PERFORMANCE ANALYSIS FROM THE ENERGY AUDIT OF ATHERMAL POWER PLANT SGTPS

PoojaTalwar [1],Prof. Shalini Vaishya[2],Arpit nagaria[3]

[1]. M.Tech Student Department of Electrical Engg.GGITS Jabalpur, M.P (INDIA)

[2]. Prof.at Department of Electrical Engg. GGITS Jabalpur, M.P (INDIA)

[3]. M.Tech Student Department of Electrical Engg.TCET Jabalpur, M.P (INDIA)

Abstract: Sanjay Gandhi thermal power station, Birsinghpur is situated in the district of Umaria (M.P). The total Capacity of the plant is 1340MW (4X210MW+1X500MW). The purpose of the project is to assess the major power consumption by auxiliaries and suggesting cost saving alternatives in terms of energy saving.The scope of any energy audit in a thermal power plant should include the study of the coal flow, air and flue gas flow, excess air factors and oxygen in the flue gas; study of the heat transfer, effectiveness, proportioning of heat and pressure drop in the heat-exchangers of the water-steam circuit; study of the auxiliary power consumption; the overall performance evaluation such as the gross and the net overall efficiencies, boiler efficiency, etc.

Energy audits of unit -1 along with effect of Coal quality have been conducted for main auxiliary of thermal power plant like Boiler. Various parameters from Control room and Chemical wings has been taken and it was found that the efficiency of boiler is 81.07% which we can improve by improving fuel quality. A detailed analysis of the effect of the fuel on the boiler efficiency, the dry and the wet flue gas loss, combustion characteristics, the radiation losses and the heat losses due to hydrogen in fuel, moisture in fuel, carbon monoxide in fuel are explained.

The total anticipated saving will be 4108 Lakhs. per annum with an investment of Rs.2592 lakhs and payback period is 7.5 months.

Key words-Energy audit, Thermal power plant, coal analysis, coal benifications etc.

1.1 Introduction

About 70% of energy generation capacity is from fossil fuels in India. Coal consumption is 40% of India's total energy consumption which followed by crude oil and natural gas at 24% and 6% respectively. India is dependent on fossil fuel import to fulfill its energy demands. The energyimports are expected to exceed 53% of the India's total energy consumption. In 2009-10, 159.26 million tons of the crude oil is imported which amounts to 80% of its domestic crude oil consumption. The percentage of oil imports are 31% of the country's total imports. The demand of electricity has been hindered by domestic coal shortages. Cause of this, India's coal imports isincreased by 18% for electricity generation in 2010.

Due to rapid economic expansion, India has one of the world's fastest growing energy markets and is expected to be the second-largest contributor to the increase in global energy demand by 2035, accounting for 18% of the rise in global energy consumption. Given India's growing energy demands and limited domestic fossil fuel reserves, the country has ambitious plans to

ISSN: 2278 – 1323

expand its renewable and nuclear power industries. India has the world's fifth largest wind power market and plans to add about 20GW of solar power capacity by 2022. India also envisages increasing the contribution of nuclear power to overall electricity generation capacity from 4.2% to 9% within 25 years. The country has five nuclear reactors under construction (third highest in the world) and plans to construct 18 additional nuclear reactors (second highest in the world) by 2025.

1.2 Total Installed Capacity in India (September 2013)

The installed capacity in respect of various resources is as on 30.06.2013 from the Ministry of Renewable Energy. Note: The Hydro generating stations with installed capacity less than or equal to 25 MW are indicated under RES.

Table 1.1 Total Installed Capacities on Fuel Based (September 2013)

Source	**Total Capacity (MW)**	**Percentage**
Coal	134,388.39	58.75
Hydroelectricity	39,788.40	17.39
Renewable energy source	28,184.35	12.32
Natural Gas	20,380.85	8.91
Nuclear	4780	2.08
Oil	1,199.75	0.52
Total	2,28,721.73	

Table 1.2 Total Installed Capacities on Sector Based (September 2013)

Sector	**Total Capacity (MW)**	**Percentage**
State Sector	90,062.14	39.37
Central Sector	65,732.94	28.73
Private Sector	72,926.66	31.88
Total	2,28,721.73	

1.3 To increase the Efficiency of the Power System: Energy Audit a Tool

Energy audit is an engineering technique used for accounting of energy used by a particular plant, process, system or sub system. By applying the techniques of energy audit, it is possible to know whether energy is being used efficiently or not. Results of energy audit studies also identify the problem areas of the process or equipment under study and quantify the energy losses. It also identifies the potential areas for energy conservation. The technique is used to:

- Establish the pattern of energy use
- Obtain information about the level of operating efficiency
- Identify where and how losses are occurring
- Identify the generic design deficiencies.
- Identify performance deterioration and damaged plant or machine parts
- Suggest appropriate techniques to conserve energy along with economic implications.

