DESIGN AND ANALYSIS OF CIRCULATING FLUIDIZED BED (CFB) BOILER AT DIIFFERENT NANOFLUIDS

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ABSTRACT: The circulating fluidized bed (CFB) boiler is a member of the fluidized bed boiler family. It has gained popularity, especially in the electric power-generation market, for its several practical advantages, such as efficient operation and minimum effect on the environment.

Heavy industrialization & modernization of society demands in increasing of power cause to research & develop new technology & efficient utilization of existing power units. Variety of sources are available for power generation such as conventional sources like thermal, hydro, nuclear and renewable sources like wind, tidal, biomass, geothermal & solar.

In this thesis the CFBC boiler designed in CREO parametric software and analysis in ANSYS software at different temperatures (8500C & 9500C), velocities (6 & 10m/s) and NANO fluids (water as a base fluid) and NANO fluid al2o3 at volume fractions 0.2, 0.4.

In this project CFD analysis to determine mass flow rate , heat transfer rate, pressure drop and velocity at different velocities and different temperatures. Temperature analysis to determine the temperature distribution and heat flux at different materials.

INTRODUCTION

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 water heating, central heating, boiler-based power generation, cooking, and sanitation.

'Getting rid of waste' was the ultimate goal when the fluidized bed combustion (FBC) technology was introduced This goal evolved over time to 'clean energy for the future'. Since its introduction in the 1970s the technology has gained acceptance in various industrial applications. FBC is a combustion technology used in power plants. FBC is known for its ability to burn low-grade fuels with low calorific value, high ash content and high moisture content. Fluidized beds suspend solid fuels on upward-blowing jets of air during the combustion process. The result is a turbulent mixing of gas and solids. When a fluidized bed is operated above the terminal velocity of the particles, they are carried out of the bed. The system of a circulating fluidized bed (CFB) occurs when the particles are separated from the fluid by the use of cyclones and are recycled to the bed. The part of the system where the carryover of solids transpires is normally referred to as the riser. It is known for its ability to burn low-grade fuels with low calorific value, high ash content and high moisture content. The fluidization process begins when a bed of inert material (usually sand), which is a solid granular particle, is suspended by a flow of air or gas (air). This flow is injected into the combustion chamber from the bottom and from the side. FBC boilers can burn fuels other than coal, and the lower temperatures of combustion (800 °C / 1500 °F) have other added benefits as well.

BOILER TYPES AND CLASSIFICATIONS:

There are two general types of boilers: "fire-tube" and "water-tube". Boilers are classified as "high-pressure" or "low-pressure" and "steam boiler" or "hot water boiler." Boilers that operate higher than 15 psig are called "high-pressure" boilers.A hot water boiler, strictly speaking, is not a boiler. It is a fuel-fired hot water heater. Because of its similarities in many ways to a steam boiler, the term "hot water boiler" is used.•Hotwater boilers that have temperatures above 250° Fahrenheit or pressures higher than 160 psig are called "high temperature hot water boilers".•Hotwater boilers that have temperatures not exceeding 250° Fahrenheit or pressures not exceeding 160 psig are called "low temperature hot water boiler"s.Heating boilers are also classified as to the method of manufacture, i.e., by casting (cast iron boilers) or fabrication (steel boilers). Those that are cast usually use iron, bronze, or brass in their construction. Those that are fabricated use steel, copper, or brass, with steel being the most common material.

Circulating Fluidized Bed combustion has given boiler and power plant operators a greater flexibility in burning a wide range of coal and other fuels. All this without compromising efficiency and with reduced pollution. How does the boiler work with this technology?In the olden days blacksmiths used to heat the iron by placing it on a bed of coal. Bellows provide air to the coal from the bottom of the bed. Fluidized Bed combustion is something similar to this.

