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Studies On Energy Conservation And Audit

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ABSTRACT: *Energy Audit is the systematic process for finding out the energy conservation opportunities in industrial processes. The project carried out studies on various energy conservation measures application in areas like lighting, motors, compressors, transformer, ventilation system etc. In this investigation, studied the technical aspects of the various measures along with its cost benefit analysis.*

Investigation found that major areas of energy conservation are-

1. Energy efficient lighting schemes.
2. Use of electronic ballast instead of copper ballast.
3. Use of wind ventilators for ventilation.
4. Use of VFD for compressor.
5. Transparent roofing sheets to reduce energy consumption.

So Energy Audit is the only perfect & analyzed way of meeting the Industrial Energy Conservation.

I. Introduction

India has made rapid stride towards economics self-reliance over the last few years. Impressive progress has been made in the fields of industry, agriculture, communication, transport and other sector necessitating growing consumption of energy for developmental and economic activities. If India is to achieve the targeted growth in GDP, it would need commensurate input of energy, mainly commercial energy in the form of coal, oil, gas, & electricity. However, India's fossil fuel reserves are limited. The known reserves of oil & natural gas may last hardly for 18 and 26 years respectively at the current reserves to production ratio. India has huge proven coal reserves (84 billion tones), which may last for about 200 years but the increasing ash content in Indian coal as well as associated greenhouse gas emission are the major concern.

Energy being an important element of the infrastructure sector has to be ensured it's availability on sustainable basis. On the other hand, the demand on energy is growing manifold and the energy sources are becoming scarce and costlier. Among the various strategies to be evolved for meeting energy demand, efficient use of energy and its conservation emerges out be the least cost option in any given strategies, apart from being environmentally benign.

The steps to create sustainable energy system begin with the wise use of resources; energy efficiency is the mantra that leads to sustainable energy management.

II. Major Energy Saving Areas

1. Energy Saving By Using Electronic Ballast

1.1Role of ballast:-

Ballasts (chokes) are used to provide higher voltage to start the tube light and subsequently limit the current during normal operation. Fluorescent lamp is an electric discharge lamp. The two electrodes are separated inside a tube with no apparent connection between them. When sufficient voltage is impressed on these electrodes, electrons are driven from one electrode and attracted to the other. The current flow takes place through an atmosphere of low pressure mercury vapour. Since the fluorescent lamps cannot produce light by direct connection to the power source, they need an auxiliary circuit and device to get started and remain illuminated. The auxiliary circuit housed in a casing is known as ballast.

1.2 Conventional vs. electronic ballast:-

Conventional electromagnetic ballasts (chokes) are used to provide higher voltage to start the tube light and subsequently limit the current during normal operation. Electronic ballasts are oscillators that convert the supply frequency to about 20,000 Hz to 30,000Hz.

The conventional ballast make use of the kick cost by sudden physical disruption of current in an inductive circuit to produce the high voltage required for starting the lamp and then rely on reactive voltage drop in the ballast to reduce the voltage applied across the lamp. On account of the mechanical switch (starter) and low resistance of filament when cold the uncontrolled filament current, generally tend to go beyond the limits specified by Indian standard specifications. With high values of current and flux densities the operational losses and temperature rise are on the higher side in conventional choke. The high frequency electronic ballast overcomes the above drawbacks.

The basic functions of electronic ballasts are:-

1 To ignite the lamp.
2 To stabilize the gas discharge.
3 To supply the power to the lamp.

The electronic ballasts make use of modern power semiconductor devices for their operation. The circuit components form a tuned circuit to deliver power to the lamp at a high resonant frequency (in the vicinity of 25 kHz) and voltage is regulated through an inbuilt feedback mechanism. It is now well established that the fluorescent lamp efficiency in the kHz range is higher than those attainable at low frequencies. At lower frequencies (50 or 60 Hz) the electron density in the lamp is proportional to the instantaneous value of the current because the ionization state in the tube is able to follow the instantaneous variations in the current. At higher frequencies (kHz range), the ionization state cannot follow the instantaneous variations of the current and hence the ionization density is approximately a constant, proportional to the RMS (root mean square) value of the current. Another significant benefit resulting from this phenomenon is the absence of stroboscopic effect, thereby, significantly improving the quality of light output.

