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# ENERGY CONSERVATION THROUGH ENERGY EFFICIENT TECHNOLOGIES AT THERMAL POWER PLANT

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**Abstract** - Energy audit and conservation is the burning issue nowadays due to the tremendous scarcity of electricity across the county. It is specifically quantifies as optimum use of electricity available. Normally it is extended to all the sectors viz, Industrial, commercial, residential as well as agriculture. Energy efficiency is a technique which needs to be adopted seriously and religiously for effective energy conservation. Energy saved by efficient use of energy of any electrically operated device not only leads to monetary saving but is extra energy generated for the use elsewhere. Indian power sector is caught between the pressure of adding new generating capacities to match the rapid growing demand of power to achieve economic and social development and the environmental challenges which is why our per capita power consumption is still 778 KWh only.

Therefore by implementing Energy conservation in thermal power plant we try to recover the losses which go waste. By energy management, one can draw a line between the avoidable and un-avoidable losses and plan to minimize the same. So measurement Energy is a must within a plant. This paper describes basic understanding and awareness about energy conservation around the thermal power plant and also explains the energy saving measures at thermal power plant so as to minimize the auxiliary power consumption.

***Keywords**— Energy efficiency, Auxiliary Power Consumption, Thermal Power Plant, Energy Management.*

## I. INTRODUCTION

The energy process is an organized approach to identify energy waste in a facility, determining how this waste can be eliminated at a reasonable cost with a suitable time frame. Energy efficiency is widely used and many have different meaning depending on energy service companies. Energy audit of a building can range from a short a walkthrough of the facility to a detailed analysis. It is not only serves to identify energy use among the various services and to identify opportunities for energy conservation but it is also a crucial first step in establishing an energy management program. The efficiency will produce the data on which such a program is based. The study should reveal to the owner, manager, or management team of the building the options available for reducing energy waste, the costs involved, and the benefits achievable from implementing those energy-conserving opportunities (ECOs).

The energy efficiency discusses in this paper is carried out in aim of analyzing and identifying possible energy saving measures, which can be implemented in a factory. This effort will help the plant to reduce their monthly electrical energy consumption thus reducing the cost of production. The total energy survey is conducted by means of onsite inspections, measurements, questions and discussions with the maintenance staff.

This energy analysis contains valuable information such as energy consumption patterns of the factory and the identification of high energy intense equipments, possible energy saving measures and cost benefit analysis of energy saving measures.

## II. ENERGY AUDITING PROCEDURE

Energy audit consists with several tasks which can be carried out depending on the type of the audit and the size and the function of the audited facility. Therefore an energy audit is not a linear process and is rather iterative. The efficiency describes in this paper was carried out with in four days time frame based on the following functional activities.

- Building and utility data analysis.
- Walk through survey
- Base line for building energy use.

Feasibility of energy saving measures

## III. ENERGY MANAGEMENT CELL

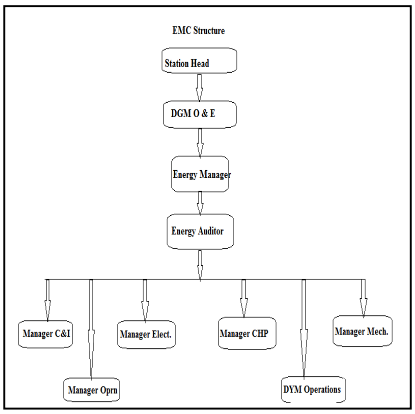



**Fig 1 EMC Structure**

*Objectives of EMC:*

- To operate the power plant at highest efficiency and optimum cost

- To create awareness about energy conservation amongst all the stakeholders.
- EMC can achieve objective of “high energy efficiency and at optimum cost” through following steps:
- Regular internal energy efficiency
- Documentation for energy management activity
- Regular energy efficiencies through accredited energy efficiency firms.
- Regular filling of energy returns to state level designated agency
- Energy conservation projects- identification, Evaluation and implementation
- Application of energy conservation techniques in the entire gamut of activities of PTPS including purchase, training, O&M, accounts, safety etc.
- Establishing energy efficiency test procedures and schedules for all equipments and systems.
- EMC can achieve objective of “Awareness Drive” through following initiatives:
- Display of posters and slogans in the plant area
- Celebration of energy conservation week
- Film show