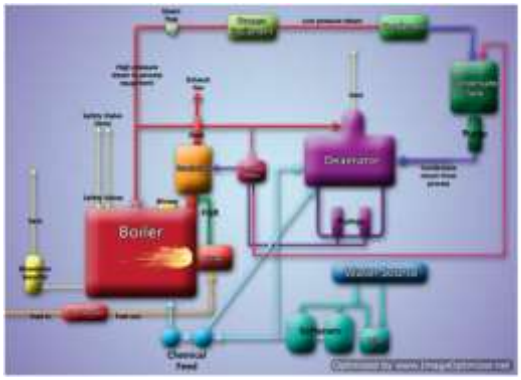
Fluidized Bed

At the bottom of the boiler furnace there is a bed of inert material. Bed is where the coal or fuel spreads. Air supply is

from under the bed at high pressure. This lifts the bed material and the coal particles and keeps it in suspension. The coal combustion takes place in this suspended condition. This is the Fluidized bed.

WORKING PRINCIPLE OF CFBC BOILER:

Cfbc stand for circo fluidized bed combustion. Here ash leaving with flue gas is recirculated to combustion zone. This ash reduces combustion temperature. Due to recirculating ash unburnt carbon get burnt. Cfbc boilers are advantageous particularly for Indian coal which has high percentage of ash. Cfbc boilers can give unburnt coal percentage as low as .5 %. Ash with low unburnt can be used in cement kiln.Circulating Fluidized Bed combustion has given boiler and power plant operators a greater flexibility in burning a wide range of coal and other fuels. All this without compromising efficiency and with reduced pollution. In the olden days blacksmiths used to heat the iron by placing it on a bed of coal. Bellows provide air to the coal from the bottom of the bed. Fluidized Bed combustion is something similar to this.



LITERATURE REVIEW

Simulation On CFBC Boiler

Heavy industrialization & modernization of society demands in increasing of power cause to research & develop new technology & efficient utilization of existing power units. Variety of sources are available for power generation such as conventional sources like thermal, hydro, nuclear and renewable sources like wind, tidal, biomass, geothermal & solar. Out of these most common & economical way for producing the power, is by thermal power stations. Various industrial boilers plays an important role to complete the power generation cycle such as CFBC (Circulating Fluidized Bed Combustion), FBC (Fluidized Bed Combustion), AFBC (Atmospheric Fluidized Bed Combustion Boiler), CO Boiler, RG & WHR Boiler (Waster heat recovery Boiler). This paper is intended to comprehensively give an account of knowledge related to refractory & its failure in CFBC boiler with due effect of flue gas flow during operation on refractory by using latest technology of CAD (Computer aided Design) & CAE (Computer aided Engineering). By conceptual application of these technology the full scale model is able to analyze in regards the flow of flue gas & bed material flow inside the CFBC loop via CFD (Computational Fluid Dynamics) software. The results obtained are helpful to understand the impact of gas & particles on refractory in different areas & also helped to choose suitable refractory material in different regions.

INTRODUCTION TO CAD

Computer-aided layout (CAD) is the usage of pc systems (or workstations) to resource in the introduction, change, analysis, or optimization of a design. CAD software program is used to growth the productivity of the fashion designer, improve the best of design, improve communications thru documentation, and to create a database for production. CAD output is often within the form of digital files for print, machining, or different manufacturing operations. The time period CADD (for Computer Aided Design and Drafting) is likewise used.

INTRODUCTION TO CREO

PTC CREO, previously called Pro/ENGINEER, is 3D modeling software used in mechanical engineering, layout, production, and in CAD drafting service companies. It became one of the first three-D CAD modeling programs that used a rule-based totally parametric machine. Using parameters, dimensions and features to seize the conduct of the product, it could optimize the improvement product in addition to the layout itself.

INTRODUCTION TO FEA

Finite element analysis is a method of solving, usually approximately, certain problems in engineering and science. It is used mainly for problems for which no exact solution, expressible in some mathematical form, is available. As such, it is a numerical rather than an analytical method. Methods of this type are needed because analytical methods cannot cope with the real, complicated problems that are met with in engineering. For example, engineering strength

of materials or the mathematical theory of elasticity can be used to calculate analytically the stresses and strains in a bent beam, but neither will be very successful in finding out what is happening in part of a car suspension system during cornering.

