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COMPARISION OF THERMAL CHARACTERISTICS OF A SUPERCRITICAL CFB BOILER WITH SIMPLE BOILER

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Abstract:

Supercritical Circulating Fluidized Bed (CFB) boiler is becomes an important development trendsetter for coal-fired power plant. In this Paper, a simple boiler and a CFB boiler are compared for the better heat transfer performance. The 3D modeling of simple boiler and CFB boiler is done in Pro/Engineer and Heat transfer analysis is done in Ansys cfd. The material used for boiler is steel. Also In this Paper, it is to be replaced with copper and brass. Thermal analysis is done to verify the better heat transfer rate by comparing simple and CFB boilers and better material.

Key words: CFB Boiler, Heat flux, Temperature, Steel, Copper, Brass, Thermal Analysis etc.

1. INTRODUCTION:

Supercritical Circulating Fluidized Bed (CFB) boiler becomes an important development trend for coal-fired power plant and thermal hydraulic analysis is a key factor for the design and operation of water wall. According to the boiler structure and furnace-sided heat flux, the water wall system of a supercritical CFB boiler is treated in this thesis as a flow network consisting of series-parallel loops, pressure grids and connecting tubes. A boiler is a closed vessel in which water or other fluid is heated. The fluid does not necessarily boil. The heated or vaporized fluid exits the boiler for use in various processes or heating applications, including central heating, boiler based power generation, cooking, and sanitation.

LITERATURE SURVEY

It is regarded as the best commercial option in large-scale utilization of low-quality fuel, circulating fluidized bed (CFB) boiler technology has been widely used in the world, due to its good fuel flexibility and low-cost emission control capability [1–4].

Increasing the boiler capacity and the steam parameters are two effective methods to improve the power generation efficiency of CFB boiler units. Engineers and researchers have made considerable progress in developing the large scale CFB boiler technology during last two decades, especially for the supercritical one. In 2013, the world's largest 600 MW supercritical CFB boiler developed by Chinese domestic technology successfully passed 168 h full load test and turned into commercial operation. The boiler operation data is in good agreement with the design values [5]. By 2018, over 22 units of 350 MW supercritical CFB boilers (manufactured by Dong fang Boiler Company, Shanghai Boiler Company and Harbin Boiler Company) have been put into commercial operations in worldwide [6].

Recently, with the support of the National 13th Five years Science and Technology Plan Project, Harbin Boiler Company limited has begun to develop the 660 MW ultra-supercritical CFB boiler. The thermal-hydraulic performance of the evaporator system needs deep concern in the design of a large-scale once-through coal fired boiler for safety issues. The extensive works analyzing the thermal-hydraulic performance of the evaporator system for supercritical and ultra-supercritical pulverized coal boiler with different burner arrangements [7-9] showed that either the spiral water wall with smooth tubes and high mass flux design or the vertical water wall with internal-ribs tubes and low mass flux design can satisfy the safety requirements.

2. THERMAL ANALYSIS OF CFB BOILER USING CFD:

CFD provides a qualitative (and sometimes even quantitative) prediction of fluid flows by means of:

a) mathematical modeling (partial differential equations)

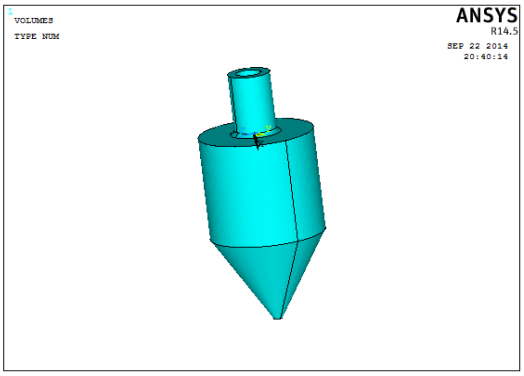
b) numerical methods (discretization and solution techniques)

c) software tools (solvers, pre- and post processing utilities)

In this chapter, thermal analysis of different materials like steel, brass and copper performed.

