MODELLING AND ANALYSIS OF BOILER USED IN POWER PLANT

Capstone Project Report submitted in

partial fulfillment for the award of the

degree of

BACHELOR OF TECHNOLOGY

Submitted by

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1714101025

IN

MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

UNDER THE SUPERVISION OF

Dr. S. KENNEDY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

JUNE- 2021

GALGOTIAS UNIVERSITY

DEPARTMENT OF MECHANICAL ENGINEERING

BONAFIDE CERTIFICATE

Certified that this project report **"MODELLINGANDANALYSIS OF BOILER USED INPOWER PLANT"** is the bonafide work of "**PRASHANT SHUKLA (1714101078) and ASHWANI KUMAR VISHWAKARMA (1714101025) "** who carried out the project work under my supervision.

SIGNATURE OF SUPERVISOR

APPROVAL SHEET

This project report entitled **"Modelling and Analysis of Boiler used in Power Plants"** by **"Prashant Shukla (1714101078)** and **Ashwani Kumar Vishwakarma (1714101025)"** is approved for the degree of Bachelor of Technology in Mechanical Engineering.

Supervisor

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Project Coordinator

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Date:_____

Place: _____

ACKNOWLEDGEMENT

The contributions of many different people, in their different ways, have made this possible. I would like to extend my gratitude to the following.

We are grateful to my supervisor Mr. Kennedy S, who has been there always for the guidance and constantly helping us to come out with creative ideas and always come up with a solution to the problems we faced during the throughout work.

We'd also want to express our gratitude to the Dr. Pawan Kumar Singh Nain, Dean, Department of Mechanical Engineering, Galgotias University for providing the essential resources.

We would like to thank other staff of Department of Mechanical Engineering, Galgotias University for providing us opportunities and working in a great environment.

_____

(PRASHANT SHUKLA;

ASHWANI KUMAR VISHWAKARMA)

(Department of Mechanical Engineering)

ABSTRACT

Today in world of rapid development power is basic input and requirement of all

industries. Nearly every industry needs power weather in form of raw material like power plant or as input to run their equipment. Power plant is one of the major power generation facilities. A boiler is basically a closed container in which water is heat until it becomes steam under specific pressure. Boilers are used for many different purposes like warm up surrounding; sanitizing an area, give power to industries and many more. This theory is describing the boiler ufsed in power plant; the water vapor flow in the boiler vessel is modelled victimization Creo Parametric style program package. This theory can direct to CFD and thermal analysis with completely various speed (25, 30, 35 & 40m/s). Thermal analysis was finished under various type of heat release at constant speed. This values area unit computational Fluid Dynamic obtained from analyze at completely various speed. In computational fluid Dynamic analysis to see warmth transfer at constant rate, mass rate of flow, heat analysis to see the temperature distribution and pressure drop, the heat flux with various materials. Three-D' modelled constant program package Creo Parametric & analysis.

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CHAPTER 1

INTRODUCTION

1.1 STEAM BOILER

A boiler is mainly used to boil water until it becomes steam through combustion of fuels in a closed vessel. This steam under pressure or hot water is usable for transmitting heat, this steam or hot water is then transferred for further processes. Water is basically used because it is cheap and easily available everywhere [1]. There are three ways to distinguish between boilers [2].

They are as follow: -

1. Based on water tube and fire-tube.
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The Steam boiler increase the temperature of water to provide the steam, that is wont to generate energy or heat for other purposes. The length of pipelines depends on shape and arrangement of boilers. So with proper improvement in design will reduce the length of pipeline which ultimately reduces the overall cost [3, 4].

1.2 GENERALDATA

Boiler area unit won't to mead steam that provides the heat energy or power energy. Water heat-again and steam is generated within the boiler. The steam vapor is travel by tube the heat equipment which is might be any type of apparatus that needs steam vapor for operations [5]. The condensed steam changed into liquid and return to the boiler vessel.

1.3 EQUIPMENTSTYLE

There are unit 3 main varieties of steam boiler:

- Watertube
- Forgedtube
- Hearthtube

In this hearth tube, the heated gases move at intervals in tub to heats encircling Waters. In liquid (Water) tube boilers on the opposite hand, the Water move within tube and heated on skin is higher than that diagram below shows the parts of a hearth tubeboiler.

