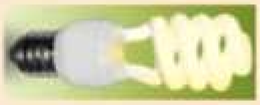
Artificial lightning consumes one-fifth of global electrical energy [6] while 50-70% of general use lighting is provided by conventional incandescentlamp (GLS) [7] that are 90-95% ineffectual. IL has short bulb life as it converts about 90% of electrical energy into heat. [8] According energy consumption and durability CFL are the much better and has more efficiency than IL [9] but the CFL has the mercury filled inside at which is hazardous material and also it faces recycling problems. [10] So to resolve this problem a distinctive lightning technology called light emitting diode (LED) is used. The LED has low power consumption compare to the other two bulbs (IL and CFL). These bulbshas better efficiency, more durability, high tolerance to moisture, no recycling issue like as in CFL and IL, also it does not release any radiation [11-13] so we can replace the conventional light bulb with LED for energy consumption, better performance, cool operation elongated life and are highly efficient. [14, 16]

Light Output	 Light Emitting Diodes (LEDs)	 Incandescent Light Bulbs	 Compact Fluorescents (CFLs)
Lumens	Watts	Watts	Watts
450	4-5	40	9-13
800	6-8	60	13-15
1,100	9-13	75	18-25
1,600	16-20	100	23-30
2,600	25-28	150	30-55

Important Facts	 Light Emitting Diodes (LEDs)	 Incandescent Light Bulbs	 Compact Fluorescents (CFLs)
Sensitivity to low temperatures	None	Some	Yes - may not work under negative 10 degrees Fahrenheit or over 120 degrees Fahrenheit
Sensitive to humidity	No	Some	Yes
On/off Cycling Switching a CFL on/off quickly, in a closet for instance, may decrease the lifespan of the bulb.	No Effect	Some	Yes - can reduce lifespan drastically
Turns on instantly	Yes	Yes	No - takes time to warm up
Durability	Very Durable - LEDs can handle jarring and bumping	Not Very Durable - glass or filament can break easily	Not Very Durable - glass can break easily
Heat Emitted	3.4 btu's/hour	85 btu's/hour	30 btu's/hour
Failure Modes	Not typical	Some	Yes - may catch on fire, smoke, or omit an odor

Energy Efficiency & Energy Costs	 Light Emitting Diodes (LEDs)	 Incandescent Light Bulbs	 Compact Fluorescents (CFLs)
Life Span (average)	50,000 hours	1,200 hours	8,000 hours
Watts of electricity used (equivalent to 60 watt bulb). LEDs use less power (watts) per unit of light generated (lumens). LEDs help reduce greenhouse gas emissions from power plants and lower electric bills	6 - 8 watts	60 watts	13-15 watts
Kilo-watts of Electricity used (30 Incandescent Bulbs per year equivalent)	329 KWh/yr.	3285 KWh/yr.	767 KWh/yr.
Annual Operating Cost (30 Incandescent Bulbs per year equivalent)	$32.85/year	$328.59/year	$76.65/year

Table 1 - Light bulb efficiency comparison

Comparison Chart LED Lights vs. Incandescent Light Bulbs vs. CFLs			
	(LEDs)	Incandescent Bulbs	Compact Fluorescents (CFLs)
Energy Efficiency & Energy Costs			
Contains the TOXIC Mercury	No	No	Yes - Mercury is very toxic to your health and the environment
RoHS Compliant	Yes	Yes	No - contains 1mg-5mg of Mercury and is a major risk to the environment
Carbon Dioxide Emissions (30 bulbs per year) CARBON FOOTPRINT	451 pounds/year	4500 pounds/year	1051 pounds/year

I. ENERGY CONSERVATION OF THE END USER

Today, there is a huge gap between energy generations and energy demand to bridge this gap there should be increase in generation of energy. At same time the energy generation fuels which are coal and fossil fuel will also be depleted. A survey was conducted in 1992 for the improvement in efficiency of the end user so as to be essential because to fill thegap between energy generation and energy demand the major area of conservation is the end user sector. Through end user around 15,000 MW of the energy can be saved. [15] For conservation of energy the inefficient lights fitting should be replaced by efficient one as the lightning energy is the most significant field for energy consumption. For every sector that can be domestic, commercial, industrial, it lightning's is needed but in some cases the indoor lighting get much important than domestic building which gets less importance.

II. HEAT PRODUCED

The various types of bulbs are available which emit lots of heat and are not energy efficient. The heat produced by the lightning alternative are often overlooked but while purchasing we should know about it so that to buy energy efficient a light bulb. The heat producing a bulb can cause fire hazards at releasing of much heat and also increase the cooling cost.

According to test done we get a result how much the heat is produced by lightning bulb which is shown below in a table: -

LIGHTNING BULB	HEAT PRODUCE (*F)
Incandescent bulb 35.4	3
CFL 79.2	1
LED 7.2	8

I. CO_2 EMISSION

Comparison of the actual volume of CO2 gas emitted as the result of illuminating a 60W incandescent bulb, an equivalent compact fluorescent bulb (14W) and an equivalent light emitting diode bulb (7W) for 24 hours using US grid electricity.[17]

Incandescent bulb:

60W × 24 hrs. = 1.44KWH = 0.798 kg CO_2 emission

Compact fluorescent bulb:

14W × 24 hrs. =0.336KWH = 0.186 kg CO_2 emission

LED bulb:

7W × 24 hrs. = 0.169 KWH = 0.093 kg CO_2 emission

II. A CASE STUDY OF REPLACING EXISTING LIGHTNING SYSTEM BY LED LIGHT IN THE AKS UNIVERSITY CAMPUS (BLOCK 'C')

A survey was conducted to an AKS University campus and found that 120 number of fluorescent lamp (T5) fixture is connected to the entire campus for vigilance purpose. All the lights are operated for around 07 hours at day (9AM-4pm) for every day. During the seasonal change the operation duration may vary. By observation it is seen that the light remains operated through the year irrespective of holidays and vacations for vigilance purpose. To drive a fluorescent tube, inductive ballast or electronic ballast is required while LED tube does not need such kind of ballast.

In the university campus block 'C' fluorescent tube light fitting according to different watts:

28watt: - 73 no of tube lights

30watt: - 6 no of tube lights

40watt: - 41 no of tube lights

FLUORESCENT TUBELIGHT REPLACED TO LED TUBE LIGHT

FLUORESCENT TUBELIGHT		LED TUBELIGHT	
Watts	Lumen	Watts	Lumen
28w	2520lm	22w	2530lm
30w	2700lm	24w	2760lm
40w	3600lm	32w	3680lm

Taking 07 hrs of operation in a day for 317 days

For 28 watts fluorescent tube light:-

Annual consumption of single fluorescent tube light: - 317*7*28*1=62,132 Watt hrs

Annual consumption of 73 fluorescent tube light: - 317*7*28*73= 4, 53,563 Watt hrs

4, 53,563/1000 = 453.563 kWh

4,535.63 units (1 kWh = 1 unit)
Considering unit cost as Rs.8/- 4,535.63*8 = 36,285.04/-
For 30 watts fluorescent tube light:-
Annual consumption of single fluorescent tube light: - 317*7*30*1=66,570 Watt hrs
Annual consumption of 6 fluorescent tube light: - 317*7*30*6= 3, 99,420 Watt hrs
For 30 watts fluorescent tube light:-
Annual consumption of single fluorescent tube light: - 317*7*30*1=66,570 Watt hrs
Annual consumption of 6 fluorescent tube light: - 317*7*30*6= 3, 99,420 Watt hrs
3, 99,420/1000 = 399.420 kWh
399.420 units (1 kWh = 1 unit)
Considering unit cost as Rs.8/- :- 399.420*8 = 3,195.36/-
For 40 watts fluorescent tube light:-
Annual consumption of single fluorescent tube light: 317*7*40*1=88,760 Watt hrs
Annual consumption of 41 fluorescent tube light: - 317*7*40*41= 36, 39,160Watt hrs
36, 39,160/1000 = 3,639.160 kWh
3,639.160 units (1 kWh = 1 unit)
Considering unit cost as Rs.8/- :- 3,639.160 *8 = 29,113.28 /-
Total annually cost for fluorescent tube light = 36,285.04 + 3,195.36 + 29,113.28 = 68,593.68/-
For 22 watts LED tube light:-
Annual consumption of single LED tube light: - 317*7*22*1=48,818 Watt hrs
Annual consumption of 73 LED tube light: - 317*7*22*73= 35, 63,714 Watt hrs
35, 63,714/1000 = 3,563.714 kWh
3,563.714 units (1 kWh = 1 unit)
Considering unit cost as Rs.8/- : 3,563.714*8 = 28,509.71/-
For 24 watts LED tube light:-
Annual consumption of single LED tube light: - 317*7*24*1=53,256 Watt hrs
Annual consumption of six LED tube light: - 317*7*24*6= 3, 19,536 Watt hrs.
3,19,536/1000 = 319.536kWh 319.536 units (1 kWh = 1 unit)
Considering unit cost as Rs.8/- :- 319.536*8 = 2,556.28/-
For 32 watt LED tube light:-
Annual consumption of single LED tube light: - 317*7*32*1=71,008 Watt hrs
Annual consumption of 41 LED tube light: - 317*7*32*41= 29, 11,328 Watts
29,11,328/1000 = 2,911.328 kWh
2,911.328unit (1 kWh = 1 unit)
Considering unit cost as Rs.8/- :- 2,911.328*8 = 23,290.62/-
Total annually cost for LED tube light = 28,509.71 + 2,556.28 + 23,290.62 = 54,356.61/-
Hence annual energy saving is (8,577.210 – 6,794.57) = 1,782.63 units
Annual savings in energy cost is :- (68,593.68 – 54,356.61) = 14,237.07 /-

I. CONCLUSION

It is found that the improvement of end user efficiency with proposed higher efficient LED tube light provide significant result for campus lightning system. It is also found that the operating life of LED system is reasonably high which results large savings in initial investment on long term basis as compared to the existing fluorescent tube light (T5). It is also found that the initial investment for LED tube light is more but has a payback period about 3-4 years. It is found that around 20.75% of annual energy consumption can be reduced by replacing the fluorescent tube lights by LED tube lights.

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IMPULSE VOLTAGE GENERATION USING MATLAB/SIMULINK

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Abstract: Increase in demand for electrical energy has led to increase in both the size and capacity of electrical power system. The quality of the power system relies on the reliability of its apparatuses such as transformer, transmission lines, insulators, circuit breakers etc. The transient voltage caused due to internal or external abnormalities may affect the health of the equipment or the insulation. The insulation of such equipments must be tested under the given artificial lightning or switching overvoltages to find the insulation's transient voltage withstanding capacity before making it to the part of the system. This paper describes MATLAB/Simulink implementation of Multi-stage impulse voltage generator circuit used to generate the impulse voltages of 1.2/50µs or 250/2500µs in high voltage laboratories for testing the impulse voltage withstanding capacity of insulation and equipment. This model is simulated to enrich the practical skills of undergraduate students in high voltage generation techniques. The suggested technique has been successfully united into high voltage engineering course at CHARUSAT University, Changa, Gujarat,India.

Keywords- Marx Impulse Voltage Generator, Impulse Voltage Wave, MATLAB.

I. INTRODUCTION

Computer-based teaching-learning makes the students continuously active and flexible. These advantageous properties of these tools have been increasingly used in educating students of heard engineeringsubjects such as computer, electrical and mechanical engineering of the past years [1]. The computer based simulation models used as education tool in electrical engineering supports the coaching by empowering the instructor through computer-generated output, to clarify the characteristics and performance of components and equipments under applied overvoltage circumstances[2].

The software implementation as a part of laboratory trials not only improve practical skill but also give an opportunity to students to validate the outcome of hardware and relate them with gained through simulation.

Such assessment brings the opportunities for the students to recognize the boundaries of simulations and hardware and, as a counterpoint, realize that PC based simulations cannot be a supplement of actual hardware as it might not precisely signify actual performance of apparatus under the overvoltage conditions due to some modelling assumptions. Besides, the course on high voltage engineering at undergraduate incorporate up-to-date PC based simulation and hardware tools in both theory and practical sessions to meet the expectation of today's students in every aspect of a course[2].

The simulation tools must be integrated for experimentation in high voltage engineering to supply useful preliminary training to the students before they come to the laboratory. The goal of this work is to demonstrate the computer aided Simulink model of the impulse voltage generator used in highvoltagelaboratories for assessing the quality of the insulation under various types of overvoltages. The 5-stage impulse voltage generator is developed and simulated using MATLAB/Simulink and Power System Blockset(PSB).

II. MATLAB/SIMULINK AND POWERSYSTEM BLOCK SET (PBS)

Simulink is an expansion of MATLAB purposely designed to model, analyze and simulate a wide variety of dynamic systems. It provides a graphical user interface to build a block diagram models using pull and drop operations [3]. The PSB is a constructive software package to build up a verity of models for power system applications in the MATLAB/Simulink background. Its graphical user interface and extensive library provides power engineers and researchers to build simulation models speedily and effortlessly [2]. MATLAB and Simulink/PSB have been widely used by educators to enhance education of various engineering courses such as power electronics, power system, high voltage engineering etc. Of course, other commercial software package like PSPICE is often used in education with its strengths andweaknesses.

The motive of selecting MATLAB with its toolboxes was; it is utilized virtually in all courses of undergraduate at the author's institution as an analysis tool to emphasize the education on entire electrical systems. Therefore, students can access MATLAB easily as they have acquired the basic skills previously about to use the given Simulink models before coming to the high voltage engineering laboratory[2].

III. MULTISTAGE IMPULSE VOLTAGE GENERATOR

Multistage Impulse Voltage Generator is also known as Marx impulse voltage generator. The principle on which Marx Generators work is; the capacitors are charging in parallel and discharging in series into the load circuit. The overvoltage of impulsive nature produced by this generator is used in testing of HV apparatus such as transformers, cables and insulators. Fig. 1 shows the schematic drawing of Marx impulse voltage generator. The charging resistors (R_s) needs to be properly sized for both charging and discharging, generally in the order of 10 to 100 kΩ [4]. Each resistor will design to have a maximum voltage between 50 to 100 kV. The generator capacitance *C* is chosen in such a manner that the product CR_s will be about 10 s to 1 min [4].

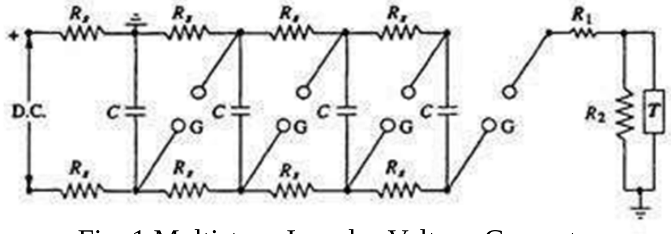

Fig. 1 Multistage Impulse Voltage Generator

In the Marx's generator, the wave shaping circuit is connected externally to the capacitor unit. The wave shaping circuit comprises of wave front resistor (R_f or R_1) and wave tail resistor (R_t or R_2). The time taken for charging (rise time/front time) is three times the time constant of the circuit and is given by [4, 5,6]:

$$T_f = 3 \times R_f \times \frac{C1 \times C2}{C1+C2} \quad (5)$$

The time taken for discharging (fall time/tail time) is given by the time taken to achieve 50% of peak value during discharging that occurs through the parallel combination of the generator capacitance, load capacitance and the series combination of R1 and R2 [4, 5,6].

$$T_t = 0.7 \times (R_f + R_t) \times (C_1 + C_2) \quad (6)$$

Standard impulse testing method requires the application of a specified wave-shape. IEC60060-1 and -2 arean international standard that specifies the high voltage measuring equipment and technique for impulse testing. As per the international standard, a full lightning impulse wave-shape is specified as having a wave fronttime(T_f) of1.2μs±30%and awavetail time(T_t) of50μs±20%[7, 8].

I. SIMULINK PSB MODEL

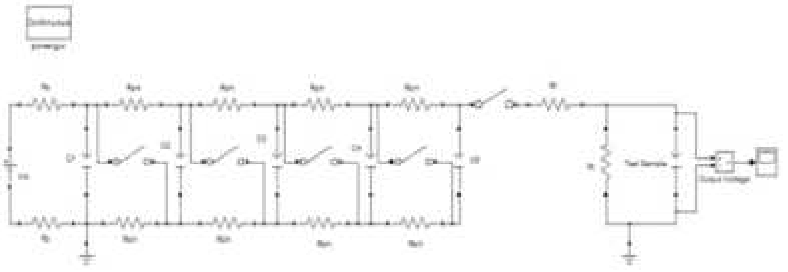

Fig. 2 Multistage (Marx) Impulse Voltage Generator

Fig. 2 shows the Simulink model of Marx impulse voltage generator. The triggering circuit is demonstrated by switches (G_1 to G_5). The impulse voltage of standard time is obtained by triggering all five switches at the same instant. Each of the five stage capacitors are initially charged with a voltage of 10 kV, 15 kV, 20 kV and 25 kV respectively in steps, are the same as that used in the actual impulse voltage generator in laboratory at author's institute. The wave front resistor allows the wave to reach peak magnitude in the desired time andwavetailresistorallowsattaining50%ofpeakmagnitudeattheendortailofthewaveshape.

Table.1 Circuit Parameters

Parameter	Value
Charging Resistor	270 k?
Generator Capacitors (C1 to C5)	0.7 μ F
Load Capacitor (Test Sample)	3000 pF
Wave Front Resistor	32 ?
Wave Tail Resistor	750 ?

Table 1 shows the values of circuit parameters used for simulating the impulse voltage generator.

I. COMPARISION OF SIMULATION RESULTS WITH EXPERIMENTAL SETUP

To demonstrate the usefulness of the projected simulation models, the results obtained from simulations are match up with those achieved from hardware experiments. Fig.3 shows 5-stage Marx impulse voltage generator located at CHARUSAT University's High VoltageLaboratory.