Advantages:-

1 One of the largest advantages of electronic ballast is the enormous energy savings it provides. The losses in electronic ballast for tube lights are only about 1watt, in place of 10 – 15 watts in standard electromagnetic chokes. This is due to its amazingly low internal core loss, quite unlike old fashioned magnetic ballasts. Hence a saving of about 15 -20 watts per tube light can be achieved by use of electronic ballasts. Energy savings up to 35% is achieved.

Type of Lamp	With Conventional Electromagnetic ballast	With Electronic Ballast	Power Savings Watts
40W Tube light	51	35	16
35W Low pressure sodium	48	32	16
70W High pressure sodium	81	75	6

Table no.1: Units Consumption

2 The efficiency of tube lights improves at higher frequencies, resulting in additional savings if the ballast is optimized to provide the same light output as with the conventional choke.
3 The tube light lights up instantly without flickering.
4 Less heat dissipation which reduces the air conditioning load.
5 Lights instantly.
6 Improved power factor.
7 Less in weight.
8 Increase the life of lamp.

The advantages of HF electronic ballast, outweigh the initial investment (higher costs when compared with conventional ballast).In the past the failure rate of electronic ballast in Indian industries was high. Recently many manufacturers have improved the design of the ballast leading to drastic improvement in their reliability. The life of the electronic ballast is high especially where, used in a lighting circuit fitted with a automatic voltage stabilizer.

III. Energy Saving By Compact Fluorescent Lamp

Definition: A Compact Fluorescent Light produces light when electricity is passed through a gas sealed in a glass tube, creating UV rays which react with a phosphor coating on the inside of the glass tube. CFLs use less power, release less heat, and last a longer than an incandescent light bulb.

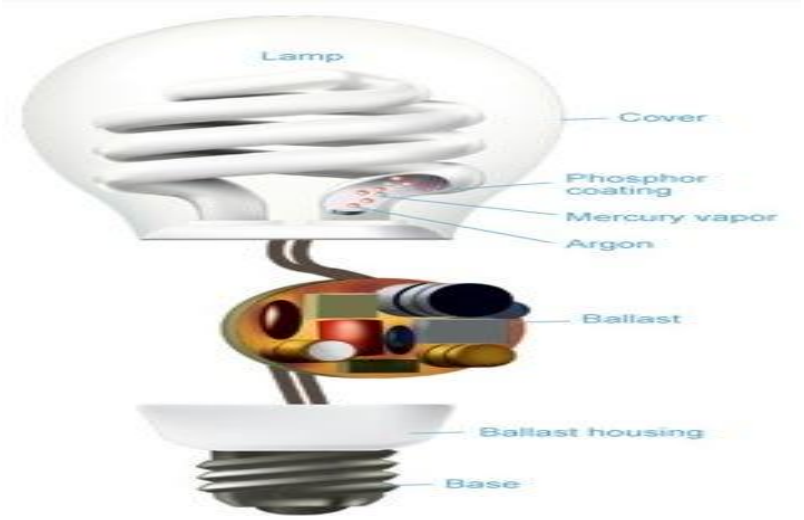

Fig. No.1 Compact Fluorescent Lamp

Comparison with Incandescent Lamps

1. Lifespan:- Modern CFLs typically have a lifespan of between 6,000 and 15,000 hours, whereas incandescent lamps are usually manufactured to have a lifespan of 750 hours or 1,000 hours. These lifetimes are quoted according to IEC60969, which specifies that "life to 50% of failures shall be not less than value declared by the manufacturer". The life time of any lamp depends on many factors including manufacturing defects, exposure to voltage spikes, mechanical shocks, frequency of cycling on and off and ambient operating temperature, among other factors.

The life of a CFL is significantly shorter if it is only turned on for a few minutes at a time: In the case of a 5-minute on/off cycle the lifespan of a CFL can be up to 85% shorter, reducing its lifespan to the level of an incandescent lamp. The US Energy Star program says to leave them on at least 15 minutes at a time to mitigate this problem.

CFL's give less light later in their life than they did at the start. The light output depreciation is exponential; with the fastest losses being soon after the lamp was new. By the middle to end of their lives, CFLs can be expected to produce 70-80% of their original light output.

2. Interaction with other energy sources:-All operating electrical lamps contribute heat to a building and therefore, when considering the energy savings of CFLs versus incandescent lamps, it is necessary to consider energy used for illumination as well as energy used for heating or cooling.

