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# Design and Thermal Analysis of The Boiler Tube With Internal Helical Ribs

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**Abstract:**
The present day the usage of power is increasing rapidly. So in order to generate the power we have to use our resources effectively. The power is mainly generated from the power plant where the major contribution is from thermal power plants. In thermal power plant the main component is the boiler, if we make using effective of it we can increase the power generation as that the boiler converts the water in to the high pressure steam by taking heat from the furnace. If we able to make the heat transfer effectively, more amount of steam is generated.
So the changes in the boiler tubes are done by adding the internal helical ribs internally to the boiler. So that the fluids inside the boiler will travels more time in the tube and the maximum heat transfer will be taking place. So for short span of time the phase change takes place and the water will converted to steam. Here we are going to do the static and thermal analysis on the tube with the internal helical ribs and compare with the normal boiler tube, by taking the boundary conditions as of the industry. The consumption of coal can be minimised for generation of same coal as that using the normal boiler pipe.

**Keywords:** Thermal Power Plant, Boiler, High Pressure Steam, Boiler Tubes, Internal Helical Ribs.

## I. INTRODUCTION OF BOILERS

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.

### MATERIALS

The pressure vessel of a boiler is usually made of steel (or alloy steel), or historically of wrought iron. Stainless steel, especially of the austenitic types, is not used in wetted parts of boilers due to corrosion and stress corrosion cracking. However, ferritic stainless steel is often used in superheater sections that will not be exposed to boiling water, and electrically-heated stainless steel shell boilers are allowed under the European “Pressure Equipment Directive” for production of steam for sterilizers and disinfectors.
In live steam models, copper or brass is often used because it is more easily fabricated in smaller size boilers. Historically, copper was often used for fireboxes (particularly for steam locomotives), because of its better formability and higher thermal conductivity; however, in more recent times, the high price of copper often makes this an uneconomic choice and cheaper substitutes (such as steel) are used instead.

**TYPES OF BOILER**

**1. Pot boiler:**

A primitive "kettle" where a fire heats a partially filled water container from below 18th century Haycock boilers generally produced and stored large volumes of very low- pressure steam, often hardly above that of the atmosphere. These could burn wood or most often, coal. Efficiency was very low.

**2. Fire tube boilers**

Here, water partially fills a boiler barrel with a small volume left above to accommodate the steam. This is the type of boiler used in nearly all steam locomotives. The heat source is inside a furnace or firebox that has to be kept permanently surrounded by the water in order to maintain the temperature of the heating surface below the boiling point. The furnace can be situated at one end of a fire-tube which lengthens the path of the hot gases, thus augmenting the heating surface which can be further increased by making the gases reverse direction through a second parallel tube or a bundle of multiple tubes (two- pass or return flue boiler); alternatively the gases may be taken along the sides and then beneath the boiler through flues (3-pass boiler). In case of a locomotive-type boiler, a boiler barrel extends from the firebox and the hot gases pass through a bundle of fire tubes inside the barrel which greatly increases the heating surface compared to a single tube and further improves heat transfer. Fire-tube boilers usually have a comparatively low rate of steam production, but high steam storage capacity. Fire-tube boilers mostly burn solid fuels, but are readily adaptable to those of the liquid or gas variety.

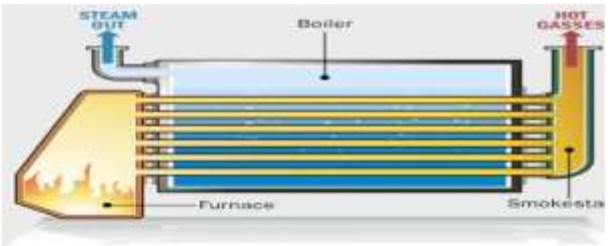



**Fig 1 Fire tube boiler**

**3. Water tube boiler**

In this type, tubes filled with water are arranged inside a furnace in a number of possible configurations, often the water tubes connect large drums, the lower ones containing water and the upper ones, steam and water; in other cases, such as a mono-tube boiler, water is circulated by a pump through a succession of coils. This type generally gives high steam production rates, but less storage capacity than the above. Water tube boilers can be designed to exploit any heat source and are generally preferred in high-pressure applications since the high-pressure water/steam is contained within small diameter pipes which can withstand the pressure with a thinner wall.

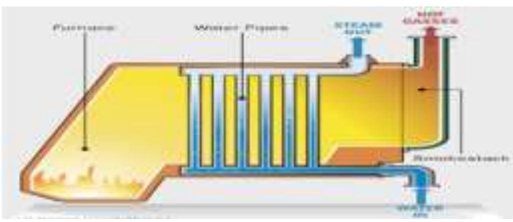


**Fig 2 Water tube boiler**

**4. Flash boiler**

A flash boiler is a specialized type of water-tube boiler in which tubes are too close together and water is pumped through them. A flash boiler differs from the type of mono- tube steam generator in which the tube is permanently filled with water. In a flash boiler, the tube is kept so hot that the water feed is quickly flashed into steam and superheated. Flash boilers had some use in automobiles in the 19th century and this use continued into the early 20th century…Fire-tube boiler with Water-tube firebox. Sometimes the two above types have been combined in the following manner: the firebox contains an assembly of water tubes, called thermic siphons.

