Energy Management Approach to Reduce Auxiliary Power Consumption and Improve the Efficiency of 500 MW Thermal Power Plant- A Review

Vineeta Thakre[1] Savita Vyas[2] Pankaj Jain[3]
[1]M.Tech. Scholar [2,3]Assistant Professor
[1,2,3]Department of Energy and Environment Management
[1,2,3]Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, India

Abstract— The thermal power station uses certain portion of their generated power to cater its auxiliary power requirements. The auxiliary power consumed in India is around 8-9%. Thus, the aim of this paper is to determine the potential areas for minimizing auxiliary power consumption in any thermal plant by energy management policy to improve energy efficiency of auxiliaries. This paper gives the basic understanding of energy efficiency, energy management approach and energy saving areas so as to achieve higher plant efficiency resulting fuel saving.

Key words: Coal Fired Power Plant, Energy Management, Auxiliary Power Consumption, Energy Auditing

I. INTRODUCTION

Thermal power plants convert energy rich fuels such as coal, natural gas, petroleum products, agricultural waste, domestic trash/waste, etc. into electricity. Coal and lignite accounted for about 60% of India's total installed capacity and coal as a conventional source is abundantly present in India which consumes about 72% of the coal produced for electricity sector. As population is increasing tremendously, power demand is increasing simultaneously which is required to be fulfilled in a short period of time. This requirement has brought urgency to India for the rapid growth in electricity generation by thermal power plants. [1]

'Energy saved is energy generated', energy conservation is one of the most important aspect of power plant as it helps in the reduction of fuel consumption and also reduces CO_2 (GHG) emission. Usage of coal is still growing and is use as a main constituent for power generation in many fossil fuel power plants. [2]

Auxiliary power consumption (APC) plays an important role for mitigating fuel consumption and generating electricity with the same configuration of the plant.

II. PRESENT SCENARIO OF NON-RENEWABLE ENERGY SOURCES IN THE WORLD

Coal still accounts for 29% of the world total energy supply, just second behind oil (31%); while its share is even higher (41%) in terms of electricity production, which compares to 22% for natural gas and 22% for all renewable sources. Power generation remains the primary use of coal and coal products, with large coal consuming countries such as the People's Republic of China and India, with respectively 52% and 65% of their coal consumed for power generation. Other coal consuming countries like the United States and Australia have an even higher share of their coal consumption going to power production, with respectively 92% and 90%, with 81% within the OECD countries as a whole.

Two countries, namely the People's Republic of China (23%) and the United States (18%) dominate the electricity production in the world. They are followed by India, the Russian Federation, Japan, Canada, Germany, France, Brazil and Korea. India is number 3 in terms of production of electricity and appears at the 107th place in terms of electricity consumption per capita. [3]

III. PRESENT SCENARIO OF ELECTRICITY GENERATION IN INDIA

Total installed capacity of India is 307.278 GW as on 31st October 2016 out of which 70% constituted by conventional sources and remaining 30% constituted by non-conventional sources. India holds rank 3 in production of electricity in the world. About 61% of total installed capacity is accounted by coal, 2% by nuclear energy, 9% by natural gas, 15% by hydro and 13% by renewable sources.

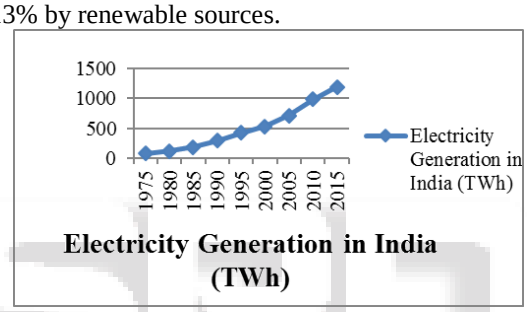

Fig. 1: Electricity generation in India

The renewable energy sources which comprises of small hydro power, wind power, bio-power, solar power. All this non-conventional sources contribute to total installed capacity of 45.916 GW as on 31st October 2016. [4]

