2581-4575

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DESIGN AND THERMAL ANALYSIS OF STEAM BOILER USED IN POWER PLANTS

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ABSTRACT

Steam boiler is a closed vessel in which water or other fluid is heated under pressure and the steam released out by the boiler is used for various heating applications. The main considerations in the design of a boiler for a particular application are Thermal design and analysis, Design for manufacture, physical size and cost.In this Project the Steam flow in steam Boiler (Without Baffles & With Baffles) is Modeled using CREO Parametric design Software. The Project Will Focus on Thermal and CFD Analysis with Different inlet Velocities (20, 30, 40& 50m/s). In this Project the CFD Analysis to Determine the Heat Transfer coefficient, Heat Transfer Rate, Mass Flow Rate, Pressure Drop.Thermal Analysis is to determine the Temperature Distribution, Heat Flux for both models steam boiler without baffles and steam boiler with baffles. Finding which model is best one.3D Modeled In Parametric Software CREO and Analysis Done In ANSYS.

Software's used: ANSYS, CREO, And Thermal Analysis

1. INTRODUCTION

Boilers Are Pressure Vessels Designed to Heat water or Produce Steam, Which can then be used to provide Space Heating and/or Service Water Heating to a Building. In Most commercial Building heating applications, the Heating source in the Boiler is a Natural gas Fired Burner. Oil Fired Burners and Electric Resistance Heaters can be used as well. Steam is preferred over hot water in some applications, including Absorption Cooling, Kitchens, Laundries, Sterilizers, and Steam Driven Equipment.

Boilers Have Several Strengths that have Made Them a Common Feature of Buildings. They have a long Life, can Achieve Efficiencies up to 95% or Greater, Provide an Effective Method of Heating a Building, and in the case of Steam Systems, Require Little or no Pumping Energy. However, Fuel Costs can be Considerable, Regular Maintenance is Required, and if Maintenance is Delayed, Repair can be Costly.

Guidance for the Construction, Operation, and Maintenance of Boilers in Produces the Following Resources:

- Rules for Construction of Heating Boilers, Boiler and Pressure Vessel Code, Section IV-2007
- Recommended Rules for the Care and Operation of Heating Boilers, Boiler

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and Pressure Vessel Code, Section VII-2007

Boilers are often one of The Largest Energy Users in a Building. For Every Year a Boiler System Goes Unattended, Boiler Costs Can Increase Approximately 10% (1). Boiler Operation and Maintenance is therefore a Good Place to Start When Looking for More Ways to Reduce Energy Use and Save Money.

1.1. Steam Boiler

Steam Boilers Heat Water to Produce Steam, Which is then used to Generate Energy or Heat for Other Processes.

Fig 1 .Steam boiler

Boilers Are Used To Generate Steam that then Provides Heat or Power. Water Is Converted to Steam In the Boiler. This Steam Travels Through the Heating Apparatus Which Can Be Any Piece of Equipment That Requires Steam for Operation. The Cooled Steam Is Then Condensed Into Water and Returns to the Boiler to Start the Cycle Again.

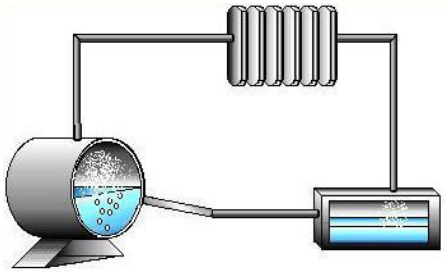

Fig 2.Boiler Diagram

1.2. Problem Description:

The Objective of This Project Is to make A 3D Model of The Steam Boiler and Study the CFD and Thermal Performance of the Steam Boiler by Performing the Finite Element Analysis.3D Modeling Software (PRO-Engineer) Was used for Designing and Analysis Software (ANSYS) Was used for CFD and Thermal Analysis.

