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Modification of Combustion Chamber in Boiler to Maintain Pressure and Temperature

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***Abstract*: In the present scenario of energy demand operated on continuous basis and consumes large quantities of energy. Efficient management of process system can lead to energy savings, improved process efficiency, lesser operating and maintenance cost, and greater environmental safety. With the growing need for energy conservation, most of the existing process systems are either modified or are in a state of modification with a view for improving energy efficiency. Any new proposal for improving the 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.**

***Keywords*: Efficiency improvement, boilers**

1. Introduction

In the present day technology of gaseous fuel combustion, it is possible to completely remove this loss. Most of the oil firing equipments would also ensure complete combustion of the oil. In the case of solid fuels however, there is always a certain quantum of un burnt carbon found along with the residual ash. The typical of values of un burnt carbon found in boiler ash is indicated . The un burnt carbon can be significantly reduced by improving the design and operation of combustion equipment. The combustion of fuels improves by increasing the temperature of the fuel and air as well as by increasing time available for combustion. By providing adequate turbulence to the combustion air, it will allow fresh molecules of oxygen to continuously come in to contact with solid fuel particles and thereby ensure complete combustion. In order to achieve these results ,we must increase the air pre-heat and the 'heat loading' in the furnace. Burners with high swirl numbers would improve the turbulence and as sit incomplete combustion of the fuel. The admission of combustion air at appropriate locations along the trajectory of the fuel particles would also enhance completeness of combustion. The reduction of this loss would therefore be possible by improving the combustion system design. The fluidised bed combustion is a very effective method of reducing un burnt fuel loss.

A fire tube boiler is a type of boiler in which hot gases from a fire passes through one or more tubes running through a sealed container of water. The heat of the gases is transferred through the walls of the tubes by thermal conduction, heating the water and ultimately creating steam. The fire-tube boiler developed as the third of the four major historical types of boilers low-pressure tank or "haystack" boilers, flued boilers with one or two large flues, fire tube boilers with many small tubes, and high-pressure water-tube boilers. Their advantage over flued boilers with a single large flue is that the many small tubes offer far greater heating surface area for the same overall boiler volume. The general construction is as a tank of water penetrated by tubes that carry the hot flue gases from the fire. The tank is usually cylindrical for the most part being the strongest practical shape and this cylindrical tank may be either horizontal or vertical. The process of designing the Lancashire boiler involves developing a conceptual physical geometry, making necessary calculations from which dimensions and other deductions can be made, and finally, developing a working drawing, analyzing with software. There are several researchers working on fire tube boiler and its efficiency. As per the present market condition, there are few fire tube which can be used for steam generation. So the efficiency of Lancashire boiler can be analyzed with the help of performance parameters and this analysis can be used for improvement of boiler efficiency. Lancashire boiler is one of the type of fire tube boiler, it is horizontal smoke tube boiler with single furnace and three pass boiler. It is placed in horizontal position over a brick work or saddle support it is partly filled up with water. The water level inside the shell is well above the furnace tubes

2. Equipment's

A. Grate

Bagasse burns in suspension and has a relatively low ash content of 4%, part of which leaves with the flue gases. The removal of bagasse ash is therefore rather simple and can be achieved by a dumping or pinhole grate (Misplon et al, 1996). Coal burns on top of the grate, has a much higher ash content of typically 11-16% forming clinker and requires a continuous ash discharge (CAD) stoker Under grate air temperatures should not exceed 250°C for bagasse or 150°C for coal fired boilers to prevent overheating of the grate.

B. Airheater

In a bagasse fired boiler, the air heater is normally situated before the economiser. The air temperature is raised from ambient to the under grate air temperature which is about 250°C when burning bagasse and 150°C when using coal. Flue gas velocities are usually below 25 m/s.

C. Scrubber

The main pollutants in the flue gas are particulate matter, NOx and SOx, the latter only when coal is being burnt. Legislation only makes mention of the emission of particulate matter which must be below 200 mg/m^3 measured under standard conditions. Scrubber types are wet scrubbers, cyclonic scrubbers, bag filters and electrostatic precipitators. While electrostatic precipitators are probably the most effective, wet scrubbers are much cheaper and they do meet the statutory requirements (Boshoff and Yeo, 1999).

D. Induced draught (ID) fan

Because erosion is more troublesome than corrosion, wet ID fans (downstream of the scrubber) are preferred to dry ID fans (upstream of the scrubber). In addition wet fans absorb less power because of the cooler and therefore denser gas.

E. Forced draught (FD) fan

The temperature of the FD air plays an important role in cooling the grate and is controlled by air heater bypass dampers. The balance between ID and FD air should be such as to provide a furnace pressure just below atmospheric.