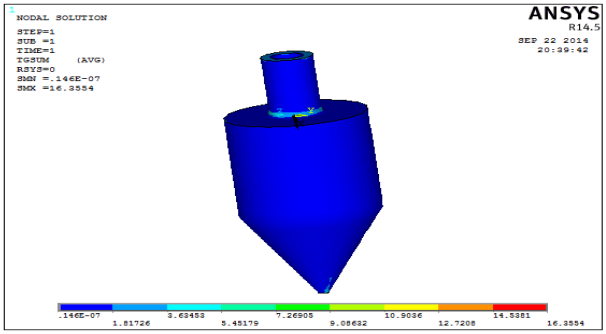
MATERIAL – STEEL

File>import>open file
Imported model



Preferences>thermal>ok
Preprocessor>element type>add/edit/delete>add>solid>20node90>ok
Material properties>material models

THERMAL GRADIENT



3. CFD ANALYSIS OF CFB BOILER:

This chapter carried out different velocities for CFB Boiler like 4m/s, 5m/s & 6m/s.

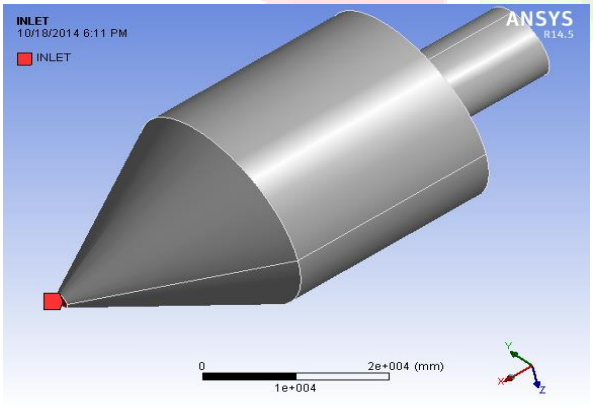
Here showing for velocity 4 m/s.

Inlet velocity – 4m/s

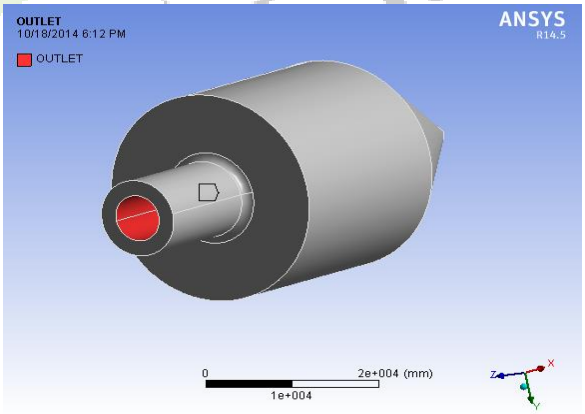
→→Ansys → Workbench→ Select analysis system → Fluid Flow (Fluent) → double click

→→Select geometry → right click → import geometry → select browse →open part → ok

Inlet



Outlet



3.1.Specifying boundaries for inlet and outlet:

Contours

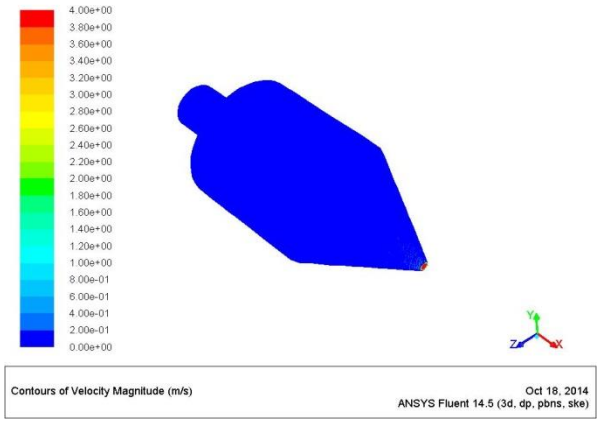


Fig: Velocity Magnitude

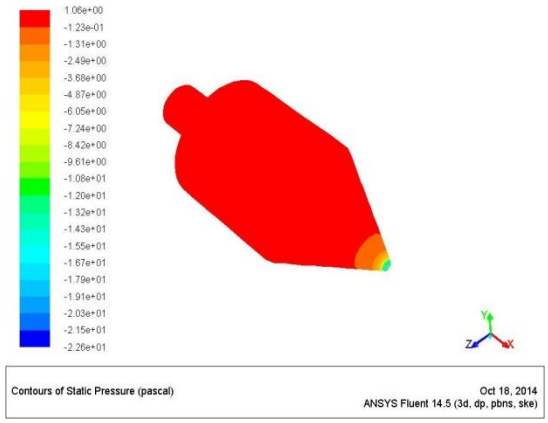


Fig:Static Pressure

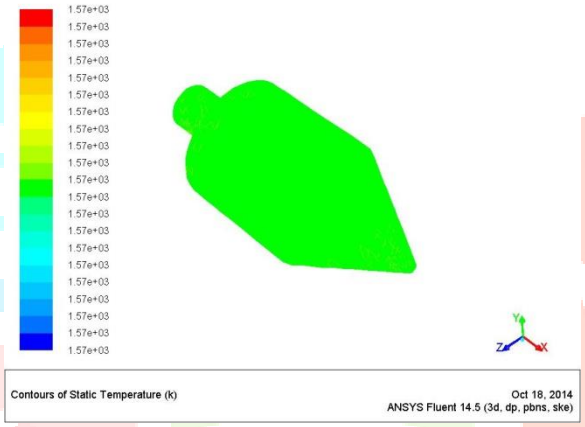


Fig: Temperature

3.2 Mass flow rate

"Flux Report"

Mass Flow Rate	(kg/s)
Inlet	39.813224
Interior-____msbr	928.74986
Outlet	-40.278172
Wall-____msbr	0
Net	-0.46494834

4. RESULTS:

4.1 Simple Boiler Thermal Characteristics

MATERIAL	STEEL	COPPER	BRASS
NODAL TEMPERATURE(K)	1123	1123	1123
THERMAL GRADIENT(K/mm)	22.0208	21.1724	21.8559
HEAT FLUX (W/mm^2)	1.10104	8.25724	2.40415

4.2 CFB Boiler Thermal Characteristics

MATERIAL	STEEL	COPPER	BRASS
NODAL TEMPERATURE(K)	1573	1573	1573
THERMAL GRADIENT(K/mm)	16.3554	15.9157	16.2347
HEAT FLUX(W/mm^2)	1.47198	9.23111	3.57164

4.3 Comparison of Thermal Characteristics:

	Inlet Velocity (m/s)	Results			
		Outlet Velocity(m/s)	Pressure(Pa)	Temperature(K)	Mass flow rate (Kg/s)
Simple boiler	4m/s	$2.067e^{+02}$	$1.36e^{+07}$	$1.12e^{+03}$	69.938379
	5m/s	$3.34e^{+02}$	$2.12e^{+07}$	$1.12e^{+03}$	87.881665
	6m/s	$4.01e^{+02}$	$3.05e^{+07}$	$1.12e^{+03}$	104.25339
CFB boiler	4m/s	$4.00e^{+00}$	$1.06e^{+00}$	$1.57e^{+03}$	0.46494834
	5m/s	$5.00e^{+00}$	$1.65e^{+00}$	$1.57e^{+03}$	0.42116011
	6m/s	$6.00e^{+00}$	$2.36e^{+00}$	$1.57e^{+03}$	0.48990058

CONCLUSION:

In this thesis, a simple boiler and a CFB boiler are compared as per thermal characteristics for the better heat transfer performance. The 3D modeling of simple boiler and CFB boiler is done in Pro/Engineer and Heat transfer analysis is done in Ansys. The material used for boiler is steel. In this paper, it is to be replaced with copper and brass. Thermal analysis is done to verify the better heat transfer rate by comparing simple and CFB boiler and better material.

By observing the thermal characteristics results, by using CFB boiler, heat transfer rate is increased since thermal flux is more than that of simple boiler. By comparing the materials, using copper is better since thermal flux is more.So, it can be concluded that using CFB boilers yields better results than simple boilers.

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