"ANALYSIS OF SUPERHEATER OF BOILER IN VIEW OF BOILER TUBE LEAKAGE"

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ABSTRACT: *All the Thermal Power Plants are struggling with the problem of boiler tube leakage. The consequences of which affects the working of power plant and national income in general. The purpose of this project is to study boiler tube leakage problem in the superheater and try to find the causes of tube leakages and suggest remedies. In this project report the general working of the superheater has been explained in brief. Causes of boiler tube failure and the study of trend of failure has been mentioned in this report with the remedies. It was noticed from the plant data that the flue gas erosion is the major cause for the boiler tube leakage and hence some advanced preventive methods for erosion has been studied in this report. It was also found from the trends of failure that the superheater and reheater are the zones where the leakages are found more. A 2-D modeling of final superheater is performed and flow of the flue gases over the coils has been observed. Also the temperature, pressure and velocity field within a superheater using the actual boundary conditions has been studied. With the CFD analysis of superheater, it is observed that the velocity of the steam and flue gases near the U-tube bend found more. Also the temperature plot shows that the high temperature affecting zone is the tube U-bends of the superheater. The CFD results can be useful for the maintenance engineer to make suitable prediction of the tube life and make suitable arrangement for the high temperature zone to reduce the erosion of tube coil and restricting the tube leakage problem.*

1. INTRODUCTION

The boiler tube failure is prime reason of forced outages at coal fired thermal power plants. The world is facing problem in energy sector. The production rate of energy is less as compared to demand. The electricity generation capacity is also fulfilling by using hydro, nuclear and nonconventional power station. Due to over load the power station are also facing many technical difficulties. One such major problem is the boiler tube rupture in the thermal power stations

CFD modelling has been used to study BTL problem by considering the superheater section. It explains the fundamental physical processes that determine the interactions among the input and output variables. Simulation modeal of superheater offer a cost effective tool for studying the operating characteristics of the superheater. This model can simulate various operating procedures similar to those actually used in power plant operation. Hence, simulation of the superheater helps to understand the behaviour of superheater.

Computer simulation of the superheater provides the detail of the flow pattern over the tube, the colored plots of temperature, pressure and velocity of the flue gases which will be helpful to the maintenance engineer to know the process and knowing the critical areas and reasons of tube failure. Taking this view in consideration some objectives was set for the work on BTL.

2. RESEARCH GOALS AND APPROACH

The project work is to study the various reasons of tube failure and remedies over that. The scope of work is not limited but more stress is on following content.

1. Study of boiler tube failure problem, its causes and remedies.
2. To model and simulate the final super-heater using ANSYS-CFD.
3. To determine the velocity and temperature of the flue gases and water flowing inside tube.

3. BOILER TUBE LEAKAGES IN SUPERHEATER AND ADVANCED EROSION PROTECTION TECHNIQUES

The power plants are facing the problem of boiler tube leakage 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 lost in generation. The work field of cause and solution would be of great benefit to the utility industry.

Hence, study of causes and remedies are immensely important. The failure mechanism tube leakage consists of a physical failure appearance and its data base database, and suggested verification methods. The primary and secondary causes and remedies include experience base solution and suggested by the expert for a particular leakage.

Boiler tube failures continue to be the main problem of boiler power plants. 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 cause. Computational flow analysis of boiler will be the most effective method of determining the root cause of a failure. A tube failure is usually a symptom of other problems. In addition to evaluating the failure itself, you should investigate all aspects of boiler operation leading to the failure to fully understand the cause. In many cases, the field investigation can isolate the root because that leads to the tube failure.
Replacement such tubes, and process controls are best practice to avoid such failure.

Advanced Erosion Protection Techniques

1 Baffle Plates: In our observation it was found that the gap between boiler wall and the failed tube area was relatively less causing relatively high flue gas velocity in that zone. As

W = a Vn,

Where: W is the measured erosion wear rate in mg/ kg of erodent.

Thus the erosion rate increases with increase in flue gas velocity. So baffle plates can be provided in the low area zones to prevent the direct impact of the flue gases on the boiler tubes as shown in figure The flue gases will impinge on the baffles, which will reduce its velocity, and the tubes will wear less due to reduced velocity of flue gases.