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to run their equipment. Power plant is one of the major power generation facilities. A boiler is basically a closed container in which water is heat until it becomes steam under specific pressure. Boilers are used for many different purposes like warm up surrounding; sanitizing an area, give power to industries and many more. This theory is describing the boiler used in power plant; the water vapor flow in the boiler vessel is modelled victimization Creo Parametric style program package.

CHAPTER 2

LITERATUREREVIEW

The efficiency of boiler is described by **V. Kumar**; according to him the two factor depends in

dry fuel gas. The excess of air gas heater outlet temperature is excess [6]. In the research performed by **Farhan and Amula** suggests that the efficiency calculated by the direct Method which has a significantly low accuracy than the Indirect/losses Method employed at the power plant [7]. **Anjali T H, Dr. G Kalivarathan** performed analysis to find the losses, their location and magnitude to maximize the efficiency of the 15 MV thermal boiler using energy analysis based on thermodynamics laws basically first and second law [8].Another research showed that optimizers are very useful in fuel consumption in steady state. SECS show satisfactory results [9]. A boiler generate steam may be in a closed vessel accustomed. Almost20%ofoverallcostofpowerplant depends on pipelines.

In the process of generation of steam, the vessel isfixed to very large thermal or structural hundreds. They get efficient operation of the facility plant, it is necessary to design the structure to face up to the thermal and structural loads mistreatment CAD and CAE code is that the advanced technology of planning these structures before constructing a model during this project, a finite component of vessel was administered operatingconditions. The most work within the project area unit activity in 3d design of the boiler and finite component analysis. During this project, the design optimization of the Boiler is additionally done supported the result get by the analysis of thermal and structural design. PRO-E code is employed for style and 3D modelling. ANSYS code is employed for doing finite component analysis.

CHAPTER 3

PROBLEMDESCRIPTION

In the objective of the project is design and analysis in 3D structure of steam boiler and study of compressed fluid dynamic and thermal behavior of the boiler by the activity of component

analysis 3D modelling package (PRO-E) was used for compressed fluid dynamic and thermal analysis.

1. Design 3D model of boiler assembly victimization parametric package PRO-E.
2. Convert a surface of boiler model into a para solid file and import the model into ANSYS to try and do analysis.
3. Check thermal analysis on the boiler assembly for thermal hundreds.
4. Check CFD analysis on the present model of the surface boiler for rate water to seek out the mass rate of flow, heat transfer rate, pressure drop.

3.1 INTRODUCTION TOCAD/CAE:

Computer-aided design, conjointly referred to as computer-aided design and drafting (CADD), is the use of technology for the method of style and design -documentation.

CHAPTER 4

METHODOLOGY

Models of boiler are designed using (Creo Parametric) : The steam boiler under this statement and model formula from the data book. The iso- metric view of boiler is shown in the figure below. Ansys is used to simulate the boiler using Finite Element Approach. Finite Element analysis is widely used method for structural analysis where load varies with time [10].

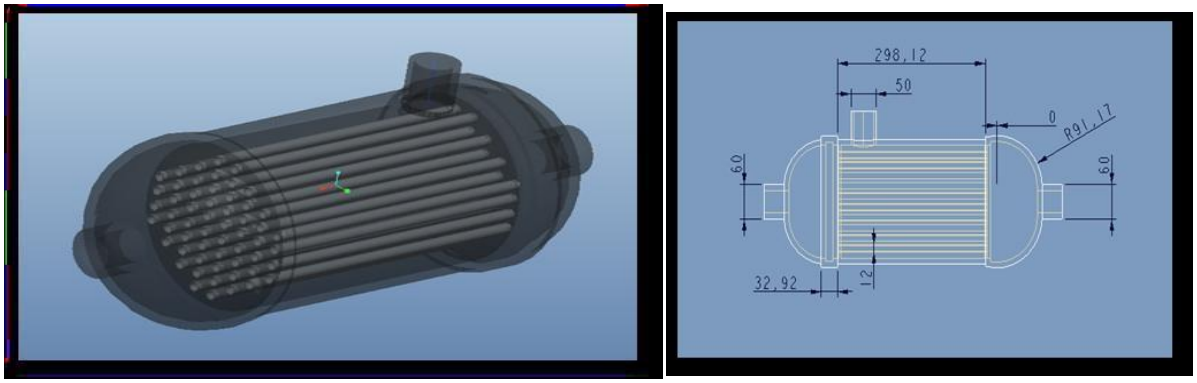

Figure: 1:-Isometric View and dimensions of boiler

4.1 Materials used for making boiler: -

- Chrome steel, and steel, copper,Brass
- Chrome steel for Boiler casing and steel,brass