**5. Sectional boiler**

In a cast iron sectional boiler, sometimes called a "pork chop boiler" the water is contained inside cast iron sections. These sections are assembled on site to create the finished boiler.

**Key components of boilers**

The key elements of a boiler include the burner, combustion chamber, heat exchanger, exhaust stack, and controls. Boiler accessories including the flue gas economizer are also commonly used as an effective method to recover heat from a boiler and will be discussed briefly in the section Best Practices for efficient operations.

Natural gas boilers employ one of two types of burners, atmospheric burners, also called natural draft burners and forced draft burners, also called power burners. Due to more stringent federal and state air quality regulations, low NOx burners and pre-mix burners are becoming more commonly used and even required in some areas. By ensuring efficient mixing of air and fuel as it enters the burner, these types of burners can ensure that NOx emissions are reduced.

## ENERGY

The source of heat for a boiler is combustion of any of several fuels, such as wood, coal, oil, or natural gas. Electric steam boilers use resistance or immersion- type heating elements. Nuclear fission is also used as a heat source for generating steam, either directly (BWR) or, in most cases, in 5specialized heat exchangers called “steam generators” (PWR). Heat recovery steam generators (HRSGs) use the heat rejected from other processes such as gas turbine.

## SAFETY

To define and secure boilers safely, some professional specialized organizations such as the American Society of Mechanical Engineers (ASME) develop standards and regulation codes. For instance, the ASME Boiler and Pressure Vessel Code is a standard providing a wide range of rules and directives to ensure compliance of the boilers and other pressure vessels with safety, security and design standards.

Historically, boilers were a source of many serious injuries and property destruction due to poorly understood engineering principles. Thin and brittle metal shells can rupture, while poorly welded or riveted seams could open up, leading to a violent eruption of the pressurized steam. When water is converted to steam it expands to over 1,000 times its original volume and travels down steam pipes at over 100 kilometers per hour. Because of this, steam is a great way of moving energy and heat around a site from a central boiler house to where it is needed, but without the right boiler feed water treatment, a steam-raising plant will suffer from scale formation and corrosion. At best, this increases energy costs and can lead to poor quality steam, reduced efficiency, shorter plant life and unreliable operation. At worst, it can lead to catastrophic failure and loss of life.

## BOILER FITTINGS AND ACCESSORIES

1. Safety Valve: It is used to relieve pressure and prevent possible explosion of a boiler.
2. Water Level Indicators: They show the operator the level of fluid in the boiler, also known as a sight glass, water gauge or water column.
3. Bottom Blow down Valves: They provide a means for removing solid particulates that condense and lie on the bottom of a boiler. As the name implies, this valve is usually located directly on the bottom of the boiler, and is occasionally opened to use the pressure in the boiler to push these particulates out.
4. Continuous Blow down Valve: This allows a small quantity of water to escape continuously. Its purpose is to prevent the water in the boiler becoming saturated with dissolved salts. Saturation would lead to foaming and cause water droplets to be carried over with the steam - a condition known as priming. Blow down is also often used to monitor the chemistry of the boiler water.
5. Flash Tank: High-pressure blowdown enters this vessel where the steam can 'flash' safely and be used in a low-pressure system or be vented to atmosphere while the ambient pressure blows down flows to drain.
6. Automatic Blow down/Continuous Heat Recovery System: This system allows the boiler to blow down only when makeup water is flowing to the boiler, thereby transferring the maximum amount of heat possible from the blow down to the makeup water. No flash tank is generally needed as the blow down discharged is close to the temperature of the makeup water.
7. Hand Holes: They are steel plates installed in openings in "header" to allow for inspections & installation of tubes and inspection of internal surfaces.
8. Steam Drum Internals: A series of screen, scrubber & cans (cyclone separators).
9. Low-Water Cutoff: It is a mechanical means (usually a float switch) that is used to turn off the burner or shut off fuel to the boiler to prevent it from running once the water goes below a certain point. If a boiler is "dry-fired" (burned without water in it) it can cause rupture or catastrophic failure.
10. Surface Blow down Line: It provides a means for removing foam or other lightweight non-condensable substances that tend to float on top of the water inside the boiler.
11. Circulating Pump: It is designed to circulate water back to the boiler after it has expelled some of its heat.
12. Feed water Check Valve or Clack Valve: A non-return stop valve in the feed water line. This may be fitted to the side of the boiler, just below the water level, or to the top of the boiler
13. Top Feed: In this design for feed water injection, the water is fed to the top of the boiler. This can reduce boiler fatigue caused by thermal stress. By spraying the feed water over a series of trays the water is quickly heated and this can reduce lime scale.
14. Desuperheater Tubes or Bundles: A series of tubes or bundles of tubes in the water drum or the steam drum designed to cool superheated steam, in order to supply auxiliary equipment that does not need, or may be damaged by, dry steam

## ENERGY EFFICENCY OPPORTUNITES

### 1. Stack Temperature Control

The stack temperature should be as low as possible. However, it should not be so low that water vapor in the exhaust condenses on the stack walls. This is important in fuels containing significant sulphur as low temperature can lead to sulphur dew point corrosion. Stack temperatures greater than 200°C indicates potential for recovery of waste heat. It also indicates the scaling of heat transfer/recovery equipment and

hence the urgency of taking an early shut down for water / flue side cleaning.
Keep as low as possible
If >200°C then recover waste heat

**2. Feed Water Preheating Economizers**

Potential to recover heat from 200 – 300oC flue gases leaving a modern 3-pass shell boiler, the flue gases leaving a modern 3-pass shell boiler are at temperatures of 200 to 3000C. Thus, there is a potential to recover heat from these gases. The potential for energy savings depends on the type of boiler installed and the fuel used.

