Analysis and Adaptation of Cost Effective Boiler

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Abstract - *Boiler as an integral part of an industry should not be just work efficient but also cost effective as well.. The furnace oil fired boilers leads to greenhouse gas emissions and secondary pollutants. Briquette as a fuel to address these problems is a better alternative. The Retrofication of Boiler can be done to make it possible. To balance the efficiency factor loss, additional modifications have been put in practice i.e., condensate recovery, redesigning of tubes along with changing its material also and generation of electricity through turbine blades. After all these modifications, in return we will get increase in boiler's overall performance including its ability to meet full load, auxiliary power consumption, net plant heat rate, availability of unit and would also reduce operation cost and maintenance cost.. .*

Key Words: Briquettes, cost effective, fire tube boiler, condensate recovery , power regeneration , steam tube design.

1. INTRODUCTION

1.1 General Introduction

The "Digichem Industries, Ambernath", works on a furnace oil fired boiler which increases the cost input by the company. The methodology of this project will help the company by reducing the fuel cost and other day to day routine practices which will be replaced by automation as we would be doing retrofication of boiler. The process of this project will ensure the usage of additional parts which can be taken into account and machines that will help reduce man power and will also help in fast processing by redesigning the current circuitry of tubes as design proposed in the project.

Also the project will help in selecting alternative recommendations such as fuel and material used in current boiler which will help in reducing the cost and which will be efficient in nature and also cheaper than the current ones.

1.2 Problem Statement

- The Company is using an expensive fuel
- The overall performance of the boiler is not that efficient
- Evaluation of the short comings in the traditional approach of the company.

2. Objectives

- To improve the boiler efficiency with economical consumption of fuel while providing the desired effect.
- To improve efficiency through condensate recovery.
- To design factory modifications to enhance the steam usage through tubes.
- To calculate heat losses due to unburned and exhaust gases.
- To generate electricity from exhaust gases through turbine blades.
- To increase heat conduction by using alternative material.

3. Methodology

The methodology that is followed to attain the research objectives is divided into the following work phases:

- **Fuel**

The fuel used in the boiler is furnace oil which is very costly. So, as per the objective economical consumption of fuel we used alternative fuel which is cheap but efficient. The alternative fuel used is biomass fuel which is solid fuel and also known as briquettes. But briquettes is slightly less efficient than furnace oil. This drawback can be recovered and with same efficiency as that of furnace oil boiler can be achieved by retrofication of boiler.

- **Condensate Recovery**

The trap water and the condensed water after condensation of steam can be recovered by using it again as inlet water supply. To achieve this we have to connect the outlet of condensed water and trap water to the inlet water tank. This will increase efficiency by 1-2% of overall boiler efficiency.

- **Designing Of Tubes**

The efficiency can be further increased by changing the dimension of tubes from circular to square or hexagonal and changing the material to copper or brass. This will increase efficiency by 4-5% as it increases the heat transfer and conduction rates significantly. Changing the dimension helps in reduction of condensation of steam hence, reducing trap water and changing the material increases heat conduction of surfaces.

- **Electricity Generation Through Turbine Blades**

The exhaust flue gases are very high in pressure and temperature. This property of boiler flue gases can be used for electricity generation. The turbine blades can be placed in the outlet of exhaust flue gases this will rotate the turbine blades as the exhaust flue gases expand as they pass through the blades. Hence electricity will be generated.

4. Working

The whole process comprises of generating heat energy in the boiler and then converting the water into superheated steam.

Fuel burns on the grate in the fire box. The resulting hot flue gases are allowed to pass through the tubes surrounding the cylindrical firebox. The water fed in the boiler receives heat by convection and radiation, thus steam is produced. The water circulation in the boiler depends on the density difference between in water.

