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IMPORTANCE OF COAL COMBUSTION OPTIMIZATION AND MANAGEMENT FOR THERMAL POWER STATION

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The overall performance, operability, load response, reliability, and capacity of all the unit's components are all inter-related. The evaluation and sustainable control of major pollutants must include understanding of a unit's boiler condition, fuel quality variations, firing system equipment condition, soot blowing equipment, air-fuel measurement equipment, instrumentation and the overall steam cycle performance. Efficiency of the power station is lying with the proper utilization of plant characteristics with respect to the general operation parameter and good maintenance practice these all are the things are lying with the process parameter. This process parameter is in the stage of good coal utilization and also with good coal characteristics. Which will depend on the process of coal utilization by taking care of the optimization?.

Keywords: Heat Rate, Calorific Value, Thermal Flux, Optimization, SCR,APC.

INTRODUCTION

Considering that supercritical units operate at higher pressures and temperatures (Dirk, 2013) than a subcritical boiler, the transfer of energy through the system and boundaries are very interrelated with one another. At supercritical pressures and temperature (Hoseininejad, 2011) the increased efficiency reduces fuel (Paul, 2015) consumption with the thermodynamics of expanding higher pressure and temperature (Milind, 2013) steam through the turbine and has been largely responsible for their "better than average" fleet efficiency and heat rate consistently throughout their operation.

Monitoring processes of thermal performance (Tharayil, 2015) is the evaluation index for integrated boiler and turbine cycle. Fuel quality (Jose, 2012) has a major influence on a plant's heat rate. With new enacted environmental regulations, power plants must perform well (Jie, 2012). Thus, in addition to the challenges with coal shortages, controllable heat rate optimization is especially important for Indian thermal power plants to ensure they meet the new environmental regulations.

The higher capacity of the boiler will leads to

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the better heat distribution along with the energy distribution (Paul, 2015). As the Pressure and Temperature (Mukesh, 2015) are raising up these parameter will leads to start changing and will leads to the moderate rise in the manufacturing and costing of thermal plants (Milind, 2013; Ilamathi, 2012). These characteristics will lead to environmental change also (Mahmoud, 2011).

Variations of fuels being fired also make strong impact o the combustion process (Ashish, 2015) as well as the overall performance of the firing system equipment. The fuel constituents (Milind, 2013) and preparation have significant influence on the milling systems. slagging and fouling tendencies in the Thermal Chamber having a total flue gas volume, combustion (Tharayi, 2015) quenching on the boiler tubes and contributing mainly formation of major pollutants such as NOx , SOx , etc. (Gireesh, 2015).

COAL COMBUSTION

Coal is the primary fuel is going to burn in the Thermal power plant along with the lower grade oil as a secondary fuel. But the oil is having higher calorific value and requires less amount of oil utilization (Mukesh, 2015; Ilamathi, 2012) for the same index of electrical energy production. With this reference the coal consumption for generating the electrical energy is on higher side (Milind, 2013). This requires the plant to optimize the coal consumption for generating the electrical units. This will depend on the plant heat rate and this will require the optimal electrical energy production for getting the specific fuel consumption to be low for a specific index of coal (Ashish, 2015).

Heat Rate is the plant to plant specific and is going to increase as the life span of the Thermal plant is going to increase than also the heat rate is also going to increase. The bigger size of thermal power station is also having low heat rate and this will try to reduce the fuel consumption (Gireesh, 2015).

New pulverized coal combustion systems (Ilamathi, 2012) – utilizing supercritical and ultra-supercritical technology – operate at increasingly higher temperatures and pressures and therefore achieve higher efficiencies than conventional sub-critical units with significant CO_2 reductions (Hosieninejad, 2011). The objective of power plants (Milind, 2013) within today's market boundaries is more than ever to ensure high efficiency (to reduce the environmental impact as much as possible) while at the same time to increase their economics in competition to existing alternatives (Paul, 2014). The development of an economical and efficient concept needs to look at the steam turbine and all other main components like boiler, flue gas cleaning equipment and the optimization (Jie, 2012) of the water-steam-cycle as main parts for the optimization.

