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Performance Analysis of Economizer by Adding Extra Coils

T.Venkateshan[1], T.Shathriyan[2], P.Mahaduraisamy[2], J.Chiffathulla[2], T.Vishnuprabhu[2]

[1]Assistant Professor, [2]UG Students

Department of Mechanical Engineering,

Nanda Engineering College, Erode-52, Tamil Nadu, India.

[1]*venkateshaneil@gmail.com*,[2]*mahasmart812@gmail.com*,[2]*saranshathriayn896@gmail.com*

Abstract -India's energy market is one of the country a fastest developing sectors. The electricity generated from thermal power plants contributes 68.14% of the total generation. The availability of coal in the country such that the high grade of coal, which have higher calorific value, have been exhausted and progressively over grades of coal are being made available for generation of electricity in power plants.This has resulted in poor thermal efficiencies of power plants.The major loss of a boiler is caused by the hot stack gases discharging to the atmosphere in order to increase the efficiency of boiler. But we have to extract maximum amount of heat from the flue gases and increase the heat pick up the rate of the rate of the feed water outlet in boiler.

Index words - boiler, economizer, air pre-heater, thermal efficiency, heat exchanger.

1. INTRODUCTION

Power generation in any country depends upon the available resources in the country.The major sources of power are thermal (coal), hydro (water) and nuclear power plants. The hydro power generation is dependent on periodic rainfall which is highly uncertain and sites for hydro power plant cannot be humanly created.Nuclear power generation is highly capital based and requires advanced technological developments and fuel resources .To overcome these limitations, thermal power plants become necessity of economic and abundant generation of power.thus thermal power plants are major contributors of country's power generation. "Energy can neither be created nor be destroyed; it can be transformed from one from of energy to another".Power generation is a thermal power plant involves the following basic conversions of energy. Boiler is a combination of heating surfaces in which superheated steam is generated from continuously fed water by utilizing the heat energy of coal, which is fed into boiler furnace together with the air, required for the combustion.Circulation through various heating surfaces, does the processes of conversion from water to steam by addition of sensible heat, latent heat and superheat. Steam boiler consists only of the containing vessel and conductive heating surface. Economizer is used to pre heat the boiler feed water (adding sensible heat) before it enters the drum by absorbing heat from the flue gas.The most common economizer design is the bare tube, in-line and cross flow type to the hot flue gases and also the gas velocity is another important for economizer design.Bowl mill consist of stationary roller mounted on an electrically driven rotating bowl. Coal fed through the hopper gets pulverized by friction as it passes between the slides of the rollers and bowl.

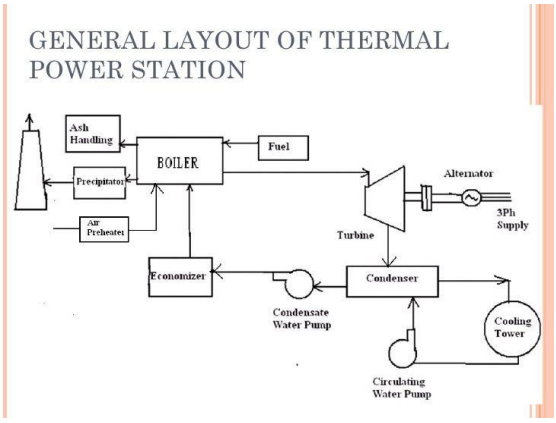

Fig. 1 Thermal plant layout

The fuel and combustion air streams from these burners or compartments are directed tangentially to an imaginary circle and this creates a turbulent vortex motion of the fuel,air and hot gases ,which promotes mixing ,ignition energy availability and thus combustion efficiency.The proportioning of airflow is done based on boiler load,individual burner load,by a series of air dampers.

Each of the auxiliary and end air nozzles are provided with lower type regulating dampers, at the air entry to individual air compartment.The damper regulates on elevation basis,in unison, at all comers. Since combustion is the surface reaction, greater the extent of coal surface available, higher will be the rate of combustion. Hence, coal is pulverized to increase the surface area per unit mass of fuel. The development of growth of coal pulverize closely parallels the development of pulverized coal firing technology. Early systems used ball and tube mills to grind coal and holding pins to temporarily store the coal before firing. Evolution of the technology to eliminate the bins and direct fire the coal pneumatically transported from pulverizes required more responsive and reliable grinding equip men

II. LITERATURE SURVEY

V.Malikarjuna et al [1]

Preparing mathematical analysis an attempt has been made to study about the boiler and economizer. Hot air is necessary for rapid combustion in the furnace and also for drying coal in milling plants .so an essential boiler accessory which serves this purpose is air preheater. The air preheater are not essential for operation of steam generator, but they are used where a study of cost indicates that money can be saved or efficient combustion can be obtained by their use. The performance of the air preheater is improved. Load on fan are reduced thus power consumption is reduced and cost is reduced. Fuel consumption is also reduced, thus fuel is saved and cost is reduced. By comparing Rothemuhle with ljunstrom air leakage are more, gas side efficiency and air side efficiencies are less in Rothemuhle air preheater. The thermal performance of the ljunstrom air preheater is better than Rothemuhle

