Comprehensive Study on A Method of Improving Boiler Efficiency In Industrial Settings

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Abstract- *Coal fired water tube boilers are mostly used for power generation in India. But there is few losses obtained. By reducing those losses we can increase the overall efficiency. Here, the boiler tube failure was reduced by changing the material.*

Boiler tube failure continues to be leading cause for outages in water tube bailers. The tube failure may be a simple problem unless it causes damage to the power plant and affects safety of the human being. The problem due to tube failure is realized only when the cost due to failure is estimated. The main objective of our project is to reduce the number of tube failure occurring in boiler accessories at the thermal power station by analysing the tube failure and provide suitable remedies for it.

The major reasons are taken from the tube failure data collected from Mettur thermal power station. Major cause for failure will occur in pressure parts such as super heater tubes, water wall panels, re heater coils, economiser coils etc. In our project we are analysis the failure of water boiler tubes.

In this project the causes of the boiler tube failure are analysed in detail and by this way efficiency of boiler increases slightly.

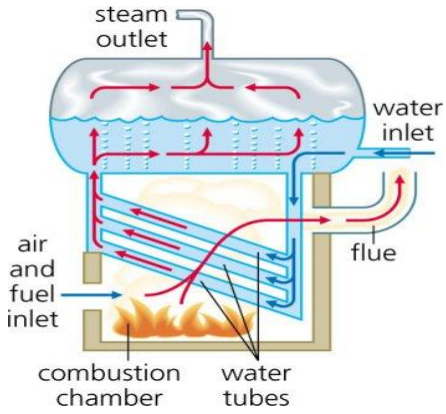
I. INTRODUCTION

In the modern increasing competitive environment, an efficient operating criterion for pulverised coal fired furnace is vital for the future of thermal power station. Thermal power plants contribute about 75% to all India installed capacity of electric power generating stations. In worldwide energy sector, total 37% of electricity is produced by combusting coal. [1-2] In the thermal power station, the boiler performance is a backbone for power production. With ever increasing demand for electricity, it is very necessary for the power plants to generate electricity without forced outages.

The power plants are facing the problem of boiler tube leakage and it is more critical when they are running on full load. It becomes one of the critical reasons among numerous reasons of the energy crisis. Utilities have been fighting boiler tube failure since long. The tube failure cost crores of rupees lost, as it causes loss in generation. Boiler tubes have limited life and can fail due to various failure mechanisms.

Boiler tube failures results in loss of 465 Million Of Units (MU's) in power generation. Moreover the severe service condition in coal fired thermal power plants causes failures such as the effects of high temperature, erosion, stress, vibration and corrosion combined resulting in failure of the boiler tubes thus it is extremely important to determine and correct the root cause to get your boiler back on line and reduce or eliminate future forced outages.

II. BOILER



BOILER DEFINITION

Bailer is a closed vessel which is used to produce steam under heavy pressure. In others words boiler is nothing but steam generator.

As per Indian Boiler Regulation "Boiler is a closed vessel having pacity of more than 22.75 litres and it is used generate the steam under pressure and provide with all necessary mounting and other fitting for the reliable operation

WATER- TUBE BOILERS

A water tube boller (also spelled water-tube and water tube) is a type of boiler in which water circulates in tubes heated externally by the fire. Fuel is bumed inside the furnace, creating hot gas which heats water in the steam generating tubes. In smaller boilers, additional generating tubes are separate in the furnace, while larger utility boilers rely on the water-filled tubes that make up the walls of the furnace to generate steam.

The heated water then rises into the steam drum. Here, saturated steam is drawn off the top of the drum In some services, the steam will re-enter the furnace through a super heater to become superheated. Superheated steam is defined as steam that is heated above the boiling point at a given pressure Superheated steam is a dry gas and therefore used to drive turbines, since water droplets can severely damage turbine blades.

Cool water at the bottom of the steam drum returns to the feed water dum via large-bore 'down comer tubes', where it pre-heats the feed water supply. (In large utility boilers, the feed water is supplied to the steam drum and the down comers supply water to the bottom of the water walls). To increase evonomy of the boiler, exhaust gases are also used to pre-heat the air blown into the furnace and warm the feed water supply. Such water tube boilers in thermal power stations are also called steam generating units.

Tube material	SA210CirA l(c = 0.27%)
Tube diameter	44.5mm
Tube thickness	4.5mm
Tube length	32km
No of bends	14
Tube arrangement	Horizantal
Tube bend diameter	65mm

BOILER MOUNTING

Different fitting & devices generally mounted on the body of the safety of the boiler during operation & complete control of steam generation process.

BOILER FITTINGS

Valves, gauges &other connecting devices attached ot the boiler necessary for safe & efficient operation of the boiler.

BOILER AUXILIARIES

The equipment which supports the function of the boiler is called boiler auxiliarie

BOILER ACCESSORIES

Equipment which is mounted on the boiler to assist the adequate control and operation of the boiler and also in safety against accidents are called boiler accessories.

FURNACE

Furnace is a primary of boiler where the chemical energy in the fuel is converted into thermal energy by combustion. Furnace is designed for efficient & complete combustion.