Design of Plant with higher size of plant capacity will make a significant increase in the installation cost over the conventional plant. The operating fuel costs are considerably lower due to the increased efficiency and operating costs are at the same level as sub-critical plants (Paul, 2014). Plant with higher size capacity with lower heat rate will make contribution to cost in the terms of per megawatt (MW) Capacity. Thus the efficiency in the coal combustion (Gireesh, 2015) process will make a vital and fulfils the requirement of balance reliable power supply,(Hosieninejad, 2011) sustainable use of existing resources and economic operation (Shyamalesh, 2012).

COAL MANAGEMENT AND OPTIMIZATION

Coal Transportation and its management in thermal power station is a kind of management that require a lot of analysis when we are going to install a big capacity of thermal power station as it require a huge amount of coal on daily basis consumption.

Coal management (Ilamathi, 2012) in the plant is also having the analysis of day to day basis as its requirement and at the same time depends on which quality of coal is going to be in thermal power station. Coal once fired in the plant converted into ash which is a secondary product and also requires settling the ash Quantity in the specific location because of the environmental issue.

Coal energy having a thermal flux and it would contribute (Ashish, 2015) a significant amount of heat in the boiler and this will create the heating zone for energy transfer from chemical phase to thermal phase.

Considering this, it is important to understand that combustion efficiency, reliability and air pollution control are all very much inter-related. Heat transfer through (Jie, 2012) the furnace or convection pass can have a significant impact on the boiler exit gas temperatures. If lower furnace heat transfer is not optimized,[8] the furnace exit gas temperature can result in performance challenges such as forced outages due to overheating of the upper zone.

Thermal performance is non-optimal, the end result is commonly identified with non-optimal temperature gradients, velocities and increased gas volume exiting from outlet ductwork is also being digested by the Air Pollution Control (APC) equipment.

Heat transfer surfaces – the metal in the boiler acts as a catalyst – and also form contact with the catalyst in selective catalytic reduction (SCR) systems.

COAL INDEXING AND MANAGEMENT

Coal combustion is the vital role for optimization of the coal chemical energy and it will make significant role during the combustion for controlling various facts (Paul, xxxx; Jose, xxxxx). one of the plant parameters like heat rate plays a vital role when significant improvement was done in this area as below.

- Fuel savings
- Lower greenhouse gas emissions
- Improved reliability
- Water conservation
- Increased power generation

The overall thermal efficiency, reliability, and emissions from a large steam generator are very much influenced by the combustion.

A. Input Energy (Kcal) Ie = (Plant Capacity X Plant Load Factor X KWhr to Kcal Conversion X1000)/Efficiency

B. Coal Requirement per hour (Kg) C_k = Input Energy (Ie)/ Calorific Value (Kcal/Kg)

C. Coal Saving Factor (I_{scf})= Yearly Coal saving by increasing Efficiency by 1%

D. Coal Cost Saving Factor (I_{ccsf}) =Yearly Cost saving of Coal by Increasing efficiency by 1%

ANALYSIS AND RESULT

Combustion in the boiler a measure of how efficiently a fossil-fuelled power plant converts the chemical energy from the fuel into electrical energy (Gireesh, 2015). There are many factors which is broadly influence a the plant performance and its requirement to make fuel firing in such a way that the coal energy is best utilised and it is require good performance indicator.