Fig. 3 Marx Impulse Voltage Generator at CHARUSAT University

A set or hardware experiments are first performed to obtain the output voltage which is then compare with the output of the simulation circuits. Furthermore the simulation software is used to explain more about the effect of change in various parameters over the performance of 3-stage Cockcroft-Walton voltage multiplier and also the effect of wave shaping resistors over the performance of impulse voltage generator before the students. The resulting outputs for these circuits are shown in tables 2 & 3respectively.

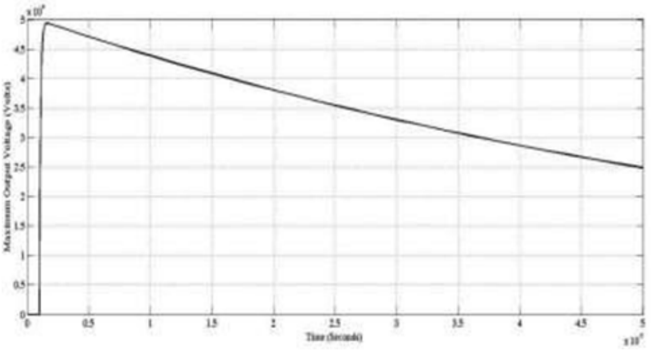

Fig. 4 Peak Output Voltage Waveform of Marx impulse generator at 10 Kv

Fig.4 shows the simulated result for peak output voltage of Marx impulse generator at 10 kV charging voltage.

Charging Voltage (kV)	Maximum Impulse Voltage Magnitude (kV)		
	Expected Result	Experimentally obtained inLab	Simulated Result
10	50	48.9	49.30
15	75	73.35	74.00
20	100	97.8	98.70
25	125	122.25	123.34

Table.2 Comparison of Simulated and Experimentally obtained Results

Wave Front Resistor	Wave Tail Resistor	Wave Front Time (μs)	Wave Tail Time (μs)	Max. Output Voltage (kV)
100 Ω	1 kΩ	0.88	23.27	132.5
1 kΩ	5 kΩ	8.81	600.6	120.8

Table.3 Influence of wave shaping resistor (Charging Voltage = 10 kV)

Table 3 show the influence of the wave shaping resistor over the performance of the impulse voltage generator. It can be seen that, with increase in the values of wave shaping resistors, the output voltage wave takes longer time to obtain the peak magnitude and also reduces towards zero with slow rate. Moreover, with increase in the resistor values, the output voltage also reduces. The same impulse voltage generator not only used for the generation of overvoltages of shorter duration but also for generating the longerduration.

I. INTEGRATION OF SIMULINK MODEL INTO HIGH VOLTAGE COURCE

In this segment, the writer has illustrated the coordination of this Simulink model into high voltage engineering course at CHARUSAT University, Changa. In order to incorporate simulation model of impulse voltage generator circuit into the syllabi, the Department of Electrical Engineering at CHARUSAT University has proposed two different courses: (1) high voltage engineering (EE308.01) that concentrates on the fundamentals of insulations, generation and measurement of high voltages and the testing of high voltage electrical equipments and (2) simulation lab-II (EE311) at undergraduatelevel.

The laboratory session (two hours a week) of simulation lab-II gives the opportunity to the students to simulate the impulse voltage generator circuit and verify the data essential to realize the operation of the above said circuits thoroughly. A week before the software laboratory, the Simulink/PSB models of these circuits and a detailed procedure describing how each model is to be generated in Simulink environment are made available to students [2].

During the practices on hardware, learners are informed to carry out the experiment on generation of impulse voltage. Analogous to what is executed with the software; they take measurements to observe the effects of change in various parameters over the function of the impulse voltage generator. As a consequence of the experience gained in the software laboratory, students seem to be more familiar with theory and function of this circuit[2].

Moreover, as shown in Table 2, this equivalency is not the case, and trivial differences are witnessed between the results of simulated and experimentally recorded. In reports, learners are expected to present clarification for these differences. These differences might be the consequence of modelling of the multistage impulse voltage generator through software package or due to the errors often appeared during the measurement through hardware. Needless to say, the suggested simulations make aware the students towards the experimental technique and the predictable results before implementing the physical experiment at high voltage laboratory[2].

II. CONCLUSION

In this paper, the author has offered the computational model of Marx impulse voltage generator used to generate transient overvoltage of long and short duration used for testing the insulation strength of high voltage equipments. Simulink model is clarified in specific way and its result is linked with the equivalent hardware setup. The study shows that MATLAB combined with Simulink/PSB is a good simulation tool to investigate characteristic of impulse voltage. Additionally, a fruitful mixture of simulation models with corresponding hardware not only complements classroom and laboratory coaching but also gives an opportunity to learner for getting thorough understanding of impulse voltage generator. A comprehensible extension of the software laboratory would be to support the education related to impulse voltage generation by including Simulink/PSB model based experiment such as parametrical analysis of impulse generator, impulse testing of transformers andinsulators.

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ENERGY SAVING IN THE CEMENT MANUFACTURING WITH DIFFERENT RELIABLE WAYS

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Abstract - *The cement industry occupies a front position in the ranks of energy consumedindustriesin terms of absolute consumption,about 30 to 40 percent of the total productioncosts of cement is total energy costs (thermal and electrical) ofmakeup. That is the basic reason why efficient energy utilization has always been a point of priority in cement plant.To initiate the reaction and phase changes is necessary to formthe complex mineral compounds that give cement its unique propertiesCement manufacturing requires very high temperatures for Pyro-processing in large rotary kiln which is theoperational step that provides the energy and environmental conditions necessary for the reaction and phasechange. This operation Leeds the energy (electrical and thermal) consumption and it also impacts on the environment. Hence the improvement in energy efficiency is necessary to reduce the electricity consumption and co2 emission which in turn reduces the production cost of cement. Process improvement may be attained byenergy management and by adopting more energy efficient process tool or equipment and by replacing old installations with newmechanism in cement production operation, the cement kiln optimization process. To prepare and burning the alternative fuels in cement kiln and to develop new cement manufactures performing the research and development necessary.*

I. INTRODUCTION

Clinker basically made from calcareous, argillaceous, and siliceous oxides bearing as raw material. All the raw material is mixed or blended and grind to form the RAW MEAL. Manufacturing of clinker consist first of all crushing and grinding of raw material. The Homogenizing them initially at different proportion and sintering them usually in a furnace which is called as rotary kiln. The temperature of rotary kiln is around 1300 – 1450^{o}C ar the material burn and partially fuses to promote the formation of clinker phases. The main phase in the clinker is tri calcium silicate, die calcium silicate, tri calcium aluminates, and tetra calcium aluminaferite. The clinker is then cooled and grind as fine powder with addition of the gypsum. The result pretendswhich is called commercial Portland cement. To manufacture the cement lots of energy required in the form of thermal and electrical. [1]

During drying up and burning process the decomposition reaction phase transformation occurs. These phenomena influence each other regarding the energy consumption in the kiln plant the important aspect are the enthalpy of the reaction which may be endothermic or exothermic. [2]

Table (1) brings an overview of the basic &very much important thermal reaction which occur during the manufacturing operation. There is different operation for clinker manufacturingex. – wet process, semi dry process & dry process. The dry process is classified into three main type namely long dry process, dry process with preheater, dry process with pre calciner preheater with or without tertiary air duct. These processesdifferentiate mainly in the type & state of raw meal to the kiln or furnace which range from slurry with approximately 35% water content in the wet process to a raw meal that is a calcined to a great extend in the dry process with pre calciner. The dry process with pre calciner is the letest process for the clinker manufacturing due to its several advantages. (3-5)

The calciner is operated between the kiln and the pre heater. To distinct from the main firing system in the kiln. This pre calcinations step is get in the operation so called secondary firing. The main principle in the plant with pre calciner is to substantial fuel energy is introduced into the feed material outside the rotary kiln so that declaration of lime stone is done before entry into the rotary kiln.

II. REVIEW FOR ENERGY SAVING IN CEMENT KILN

2.1 Modeling Balance of Cement Kiln

Attains 75-80% of the energy consumed in a cement clinker kiln plant of the overall energy consumed in theprocess of cement production as a whole. The remaining (25-35%) is the part of electrical energy. On the other side,for the sintering of the clinker kiln, thermal energy needs 90-95% of the required energy and the electricalenergy accounts for only 4-8%. Therefore, potentials for reducing specific heat consumption in the cement plant deserve priority (6-10). So that's why we considered this article for energy saving in cement plant with modern techniques. The effect of the different factors on the fuel energy consumption incement kiln plants is widelydiscussed.

A model of cement plant without preacalciner has been proposed by Elkjore [11]. The effect of parameters on the heat consumption and preheater exit gas temperature are examine by theauthor with the aid of that model. Examined parameters were the amount of the excess air, primary air, falseair at the kiln, false air in the pre-heater, wall heat losses and kiln gas bypass ratio. These operation plays in important value such as thehot meal temperature at the kiln inlet, kiln gas temperature, degree of calcinations in the bottom stage cyclone pre-heater, dust load in the kiln exit gas.At the end result says that amount of fuel increases with increasing of excessair, primary air, and false air at the kiln inlet, the kiln gas by pass ratio &cooler energy loss, false air in the pre-heater. On the other side, the P.H exit gas temperature raises with the increase of the excess air, false air atthe kiln inlet. It decreases with the increase of the false air in the Suspension p-h and with the kiln gas by pass ratio.

A balance model of cement kiln plant with PC with TAD has been established by Ghazi [12]. Theeffect of various factors such as the proportion of secondary fuel energy, number of stages of pre-heater, by pass ratio of kiln gas and the type of the source of fuel used on the energy consumption and the PH exit gas temperature weregoverned. Some operation conditions of the process have been specified at certain values, such as the clinkering temperature, combustion excess air factors, cooler efficiency and wall heat loss. By applying the model on different cement plant in Egypt and other kiln plants in France, the result comesthat the difference between measured values of fuel energy consumption are in the range of 0.12 to 5.9% andtheoretical calculated. The changein the energy losses from the individual sections of the system affects on the fuel consumption by different degrees.A balance model of cement plant with PC with tertiary air has been established by Gardeil *et al* [13].

Thermal analysis of pre-heater system based on a model has been established by Peng Fei [14]. The modelwas used to know the effect of dust loads at kiln inlet, cyclones precipitation efficiency and number of thestages of cyclone PH on fuel consumption. Some operation conditions of the process have been keptconstant at certain values, such as kiln exit gas temperature, heat of reaction, wall heat losses, clinker temperature atthe kiln outlet, and efficiency of the cooler. The results showed that with the increase of dust load of kiln exit gas by0.1 kg dust/kg clinker, the specific energy consumption increases by about 13-17 KJ/kg clinker. The resultsindicated that the effect of precipitation efficiency of the lower cyclones on the fuel consumption is stronger than ofthe higher located cyclones.

From industrial trial in cement kiln plants with pre-calciner equipped with tertiary air duct(productivity rangingfrom 1041 to 3427 ton of clinker/day). They found that the energy loss from the pre-heater is about 0.75-1.25 MJ/kgclinker, the loss through the walls of the rotary kilns is about 0.2-0.55 MJ/kg of clinker, loss from the cooler is about 0.4-0.65 MJ/kg clinker. The change in the energy losses from the individual sections of the system affects on the fuel consumption by different degrees. Furthermore, on applying the mathematical models, the effect of differentfactors on the apparent degree of calcinations and secondary fuel energy proportion in the calciner have beenestimated. Such factors were enthalpy of the kiln exit gas, potassium chloride cycle between kiln and the caclinerand the enthalpy of the tertiary air. The resultsshowed that the secondary fuel energy proportion supplied to thedecreases with the increase of the kiln exit gas temperature and with the temperature of the tertiary air. On the other hand, the degree of calcinations in the calciner increases with the increase of the kiln exit gas temperatureand with KCl concentration in the hot meal [3].

2.2 Circulating Element in Cement Kiln

Impurities such as chlorine, alkalis and sulphates are feed with raw materials and the fuels fed to the cement burning process contain various amounts of secondary constituentspresents usually, which may form volatilescompounds. In a dry process with preheater and PC these secondary component make a circle and recalculate again and again because when the enter into the kiln with raw material it get evaporated due to high temperature and as per the action of kiln gas it go back to the inlet section of kiln in form of vapor and then when it got favorable condition to condense it get condense & again it enter with raw meal that is known as the circulating phenomena. There are two cycles in aclinker burning system, namely, internal cycle and external cycle. The internal cycle is formed by vaporization ofthe secondary constituents in the rotary kiln and the condensation in the colder zones of the process. On the otherhand, the external cycle is caused through the return of the dust transferred with pre-heater exit gas to the rawmixture via the raw mill, the cooling of tower, the filter. The behavior of circulating elements depends on its degreeof volatilization, its extent of adsorption by the hot meal and the condensation in the pre-heater, mill and filter andalso by the degree of combination in the clinker [15].

Problems due to coatingformation, clinker quality deterioration in addition to the emission problems. The intensity of the cycles depends onthe following factors:

The intake of alkalis, sulphur and chorine in the raw materials and fuel, the burning temperature, the kiln gastemperature, the throughput of materials, the gas/materials temperature gradients, and the specific surface of the kilnfeed.

Table 1: Reactions of Raw Materials and Reactions Enthalpies in Cement Clinker

Reaction	Equation of reaction	kJ/kg clinker
Formation of oxides and decomposition reactions		
Volatilization of H2O	H2O liq. H2O vap.	4
Kaolinite decomposition	Al2O3.2SiO3.2H2O Al2O3+2SiO2+2H2O	78
Mg CO3 dissociation	Mg CO3 MgO +CO2	22
Formation of intermediate products		
Formation of CA	CaO+Al2O3 CA	-8
Formation of C2F	2CaO+Fe2O3 C2F	-6
Formation of C2S	2CaO+ SiO2 ß C2S	-493
Clinkering reactions		
Formation of C4AF	CA+C2F+ CaO C4AF	3
Formation of C3A	CA+ CaO C3A	1
Formation of C3S	ß C2S +CaO C3S	35
Overall reactions	Kiln meal clinker	1749

Table 2: Average and Best Practice Energy Consumption Values for Cement Plant by Process

Process	**Unit**	**India average**	**Would best**
Raw material preparation			
coal mill	kWh/t clinker	8	2.4
Crushing	kWh/t clinker	2	1.0
Raw mill	kWh/t clinker	28	27
Clinker production			
Kiln and cooler	kWh/t clinker	770	680
Kiln and cooler	kWh/t clinker	28	82
Finish grinding			
Cement mill	kWh/t clinker	30	25
Miscellaneous			
Utilities mining and transportation	kWh/t clinker	1.6	1.5
Utilities packing	kWh/t cement	1.9	1.5
house			
Utilities misc	kWh/t cement	2.0	1.5
Total electric	**kWh/t cement**	**95**	**77**

Table 4: Fuel Energy Consumption of Rotary Kiln Plant with Cyclone Pre heater

Energy loss kJ/kg	By Ghazi	By
Exhaust preheater energy loss	0.74	0.87
Wall heat loss of the first stage 0.22 0.20	0.20	0.22
Wall heat loss of the second stage 0.44 0.40	.040	.044
Wall heat loss of the third stage 0.76 0.63	0.63	0.76
Wall heat loss of the forth stage 1.18 0.96	0.96	1.18
Rotary kiln wall heat loss 1.18 0.96	0.96	1.18
Cooler energy loss 1.46 1.47	1.47	1.46
Bypass energy loss ----- 0.46	0.46	___

Figure1. Flow Diagram of Cement Kiln Plant with Cyclone Pre-heater, Calciner and Tertiary Air Duct

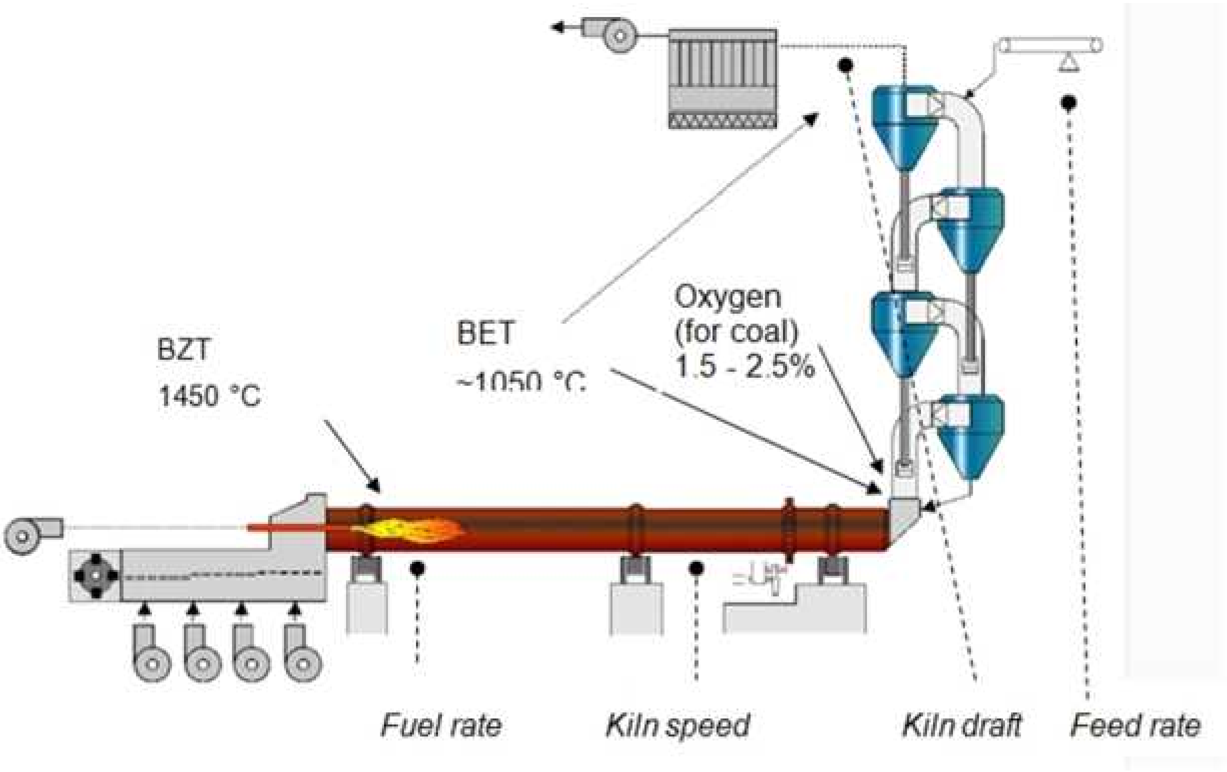
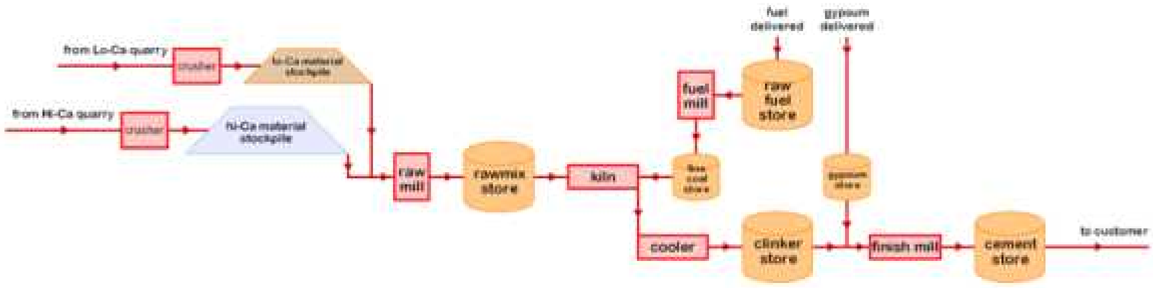


Figure 2. Flow Diagram for the Kiln Cement System



The following substances are undesirable when present in quantities of the order of magnitudeindicated that sulphates (SO3) with total inputs of 10-30g//kg clinker, alkalies (K2O, Na2O) with total input 1-20 g/kg clinker, chlorine with total input of 0.4-8 g/kg clinker [2,4].

