POWER PLANT PERFORMANCE

Setlem Sreenivasulu[1], Prof. J. Katyayani[2]
[1]Research Scholar, Sri Chandrasekharendra SaraswathiViswa Mahavidyalaya
[2]Research Guide, Sri Padmavati Mahila Visvavidyalayam

Abstract

This study focuses on the relation between boiler efficiency versus power plant performance and turbine efficiency versus power plant performance. Organizations should focus on increase the availability, lower the auxiliary power consumption, higher the plant load factors, lower the O&M cost, adaption of new technologies have to be implemented to achieve high plant efficiency. The purpose of conducting performance test is to compare the results after a major overhauling, in some cases it gives indication for a total plant revamping or repairs.

Plant performance will be compared with the baseline values arrived during commissioning stage rather than the design parameters. The losses that are unburn gases, water/steam leakages, cooling water losses, startup and shutdown losses, electrical losses to be monitored and minimized to get optimum efficiency.

Keywords: Specific steam consumption, Boiler efficiency, Turbine efficiency, NOX, SOX, Overall Plant Efficiency, Unit cost, Plant Availability, Auxiliary Consumption, Unit Generation, Vacuum, Rated Capacity

Introduction

Plant Efficiency is defined as the amount of heat content per generation of electrical energy, commonly called as heat rate. The efficiency of the existing plants is lesser than the new plants because of adopting new technology. The efficiency of the plant differs mainly with the type of fuel used in the boiler. It defined by the ratio of the output to that of the input.

Plant efficiency will also be affected by the Operational and Managerial practices of power plant. Power plant design and operation also influence the efficiency of the power plant. Efficiency is affected when plants operate on part loads or with design deviations. Boiler efficiency mainly depends on water parameters, fuel used, back end temperatures, emission levels, ash handling systems. Turbine Efficiency mainly depends on water parameters, vacuum, pressure and temperature of the steam, extraction/bleed of steam. Super critical and ultra-super critical steam parameters with new updated design, full automation will improve the plant efficiency.

Kiran Bala Sachdeva and Karun (2012) – are determined that the magnitude, location and source of thermodynamic inefficiencies of thermal power plant. This paper has presented the results of energy and energy analysis performed in a steam power plant. From the energy analysis, the overall plant energy losses are calculated as 68%.The results of the energy indicate that the boiler produces the highest energy destruction.

Isam H. Aljundi (2009) – is studied that the energy and energy analysis of Al-Hussein power plant (396MW) in Jordan is presented. The performance of the plant was estimated by a component wise modeling and a detailed break-up of energy and energy losses for the considered plant has been presented. It was found that the

energy destruction rate of the boiler is dominant over all other irreversibility in the cycle.

M.A. Ehyaei, A. Mozafari and M.H. Alibiglou (2011) – are presented that the energy, economic & environmental analysis of Shahid Rajaee gas turbine power plant in Iran. Also a new function is proposed for system optimization that includes the social cost of air pollution for power generating systems. The new function is based on the first law efficiency, energy cost and the external social cost of air pollution for an operational system.

Research Area:

From the above literature very few are available relating to power plant efficiency. In this Scenario the present study focus is on technical problems on power plant efficiency.

Research Problem:

What is the effect of Technical issues on Power Plant Efficiency?

Objectives:

To describe the effect on Power Plant efficiency.

Research Methodology:

Descriptive and exploratory research methodology is used.

Data Collection Method:

Primary data has been collected from the operation & maintenance team.

Secondary data has been collected from the management, Power plant Operation manuals and log sheets.

Sample Data:

Data has been collected from 3 different power plants having different capacities, 2.5MW, 12MW, 70MW.

Primary data has been collected from 50 employees in each plant.

Scope of the study:

Data contains the boiler information & turbine information as per the power plants capacity

Unstructured interviews & one to one interviews were conducted on TPM & TQM practices as well as factors influencing power plant operations & maintenance.

Data Analysis Method:

After collection of the data, the data is analysed using SPSS 20.0 and Excel. Descriptive statistics, Pearlson's Correlation, multiple regression and factor analysis are used to test the hypothesis.

Interpretation:

Technical problem areas in power plant:-

- Auxiliary Consumption, Plant Availability, Efficiency & Specific steam consumption of power plants has been calculated.
- The Auxiliary Consumption is 10.5% for 2.5MW unit, 9.24% for 12 MW and 11.01% for 70MW against the design consumption of 10%, 9.78%, 12% respectively. Auxiliary Consumption of 70MW is higher side as compared with other two plants.
- The Plant Availability for 2.5MW is 88.72%, 99.74% for 12MW and 72.47% for 70MW against design values of 98%, 100%, 100% respectively. This indicates 12MW power Plant is better and 70MW Power Plant is worst.
- The designed Plant Efficiency for 2.5MW is 21%, for 12MW is 25% and for 70MW is 28.37%, whereas the actual plant efficiencies are 17.22%, 23.5% and 25.95% respectively against designed plant efficiencies, 70MW is better than other 2 plants.
- Specific Steam Consumption for 2.5MW is 5.63 kg/kwh against the design of 4.70 kg/kwh, 12MW is 4.11 kg/kwh against the design value of 3.98 kg/kwh and 70MW is 4.07 kg/kwh towards design of value of 3.96 kg/kwh. Specific steam consumption of 2.5MW Power Plant is very abnormal.
- The designed Unit Cost for 2.5MW Power Plant is Rs. 1.50, 12MW is Rs. 1.30 and 70MW is Rs. 3 for the actual values of Rs. 0.37, Rs. 1.03 and Rs. 5.26 respectively. Unit cost of 2.5MW power plant and 12MW Power Plant is very low

because of waste heat recovery and bi-products of furnace. At present 70MW Power Plant is very abnormal unit cost and makes loss to the organization.