## IV. AUXILIARY POWER CONSUMPTION IN THERMAL POWER PLANT

The auxiliary power consumption plays a major role in enriching the energy efficiency of the thermal power plant. As per the norms APC should well within the 10%. Since Thermal power plant is also falls under energy intensive consumer category like railways, metal industries, port trust etc according to Electricity Act features it is paramount importance to analyze the consumption pattern of the plant and work on various areas so as to boost up the efficiency of cycles and sub-cycle.

*4.1 Capacity wise APC in thermal power plant as per CEA norms*

| Capacity Group in MW | Auxiliary Power Consumption In % |
|---|---|
| 500 | 6.13 |
| 250 | 8.80 |
| 210 | 8.77 |
| 195-200 | 7.67 |
| 100-200 | 10.32 |
| <100 | 10.31 |

Table 1 Capacity wise APC in Thermal Power Plant

National Level APC = 8.32 %

Best APC is found at Sipat STPS of NTPC – 5.04 %

*4.2 Elements of APC:*

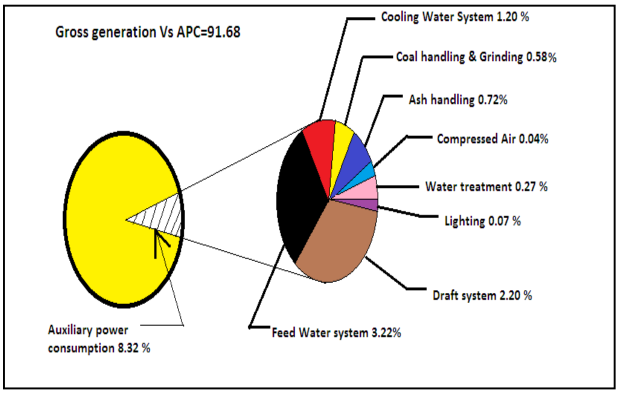



**Fig 2 Tipical Breakup of APC in Thermal Power Plant**

Keeping in view the typical distribution of auxiliary power in a power plant it may be observed that the total APC may reach up to 12% depending on the condition of the plant. Therefore reduction of even 0.5 to 3 % may result in huge energy saving and gives rise to additional output of few megawatts.

*4.3. Factors affecting the APC*

- Plant load factor = high
- Operational efficiency of the equipment = Moderate
- Startup and shutdown = low
- Age of the plant = high
- Coal quality = Moderate to high

## V. ENERGY SAVING POTENTIAL AREAS

*5.1 AIR & FLUE GAS CYCLE:-*

a. Optimizing excess air ratio: - It reduces FD fan & ID fan loading.

b. Replacement of oversize FD and PA fan: - Many thermal power plants have oversize fan causing huge difference between design & operating point leads to lower efficiency. Hence fan efficiency can be improved by replacing correct size of fan. If replacement is not possible, Use of HT VFD for PA & ID fan can be the solution.

c. Attending the air & flue gas leakages: - Leakages in air & flue gas path increases fan loading. Use of Thermo vision monitoring can be adopted to identify leakages in flue gas path. Air pre-heater performance is one crucial factor in leakage contribution. If APH leakage exceeds design value then it requires corrective action.