**3. Combustion Air Preheating**

If combustion air raised by 20°C = 1% improve thermal efficiency Combustion air preheating is an alternative to feed water heating. In order to improve thermal efficiency by 1%, the combustion air temperature must be raised by 200C. Most gas and oil burners used in a boiler plant are not designed for high air-preheat temperatures.

**4. Excess Air Control**

- Excess air required for complete combustion
- Optimum excess air levels varies
- 1% excess air reduction = 0.6% efficiency rise
- Portable or continuous oxygen analyzers

Controlling excess air to an optimum level always results in reduction in flue gas losses; for every 1 percent reduction in excess air there is approximately 0.6 percent rise in efficiency.
Various methods are available to control the excess air:
Portable oxygen analyzers and draft gauges can be used to make periodic readings to guide the operator to manually adjust the flow of air for optimum operation. Excess air reduction up to 20 percent is feasible.
The most common method is the continuous oxygen analyzer with a local readout mounted draft gauge, by which the operator can adjust air flow. A further reduction of 10-15 percent can be achieved over the previous system. The same continuous oxygen analyzer can have a remote controlled pneumatic damper positioned, by which the readouts are available in a control room. This enables an operator to remotely control a number of firing systems simultaneously

**5. Radiation and Convection Heat Loss Minimization**

- Fixed heat loss from boiler shell, regardless of boiler output
- Repairing insulation can reduce loss

The external surfaces of a shell boiler are hotter than the surroundings. Therefore, the surfaces lose heat to the surroundings depending on the surface area and the difference in temperature between the surface and the surroundings. The heat loss from the boiler shell is normally a fixed energy loss, irrespective of the boiler output. Repairing or augmenting insulation can reduce heat loss through boiler walls and piping

**6. Automatic Blow down Control**

- Sense and respond to boiler water conductivity and pH
- Uncontrolled continuous blow down is very wasteful. Automatic blow down controls can be installed that sense and respond to boiler water conductivity and pH.

**7. Scaling and Soot Loss Reduction**

- 3 mm of soot = 2.5% fuel increase
- Every 22oC increase in stack temperature = 1% efficiency loss
- In oil and coal-fired boilers, soot buildup on tubes acts as an insulator against heat transfer. Any such

deposits should be removed on a regular basis. An estimated 1per cent efficiency loss occurs with every 22oC increase in stack temperature. Therefore, stack temperature should be checked and recorded regularly as an indicator of soot deposits. It is also estimated that 3 mm of soot can cause an increase in fuel consumption by 2.5per cent due to increased flue gas temperatures.

Periodic off-line cleaning of radiant furnace surfaces, boiler tube banks, economizers and air heaters may be necessary to remove stubborn deposits

**8. Reduced Boiler Steam Pressure**

- Lower steam pressure
- Lower saturated steam temperature
- Lower flue gas temperature
- Steam generation pressure dictated by process

Reduction of boiler steam pressure is an effective means of reducing fuel consumption by as much as 1 to 2 per cent. Lower steam pressure gives a lower saturated steam temperature and without stack heat recovery, a similar reduction in the temperature of the flue gas is obtained. Steam is generated at pressures normally dictated by the highest pressure and temperature requirements for a particular process.

**9. Variable Speed Control for Fans, Blowers and Pumps**

- Suited for fans, blowers, pumps
- Should be considered if boiler loads are variable
- Variable speed control is an important means of achieving energy savings. Generally, combustion aircontrol is affected by throttling dampers fitted at forced and induced draft fans. Though dampers are simple means of control, they lack accuracy, giving poor control characteristics at the top and bottom of the operating range. In general, if the load characteristic of the boiler is variable, the possibility of replacing the dampers by a VSD should be evaluated.

**10. Control Boiler Loading**

- Maximum boiler efficiency: 65-85% of rated load
- Significant efficiency loss: < 25% of rated load

The maximum efficiency of the boiler does not occur at full load, but at about two- thirds of the full load.

**11. Proper Boiler Scheduling**

- Optimum efficiency: 65-85% of full load
- Few boilers at high loads is more efficient than large number at low loads
- Since, the optimum efficiency of boilers occurs at 65-85 percent of full load, it is usually more efficient, on the whole, to operate a fewer number of boilers at higher loads, than to operate a large number at low loads.

**12. By introducing helical ribs in the boiler tube.**

In this type of boiler effective heat transfer takes place because of turbulence created in the water the time taken by the water is increases slightly thus the fluid takes more heat. By this reason efficiency slightly increases.

## II. REVIEW CRITERIA

**1.** This Nancy Giges, Wisinski the scientist in the cleaver brooks has conducted an experiment on the boiler tubes by re-design of it. That became a 24-month process from initial concept, design, and validation through testing, engineers at Cleaver-Brooks started by designing a new boiler incorporating the idea of changing the burner. One critical factor was a re-design of the tubes within the boiler to increase heat transfer in the tubes. Engineers added helical ribs to the inside of the tubes, creating more turbulence of the hot flue gasses and thus more heat transfer.