If incandescent lamps are replaced by CFLs the heat produced by the building's lighting system will be reduced. At times when the building requires both heating and lighting, the building's central heating system will then have to work harder to maintain the same temperature. Depending on the sources of energy used for heating and for electricity production, this may result in either a small increase or a small decrease in the total cost and environmental impact of changing to CFLs.

There is a third case where electric lighting is used with natural vibration and without either heating or cooling. In this case the energy saving due to CFLs are simpler to estimate, as described above.

Conversely, if the building requires both illumination and cooling, then CFLs will use less electricity themselves and will also reduce the load on the cooling system compared to incandescent lamps. This results in two concurrent savings, and since most air conditioners are also electrically powered, they are directly comparable.

When the energy used for both heating and lighting is considered, the use of CFLs saves three quarter to four fifth of lighting energy in temperate climates and cooled buildings, and less in cold climates and heated buildings.

3. Energy Efficiency:- In order to compare the actual energy efficiency of CFLs with various other lamp technologies such as incandescent, LED and halogen, factors to compare include lumens, the subjective usefulness of different frequencies of light, the distribution of light over imaginary 360 degree spheres around

the lamps and other factors. In round figures, typical incandescent lamps are around 2% efficient and domestic CFLs are currently 7%-8% efficient (life cycle comparisons are necessarily more complex).

4. Cost: - In addition to the above savings on energy costs, the average life of a CFL is between 8 and 15 times that of incandescent. While the purchase price of a CFL is typically 3 to 10 times greater than that of an equivalent incandescent lamp, the extended lifetime (fewer lamps to replace and reduced labor) and lower energy use will compensate for the higher initial cost in many applications.

5. Cost-Effectiveness in Commercial Buildings:-CFLs are extremely cost-effective across commercial building types and applications. Savings are greater and payback periods shorter in regions with higher than average electric rates and, to a lesser extent, higher than average cooling requirements.

6. Cold weather function:- Incandescent give light almost immediately upon the application of voltage. CFLs take a moment to brighten up, and can take much longer in very cold temperatures. Coupling this with the shorter life of CFLs when turned on and off for short amounts of time may make incandescent bulbs more attractive for things like outdoor and/ or motion activated lighting.

IV. Energy Saving By Transparent Roofing Sheets

Energy saving through "Translucent roofing sheet" Translucent sheets are the transparent type having ability to pass specific type of light through it.

As natural light is freely available at the day time we can use it with the help of these sheets. Utilization of free natural light requires Specific type of sheets passing specific lumens through it. These sheets are FRP or poly roof sheet. These are protected against degradation from UV radiation and long term exposure during extreme weather conditions.

Fig.No.2 Transparent Roofing Sheets

Sheet Specifications

- Thickness ranging from 0.60 mm to 8.00 mm.
- Width is maximum 59 inches (1500 mm).
- Length is custom made.
- Its outstanding performance includes.
- Excellent light transmission.
- Ability to withstand wind loads up to 140 mph (200 kmh).
- UV resistance and impact strength.
- Exceptional sound dampening qualities to create quieter indoor environment.
- Thermal insulation.
- Low maintenance, Long life product constructed of mold, mildew and fungus resistant materials.

ADVANTAGES:-

- Excellent clarity improves natural light transmission.
- Self-emboss surface finishing enhancing aesthetic of roof.
- UV stabilized.
- No warp during long-term heat exposure.
- Excellent Heat and sound insulation.
- Weather resistant.
- Nil maintenance and homogeneously colored.
- Moisture Absorption 0.008%.

- High chemical resistance.
- Lightest in weight compare to any other roofing material.
- Easily cut with saw, Nailed and screw.
- Conventional fixing methods applied for installation.
- Material used can be poly carbonate, which has ability to withstand wind loads up to 140mph (200Kmh).
- This sheet retains light transmission & at the same time provides excellent light transmission.
- Translucent sheet is mainly applicable to admit high levels of light while keeping access heat to minimum.

Also, it gives better lumens value at working point & saves 30-40% of electricity of the total electricity for lighting purpose.

V. Energy Saving In Ventilation By Using Wind Ventilator

Wind ventilators are the ventilators used at the top of the roof of workshop area for natural ventilation of air in this area. This ventilators rotate by wind pressure so no, power requirement.

These are designed to allow the vent to spin freely under wind load & provide the same exhaust rate as the traditional Hurricane Vent.