- Unit Generation for 2.5MW is 96lkwh, 12MW is 919lkwh and 70MW is 5131lkwh with respect to the design values 219lkwh, 984lkwh and 5712lkwh respectively. Optimum utilisation of the Turbine generator is happening in 12MW Power Plant whereas 2.5MW Power Plant is very low due to insufficient Blast furnace gas availability.
- Vaccum Comparision between 2.5MW, 12MW and 70MW design values -0.90kg/cm2, -0.91kg/cm2, -0.82kg/cm2 and the actual values are -0.90kg/cm2, -0.90kg/cm2 and -0.81kg/cm2 respectively.2.5MW Power Plant as well as 12MW Power Plant is being run with designed values and good vaccum where as 70MW Power Plant has gone to Air Cooled Condenser which results in low vaccum.

The Correlation analysis has been done to explore the variables in Power Plant that effect the plant efficiency which inturn effects the performance of the Power Plant. Table I shows the Correlation analysis of the factors over overall efficiency..

Table I: Correlation Analysis

	Variables	Overall Efficiency
Pearson Correlation	Overall Efficiency	1.000
	Auxiliary Power Consumption	.037
	Availability	-.376
	draft	-.877
	NOX	.748
	SOX	.212
	rated capacity	.815
	Specific Steam Consumption	-.968
	Vacuum	.246
	Boiler Efficiency	-.717
	Turbine Efficiency	.986

Results:

The result shows that both efficiencies play a significant role on plant performance.

There is a significant relation between boiler efficiency and turbine efficiency. To test the objective, Correlation Analysis is conducted. The Correlation between overall effeciency and boiler effeciency is 0.717 with significant t value (t= 0.179, sig= 0.001). the Pearson correlation between Turbine effeciency and overall effeciency is 0.986 with significant t value (0.179, sig=0.008). This result concludes that boiler efficiency & turbine effeciency are influencing overall effieciency of power plant.

- Auxiliary power consumption should be as minimum as possible to have better specific steam consumption. If Auxiliary consumption increases, net generation of the plant will decrease there by Plant performance will get detoriated.To achieve better efficiency we need to go for VFD's where ever possible. The correlation between Auxiliary Steam Consumption and Overall efficiency is less(0.037).
- Maintenance and Operation department maintains the equipment with latest preventive maintenance schedules, which will increase the availability of the plant which influence the overall efficiency of the plant. If Availability increases the overall efficiency increases but the correlation is less, which have to be improved.
- Draft has to be maintained as per the design values to get boiler combustion effectively this increases boiler efficiency which

inturn increases the overall efficiency.Draft is high according to correlation analysis with overall efficiency.

- If we observe the NOX and SOX at chimney of the boiler, we can the boiler condition. The levels of the NOX and SOX should be as per the design. The levels of these two increases, the overall efficiency decreases. The correlation analysis of NOX is high where as SOX is low with respect to the overall efficiency.
- Plant should run at Rated Capacity as per the design if it runs partial loads, this will increase the specific steam consumption inturn results in lower efficiency of the power plant.According to the analysis shown above the Rated Capacity is high.
- If Plant runs at partial loads, more shut downs or breakdowns, Start ups and Shut downs of the plant which increases the Specific Steam Consumption inturn decreases the efficiency of the plant. The analysis show that it is high with respect to overall efficiency.
- Vacuum will play a main role in Turbine efficiency. Vacuum should be maintained according to the design values to get best performance of the plant. So Vacuum should not be below design values as it decreases the overall efficiency of the plant. Vacuum is less when compared to overall efficiency of the plant in the analysis done.
- Many parameters will influence Boiler Efficiency, some of them are soot blowers, combustion, heat transfer, water parameters, flue gas temperations, steam parameters, pipeline inside and outside, corrossion, errossion, scale, fans, fuel, manpower etc. It is directly proportional to overall efficiency. This factor is high when correlation analysis is done.
- Even though many factors involve in the turbine efficiency some of them are condenser, vacuum, pressure and temperature of the steam, cooling tower water parameters, type of the turbine etc. If turbine efficiency increase, overall efficiency increases. It is high in correlation analasis done with overall efficiency.

Conclusion

As these power plants have become older ,the research study recommends the following bench marking practices which will help the management to improve the performace of the plant.

Power plant efficiency is low, which has to be raised by running plants at rated loads, good preventive maintenance schedules which will improve availability, latest automation implementation, adaption of standard operating procedures.

It is easy to describe the technical and management requirements to take oldest power plants and bring it to the standards close to those of present day new power plants which are very difficult to execute. Boiler efficiency and turbine efficiency interrelated with overall efficiency which can be enhanced with the latest developments.

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