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Energy Audit of Boiler at Chandigarh Distillers and Bottlers Limited

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Abstract: **Boiler is one of the essential component of thermal power plant. The overall performance of the plant is highly dependent on the performance of the boiler. This study presents the energy audit of the boiler. The boiler taken up for analysis has a steam generating capacity of 55 tonnes per hour with 500°C of steam temperature and 67.5 kg/cm^2 of steam pressure. The specifications of the boiler have been described. The properties of the fuel used have been considered. The ultimate analysis and proximate analysis of the fuel was performed. Flue gas analyser was taken to the boiler plant and the results has been shown. By minimising the various losses at the plant the overall profit and efficiency of the boiler have increased. Various components such as storage tank, variable feed drive motor and rice husk feeder are taken into account for analysis and studied. Excess air used in the furnace is the cause of major exergy destruction in the boiler.**

1. INTRODUCTION

Biomass based steam power plants use fuels like rice husk, groundnut shell, fire wood, coconut and other agro waste & municipal solid waste (instead of conventional fuels like coal) burnt in biomass fired boiler to generate steam at high pressure. Due to the rapid depletion of conventional fuels there is increasing demand for using renewable sources of energy and use of biomass seems to be an alternative to conventional fuels in generating power. The object of this paper is to discuss various exergy losses in the boiler and to minimise them to increase the efficiency of the boiler. Moreover analysis is done to increase the profit of the industry by saving the fuel and electricity generated. The analysis uses parameters of a working biomass based steam power plant of 55 tonnes per hour capacity. Most of the plants are analyzed and reported in literature are pertaining to either plants of more than 100 MW capacity or it is less than 1MW capacity. Plants of the capacity less than 1 MW are mostly of academic interest and outcome of the reports indicate the total efficiency. As per the recent studies conducted on exergy analysis of plants are either directly coal fired plants or large capacity gas turbine plants. As on today to overcome the fast depletion of fossil fuels and support the renewable energy options for power generation there is a scope for biomass based power plants. Biomass can be used for either direct combustion in the specially designed waste recovery boiler or can be converted into useful syn gas by thermo chemical gasification.

2. EXPERIMENTAL SETUP

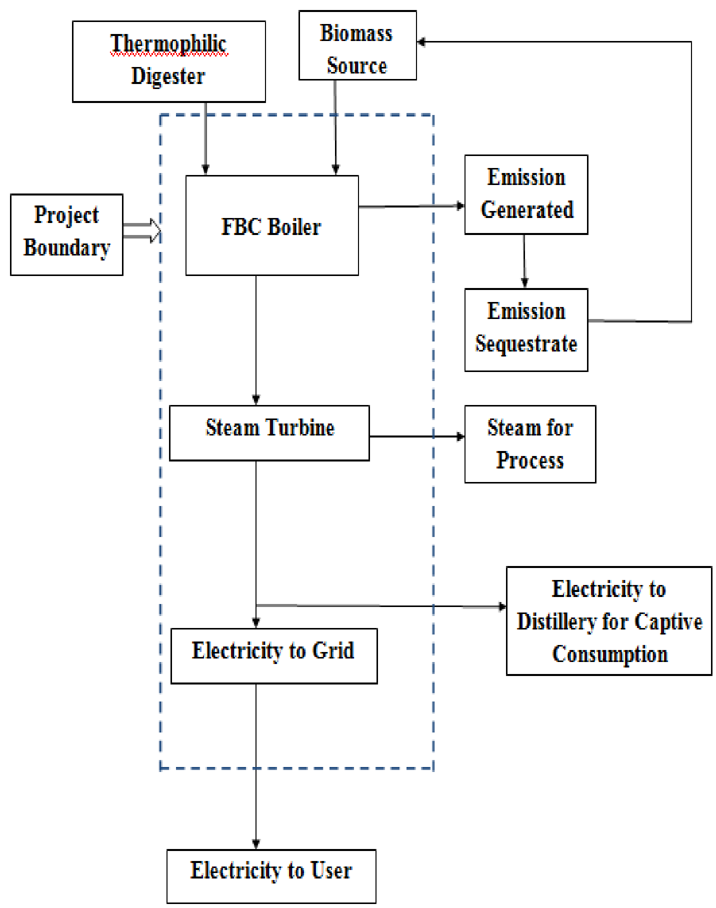

Fig. 1: Experimental Setup

As the aim of this study is to improve the efficiency of the boiler so I am using the data and thermophysical parameters of the fluidised bed combustion boiler which is installed at banur distillary and bottlers limited. This boiler is having the following specification:

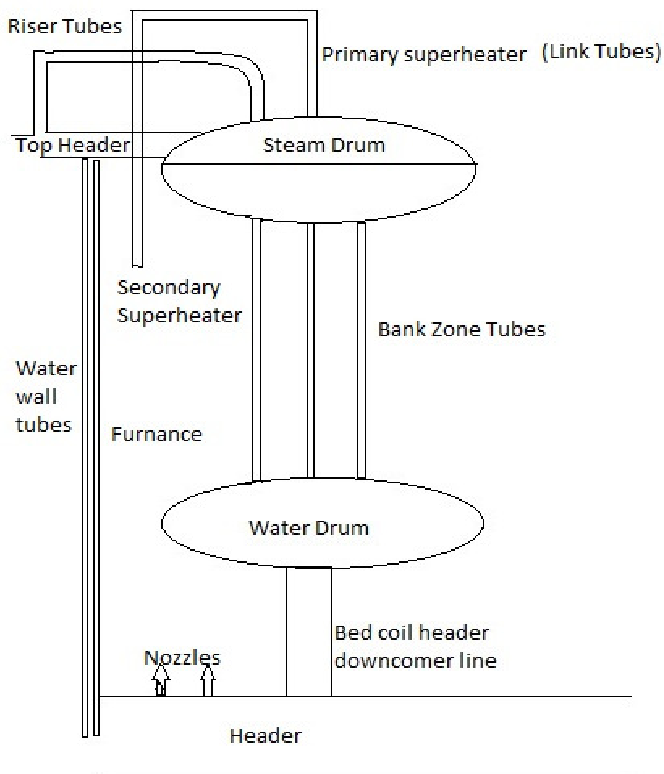

Fig. 2: Energy Flow Diagram

TABLE 1: Specifications of boiler

Specification	Units	Value
NCR Evaporation (Gross)	T/hr	42
Peak evaporation (half an hour in a shift)	T/hr	110%
Steam pressure at main steam stop valve outlet	Kg/cm2(A)	66
Steam temperature at main steam stop valve outlet	°C	495+/-5
Feedwater temperature at inlet of economiser	°C	115/130
Steam temperature control range	%	75-100
Fuel for load carrying	Rice husk	100%
Fuel size	Rice husk	Natural

2.1 Energy flow in boiler is shown in the following figure.

The boiler above shown is a atmospheric fluidisation bed combustion boiler. It is a 55 tonnes per hour boiler. It has got a 8.25 MW turbine and a 9 MW alternator. The induced draught fan, forced draught fan and feed pump are 220 hp, 220 hp and 430 hp respectively. The rpm are 740, 1400 and 3000 respectively. Above header is air box in which forced air is sent. Above air box is DB plate on which nozzles are mounted. The nozzles are 3600 in number. The riser tubes are 17 in number and the 4 inches in dia. The diameter of the water wall tubes is 2 inches. In the steam drum 50% is steam and 50% is water. The link tubes are 16 in number. The air pre-heater duct has got 1200 number of tubes and their diameter is 2 inches. Inside the tubes flue gases are flowing and outside is forced draught air. 3 pumps are there to pump water from feed tank to de-aerator tank or dome tank but only one is sufficient to pump. Screw feeders are used to feed husk in the boiler. Secondary air is used along with it to spread the husk properly in the boiler so that proper combustion takes place. Nozzles are used to cause bubbling in the boiler. The bed of the boiler contains sand. Forced draught air is passed through the holes in the nozzles. The feed pressure is 100 kg/cm2. The temperature of steam in primary super-heater is 500°C and in secondary super-heater is 550°C. The temperature at APH or Economiser outlet is 100°C.