4.2 Imported Model of Boiler

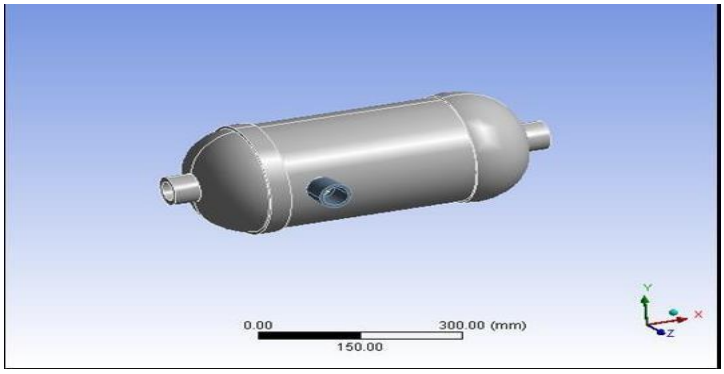

Figure: 2:- Foreign model of boiler

4.3 MESHED MODEL OF BOILER

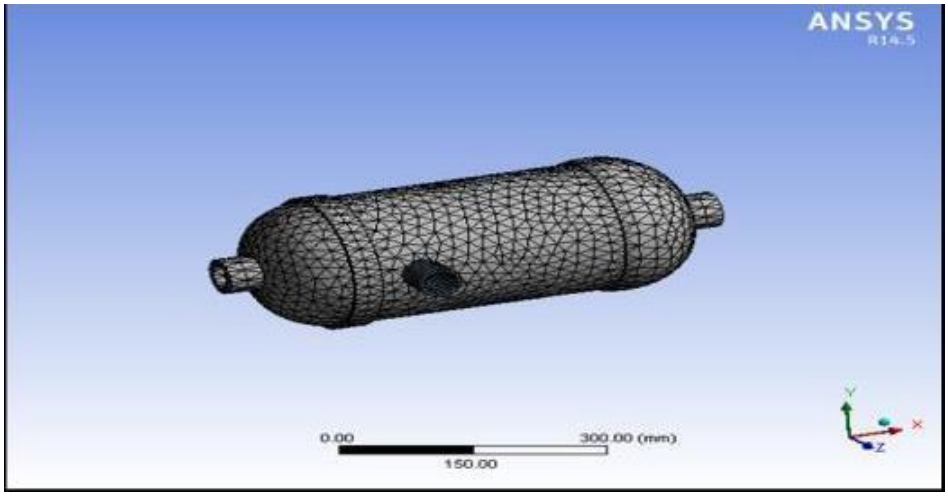

Figure:3-Meshed model of boiler

- A finite part of boiler represent true project as a "mesh model "a little, frequently formed polyhedron connected component, as show with in the top of fig and then setting up and resolution vast concurrent equations. The finer the mesh, the additional correct result however additional computing power is needed.
- Heat transfer co-efficient=7.93e+01w/m^2-k
- Material-steel for boiler vessel
- Copper for tubes
- Speed-27m/sec