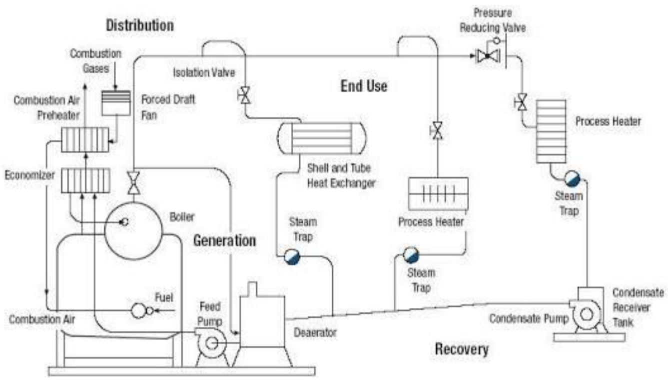

Fig 1. Schematic Diagram

5. Observations

Following observations were seen

A. Fuel Analysis

Fuel properties	Units	Furnace oil	Briquettes
Gross calorific value	kCal/kg	10,500	4799
Specific gravity	-	0.93	-
Bulk density	-	-	0.65
Carbon	%m	87	48.55
Hydrogen	%m	11	7
Oxygen	%m	1.03	41.93
Sulphur	%m	3.05	0.1
Ash	%m	-	1.63
Type of fuel	-	Liquid	Solid

Table 1. Fuel Chart

B. Emission Analysis

Gaseous emissions	Units	Furnace oil	Briquettes
Oxygen (O_2)	% Vol.	6.5	3.5
Carbon dioxide (CO_2)	% Vol.	11	8.6
Carbon monoxide (CO)	ppm	61	120
Sulphur Oxides (SO_x)	ppm	1343	70
Nitrogen Oxides (NO_x)	ppm	345	12