2.3 Clinker Cooling

The reciprocating grate cooler is the most widely used cooler system in the world. The grate cooler is independent of the kiln, but kilns are heavily dependent on their grate cooler for heat recuperation in the forms of primary, secondary, and tertiary air. More heat recuperation from the cooler to the kiln in lower kiln fuel consumption. Conventional grate coolers provide thermal efficiency of 40 to 80%, depending *on the* Mechanical condition and process operation of the cooler. Typically, the thermal efficiency of most grate coolers is less than 70%.

In today's cement market environment of high competition, rising fuel and electrical cost, and strict environmental compliance, tie kiln/cooler system is almost alwayscited for improvement to reduce works operating costs. If the cooler was moreefficient, savings could be gained by reducing the amount of fuel to the kiln. In orderto improve the cooler's efficiency, most works attempted 'deep bed" operation. TMsinvolved either slowing down the cooler grate speed, utilizing bridging and bumming
Plates, or forming a refractory "hors=hoe," which narrowed the cooler inlet forming a
Stationary band of clinker. Although sometimes successful, the methods solved only
a portion of the problems of achieving both high efficiency heat recuperation and 'cold"
clinker outlet temperature. Therefore, the ability to recover the maximum amount of
heat from the clinker entering the cooler and return it to the kiln has been thechallenge of grate cooler manufacturers.

2.4 Process Control

As competition becomes stiffer in the chemical marketplace and processes become more complicated to operate, it is advantageous to make use of some form of automatic control. Automatic control of a process offers many advantages, including

Enhanced process safety
Satisfying environmental constraints
Meeting ever-stricter product quality specifications
More efficient use of raw materials and energy
Increased profitability

Control systems are used to maintain process conditions at their desired values by manipulating certain process variables to adjust the variables of interest. A common example of a control system from everyday life is the cruise control on an automobile. The purpose of a cruise control is to maintain the speed of the vehicle (the controlled variable) at the desired value (the set point) despite variations in terrain, hills, etc. [17
The cement property is depended on the clinker quality and also burning reactions . Therefore, this temperature profile has to be carefully controlled to produce high quality clinker and to reduce the disturbance effects such as variation in the raw materials composition and in the combustible properties of the clinker [18].

In the literature, few model of the cement kiln are proposed. The simulation of the behavior of the cement kiln is performed using a dynamic model. This model is based on distance approach but invention have been introduced to make the model more reliable and more appropriate to design a control structure. This model of cement kiln consists in a set of partial differential equations describing the heat and mass transfers occurring in the kiln [18].

Recent studies on the manufacturing of cement reported in the literature are mostly based on computational fluid dynamics and they mainly study aerodynamic behave ofa particle in the pre-heating system, the shape and the flame in the combustion zone, coal combustion itself as well as oxygen enrichment in the burning zone and not so much the thermodynamics and clinker chemistry taking place in the kiln system [20].

III. MASS AND HEAT BALANCE OF CEMENT KILN

Heat and mass balance place the important role of the in cement kiln to improve the productivity, and maintain the quality of the product. coal based rotary kiln process raw material used are lime stone, iron ore, fky ash ect. A heat balance consists of a listing an evolution of all times of the heat bsupplied or availble and a similar listing or evolution of heat used lost or distributed the sum of the first set of itoms being equal the second set. The hot cooler gases tempreture about 1450C the clinker temp.is 120C and releasimg hot air temp.is arond 1200C The rotary kiln system considered for the energy audit is schematically shown in Figure.2.

3.1 Mass Balance of Cement Kiln: The mass balance for both preheater, rotary kiln and cooler is shown as the following

3.1.1 Mass Balance of Preheater Calciner

Inlet mass =outlet mass
Inlet mass= mc+mra+m kg+m kd+mtair+mpair
Outlet mass=m ex gases + m h c+ mpd

3. 1.2 Mass Balance of Rotary Kiln

Inlet mass=mk+m p air +m sec. air + m h c

Outlet mass= m k g+ m kd + m hk

3.1.3 Mass Balance of Cooler

Inlet mass= m cair + m hk

Outlet mass= m sair +m tair + m w air+ m cd

3.2 Heat Balance of Cement Kiln: The energy balance for both preheater, rotary kiln and cooler is shown as the following:

3.2.1 Preheater Calciner

Accumulation rate = heat input –heat out put

Heat input = Q1+Q2+ Qra+ Q4+ Qkgas + Qdust + Q Tair +Q Pair

Heat output =Q7+Q6+Q10+Q8+Qhc+Ql

3.2.2 Rotary Kiln

Accumulation rate = heat input –heat out put

Heat input = Q1k+ Q2k+ Q pair +Q sair + Qhc

Heat output =Q6+ Qkgas +Qkdust + Q hk + Ql

3.2.2 Cooler

Accumulation rate = heat input –heat out put

Heat input= Q hc + Q5

Heat output = Q sair +Q tair+Q9+Q11+Ql

The effect of different parameters on the fuel energy consumption in cement kiln plant can be determined by usingthe above modeling.

IV. ENERGY CONSUMPTION IN CEMENT KILN PLANT

Table (2) The energy consumption in cement plant is depended on the raw material, the production of cement clinker from lime stone and chalk heating lime stone temp. is main energy consuming process.

V. POTENTIAL FOR ENERGY SAVING THROUGTH PROCESS OPTIMIZATION

Cement is a global valuable think, lots of plant manufacturingit. The cement industry is consolidating globally, but large international firms account for only 30% of the worldwide market (European Commission, 1997). The main purpose of manufacturing of cement for the construction industry in a multitude of applications where it is combined with water to make concrete. The cement manufacturing process are depending on the burning, precalcing, cooling process. As a result, cement manufacturing is the third largest cause of man-made CO2 emissions due to the production of lime, In the cement/concrete industry improvement of energy efficiency and reduction of CO2 emissions could be mainly achieved through two procedures: (i) by changes in the manufacturing and production processes, and (ii) by improved burning technology and efficient technology and efficient use of waste of pre heater exist gas. The fuel energy requirement for efficient production may approach 3000kj\kg, 2000kj\kg is using for the drying process.

So, measures for further saving of the fuel energy are concentrated on operational optimization of preheating system for the air (in clinker cooler) and kiln feed (in pre-heater system), and reducing the wall heat losses in rotary kiln, pre-heater and cooler and reducing the heat losses through by pass system [27].

5.1 Saving Fuel Energy Consumption by Kiln Optimization

Cement industry is one of the most energy intensive industries in the world. It is essential to investigate the feasibility of reducing coal consumption and greenhouse gas emissions of the rotary kilns in the industry. In comparison to the difference industries, cement industry has been consuming the highest proportion of energy. A typical well-equipped plant consumes about 4 GJ energyto produce one ton of cement. At the same time, this sector is one of the worst pollutant sector greenhouse gases such as carbon dioxide, nitrogen oxide, chlorofluorocarbonsand methane. For each ton of clinker produced, an equivalent amount of greenhouse gases is emitted. Cement production in the world is about 3.6 billion tons per year. About 2% of the electricity produced in the whole world is used during the grinding process of raw materials. Total electrical energy consumption

for Portland cement production is about 112 kWh/t of cement, roughly two thirds of this energy is used for grinding or size reduction. Because of high energy consumption rates and high environmental impact of the process, the manufacturing process has been considered by the investigators for many years. Schuer et studied energy consumption result and focused on the energy saving techniques for france cement industry considering electrical and thermal energy saving methods. et al. investigated energy efficiency of a cement plant in India. Worell et al. dealt with energy analysis in the U.S. cement industry for the years 1970 and 1997. analyzed a dry type rotary kiln system with a kiln capacity of 650 t clinker per day. They found that about 42% of the total input energy was lost through hot flue gas, cooler stack and kiln shell. The study indicates that for a dry type cement production process, the carbon dioxide emission intensity for kiln feed.

5.1.1 Clinker Cooler

Clinker leaves thekilnred hotat atemperature usually inthe range of 1300-1400”C (2372-2552” F). It passes over the nose ring of the kiln to the clinker cooler. The purpose of a cooler is not only to cool the clinker, but also to recuperate heat and return it to the kiln in the form of preheated primary, secondary, or tertiary air for combustion. The clinker leaving the cooler should be cool enough to avoid damage to handling equipment (particularly rubber belt conveyors). Cold clinker can also be beneficial to cement mill efficiency by reducing the possibility of overheating. The heat contained in the clinker leaving the cooler depends on its exact temperature but will usually be in the range of 300-350 kcal/kg (1.079-1.259 mmBTU/ston).

Obviously, it is important to return as much of this heat to the process as possible, and to keep the overall kiln fuel consumption to a minimum.

THERMAL EFFICIENCY

The thermal efficiency (q) of (A-B)

n= ------ -Acx 100%= --- x 100%

where

A = heat content of the clinker leaving the kiln

B = heat losses from the cooler

“B” can consist of heat loss in any excess or exhaust air, heat contained in the clinker leaving the cooler, radiation or other losses. “C” is the heat content of the secondary,

and in the case of precalciner kilns, tertiary air returned to the kiln. Conventional cooler thermal efficiencies are typically in the range of 40°!6 to 800A.

The heat transfer can also be improved by the grate plate with horizontal air outlets and increased pressure drop inthe grate plates.

The heat recovery in the grate cooler can be increased by utilization of the heat of the waste air. In this case, it canbe appropriate to separate the recuperation zone of the cooler structurally from the cooling zone and optimizing eachof them independently. The general aim is to achieve an efficiency of the cooler approximately more than 70.0%(27).

5.1.2 Rotary Kiln

A part of chemical process takes place in the pre-heater tower cyclones as the material is heated to 820°c by the hot kiln gas. This includes the evaporation of free and absorbed water. These simple processes can take place very rapidly provided enough heat can be supplied from the surroundings. The chemical processes take place at higher temperatures after the decomposition of carbonates is different and more time consuming. They are also accompanied by the melting of a part of the material which transforms the dry particle into clinker nodules.

With the view to obtain a useful description for the analysis of the phenomena which takes place in the kiln, a kiln model is used, which can be divided into five zones. The zones, of course are not distinguished by sharp boundaries but instead they are characterized by the dominant physical and chemical processes occurring to the material in each zone

These zones are commonly denoted as the Calcining Zone (CZ), Heating Zone (HZ), Liquid Zone (LZ), Maximum temperature Zone (MZ) and Cooling Zone (AZ).

The transformation of the raw meal into clinker comprises various processes which takes place as a function of temperature during the passage of the material through the clinkerization system.

The chemical reactions determine the formation of the hydraulic minerals alite (C3S), belite (C2S), aluminate (C3A) and ferrite (C4AF). The propertias of the cement depends not only on the potential contents of these minerals in the clinker – which are determined by the chemical composition of the kiln feed – but also on the degree to which the synthesis of these is completed in the kiln. [28].

5.1.3 Cyclone preheater with calciner

The idea of precalcination is, to let this process take place before the meal enters the rotary kiln by introducing that part of the fuel i.e. up to 65% in to a stationary reactor called PC. There is a PC vessel near the kiln inlet in which the firing is done with help of the coal supporting with the hot air separated from the cooler from TA duct. With the combined working of this the heat is supplied from bottom to top throughout the calciner string.

Advantages of precalcination are

- **More stable kiln operation due to better kiln control via two separate fuels feed.**
- **More stable kiln operation due to controlled meal conditions at kiln inlet,**
- **Reduced thermal load of burning zone.**
- **Higher kiln availability**
- **Longer life of burning zone refractory's**
- **Lower Nox emission**

- **Allows shorter kiln**
- **Possibility of increasing capacity of existing kilns** [28].

5.1.4 Rotary Kiln Firing Systems

Firing in the cement industries with the help of the burning fuel., the most common feature of the firing system is burner pipe which situated in kiln hood or kiln hot end, arrange more or less along the kiln centre line and through which the fuel enter the kiln at high velocity. The burner producing a flame that EXTAND SOME WAY in THE KILK. Primary air is the high velocity air that passes the firing pipe with the fuel.

5.1.5 Lime Saturation Factor, Silica Moduli and Alumina Moduli of Kiln Feed

Lime saturation factor, SM, AM are the important factors in the kiln feed for the quality. The quality control department is controlling the feeding of kiln. It can be effect the quality of the cement and the amount of energy required for sintering.

If the Values of LSF above 1.0 indicate that free lime is likely to be present in the clinker. This is because, in principle, at

LSF=1.0 all the free lime should have combined with belite to form alite. If the LSF is higher than 1.0, the surplus free lime has nothing with which to combine and will remain as free lime.

(ii) A high silica ratio means that more calcium silicates are present in the clinker and less aluminates and ferrite. SR is

Typically, between 2.0 and 3.0.

(iii) An increase in clinker AR (also sometimes written as A/F) means there will be proportionally more aluminates and less

Ferrite in the clinker. In ordinary Portland cement clinker, the AR is usually between 1 and 4 [28].

5.1.6 Installing Modern Cement Kiln Plant

Now the modern cement plants are using dry process, for consuming the energy in more amounts. The old cement plants are

Using the wet process, and semi dry process and waste the heating in more amount.

wet cement plant are consuming the energy 1100-1200 k cal\kg clinker but now the cement plant are use only 700-800k cal\kg clinker . so the cement plants are saving the electrical and thermal energy.

5.1.7 Fuel Quality and Fuel Combustion Efficiency

Fuel efficiency is a form of thermal efficiency. That proportion of energy released by a fuel combustion process which is converted into useful work. Moving the current average global efficiency rate of coal-fired power plants from 33% to 40% by deploying more advanced off-the-shelf technology could cut two giga tones of CO_2 emissions now. Coal is used as an energy source in cement production. Large amounts of energy are required to produce cement.

5.1.8 Process Control

To use energy saving control plan it is requiringto have reliable measured values available for the mostimportant influencing variables and controlled variables. The external variables include the compositions and massflows of the input materials and the exhaust gas mass flow after the pre-heater. Internal influencing variables are themass and energy flows in the kiln system which even if the external influencing variables are constant can besubjected to significant fluctuations as a result of the linked heat and mass transfer. The energy flows of the rotarykiln inlet gas and of the hot clinker are particularly important in this context. Inspection have shown that theenergy flow of the rotary kiln inlet gas can be subjected to considerable fluctuation due, in particular, to changingcirculating processes between the rotary kiln and calciner. For regular external influencing variables, the fluctuations act directly and exclusively on the degree of calcinations with which the kiln feed material from thecalciner enter the kiln. In practice, if the external influencing variables are constant, the hot clinker energy flow onlyaffects the secondary air energy flow. It is determined by the hot clinker mass flow and its temperature.Any changes which occur to the influencing variables should be indicated at an early stage by informative signalsand offset by appropriate control interventions so that process is able to run smoothly and save energy. In thissituation use is made of so called virtual signals which are calculated from several measured variables. Examples of this, the fuel energy flow, the calcium carbonate mass flow, the level of pre-calcination of the kiln feed materialafter leaving the calciner and the secondary air energy flow. This requires simple and operationally reliablemeasuring equipment and powerful digital data processing systems for central evaluation and storage of the signals[6, 27].

5.2 Energy Saving by Utilization Waste Heat

In the cement kiln have generally 55% energy need to the chemical reactions for the drying of the raw material need 16% energy of the fuel. So the total 71% energy are used by the plant, remains 29% energy are covered in loss energy, namely 9.6% in wall heat loss 17.9% in exhaust gas and 1.8% cooling for the clinker and 1.2 % other losses. The use of better insulating refractory's can reduce heat losses. Refractory choice is the function of insulating qualities of the brick and the ability to develop and maintain a coating. There are few measure heat loss source considered for the Heat recovery, like exhaust gas and cooling clinker and kiln surface.