4.4 MATERIALPROPERTIES:

- **Copper material properties**

Thermal physical phenomenon = 384 w/m-k Specific heat = 0.38556j/g^0C

Density =0.0000077645 kg/mm3

- **Properties of steel**

Thermal physical phenomenon = 95.102/m-k Specific heat = 0.66912 j/g^0C

Density = 0.000007445 kg/ mm^3

- **Properties of stainless steel**

Thermal physical phenomenon = 34 w/m-k

Specific heat = zero.620j/g∘C Density = 0.00000901021 kg/ mm^3

- **Brass material properties**

Thermal physical phenomenon = 233 w/m-k Specific heat = 0.3810j/g^0C

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CHAPTER 5

Results and Discussions

5.1 Pressure

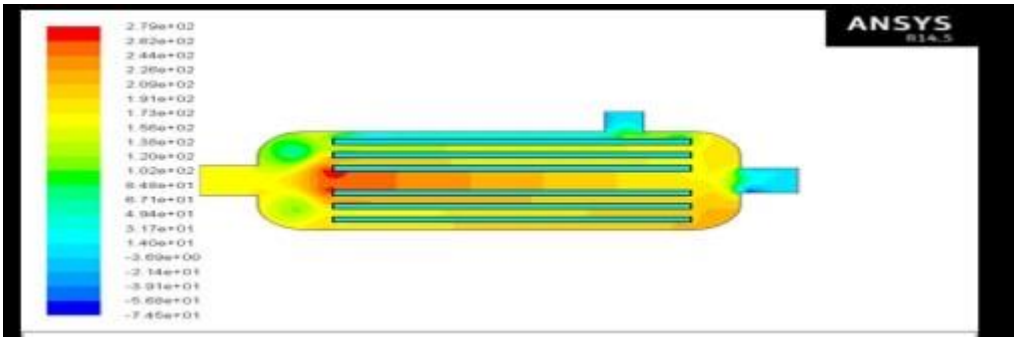

Figure: 4- Measure static pressure at the end of boiler tube

According to the above figure, the max static pressure within the boiler is developed at one end of the tubes i.e. at inlet tube because applying the boundary conditions are applied at this end and less pressure can be seen at the steam outlet and exhaust outlet. The analysis shows that the max changing pressure is off .79e+02Pa and minimum changing pressure .

5.2 Heat transfercoefficient

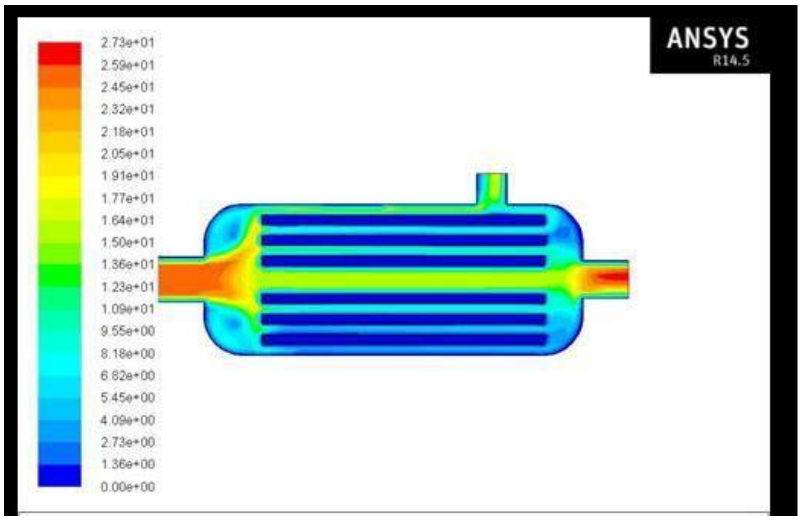

Figure5: -Measure heat in the boiler

The highest heat transfer coefficient of the steam is developed on the Surface side of the steam boiler and vessel and less heat transfer coefficient is developed at the inside of the tubes and

steam boiler. According to the analysis:

maximum heat transfer coefficient is 7.49e+01w/m^2.-k
minimum heat transfer coefficient is 3.75e+00w/m^2.-k.

5.3 Thermal analysis ofboiler:

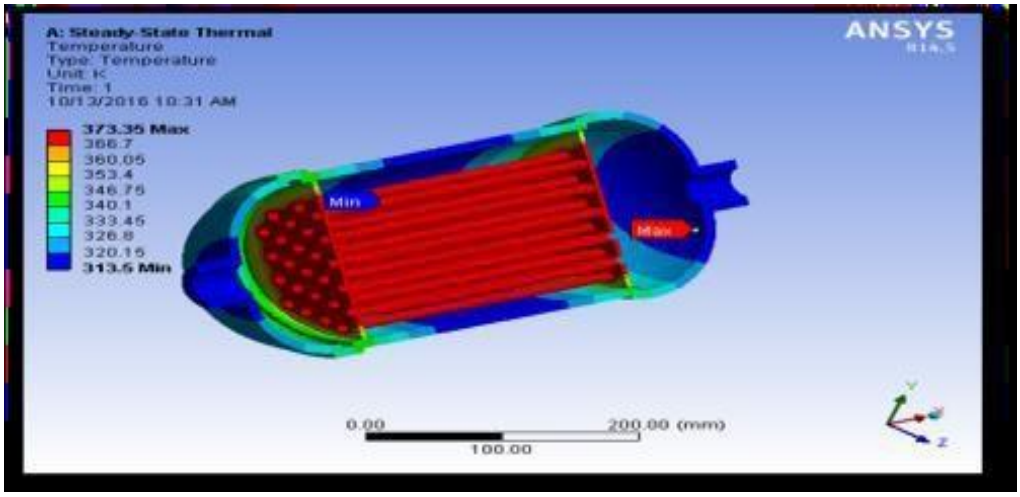

Figure: 6-Thermal analysis of steam boiler

From 6 shows that the tube is having max temperature as compared to the other parts because steam is mainly passing through the tube. The part of steam casing which covers the tube also shows high rise in temperature while the outer end of casing have min temperature.