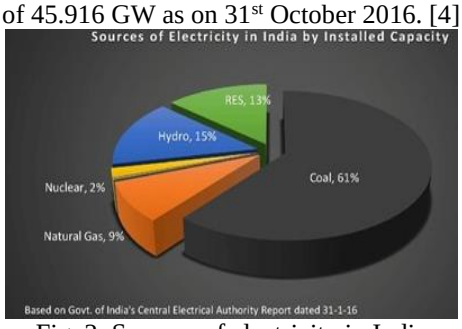

Fig. 2: Sources of electricity in India

res- renewable energy sources

India consumes almost 72% of coal produce in electricity sector.

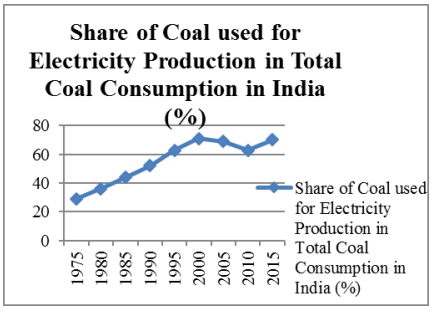

Fig. 3: Percentage of coal used for electricity production in India

IV. DESCRIPTION PROCESS OF THERMAL POWER PLANT

In a typical coal fired plant, the raw coal is received from mines in CHP and then process of crushing and pulverizing is done by mills to the size of 200 meshes. The pulverized coal is transported to boiler furnace by PA fan. The coal burns in furnace to generate superheated steam which drives a turbine with 3000 rpm connected to an alternator to generate electricity and is fed through terminal connections to Generator Transformer, those steps up the voltage to 400kv. After steam passes through the turbine, the steam is condensed in a condenser and again resends back to the boiler with the help of pumps for steam production. The flue gases produced in boiler are used to reheat the condensate in the Economizer and then passes through the AH to the ESP where ash is collected. Finally, they are drawn by the ID Fan into the main flue and to the chimney. The process of power generation is shown in figure 4. [5]

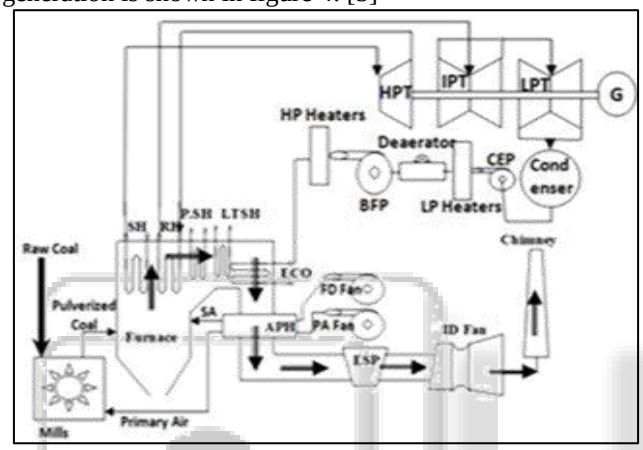

Fig. 4: Layout of thermal power plant [16]

V. PERFORMANCE REVIEW OF THERMAL POWER STATIONS 2013-14

Due to unavailability of thermal units, power generation losses increased from 13.59% during 2012-13 to 17.65% during 2013-14. This loss was due to coal supply problem and transmission constraints and equipment problems of some new units.

Sl. No.	Category	Energy (BU) (2012-13)	Energy (BU) (2013-14)
1.	Shortage of coal	15.84	8.10
2.	Wet/poor coal quality	16.41	27.21
3.	Backing down/Reserve shut down	23.39	96.01
4.	Transmission Constraints	4.10	5.38
5.	Gas shortage	73.09	51.78
6.	Total	132.83	188.48

Table 1: Energy loss

The energy loss due to partial unavailability of thermal generating units during 2013-14 had also increased to 12.13% from 10.68% during 2012-13.