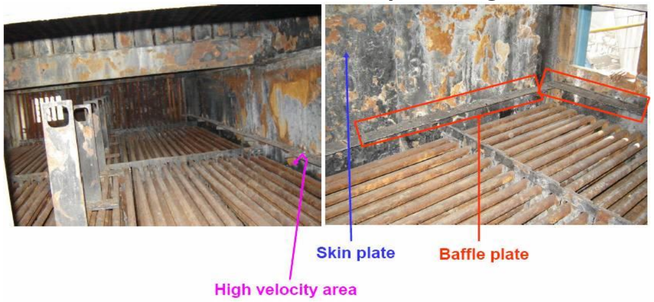

Figure 1: Baffle plates

Infiltration Brazed Tungsten Carbide Cladding

Infiltration brazed tungsten carbide cladding was tested for its high temperature erosion performance laboratory testing and the destructive evaluation of tubes indicates that the infiltration brazing of tungsten carbide cladding to boiler tubes, under high temperature and pressure, will not significantly alter the mechanical characteristics of the material. Hence out of various erosion prevention techniques, this will provide significant reduction in the risk of tube failures. Infiltration brazed tungsten carbide cladding overcomes the constraints of tube shields, spray coatings, and weld overlay materials.

Figure shows infiltration brazed tungsten carbide coating applied to the high erosion areas of superheater tube bends

Figure 2: Infiltration brazed 70% tungsten carbide coating applied to the high erosion areas of superheater tube bends

4. COMPUTATIONAL FLOW ANALYSIS OF BOILER

Simulation is to get a better understanding of how things work and, when dealing with large complex machines, it is the only possibility for understanding how their components interact. When a model describes reality in a correct manner it is possible to determine how a machine is going to operate in different configurations. It can be used for optimization of the machine, where trying all the possible configurations in practice is too expensive and time consuming.

Power generation units have to be controlled properly to ensure continuous energy production. The energy engineer has, due to economic and environmental demands during the last decades, had to focus on improving efficiency and reducing the problems associated with the power plant. A well-designed control system and trained operators are essential for reliable, safe and efficient operation of the plant. Simulators play an important role in achieving these objectives. Computer simulation is only one of the tools that may be applied in search for optimal solutions.

Simulator is a powerful tool used to train employees to operate power plants. A modern simulator consists of an operator interface, which is a replica of the control panel of the plant and a computer that runs mathematical models. Computer runs the simulation with inputs from the operator and displays the results of the simulation.

5. CFD ANALYSIS

CFD analysis of superheater can be useful to gain insight to the gas flow distribution. Efforts are made to measure the velocity distribution of flue gases which will be useful to find the effect of the operating parameter on the tube erosion rate and velocity distribution inside the superheater of 210 MW boiler. CFD has evolved as important tool for modeling of coal fired boiler and it can useful to quantify the gas flow field and temperature distribution with the boiler superheater. Hence CFD model of superheater was developed to study the velocity and temperature distribution of the steam inside the superheater. Thus this study is focused on simulating turbulent flow within the boiler superheater.

6. RESULTS

Result obtained with CFD model shows the variation of various parameter of superheater. The velocity and temperature of steam are increases from inlet to outlet and temperature of flue gases decreases from inlet to outlet. There is no critical zone found in CFD result. Result of CFD shows through various plots.

Temperature Plot for Steam: Figure shows the temperature variation in superheater tube section1 from inlet to outlet of superheater it shows inlet temperature of steam is 728 K it increases with length and finally at outlet of superheater tube section1 it gives 780 K. There is no critical zone found in CFD result. Figure shows the temperature variation in superheater tube section2 from inlet to outlet of superheater it shows inlet temperature of steam is 780 K it increases with length and finally at outlet of superheater tube section1 it gives 813 K.