COMBUSTION

Combustion means rapid burning of carbon, hydrogen and sulphur in fuel. So combustion is the chemical reaction in which chemical energy is converted into heat energy.

WATER WALL TUBES

Water wall tubes are the bunch of tubes which surrounds the first pass of the boiler in which water gets heated inside the tubes from the external firing and the generate steam moves upward to drum by density difference. In Mettur Thermal Power Station each unit has 696 number of water wall tubes.

DOWN COMERS

Down comers are the bigger pipe line which supplies water to boiler bottom ring header from boiler drum by gravity. In 210MW boiler totally 6 down comer's pipes are provided.

BOILER DRUM

Boiler drum is the drum which provides necessary space for the separation of steam from steam water mixture and water storage for preventing the starvation of boiler tubes.

STEAM COOLED WALLS

Steam cooled walls are the tubes which surrounds the boiler second pass, inter pass furnace roof in which the saturated steam converted into superheated steam by 14 super heater header.

SUPER HEATERS

Steam super heater is a boiler auxiliary to superheat the steam produced in the evaporator to a specified temperature. Ex, around 540°C

REHEATERS

Re-heaters are a bunch of tube arrangement used to reheat the turbine exhaust steam to superheat temperature once more. It is also called as intermediate super heater.

ECONOMIZER

Economizer is a shell and tube type heat recovery equipment designed for preheating the boiler feed water by recovering some of the waste flue gas leaving and then boiler efficiency increases.

AIR PREHEATER

Air pre-heater is recovery equipment that pickup heat from the combustion products of a boiler to preheat the combustion air before entering into the boiler so that boiler efficiency considerably increases.

SCANNERS

Scanners are the sensing device which is used to sense the flame condition inside the furnace. In MTPS fireball and discrimination scanners are used to sense the coal and oil frame conditions inside the boiler

MOUNTINGS

The boiler mountings are the part of the boiler and are required for proper functioning. In accordance with the Indian Boiler Regulations, of the boiler mountings is essential fitting for safe working of a boiler. Some of the important mountings are given in this chapter.

WATER LEVEL INDICATOR

Water level indicator is located in fornt of boiler in such a position that the level of water can easily seen by attendant. Two water level indicators are used on boilers.

PRESSURE GAUGE

A pressure gauge is fitted in front of boiler in such a position that operator can conveniently read it. It reads the pressure of steam in the boiler and is connected to steam space by a siphon tube.

The most commonly, the Bourdon Pressure Gauge is used.

SAFETY VALVE

Safety valves are located on the top of the boiler. They guard the boiler against the excessive high pressure of steam inside the drum. If the pressure of steam in the boiler drum exceeds the working pressure then the safety valve allows blow-off the excess quantity of steam to atmosphere.Thus the pressure of steam in the drum falls. The escape of steam makes Audio nise to warm the boiler attendant.

- There are four types of safety valve.
- Dead Weight safety valve
- Spring Loaded safety valve
- Lever Loaded safety valve
- High steam and low steam safety valve.

FUSIBLE PLUG

It is very important safety device, which protects the fire tube boiler against overheating. It is located just above the furnace in the boiler. It consists of gun metal plug fixed in a gun metal body with fusible molten metal.

During the normal boiler operation, the fusible plug is covered by water and its temperature does not rise to its melting state. But when the water level falls too low in the boiler, its uncover the fusible plug.

The furnace gases heat up the plug and the fusible metal of plug melts, the inner plug falls down. The water and steam rush through the hole and extinguish the fire before any major damage occur to the boiler due to overheating

BLOW-OFF COCK

The function of blow-off cock is to discharge mud and other sediments deposited in the bottom most part of the water space in the boiler, while boiler is in operation. It can also be used to drain-off boiler water.

Hence it is mounted at the lowest part of the boiler. When it is open, water under the pressure rushes out, thus carrying sediments and mud.

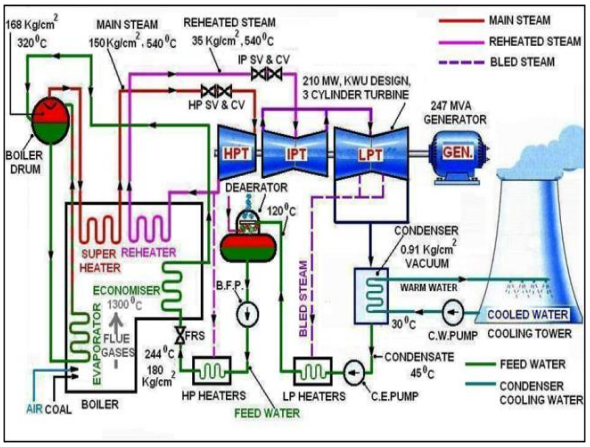
FEED CHECK VALVE

The feed check valve is fitted to the boiler, slightly below the working level in the boiler. It is used to supply high pressure feed water to boiler. It also prevents the returning of feed water from the boiler if feed pump fails to work.