Natural Air ventilators are practically the most suitable type of ventilator for the use today as it is a Ventilator. It Works on the natural movement of wind energy, and works even at the slowest velocity of wind. Golden turbo vent is definitely a revolution in the world of attic ventilators, as these require minimal maintenance.

Benefits:-

- Completely reliable, just fit and forget.
- Ample of fresh air in the living area for pleasure of living.
- Prolongs life of costly electrical appliances.
- High quality and corrosion resistant body.
- Satisfactory prices and marvelous performance.

Features:-

- Works minus noise.
- Nonresistant from sunlight and rain.
- Available in aluminum and stainless steel.
- Works with natural wind energy.
- Literally maintenance free.
- Easy to installation.

Fig.No. 3 Natural Air Ventilators

Procedure For Energy Audit

A GUIDE FOR CONDUCTING ENERGY AUDIT AT A GLANCE

Industry-to-industry, the methodology of Energy Audits needs to be flexible. A comprehensive ten-step methodology for conduct of Energy Audit at field level is presented below. Energy manager and Energy Auditor may follow these steps to start with and add/change as per the in needs and industry types.

Phase I -Pre Audit Phase Activities:-

A structured methodology to carry out an energy audit is necessary for efficient working. An initial study of the site should always be carried out, as the planning of the procedures necessary for an audit is most important.

Initial Site Visit and Preparation Required For Detailed Auditing:-

An initial site visit may take one day and gives the Energy Auditor/Engineer an opportunity to meet the personnel concerned, to familiarize him with the site and to assess the procedures necessary to carry out the energy audit.

During the initial site visit the Energy Auditor/Engineer should carry out the following actions: -

- Discuss with the site's senior management the aims of the energy audit.
- Discuss economic guidelines associated with the recommendations of the audit.
- Analyse the major energy consumption data with the relevant personnel.
- Obtain site drawings where available - building layout, steam distribution, compressed air distribution, electricity distribution etc.
- Tour the site accompanied by engineering/production.
- The Main Aims Of This Visit Are:-
- To finalise Energy Audit team.
- To identify the main energy consuming areas/plant items to be surveyed during the audit.
- To identify any existing instrumentation/ additional metering required.
- To decide whether any meters will have to be installed prior to the audit e.g. kWh, steam,
- Oil or gas meters.
- To identify the instrumentation required for carrying out the audit.
- To plan with time frame.
- To collect macro data on plant energy resources, major energy consuming centres.
- To create awareness through meetings/ programme.

Phase II- Detailed Energy Audit Activities:-

Depending on the nature and complexity of the site, a comprehensive audit can take from several weeks to several months to complete. Detailed studies to establish, and investigate, energy and material balances for specific plant departments or items of process equipment are carried out. Whenever possible, checks of plant operations are carried out over extended periods of time, at lights and at weekends as well as during normal daytime working hours, to ensure that nothing is overlooked.

Case study:-

Sr. No.	Energy Saving Recommendations	Annual Energy (Fuel And Electricity) saving kWh/MT	Annual Savings In Rs.	Capital Investment In Rs.	Simple Payback Period
1	Replace FTL - 40 W magnetic choke with electronic ballast of 54 no.	2592 units/year	14,280/-	12,000/-	10 months
2	Ceiling fans - 2 nos. to be provide with electronic regulators	42 units/year	230/-	300/-	16 months
3	Pc's of 2 nos. to be replaced with LCD monitor	400 units/year	2200/-	10,000/-	55 months
4	Turbo ventilator fans of 4 no's for new shade to avoid use of electrical exhaust fans of 200 W-4 nos.	2000 units/year	11,000/-	30,000/-	33 months

Table No.2 :Case Study

VI. Conclusion

The increasing preference for commercial energy has led to a sharp increase in the demand for electricity and fossil fuels. Use of fossil fuels has resulted in emission of huge quantity of carbon dioxide causing serious environmental damages. There is still a considerable potential for reducing energy consumption by adopting energy efficiency measures at various sectors of our country. Energy Audit will not only reduce the need to create new capacity requiring high investment, but also result in substantial environmental benefits. With the enactment of the Energy Conservation Act 2001, a legal framework is now available for promoting energy efficiency in all sectors of the economy. Efficient use of energy and its conservation will succeed as a programme if opinion leaders and captains of industry take the lead in supporting the conservation programme.

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