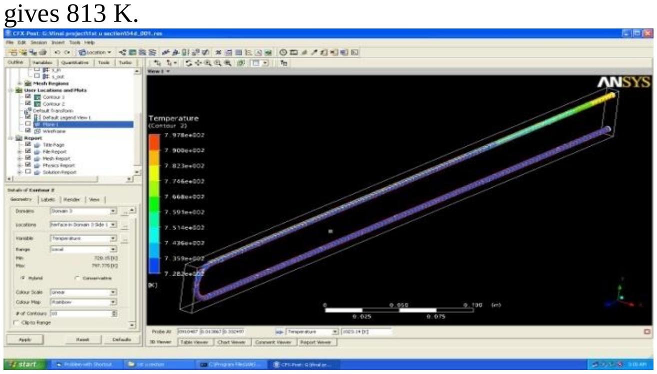

Figure 2: Temperature Plot for Steam of Superheater Section 1

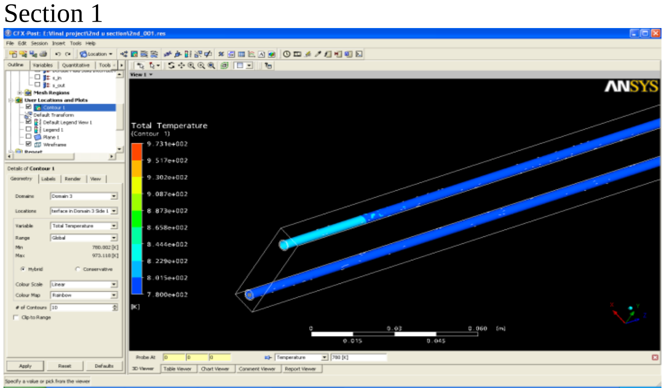

Figure 3: Temperature Plot for Steam of Superheater Section 1

VELOCITY PLOT: Figure shows the velocity plot for 1st U section of superheater tube in which velocity of steam increases from 101 m/s to 107 m/s from inlet to outlet of superheater tube. Figure shows the velocity plot for 2nd U section of superheater tube in which velocity of steam increases from 107 m/s to 112 m/s from inlet to outlet of superheater tube. Increase in velocity of steam takes place due change in molecular momentum of fluid particle of steam.

Figur shows the variation in velocity of flue gases in 1st U section and 2nd U section of superheater tube respectively. This shows decrease in velocity by dark blue colure. Velocity of flue gases decreases suddenly just above the tube surfaces because of obstacle of tube in flow.

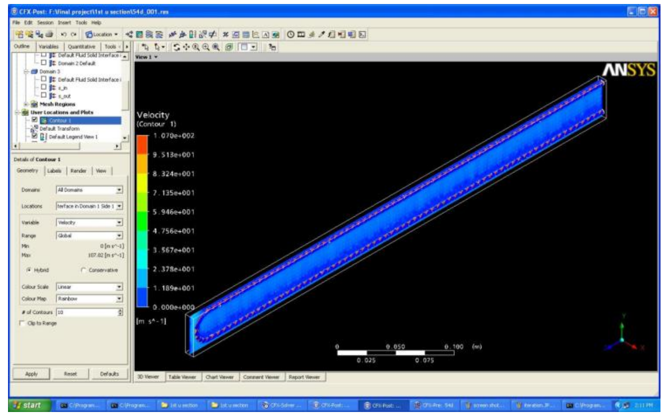

Figure 4: Velocity Plot for 1st U Section of Superheater

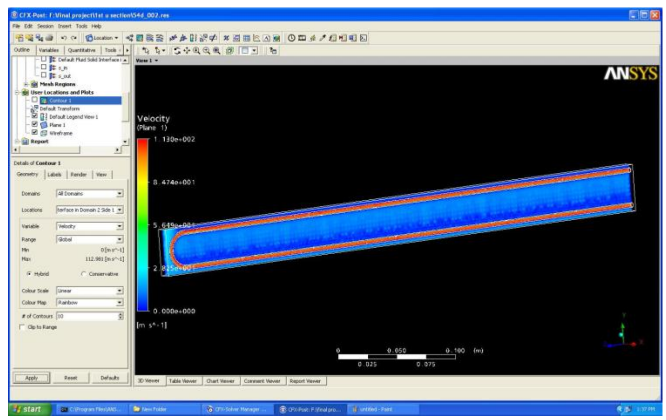

Figure 5: Velocity Plot for 2nd U Section of Superheater

7. CONCLUSION

1) ABOUT CFD

CFD is a very important tool for designing and analyzing the fluid related problems.
CFD tool tells us the behavior of flow pattern of fluids and different parameter like temperature, pressure, velocity variations at each node.

In this project, the temperature and velocity variations are shown along with the constant pressure.

2) ABOUT ANALYSIS

As per reference paper the critical zone was found at U – tube bend, hence rupture problem is more at U- bend which are due to tube temperature higher than design temperature and erosion of outer surface of tube.

But as per the analysis we had done in ANSYS ICEM CFD there are no critical zone found on the tube , this is because of following limitation.

Geometry is created for the scale of 1:100.

Because of computational limitations.

Formation of two U – section from coil.

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