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# Energy Conservation in Bagasse Fired Boiler

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***Abstract:*** Boiler is an essential component for industry. Performance of boiler is very much concerned now a day because of energy crises. It is not only required to improve the effectiveness of plant but also to improve the profitability and productivity of the industry. The easiest and most cost effective method is to estimate the efficiency value on five broad elements: Boiler stack temperature, Heat content of fuel, Fuel specification, Excess air levels & ambient air temperature and relative humidity. The paper is focused on the performance of the boiler used in sugar mill. They used bagasse as fuel for combustion. The current study puts forward an effective methodology for the performance evaluation of a boiler based on work done by some of the experts in the field of thermal/energy studies and enlists some of the factors that affect the performance of the boiler.

***Keywords:*** *Boiler, efficiency, energy savings*

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## I. Introduction:

Steam systems are a part of every industry now days. Evaluation of boiler performance like evaporation ratio and efficiency reduces with time, heat transfer fouling, due to poor combustion, poor maintenance and operation. Performance of boiler is also depends on quality of fuel and water. The purpose of Efficiency testing is how far the boiler efficiency drifts away from the best efficiency. Any observed abnormal deviations could therefore be investigated to pinpoint the problem area for necessary corrective action. Hence it is necessary to find out the current level of efficiency for performance evaluation, which is a pre requisite for energy conservation action in industry.

- Purpose of the Performance Test
  To find out the efficiency of the boiler
  To find out the Evaporation ratio

The purpose of the performance test is to determine actual performance and efficiency of the boiler and compare it with design values or norms. It is an indicator for tracking day to day and season to season variations in boiler efficiency and energy efficiency improvements. Energy is the driver of growth. International studies on human development indicate that India needs much larger per capita energy consumption to provide better living conditions to its citizens. But such growth has to be balanced and sustainable. Two important concepts here are energy management and conservation. Planning commission of India has estimated that India has conservation potential at 23% of the total commercial energy generated in the country. India's energy requirement comes from five sectors; agriculture, Industry, transport, services and domestic, each having considerable saving potential. For example, energy costs amount to 20 percent of the total production cost of steel in India which is much higher than the international standards. Similarly the energy intensity per unit of food grain production in India is 3-4times higher than that in Japan. Sustainable growth also implies that our energy management and energy conservation measures are eco-friendly and accompanied by minimum pollution, in particular minimum carbon emission.

## II. Fuel

There are many fuels which are used in boiler and they are divided in main three types: (1) solid fuels (2) liquid fuels (3) gaseous fuels. The selection of right type of fuel depends on following factors such as availability, storage, handling, pollution and landed cost of fuel. The knowledge of the fuel properties helps in selecting the right fuel for the right purpose

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and efficient use of the fuel. Our study is focused on bagasse, by product of sugar industries.

Sugarcane is one of the most promising agricultural sources in the world which is used as biomass energy. There are two types of biomass can be produced from sugar cane, Cane Trash and bagasse. Cane Trash is the field residue remaining after harvesting the Cane stalk, and bagasse is the fibrous residue left after milling of the Cane, with 40-50% moisture content and consisting of a mixture of hard fiber. Bagasse contains mainly cellulose, semi cellulose, lignin, Sugars, wax, and minerals. The quantity obtained varies from 25 to 35% on Cane and is mainly due to the fiber portion in Cane and the cleanliness of Cane supplied. The composition of Bagasse depends on the quality of Sugarcane as well as harvesting methods applied and efficiency of the Sugar processing. Calorific value of bagasse is highly depending on moisture content. i.e. the lower the moisture content, the higher the calorific value[2]. For every 100 tons of Sugarcane crushed, a Sugar factory produces nearly 25-30 tons of wet Bagasse. When bagasse burned in quantity, it produces sufficient heat, by use of this heat electrical energy is produced. The resulting $CO_2$ emissions are equal to the amount of $CO_2$ that the Sugarcane plant absorbed from the atmosphere during its growing phase. According to the International Sugar Organization (ISO), Sugarcane is a highly efficient converter of solar energy. It also gives the highest annual yield of biomass of all species. Roughly, 1 ton of Sugarcane biomass-based on Bagasse, foliage and ethanol output – has an energy content equivalent to one barrel of crude oil [3].