5.2.1 Bypass Gas from Kiln Inlet

In the bypass system, a part of the kiln gas (depending on Cl2, SO3, Na2O and K2O) is extracted temperature 1100-1250 º in kiln inlet, then cooled by quenching air to the suitable temperature 350-450 ºC, and then cooled in the water conditioning tower to 140-160 º C and then deducting in ESP and then the clean gas is passing to the stack. In order to be utilizing of this waste heat, the extracted hot gas at the inlet kiln at 1100 to 1250 º C can be cooled only to 350 º C with air and then de-dusting in hot gas esp and then this gas is utilizing for drying the raw materials, drying of slag. The bypass heat can be used for the boiler [29-30].

5.2.2 Exhaust Gas from Preheater

The pre-heater exhaust lots of amount heat. The exit temperature of 350 ºC and a dust content of about 20-30 ton/h depending on separation efficiency of cyclone pre-heater. If the material has more amount of moisture, only using a part of this gas for drying. In the case of a waste heat boiler may be installed which utilizes the upper temperature range of the exit gas from 350 to 200 ºC.

5.2.3 Utilized of Preheater Exit Gas for Drying Raw Material

One of the most effective methods of recovering waste heat in cement plant would be to preheat the raw materials before the clinkering process. Directing gas streams into the raw materials just before the grinding mill generally does this. This would lead to a more efficient grinding of the raw materials in addition to increasing its temperature. However, in most plants, the fresh raw materials taken from the mill is not directly sent to the kiln, and therefore, the temperature increase of the raw materials does not generally make sense because it will be stored in silos for a while before entering the clinkering process. On the other hands, some plants may have only kiln systems rather than grinding systems. In such cases, this may not be possible unless some additional modifications are made in the plant [30-31].

5.2.4 Exhaust Air from Cooler

In the cooler system, a considerable amount of the exhaust air is obtained as a waste air. The temperature of this waste air lies in the range of 300 to 400 ºC. For special utilization purposes, We are utilizes the hot gas of cooler in the pre separate line calciner and save the thermal energy . In this case, the waste air can be divided into two zones inside the cooler, colder and hotter portions. The hottest portion can be used for heating of the thermal and or drying of slag. It can be also use as the steam and this steam is using in thermal power plant for energy genertation . It can be used for electricity generation as from directly driving a consumer machine [6, 29].

5.2.5 Conversion Four Stage to Five Stage Cyclone Preheater

By the invitation of 6 stage cyclone preheater save of energy in the system . Reduce the exits gas tempeture and 95% calcinations in the preheater with pre calciner, the exit gas temperature last cyclone of the pre-heater was 52 º. By an addition of a one stage the retention time between gas and material will increase and consequently the pre-heater exit gas will decrease and decrease the fuel energy consumption of the cement plant [32].

CONCLUSION

Cement production is a highly energy intensive production processes. Important efforts are being made to continue for saving the energy for the cement industry.Successful reduction of fuel consumption contributes to lower fuel cost, higher clinker production, lower electricity consumption and lower greenhouse gas emission.Internationally, the cement industry is moving toward the use of alternative fuels such as tires, lubricants and oils.The use of alternative fuel can save cost and contribute to solution of the environmental problems.

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CHARACTERIZATION OF FIBER OPTIC COMMUNICATIONLINK FOR DIGITAL TRANSMISSION SYSTEM

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ABSTRACT*:-In this paper, main focus is on the experimental characteristic of optical communication link and of their components. We give an introduction to optical fiber systems and various phenomenons's related to it. The phenomena of attenuation and dispersion are discussed elaborately and details are provided through experimental observation and verification. A laser diode and photo detector are also discussed and their characteristics curves are plotted. All the details about various topics mentioned above are concluded and verified through experiments.

Keywords:Attenuation, Dispersion, Source, Detector

OVERVIEW

An optical fiber is a cylindrical structure made from a transparent material such as glass and consists of a central core of refractive index n_1, surrounded by a cladding of refractive index n_2. Light gets guided through the fiber by total internal reflection,in which a light ray incident on an interface between the denser medium (a medium of higher refractive index) and a rarer medium (a medium of lower refractive index) at angles greater than the critical angle, gets totally reflected, i.e. undergoes complete reflection [1]-[2]. The realization of low loss optical fibers and room temperature operation of compact semiconductor lasers in 1970, laid the foundation for long distance fiber optic communication. Technological advances such as optical amplifiers, dispersion compensators, high speed transmitters and receivers, optical dense wavelength division multiplexing etc. have contributed to the phenomenal growth of optical fiber communication industry [3]. The increased demand on the bandwidth continues and new innovations such as photonic crystal fibers, tunable lasers, high speed modulators, all optical signal processing, compact integrated optical devices, new modulation formats etc are expected to cater to this need [4].

This papers presents, complete experimental characterization of optical fiber communication system with emphasis a laser diode characteristics, attenuation, dispersion and, photo detector etc. In section 2 about Light Runner kit is discussed. Experiments of attenuation and dispersion in optical fiber are performed in section 3 and 4 respectively. Experiments of characterization of laser diode and photo detector are performed on Light Runner in section 5 and 6 respectively. Finally, conclusion of the paper is presented in section 7.

In fiber optics has become an absolute necessity. Towards this end, several Fiber Optic Training (FOT) kits have been developed. However, the FOT kits available currently in market primarily deal with single wavelength measurements and demonstrate basic communication principles [5]. However we can analyze 4-channel WDM, transmission system by using a proposed kit. Light Runner enables the user to perform experiments regarding Fiber Characteristics, Component Characteristics, Optical Communication Systems and Testing and Analysis.

In this paper, we have provided the detailed description of attenuation and dispersion and its effect inside the optical fiber with some experimental result implemented on light runner. The paper describes the theoretical background of optical sources (LASER) and optical detector and its importance in modern technological scenario with some experimental result reflecting the characteristics of laser and optical detector.

CALCULATION OF LOSSES FOR TRANSFORMER LIFE ASSESSMENT

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Abstract—Transformer is one of the critical equipment in the Power distribution system. Transformers are sized and selected according to their connected loads and the load cycles. It can be loaded beyond its name plate rating. A higher load beyond its name plate rating leads to a temperature rise above the specified value which will result in a higher loss of life. The Life of the transformer depends on the life of the insulation, which in turn depends on the hot spot temperature. Transformer life is a well-known and predictable phenomenon. Its premature failure can lead to interruption in power supply and a huge loss in a process plant. A transformer sized according to its loss of life has a much predictable life. In some of the installations an upgrade can be avoided if the loss of life can be predicted by calculation. In this paper an attempt is made to demonstrate how an industrial customer checks the adequacy of an existing transformer. A method to size a transformer based on loss of life method which is based on the fundamental heat transfer laws is presented.

Index Terms— Convection, Heat Transfer coefficient, Hotspot Temperature, Top oil temperature, relative aging rate, Loss of Life, Load factor, Transformer Sizing.

NOMENCLATURE

A_α Surface area of corrugate tank wall (m^2)

A_s Transformer tank surface area (m^2)

A_t Total area of transformer (m^2)

C Specific heat of the oil (J/kg/ ^oC)

E_{st} Heat stored in the oil (J)

g_r Average winding to oil temperature gradient

h Heattransfercoefficient(W/m^2/^oC)

H Hot spotfactor

L Loss of life (hours or months oryears)

m mass of oil(kg)

P_C Continuous load (W or kW)

P_i Intermittent load (W or kW)

P_{loss} Transformer loss (W or kW)

P_{total} Total loss (W or kW)

q_{conv} Heat lost through convection(W)

q_{rad} Heat lost through radiation (W)

V Relative ageingrate

ε Emissivity of electrical steel -0.6

θ_O Temperature of the top oil (^oC)

θ_s Temperature of the outer surface(^oC)

θ_h Hot spot Temperature (^oC)

θ_a Ambient Temperature (^oC)

$\otimes\theta_O$ Top oil temperature rise (^oC)

$\otimes\theta_s$ Surface temperatures rise above ambient (^oC)

The Stefan-Boltzmann Constant 5.67×10^{-8} ($W / m^2 / T^4$)

I. INTRODUCTION

Transformer is one of the critical electrical equipment in a process plant. It is sized according to the connected load which is to be supplied. The relation between load, heat energy generated, stored, lost and temperature rise in a transformer is governed by the fundamental heat transfer laws. The temperature rise in various parts of transformer is a nonlinear function. The life of transformer depends mainly on the life of insulation which depends on the hot spot temperature. Adequacy check and sizing of transformer usingthe loss of life as criteria is explained in this paper.

II. HEAT ENERGYBALANCE

The amount of electrical energy converted to heat energy depends on the losses. Based on conservation of energy, heat generated is lost by conduction, convection, radiation some part of the heat is stored in the oil. The relation between the heat stored and heat dissipated depends on fundamental heat laws, surface temperature, the ambient temperature and surface area.

III. CONDUCTION HEATLOSS

Heat loss dissipated through conduction depends on the thermal conductivity which is governed by the Fourier law of conduction. Heat transfer from the oil to the tank surface occurs by conduction and convection. Heat transfer from the surface of the transformer to the air occurs by conduction and convection. The overall heat transfer coefficient in (1) takes into account the combined effect of conduction and convection

IV. CONVECTION HEATLOSS

Heat loss dissipated through convection depends on the heat transfer coefficient *h* which is governed by the Newton's law of cooling. Amount of heat dissipated per sec is given by

$$q_{conv} = \mathrm{h} \times \mathrm{A}_s \times \otimes\theta_s \qquad (1)$$

V. RADIATION HEATLOSS

The amount of heat lost through radiation by a transformer at temperature rise of 60 deg C is found to be very less compared to convection. Hence it can be neglected without affecting the accuracy of the final result.

VI. HEAT STORED IN OIL

The heat produced by the winding has to pass from the coil to the oil and then to the tank surface and to the air. During the heat transfer process, some amount of heat is stored within the oil. The amount of heat the transformer can store depends on the thermal capacity of the oil, winding and iron. The thermal capacity depends on the specific heat and the mass. Typicalvalue of specific heat of transformer oil is 1880 J/kg/$^\circ C$. Theamount of heat energy stored in the oil due to losses is given by

$$E_{st} = c \times m \times \otimes \theta_o \qquad (2)$$

Mathematically temperature rise of the oil over the ambient can be estimated from the total heat energy stored in the oil per unit mass divided by the specificheat.

$$\otimes \theta_o = \frac{E_{st}}{m \times c} \qquad (3)$$

VII. TEMPERATURE RISENONLINEAR EQUATION

The temperature rise equation (4) is based on heat energy balance explained in section II, heat dissipated through convection (1) and heat stored in the oil (2). The equation (4) is a nonlinear function. This equation is solved numericallyby step by step method using a user written FORTRAN program.

$$P_{loss} \times t = (c \times m \times \otimes \theta_o) + (h \times A_t \times \otimes \theta_s \times t) \qquad (4)$$

$$\otimes \theta_o = \otimes \theta_s \text{ (Assumed)}$$

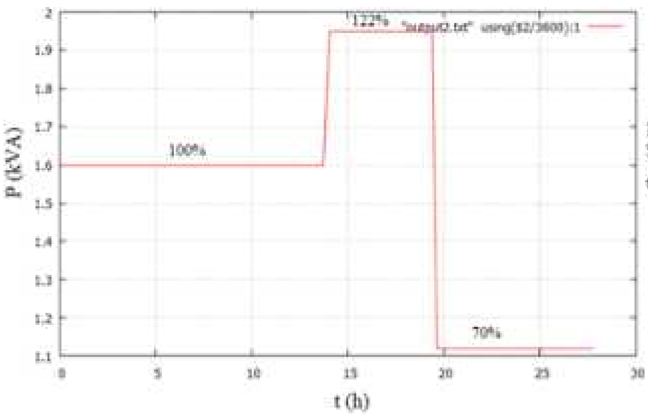
VIII. WINDING HOT SPOTTEMPERATURE

Hot spot temperature of winding is the sum of the ambient temperature, the top oil temperature rise and the top oil to the hot spot temperature gradient. The expression for hot spot temperature is given below.

$$\theta_h = \otimes \theta_o + \theta_a + H \times g_r$$

IX. TEMPERATURE RISE DUE TO VARIABLELOAD

The top oil temperature can be determined as a function of load. Variation in top oil temperature for a 1600kVA transformer with a variable load is determined by solving (4).
Variable load is as given in Fig.1. The hotspot temperature for the variable load is given in Fig.2.



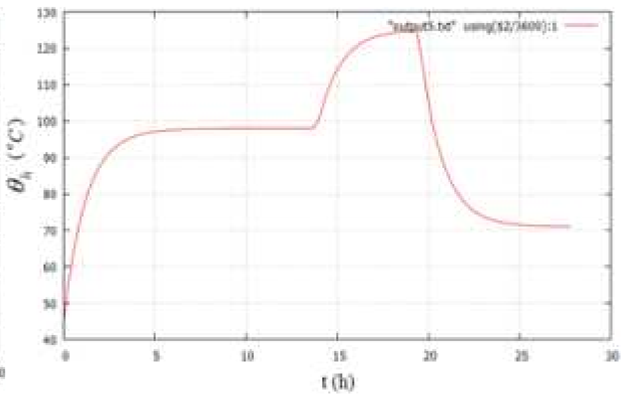


Fig.1. Load versus time for a particularFig.2. Hot spot temperature versus
day in a month time during variable load

X. LIFE OF TRANSFORMER

Life of Transformer is dependent on the life of the paper insulation. The key characteristics of the Insulation are the breakdown strength and the tensile strength. When transformer paper insulation is subjected to a high temperature, the insulation degrades as a function of the temperature. Both the tensile strength and the breakdown strength reduce. The life of insulation depends predominantly on the tensile strength. The rate of aging of the insulation due to hot spot temperature is represented by the term Relativeaging rate *V*. It is a function of hotspot temperature and can be computed using (6) [7].

$$V = 2^{(\theta_h - 98)/6} \quad \text{(Non-thermally upgraded paper)}$$

XI. LOSS OF LIFE

The method for determining the Loss of life is given by [7]. The method used to determine the loss of life for a transformer with a partcular load cycle over a certain period t_1 to t_2 using an equation is as given below.

$$L = \int_{t1}^{t2} v\,dt \qquad (7)$$

XII. ADEQUACY CHECK OF EXISTINGTRANSFORMER

In an existing facility when additional loads are added, it may require a higher size transformer. Replacing a transformer to the next higher size will not only lead to interruption in power but also affects the short circuit rating of the switchboard and the connected power cables. As an alternative, the same transformer can be operated with a higher load. But it will lead to a higher rate of loss of life. If the loss of life can be quantified based on operation history and if the figures are acceptable, the replacement of the transformer can be either ruled out or deferred until a major upgrade is inevitable.

As a case study a transformer of 800kVA existing at one of the site from the past 10 years is considered. The normal load on this transformer is 220kVA and the peak load is around 300kVA. Occasionally peak load of 550kVA was also observed. The load curve obtained through data logger from site is as shown in Fig.3. There were plans to add an additional normal load of 300kVA with a peak load of 550kVA. The combined peak load due to the additional loads may reach 1100kVA occasionally. The options are to replace the transformer to 1250kVA or use the same 800kVA transformer with occasional peak loading above its name platerating.

Using the load cycle given in Fig.3, the loss is determined as shown in Fig.4. This loss is substituted in (4) and by solving numerically, the hot spot temperature rise is obtained as shown in Fig.5. Using (6) the relative aging rate is determined as shown in Fig.6. The loss of life during the past 10 years is determined using (8) and found to be 2.5years.

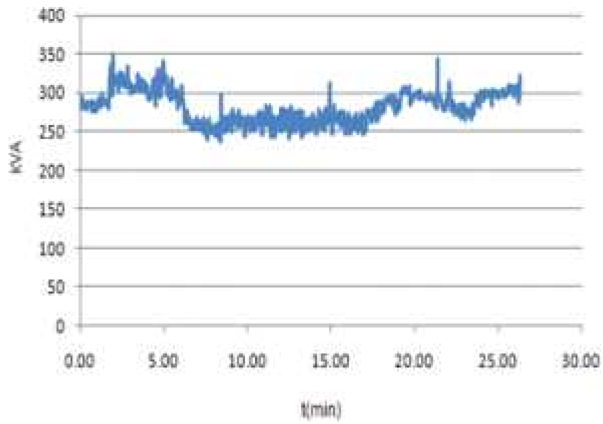


Fig.3. Load curve of an existing 800kVA Transformer

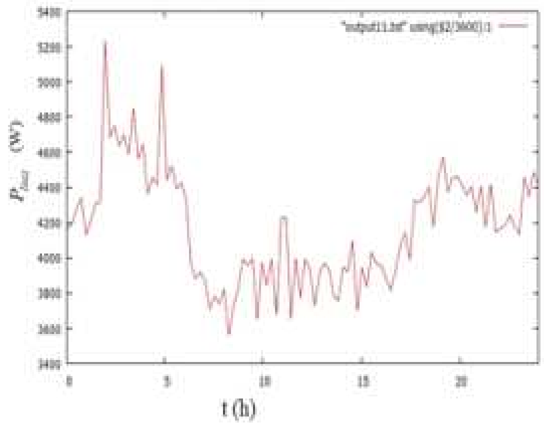


Fig.4. The Losses during a day for an 800kVA Transformer

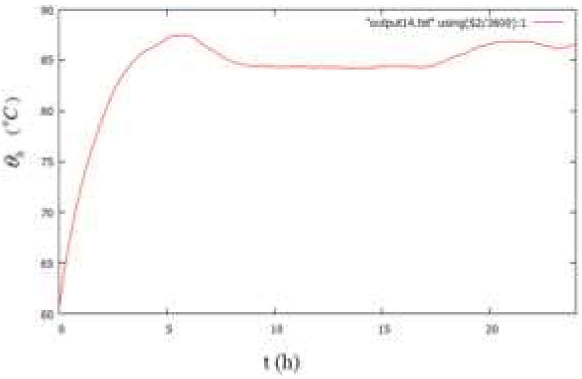


Fig.5. Variation of hot spot temperature With load

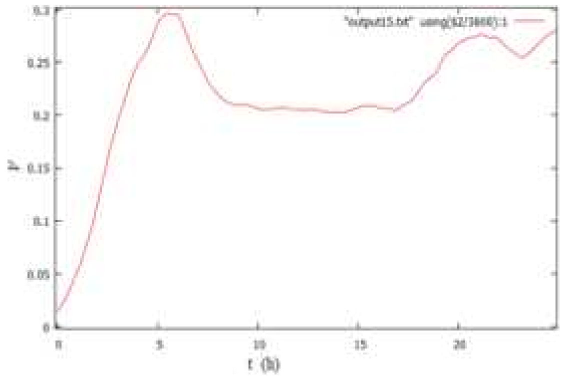


Fig.6. Variation of relative aging rate in a day

With an assumed transformer life of 30 years the remaining life is 27.5 years. However it would be sufficient if the transformer operates for another 20 years from the present date. This gives an opportunity to operate the transformer at higher aging factor which cooresponds to a higherload.