*5.2. STEAM, FEED WATER AND CONDENSATE CYCLE:-*

a. BFP scoop operation in three element modes instead of DP mode: - In three element mode throttling losses across FRS valve reduces leads to reduction in BFP power.

b. Optimization of level set point in LP & HP heater: - Heater drip level affects TTD & DCA of heater which finally affect feed water O/L temp. Hence it requires setting of drip level set point correctly.

c. Replacement of BFP cartridge: - BFP draws more current If Cartridge is wore out, causing short circuit of feed water Flow inside the pump. It affects pump performance. Hence cartridge replacement is necessary.
d. Attending passing recirculation valve of BFP: - BFP Power consumption Increases due to passing of R/C valve. It requires corrective action.
e. Installation of HT VFD for CEP: - CEP capacity is underutilized and also there is pressure loss occurs across Deareator level control valve. There is large scope of energy saving which can be accomplished by use of HT VFD for CEP or impeller trimming.

*5.3. FUEL & ASH CYCLE:-*

a. Optimized ball loading in Ball tube mill: - Excessive ball loading increases mill power. Hence ball loading is to be Optimized depending upon coal fineness report.
b. Use of Wash Coal or Blending with A- grade coal: - F-grade coal has high ash content. Overall performance can be improved by using Wash coal or blending of F-grade coal with A- grade coal instead of only using F- grade coal.
c. Avoiding idle running of conveyors & crusher in CHP
d. Use of Dry ash Evacuation instead of WET deashing System: - Dry deashing system consumes less power & also minimizes waste reduction.
e. Optimize mill maintenance:- Mill corrective/preventive maintenance is to be optimized depending parameter like- running hrs, mill fineness, bottom ash unburnt particle, degree of reject pipe chocking etc.

*5.4. ELECTRICAL & LIGHTING SYSTEM:-*

a. Optimizing Voltage level of distribution transformer: - It is found that Operating voltage level is on higher side than required causing more losses. It is required to reduce the voltage level by tap changing.
b. Use of Auto star/delta/star converter for under loaded motor Lighting: - Use of electronic chock instead of conventional use copper Chock, Use of CFL, White LED, Replacement of mercury vapor lamp by metal Halide lamp. Use of timer for area lighting is the methods can be used. Lighting has tremendous potential of saving.

*5.5. ECW & ACW SYSTEM:-*

a. Isolating ECW supply of standby auxiliaries: - Many times standby coolers are kept charged from ECW side. Also Standby equipment's auxiliaries like Lube oil system kept running for reliability. We can isolate Standby cooler from ECW system & switching of standby auxiliaries, doing tradeoff between return & reliability.
b. Improving condenser performance by condenser tube cleaning & use of highly efficient debris filter: - Tube cleaning by bullet shot method increases condenser performance, condenser tube cleaning is necessary which is to be carried out in overhaul. Also highly advanced debris filter contribute condenser performance.
c. Application of special coating on CW pump impeller: - It improves pump impeller profile condition, increasing pump performance.

*5.6. COMPRESSED AIR SYSTEM:-*

a. Optimizing discharge air pressure by tuning loading/unloading cycle: -It helpful to reduce sp. Power consumption.
b. Use of heat of compression air dryer instead of electrically heated air dryer: - Heat of compression air dryer use heat generated in compression cycle, thus reduces sp. Power consumption.
c. Use of screw compressor instead reciprocating compressor: - Sp. Power consumption of screw compressor is less than reciprocating air compressor leads to reduce aux. power consumption.

*5.7. HVAC system*

a. Cooling tower performance improvement
b. Installing absorption refrigeration system instead of vapor compression system
c. Use of wind turbo ventilators instead of conventional motor driven exhauster

## VI. ENERGY EFFICIENT TECHNOLOGIES AT THERMAL POWER PLANT

*6.1 Improving Power Factor using APFC*

The solution to improve the power factor is to add power factor correction capacitors Fig. 3 to the plant power distribution system. They act as reactive power generators, and provide the needed reactive power to accomplish kW of work. This reduces the amount of reactive power, and thus total power, generated by the utilities using Automatic Power Factor Controller Fig-4.