**2**. But it was only with the aid of CAD embedded with CFD that engineers were able to perform extremely complex calculations on various elements of a boiler system, including analyzing problems that involve fluid flows. Calculations allowed simulation of the interaction of liquids and gases with surfaces, which in turn enabled engineers to improve the tube profile.
**3.**Stephen Wilcox, showed his talent as an inventor, and after a public school education and apprenticeship, began studying machines to see if he could improve them as well as thinking about new ways to build others. He received the first of close to 50 patents at the age of 23 for a hot-air engine for a lighthouse to produce fog signals.
**4.** Then, he turned his attention to developing an improved, safer boiler. At the time boiler explosions were very common and often ended tragically. Wilcox's improved water-tube boiler increased heating surfaces and allowed better water circulation. This, in turn, reduced the risk of explosion inherent in the earlier designs. Although the boiler wasn't perfect, it was safer and more efficient than earlier ones, and Wilcox was granted a patent in 1856.

## III. CONVENTIONAL BOILER

In the major power plants the main aim of them is to get the maximum efficiency. So we are considering the boiler which is the main part of the industry.
SPECIFICATIONS OF THE TUBE:

**Table 1 specifications of the tube**

| | |
|---|---|
| OUTER DIAMETER OF BOILER TUBE | 63.5 |
| INNER DIAMETER OF BOILER TUBE | 49.3 |
| LENGTH OF BOILER TUBE | 2000 |
| WALL THICKNESS OF BOILER | 7.1 |

**DESIGN:**

We used the CATIA software to design our boiler tube with the specifications mentioned above.
The boiler tube designed is comparable to that in the industry.

The designed product is as follows

**Fig no: 3 MESHING:**

To carry out the thermal and static analysis of the boiler tube which we are going to do in ansys. To get the better results in the ansys product fine mesh has to be done as loads applied in the ansys were equally applied at all the parts of product. So we used the hypermesh for meshing of our product.
By using the element "SOLID 45" and mesh as "HEX MAPPED MESH", we meshed the above designed components and obtained the following results.
The meshed figures are as follows:

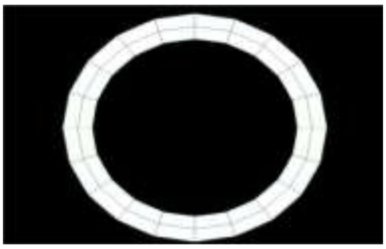


Fig 4 Side view of meshed pipe

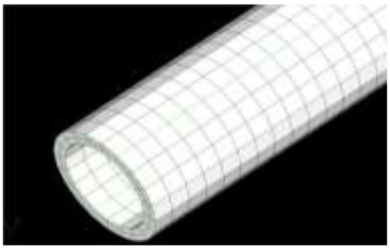


Fig 5 Mesh model of pipe

**ANALYSIS:**

For the conventional boiler tube we are going to perform the static and thermal analysis. So that we can check up to which loads the tube is going to withstand.

**STATIC ANALYSIS:**

The pressure inside the boiler tube varies from 1bar to 250 bar. If the pipe withstands at 250 bar (i.e., maximum pressure), it indicates that the pipe is safe at all other lower operating pressures. So the boundary conditions are

1. Pressure 250 bar = 25 MPa throughout the pipe
2. Line constrained

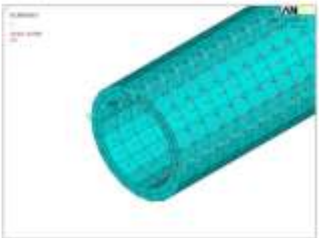


**Fig 6 Pressure applied on the pipe**

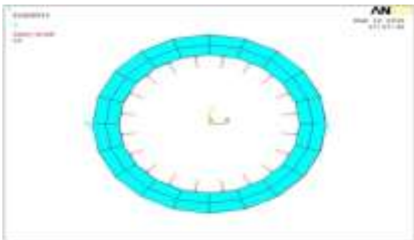


**Fig 7 Side view of pipe with application of pressure**

The above figures represent the application of pressures throughout the crosssection of the tube of pressure 25Mpa

The static analysis reports are as follows:

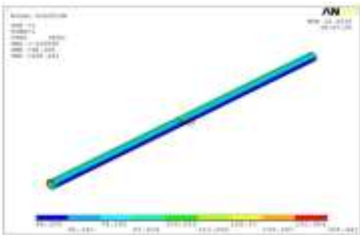


**Fig 8 Representation of the solution obtained**

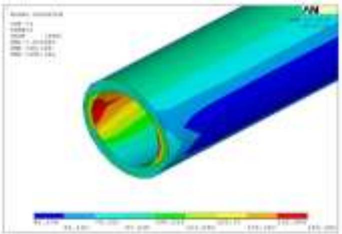


**Fig 9 Stresses distribution along the pipe**

The above figures represent the static analysis of the conventional boiler tube where the varying of the stresses was clearly observed. Throughout the entire pipe the stress is varying in the range of 48.106-87.218MPa. At the constrained point the stress formed is about 165.441 which is the peak stress and it is under safe.

**THERMAL ANALYSIS**

This analysis is carried out to check how the temperature distribution is taking place and how much thermal stress the pipe can withstand.

This analysis is done by considering the following boundary conditions.

