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A Review Paper On Boiler Tube Failure Of Coal Fired Thermal Power Plant

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Abstract -*The objective of this paper is to study the problem related to boiler tube at thermal power plant. Boiler tube failure continue to be the leading cause of force outages in fossil fired boiler, to get boiler back on line and reduce and eliminate future forced outages due to tube failure, it is extremely important to determine and correct the root cause. A tube failure is usually a symptom of other problem. In addition to evaluating the failure itself, should be investigate all the aspects of boiler operation leading to the failure to fully understand the cause.*

Keyword*-boiler tube, tube failure, coating, fossil-fired boiler, erosion, corrosion*

I. INTRODUCTION

A boiler tube is considered to have a failure when, its pressure boundary is broken by a leak or rupture, or prone to be broken due to wall thinning before the next scheduled boiler inspection. Boiler tube failures continue to be the leading cause of forced outages in fossil-fired boilers. To get your boiler back on line and reduce or eliminate future forced outages due to tube failure, it is extremely important to determine and correct the root cause. The service environment of fossil-fired boilers along with human errors during engineering, fabrication, construction, operation, and maintenance will always result in occasional boiler tube failures (BTF). The industry goal is for a forced outage rate less than 1.5% with zero chemistry related failures. The frequency of these failures depends on the corrective actions taken to prevent or reduce boiler tube damage. Repeat BTF usually result in frequent forced outages, and ultimately in costly extended outages for major tubing replacement. It is estimated that the cost of water/steam-side boiler tube corrosion is over $1.1 billion per year.

II. LITERATURE REVIEW

Adarsh Kumar and at all [1] describe the boiler tube failure is occurring frequently in fertilizer plants, power plants, sugar manufacturing plants, paper manufacturing plants and all industries using boilers. There are many factors responsible for boiler tube failure like, short time overheating, long time overheating, creep, thermal fatigue, mechanical overload, corrosive fatigue. Caustic Attack, Oxygen Pitting, Hydrogen Damage, Acid Attack, Stress Corrosion Cracking (SCC), Waterside Corrosion Fatigue, Super heater Fireside Ash Corrosion, High temperature Oxidation, Water wall Fireside Corrosion, Fireside Corrosion Fatigue, Graphitization, Dissimilar Metal Weld, Erosion and Mechanical Fatigue. There may be some other reasons depends upon the service conditions but we can diagnose the reason in advance by visual inspection and NDT techniques images were reviewed for detecting internal failure and their propagation. The mechanical properties of boiler tube material have been tested at the section of failure, which gave significant clue for preventive maintenance. which can save the production loss of the industry and increase the safety of workers.

Figure 1. Thickness Reduction due to fly ash Boiler-III SGP NFL Naya Nangal.[1]

Suhas R Bamrotwar and at all [2] describe cause & effect analysis of boiler tube failures and identifies the zone where the failure are more and also emphasis on the factors which contribute for such type failure mechanism. The data pertaining to boiler tube failures for one of Thermal Power Plant in Maharashtra State of last ten years is referred. Out of total 144 failures, 43 failures are observed in Economizer zone. Economizer is the main part of the boiler in the furnace second pass. It is the medium for transportation of the feed water to boiler drum. It helps to increase the boiler efficiency. Economizer is placed in the flue gas path, to absorb the heat from the flue gas and increase the temperature of the feed water. Factors contributing for Economizer tube failure include stress rupture, fatigue, erosion, water side corrosion, fire side corrosion and lack of material quality. Out of these factors Erosion is the prime factor contributing for tube failure as

referred from literature review. Erosion is a process in which material is removed from the surface layers of an object impacted by a stream of abrasive particles. Factor influencing the Erosion is the velocity of flue gas, the temperature of flue gas, the mineral content in coal, the arrangement of pressure parts and deviation from design condition. Amongst these factors velocity of flue gas ash particle has the predominant effect on erosion of economizer tubes.
The data shown in Table 1 pertaining to boiler tube failures for one of Thermal Power Plant in Maharashtra State of last ten years is referred. The plant is of 210 MW generation capacity with the prime fuel used as pulverised coal. Major four areas of boiler are identified i.e. Water wall, Economiser, Reheater, and Final superheater and the tube failure occurred in different zones with the loss in generation on account of tube failures were studied. Based on the data, it was found around 30% of failures occurred in Economiser zone.

Table: 1. Failure history of Boiler tubes of past ten years.[2]

Sr.No	Year	Total BTL	Zone					Loss of Gen. (MUS)
			Water wall	Economiser	Reheater	Final Superheater	Low Temp. Superheater	
1	2004-05	15	4	5	1	2	3	214.71
2	2005-06	12	8	2	0	1	1	191.98
3	2006-07	10	1	4	0	2	3	115.53
4	2007-08	7	3	2	0	1	1	61.63

K.Balamanikandasuthan and at all [3] describe use of tube shields for the boiler tube protection is studied and an analysis of different alloy materials for tube shielding is done by comparing its thermal property and a suitable material is selected. Out of the four materials Stainless Steel 30 , Stainless Steel 316
Stainless Steel 316L , Stainless Steel 304 chosen to provide as a shielding, SS 316 was found to have a higher heat transfer (Q) value than the other materials. Hence, SS 316 is suggested as a suitable material for shielding. The heat transfer co-efficient and the net heat flux is not much affected by adding the protective shield to the eroded portion of the pipe bend. In turn it slightly improves the heat transfer rate. Thus, providing SS 316 as a shielding to the reheater bends prevents the reheater tubes from getting eroded and increases the operational life of the tubes, leading to effective functioning of the plant.