Allowable relative aging factor

$$\frac{\text{remaining life}}{\text{expected life}} \qquad \frac{27.5}{20} = 1.38 \tag{8}$$

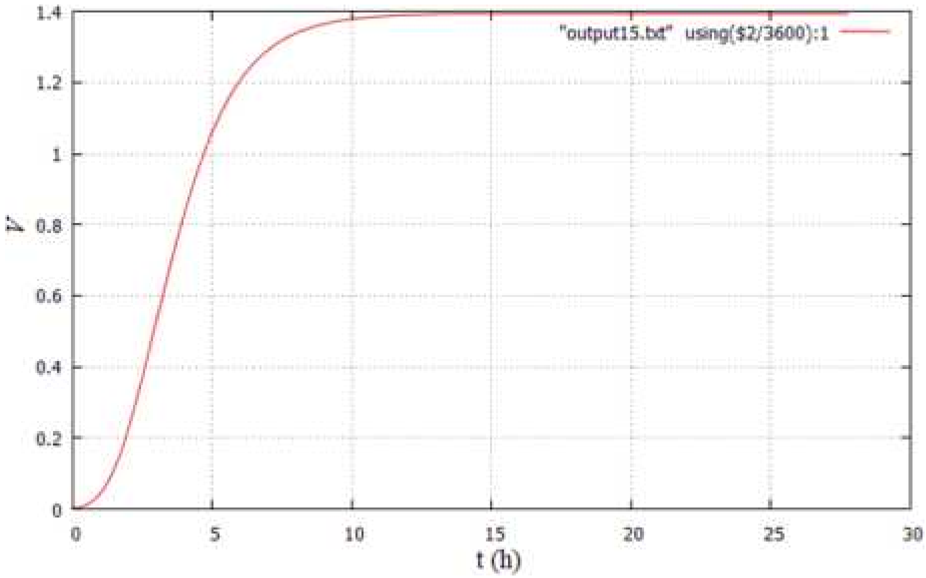
As part of adequacy check the allowable load is determined from the allowable relative aging factor. It is assumed that relative aging factor of 1 corresponds to 100% load and 100% loss. The load and loss corresponding to a relative aging factor of 1.38 is determined by solving (8), (6),(5) and (4) . The loss *Ploss* was varied from 9.5kW to 12kW. Relative aging rate at each loss was noted. It was found that for a loss of 10kW, the relative aging rate was close to 1.38 as shown in Fig.7.

Typical parameters of 800kVA transformer given below are substituted in (4), (5) and (6) as shown in (10), (11) and (12). Total surface area of 14sqm, h of 12.56 and mass of oil 530kg. Ambient temperature of 20°C is considered in this section.

$$P_{loss}\,kW \times t = (1880 \times 530 \times \otimes\theta_o) + (175.8 \times \otimes\theta_o \times t) \quad (9)$$

$$\theta_h = \otimes\theta_o + 20 + 1.3 \times 20 \quad (10)$$

$$V = 2^{(\theta_h - 98)/6} \quad (11)$$



$$\frac{\text{Power Loss at 100\% load}}{\text{Power loss at x\% load}} = \frac{9.5\text{ KW}}{10\text{ KW}} = \frac{(100\%\ \text{load})^2}{\text{x\% Load}} \quad (12)$$

Solving (12) $x\%$load = 1.026. ie the transformer can be operated at load factor of 1.026.

$$\text{Loadfactor} = \sqrt{\left(\frac{P_c^2 t_1 + (P_c + P_i) t_2^2}{t_1 + t_2}\right)} \quad (13)$$

The 800kVA transformer needs to carry an additional load up to 1100kVA. Substituting P_C = 1.0 PU and P_i = 0.37 PU in (14) ,the time for which intermittent load can be applied is verified.

$$\sqrt{\left(\frac{1^2(20 - t_2) + 1.37^2 t_2}{20}\right)} = 1.026 \quad (14)$$

Solving (14) t_2 = 1.2 years or 10512hours

The transformer can be loaded continiously at 100% load and a load of 137% can be applied intermittently for 10512 hours within the 20 years life. Based on operatorsknoweldge, the peak load may not exceed 1 hour in aday.

Hence the existing 800kVA transformer is adequate to handle the additional intermittent load in the future without upgradation.

XIII. SIZING OF A NEW TRANSFORMER IN EXISTINGFACILITY

When a transformer in an existing facility is replaced , it can be done either by a like to like transformer or with a bigger size transformer. But when the additional load is bigger it is better to install a transformer with a bigger size. The transformer size is normally determined using the utility data sheet and a load factor. The load factor for the present load can be obtained from the load curve and for the future additional load from load forecast data. The load factor can also be determined by using the loss of life criteria .In this paper the latter method of determining the load factor is explored.

The continuous load in a plant was found to be 630kVA . The connected intermittent load was 300kVA. It is seldom that all intermittent load will operate together. The peak load is the sum of continuous load and some percentage of the intermittent load. Selecting a transformer for maximum peak load will result in a very large size. Different plant owners standards have different criteria for selecting the amount of intermittent load. Examples of different such criteria are givenbelow.

$$P_{peak}=P_c+0.3P_i=720\text{kVA} \quad (24)$$

$$P_{peak}=P_c+0.5P_i=780\text{kVA} \quad (25)$$

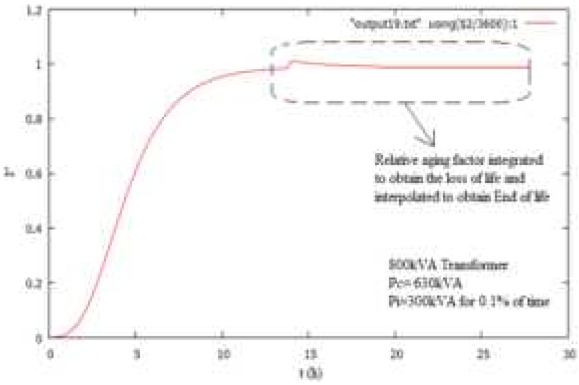
$$P_{peak}=P_c+P_i=930\text{Kva} \quad (26)$$

It is normal practice to size the transformer for 125% of peak loadtoallowforfuturegrowthof25%.Ifthepeakloadfrom (26) is used, it will require a transformer of 1250kVA.Change in transformer size has small impact on cost of transformer but a bigger impact on the short circuit rating of the LV switchboard and the outgoing cables due to changein impedance. Replacement of cables will require excavation and major shutdown of the plant.

In this section different transformer size, SC rating, amount of intermittent load allowed and operating time are tabulated asshown in Table I. The amount of intermittent load and operating time is entered in Table I is based on the history of the plant. Relative aging factor is determined by solving (4),(5),(6) and (8). Tabulation of *V* for different cases is shown in Table I.

The relative aging factor is not constant, it changes at the same rate as the temperature as shown in Fig.8. Loss of life for a certain period is calculated by integration the relative aging factor for a given period. To avoid error in the result the starting period when the transformer is in cooled condition is not considered.

The End of life during the 30 years time is calculated by interpolating the 24 hour result and the values . The results are tabulated in Table I.The size of new transformer can be selected based on the end of life acceptable. End of life below 20 years is hard to justify unless there is a strong reason like aging of the overall plant.If the life of transformer was found to be less than acceptable life, it could have been used as a basis for a major upgrade of the electrical system along with all outgoing cables and LV switchboard. However there was no such necceasity. The existing switchboard and LV system short circuit rating is 25kA, hence it is preferable to select a transformer of either 630kVA or800kVA.



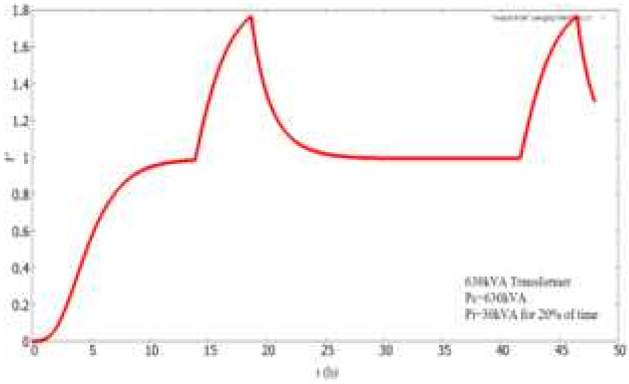


Fig.8. relative aging rate of 800kVA Fig.9. relative aging rate of 630kVA transformer with intermittentload transformer with intermittent load

Sl no	% of P_i	X % P_i kVA	P_{peak} kVA	Tr- kVA	SC (kA)	% timeof P_i	Vat P_{peak}	End of life years
1	10	30	660	630	25	20	1.74	26.59
2	10	30	660	800	25	20	nil	nil
3	20	60	690	630	25	10	2.38	25.92
4	20	60	690	800	25	10	nil	nil
5	30	90	720	630	25	5	2.3	26.84
6	30	90	720	800	25	5	nil	nil
7	40	120	750	630	25	3	2.09	27.47
8	40	120	750	800	25	3	nil	nil
9	50	150	780	630	25	2	2.03	27.91
10	50	150	780	800	25	2	nil	nil
11	66	200	830	630	25	1	1.58	28.68
12	66	200	830	800	25	1	1.04	29.9
13	83	250	880	630	25	0.5	1.33	29.25
14	83	250	880	800	25	0.5	1.07	29.8
15	100	300	930	630	25	0.1	1.08	29.9
16	100	300	930	800	25	0.1	1.02	29.9
17	100	300	930	1000	36	0.1	nil	nil
18	100	300	930	1250	36	0.1	nil	nil

Tr-kVA Transformer rating in kVA&SC (kA) Short Circuit current ration in kA rms

In a renovation and modernization (R&M) project the existing upgrade and shutdown period has to be minimum. Hence in the above case an 800kVA transformer can be selected and major shutdown can be avoided. Up to 100% of intermittent load can be handled by the transformer for 0.1% time every year and the end of life would occur around 29.8 years. A 630kVA transformer can also be selected and the % of intermittent load allowed is 50% for 2% of time everyyear.1000 or 1250kVA transformer is not preferable as it would lead to change in SC rating, which will require changes in cables , switchboard and longer shutdown.

I. CONCLUSION

By using the loss of life criteria an additional load can be added to an existing transformer and an upgrade can be avoided as shown inXII.

Similarly for an R&M project a major change in electrical infrastructure can be avoided by using the loss of life criteria in selecting a new transformer as shown in XIII. The load factor used in sizing of new transformer can be determined by using loss of lifecriteria.

It is not common to use loss of life criteria during adequacy check or during sizing of a new transformer. An attempt is made in this paper to use this method during management of existing asset and planning of upgrade.

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GROUNDING PROTECTION METHODS FOR GRID-CONNECTED HYBRID POWER SYSTEMS

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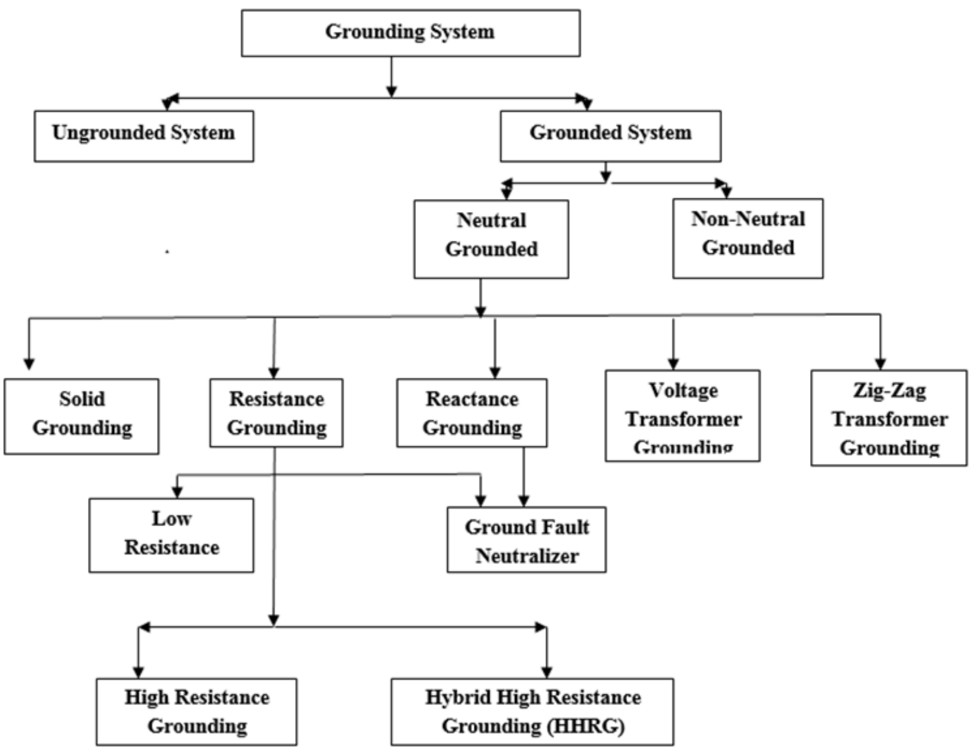
Abstract*-The effects of the wind/PV grid-connected system (GCS) can be categorized as technical, environmental, and economic impacts. It has a vital impact for improving the voltage in the power systems; however, it has some negative effects such as interfacing and fault clearing. This paper discusses different grounding methods for fault protection of High-voltage (HV) power systems. Influences of these grounding methods for various fault characteristics on wind/PV GCSs are discussed. Simulation models are implemented in the Alternative Transient Program (ATP) version of the Electromagnetic Transient Program (EMTP). The models allow for different fault factors and grounding methods. Results are obtained to evaluate the impact of each grounding method on the 3-phase short-circuit fault (SCF), double-line-to-ground (DLG) fault, and single-line-to-ground (SLG) fault features. Solid, resistance, and Petersen coil grounding are compared for different faults on wind/PV GCSs. Transient overcurrent and overvoltage waveforms are used to describe the fault case. This paper is intended as a guide to engineers in selecting adequate grounding and ground fault protection schemes for HV, for evaluating existing wind/PV GCSs to minimize the damage of the system components from faults. This research presents the contribution of wind/PV generators and their comparison with the conventional system alone.*

Figure 1. Types of Grounding System



ENERGY CONSERVATION FOR SUSTAINABLE CLINKER MANUFACTURING AND EMISSION OF CO_2 IN CEMENT INDUSTRY

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Abstract -*This paper reviews on the energy savings and CO_2 emission of clinker manufacture in cement industry.Industrial development has lead to higher energy consumption and emission of greenhouse gases. The cement industries need energy (Thermal &Electrical) including coal and solar energy.To improve the energy efficiency, implementation of a number of technologies is applicable in cement industry for clinker manufacture. According to research it has been seen that the largest amount of electrical energy, thermal energy saving, emission reduction is 35 kilo watt hour per ton, 4.1 Giga joule per ton, 112,61 kg CO_2 per ton respectively.*

I. INTRODUCTION

Industrial energy consumption varies from the 30% to 70% of the total energy consumption (6, 8, 16, 7). A renowned or notable amount of energy is used in the cement industry. The segment of industry accounts for the 50%-60% of the total production cost. (41) The electrical energy consumption of a modern cement plant is 110-120 Kilo watt hour per tonne of cement (49). Up to 700 electric motors can be used in the cement plant with different ratings (41). VSD appear in the fan of coolers,pre-heaters,kilns,mills, & the others mechanism used in cement industry (44). Cement industry constantly trying to improve the environment by provided of the reducing the total energy consumption (23). The cement industry should be focused& providing on energy related environmentally locally &globally (27,24,33, and 31).

II. SPECIFIC ENERGY CONSUMPTION IN CEMENT PLANT

Energy efficiency to measure the cement plant for the production of clinker is Mega joule per tonne of clinker. In the cement industry there are different types of clinker kilns available with difference types of energy consumption & emission of CO_2. IN the dry process the specific energy consumption is varying from 3.40 Giga joules per tonne and for wet process the specific energy consumption is about 5.29 Giga joules per tonne. In the world some countries plant specific energy consumption for production of clinker is lower than 2.95 Giga joules per tonne (28,39, and 42). In, 2001 cement industry consumed about 16% on whole manufacturing of energy consumption (36).