However, it is important to understand that some plants are built and designed to be more efficient than others based on specific plant parameter. A boiler's design pressure and temperature ratings certainly impact heat rate, while variations of the plant components, the stages of reheat, feed water heaters, pump design, fan design, ambient conditions, and operations also influence the performance. When we go for overall efficiency and optimization then the coal energy [9] requirement on per hour basis and efficiency improvement with respect to the unit size and heat rate will make significance contribution in the plant performance. Gross heat rate is calculated using the total unit heat input and the gross electrical generation produced. Net heat rate is calculated using the total heat input and the net electrical generation from the power plant and requirement of coal energy per day and total saving of the cost per year along with the unit size and for a specific calorific value is given here

CASE-1

210 MW

Unit Details	Case-1	Unit Details	Case-2
MW	210	MW	210
Efficiency	33%	Efficiency	34%
PLF	90%	PLF	90%
No of Days	365	No of Days	365
No of Hours	24	No of Hours	24
No of Years	25	No of Years	25
Design GCV (Kcal/Kg)	3300	Design GCV (Kcal/Kg)	3300

Figure 1: Efficiency curve Vs Plant Characteristics

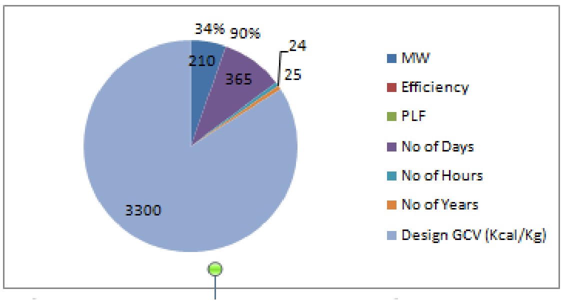


Figure 2: Requirement of Plant Performance Parameter

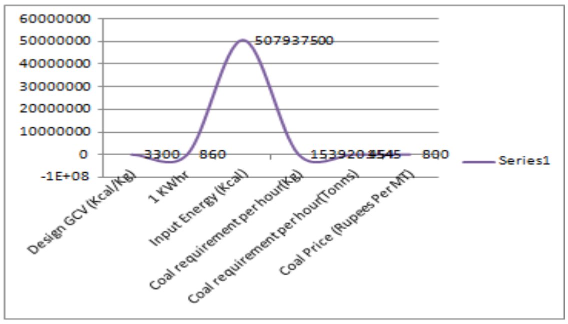
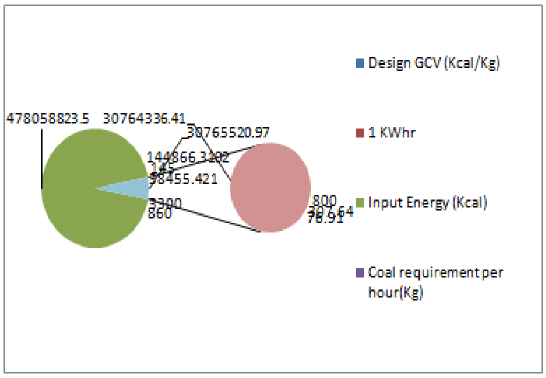


Figure 3: Optimization Characteristics



CASE-2

500 MW

MW	500	MW	500
Efficiency	33%	Efficiency	34%
PLF	90%	PLF	90%
No of Days	365	No of Days	365
No of Hours	24	No of Hours	24
No of Years	25	No of Years	25
Design GCV (Kcal/Kg)	3300	Design GCV (Kcal/Kg)	3300

Figure 4: Efficiency curve Vs Plant Characteristics

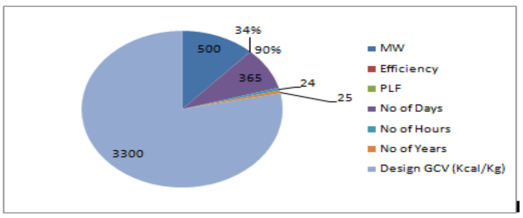
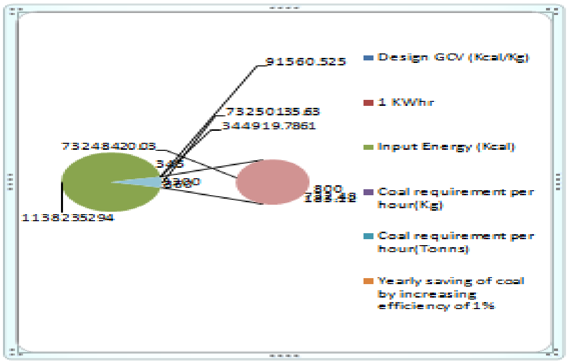