The Energy Conservation Act 2001 has made it mandatory for many types of industries to operate at prescribed energy efficiency. Thus it formalises the concept of energy conservation by making it mandatory (through legislation) to consume energy at prescribed efficiency levels or better. Under this act Govt. of India prescribes the standards and directs the consumers on ways

ISSN: 2278 – 1323

and means of efficient utilisation of energy with a view to improve productivity, enhance operating efficiency, reduce operating costs, and minimise pollution. Power Stations are coming under Energy Conservation Act as designated consumers. The parameters, which will come under the ambit of the act, are:

1. Unit Heat rate
2. Auxiliary Power
3. Specific Oil consumption
4. Plant load factor

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

1.3 Type of Energy Audit

The type of Energy Audit to be performed depends on:

- Function and type of industry
- Depth to which final audit is needed, and
- Potential and magnitude of cost reduction desired

Thus Energy Audit can be classified into the following two types.

1. Preliminary Audit
2. Detailed Audit

1.4 Energy Audit Procedure

Step1-Interviewwith Key Facility
Step 2 - Facility Tour
Step 3 - Document Review
Step 4 - Facility Inspection
Step 5 - Staff Interviews
Step 6 - Utility Analysis
Step7 - Identify/Evaluate Feasible ECMs
Step 8 - Economic Analysis
Step9 - Prepare a Report Summarizing Audit Findings
Step10 - Review Recommendations with Facility Management

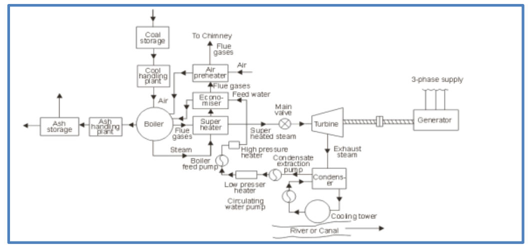

Fig 1.1 Working Cycle of Typical Coal Fired Power Station

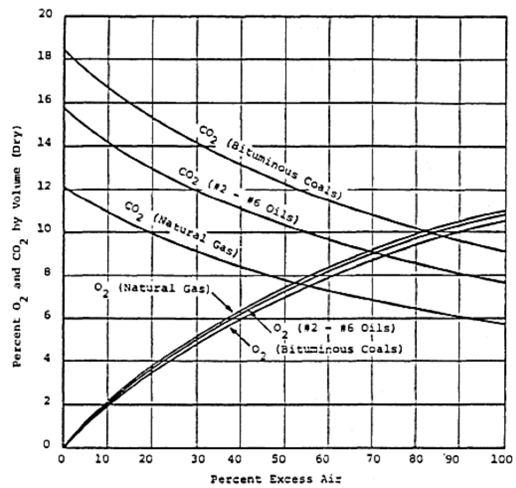

Fig 1.2Relationship between boiler excess air and stack gas concentrations of excess oxygen (O_2) and carbon dioxide (CO_2) for typical fuel compositions.

1.5 Sanjay Gandhi Thermal Power Stations,Birsinghpur(M.P.)

Sanjay Gandhi Thermal Power Plant is located at Birsinghpur railway station on Bilaspur-Katni section of SE Railway. It is situated at Umaria district of Madhya Pradesh, India. The power plant is one of the coal based power plants of MPPGCL.

Sanjay Gandhi Thermal Power Station has an installed capacity of 1340.00 MW. The First unit was commissioned in March 1993.The Water for the plant has been procured from nearby Johila Dam which is spread across 1810 Hectares. The coal for the plant has been procured by Rail from South eastern Coal Fields.