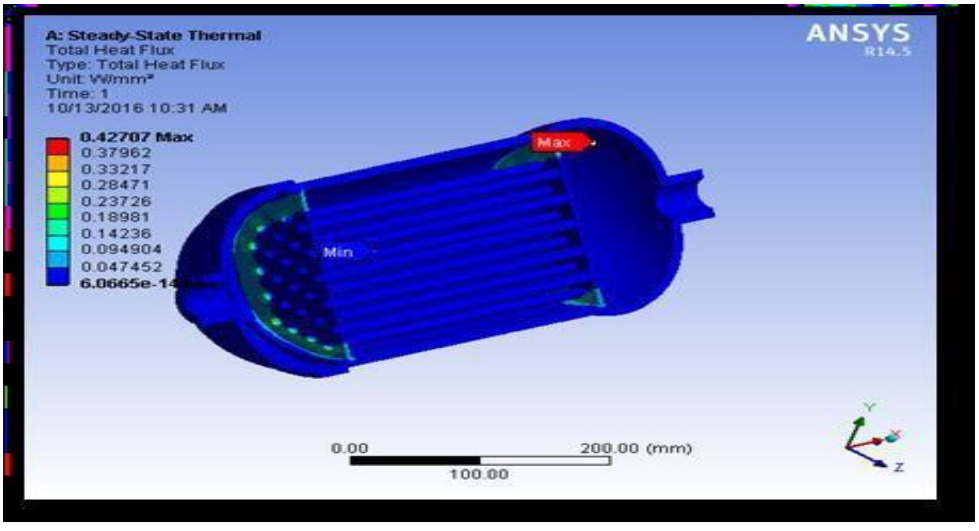

Figure: 7-Thermal analysis of steam boiler

According to the above figure, the max heat flux can be seen under the vessel because the vapor

passes under the vessel. So, we applied heat under the vessel and the movement in a gas is applied except under the vessel. The results show that the greatest temperature under the vessel and smallest vessel.

Highest heat flux is0.42707w/mm^2

Lowest heat flux is 6.0665e-14w/mm^2.

Table 1: Variation of Pressure, heat flux and heat transfer coefficient with variation in inlet velocity

	Velocity (25m/s)	Velocity(30m/s)	Velocity(35m/s)	Velocity(40m/s)
Pressure (Pa)(approx.)	2.945E+02	4.001E+02	5.821E+02	7.43E+02
Heat transfer rate(W) (approx.)	1800	1520	2400	2900
Heat transfer coefficient (w/m^2 k) (approx.)	78	83	100	110

Table 1 show the variation of pressure, Heat transfer rate and heat transfer coefficient with varying inlet velocities. Clearly pressure increase with increase in inlet velocity. Small fluctuation is seen in heat transfer rate, at 30 m/s speed but in general it increase with increase in velocity. Similarly heat transfer coefficient increase with inlet velocity.

CHAPTER 6

CONCLUSIONS

This theory mainly focusses on thermal and CFD analysis with different speed (27, 31, 37& 42m/s). The model is designed in cero and exported to Ansys for analysis. Thermal analysis is done on different materials - steel, untarnished steel& brass at totally different heat transfer constant values. Results show that pressure drop, heat flux and heat transfer coefficient all changes with change in inlet velocity. Temperature, heat flux and pressure are shown in figures and explained. The results show that the pressure developed at inlet is more than the pressure at outlet. The analysis shows that the max changing pressure is off. The inlet end of tube experiences max pressure and the outlet end of tube experiences minimum pressure formation. The max heat flux is developed under the vessel because vapor passes through the vessel. Also vessels tubes are under high temperature. So it can be concluded from the results that vessels tube is most important part to take in consideration while designing the boiler. Further work can be done in designing and selecting best material for making vessels.