Figure 5: Optimization Characteristics



CASE-3

660 MW			
MW	660	MW	660
Efficiency	33%	Efficiency	34%
PLF	90%	PLF	90%
No of Days	365	No of Days	365
No of Hours	24	No of Hours	24
No of Years	25	No of Years	25
Design GCV (Kcal/Kg)	3300	Design GCV (Kcal/Kg)	3300

Figure 6: Efficiency Curve Vs Plant Characteristics

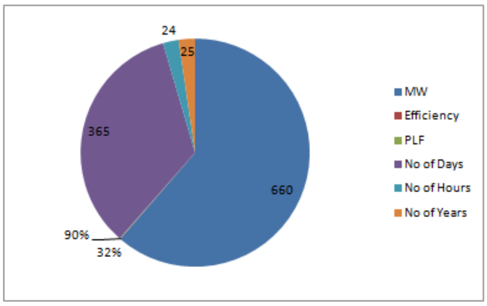
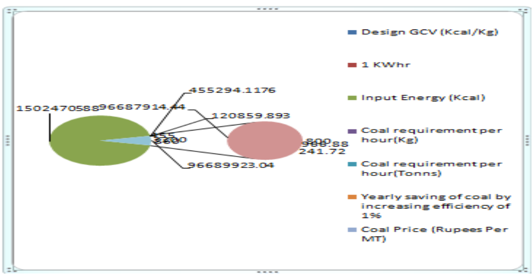


Figure 7: Optimization Characteristics



CASE-4

800 MW			
MW	800	MW	800
Efficiency	33%	Efficiency	34%
PLF	90%	PLF	90%
No of Days	365	No of Days	365
No of Hours	24	No of Hours	24
No of Years	25	No of Years	25
Design GCV (Kcal/Kg)	3300	Design GCV (Kcal/Kg)	3300

Figure 8: Efficiency Curve Vs Plant Characteristics

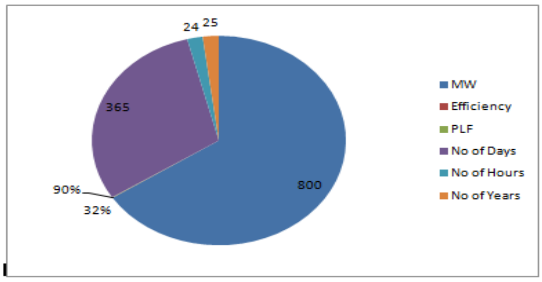
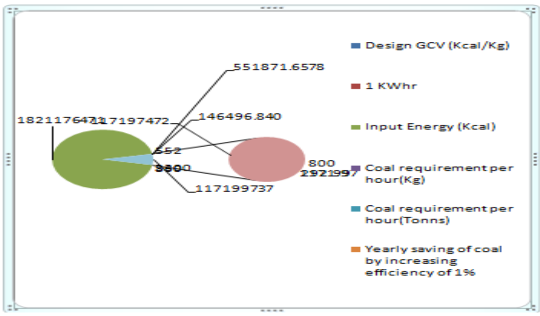


Figure 9: Optimization Characteristics



CONCLUSION

As with any steam generator, the boiler and its auxiliary equipments can be considered a series of heat exchangers or several components transferring energy through the system. Understanding the total energy distribution or "heat distribution" through operating at or above this pressure results in conditions where the water and saturated steam are in single phase and fuel quality will make efficient way to utilise the energy demand for the single source of electrical energy conversion with process changeover parameter.

Efficient way of optimization of energy is relevant to economic heat transfer. Optimization process of saving the coal energy is linked to heat rate and efficiency improvements.