ISSN: 2278 – 1323

Table 1.4 Installed capacities of SGTPS

Units	Capacity Mw	Commissioning Dates	Make Tg Set	Make Boiler
Unit I	210	26-03-1993	BHEL	ABL
Unit II	210	27-03-1994	BHEL	ABL
Unit III	210	28-02-1999	BHEL	ABL
Unit IV	210	23-11-1999	BHEL	ABL
Unit V	500	18-06-2007	BHEL	BHEL

1.6 Results and analysis

Estimating Boiler Efficiency

Unit-1 is provided with boiler manufactured by M/s ABL. Maximum ContinuesEvaporation of the boiler is 680 T/hr& maximum working pressure is 184 kg/cm^2. The boiler efficiency of the Unit-4 was evaluated by loss calculation method. During the time of site measurement parameters like O_2, CO_2 and CO in the flue gas were measured.The ultimate and proximate analysis of coal used for the calculation of boiler efficiency is calculated below and obtained from the laboratory of SGTPS on the same day of testing. During the test period blow down and soot blowing was terminated. The losses considered for calculation of boiler efficiency are given below:

1. Dry flue gas loss
2. Loss due to moisture in fuel
3. Loss due to Hydrogen in fuel
4. Moisture in combustion air loss
5. Loss due to unburnt Carbon
6. Radiation loss
7. Un-accounted loss

The losses are added and finally subtracted from 100% to get the efficiency of the Boiler. Detailed calculation on the basis of site measurement in the month of July 2013 is given below:

Proximate Analysis of coal-

Total Moisture = 11.97 %

Ash = 35.62%

Volatile Matter = 22.22%

Fixed Carbon = 30.19%

Gross Calorific Value = 3919kCal/kg

=16408.0692kJ/kg

Average Load = 207MW

Ambient Temperature = 23.20 °C

Ultimate analysis of coal (Derived from proximate Analysis)-

Carbon =41.58%

N_2 =1.81%

H_2 =2.92%

Ash =35.62(proximate analysis)

Sulphur = 0.30% (assumed)

Total moisture =11.97%(proximate analysis)

O_2 (bydiff) = 6.861%

G.C.V. of coal = 3919kCal /kg

=16408kJ/kg(Bybomb calorimeter).

Flue Gas Analysis-

Average CO_2 at APH inlet= 12.43%

Average O_2 at APH inlet= 4.87%

Average N_2 at APH inlet = 82.7% (by difference)

Average dry bulb temp.=23.2^{o}C

Average wet bulb temp.=18.07^{o}C

From psychometric chart moisture =0.017 kg/kg of air

Average APH outlet temperature =128.45^{o}C

Average unburnt carbon in bottom ash =6.27%

Average unburnt carbon in fly ash =2.05%

Average air temp.at F.D. outlet =35^{o}C

Boiler Heat Balance-

Sl. No.	Losses (%)	Design value	Present value
1.	Dry flue gas (L_1)	4.657	4.51
2.	Wet flue gas (H_2O & H_2 in fuel)(L_2+L_3)	8.767	5.231
3.	Moisture in combustion air (L_4)	0.161	0.172
4.	Combustible loss (L_5)	-------	1.972

ISSN: 2278 – 1323

5.	Radiation (L_6)	0.4	0.4
6.	Unburnt gas (L_7+L_8)	0.016	6.638
7	Manufactures margin and unaccounted loss	1.5	1.5
8.	Total losses	15.501	20.74
9.	Gross Efficiency of boiler	84.5	81.07

Comparisons of different losses and gross efficiency between the design and current values have been given in the above table along with corrected figures.

- ✓ Current dry flue gas loss is 4.51%, compared to the design value of 4.657%.
- ✓ Percentage of oxygen maintained at the inlet to the APH are (4.87*% for unit I)* compared to the design value of 3.5%, which provides less flue gas loss. Marginally lower dry flue gas loss is due tonot much higher O_2 at inlet of APH and minor air leakage across APH. So, it is advised to improve trend mill performance parameters and correct degradations at the earliest. Conduct regular dirty pitot testing for optimum running of mills. Dirty pitot survey will confirm equal loading amongst the burners, which in turn would enable boiler operation at reduced O_2 level of 3.5%.
  - ✓ Flue gas inlet temperature to the APH is (266 °C *for unit I)* compared to design 339ºC. Lower flue gas inlet temperature is due to the lower feed water inlet temperature to the FFS (Forced Flow Section).
  - ✓ The current wet flue gas loss is 5.231% against the design value of 8.767%. It is due to the higher flue gas temperature.