## III. Methodology

The actual efficiency can be measured easily by measuring all the losses occurring in the boilers using this method. The demerits of direct method can be solved by indirect method; it calculates the various heat losses in the boiler system. The efficiency can be calculated by subtracting the heat loss fractions from 100[4].

The following losses are applicable to liquid, gas and solid fired boiler:

L1. Loss due to dry flue gas
L2. Loss due to hydrogen in fuel (H2)
L3. Loss due to moisture in fuel (H2O)
L4. Loss due to moisture in air (H2O)
L5. Loss due to carbon monoxide (CO)
L6. Loss due to surface radiation, convection and other unaccounted
L7. Unburnt losses in fly ash (Carbon)
L8. Unburnt losses in bottom ash (Carbon)

Boiler trail has been carried out and all data required for calculations has been measured. All loses mentioned above has been estimated by using various equation and tabulated below

| **Input/output Parameter** | | **%** |
|---|---|---|
| **Heat Input in fuel Various Heat losses in boiler** | = | 100 |
| 1. Dry flue gas loss. | = | 5.08 |
| 2. Loss due to hydrogen in fuel. | = | 8.367 |
| 3. Loss due to moisture in fuel. | = | 7.55 |
| 4. Loss due to moisture in air. | = | 0.184 |
| 5. Partial combustion of C to CO | = | 1.035 |
| 6. Radietion and convection loss | = | 3.173 |
| 7. Loss due to Unburnt in fly ash | = | 0.0205 |
| 8. Loss due to Unburnt in bottom ash | = | 0.4628 |
| **Total Losses** | = | 25.8723 |
| **Boiler Efficiency** | = | 74.1277 |

## IV Result and Discussion

- **Efficiency v/s GCV of fuel**

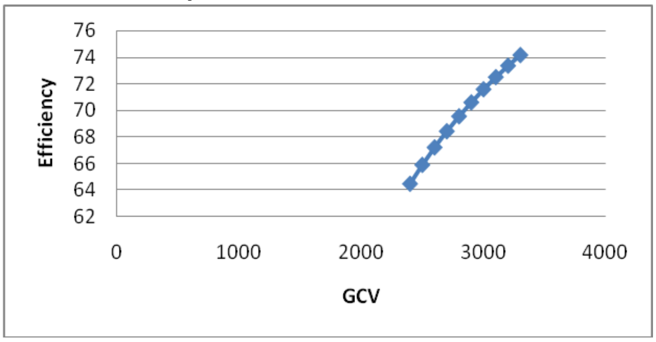


Fig.9: Efficiency v/s GCV

- As shown in figure we can say that if the GCV of fuel is increase than the efficiency is increase. There for the GCV of fuel is higher required for higher efficiency of boiler
- **Efficiency v/s moisture content**

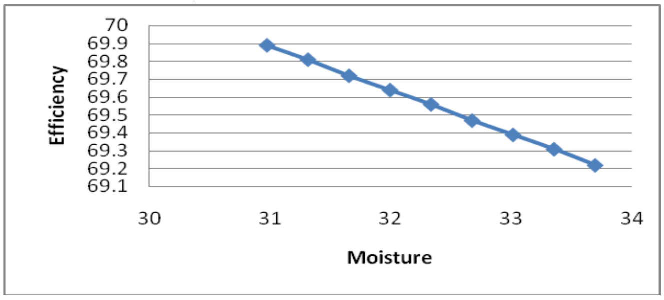


Fig.10: Efficiency v/s moisture

- The moisture percentage is increase in fuel so it affects heat supplied directly and efficiency is decrease.

- **Efficiency v/s Excess Air**

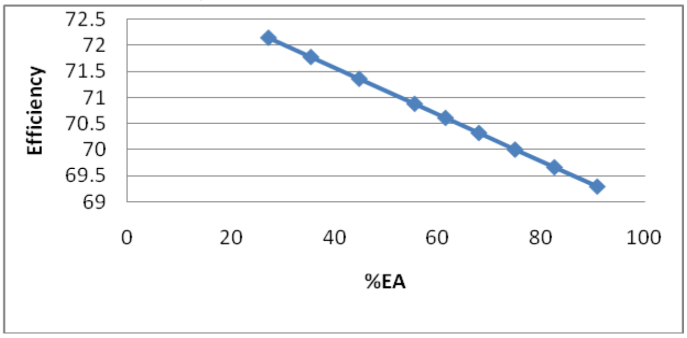


Fig.11: Efficiency v/s %EA

- The incomplete combustion is produce due to increase in excess air. And it also produce carbon dioxides or carbon monoxide, this gases are affect the environment and efficiency decrease with increase excess air.