**Table 2 Boundary conditions**

| s. no | TEMPARATURE(0C) |
|---|---|
| INNER TEMPARATURE | 350 |

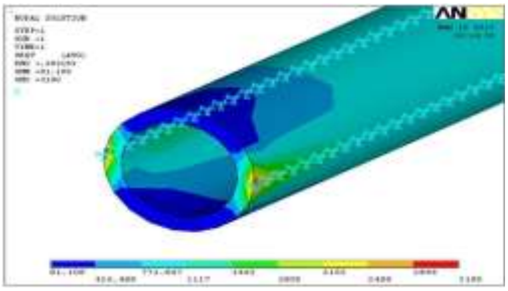


**Fig 10 Constrained pipe along the surfaces.**

In the figure shown above the pipe is constrained at the surfaces where the loads are applied on the pipe. The pie is constrained because we can't apply the loads at the free space. So the pipe is constrained.
The thermal analysis is performed on the pipe as to find the stresses obtained due to temperature and temperature distribution along the pipe.
The reports are as follows

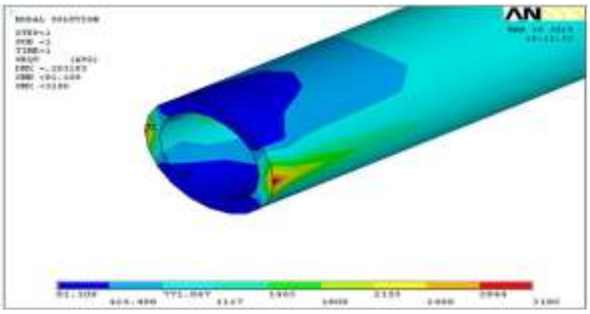


**Fig 11 Temparature distributions of the boiler pipe**

In the above thermal analysis report thermal stress is almost constant throughout the pipe. It's only varying at the ends of the pipe. As the pipe is constrained at that points, so that the stress generated in that points are high. As the flow through the pipe is continuous as that the water is converted to the high pressure steam the variations will be occurred. So that the fluctuations in the temperature is noticed. Here different colour in the figure represents the stress generated at the points on the pipe

**BOILER-HELICAL RIBS**

For a boiler to work efficiently, the main objective is to take more heat as possible from the furnace and transfer to the pipe lines to convert the steam as soon as possible. In this content we are modifying the design of the pipe where providing the internal helical ribs with different helical angles and the varying the number of ribs. The pipe designed with internal helical ribs was performed to static and thermal analysis.

**6.2 SPECIFICATIONS**

**Table 3 Specifications of the boiler tube**

| | |
|---|---|
| OUTER DIAMETER OF BOILER TUBE | 63.5 |
| INNER DIAMETER OF BOILER TUBE | 49.3 |
| LENGTH OF BOILER TUBE | 2000 |
| RIB THICKNESS | 3.5 |
| TYPE OF RIB CIRCLE | CIRCLE |

**DESIGN**

The boiler pipe with the internal helical ribs is drawn using CATIA with the different helical angles and no of ribs.

The following are images shown below

**Fig 12 Pipe with internal helical ribs**

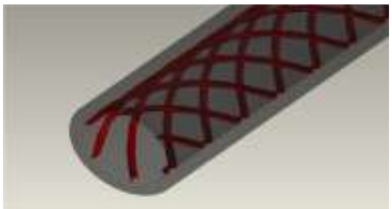


**Fig 13 Pipe with internal helical ribs**

**Fig 14 Side view of the tube with internal ribs**

These are the side view, top view of the boiler tubes which are designed with internal helical ribs.

The rib is added in the above case is circle as that it prevents the surface shear while the steam is flowing in the pipe. If any other cross-section is placed the surface gets shear as there will be sharp edges in case of square, polygon.

**STATIC ANALYSIS**

6.4.1.1 For the boiler pipe with the helical ribs at 45

6.4.1.2 Case I: 6 Ribs

The structural analysis of the boiler tube is done at the 45 degree angle

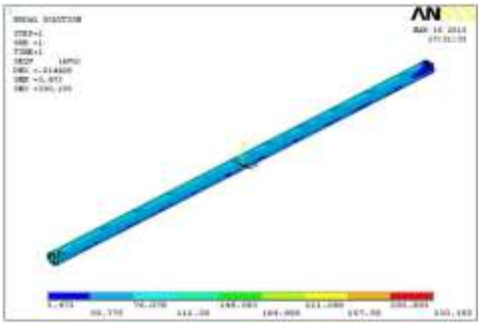


**Fig 15 Variations of pressure**

From the figure we can observe that stress generated along the pipe is of reasonable range and the peak value is obtained at the constrained point. The stress variations at the ribs are shown in the below figures.