Graphical Analysis of Results

- Effect of Excess Air

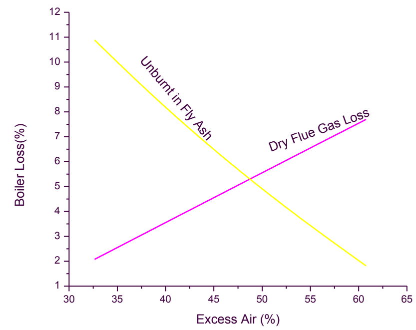

Fig1.3 shows that the dry flue gas loss increases linearly with increase in excess air

- Effect of Various Coal characteristics

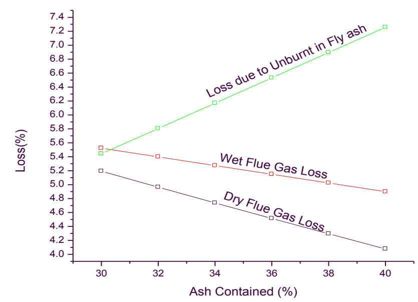

Figure 1.4 Effect of ash contained on various losses

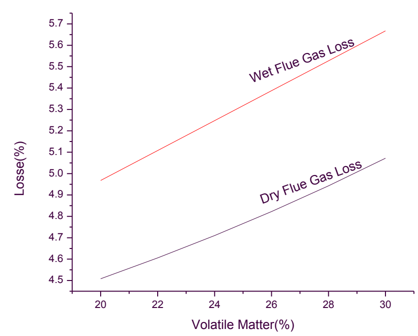

Figure1.5 Effect of Volatile Matter on various losses

ISSN: 2278 – 1323

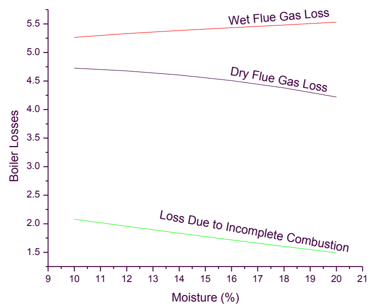

Fig1.6 Effect of Moisture on various losses

1.7 Conclusion

The following observation can be concluded after the performance analysis:

By comparing the actual values of the Boiler losses with the reference or design values it is clearly concluded that all the boiler losses are within the limit except the heat loss due to Fly ash and Bottom ash present in the fuel. The major reasons for having lower efficiency are poor quality of coal and air leakages

Un-burnt coal with fly and bottom ash and un-burnt gas loss is reduced bysupplying excess air but it is to be varied judiciously keeping in mind that an extraamount of excess air supplied takes huge amount of useful heat and passes through stack. On-line system should be developed to monitor the quality of coal as it varies continuously and accordingly amount of excess air and its location of supply should be decided. The coal particles size distribution in the pulverized coal should also be maintained properly to reduce the un-burnt loss. The leakage in the air pre-heater is another parameter which needs to be controlled and forthis possibility of trough type circumferential seal and placing of FD and PA after APH can be checked and applied

After performing the energy audit of SGTPS Birsinghpur (Unit-I) it was found that there is too much potential is available to save energy in various sections like Boiler, fuel quality. An anticipated savings of Rs.4360.2 Lakhs/month byimproving the coal quality with the help of coal bene-ficiation.

References

[1] KOTHAGUDEM thermal power station manuals.
[2] Presentation on energy audits in thermal power station byH.S.Bedi (Energy engineering projects Ltd).
[3] Bureau of energy efficiency Energy audit Guide books 1,2, 3.4 published in 2005.
Book1: General aspects of energy management and energyaudit
Book2: Energy efficiency in Thermal utilities
Book3 Energy efficiency in Electrical Utilities
Book4: Energy performance assessment for equipment andutility System
[4] BHEL manual of Turbo generator of KTPS V stage publishedin 1997.
[5] Energy audit made simple by P.Balsubramainanpublishedin 2007.
[6] Abbi Y. P., and Ramachandran, V., Energy Efficiency improvement potentialfor thermal power stations through energy audits, Proc: 4th international.
[7] Gill, A.B, 1984, Power Plant Performance Butterworths, London PublishersLtd., U.K.
[8] Mandal P.K., and Rath, B.K., High un-burnt carbon problem (fly and bottomash) in PIE stations, Proc: 4th international conference on O&M of powerStations, Organised by NTPC, February 13-15, 2008, New Delhi, Inida.
[9] Nag, P.K., 2007, Power Plant Engineering, Tata McGraw hill, New Delhi.

ISSN: 2278 – 1323