## V Recommendation

**Controlling of Excess Air:**

Losses due to flue gases can be reduced by controlling excess air to an optimum level; by reducing excess air to 1% efficiency can be raised by 0.6%. Excess air can be controlled by various methods.

Portable oxygen analysers and draft gauges can be used to help the operator to manually adjust the flow of air for optimum operation.Excess air can be reduced by 20% by this method.

Continuous oxygen analyser is the most common method with a local readout mounted draft gauge, by which the operator can adjust air flow. A further reduction of 10–15% can be achieved over the previous system.

The continuous oxygen analyzer can have a remote controlled pneumatic damper positioner, by which the readouts are available in a control room. This helps an operator to remotely control a number of firing systems simultaneously. The most advanced system is the automatic stack damper control, whose cost is really justified only for large systems.

Calculation:

% Fuel saving = (η2 – η1)/η2 * 100
= (74.641-74.1166)/74.641 * 100
= 0.7026 %
= (0.7026*7187.5)/100 kg/hr
= 50.50 kg/hr
= 442.38 Tn/yr
= 1327140 Rs. /year

**Reduced moisture in bagasse:**

All sugar industries are used wet bagasse as fuel. The moisture content on the bagasse is effort on the calorific value (CV) of bagasse and boiler efficiencies. Industries and research institutes have been working to reduce the moisture content of mill wet bagasse. The average moisture content in the bagasse is 51.5%. So dryers are used to reduce moisture in bagasse around 45% of wet bagasse was routed through the dryer.

The Bagasse dryer is installed between the boiler ID fan and the chimney. The wet bagasse from the mill is drawn from the bagasse elevator and is transported to the dryer by beltconveyor. The dried bagasse is transported back to the main bagasse carrier for boiler by another belt conveyor. The flue gas to the dryer is taken from the existing ducting that connects the outlet of the boiler to the chimney through to the dryer fan.

The bagasse feed to the dryer is controlled through rotary valve. The dryer fan moves the fuel gases and bagasse mix throughout the dryer tube where the temperature of the fuel gases and the moisture in the bagasse is reduced. Dried bagasse and fuel gases are separated in cyclone separators. The dried bagasse is discharged on the belt conveyor at the bottom of the cyclone and the fuel gases are discharged to atmosphere.

Calculation:

% Fuel saving = (η2 – η1)/η2 * 100
= (75.2848-74.1166)/75.2848 * 100
= 1.55 %
= (1.55*7187.5)/100 kg/hr
= 111.41 kg/hr
= 975.95 Tn/yr
=2927854.8 Rs/year

**Reduce flue gas temperature by using air preheater:**

The heat of waste flue gas can be used to raise the temperature of combustion air before using for the combustion. The waste heat is taken from the boiler flue gas. As an approx 1% thermal efficiency will be increased by raising temperature by 20degree C of combustion air.

The purpose of the air preheater is to recover the heat from the boiler flue gas which reduces the heat of waste flue gas and increases the thermal efficiency of the boiler.

% Fuel saving = (η2 – η1)/η2 * 100
= (75.0107-74.116)/75.0107 * 100
= 1.19 %
= (1.19*7187.5)/100 kg/hr
= 85.65 kg/hr
= 750.32 Tn/yr
= 2250966.012 Rs. /year

**Reduce radiation heat losses:**

"The loss of heat from boiler surface to the atmosphere is termed as radiation loss"

Radiation losses can be decrease by using proper refractory inside boiler surface and insulation outside boiler surface.

At particular interval the refractory is need to be replace which reduces radiation loss. But it's difficult as well as costly & time consuming to replace it. So we can use thermal camera by which we can identify the high temperature spot areas in form of thermal image and we can replace refractory at that particular point where temperature is higher. According to ASME standards the radiation loss must be only 1.5%.so by

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using proper thermal insulation and refractory we can keep radiation loss up to 1.5%.

% Fuel saving $= (\eta 2 - \eta 1)/\eta 2 * 100$
= (75.786-74.116)/75.786 * 100
= 2.2025 %
= (2.2025*7187.5)/100 kg/hr
= 158.31 kg/hr
= 1386.76Tn/yr
= 4160247.18 Rs. /year

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