F. Secondary air (SA) fans

Secondary air provides the necessary turbulence in the furnace and is about 10% of the total air required for combustion. There is some discussion about whether this air should be pre- heated or not.

G. Boiler feed water pumps

It is common practice to have at least one boiler feed water pump which is turbine driven and can operate independently of electrical power.

H. Auxiliary equipment

Most boilers are fitted with a deaerator to remove oxygen from the boiler feed water. The steam used for deaeration is usually exhaust steam. Coal fired boilers require soot blowers to periodically clean the tubes. This can bedone by steam or ultrasound. Controlling of the superheat temperature becomes important above 420°C (Magasiner, 1987) and is normally not done in the sugar industry. Boilers should have at least one safety valve, a crown valve and a non return valve in that order.

3. Types of boiler losses

The computation of boiler efficiency by determining the losses have been standardized in various countries. These standards prescribe the method of determining the boiler losses and hence the boiler efficiency. The following types of boiler losses are reckoned with:

A. Loss due to unburnt fuel

This loss directly reflects the efficiency of the combustion system. The unburn fuel is retained generally with the solid combustion residue. It is generally found in the form of free carbon. The heat value of this free carbon found with combustion residue reflects the loss due to unburnt fuel.

B. Loss due to partial combustion

The chemical energy of the fuel is released as heat through the oxidation process. Oxygen chemically reacts with the combustible matter in 'multi valent' mode. The amount of oxidation (and hence the amount of heat released) would therefore depend upon the valency under which oxygen combines with the combustibles. The most important example of this process would be burning of carbon to produce either carbon monoxide or carbon dioxide. The burning of carbon into carbon monoxide is an example of partial combustion. This would lead to a certain amount of unreleased heat from the fuel which is termed as 'loss due to partial combustion'.

C. Dry gas loss

The products of combustion from any fossil fuel would contain water vapor as well as other gases. The total gaseous product of combustion is termed as 'flue gas'. The flue gas without moisture is termed in boiler technology as 'dry gas'. It is not possible to transfer out all the heat from the flue gases to the incoming water completely, as this would require impractically large heat transfer equipment’s. In practice it is therefore necessary to let out the flue gases at some convenient temperature which is higher than the temperature of the incoming water. This temperature however can be brought down by adopting extensive air pre heat. The sensible heat contained in the dry flue gases at the boiler exit is termed as the 'dry gas loss.

D. Loss due to fuel moisture

Almost all the fuels contain a quantity of physical moisture along with the combustibles. In addition, the combustion of fossil fuel (which contains hydrogen) releases water vapour with the flue gases. This total quantity of moisture will also be leaving the boiler territory at a high temperature along with other products of combustion. In almost all the practical cases, this temperature would be higher than 100(C. Thus this total quantity of moisture takes away its requirement of latent heat of vaporization and the sensible heat of water and steam from the calorific value of the fuel. This represents the 'loss due to moisture in fuel'. In the case of gaseous fuels, the basic moisture of the fuel would be already in the vapor form. It therefore does not require latent heat of vaporization from the calorific value of the fuel.

E. Loss due to air moisture

All fuels require air for combustion. The atmospheric air contains a small quantity of water vapour because of humidity. This water vapour gets heated up along with flue gases from atmospheric temperature to the temperature of gases leaving the boiler territory. The sensible heat picked up by the water vapour in this process, is termed as 'loss due to air moisture'.

F. Loss due to sensible heat of solid combustion residue

The solid and liquid fuels contain a certain amount of non-combustible matter in them, which is known as ash. During the combustion process, the ash also gets heated up and is rejected from the boiler territory at some higher temperature. The sensible heat of this ash above the atmospheric temperature is termed as 'loss due to sensible heat of ash'. In most of the boilers firing solid fuels, a portion of the ash is rejected at the boiler furnace itself. Thus this portion of the ash will snatch away a higher quantum of heat from the system as loss. The major portion of the ash travels along with the flue gases and is termed as 'fly ash'. The fly ash then escapes from the boiler territory at the same temperature as outgoing flue gases. Correspondingly the fly ash takes away its sensible heat quantum as loss from the boiler.

G. Loss due to radiation

Most of the boiler components work at fairly high temperature levels. These equipment’s would therefore lose some heat to the surrounding space. They are generally insulated from the surroundings. However, because of practical limitations, the boiler equipments' surface temperature would be higher than that of surrounding atmosphere. The boiler surfaces are therefore losing heat continuously to the surrounding space, through natural convection. There is some heat radiation, but this would be highly negligible. This type of loss of heat from the boiler surface to the atmosphere is termed as 'radiation loss'.A typical Bagasse fired boiler loses anywhere between 30 to 33% of the input heat in various ways as explained before. The efficiency of the boiler would then be any where between 70 and 67%.