The increase was on account of backing down or shutting down of units due to poor quality coal/lignite, coal/Lignite shortage and low system demand.

Also, the average auxiliary consumption of power by thermal stations during 2013-14 increased to 8.16% from 8.15% during 2012-13. [6] Each and every thermal plant have additional equipments besides main equipments or power generating equipments, this additional auxiliary also consumes power and sometimes the amount of power is high. [7]

So, it is imperative to implement energy management approaches to reduce APC, fuel consumption, heat rate of equipments, etc. Energy management is important by which organizations ensure that their power stations generate enough energy to meet demand.

VI. ENERGY MANAGEMENT AND EFFICIENCY

Energy efficiency is the solution for the improvement of plant without increasing fuel consumption. It can improve the power output to the grid up to 10%.

It can be achieved by the following energy management practices in brief.

- Raise the plant electrical output by correcting process efficiencies.
- Generate more energy from less fuel by lowering fuel consumption of the plant.
- Increase plant revenue by selling more energy and reducing fuel wastage.
- Extending the operating life of the plant by optimizing the auxiliaries and main equipments performance.
- Improve the operational flexibility by maximizing process efficiency.
- Reduce the greenhouse gas emissions by judicious management of all sorts of energy used it the thermal power plant.

The case studies of energy improvement from different plant in the country will provide the information and data to the plants to improve their performance indicators like plant load factor (PLF), operational availability factor (OAF), planned maintenance PM), forced outage (FO), auxiliary power consumption (APC), specific coal consumption (SCC), specific oil consumption (SOC) and heat rate (HR).[8]

A. Energy auditing: an efficient tool for energy management approach

Energy audit is a powerful tool for exposure operational and equipment improvements that will reduce energy costs, lead to higher performance and save energy. Sometimes, the energy audit is also called an "energy assessment" or "energy study". Energy audits can be done as a stand-alone effort but may be conducted as part of a larger analysis across an owner's entire group. The purpose of an energy audit is to find out how, when, where and why energy is used. The energy audit is also used to identify opportunities to improve efficiency. Energy auditing services are offered by engineering firms, energy services companies and energy consultants. [9]

The energy auditors do the audit process. The basic objective of the detailed energy audit was to:

1) Study the load consumption/distribution pattern in the plant.
2) Study the operations of energy concentrated systems/ equipments to identify potential area wherein energy savings are practically feasible. [10]

VII. AUXILIARY POWER CONSUMPTION

The auxiliary power consumption (APC) plays a major role in enriching the energy efficiency of the thermal power plant. As per the norms APC should well within the 10%. It is important to analyze the power consumption pattern of plant to enhance the efficiency of cycle and sub-cycle. [11]

By following some measures auxiliary power consumption can be reduce-

- Improving plant load factor
- Examining design equipments
- Applying energy conservation measures[12]

Sl. No.	CAPACITY	APC IN %
1.	500 MW	5.69
2.	210 MW	8.65

Table 2: APC of different units

From the above table APC of higher unit have lower auxiliary consumption than lower size unit because of improvement of equipment/systems over decades like implementation of axial fans encompasses lower power consumption, introduction of variable frequency drives, other design optimizations, etc[13]

National Level APC = 8.32 %

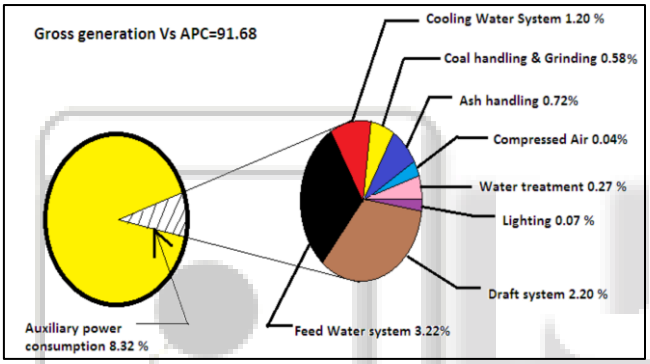

Fig. 5: APC in thermal power plant

The factors should be analyzed affecting the APC. So, following are the factors affecting APC -