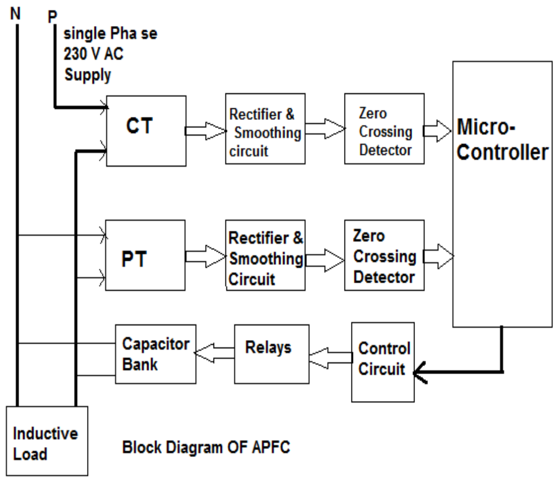



**Fig-4 Automatic Power Factor Controller**

Example :

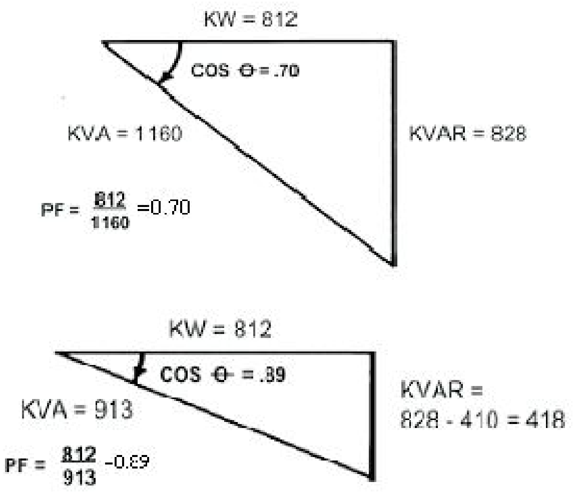



**Fig 3 Power factor before and after Improvement**

After improvement the plant had avoided penalty and the 1500 kVA transformer now loaded only to 60% of capacity. This will allow the addition of more loads in the future to be supplied by the transformer.

*The advantages of PF improvement by capacitor addition*

a) Reactive component of the network is reduced and so also the total current in the system from the source end.
b) I2R power losses are reduced in the system because of reduction in current.
c) Voltage level at the load end is increased.
d) KVA loading on the source generators as also on the transformers and lines up to the capacitors reduces giving capacity relief. A high power factor can help in utilizing the full capacity of your electrical system.

*6.2 Energy Efficient Motors*

Energy-efficient motors (EEM) are the ones in which, design improvements are incorporated specifically to increase operating efficiency over motors of standard design Figure 4. Design improvements focus on reducing intrinsic motor losses. Improvements include the use of lower-loss silicon steel, a longer core (to increase active material), thicker wires (to reduce resistance), thinner laminations, smaller air gap between stator and rotor, copper instead of aluminum bars in the rotor, superior bearings and a smaller fan, etc.

Energy-efficient motors now available in India operate with efficiencies that are typically to 4 percentage points higher than standard motors. In keeping with the stipulations of the BIS, energy-efficient motors are designed to operate without loss in efficiency at loads between 75 % and 100 % of rated capacity. This may result in major benefits in varying load applications. The power factor is about the same or may be higher than for standard motors. Furthermore, energy- efficient motors have lower operating temperatures and noise levels, greater ability to accelerate higher-inertia loads, and are less affected by supply voltage fluctuations.