The Methodology Followed in the Project is as Follows:

- Create a 3D Model of the Steam Boiler Assembly Using Parametric Software Pro-Engineer.
- Convert the Surface Model into Para Solid File and Import the Model into ANSYS to do Analysis.
- Perform Thermal Analysis on the Steam Boiler Assembly for Thermal Loads.
- Perform CFD Analysis on the Existing Model of the Surface Steam Boiler for Velocity inlet to find out the Mass Flow Rate, Heat Transfer Rate, and Pressure Drop.

2. MODELLING OF STEAM BOILER

2.1. Models of steam boiler using CREO

The Steam Boiler is modeled using the Given Specifications and Design Formula from Data Book. The Isometric View of Steam Boiler is shown in below figure. The Steam Boiler Outer Casing Body Profile is sketched in Sketcher and then it is revolved up to 360^0 Angle Using Revolve Option and Tubes are designed and assemble to in Steam Boiler using extrude option.

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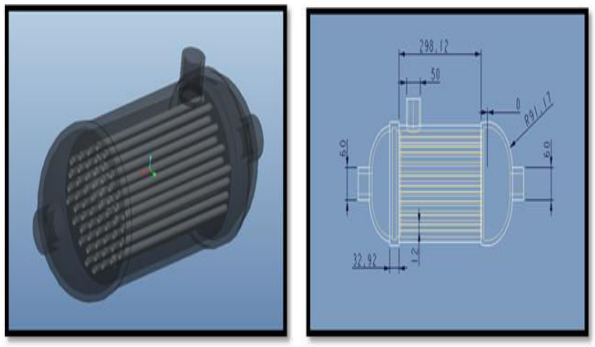

Fig 3. 2D and 3D Model of Steam Boiler

2.2. Thermal Analysis of Steam Boiler

Open work bench 14.5>select **steady state thermal** in analysis systems>select geometry>right click on the geometry>import geometry>select **IGES** file>open