2.2 Fuel Used

The fuel used in this boiler is biomass fuel which is rice husk. Rice husk is used because of its easy availability and less cost. The proximate, ultimate analysis and calorific value of the fuel used are shown in the following tables:

TABLE 2: Proximate Analysis

S. No.	Composition	% by Weight
1.	Fixed Carbon	7.5
2.	Moisture	16.60
3.	Volatile Matter	58.4
4.	Ash	17.50

TABLE 3: Ultimate Analysis

1.	Carbon	37.50
2	Hydrogen	3
3	Oxygen	24.42
4	Moisture	16.60
5	Sulphur	0
6	Nitrogen	.98
7	Ash	17.50
8	G.C.V(kcal/kg)	3100

3. RESULTS AND DISCUSSIONS

The flue gases which are coming out of the boiler are analysed by using Flue Gas Analyser and the composition of the flue gases obtained are shown in the following table:

TABLE 4: Flue Gas Analyser Results

S. No	Composition	Percentage
1	Carbon dioxide	12.2
2	Carbon monoxide	0.4
3	Oxygen	8.1
4	Nitrogen	80.5

Excess Air = $\frac{8.1}{21-8.1}$

Excess Air = 62.79%

As per the percentage of oxygen shown by the Flue Gas Analyser, the percentage of excess air going along with the flue gases out of the chimney comes out to be 62.79%. To control the amount of excess air in the flue gases variable speed drive motor must be installed. It will save the electricity consumption of the factory and it will increase the efficiency of the boiler.

From the table 3.1 the actual composition of the flue gases going out of the chimney is known to us. The analysis of the flue gases if complete combustion of each component takes place and theoretical calculations are shown in the following table.

TABLE 5: Theoretical Results

S. No.	Composition	% by weight
1	Carbon dioxide	12.9
2	Water	0.4
3	Oxygen	0
4	Nitrogen	82.7

4. ENERGY AUDIT

4.1 Types of Energy Audit

a) Targeted audits: Targeted energy audits often result from preliminary audits. They provide data and detailed analysis on specific targeted projects.

b) Comprehensive audits: Comprehensive audits involve detailed energy surveys of plant, equipment and the fabric of buildings, which is a time consuming and expensive process.

c) Preliminary audits: Preliminary energy audits seek to establish quantity and cost of each form of energy used in a facility or in an organisation.

3.2 Energy Audit at Chandigarh Distillary and Bottlers Limited

1. No insulation is provided on storage tank. With the passage of time the insulation of the storage tank has come down and rusting has also taken place. If insulation is provided on storage tank steam used in the deaerator can be saved.

2. Feeding of rice husk in the vibrating screens at the plant is done manually. If a tractor is used instead of labourers time as well as money can be saved which will overall increase the profit of the company.

3. Two rice husk feeders at the company are not working properly due to which large quantity of rice husk is going waste. If these are replaced with the new ones this wastage can be stopped and the steam generation of the plant can be increased.

4. Variable speed drive motor is not working at the factory for the past 5 years which leads to increase in the current load of the plant. Moreover excess air is going in the furnace due to which lot of rice husk is going out of the chimney unburnt. If variable speed drive motor is installed at the plant the efficiency of the boiler can be further increased and the oxygen amount in the flue gases can be controlled.

5. CONCLUSION

1. By providing insulation on the storage tank 19 tonnes of steam can be saved in the deareator .
2. By using a tractor for feeding of rice husk on the vibrating screen 3000 rupees can be saved daily.
3. By installing new rice husk feeder 1000kg of rice husk can be saved daily which goes wasted.
4. By using variable speed drive motor the excess air going in the furnance can be controlled as well as the electricity consumed per day can be saved upto 30%.

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