Computational Fluid Flow Analysis Of Water Tube Boiler

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Abstract: In this project we design gas boiler as a water tube where the number of tubes have been increased for analysis purpose and with improving the gas firing efficiency in boiler. For designing we use SOLID WORK SIMULATION the boiler shell and for the analysis we are using CFD.

KEYWORDS: **CFD, Solid Works, Boiler**

INTRODUCTION:

The world energy consumption has doubled in the last thirty years and it keeps on increasing with about 1,5 % per year. While the earth's oil and gas reserves are expected to deplete after roughly one hundred years, the coal reserves will last for almost five hundred years into the future. In Finland, 50 % of the electrical power produced, is produced in steam power plants. But there are more reasons to why electricity generation based on steam power plant will continue to grow and why there still will be a demand for steam boilers in the future:

- The cost of the produced electricity is low
- The technology has been used for many decades and is reliable and available
- Wind and solar power are still expensive compared to steam power
- The environmental impact of coal powered steam plants have under the past decade been Heavily diminished thanks to improved SOx and NOx reduction technology
- The paper industry uses steam boilers as a vital utility to recycle chemicals and derive electricity from black liquor (pulping waste)
- Waste and bio-fuels can effectively be combusted in a boiler

WATER TUBE BOILER

Water tube boilers, the water is inside the tubes and the hot gases surround them. Examples Babcock and Wilcox, Stirling.

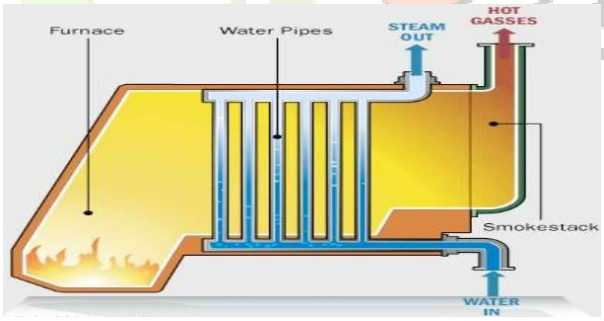

Fig:1 Water Tube Boiler

Burners and Layout

Another Benefit From Pulverizing Coal Before Combustion Is That The Coal Air Mixture Can Be Fed To The Boiler Through Jet Burners, As In Oil And Gas Boilers. A Finer Particle Is Faster Combusted And Thus The Combustion Is More Complete The Finer The Coal Is Pulverized And Formation Of Soot And Carbon Monoxides In The Flue Gas Is Also Reduced. The Size Of A Coal Grain After The Coal Grinder Is Less Than 150 Mm.

Two Broadly Different Boiler Layouts Are Used. One Is The Traditional Two-Pass Layout Where There Is A Furnace Chamber, Topped By Some Heat Transfer Tubing To Reduce The FEGT. The Flue Gases Then Turn Through 180°, And Pass Downwards Through The Main Heat Transfer

And Economizer Sections. The Other Design Is To Use A Tower Boiler, Where Virtually All The Heat Transfer Sections Are Mounted Vertically Above Each Other, Over The Combustion Chamber.

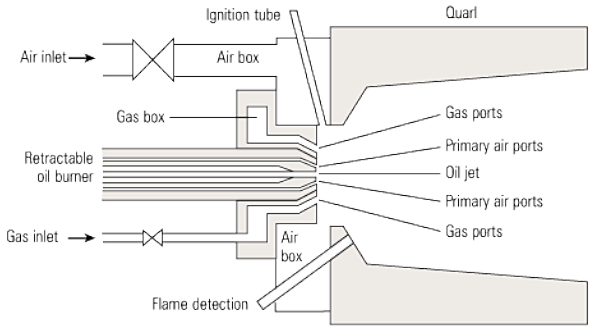

Fig:2 Burner parts

INPUT DATA OF THE BOILER BURNER

Heating chamber: 158.75cm length, 57.5cm dia, 2.54cm thickness

Water tubes: dia 3.81cm, 0.64cm thick

Analysis data:

Fluids used: air , water

Inlet mass flow rate of water: 0.01kg/s

Outlet at atmospheric conditions

Generated steam temperature: Minimum 200 deg

Heating chamber placed in atmospheric conditions

Fire input(air): at temperature 300 deg

Mass flow rate taken to fire: 0.2 kg/s , 0.5kg/s, 1kg/s

SOLIDWORKS

Solid Works is mechanical design automation software that takes advantage of the familiar Microsoft Windows graphical user interface.