Used Materials steel, Copper, Brass & Stainless Steel

Copper Material for Tube

Steel, Brass & Stainless Steel for Boiler Casing

Copper Material Properties

Thermal Conductivity = 385w/m-k

Specific Heat = 0.385j/g^{0}C

Density = 0.00000776kg/mm^3

Steel Material Properties

Thermal Conductivity = 93.0w/m-k

Specific Heat = 0.669j/g^{0}C

Density = 0.0000075kg/mm^3

Stainless Steel Material Properties

Thermal Conductivity = 34.3w/m-k

Specific Heat = 0.620j/g^{0}C

Density = 0.00000901kg/mm^3

Brass Material Properties

Thermal Conductivity = 233w/m-k

Specific Heat = 0.380j/g^{0}C

Density = 0.00000760kg/mm^3

2.3. Thermal Analysis of Steam Boiler without Baffle

Tube Materials Copper & Shell Material Steel

Copper Thermal Conductivity- 385w/m-k

Steel Thermal Conductivity – 93.0w/m-k

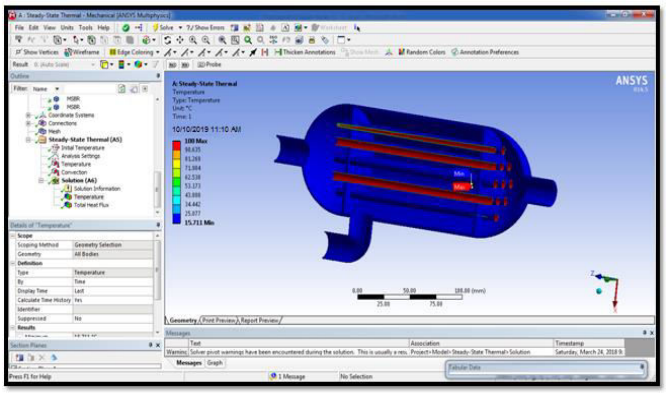

Fig4. Temperature Distribution

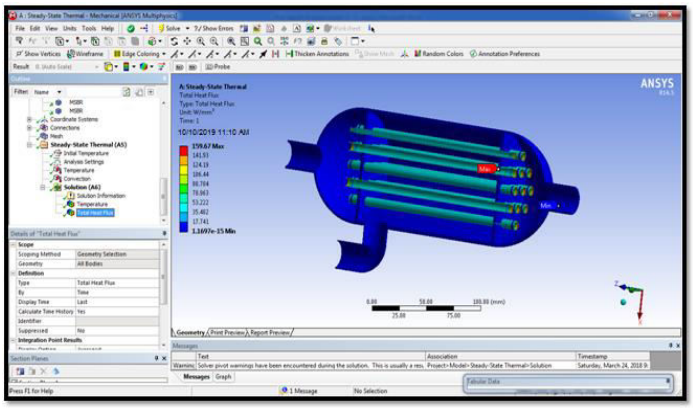

Fig5 .Heat flux

2.4. Thermal Analysis of Steam Boiler with Baffle

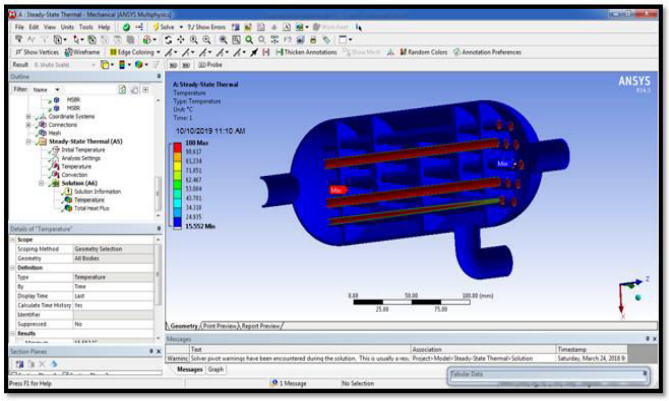

Fig6.Temparture Distribution

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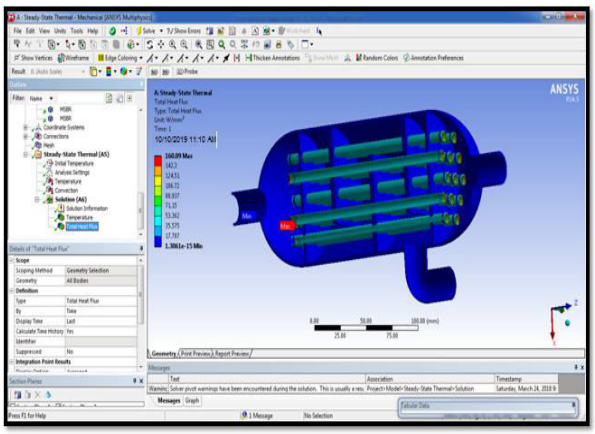

Fig7.Heat flux

3. RESULTS AND DISCUSSION

CFD ANALYSIS RESULT TABLE

Velocity (M/S)	Pressure(Pa)	Velocity (M/S)	Heat Transfer Co-Efficient (w/m^2-k)	Mass Flow Rate (Kg/S)	Heat Transfer Rate(W)
20	4.75e+02	3.93e+01	1.13e+02	0.0024671704	346.75195
30	1.07e+03	5.89e+01	1.50e+02	0.0030812621	433.06641
40	1.86e+03	7.90e+01	1.84e+02	0.0060493946	850.35938
50	2.90e+03	9.82e+01	2.15e+02	0.0077654123	1091.5234

Table 1 .Steam boiler without baffles

Velocity (M/S)	Pressure(Pa)	Velocity (M/S)	Heat Transfer Co-Efficient (W/M^2-K)	Mass Flow Rate (kg/s)	Heat Transfer Rate(W)
20	4.53e+02	3.86e+01	1.12e+02	0.0034194887	480.56836
30	1.08e+03	5.87e+01	1.47e+02	0.0051520169	724.10156
40	1.82e+03	7.80e+01	1.80e+02	0.0066094995	928.91406
50	3.00e+03	9.82e+01	2.28e+02	0.0089534521	1258.6406