Though both SS 304 and SS 316 have high erosion resistance and high temperature with standing capacity. The heat transfer rate is higher in the case of SS 316 when compare to SS 304. It has been concluded that SS 316 is the material which is capable of increasing the lifetime of reheater tubes to a greater extent. Higher the temperature and erosion resistance of the shield material, better the life of the boiler tubes. Since, the chromium content of SS 316 is higher than any other material; it will therefore have the highest erosion resistance which will support its cause as a suitable material for the protective coating around the boiler tubes.

Both SS 316 and SS 316L have the same hardness, but SS 316 is a more suitable material for an erosion protection shield rather than other materials due to its comparable physical, chemical and mechanical properties as well as erosion resistance, temperature range and heat transfer. The thermal analysis suggests that the thermal conductivity of SS 316 when compared to the boiler tube material, SA213T11 is minimal therefore SS 316 would be a more suitable material for the protective shield.

Amabogha B. [4] describes Coating technology is one of the more rapidly growing technologies in the field of materials. A combination of the development of materials specifically designed for erosion and corrosion resistance and the appropriate technique for the application of these materials, as a coating would be the optimum solution. From a production point of view, three methods are in current use to deposit coatings, these being chemical vapour deposition (CVD), physical vapour deposition (PVD) and Plasma spraying. The CVD process comes under the category of Diffusion coatings, in which the coating material forms a chemical bond with the substrate. Whereas the PVD and Thermal spraying processes comes under the category of Overlay coatings, in which the desired material is placed over the substrate material. coatings made of Al_2O_3 containing 13 wt% TiO_2 are commonly used to improve the wear-corrosion and erosion resistance of steel.

Piyushkumar B. and at all [5] describe**s** about case study of CFBC boiler whose tube failure frequently due to erosion. It is found out that the causes, as known Lignite contains 2.55% sulphur it breaks bond between refractory and it breaks so, erosion is mainly found due to refractory failure. When lignite fired in internal circulation within furnace so back flow occurs. And furnace bed temperature not maintained it causes uniform erosion pattern at kick off zone. There are many more solutions available to avoid erosion; anti abrasive coating is one of them. Also in this case it is required to remove excess refractory from kick off zone as shown in fig.2 and at time of erection of panel butt joints of fin are not properly ground flushed shown in fig 3, due to these flow of material gets diverted and tube eroded.

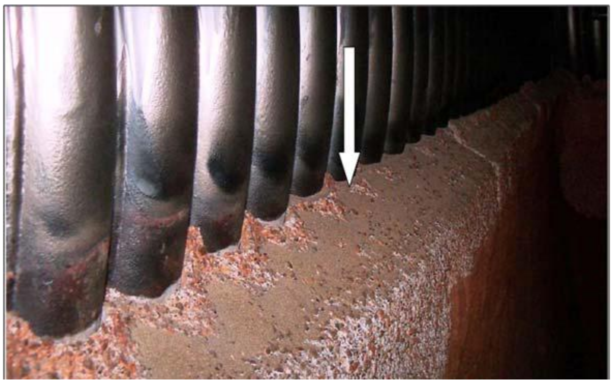

Figure 2: Shows excess refractory at kick off zone

Figure 3: Shows Butt joints of fin are not ground flushed

Mohammed Imran [6] describes Oxygen corrosion in boiler feedwater systems can occur during start-up and shutdown and while the boiler system is on standby or in storage, if proper procedures are not followed. Systems must be stored properly to prevent corrosion damage, which can occur in a matter of hours in the absence of proper lay-up procedures. Both the water/steam side and the fireside are subject to downtime corrosion and must be protected. Corrosion also occurs in boiler feedwater and condensate systems. Corrosion products generated both in the preboiler section and the boiler may deposit on critical heat transfer surfaces of the boiler during operation and increase the potential for localized corrosion or overheating.

The degree and speed of surface corrosion depend on the condition of the metal. If a boiler contains a light surface coating of boiler sludge, surfaces are less likely to be attacked because they are not fully exposed to oxygen-laden water. Experience has indicated that with the improved cleanliness of internal boiler surfaces, more attention must be given to protection from oxygen attack during storage. Boilers that are idle even for short time periods (e.g., weekends) are susceptible to attack. Presence of sulfur in the oil ash deposited on the fireside surfaces of the tube appears to be the main cause of the failure of the boiler tubes.

The mode of failure is intergranular corrosion attack induced by molten ash. Deposits when the tube metal temperature was raised above normal working temperature, i.e., 480 0C. Thinning of the tube walls is due to localized deposits and overheating problem.

III. CONCLUSION

From above research papers we can conclude that,

- The main causes of boiler tube failure are short time overheating, long time overheating, creep, thermal fatigue, mechanical overload, corrosive fatigue , Waterside Corrosion Fatigue, Super heater Fireside Ash Corrosion, Water wall Fireside Corrosion, Fireside Corrosion Fatigue, Graphitization, Dissimilar Metal Weld, Erosion and Mechanical Fatigue.
- The Major four areas of boiler are identified i.e. Water wall, Economiser, Reheater, and Final superheater and the tube failure occurred in different zones with the loss in generation on account of tube failures were studied. Based on the data, it was found around 30% of failures occurred in Economiser zone.
- Providing SS 316 as a shielding to the reheater bends prevents the reheater tubes from getting eroded and increases the operational life of the tubes, leading to effective functioning of the plant.
- Coatings made of Al_2O_3 containing 13 wt% TiO_2 are commonly used to improve the wear-corrosion and erosion resistance of steel.
- Presence of sulfur in the oil ash deposited on the fireside surfaces of the tube appears to be the main cause of the failure of the boiler tubes.

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