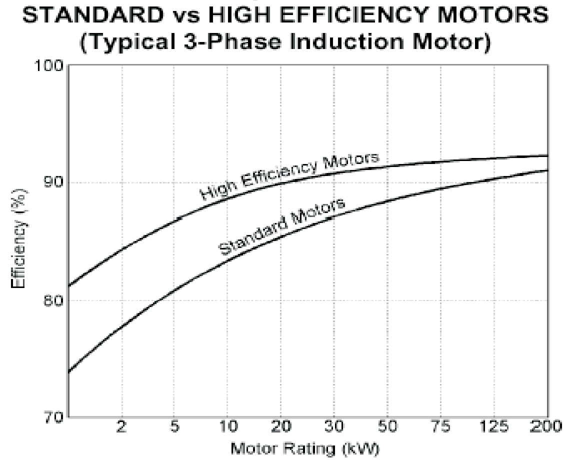



**Fig 4 Comparison of standard and energy efficient motor**

*6.3 Soft Starters*

When starting, AC Induction motor develops more torque than is required at full speed. This stress is transferred to the mechanical transmission system resulting in excessive wear and premature failure of chains, belts, gears, mechanical seals, etc. Additionally, rapid acceleration also has a massive impact on electricity supply charges with high inrush currents drawing +600% of the normal run current. The use of Star Delta only provides a partial solution to the problem. Should the motor slow down during the transition period, the high peaks can be repeated and can even exceed direct on line current.

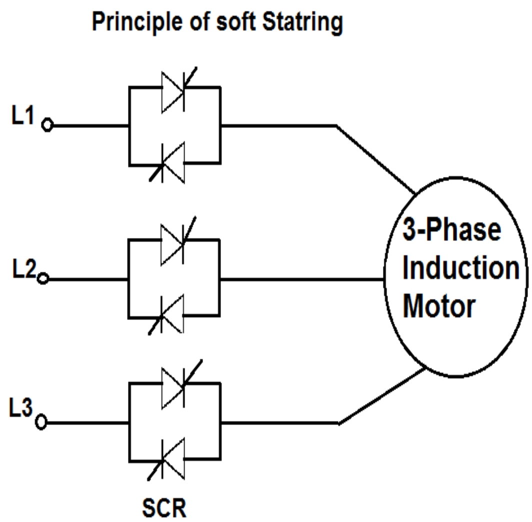



**Fig 5 Principle of Soft Starter**

Soft starter provides a reliable and economical solution to these problems by delivering a controlled release of power to the motor, thereby providing smooth, steeples acceleration and deceleration. Motor life will be extended as damage to windings and bearings is reduced. Soft Start & Soft Stop is built into 3 phase units, providing controlled starting and stopping with a selection of ramp times and current limit settings to suit all applications.

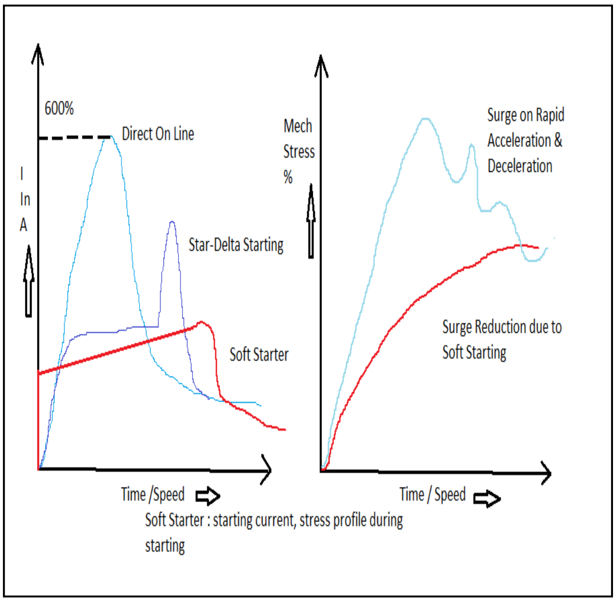


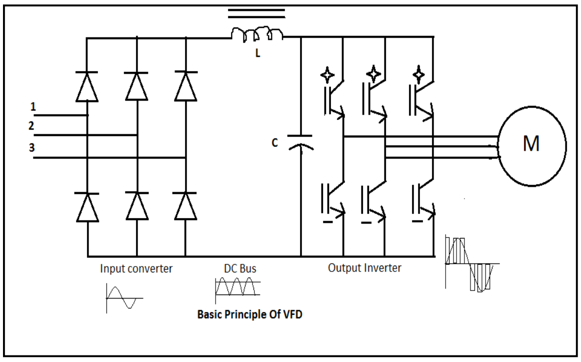

**Fig 6 Comparison between direct and soft starter**

*Advantages of Soft Starter*

- Less mechanical stress
- Improved power factor.
- Lower maximum demand.
- Less mechanical maintenance
- Reduction in current surge
- Reduction in voltage fluctuations
- Significant amount of space is saved as compared to conventional one