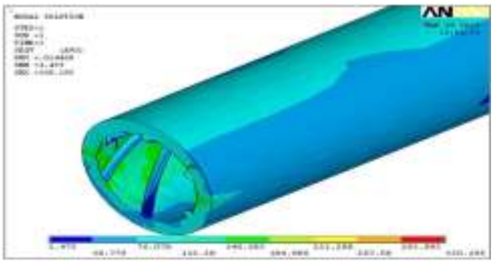


**Fig 16 Static variations observed clearly at the outlet of pipe**

**Fig 17 Stress variations clearly observed at the ribs**

**Case II: 8 Ribs**

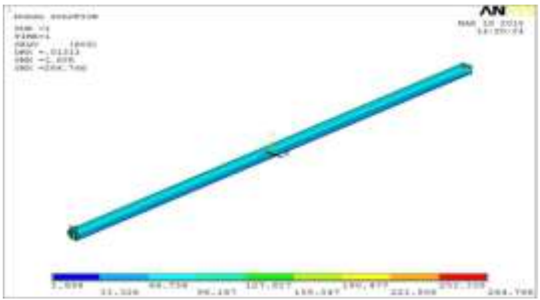


**Fig 18 Variations of the pressure Fig**

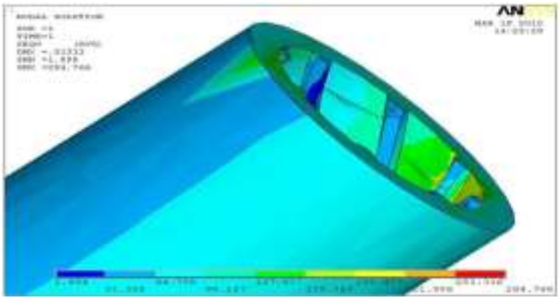


**fig 19 The static variations at the outlet of pipe**

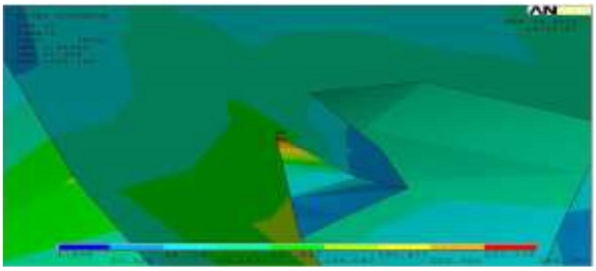


**Fig 20 Clear view of pressure at the ribs**

For the boiler pipe with the helical ribs at 60

**Case I: 6 Ribs**

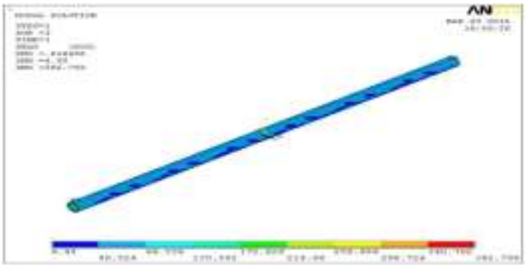


Fig21Variationinthepressure

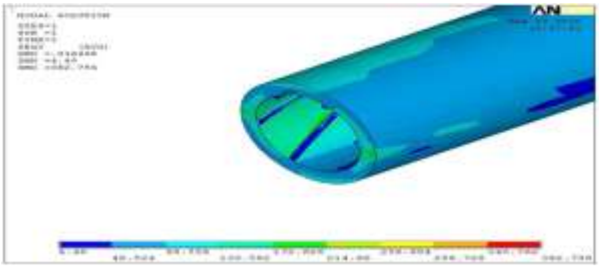


Fig: 22The static variations at the outlet of pipe

**CASE II: 8 RIBS**

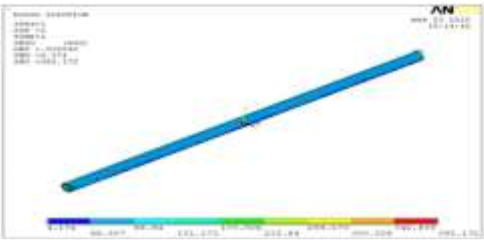


Fig: 23 variations of pressure

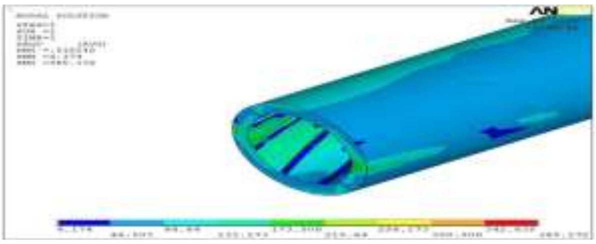


Fig 24 Static variations at the outlet of pipe

**THERMAL ANALYSIS:**

Thermal analysis of the pipe containing helical ribs at an angle 45

**Case I: 6 RIBS**

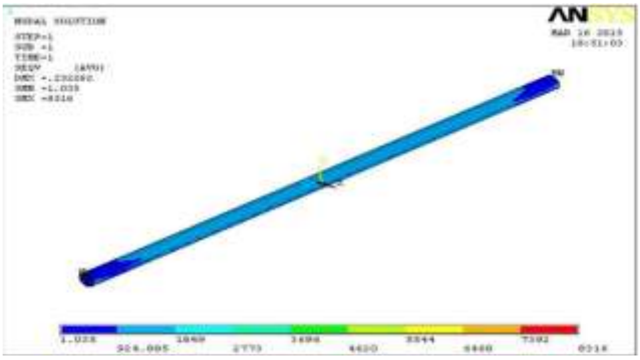


Fig: 25 Variations in the temperature

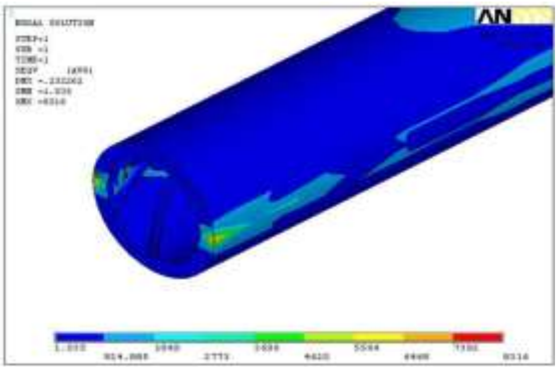