Table 2. Elements In Emission Gases

6. Design

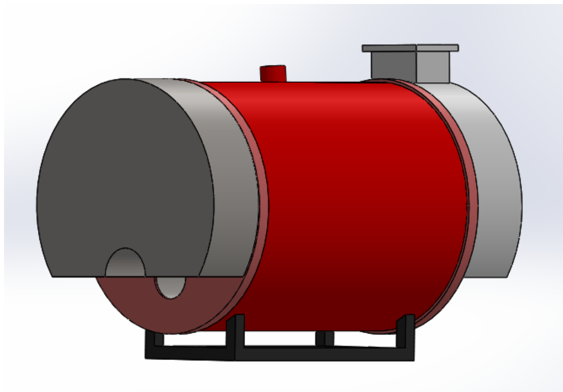

Fig 2. Front View

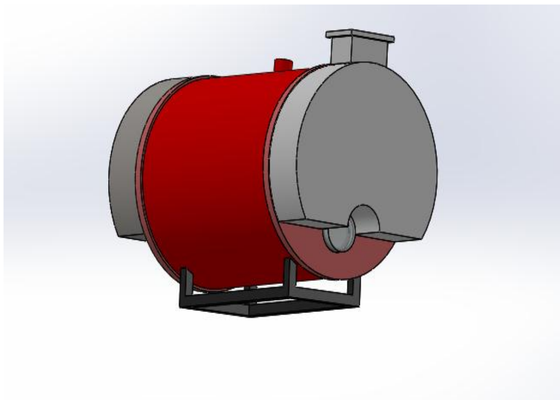

Fig 3. Back View

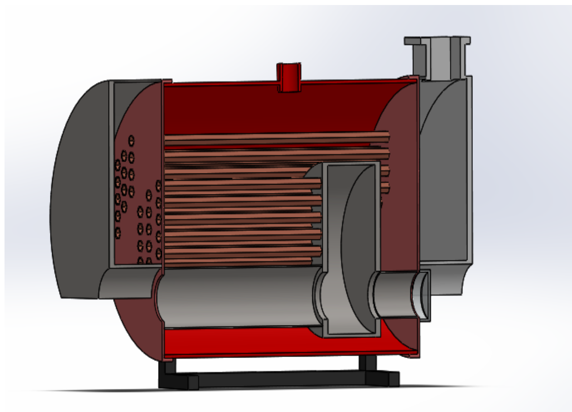

Fig 4. Cross-sectional View

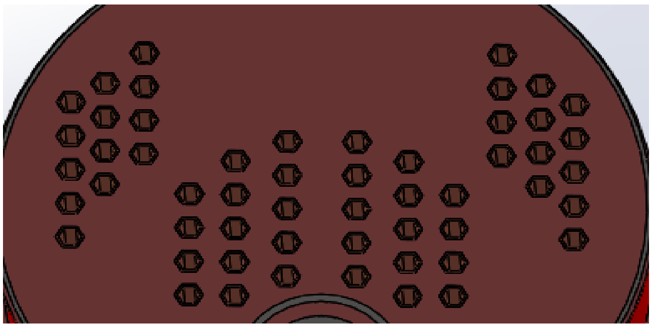

Fig 5. Hexagonal Shape of Tubes

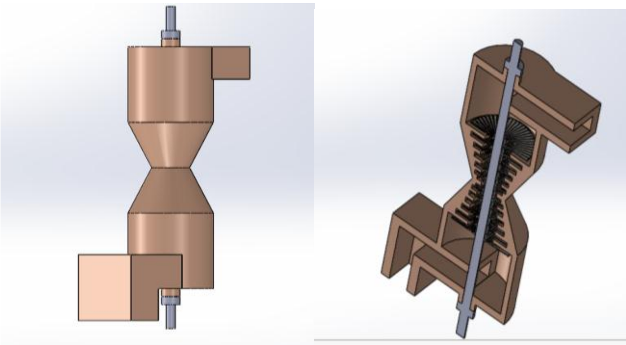

Fig 7. Turbine blades with cross sectional view

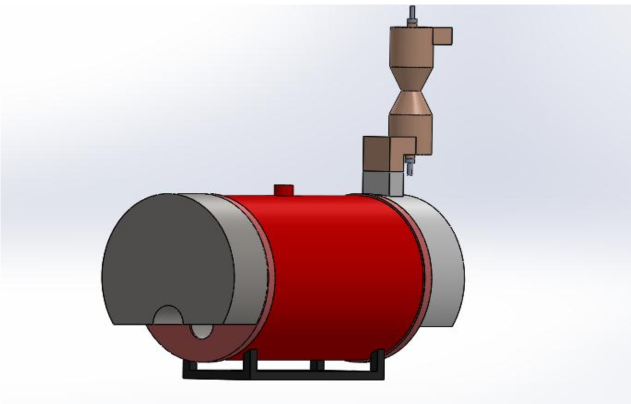

Fig 7. Boiler Assembly With Turbine Blades

7. Analysis

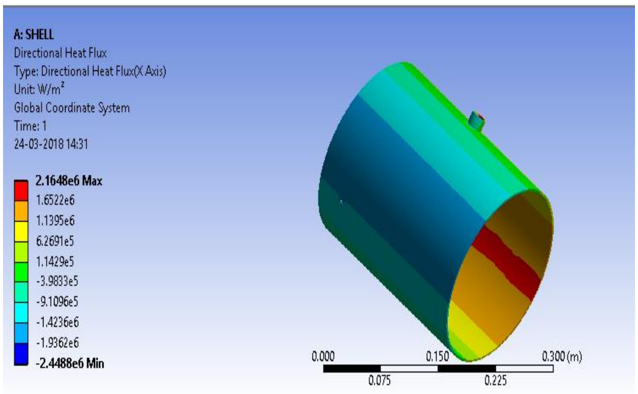

Fig 8. Shell

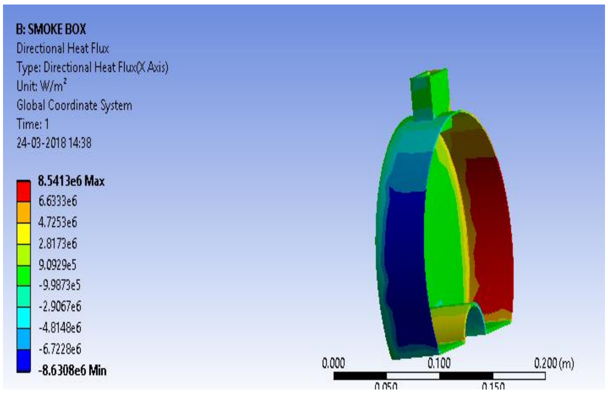

Fig 9. Smoke Box

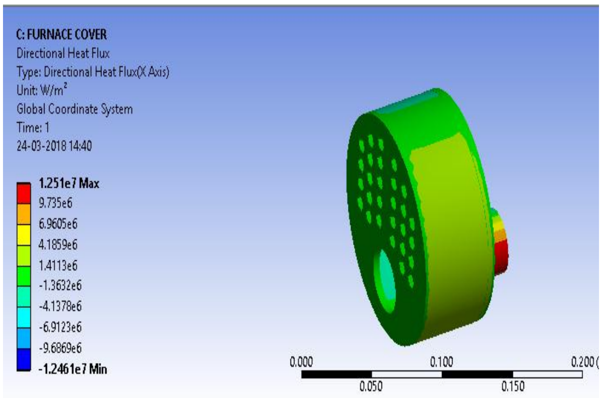

Fig 10. Furnace Cover

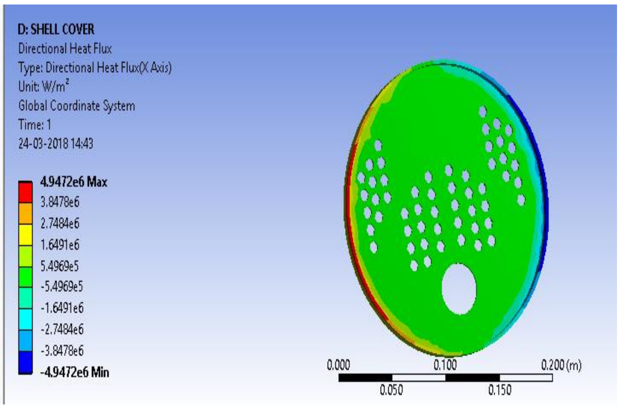

Fig 11. Shell Cover

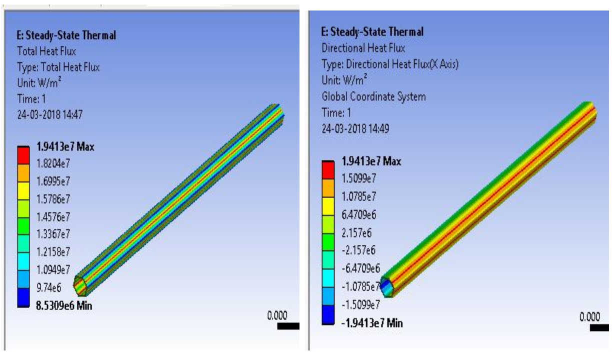