*6.4 Variable Speed Drives*

Induction motor is the workhorse of the industry. It is cheap rugged and provides high power to weight ratio. On account of high cost-implications and limitations of D.C. System, induction motors are preferred for variable speed application, the speed of which can be varied by changing the supply frequency.




The VFD operates on a simple principle. The rotational speed of an AC induction motor depends on the number of poles in that stator and the frequency of the applied AC power. Although the number of poles in an induction motor cannot be altered easily, variable speed can be achieved through a variation in frequency. The VFD rectifies standard 50 cycle AC line power to DC, then synthesizes the DC to a variable frequency AC output. Motors connected to VFD provide variable speed mechanical output with high efficiency. These devices are capable of up to a 9:1 speed reduction ratio (11 percent of full speed), and a 3:1 speed increase (300 percent of full speed). In recent years, the technology of AC variable frequency drives (VFD) has evolved into highly sophisticated digital microprocessor control, along with high switching frequency IGBTs (Insulated Gate Bi Polar Transistors) power devices. This has led to significantly advanced capabilities from the ease of programmability to expanded diagnostics. The two most significant benefits from the evolution in technology have been that of cost and reliability, in addition to the significant reduction in physical size.

*6.5 Electronic Ballast*

The conventional ballasts make use of the kick caused 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.

*6.6 Energy Efficient Lighting Controls*

6.6.1 Occupancy Sensors

Occupancy-linked control can be achieved using infra-red, acoustic, ultrasonic or microwave sensors, which detect either movement or noise in room spaces. These sensors switch lighting on when occupancy is detected, and off again after a set time period, when no occupancy movement detected. They are designed to override manual switches and to prevent a situation where lighting is left on in unoccupied spaces. With this type of system it is important to incorporate a built-in time delay, since occupants often remain still or quiet for short periods and do not appreciate being plunged into darkness if not constantly moving around.

6.6.2 Timed Based Control

Timed-turnoff switches are the least expensive type of automatic lighting control. In some cases, their low cost and ease of installation makes it desirable to use them where more efficient controls would be too expensive.

6.6.3 Daylight Linked Control

By using an internally mounted photoelectric dimming control system, it is possible to ensure that the sum of daylight and electric lighting always reaches the design level by sensing the total light in the controlled area and adjusting the output of the electric lighting accordingly. If daylight alone is able to meet the design requirements, then the electric lighting can be turned off. The energy saving potential of dimming control is greater than a simple photoelectric switching system..

6.6.4 Localized Switching

Localized switching should be used in applications which contain large spaces. Local switches give individual occupants control over their visual environment and also facilitate energy savings. By using localized switching it is possible to turn off artificial lighting in specific areas, while still operating it in other areas where it is required, a situation which is impossible if the lighting for an entire space is controlled from a single switch.

## VII. CONCLUSION

The study reveals that the plant has a considerable savings on energy in the areas of lighting, compressor, pumps units and boilers. Some of the measures need absolutely no money, some are low investment and for some huge investment is needed which may not be possible without top management support. The total energy saving is recorded to substantial having over all small simple payback period. During the study the auditors have identified the motivation of the employees is the key issue to save the energy without having a investment The possible benefits to employees from a successful EMP should addressed to improve the job security, improved working conditions & environment and incentive payments. It is important to have a well-structured employee information program regarding the energy savings and its outcomes.

The implementation of above energy saving measures at thermal power plant is solely dependent upon the decision of the management of the plant. Several energy conservation methods that are cost effective are not often implemented due to the lack of internal funding.

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