The leading change in unit size from subcritical units to supercritical units will make the process conversion and which enable the power generation cost or production costs can be largely influenced by fuel flexibility options, heat rate, and condition of plant operating equipments. Thus by the way of changing the efficiency along with process parameter will make optimize coal consumption and saving of fuel for plant life operation and its management.

Overall heat transfer of the system and yields uncontrolled "lower furnace" combustion that impacts sustainability and control of emissions at the back-end if control, monitoring and tuning is not proactively employed.

REFERENCES

1. Ashish M Pullekunnel and Manish R Moroliya, "Optimization of Bed Material Consumption in a CFBC Boiler", *International Journal of Engineering Research,* ISSN:2319-6890) (online), 2347-5013(print), Vol. 4, No. 1, pp. 27-32.

2. Dirk Breitenreicher, Jan Lellmann, Christoph Schnörr (2013),"COAL: a generic modelling and prototyping framework for convex optimization problems of variational image analysis" *Optimization Methods and Software*, Vol. 28, No. 5,pp. 1081-1094

3. Gireesh Kumar, Manish Kumar soni and Singh M P (2015), "A Journal paper on Fuel Optimization &increase boiler efficiency by heat extraction system" *International Journal in IT and Engineering*, Vol. 3, Issue-06, (June, 2015).

4. Hosseininejad B, Fuller T A and Fuller E D (2011), "Coal Flow Optimization with B&W PGG's Even Flow™ System", BR-1865 Power-Gen International Las Vegas, Nevada, U.S.A. December 13-15, 2011.

5. Ilamathi P, Selladurai V, Balamurugan K (2012), "Predictive Modelling and Optimization of Power Plant Nitrogen Oxides Emission", *IAES International Journal of Artificial Intelligence* (IJ-AI) Vol. 1, No. 1, March 2012, pp. 11~18 ISSN: 2252-8938.

6. Jie Xiong, Haibo Zhao, Chao Zhang, Chuguang Zheng and Peter B Luh (2012), "Thermoeconomic operation optimization of a coal-fired power plant", *Energy,* Vol. 42 (2012) 486-496. 0360-5442/$ - see front matter © 2012 Elsevier Ltd.

7. José-Luis Casado-Sánchez, Alberto Ramos Millán and José María Palacios De Liñá (2012), "Coal Purchase Optimization: A Review from Spain", *Universidad Politécnica de Madrid, Ríos Rosas*, 21 28003 Madrid, Spain.

8. Mahmoud M.Ahmed (2011), "Optimization of A Jigging Process Using Statistical Technique", *International Journal of Coal Preparation and Utilization,* Vol. 31, Issue 2.

9. Milind S Mankar (2013), "Nitrogen Oxides Emission Prediction & Optimization in Thermal Based Coal Power Plant Using Artifical Neural Network- A Review", *International Journal of Engineering Research & Technology* (IJERT), Vol. 2, Issue 12, December.

10. Mukesh Gupta and Raj Kumar (2015), "Thermoeconomic Optimization Of A Boiler Used In A Coal Fired Thermal Power Plant Based On Hot Air Temperature" *International Journal of Recent advances in Mechanical Engineering (I*JMECH) Vol. 4, No. 2, May.

11. Paul R and Pattanayak L (2014), "Performance Improvement of Pulverized Coal Fired Thermal Power Plant: A Retrofitting Option", *Research Inventy: International Journal of Engineering And Science,* Vol. 4, Issue 9 (Sept 2014), pp. 05-13 Issn (e): 2278-4721, Issn (p):2319-6483.

12. Shyamalesh Khan and Sanjay Kumar (2012), "Optimization of Material Procurement Plan – A Database Oriented Decision Support System" BIJIT - BVICAM's *International Journal of Information Technolog,y* January - June, 2012; Vol. 4, No. 1; ISSN 0973 – 5658.

13. Tharayil James Joseph,Shah B A and Jethva D M (2015), "Optimization Of Combustion In Pulverized Coal Fired Boiler", Issn(print): 2394-6202, (Online): 2394-6210, Vol. 1, Issue 4.

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