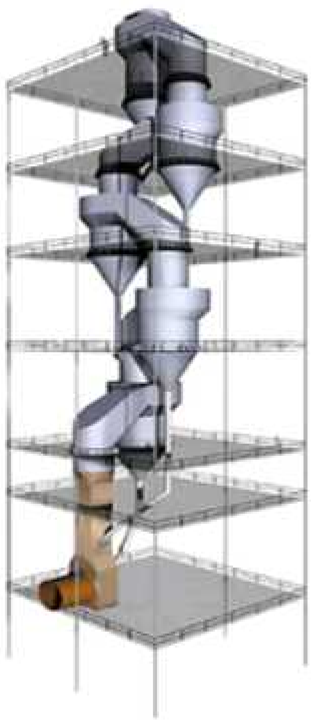
III. ENERGY EFFICIENCY

There are two ways for energy efficiency improvements theseare: -

(1) Technological upgradation

(2) Waste heat recovery (WHR)

Technological upgradation: -



NSP illustration

Waste heat recovery: -

The clinker formations release huge amount of heat and the calcinations needs significant amount of energy. Then the natural energy exchange between kiln&calcinations has been deployed in cement production, as cause of NSP.In this process the waste heat is recover & increases the energy efficiency.

There are two types of cycle are below there: -

(1). Organic Rankine Cycle

(2). Kaline cycle

Organic Rankin Cycle (ORC): -

In the exhaust of clinker cooling & waste gas the pre-heaters (above300'C). The exhausts produce 1.5 MPA& 320*C over heated steam (43). ORC applied in the organic fluid as an efficient carrying media of thermal energy, going through thecompression, evaporation, & cogeneration cycle, to generate the power. It managed the laden dust in the atmosphere & low temp. Waste heat from from clinker cooler air & kiln exhaust has been analyzed for cost and electricity yields (39,42).

Kaline Cycle: -

In the power cogeneration the kaline cycle is designed for the low & medium temperature, for the waste heat recovery. Kaline cycle has the energy efficiency is about 50% of low temperature (200*C-280*C) compared the ORC & 20%-40% performance efficient than ORC at medium temperature above 500`C (37). In this cycle ammonia is cheaper than organic liquid.

Table 1: Energy saving measures for clinker production

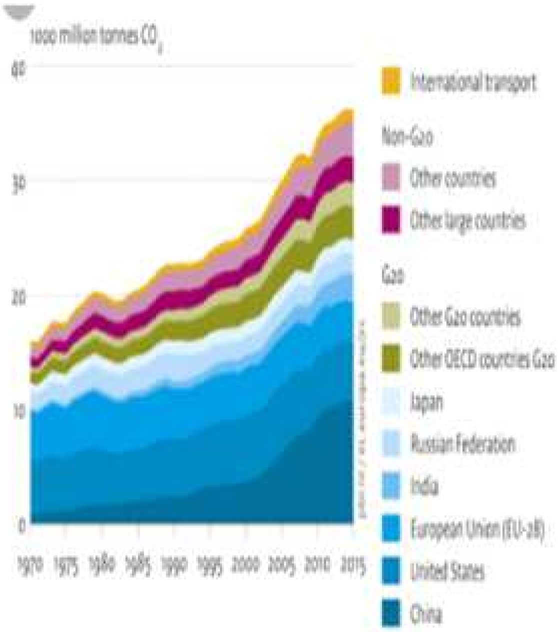
Number of energy saving measure	Thermal energy saving [GJ/t]	Electric energy saving [KWh/t]	Emission reduction [Kg Co_2/t]	References
1	0.12-0.63	-	10.3-15.5	[23,28,43,14,19,20,30,37]
2	0.1-0.2	2.35-5	2.48-16.61	[14,19,20,29,37,38]
3	0.05-0.62 - 30% -	4.95-6.1 Reduced electricity use by 5.5 - Reduction in electricity consumption 40%	1.4-6.27 - - -	[19,20,29,37,36] [16] [24] [4]
4	0.16-0.7 Reduction in specific fuel consumption 0.16-3.4	- -	4.1-40.68 -	[20,29,33,38,36] [15,22]
5	0.4-1.4	-	20.46-112,61	[20,21,37,38,36]
6	0.73-0.9 Reduction in specific fuel consumption 3.6-4.1	- -	23-72.39 -	[20,21,37,38,36] [12]
7	0.08-0.111	-	8.44-9.3	[20,30,33]
8	0.19-0.38% Reduction in specific fuel consumption 3%	- - -	6.3-20.46 - -	[20,36,37,44] [41] [5]
9	0.1-0.24 2-10%	- -	2.6-24.13 -	[20,37,38,36] [7,24,34]
10	0.015-0.22	-	0.39-0.57	[36]
11	0.05-0.16	-	0.8-40.68	[4,9,19,20]
12	0.25-0.345	20-35	4.6-31.66	[20,29,40,36]
13	0.011	-	0.3	[36]
14	0.21-0.22	17.84-22	3.68-9.25	[20,36,38]
15	0.02-0.04	0.66-4.4	0.16-2.67	[4,16,19,20,29,36,38]
16	0.005-0.006	0.45-3.9	0.13-0.9	[20,29,31,36,38]
17	2.4	-	62	[27,36]

IV. CO_2 EMISSION

In the cement plant emission of CO_2 reduction is 112,61 kg per tonne of clinker. In the cement plant exhaust the emission of CO_2 is 15%-33% by the volume &the power plant is 3%-15% by the volume (35-41). In the cement production CO_2captured is more efficient &affects the cost. In the cement industry, they use the various types of alternative fuel like as-peat cock,waste oil, oil shale, tyre, then produced the high amount of CO_2. Oxygen fuel combustion can enrich CO_2 concentration significantly in clinker production. The 80% of nitrogen air has been blocked away. In the loop flue gas the 3500*C the diluted the kiln manufactured the materials has enriched &CO_2 up to 75%-80% by volume. In the kiln 1500*C temperature as controlled formation of clinker (31).

The organic (Amine based) &inorganic (ammonia), which could serious corrosion, can be used the scrub the CO_2 from the hot flue gas (25,36). It is the challenge of the scale of CO_2 capture due to high cost& corrosion issues. LIME has been tested to absorbed the CO_2 with carbonation and calcinations as a loop for the clinker production. (38).

Global CO_2 emissions per region from fossil fuel use and cement production



V. CONCLUSION

In this paper discussed the energy conservation in the cement plant during the clinker formation. It is found the improved energy efficiency by the different ways & conservation of energy. A lot of amount of emission of CO_2 can be reduced. energy efficiency focuses on the new technology update & waste heat recovery. The conserving the thermal energy,electrical energy is about at varies from 5 to 4.1 Giga joules per tonne &0.45-0.35 kilo watt hour per tonne of clinker respectively. Emission reduction is varying from 0.13-112.61 kg CO_2per tonne of clinker.

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HOT SPOT TEMPERATUREMEASUREMENT AND AGING OF A TRANSFORMER

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***Abstract*— Temperature is one of the prime factors that affect the Transformer life. In fact increase temperature is a major cause of reduce Transformer life. Further the cause of most transformer failuren is breakdown of insulation system, so anything that adversely affects the insulation properties inside the transformer reduces its life. Such things as overloading of transformer, moisture in transformer, poor quality oil and insulating material, extreme temperature affect the insulating properties of thetransformer.**
Keywords – transformer, insulation, hotspot temperature,aging.

I. INTRODUCTION

A transformer has many components that require maintenance. The insulating system is a truly vital part, consisting of the oil and the solid insulation. The solid insulation may not be so readily accessible, but the oil certainly is. Oil can be kept in a good condition for a very long time and with proper care, probably for an indefinite period of time. However, poorly maintained oil will significantly reduce the technical life of the transformer

It is sometimes stated that the end of life of a transformer is ultimately decided by the end of life of the solid insulation. Even though it is true that many transformers are taken out of service before the solid insulation is so severely degraded, it is still true that the condition of the cellulosic insulation sets a limit for how long a transformer can be safely and reliably operated. For this reason alone, it is wise to carry out preventive maintenance.

II. EFFECT OF MOISTURE IN INSULATING OIL

Moisture and oxygen cause the oil to decay much faster than the normal rate and form acid and sludge. Sludge settles on windings and inside the structure, causing transformer temperature rises. If temperature increases then conductor resistance increases and consequently transformer Output voltage and load voltage decreases. So under voltage occurs if transformer temperature rises.

Moisture lowers the dielectric strength of oil. Thus insulating property decreases. So breakdown voltage also decreases with increase of moisture content in oil, which is shown in Fig.1.

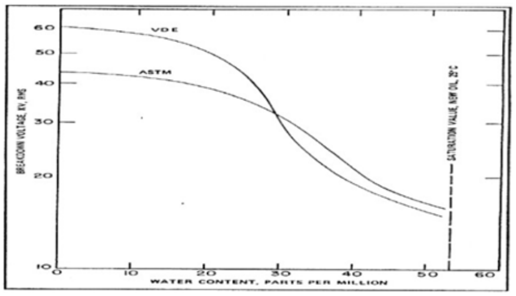

Fig 1.Moisture vs Dielectric Breakdown.

III. EFFECT OF MOISTURE IN INSULATION

Moisture rises temperature and lowers the dielectric strength of solidinsulation. Moisture raises the temperature and hence dielectric power factor and increases the risk of thermal breakdown of solid insulation. Moisture accelerates thermal aging of paper insulation [1].

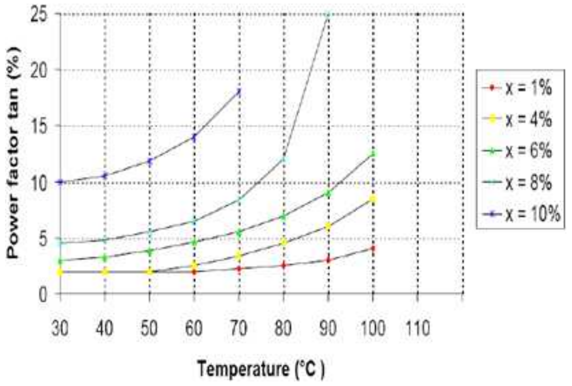

Fig 2.Temperature vs Breakdown Voltage curve for insulating material.

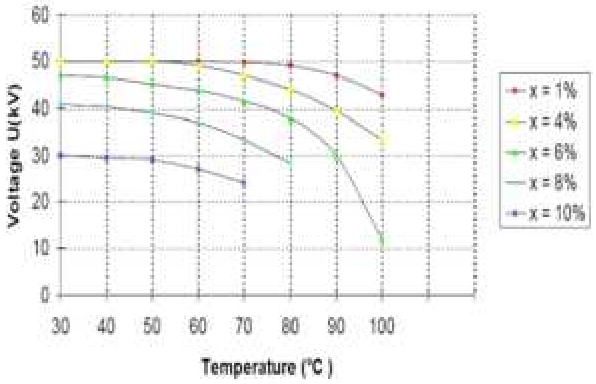

Fig 3. Temperature and hence Dielectric Power factor curve.

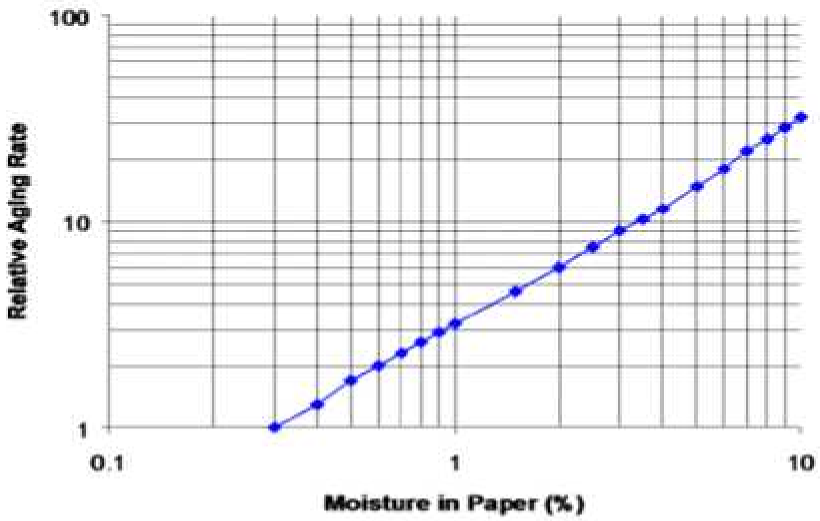

Fig 4. Linear relation between Moisture content in paper and aging rate.

IV. CALCULATION OF HOTSPOT TEMPERATURE IN154KV TRANSFORMER

The heat run test is conducted to determine whether the temperature rise limits of the top liquid and the average winding satisfy to the specification or not. The heat run test is mostly used for the routine test in the factory. Test methods of the heat run test are actual loading method, loading back method and short circuit method. In the factory test, however, the heat run test is measured by the short circuit method. The heat run test by the short circuit method makes the secondary winding short and applies voltage to the primary winding, supplying current equivalent toloss.***A. Specification of the 154 kvtransformer***

A. Specification of the 154 kvtransformer

Classification		Specification
Loss	No-load	11,280W
	Load	78,956W
	Total	90,236W
Rated voltage		154/22.9kV
Rated capacity		Single-phase, 15/20MVA, 60Hz
Core type		Shell
Temperature rise limits		Top liquid 60 ^{0}C
		Average winding 65 ^{0}C
Cooling method		ONAN/ONAF
% impedance		20%
Liquid volume		11,000 liters

Table 1. Specification of the 154 KV transformer

B. Specification got from heat run test and temperaturerise test

The power transformer uses a heat run test to measure top liquid temperature rise and average winding temperature rise by the factory test, which is specified in its specification [2].

Classification		Specification
oil	Top liquid temperature rise(? θ_0)	50^{0}C
	Radiator upper temperature(θ_u)	66^{0}C
	Radiator bottom temperature(θ_b)	40^{0}C
Transformer winding	Measured winding resistance After shutdown of the power supply	HV - 0.924?
		LV - 0.0201 ?
	Cold resistance measured(R_1)	HV - 0.793?
		LV- 0.017228?
	θ_{u1}	20^{0}C
	θ_{b1}	19^{0}C
	θ_{01}	20^{0}C

Table 2. Specification got from heat run test and temperature rise test

C.Calculation of average temperature ofoil

Primary rated voltage = lowest voltage under the ratedphase voltage = $\frac{154}{\sqrt{3}}$ ± 12.5% =77798V

The rated current (I_r), equivalent to load loss is

$$= \frac{\text{rated capacity}}{\text{primary rated voltaes}} = \frac{15MVA}{77798V} = 192.8A$$

The ratio of the current transformation is400/5A

Rated current at secondary(I_r) = $\frac{192.8}{400/5}$ =2.41A

Total loss current (I1) = Rated current × $\sqrt{\frac{total\ loss}{load\ loss}}$ = 192.8 × $\sqrt{\frac{90236}{78956}}$ = 206A

Total loss current (I1) at secondary = $\frac{206}{400/5}$ = 2.575A

The top liquid temperature is the temperature of the insulating liquid at the top of the tank, representative of top liquid in the cooling flow stream. The top liquid temperature is conventionally determined by thermocouple immersed in the insulating liquid at the top of thetank.

Top liquid temperature rise ($\Delta\theta_0$) = 50^0C

Let Ambient temperature (θ_a) =25^0C

Top liquid temperature (θ_0) = Ambient temperature (θ_a) + Top liquid temperature rise ($\Delta\theta_0$) = (25 + 50) = 75^0C

Average liquid temperature (θ_{om}) = Top liquid temperature(θ_0)– $\frac{\text{radiator upper temperature } (\theta_u) - \text{radiator bottom temperature } (\theta_b)}{2}$

= 75 – $\frac{66-40}{2}$) = 62^0C

Average liquid temperature rise ($\Delta\theta_{om}$) = Average liquid temperature – Ambient temperature (θ_a) = (62 – 25) =37^0C

D. Calculation of average temperature ofwinding

The measured winding resistance after shutdown of the power supply was 0.925Ω on the high voltage winding; and was 0.0201Ω on the low voltage winding. The average winding temperature shall be determined using the value of resistance at the instant of shutdown. In Heat Run Test when making power shutdown, connecting the DC power supply and measuring the winding resistance, the winding temperature goes down, resulting in the lower measurement of the winding resistance compared to the instant of power shutdown.

The decay of the winding resistance with time t after shutdown of the power supply can be expressed with the relation

$$R\ (t) = A\ (t) + \Delta R \times e^{-t/T}$$

Where T is an estimate for the time constant of the winding cooling down to the liquid with an exponential decay. Thus, the winding resistance at the instant of shutdown (t = 0) is as

$$R_w = A_0 + \Delta R$$

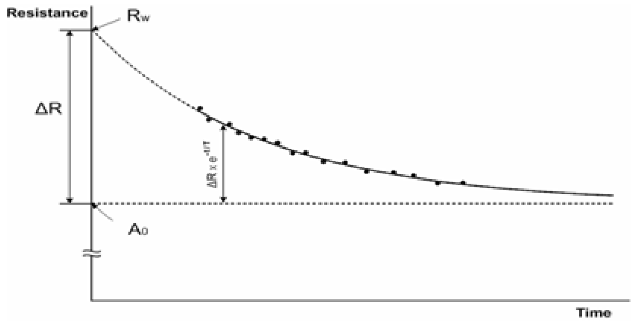

Fig 5. Average winding temperature variation after shutdown

The fall of the resistance from power shutdown tomeasuring winding resistance is calculated by the extrapolation method. The fall of the resistance (ΔR) measured by the extrapolation method was 0.06575Ω on the high voltage winding and 0.001371Ω on the low voltage winding.Thus, the winding resistance at the instant of shutdown (R_W) was (0.925Ω + 0.06575Ω) = 0.991Ω on the high voltage winding and (0.0201Ω + 0.001371Ω) = 0.02147Ω on the low voltage winding.

Average winding temperature (θw) is the winding temperature determined at the end o temperature rise test from the measurement of windingresistance.

Average winding temperature (θw) = $\frac{R_W}{R_1}(235 + \theta 1) - 235$ Where, reference measurement R1 and θ are the winding resistance and the liquid temperature before the heat run test. Cold temperature (θ1 was $\theta 1 = \theta 01 - (\theta u1 - \theta b1)/2 = 20 - (20\text{-}19)/2 = 19.5\ ^0C$

Cold resistance (R1) measured is 0.793Ω on the high voltage winding and 0.017228Ω on th low voltagewinding.