Table 2 .Steam boiler with baffles

Table 3.Thermal analysis result

Without Baffles	Temperature(^{0}C)	Max.	100
		Min.	15.711
	Heat Flux(w/mm^2)		159.67
With Baffles	Temperature(^{0}C)	Max.	100
		Min.	15.552
	Heat Flux(w/mm^2)		160.09

GRAPHS

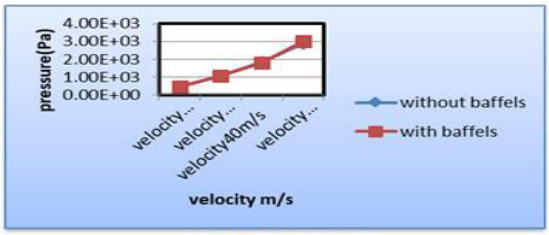

Fig8 .Pressure Plot

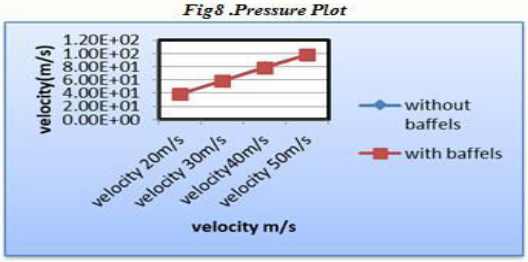

Fig9. Velocity Plot

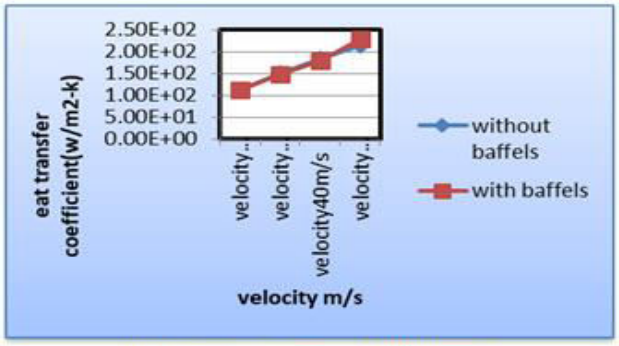

Fig10. Heat Transfer Coefficient Plot

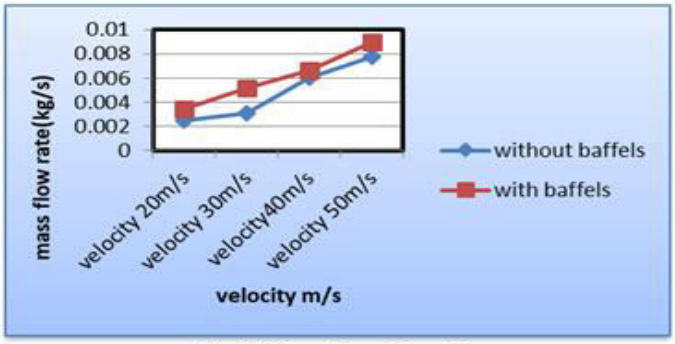

Fig11. Mass Flow Rate Plot

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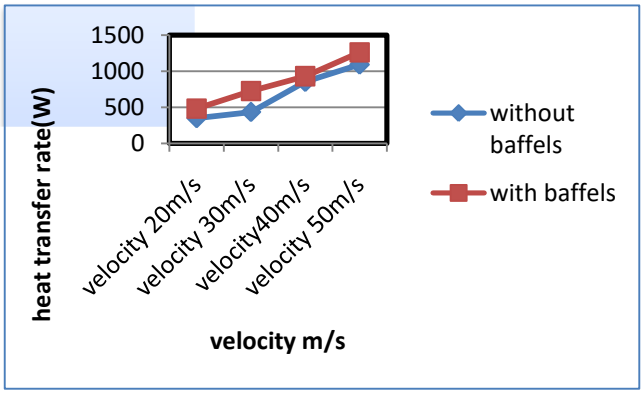