It is an easy-to-learn tool which makes it possible for mechanical designers to quickly sketch ideas, experiment with features and dimensions, and produce models and detailed drawings.

3-D MODELING OF BOILER BURNER BY USING SOLID WORKS

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ASSEMBLY OF BOILER:

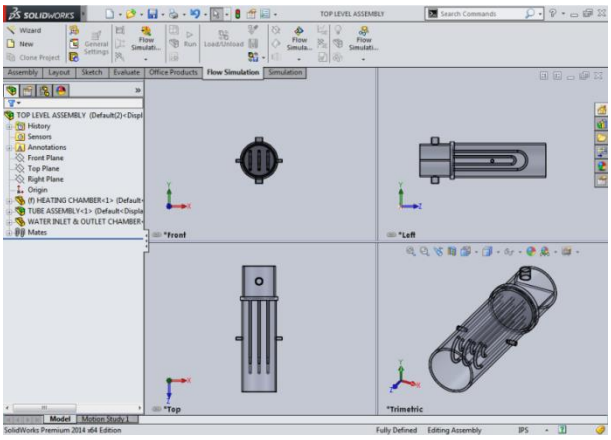

Fig:3 Different views of Boiler Burner

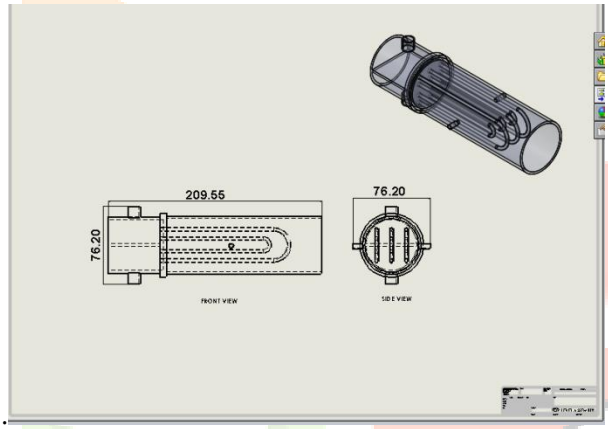

Fig:4 Drawing of a Assembly of a Boiler

INTRODUCTION TO FLOW SIMULATION

CFD ANALYSIS OF BOILER BURNER AT 0.25 KG / SEC

- **Creating lids for fluid volume is the first step in CFD Analysis.**
- **Then showing fluid volume or fluid flow**