Fig 12. Hexagonal Pipe

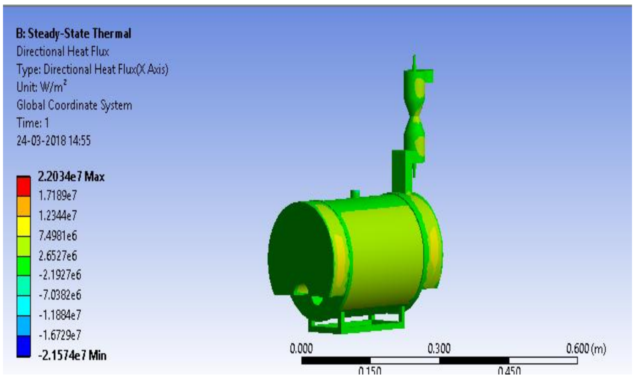

Fig 12. Assembly

8. Results

Losses (%)	Furnace Oil	Briquettes
Dry Flue Gas	7.86	5.47
H_2 In Fuel	7.08	2.43
Moisture In Fuel	0.033	1.53
Moisture In Air	0.38	0.12
Incomplete Combustion	-	1.57
Fly Ash	-	0.015
Bottom Ash	-	0.25
Radiation And Other Losses	0.5	8
Total	15.85	19.385
Total Efficiency	**84.15**	**80.615**

Table 3. Losses

8. Conclusion

The Boiler is made cost effective by using briquettes instead of furnace oil and the lack of efficiency can be overcome by redesign of tubes and condensate recovery and the capital cost of retrofication invested will be returned within 2-3 months as all this modifications done will lead the company a hefty profit per month.

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