The average winding temperature (θw) on the high voltage winding = (0.991/0.793) (235 + 19.5) – 235 = 83.04 ^{0}C

The average winding temperature (θw) on the low voltage winding = (0.02147/0.017228) (235 + 19.5) – 235 = 82.16 ^{0}C

E.Calculation of Hot Spot Temperature(HST)

The hot spot temperature is calculated by the winding resistance for reference which is detected during the heat run test. If the hot spot temperature calculated by the winding resistance is different to the actual hot spot temperature, the life of transformer will be estimated a big error [3].

The average winding to liquid temperature gradient (g) = average winding temperature (θ_W) ‑ Average liquid temperature (θ_{om})So average winding to liquid temperature gradient (g) for high voltage winding = (83.04 – 62) = 21.04^{0}C and average winding to liquid temperature gradient (g) for low voltage winding = (82.16 – 62) = 20.16^{0}C

Corrected average winding to liquid temperature gradient (g_C)

$$= g \times [\frac{I}{I_r}]^{1.6}$$

gc for high voltage winding = $21.04 \times [\frac{2.41}{2.575}]^{1.6} = 18.92^0C$

gc for low voltage winding = $20.16 \times [\frac{2.41}{2.575}]^{1.6} = 18.13^0C$

Hot spot temperature (θ_h) = top liquid temperature (θ_0) + (h × g_C), Where H=1.3(for power transformer) or 1.1(for distribution transformer).

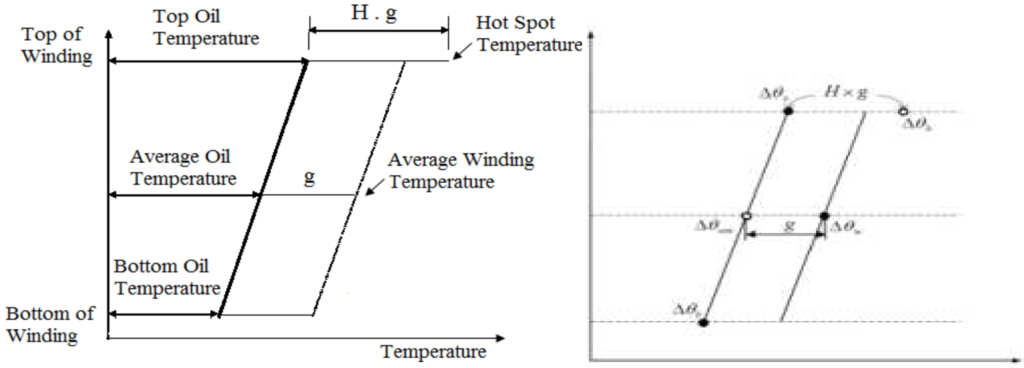

Fig 6. Temperature rise distribution model

Hot spot temperature (θh) for high voltage winding = 75 +(1.3 × 18.92) =99.6^{0}C and Hot spot temperature (θh) for low voltage winding = 75 + (1.3 × 18.13) =98.57^{0}C

The hot spot temperature rise (Δθh) = Hot spot temperature (θh) – Ambient temperature (θa) = (99.6 – 25) = 74.6^{0}C for high voltage winding and (98.57 – 25) = 73.57^{0}C for low voltagewinding.

F.Aging calculation oftransformer

The standard normal lifetime for oil-immersed power transformer for continuous HST of 110^{o}C based on and other IEEE standards.IEEELoading guide shows that insulation life is an exponential function of HST:

% of Insulation life = A × exp (B/ (θh+273))

Here θh is the HST (^{0}C), A and B are constants that are determined according to insulation material and HST reference defined for normal insulation life. This Equation can be used for both distribution and power transformers because both are manufactured using the same cellulose insulation. For instance, suppose HST reference for insulation life to be 110^{0}C. It means that if the transformer works continuously with this HST, its life will be 1 per unit (life in hour can be determined according to the used insulation) [3]. Using above assumptions above equation would be
Per Unit Life = 9.8 × 10^{-18}× exp (15000/ (θh+273))

This Equation yields a value of 1 per unit life for the reference HST of 110^{o}C.

For HV winding Per Unit Life = 9.8 × 10^{-18}× exp (15000/ (99.6+273)) = 2.98 pu

For LV winding Per Unit Life = 9.8 × 10^{-18}× exp (15000/ (98.57+273)) = 3.33 pu

Aging Acceleration Factor (FAA) is the rate at which a transformer insulation aging is accelerated compared with the aging rate at 110 ^{o}C. FAA is given as

FAA= exp (15000/ (110+273)) - (15000/ (θh+273))

= 0.3351 For HVwinding

= 0.2997 For LVwinding

FAA is greater than 1 when the HST is over 110 ^{o}C and less than 1 when the HST is below 110 ^{o}C. Some FAA values at different temperatures are presented in Table

HST (^{O}C)	FAA	HST (^{O}C)	FAA
60	0.0028	130	6.9842
70	0.0104	140	17.1995
80	0.0358	150	40.5890
90	0.1156	160	92.0617
100	0.3499	170	201.2294
110	1.0000	180	424.9200
120	2.7089	190	868.7719

Table 3. FAA values at different temperatures

A curve of FAA vs. HST is shown in Fig. 7. And the conclusion is that the loss of life of transformer insulation is related to the HST exponentially.

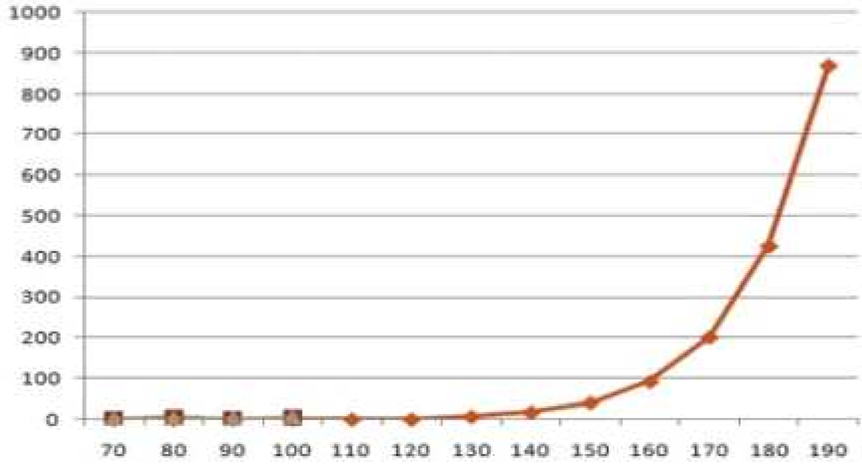

Fig 7. Curve of FAA vs. HST

G. Percentage Loss ofLife

The HST is varying according to load and ambient temperature. The equivalent aging acceleration factor at the reference temperature in a given time period (FEAA) for n=1 to N for the given temperature cycle is defined as

$FEAA = \sum (FAA,n. \Delta tn) / \Delta tn$

Where N is total number of time intervals. Δtn is nth time interval and FAA,nis aging acceleration factor for the temperature which exists during the time interval Δtn.

The equivalent loss of life in the total time period is determined by multiplying the equivalent aging by the time period (t) in hours. In this case total time period used is 24 hours. Therefore, the equation of percent loss of life equation is asfollows

% Loss of Life = (FEAA×t×100)/normal insulation life Hence we can say, if HST raises then Aging AccelerationFactor (FAA) increase and FEAA increase. So % Loss of Life will behigher.

V. CONCLUSION

The Hot Spot Temperature (HST) value depends on the ambient temperature, the rise in the top oil temperature (TOT) over the ambient temperature, and the rise in the winding HST over the top oil temperature. Moisture management in power transformers is a persistent concern especially for aging units. Extensive drying procedures are applied at the manufacturing stage and sustained efforts are deployed in service to maintain high dryness. The effect of moisture on insulation aging is well documented along with the detrimental effect on insulation strength and partial discharge inceptionlevel.

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FAULT DIAGNOSIS OF POWER TRANSFORMER BUSHING USING SFRA AND DGA AS AUXILIARY TOOLS

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Abstract—Dielectric insulation of a transformer bushing deteriorates as a function of temperature, oxidation, and moisture. This causes accelerated aging of oil and cellulosic solid insulation, generating fault gases within bushing oil and eventual permanent failure. To prevent such failures, effective analyses and diagnoses need to be investigated. Dissolved Gas Analysis (DGA) can give the indication of internal abnormalities inside the transformer bushing. In addition, Frequency response analysis(FRA) is a widely accepted tool for mechanical deformation diagnosis within power transformers. Although a large number of studies have been conducted on the detection of transformer winding deformation by FRA technique, the impact of bushing faults on the transformer FRA signature has not been sufficiently investigated. It is the goal of this paper to propose precise simulation as well as practical analyses demonstrating the impact of bushing faults on the FRA signature. A real transformer bushing geometry is modelled through 3D finite element analysis (FEM) on which different bushing faults are emulated. To verify the derived simulation results, DGA of transformer oil as well as FRA are performed on a three-phase, 132 kV,315MVA power transformer. It can be observed clearly from the results, that bushing faults have an impact on the FRA signature and DGA of the power transformer.

Index Terms- **condition monitoring, power transformer bushing, FRA, DGA, finite-element**

I. INTRODUCTION

Power transformers are unquestionably one of the most crucial pieces of equipment in electrical power systems. As a result of the continuing advancement in electric power transmission and distribution systems and the increasing worldwide transformer population age, the likelihood of transformercatastrophicfailures,whichinturnleadstopower outages, is increasing [1]. Hence, the importance of developing a standard diagnosis tool to detect potential mechanical problems, including displacements or deformations[2-4].

Bushings are critical components of power transformers and also one of the major initiators of transformer failures [5]. According to CIGRE, transformer bushings contribute to around17%ofalltransformerfailures,arethe3rdmostcommon cause of breakdowns, and are the most common cause of transformer fires and explosions. Therefore, establishing state- of-the-art diagnostic tools to help reduce the risks of failures and serious fires is of paramountimportance.By detecting the defect or degradation of bushings caused by the stresses acting on them, bushing failures can be avoided.

Current detection methods include, capacitance anddissipation factormeasurement,partialdischargeandoilsampling[6-8].In additionFRAisatrenchanttoolformonitoringtransformersto diagnose mechanical faults such as axial and radial displacement [9, 10], disk space variation [11] and inter-turn shortcircuit[12]ataninitiallevel.However,littleattentionhas beengiventotheimpactofbushingfaultsontheFRAsignature. In this paper, FEM is used to simulate the physical geometrical dimension of a transformer bushing, and investigate how different levels of fault will affect equivalent circuitparametersandFRAsignature.Toattempt thisconcept,DGA and FRA have been utilized as auxiliary tools to detect transformer bushing faults prior to failure.

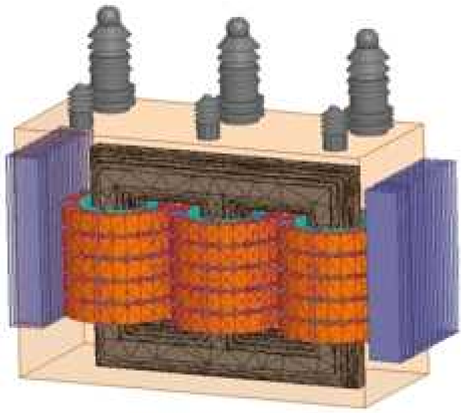

Figure 1. 3D model of a power transformer

II. FINITEELEMENTANDELECTRICALMODELOFA TRANSFORMERBUSHING

Failure of a power transformer results in serious damage to assetsandreducedreliabilityofthepowersystem.Afailedhigh voltage (HV) bushing is one of the major transformer components responsible for forced outages of a power transformer. There are two common types of transformer bushings,namelysolidporcelainbushing,whichisusedforlow voltage (LV) transformers, and oil impregnated paper (OIP) bushing, for HV transformers. According to CIGRE, close to 50% of serious transformer fires are initiated by Oil- Impregnated-Paper(OIP)bushings and they are the most common cause for transformer fires. The insulation body of an OIP transformer bushing is comprised of several cylindrical layers of insulation material wound around a central core. The insulation layers are usually filled with an insulating fluid such as oil whose ageing and moisture content have noticeable impacts on bushing dielectric properties. In order to achieve a high degree of uniformity in the electric field,conductive layers are placed between paper layers[13].The outermost conductive layer is connected to the flange of the bushing which is grounded while intermediate conductive layers remain insulated. The above described construct acts as a set of capacitors connected in series, creating a capacitive voltage splitter.

The equivalent electrical model of the bushing connected to a one-phase transformer is shown in Figure 3. The capacitance Cbnofeach layer can be calculated using equation(1),where $?_r$ is the relative dielectric constant of dielectric material, ln is the length of nth bushing layer and rn is the radius of nth bushing layer. Volume resistance Rsncan be obtained using equation (2),where ρ is the resistivity and Rpn is a resistance in the range of M? which represents surface resistance of bushing layersand bushing external insulation dielectric.

The main insulation system is known as the C_1, which is the equivalent capacitance of the inner insulation layers. The last few layers near ground are known as the C_2 insulation.

As a result of insulation degradation, which occurs mainly duetoheat, oxidation,acidity, andmoistureingress, therelative dielectric constant of the bushing, $?_r$ varies, thereby changing the bushing capacitance. Bushings are designed to have a constantdielectriccapacitanceovertheas setoperationallifeandtherefore,a3%to5%variationinbus hin gcapacitance can indicate potential problems within bushings [15]. To accurately identify the effect of bushing faults on the electrical parametersofthebushing,inFigure2,thephysicalgeometrical dimension of a 200 KVA bushing of a three-phase transformer showninFigure1issimulatedusingFEMsoftware(Ansys)for healthy and faulty conditions. In order to emulate a fault in the bushing, its insulation complex permittivity is altered. The electrical parameters for normal and faulty conditions are extracted using FEM based on the following 4steps:

- Step1:TheTransformerbushingismodeledusingFEAwith properties material in electrostatic, magnetostatic and DC conduction solvers to obtain the capacitances, conductance and inductance for healthycondition.
- Step 2: The permittivity of oil and paper in the bushing are changed within properties material option to simulate the moisturecontentandinsulationdegradation.Theresultantis solved in electrostatic solver to calculate the variation of the capacitances for different levels offault.
- Step3:Theelectricalparametersareextractedfornormaland faultyconditions.
- Step 4: The FRA signature is plotted as the gaining transfer function $TF_{dB} = 20 \log_{10} |V_O/V_{in}|$ for healthy and faulty conditions.

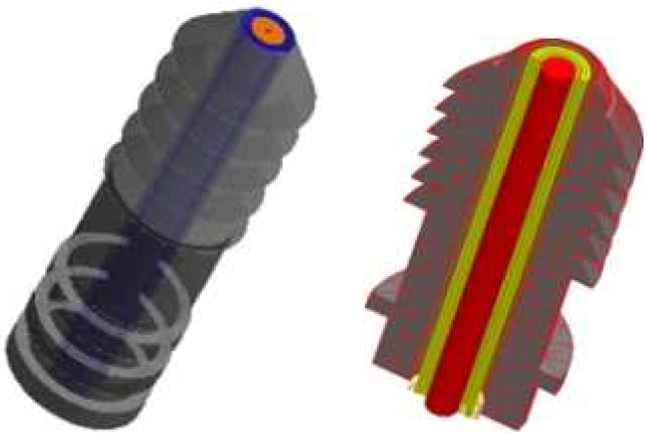

Figure 2. 3D model of Bushing solved in electrostatic FEM solver.

III. BUSHING FAULTDETECTION

As a result of moisture ingress inside the bushing dielectric insulation, the capacitive components, C_1 and C_2 change. InFEA, this effect can be simulated through altering thepermittivity or conductivity of the dielectric insulation. Moisture content variation inside the bushing insulation is emulated by increasing the oil-paper permittivity from 1% to 5% for the model under study. Table 1 shows the percentageof corresponding alteration of the bushing capacitances C_1 and C_2 due to the permittivity variation inside the bushing dielectric insulation.Itisclearthatforaparticularpercentageincreasein dielectric permittivity, C_1 varies more significantly in comparison with C_2, e.g. a 2% permittivity rise leads to a 9.5% increasein C_1whilethevalueofC_2increasesbyamere4%.

TABLE 1. CAPACITANCE VARIATION OF BUSHING MODEL

Dielectric Insulation PermitivityVariation (%)	CpacitanceVariation (%)	
	C_1	C_2
1	8	2
2	9.5	4
3	11	5.5
4	13	6.8
5	15	7.5

Figure 4 shows the impact of moisture ingress in bushing insulation on the HV winding FRA signature. The variation of high voltage FRA signature for rises of 2% and 4% in the permittivityofthetransformerbushingoilandpaperhavebeen investigated in thesimulation.

