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ANALYSIS THE FAILURS IN BOILERS SUPER HEATER TUBE

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ABSTRACT

This paper presents the failure investigation of superheater tubes. Samples were collected from one of the coal fired power plants in Mettur, namely, mettur thermal power station plant I. After eight years of non-continuous services of three boilers, welded support-clips were completely separated (detached) from superheater tubes, which caused the wall thinning. Collected failed samples were undergone several experimental investigations including visual inspection, thickness measurement, Vickers hardness testing, and microstructure evaluation. The results revealed that some cracks were initiated at the heat-affected zone (HAZ) and propagated partly throughout the weld metal. The estimation on operating temperature and operating hoop stress show indication that the specimen may experienced a hig operating temperature. Other findings confirmed that the detachment of welded support-clips from Superheater tubes may also caused by dissimilar metal weld (DMW) failure due to the differences in expansion properties of parent metal and weld metal

Keywords- Superheater tube, coal-fired boiler, localized overheating, visual inspection, microstructure evaluation.

I.INTRODUCTION

Boiler or steam generator plays a vital role in power plant for electricity generations. In a high capacity power plant, coal fired boiler is normally chosen in the purpose to increase the capacity of electricity generation, and prevents corrosion and reduces steam consumption of the steam turbine. In a coal fired steam generator, rows of tubes are heated by fireball with temperature of 530-1000˚C. Exposure of tubes to temperatures at the outer surface, high pressure inside the tubes, and flame contaminated with corrosive residues for a long period of time usually causes tube. A pulverized coal-fired boiler is an industrial or utility boiler that generates thermal energy by burning pulverized coal also known as powdered coal or coal dust. This type of boiler dominates the electric

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power industry, providing steam to drive large turbines. Pulverized coal provides the thermal energy which produces about 50% of the world's electric supply. Superheater tubes are usually located in the hottest zone of a steam generator. The steam with highest pressure and highest temperature is carried inside the superheater tubes, which are exposed to very high temperature generated by combustion of coal. Therefore, the superheater tubes are most susceptible to high-temperature creep and corrosion failures. Although the materials of superheater tubes are superior compared to other tubes, failures of superheater tubes occur most frequently.

To prevent tube failures, which causes temporary shutdown of the power plant, assessment of the tubes are always conducted according to power plant preventive maintenance practices. Boiler tube failures are leading cause of forced outages in fossil-fired boilers. It is extremely important to determine and correct the root cause to get the boiler back in operation and eliminate or reduce future outages. In order to evaluate the failure, all aspects of boiler operations leading to the failure should be investigated to fully understand the cause. There are many types of boiler tube failures, i.e, caustic attack, hydrogen damage, oxygen pitting, acid attack, stress corrosion cracking, water corrosion fatigue, superheater fireside ash corrosion, fireside corrosion fatigue, short-term overheat, long-term overheat, dissimilar metal weld (DMW) failure, erosion, and mechanical.

II.SUPERHEATER TUBES

A superheater is a device used to convert saturated steam or wet steam into superheated steam or dry steam.

Superheaters are used in steam turbines for electricity generation, steam engines, and in processes such as steam reforming.

Superheater tubes in a comprehensive range of stainless steels and nickel alloys covering outside diameters 12 to 260 mm (0.472 to 10.24 in.).

Types

- A radiant superheater is placed directly in the combustion chamber.
- A convection superheater is located in the path of the hot gases.
- A separately fired superheater, as its name implies, is totally separated from the boiler.

III.CONCLUSIONS

In the present study, the failure mechanism in superheater tubes has been investigated. Superheater tubes were made of Cr-Mo low alloy steel, the composition of which is close to the polish specification of ‘Steel 10H2M’. Its equivalent specification is DIN 10CrMo910 / T22. The concentration of major chemical species of failed tubes was within the specified limit. Therefore, failure due to discrepancy in composition can be ruled out. As the received microstructure of steel consisted of polygonal fine grain, ferrite can be assumed to contain some amount of pearlite and complex alloy carbides. During service exposure, initially oxide scales were formed inside the tube. Thus, exfoliation inside the tube reduced the effective wall thickness. When the scale grew substantially, it hindered heat flow across the tube wall. Localized heating took place. Heating coarsened the carbides and propelled precipitation of new brittle phases along the grain boundary. At elevated temperatures, the grain boundary also lost its angularity. Moreover, due to internal deposits and partial choking, tubes are subjected to long-term overheating. The reason for long term overheating of the tube is the fact that tubes are subjected to temperatures so high that it causes their instantaneous bulging to a failure point.

During this period, the outer of tubes surface develops bulging as well, resulting in elongated fissures along their axis. These two simultaneous phenomena, i.e. reduction of wall thickness of tube and its softening due to structural degeneration, come into play. To summarize, the failure mechanism includes excessive oxidation corrosion inside the tube wall, reducing thickness, the spheroidization of alloy carbides, and the coarsening of precipitate along grain boundary. There is also loss of angularity and creep void formation along the grain boundary leading to inter-granular cracking with material flow near regions covered with thick scales. Further, there is a drastic reduction in bulk hardness (lower than 200 HB) of the tubes and, finally, thin lip fish mouthd fracture develops at both the failed locations, leading to failure.

REFERENCES

[1].Power from a hot gas stream with multiple superheaters and reheaters by S. Lorente J. Lee, Y. Kim , A. Bejan, August 2013

[2]. Estimation of oxide scale growth and temperature increase of high (9–12%) chromium martensitic steels of superheater Tubes by M.Z. Hamzah ,W.H. Yeo, A.T.Fry, J.I.Inayat-hussain, 8 April 2012.

[3]. High Temperature Corrosion Behaviors of the Superheater Materials by Wen-Wen Luoa , Zong-De Liua, Yong-Tian Wanga, Rong-Juan Yanga, 2012.

[4]. Heat and mass transfer by yunus A. Cengel.

[5]. Industrial Boilers and Heat Recovery Steam Generators Design, Applications, and Calculations by V. Ganapathy, 2003.

[6].Power from a hot gas stream with multiple super heaters and reheaters by S. Lorente J. Lee, Y. Kim, A. Bejan, August 2013

[7].J. Ahmad, J. Purbolaksono, and L.C. Beng, “Failure analysis on high temperature superheater Inconel® 800 tube”, Engineering Failure Analysis, 17: 328 - 333, 2010.

[8] R.D. Port, H.M. Herro, “The NALCO guide to boiler failure analysis”, Nalco Chemical Company, McGraw-Hill Inc., 1991.

[9] F. Gulshan, Q. Ahsan, A.S.M.A. Haseeb, and E. Haque, “Failure analysis of superheater tube supports of the primary reformer in a fertilizer factory”, Journal of Failure Analysis and Prevention, 5(3): 67 - 72, 2005.

[10] E.P Saeidi, M. Aieneravaie, and M.R.M. Arhani, “Failure analysis of a 9-12%Cr steel superheater tube”, Journal of Pressure Vessel Technology, 131(6): 61401 - 61409, 2009.

[11] Alstrom Publication, Manjung-Malaysia Coal-Fired Steam Power Plant, 200