CHAPTER 7

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Appendix- A

Plagiarism Report

Appendix- B

The papers

MODELLING AND ANALYSIS OF BOILER USED IN POWER PLANT

Ashwani Vishwakarma[1], Prashant Shukla[2], Kennedy.S[3]

Department of Mechanical Engineering, Galgotias University, Greater Noida, India

ashwanikumargkp01@gmail.com

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PRO-E inferno that the commonplace in 3D model product design, that includes industry-leading productivity tools that prompts best practices in style whereas guaranteeing

Compliance together with trade and company standards. The integrated PRO-E/CAD/CAM/CAE allows you to style quicker than ever whereas maximizing innovation and quality to utility produce exceptionally products. Different modules in PRO-E Part design, on assembly, drawing sheet.

5. Methodology

Models of boiler are designed using (Creo Parametric) wildfire 5.0: The steam boiler is modelled under the given statement and model formula from the data book. The iso-metric view of boiler is shown in the figure below. Ansys is used to simulate the boiler using Finite Element Approach. Finite Element analysis is widely used method for structural analysis where load varies with time [10].

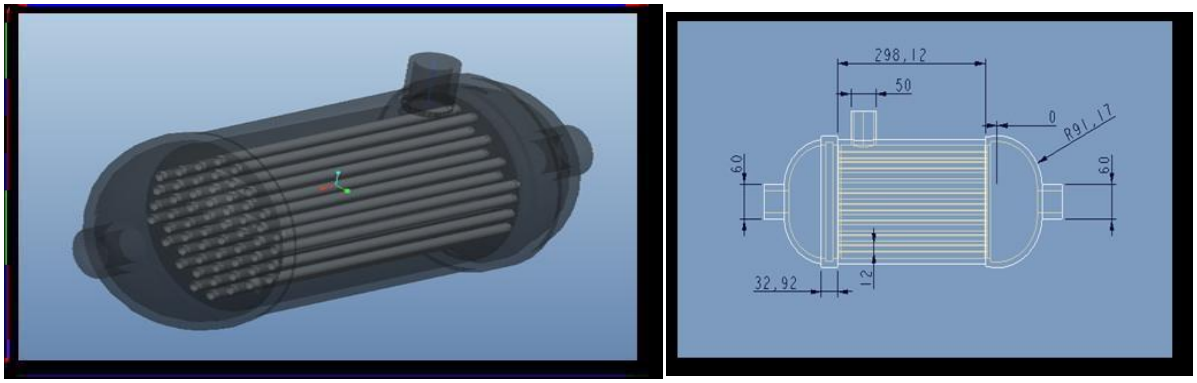

Figure: 1:-Iso-Metric View and dimensions of boiler

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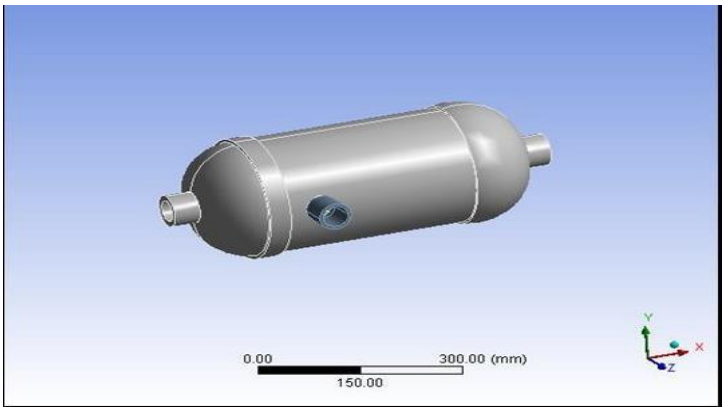
- Chrome Steel for Boiler casing and Steel,brass.