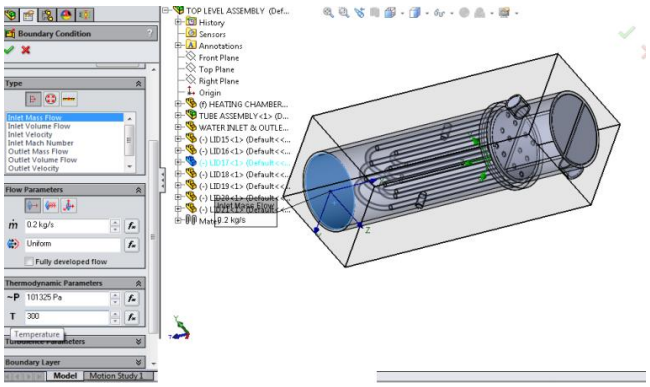

Figure:5 Inlet mass flow of fuel of 0.2kg/sec

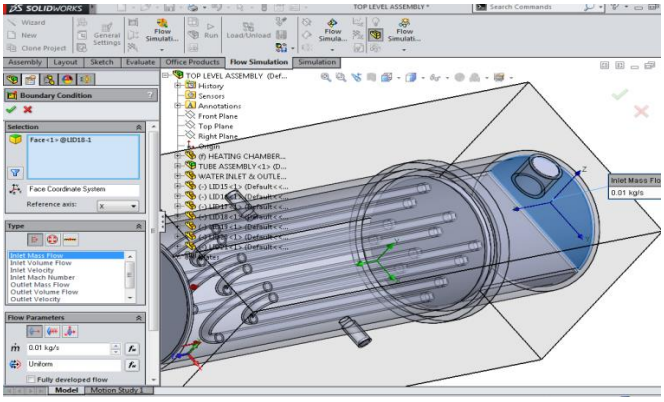

Figure:6 Inlet mass flow of water of 0.01kg/sec

After running the analysis the results are as follows:

TEMPERATURE: In the below figure, the temperature 0.2 kg/s of fire the min temp obtained at outlet is 92deg.

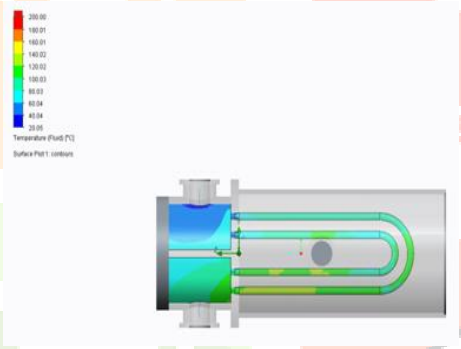

Fig:7 CFD Analysis of Boiler Burner at 0.2kg/Sec

TEMPERATURE: 0.5kg/s of fire the min temp obtained at outlet is 115 deg.

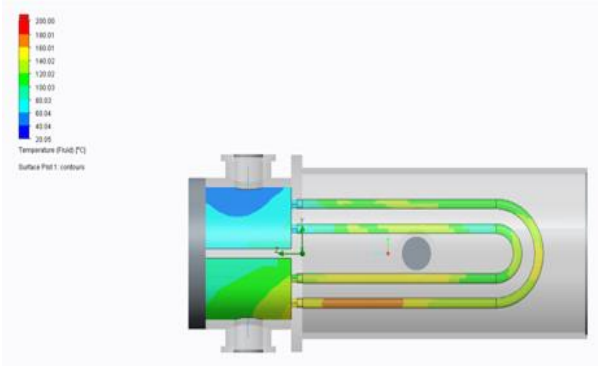

Fig:8 CFD Analysis of Boiler Burner at 0.5kg/Sec

CFD ANALYSIS TABLES & GRAPHS OF BOILER BURNER AT 1KG/SEC

TEMPERATURE: 1kg/s of fire the min temp obtained at outlet is 230 deg.

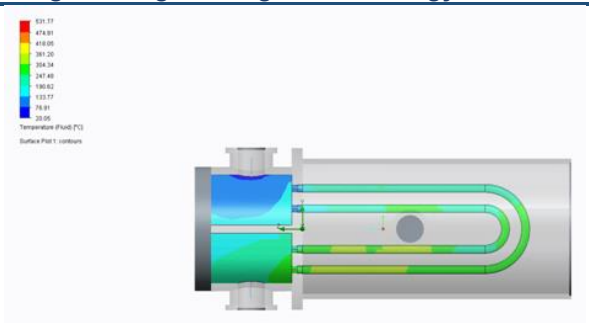

Fig:9 CFD Analysis of Boiler Burner at 1kg/Sec

CONCLUSION:

The main aim of this project is to obtain a super saturated steam at minimum 200 deg centigrade, what amount of fire is to be maintained in boiler burner. Here we took 3 mass flow rate of fire 0.2 kg/s, 0.5 kg/s, 1.0 kg/s

at 0.2 kg/s of fire the min temp obtained at outlet is 92deg

at 0.5kg/s of fire the min temp obtained at outlet is 115 deg

at 1kg/s of fire the min temp obtained at outlet is 230 deg

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