Fig: 26 Temperature variations at the outlet of pipe

**CASE II: 8 RIBS**

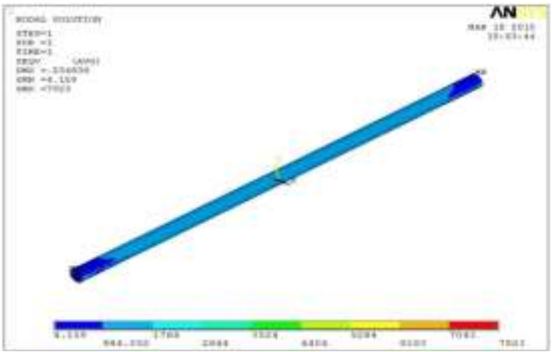


**Fig: 27 variations in the Temperature**

The variations in case of 8 ribs is clearly observed in the diagram and the temperature distributions are clearly represented at different points in the pipe.

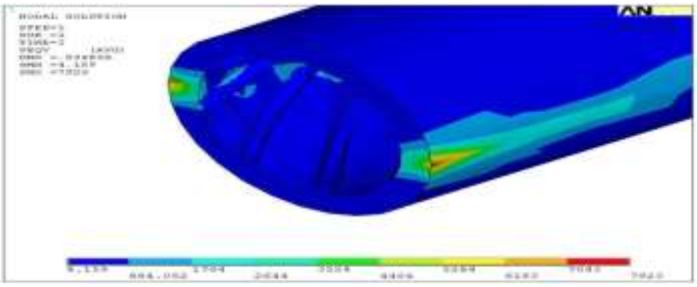


**Fig: 28 Temperature variations at the outlet of pipe**

**Helical ribs at an angle 60**
**Case I: 6 Ribs**

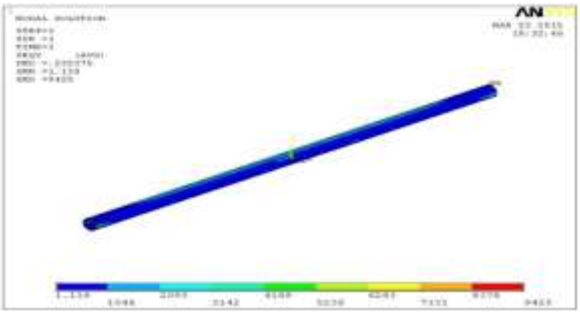


**Fig: 29 Temperature variations in the pipe**

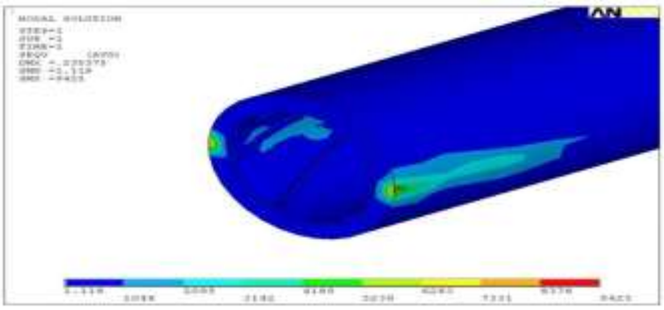


**Fig: 30 Temperature variations outlet of pipe**

**CASE II: 8 RIBS**

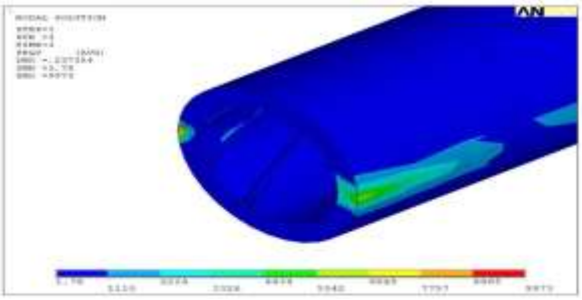


**Fig: 31 Temperature variations at outlet of pipe**

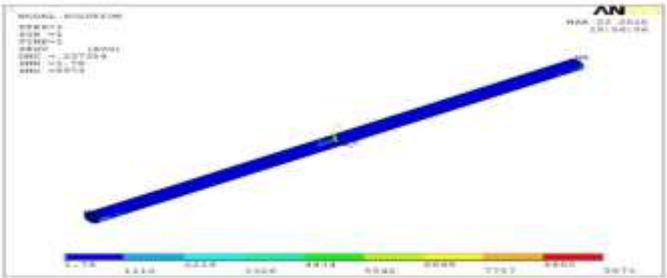


**Fig: 32 Temperature variations of the pipe**

The temperature analysis of the pipe different ribs and at different angles is performed and the distribution values are taken. The temperature distribution along the pipe is varies as that the presence of ribs inside the tube, the variations in the temperature will occurring and high at the presence of ribs.