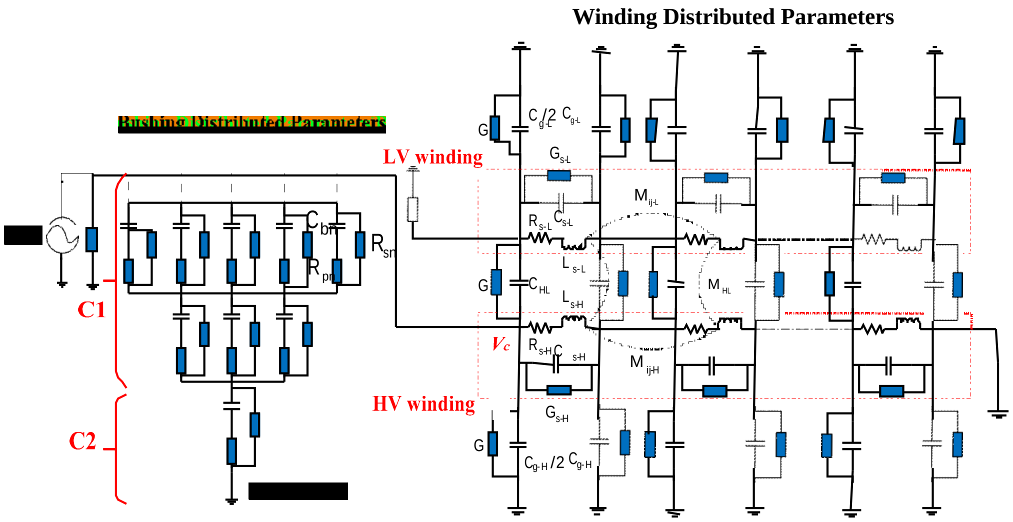

Figure 3. Electrical model of transformer winding and bushing

As can be seen, moisture content inside the dielectric insulation can affect the FRA signature at high frequency rangeover700kHzwheretheresonanceandanti-resonance frequencies decline in comparison with the healthy condition. The impact can be more predominant if more moisture penetrates within bushing insulation. To simulate the worst conditions, the permittivity of the dielectric insulation can be further varied inFEM

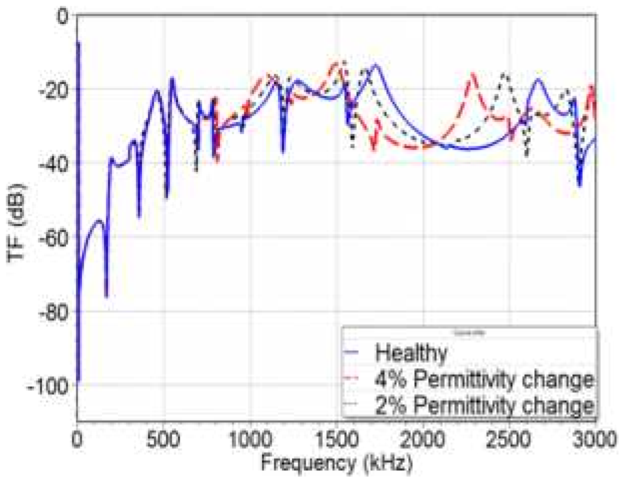

Figure 4.Effect of moisture content in bushing insulation on HV winding FRA signature.

IV. PRACTICALMEASURMENTS

In this study, a 200 MVA step up transformer has been takenasacaseinordertoevaluatethecapabilityofFRAandDGA methods to diagnose bushing faults. The results of DGA test are presented in Table 2.

TABLE 2. DGA TEST DATA

Test Date	Dissolved Gas (ppm)				Moisture content (ppm)
Dec 2010	C2H4	CH4	CO	CO2	10
Feb 2011	0.1	2.25	135	250.43	12.5
March2012	4943	10556	4195	1547	24
July 2013	2940	7790	3100	4650	26
June2014	3650	5965	4800	5900	35
Nov2015	4500	65022	8718	6380.6	45

According to Table 2, the total dissolved gas content has increased continuously over the 5-year period. Carbon monoxide (CO) and Carbon dioxide (CO2) concentration level increased rapidly from 135 and 8715 to 250.43 and 6380.6, respectively. According to IEC standard, the increment of CO and CO2 level in transformer oil can be used as an indication of dielectric insulation aging and decomposition. This degradation can be due to the increase inmoisturecontentinsidetheoilandthenpenetrationofthe paper insulation which leads to the decomposition of cellulose [16]. Table 2 shows that the moisture content increased from 10 ppm to 45 ppm over the period, which leads to a higher degradation rate of the bushing insulation, hencesignificantlyaffectingthedielectricinsulationrelative permittivity(?r).

Detailed investigation of the level and the change of combustible gases in the insulating oil revealed that the faultis developing in nature and adversely affecting the dielectric insulation inside the bushing.

TovalidatetheDGAresults,thetransformerHVwinding FRA signature is plotted. Figure 5 shows the impact of bushing failure on the transformer FRA signature. FRA measurements were performed as the magnitude of the transfer function (TF) in dB, 20log10(V_o/V_i), against frequency. In this case, the FRA measurement is at two different time intervals. The responses shows that as the conditionofthedielectricinsulationdeteriorates,resonances and anti-resonance frequencies are shift to the left. The variation is seen in the high frequency range after 800kHz.

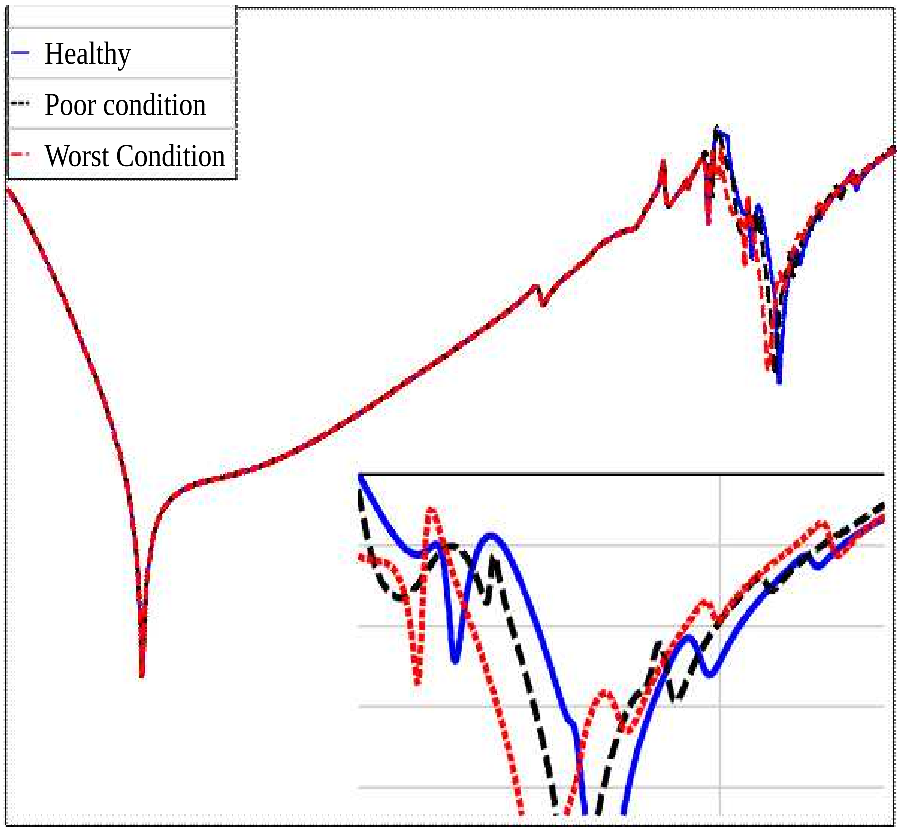

Figure 5. Practical phase-A FRA signature with 3% moisture content in the bushing oil

I. CONCLUSION

This paper presents an improved method using comprehensive finite element analysis to analyse the effect of dielectric insulation failure of HV transformer bushing on the FRA signature.

Based on simulation results and practical tests, the following conclusions can be drawn:

- Simulation and practical results also reveal that moisture content inside the dielectric insulation of a transformer bushing can be observed in the high frequency range of the transformer FRA signature as it changes the magnitude and resonance frequencies position.
- By considering the change in capacitances of the bushing model, failures could be detected through the frequency response analysis (FRA) signature of the model, and the FRA signature gained from the simulation is validated by the FRA signature derived from the practical measurement.
- During operation, minor faults developing inside the transformer bushing will develop into major faults and further result in catastrophic failures. To avoid permanent failure, DGA and SFRA diagnostic techniques can be used as auxiliary tools which relate fault gases' concentration level with the resonanceshift observed in SFRA signature to diagnose bushing faults at initial stages.

Appendix

Table A.2. Dielectric properties of bushing

Dielectric properties	Oil	Paper layer	porcelain
ε	2.4	2.5-16	6.5

Table A.4. Bushing Model Parameters (T Model)

Electrical parameters	$C1$	$C2$	L_S	R_S
Value	2000pF	450pF	2.5μH	0.2Ω

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SIZE CALCULATION THE VERTICAL EARTH GROUNDING USING NOMOGRAMS

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Abstract—The design of earth grounding at rated values corresponding to the role to be accomplished is relatively laborious and there are no highlighted optimum criteriagiving the justification for the chosen solution. The vertical earth grounding calculus is restructured in this paper, realizing sizing nomograms which include allcharacteristic sizes, the final goal being the determination of the electrodes number which ensures the rated value achieving for the dispersion resistance. For the designing simplification, the unitary earth grounding is defined versus which the earth grounding may be easily finalized with different values compared to the unitary one. The dispersion resistance determination for the simple earth grounding with only one electrode is considered as the first step in earth grounding sizing, for which a calculation nomogram was conceived. The second step is represented by the electrodes number determination for the multiple earth grounding which leads to the obtaining of the rated value for the earth grounding dispersion resistance.

Keywords—vertical earth grounding; earth grounding dispersion resistance; ground rods number; calculation by nomograms; artificial earth grounding

DESIGN OF EARTHING SYSTEM USING TWO LAYER MODEL

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Abstract—A two layer ground model for the computation of the earthing systems is presented. The model combines the pipe element method with multiple image technique by using a fundamental solution defined for the two-layered three- dimensional (3D) half space. The model couples two problems: an external one that models the phenomena that occur in the soil – solved with the boundary element method (BEM), and an internal one that models the potential distribution in the buried metallic structures - solved with the finite element method (FEM). In order to evaluate the two layer ground computational model, the resistance-to-earth is computed for three particular earthing systems (vertical rod, horizontal rod and gradient control mat) and compared with the analytical solution. The earth potential rise (EPR) in case of the gradient control mat is represented.

Keywords—two-layer ground, fundamental solution, multiple image technique, pipe elements, BEM, FEM, earthing systems

OVERVIEW

The earthing systems are safety elements of outmost importance in the protection of both electrical equipment and personnel. In principle they should cover two main aspects: a) provide means for the electricity conduction during normal or fault operation conditions without exceeding the safety limits of electrical equipment or endanger the servicing personnel; b) ensure that a person near a grounding system electrode is not exposed to the electrical shock hazards, (e.g. touch and step potentials). The main characteristics that comprehensively describe the functional behavior and effectivity of the earthing systems are the resistance-to-earth and the ground potential rise. The design parameters of the earthing systems are described in many normative or standards, e.g. [1] and [2]. Basically most of them are based on the analytical or empirical formulations but lack in generality because they are limited to particular geometries and/or homogenous soil. Therefore, a special interest has been put in the developing of numerical modeling techniques of complex grounding systems in inhomogeneous soil. Colominas*et. al*. proposed in [3] a numerical formulation for the grounding analysis in stratified soils. On the basis of BEM they derived an analytical integration technique and demonstrated it on a real earthing system in two-layer soil. Nassereddineet. al. analyzed in [4] the implications of the soil resistivity data computations on the earthing design. They used a commercial software for thecomputation of two layer soil resistivity based on measurement data, resistance-to-earth of the earthing systems and EPR. Papaiz-Garbini*et. al*. presented in [5] the importance of taking into account a multilayer ground and demonstrated with a commercialsoftware.

In this paper a two layer ground computational model is presented and demonstrated for the numerical computation of grounding systems. The model is based on the pipe element method developed by Brichau*et. al.* in [6-8]. In order to account for inhomogeneous soil structures, the pipe element method was combined with multiple image technique and it was demonstrated in [9] by Purcar*et. al.* for the cathodic protection of buried pipes in two layer ground. At this moment the model is integrated in the commercial software CatPro [10].

The presented model combines the pipe element method with multiple image technique by using a fundamental solution defined for the two-layered 3D half space. The computational model was compared with theanalytical solution found in literature for the resistance to earth of three particular grounding systems (vertical rod, horizontal rod and gradient control mat). A good agreement between the numerical and analytical solution of the resistance-to-earth with relative errors (in %) varying from 0.88 to 5.67 has been obtained. The two layer ground computational model can be applied for the simulation of complex grid systems e.g. the gradient control mats. Important values that characterise the effectivity of the earthing systems, like EPR, can be easily visualized. Further developments will be performed for the investigation and design of complex earthing systems, e.g. those of high voltagesubstations.

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PROMOTING RENEWABLE SOURCE OF ENERGY TO REDUCE DEPENDABILITY ON FOSSIL FUELS

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Abstract: An ever-growing population means an ever-growing requirement for energy. Nowadays, the enormity of energy cannot be denied. It is essential in every walk of life. Energy sources can be broadly classified as renewable and nonrenewable. Knowing the dreadful fact that non-renewable sources will eventually deplete, the importance of renewable sources cannot be underestimated. The most important aspect while utilizing them is their impact on the environment. India owns important renewable energy potential this important potential is still suffering from poor development the main cause of poor use renewable energy is the poor commitment and dedication of government who have not taken the necessary measures to boost the sector the work also shows availability of renewable energy source and suggests action to promote and sustain its development based on the knowledge of the India renewable energy sector.

1. **Introduction: R**enewable energy is the energy which is derived from a limitless source. Proper utilization of energy resources is a hot debate going on these days. It is very essential to choose which source of energy must be used and why. Majority of factors such as cleanliness, cost, stability, efficiency and environment effects must be taken into account. It is a bitter fact that many industries around the world are still dependent on fossil fuels for electricity generation. No doubt, these fuels are very effective as far as power production quality is concerned, but in the long run, they are not advantageous. Fossil fuels will deplete one day and the industries must turn to renewable sources as soon and possible. Moreover, these fossil fuels pose a huge threat to environmental balance and are a cause of many ecological hazards India owns important renewable energy potential, namely hydro, solar and wind. This important potential is still suffering from poor development up to the point where the sub-region is still abundantly using the fossil energy as main power source. The main cause of the poor use of renewable energy is the poor commitment and dedication of governments who have not taken the necessary measures to boost the renewable energy sector.

2. **Methodology**:

The work shows the availability of renewable energy sources and suggests actions to promote and sustain its development. Based on the knowledge of the Indian energy sector, this paper will identify actions for improved access to sustainable, friendly, affordable energy services to users as well as a significant improvement of energy infrastructure in India and the promotion of renewable energy and energy efficiency. The work will show at first the potential for the three primary energy sources which are solar, wind and hydro while showing where available the level of development. Then identified obstacles to the promotion of clean energy will be targeted. Finally, suggestions will be made to help the countries develop a vision aiming at developing good clean energy policy to increase the status of renewable energy and better contribute to fighting against climate change and clean environment. the country has a great renewable energy potential and can develop and export energy to neighboring countries..

3 **Renewable energy potential in India**:

3.1 **Solar Potential** :

India plans to become of the largest solar power markets in the world has received a massive boost as the latest estimated of its solar power potential 750GW the estimates Rajasthan and Jammu & Kashmir have the highest solar power potential. Rajasthan with its healthy resource of solar radiation and a large area of wasteland in Ladakh. The state has an estimated potential of 111GW. Madhya Pradesh and Maharashtra both have more than 60GW of solar power potential. The Rewa ultra mega solar is an operational solar park spread over an area of 1,590 acres (6.4 km2) in the Gurh tehsil of Rewa district of Madhya Pradesh the project was commissioned with 750 MW capacity in July 2018.

3.2 Hydro potential:

India is the 7th largest producer of hydroelectric power in the world. As of 30 April 2017, India's installed utility-scale hydroelectric capacity was 44,594 MW or 13.5% of its total utility power generation capacity. Additional smaller hydroelectric power units with a total capacity of 4,380 MW (1.3% of its total utility power generation capacity) have been installed. India's hydroelectric power potential is estimated at 148,700 MW at 60% load factor.[4] In the fiscal year 2016-17, the total hydroelectric power generated in India was 122.31 TWh (excluding small hydro) with an average capacity factor of 33%.

The hydroelectric power plants at Darjeeling and Shivanasamudram were established in 1898 and 1902, respectively. They were among the first in Asia and India has been a dominant one in global hydroelectric power development. India also imports surplus hydroelectric power from Bhutan

3.3 Wind potential:

The india well developed wind power industry has the capability and experience to help meet the country's climate and energy security goals. Today india is the 4th position in the world with installations of over 31GW (28.7 GW at the end of calendar year 2016) with almost 90% of the investment. The short –term national target of 60GW by 2022.

3.4 Biomass Potential:

The biomass energy resource potential energy conversion and policy for promotion implemented by government of india are discussed the electricity generation in india is 2666.64 GW as on 31st march 2013 in india total biomass power generation capacity is 17,500MW at present power being generation is 2665 MW which include 1666MW by cogeneration.

5Geothermal potential:

India is blessed with good potential for geothermal energy. India is considered to have low(<100 degree c)to medium (100-200 degree c) northern india puga state of Jammu and Kashmir (temperature range is between 30 degree c to 84 degree c which is boiling point at puga and discharge is around 300 liters/minute). West india (tattapani state of chattisgrah(highest potential in country) East india west Bengal The geothermal energy india is about 10000MW there are seven geothermal provinces in india.

4 . Conclusion:

India is a region with great renewable energy potential, a place was almost all renewable energy sources can be found. The region owns the first wind potential, an important solar radiation hydro potential of the continent all year long. Despite the great renewable energy sources, the region is experiencing very poor renewable energy and energy efficiency problems. Although some actions are ongoing, more specific and serious steps are needed at several levels. Suggestions have been made to help the region develop a good vision to address the issue and take the necessary measures at all levels for promoting renewable energy and energy efficiency, Energy conservation awareness campaigns must be initiated by the government to make people aware of the importance of conserving energy and saving the environment. Moreover, power companies should gradually resort to the use of renewable resources as they are abundant and will never deplete.Social media can play a key role in this by educating people about renewable energy sources and their utilization. School, Colleges, and universities should teach a compulsory subject on energy conservation and utilization.

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