H. Latent heat loss

The vapour in the flue gas is derived from the moisture in the fuel, water formed through the combustion of hydrogen in the fuel and moisture in the air. Only the contribution from the fuel must be considered as a latent heat loss. The moisture in the air both enters and leaves the boiler in the vapour form and does not form a latent loss. If this was otherwise the NCV would be function of the moisture content of the air. It is also important to use the latent heat at ambient temperature and not at the final flue gas temperature or else the NCV would depend on the combustion process. Sensible heat loss. The sensible heat loss is the total flue gas mass times the mean specific heat multiplied with the temperature difference between the final flue gas temperature (before the scrubber) and the ambient temperature. The mean specific heat of the flue gas can be calculated from the mean specific heat of the individual gases which in turn can be derived from the specific heat of these gases, which are virtually linear with temperature (Hugot, 1986), by integration

4. Analysis

- Overreliance on energy from coal is unsustainable because of their regional depletion and associated environmental impacts. Effective utilization of available energy and its management for minimizing irreversibility has made power plant engineers to look for efficient energy consumption & conversion. This study deals with the energy and energy analysis of a 10 & 20 MW coal fired boiler in design and off design condition at constant pressure mode of operation. Locations and magnitude of energy destruction is evaluated in the boiler and found that the major energy destruction occurs at combustor followed by heat exchanger.
- Nowadays most of modern chemical industries have packaged type boilers also they are using three pass and combined type water tube and fire tube type boilers. Generally when boiler run according to load capacity which is designed by industry , losses are comes out from it will also high so with calculating these losses we can improve efficiency of boiler by selecting different methods which are given by different authors and choose any suitable method and can implement it in industry. Only direct method is not sufficient for solving this problem, so indirect method also applied by technical approach.
- In the present scenario Most of the process plants are operated on continuous basis and consumes large quantities of energy. Efficient management of process system can lead to energy savings, improved process efficiency, lesser operating and maintenance cost, and greater environmental safety. With the growing need for energy conservation, most of the existing process systems are either modified or are in a state of modification with a view for improving energy efficiency. The focus of the present work is to study the effect of system modification for improving energy efficiency.
- The world over energy resources are getting scarcer and increasingly exorbitant with time. In India bridging the ever widening gap between energy demand and supply by increasing supply is an expensive option. The share of energy costs in total production costs can, therefore improve profit levels in all the industries. This reduction can be achieved by improving the efficiency of industrial operations and equipments
- This review paper is comprehensive study of design and analysis of Lancashire Boiler. Today the main concern is to increase the efficiency of Lancashire boiler by enhancing the heat transfer rate in the boiler tube. Due to economic and environment demand, engineers must continuously focus on improving the efficiency of the boiler and reducing emission. Wide

variety of engineering situations, including heat exchangers for viscous liquids in chemical process and food industry. various testing will give always prevent boiler bursting or any accidents regarding boiler, So these are the necessary testing for boiler.