P.N.Sapkal et al [2]

Performed an analysis for the optimization of air preheater design with inline & staggered tube arrangement. The poor performance of an air preheater in the modern power plants is one of the main reason for higher unit heat rate & is responsible for deterioration in boiler efficiency.. In case of tubular air heaters a variety of single and multiple gas and air path arrangements can be used to optimum performance. Modern tubular air heaters can be shop assembled into large, transportable modules. Erosion of air preheater parts can be controlled by reducing velocities, removing erosive elements from the gas stream, or using sacrificial material. The performance of tubular air preheater can be evaluated with the help of CFD analysis for Inline & staggered tube arrangement with the latter being more thermally efficient. The model can be used while selecting a new type of surface geometry in order to have uniformly distributed flow pattern for optimizing the design of air preheater.

Sangeeth G.S et al [3]

Performed an analysis for energy efficiency of the process or equipment should prove itself to be economically feasible for gaining acceptance for implementation. The focus of the present work is to study the effect of system modification for improving energy efficiency. The objective of the study was to analyze the overall efficiency and the thermodynamic analysis of boiler. There are many factors, which are influencing the efficiency of the boiler. The fuel used for combustion, type of boiler, varying load, power plant age, heat exchanger fouling they lose efficiency. Much of this loss in efficiency is due to mechanical wear on variety of components resulting heat losses. Therefore, it is necessary to check all the equipments periodically. Moreover, it is noticed that the overall efficiency of any boiler depends upon the technical difficulties under unpredictable conditions. Hence, a viable study is carried out to assess the performance of boiler plant in this context. The paper set to show the

weakness of depending on energy analysis only boilers as a performance measure that will help improve efficiency.

Gaurav T. Dhanre et al [4]

Performed an analysis for This reduction can be achieved by improving the efficiency of industrial operations and equipments. Energy audit plays an important role in identifying energy conservation opportunities in the industrial sector, while they do not provide the final answer to the problem; they do help to identify potential for energy conservation and induces the companies to concentrate their efforts in this area in a focused manner. which we are getting from energy auditing . Hence there is a need to prefer energy auditing of every plant once in an year. For the research, it is found that it is also possible to do auditing at different load conditions and by comparison we get the actual consumption as well as wastage.

M. J. Poddar et al [5]

As per the study carried out by, the share of energy costs in total production costs can get improves profit levels in all the industries.

It can be achieved by improving the efficiency of industrial operations and equipments. Energy audit plays an important role in identifying energy conservation opportunities in the industrial sector, while they do not provide the final answer to the problem, they do help to identify potential for energy conservation and induces the companies to concentrate their efforts in this area in a focused manner. The comparative study has been done. From the audit it is concluded that the major reasons for having lower efficiency are poor quality of coal and air leakages. Efficiency of the boiler is increased by 0.27% by reducing air leakage about 6% in air heater.

Venkata Seshendra et al [6]

Performed an analysis for the environmental issues and economy are the secondary factors to be considered after finding the losses. Due to increase in fuel price and demand in more energy requirement in everyday life, proper utilization of materials and resources are necessary. This present deals with the aim of estimating the heat losses occurring in thermal power plant boilers and hence finding suitable ways for reducing it, hence allowing plants to achieve more performance, sustainability and cost-effective maintenance operation of a steam system. Thermal power plant is the detailed study of boiler in the plant and then the efficiency calculation. The efficiency calculation by indirect method is the best way to account all the boiler losses. The flue gas loss is always higher than any other losses. The flue gas loss can be minimized by heat extraction and proper utilization. Moreover when the primary fuel is coal, it should be accounted that it is of higher calorific value, low moisture and low ash content.

K.Sampath Kumar reddy et al [7]

Performed an analysis for the Computational Fluid Dynamics (CFD) approach is utilized for the creation of a two-dimensional model of the economizer coil. Using mild steel material in the economizer part it gives better performance compared with the carbon steel material. The fluid flow temperature, pressure is increase and velocity is decrease field of fluid flow within an economizer tube using the actual boundary conditions have been analyzed using CFD tool. The CFD model may be used to optimize its thermal performance by varying the location in the economizer and in turn improve the performance of boiler. And

due to changing the material of economizer such as mild steel. Out let pressure of the economizer is increased and temperature is not varied but velocity is decreased due to using the mild steel. Finally the boiler efficiency is increased

III. CONSTRUCTION FEATURES

CLASSIFICATION OF BOILERS:

1. Based on the working pressure
   - ❖ Sub critical boiler (<222 bar)
   - ❖ Super critical boiler (>222 bar)

2. Based on boiler layout

The mutual arrangement of the gas ducts of a boiler and the direction of combustion products in them determine the layout.