Fig12. Heat Transfer Rate Flow

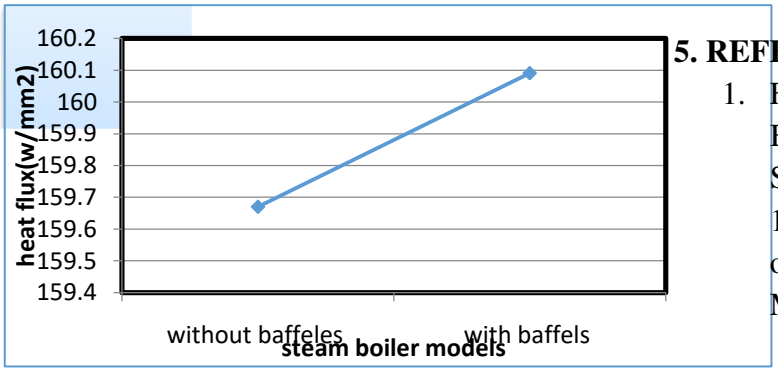

Fig13.Heat Flux Plot

4. CONCLUSION

In This Project the Steam Flow in Steam Boiler (Without Baffles & with Baffles) is Modeled Using CREO Parametric Design Software. The Project will focus on Thermal and CFD Analysis with Different inlet Velocities (20, 30, 40& 50m/s).

In This Project the CFD Analysis to determine the Heat Transfer Coefficient, Heat Transfer Rate, Mass Flow Rate, and Pressure Drop.

Thermal Analysis is to determine the Temperature distribution, Heat Flux for Both Models of Steam Boiler without Baffles and Steam Boiler with Baffles.

By observing the CFD Analysis the Pressure Drop, Velocity, Heat Transfer Coefficient, Mass Flow Rate & Heat Transfer Rate increases by increasing the inlet Velocities. And Compare the Steam Boiler Models the Heat Transfer Rate value more for Steam Boiler with Baffles Model.

By observing the Thermal Analysis, the taken different Heat Transfer Coefficient values are from CFD Analysis. Heat Flux value is more for Steam Boiler with Baffles.

So we can conclude the Steam Boiler with Baffles Model is Better Model.

5. REFERENCE

1. Finite Element Analysis of Steam Boiler Used In Power Plants 1M. Suri Babu, 2 Dr.B.Subbaratnam 1M.Tech student, 2Professor, Dept of Mechanical Engineering, Kits, Markapur, A.P, India.
2. Structural and thermal analysis of a boiler using finite element Analysis D.Kondayya Department of Mechanical Engineering, Author Correspondence: Department of Mechancal Engineering, Sreenidhi institute of Science & Technology, Ghatkesar, Hyderabad – 501301.
3. Analysis of New Boiler Technologies Dr Mike Inkson
4. A Study Analysis and Performance of High Pressure Boilers With its Accessories J. Suresh babu1,R.Latha2 ,B.Praveen3,V.Anil kumar4,R Rama kumar5,s.peerulla6 1 Assistant Professor in MED,

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5. Design and analysis of the prototype of boiler for steam pressure control 1Akanksha Bhoursae, 2 Jalpa Shah, 3Nishith Bhatt Institute of Technology, Nirma University, SG highway, Ahmedabad-382481,India 3Essar steels limited,Hazira,Surat-394270,India
6. Lou Roussinos, P. E., "Boiler Design and Efficiency" [online], Available: http://www.forestprod.org/drying06williamson .pd f, Accessed: September 1, 2010.
7. Murdock, K. L., "3ds max 9 Bible, Wiley Publishing Inc. Indianapolis, Indiana, 2007.
8. Nagpal, G. R., 1998, Power Plant Engineering, Khanna, Delhi.
9. Steam Pressure Reduction: Opportunities and Issues by U.S Deportment of energy,
10. Rapid Start up Analysis of a Natural Circulation HRSG Boiler with a Vertical Steam Separator Design by M.J. Albrecht, W.A. Arnold, R. Jain and J.G. DeVitto,
11. Technological investigations and efficiency analysis of a steam heat exchange condenser:
12. conceptual design of a hybrid steam condenser by R K Kapooria and S kumar,
13. Developmental design of a laboratory fire tube
14. Steam boiler by I. O. OHIJEAGBON,

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