- Plant load factor = high
- Operational efficiency of the equipment =Moderate
- Start-up and shutdown = low
- Age of the plant = high
- Coal quality = Moderate to high [11]

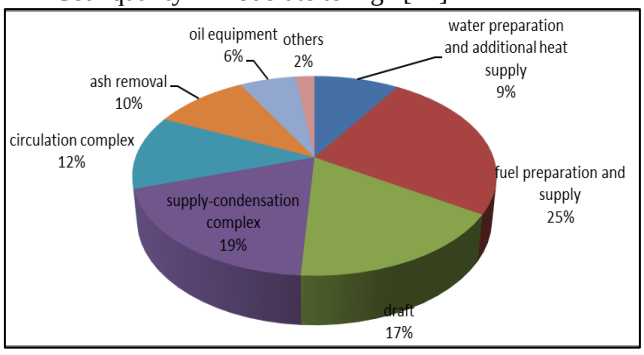

Fig. 6: Annual electric power losses

Electric energy consumption by equipments also contributes as the planned and accountable parameters in modern thermal electric plant. This is important for management since the amount of energy consumed effects the energetic and economic efficiency of station. Chart 6 shows the structure of annual electric power losses by different auxiliaries.

The percentage of losses from the annual electric power production is:

- 0.4% for State regional power plant and rated at1200 MW,
- 1.07% Thermal electric power station(TEPS) with cross connections and rated at 270 MW,
- 0.44% for Modular Thermal electric power station (MTEPS) utilizing coal and rated at 600 MW,
- 0.23% for MTEPS utilizing gas and rated at 140 MW. [14]

VIII. ENERGY SAVING AREAS

By analyzing energy saving potential areas energy can be conserve efficiently.

- Performance monitoring of each unit should be performed which include auxiliaries such as coal handling plant, ash handling plant, water treatment plants and compressors.
- Monthly performance tests should be conducted to evaluate boiler efficiency, condenser performance, turbine cylinder efficiency, LP/HP heater performance, turbine heat rate etc.
- Installation of variable feed drive should be done which can save 14% to 27% of energy.
- Flue gas leakage can be reduced by replacing metallic joints with fabric joints
- Use of soft starters can save considerable energy for the motors which operate on continuously variable load.
- The moisture of coal should be removed before use otherwise it increases the load on boiler and hence decreases its efficiency.
- Proper crushing of coal should be done which reduces the unburnt carbon and bottom ash.
- Monitoring of Oxygen and CO to ensure a complete combustion and control combustion air to limit the dry gas losses.
- Regular monitoring operating controllable parameters to gain efficiency and availability.
- Monthly performance monitoring of the station should be reported in meting to the head of department.
- Annual overhaul of units and auxiliaries should be done regularly based on the performance deterioration.
- Energy efficient lighting system to utilize the latest LEDs to reduce the life cycle cost.
- A separate company can be developed at loading point or a centralized location which can screen to detect any metal material, blend and grind coal to 1-5 mm size with ensured quality. After crushing, the coal can again screened for elimination of extraneous materials, weighed and sent prepared fine coal to plant. This can reduce the losses to minimum and reduce the auxiliary power consumption.[15]

IX. CONCLUSION

From the overall review, it get concluded that after implementing energy management approach, there will be an improvement in performance parameters, i.e APC, life of auxiliaries, fuel consumption, electricity production, overall plant performance .Energy auditing plays the major role in implementing energy management practices for energy conservation. The possible energy saving areas have also

been suggested which can generate more electricity and reduce cost of electricity generation.

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