5.2IMPORTED MODEL OF BOILER



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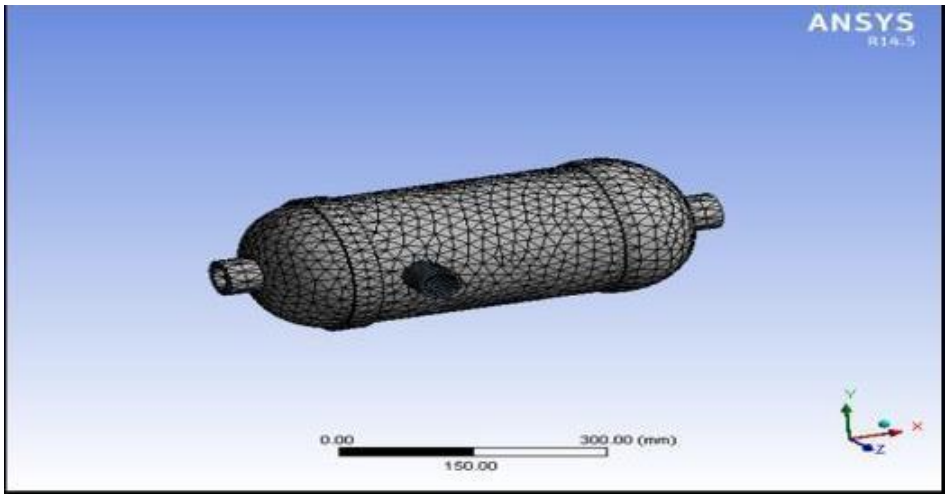

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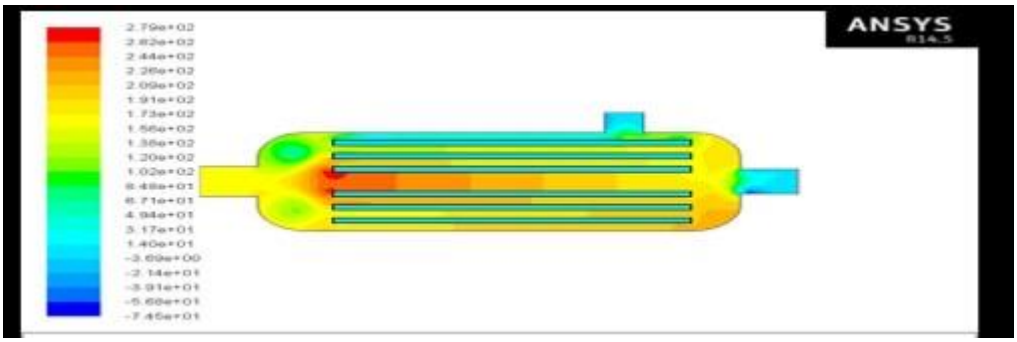
6. Result and discussion:

6.1Pressure



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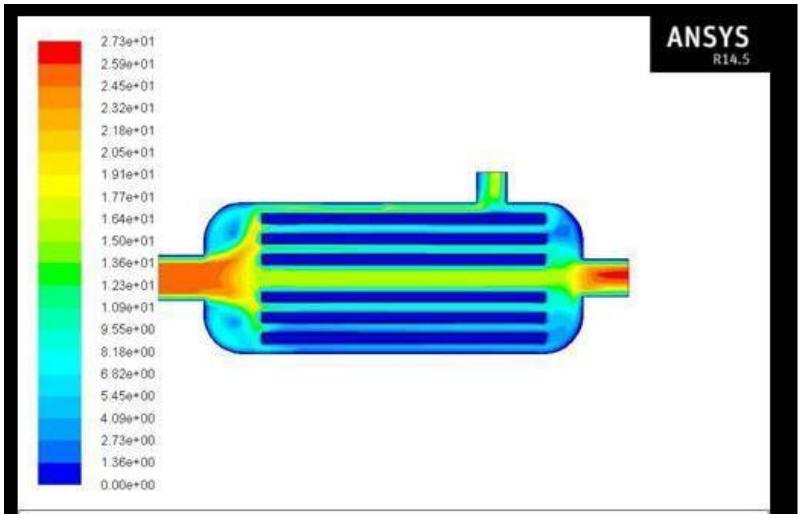

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According to the above figure, the highest heat transfer coefficient of the steam is developed on the Surface side of the steam boiler and vessel and less heat transfer coefficient is developed at the inside of the tubes and steam boiler. According to the analysis:

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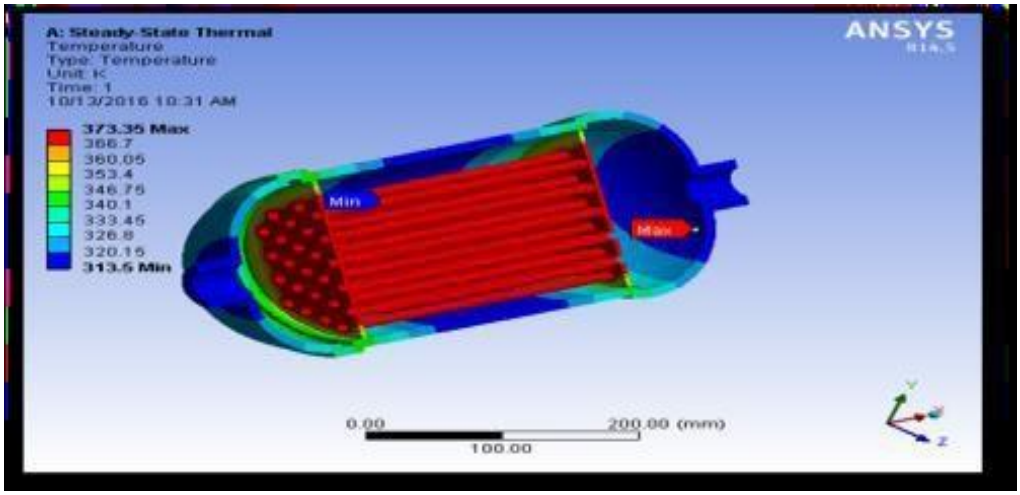

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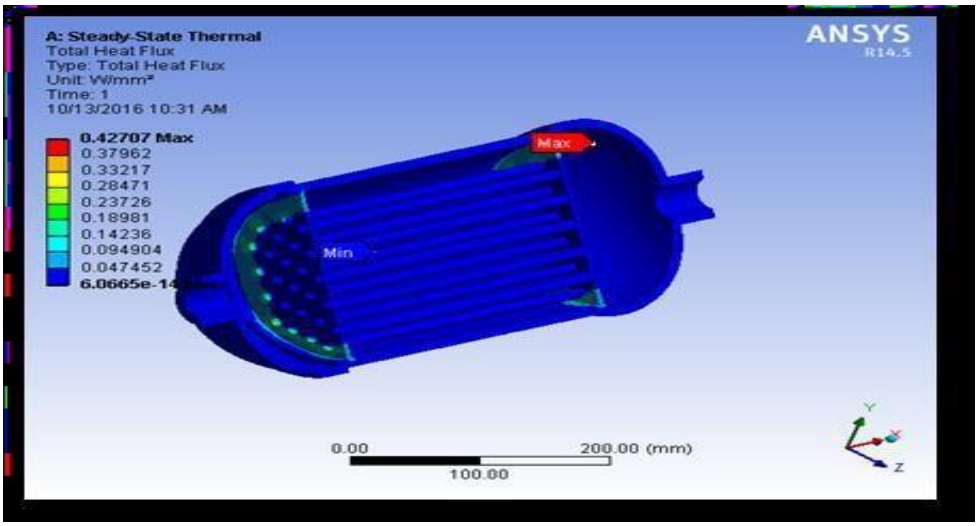

Figure: 7-Thermal analysis of steam boiler

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7. Highest heat flux is0.42707w/mm^2
8. Lowest heat flux is 6.0665e-14w/mm^2.

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Table 1 show the variation of pressure, Heat transfer rate and heat transfer coefficient with varying inlet velocities. Clearly pressure increase with increase in inlet velocity. Small fluctuation is seen in heat transfer rate, at 30 m/s speed but in general it increase with increase in velocity. Similarly heat transfer coefficient increase with inlet velocity.

6. Conclusion

This theory mainly focusses on thermal and CFD analysis with different speed (27, 31, 37& 42m/s). The model is designed in cero and exported to Ansys for analysis. Thermal analysis is done on different materials - steel, untarnished steel& brass at totally different heat transfer constant values. Results show that pressure drop, heat flux and heat transfer coefficient all changes with change in inlet velocity. Temperature, heat flux and pressure are shown in figures and explained. The results show that the pressure developed at inlet is more than the pressure at outlet. The analysis shows that the max changing pressure is off .79e+02Pa and minimum changing pressure is -7.45e+01Pa. The inlet end of tube experiences max pressure and the outlet end of tube experiences minimum pressure formation. The max heat flux is developed under the vessel because vapor passes through the vessel. Also vessels tubes are under high temperature. So it can be concluded from the results that vessels tube is most important part to take in consideration while designing the boiler. Further work can be done in designing and selecting best material for makingvessels.

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