- ❖ Single pass
- ❖ Two pass
- ❖ Three pass
- ❖ Four pass
- ❖ T type

3. Based on circulation of working fluid
   - ❖ Natural circulation or Drum type
   - ❖ Forced circulation or Controlled circulation

Two types of construction are predominant for the design of steam generators. They are single pass and two pass boilers. The single pass boiler has found no wide use in India. At thermal power station for sub critical boilers, two pass systems is employed. The two pass boilers consist of two vertical shafts connected at the top by a horizontal gas duct. The first pass serves as the boiler furnace. The water wall tubes are arranged around the side and align the whole height of the furnace champer.They are heated directly by the radiant heat of the flame. The second vertical shaft and the horizontal duct that connects it with first pass serve for accommodating super heating heater surfaces, which receive heat by convection. The heating surfaces like platen SH, re heater, pendent SH are placed in the horizontal duct &low temperature SH and economizer are in second pass of boiler.

The convective super heaters are the system of a large number of tubes connected by headers at the inlet and outlet end. The water wall outlet headers, super header and boiler drum are placed at the penthouse.

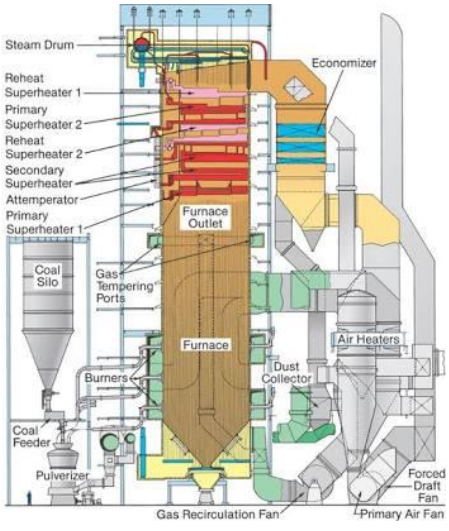

Fig: 2 Boiler

The important components of the steam generator such as boiler drum with internals, the furnace water wall panels, super heaters, pre heater, de super heater, and economizer are mostly suspended from the structural steel work. Various sub systems like coal /oil burners, forced draft fans to supply air for combustion, induced draft fans to eject combustion products, ash removable systems, spray systems are connected with boiler.

ECONOMIZER:

Economizer is arranged the 2nd pass of the boiler in which feed water is heated from 247-272* and sent to the boiler drum.

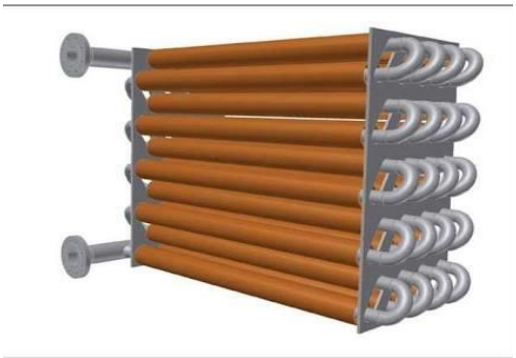

Fig: 3 Economizer

Economizer is used to pre heat the boiler feed water (adding sensible heat) before it enters the drum by absorbing heat from the flue gas. The most common economizer design is the bare tube, in-line and cross flow type to the hot flue gases and also the gas velocity is another important for economizer design.

IV. EXTRA ADDING COILS IN EXISTING ECONOMIZER:

In economizer extra tubes should be added to utilize the waste. In economizer extra coils or tubes are added on the basis of area available in economizer. In economizer if number of tubes is increased heat transfer rate of flue gas to feed water increases which in turn reduces the consumption of coal consequently increases efficiency of the system.

CALCULATION:

Length of each coil = 9m=9000mm
Diameter of coil=0.120m
Area of a coil= (2*3.14*r*r) + h (2*3.14*r)
= (2*3.14*0.6*0.6) + 9(2*3.014*0.6)
=3.482m^2
Total area of 78 coils=3.482*78
=271.44 m^2
Total area of 243 coils=243*3.482
=846.126 m^2

Total surface area of economizer=1230.52 m^2
Total surface area of (243+78) coils= 1117.56 m^2
Total available area in economizer is 1230.5 m^2 and the area required for addition of 78 coils is 271.4 m^2.

V.CONCLUSION

Thus by adopting the proposed optimization, the efficiency of the boiler can be increased and consumption of coal is reduced. In air pre heating system, the outlet temperature of air heater can be reduced from 163°c to 147°c. For every 22°c of temperature reduction the boiler efficiency is gained by 1%. As per the suggested optimization savings per annum is around 1.130 crores per annum. By implementing heat exchanger after pre heater, a portion of feed water can be preheated without use of economizer. This can save consumption of coal up to 1000 tons of coal. This methodology proposed in the project can be used as guidance. By changing up parameters and testing the boiler regularly these logics can be further improved and the work can be extended. Based on the addition and alteration the efficiency can be increased.

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