- Present the functionality of a thermal power plant, on the one hand, and the boiler efficiency calculations, on the other hand. This is why we present a stratification survey by circuit, by equipment and by organ witch the objective is to determine the possible reasons of the deterioration of the plant heat rate. This survey concerns particularly the application of the causal analysis in order to determine the different losses at the level of the boiler of a thermal power plant. In this paper, we presented an exploration of the ways permitting the improvement of the plant heat rate. This is why we present two methods for the boiler efficiency calculations on the one hand and an analysis of the different losses at the level the boiler using the causal analysis, on the other hand. Calculating the boiler efficiency by the Input Output method is desirable because of the simplicity of the method but is subject to the inaccuracies of all of the measurements needed. The method of heat losses increases the accuracy of the calculation but, while the number of measurements is decreased, the difficulty of obtaining accurate measurements is increased. Finally, it important to determine the possible causes generating the losses and provoking the deterioration of the plant heat rate while using the causal analysis.
- An investigation, based on the second law of energy, of the boilers at the UI district energy plant has been conducted. Four different boilers, each with different configurations, are evaluated and the thermal and energy efficiency of each is compared. Energy efficiency varies from 76 to 85%, while energy efficiency is significantly lower at 24 to 27%. Much of the reduced energy efficiency for both fuel types is due to the energy destroyed during the combustion process, an unavoidable characteristic of combusting fuel. The reduced heating value of the wood chip fuel is the primary cause for the reduced efficiency when compared to natural gas, however the proximity of the fuel source still results in substantial economic savings and increases the sustainability footprint of the school thanks to reduced transportation costs. This minimizes the ancillary emissions created by regular shipments of wood chips delivered by trucks.
- Finding of boiler house efficiency improvement study carried out in a large boiler house unit of a pulp and paper mill has been presented. The causes of poor boiler efficiency were various heat losses such as loss due to un burnt carbon in refuse, loss due to dry flue gas, loss due to moisture in fuel, loss due to radiation, loss due to blow down, and loss due to burning hydrogen, etc. The various heat losses were analyzed and a set of recommendations were made to the plant management for implementation, so that efficiency of boiler can be increased. Five important recommendations were implemented by plant management, and it has been seen that there is tremendous increase in boiler efficiency. This work determines and concludes that, tremendous positive gains can be attained by employing above approach in a given energy intensive activity, in this case in boiler house of a large paper mill. Overall boiler efficiency on account of all improvement recommendations has increased by 2% from 80.98% to 82.98%, which is a remarkable increase given the facts that no new equipment has replaced old boiler house equipment. This increase in efficiency speaks volumes about use of energy management which is need of hour and this will lead to an economy with higher productivity and sustained growth.
- Thermal power plant converts the chemical energy of the coal into electricity. The heat rate of a conventional coal fired power plant is a measure of how efficiently it converts the chemical energy contained in the fuel into electrical energy. Coal fired Boiler is one of the most important components for any Thermal Power Plant. The aim of monitoring boiler performance is to control the heat rate of plant. The world over energy resources are getting scarcer and increasingly exorbitant with time. 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 performance of the boiler. Heat rate is increases as boiler efficiency decreases so to achieve desired heat rate boiler performance required to be improved. Boiler efficiency is improved by reducing various losses and controlling stack temperature
- This paper is concerned with calculating boiler efficiency as one of the most important types of performance measurement in any steam power plant. Thermal power plant converts the chemical energy of the coal into electricity. The heat rate of a conventional coal fired power plant is a measure of how efficiently it converts the chemical energy contained in the fuel into electrical energy Heat rate is expressed as kcal/kwh. The aim of monitoring boiler performance is to control the heat rate of plant. This paper deals with determination of operating efficiency of Boiler and calculates major losses for GSECL 210 MW unit in India. Thermal power plant heat rate is directly affected by boiler efficiency. Heat rate is increases as boiler efficiency decreases so to achieve desired heat rate boiler performance required to be improved. Boiler efficiency is approved by reducing various

losses and controlling stack temperature.

5. Conclusion

After studying all these research paper, we summaries that,

- The fluctuation in temperature of the combustion chamber is directly affected to the efficiency of the boiler
- The fluctuation in pressure is directly affected to efficiency of the boiler
- The in complete combustion increase the emission problems and this directly affected to the nature.
- Energy loss can be reduced by solving above all this problems.

References

[1] Sidhesh M. Sathe, Arati K. Mahurkar: "Energy Analysis of a Boiler at Thermal Power Station" International Journal on Research & Modern Trends in Engineering & Management (IJRMTEM) Vol. 2, Issue1, March 2017.

[2] Praveen Marathur "Efficiency improvement of boiler, "International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 05, Aug. 2015.

[3] Gaurav T. Dhanre , Urvashi T. Dhanre, Krunal Mudafale "Energy Audit of a Boiler in Thermal Power Plant" International Journal of Engineering Research and General Science, Volume 2, Issue 6, October-November, 2014

[4] R.V.Sanga,C.V.Papade, Dr.B.K.Sonage "Design &Analysis of Lancashire Boiler", International Journal of Latest Trends in Engineering and Technology (IJLTET).

[5] M. N. lakhoua. "causal analysis and boiler efficiency calculations of a thermal power plant" Laboratory of Analysis, Design and Command of Systems (LACS) ENIT, BP 37, Le Belvedere, 1002 Tunis, Tunisia

[6] Marc Compton and Behnaz Rezaie "Sustainability Enhancement of a Biomass Boiler through Exergy Analysi" Applied Energy Research Laboratory (AERL), Department of Mechanical Engineering, College of Engineering, University of Idaho, Moscow.

[7] Rahul Gupta"Energy Efficiency Improvement Strategies for Industrial Boilers: A Case Study" Department of Mechanical Engineering, National Institute of Technology, Kurukshetra, India

[8] Swapnil V. Charde, Sanket G. Bhoyar, Harsha R. Sonkusre, Sagar M. Nakade, and Hitesh Bisen, "Case study on efficiency of boiler and factors affecting it" International Journal on Research & Modern Trends in Engineering & Management (IJRMTEM), Vol. 2, Issue1, March 2017.

[9] Acharya Chirag, Nirvesh Mehta, and Jaspal Dabhi, "Research paper on Analysis of Boiler losses to improve Unit heat rate of coal fired thermal power plant." International Journal of Advance Engineering and Research Development (IJAERD), Volume 1, Issue 5, May 2014.

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