## IV. COMPARISIONS (CONVENTIONAL V/S MODIFIED)

**STATIC ANALYSIS**

**CASE I: WITHOUT RIBS**

**Table 4 static results of boiler tube**

| S.NO | STRESS(MPa) |
|---|---|
| 1 | 165.441 |

**CASE II: WITH RIB S**

**AT 450 ANGLE**:

The peak stresses developed in the pipe at this angle are:

**Table 5 static results of boiler tube at angle 450**

| S.NO | NO. OF RIBS | STRESSES(MPa) |
|---|---|---|
| 1 | 6 | 330.195 |
| 2 | 8 | 284.766 |

The static distribution values are shown in the above table for different ribs.

**AT 600 ANGLE**:

The peak stresses developed in the pipe at this angle are:

**Table 6 static results of boiler tube at angle 600**

| S.NO | NO.OF RIBS | STRESSES(MPa) |
|---|---|---|
| 1 | 6 | 382.796 |
| 2 | 8 | 385.172 |

**THERMAL ANALYSIS**

**CASE I: WITHOUT RIBS**

**Table 7 Thermal distribution results of boiler tube**

| S.NO | STRESS(MPa) |
|---|---|
| 1 | 771.867 |

**CASE II: WITH RIBS**

**AT 450 ANGLE**:

The peak stresses developed in the pipe at this angle are:

**Table 8 Thermal distribution results of boiler tube at angle 450**

| S.NO | NO. OF RIBS | STRESSES(MPa) |
|---|---|---|
| 1 | 6 | 924.665 |
| 2 | 8 | 1764.619 |

The temperature distribution values are shown for a boiler tube with internal helical ribs alongs the pipe

**AT 600 ANGLE:**

The peak stresses developed in the pipe at this angle are:

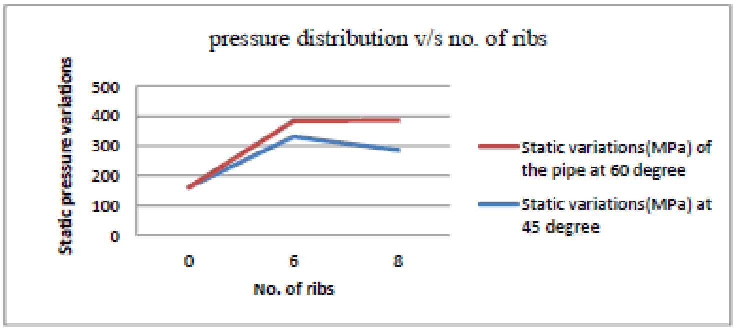
**Table 9 Thermal distribution results of boiler tube at angle 600**

| S.NO | NO.OF RIBS | STRESSES(MPa) |
|---|---|---|
| 1 | 6 | 2095.172 |
| 2 | 8 | 2218.796 |

## V. RESULT AND DISCUSSION

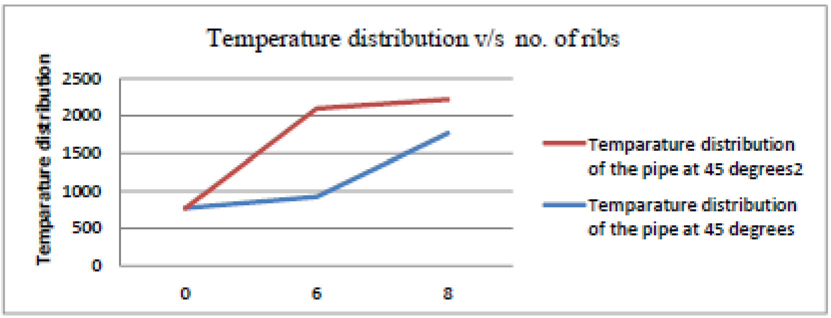
Here in this project we had compared the thermal stresses and static variations of the pipe differencing from the normal to the pipe with added internal helical ribs. The comparisons of the two pipes are performed.

The graph plotted for the static variations at internal helical ribs at different angles.:




Graph plotted between Static variations and number of ribs at different angles. We can observe that the static variations in the pipe are more when we give 6 ribs at an angle 600.

The graph plotted for the thermal variations at internal helical ribs at different angles.




The temperature distribution of the pipe at different angles is shown.

The value at the 6 ribs at the 450 degree angle is better when comparable to other ranges.

At the 6 ribs 450 angle the values of the static and thermal are better in both the cases. When comparable to the normal pipe the tube added with internal helical ribs was increased some parameters of the pressure variations and the temperature distribution.

## VI. CONCLUSION

A In order to prevent the deficiency of coal energy we have to extract more energy from the coal as maximum as possible.

In the boiler to produce the steam, coal is used as the burning agent. In order to reduce the coal the boiler should make more efficient. So the boiler pipe is concentrated to make it work more efficient.

As providing the internal helical ribs in the boiler tube the pressure variations occurred are in the optimum range when compared to the normal boiler tube. The temperature distribution is high at the outlet of the pipe when compared to the normal boiler pipe.

By providing the internal helical ribs the heat will transfer more in to the boiler pipe and make the water into steam quickly. So that the length of the pipe will decreased which reduces the production cost of excess pipe.

## SCOPE FOR FUTURE WORK

In the pipe with the helical ribs, if we use the Nano fluids the heat transfer rate will increases more.

These pipes are introducing in the tyres retyring operation plants where the seamless tubes of short span are used.

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