STEAM STOP VALVE

The steam stop valve is located on the highest part of the steam space. It regulates the steam supply to use. The steam stop valve can be operated manually or automatically.

III. UNIT OVERVIEW



IV. PROBLEM IDENTIFICATION

This chapter explains about a problem in the boiler tubes and the factors that cause major damage to the boiler tubes. This helped us to identify the major reason for tube failure and suggest remedies for the failures caused due to the problems, By reducing the boiler tube failure, we can increase the boiler efficiency.

TYPES OF FAILURES

Failures in boiler occur at various places corresponding to the parameter causing the defect. Below listed are such failures which could be seen in boiler rubes.

- Fish mouth opening.
- Window opening.
- Burst open puncture.
- Pin hole puncture.
- Crack formation.

AREAS OF FAILURE

Most of the failures happen at repeated places. Place at which tube re- heater tubes, platen super heater and final super heater. All these places require very good maintenance for longer life and to reduce the failure rate occurring in it

FAILURES OCCURS AT MTPS

At MTPS (Mettur thermal power station) the failure records of boiler des over a period of time collected and the details of failure are displayed ow. The data displayed are failure data till date 31.01.2015. Record shows around 280 failures occur regularly over a period of time a power station,

EROSION

- Fly ash-147
- Falling slag -07
- Soot blower-16
- External erosion -01

Total -171

STRESS RUPTURE

- Short term over heating -06
- Long term over heating -29

Total -35

WELDING DEFECT

- Site welding -27
- Shop welding -10
- Fin area -06
- Attachment zone -6

Total -49

MATERIAL DEFECT

Material Defect -02

MECHANICAL DAMAGE

Damage -02

AIR INGRESS

Air ingress -02

V. CONCLUSION

By using SANICRO 25, upto 80% of tube failures were reduced. Because of this scale formation, corrosion & erosion losses were recovered. SANICRO 25 also suitable for thermal conditions of boiler and its having good conductivity properties also. So this is very much suitable to increase the boiler efficiency.

By this method, we can increase the boiler efficiency in two ways. One is by using SANICRO 25 thermal conductivity of boiler tubes was increased so that the water converted into steam instantly. Another one is by reduction of losses in boiler tubes, the maintenance cost is reduced and efficiency increases.

REFERENCES

[1] [11:46 pm, 19/02/2024] vragul55: Moreira PM.GP, AMP de Jesus, A.S. R. Ribeiro, PM.ST. de Castro (2008), Fatigue crack growth in friction stir welds of 6082-16 and 6061-T6 aluminum alloys: A comparison". Theoretical and applied fracture Mechanics Vol. 50. Issue 2. Pages 81-91.

[2] Shanmugasundaram N., Murugan, N. (2010), "Tensile behavior of dissimilar friction stir welded joints of Vol. 31, pp. 4184-4193. aluminium alloys, Journal of Materials and Design,

[3] M.Ilangovan, V. Balasubramaniamand S. RajendraBoopathy, (2014), Journal of defence technology, Vol. 11, Issue 2, Page 174- 184, "Effect of tool pin profileon microstructure and tensile properties of friction stir welded dissimilar AA 6061-AA 5086 aluminium alloy joints".

[4] Biswajit Parida, Sukhomay Pal, Pankaj Biswas, M.Mohapatra Sujoy Tikader (2011). "Mechanical and micro-structural study of friction stir welding of Al-alloy". International journal of applied research in Mechanical Engineering. Voll, Issue 2

[5] P.Prasanna, Dr.Ch. Penchalayya, Dr.D. Anandamohana Rao (2007), Effect of tool pin profiles and heat treatment process in the friction stir welding of AA 6061 Aluminium alloy", American Journal of Engineering Research, Vol. 2. Issue 1. pages 07-15.

[6] P. Sadeesh, M. VenkateshKannan, V. Rajkumar, P. Avinash, N. Arivazhagan, K. Devendranath Ramkumar, S. Narayanan, "Studies on friction stir welding of AA 2024 and AA 6061 dissimilar metals", International Conference on materials for advanced technologies, Vol. 75, pages 145-149.

[7] S. Kalainathan (2014), "Influence of friction stir welding parameter in mechanical properties in dissimilar Aluminium alloys", International journal of Innovative Research in Science, Engineering and Technology, Vol. 3, Issue 8.

[8] K. Lakshminarayanan, V.Balasubramanian(2009), "Comparison of RSM with ANN in predicting tensile strength of friction stir welded AA7039 Aluminium alloy joints", Trans Non Ferrous Met Soc. China 19, pages 9-18

[9] [11:54 pm, 19/02/2024] vragul55: V Gunaraj and N.Murugam (2008), Application of Response Surface Methodology for predicting weld head quality in submerged are welding pipes Journal of Materials processing technology, Vol 88, pages 266-275.

[10] G.Elatharasan and V.S. Senthil Kumar (2010), "An experimental analysis and optimization of process parameter on friction stir welding of AA6061-T6 aluminium alloy using RSM", International Conference on Design and Manufacturing, Vol. 64, pages 1227-1234.