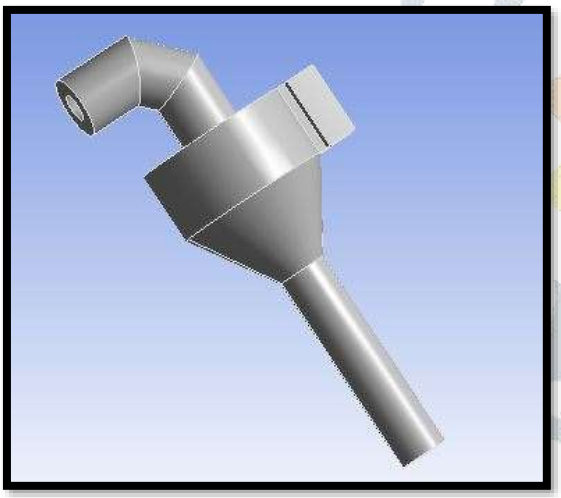
NANO FLUID PROPERTIES

FLUID	Volume fraction	Thermal conductivity (w/m-k)	Specific heat (J/kg-k)	Density (kg/m^3)	Viscosity (kg/m-s)
ALUMINUM OXIDE	0.2	2.647	1809	2150.92	0.002006
	0.4	4.17	1570.9	2439.1	0.002256

RESULTS AND DISCUSSION

CFD ANALYSIS OF CFBC BOILER

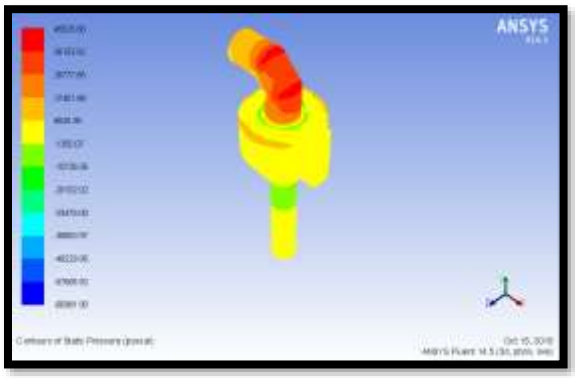
Imported model



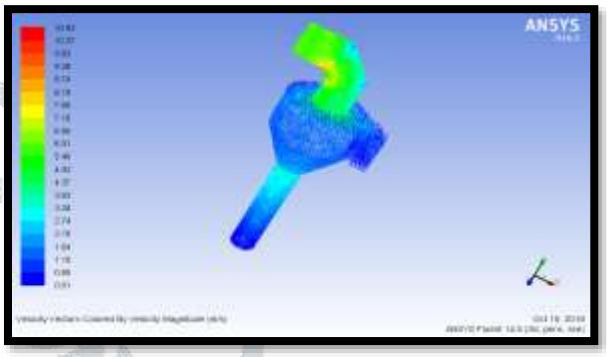
Velocity – 6m/s

NANO fluid AL_2O_3 volume fraction 0.2 Temperature 850^{0}C

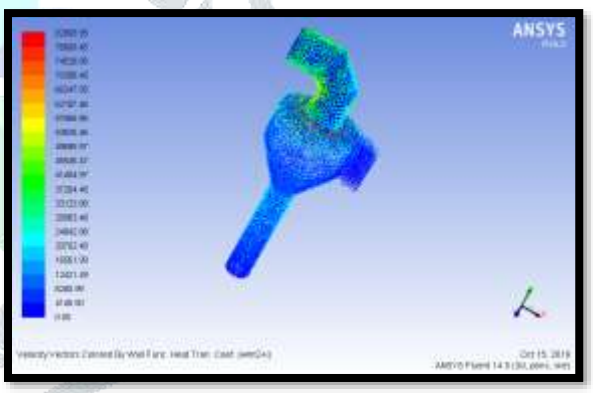
Pressure



Velocity



Heat transfer coefficient

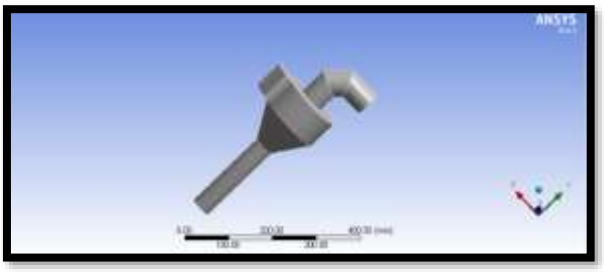


Heat transfer rate

Total Heat Transfer Rate	(w)
inlet	42573308
wall-___msbr	0
zone0utlet	0
Net	42573308

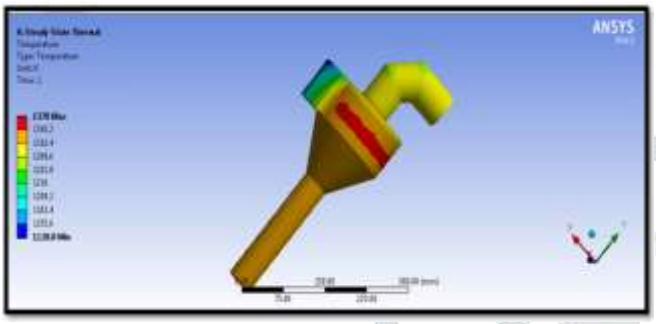
THERMAL ANALYSIS OF CFBC BOILER

Imported model

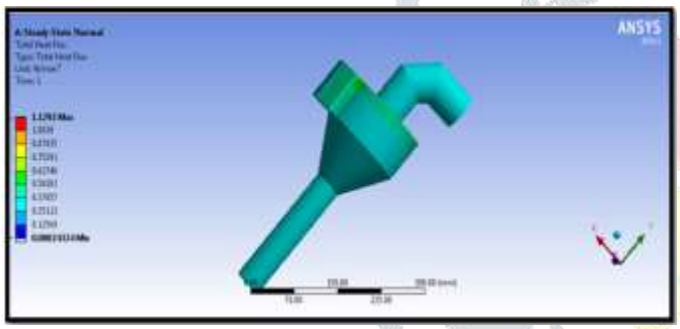


MATERIAL- BRASS

Temperature



Heat flux



Results table

Velocity (m/s)	Temperature (°C)	Volume fractions	Pressure (Pa)	Velocity (m/s)	Heat transfer coefficient(w/m2-k)	Eat transfer rate(W)
6	850	0.2	45529.80	10.92	82809.95	42573308
		0.4	63138.00	11.41	109038.86	41923040
	950	0.2	55253.63	1140	85993.66	47734656
		0.4	63138.03	11.42	109038.87	47005568
10	850	0.2	154182.0781	10.0969	118594.9688	70955512
		0.4	175392.8125	19.0751	129230.6797	69871736
	950	0.2	187194.500	20.9449	109691.0156	87513568
		0.4	211936.0	21.0095	128618.2734	86176816

CONCLUSION

In this thesis, The coal combustion in circulating fluidized bed Combustion and the k–ϵ two-phase turbulence model was used to describe the gas–solids flow in a CFBC. The analysis of coal combustion is done by discrete phase model (DPM) and non pre mixed combustion in species model .Predicting the performance of large scale circulating fluidized bed boilers requires reliable and efficient modelling tools. In a CFB furnace, the fuel, air, and other input materials are fed locally and the mixing of different reactants is limited.

By observing the CFD analysis the heat transfer coefficient, pressure drop values are increasing by increasing the inlet velocities. And the heat transfer rate & mass flow rate values are more at volume fraction 0.4, inlet velocity 10m/s and 9500C.

So it can be concluded the aluminium oxide NANO fluid at volume fraction 0.4 is the better fluid for CFBC BOILER.

By observing the thermal analysis the heat flux values are more for brass material.

So it can be concluded the brass material is better material for CFBC boiler.

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