Abstract

In the past years, there are a number of ways to increase boiler performance like air pre-heater (APH) which recover waste heat from flue gases then use it to pre-heat combustion air. Bagasse drying can save more energy than APH. In this study, different types of losses are being calculated (such as heat loss due to dry flue gas, formation of water from $H_2$ in fuel, moisture in fuel air, partial conversion of C to CO, radiation unburnt in fly ash) in boiler performance with dryer and without dryer, all input data’s are taken from TRIVENI ENGG. INDUSTRIES and DHAMPUR SUGAR MILL. The objective of this study is to do a comparative study of boiler performance with and without using bagasse dryer. The data has been collected from sugar industries and boiler performance has been checked by using bagasse dryer and without dryer. When dryer is used the cost estimation and amount of fuel saving (8.8 ton fuel saved with dryer for same steam generation) has also been done in this study on the basis of that the payback period of bagasse dryer has also been calculated (On the basis of experimental work, It was found that the efficiency of boiler increase (7.61% with bagasse with dryer). The major losses like dry flue gas loss (improved 0.37% with dryer), loss due to formation of water from hydrogen in fuel (improved 2.23% with dryer), loss due to moisture in fuel (improved 5.02% with dryer), loss due to unburnt (improved 0.14% with dryer). The socio-economic impact of this study that it reduces air pollution bagasse which is environmental necessity. The process of bagasse drying using flue gases is economic necessity, as it improves the efficiency of the plant & reduces the requirement of fuel supply. The profit of the plant increases, which will ensure the timely payment to the farmers. The prosperity of the farmers will increase which will reduces the suicide case of the farmers. Ultimately it will help in the development of rural area.

Keywords: Bagasse, Sugar Mill, Bagasse dryer, Air Pre-Heater

1.0 Introduction

The rapid depletion of fossil fuel resources has necessitate d an urgent search for alternative sources of energy. To fulfill its energy requirements every country is dependent on diverse sources. These sources are categorized predominantly as commercial and uncommercial sources. The commercial part incorporate the fossil fuels (oil, coal and natural gases), nuclear and hydroelectric power, whereas uncommercial sector includes zoological wastes. In mechan ed countr y like USA majority of the energy requirement is fulfilled via commercial sources. On the contrary in developing countries like INDIA, there is unequal distribution in the usage of commercial and un-commercial sources.

1.1 Requirement for Cogeneration

Warm power plants are a noteworthy wellspring of power supply in India. The traditional strategy for control age an d supply to the client is inefficient as in just about 33% of the essential vitality encouraged into the power plant is really influenced accessible to the client as power. In traditional power plant, effectiveness is just 35% and staying 65% of vitality is lost. Therea wellspring of misfortune in the transformation procedure is the warmth rejected to the encompassing water or air because of the inborn limitations of the distinctive thermodynamic cycles utilized in influenc e age. Additionally further misfortunes of around 10– 15% are related with the transmission and circulation of p ower in the electrical network.

1.2 Cogeneration

Cogeneration is the generation of in excess of one valuable type of vitality, (for example, process warmth and electric power) from a similar vitality source. Cogeneration frameworks frequently catch generally squandered warm vitality, normally from a power delivering gadget like a

Performance evaluation Of Boiler In 46mw Bagasse Based Cogeneration Power Plant

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warmth motor (e.g., steam-turbine, gas-turbine, diesel-motor), and utilize it for space and water warming, modern process warming, or as a warm vitality hotspot for another framework segment.

The "falling" of vitality use from high-to low-temperature utilizes, regularly recognizes cogeneration frameworks from ordinary separate electrical and warm vitality frameworks (e.g., a power plant and a mechanical heater), and from basic warmth recuperation procedures.

The vital specialized favorable position of cogeneration frameworks is their capacity to enhance the effectiveness of fuel use in the creation of electrical and warm vitality. Less fuel is required to deliver a given measure of electrical and warm vitality in a solitary cogeneration unit than is expected to create similar amounts of the two kinds of vitality with particular, customary advances (e.g., turbine-generator sets and steam boilers). This is on the grounds that warmth from the turbine-generator set, which utilizes a generous amount of fuel to flame the turbine, ends up valuable warmth vitality (e.g., process steam) in a cogeneration framework rather squander warm. Diverse sorts of co-generators have distinctive fuel-utilize attributes and create distinctive extents of power and steam. The power to warm proportion alludes to the relative extents of electrical and warm vitality created by a cogeneration unit.

2.0 Literature Review Of Drying Concepts

Drying process is mainly used to decrease the moisture from a wet solid material by bringing this moisture into/a gaseous phases. Mostly drying operation are used all sugar factory because drying process is the main process of increasing the efficiency of industries. According to this process which results in quality enhancement, and ease of handling and processing (Sokhansanj and Jayas 1995). A drying process is a similar process heat and mass transfer operation which is widely used thermal energy applications (Hossain and Bala 2002) when the fuel is supplied and increase the temperature then the heat is transported through convection from the surroundings to the surfaces area. When heat supplied into surface area then conduction the small particle through the drying (Midilli 2001; Dincer and Hussain 2002). The moisture is decrease in maximum quantity (Midilli and Kucuk 2003; Syahrul et al 2002).

Thus, in present time is very competition time all industrial field that increase the efficiency of industries. So one of the most important challenges of the drying factory is to minimize, the cost of energy sources for good quality dried products (Dincer 1998). The heat sources with the greatest potential for drying energy in process industries are secondary heat flows like flue gases and low pressure steam varying from 3 to 4 bar.

2.1 Bagasse Drying Review

The flue gases flowing from bagasse fired boilers have temperatures around 300°C. The first interest shown in bagasse drying with boiler stack gases dates back to 1910, when Prof. E.W.Kerr (Louisiana Bulletin 1911) showed that it was impossible in Som Louisiana mill at that time to cover the sugar mill’s energy demands with bagasse alone, owing to its high moisture content. He built a dryer which reduced the moisture content from 54.47 to 44.45 %, main aim of drying industries that the increase of steam production from 1.63 to 2.5399 kg steam/kg bagasse. His dryer was a square tower with bagasse descending and stack gas rising in a counter current manner. The tower was equipped, with deflectors to advertisement better gas-solid contact. Between 1910 and 1970, only very few bagasse drying works reported is describe that increase the efficiency of all drying industries., due to the usage of cheap oil. Because of the energy crisis in 1970’s, efforts have been concentrated in further reducing the bagasse moisture. Since then a number of technical reports on bagasse drying both theoretical and practical have appeared.

Roy et al., (1980) and Keenliside (1983) have reported the use of moving bed dryers for bagasse drying. Roy et al., (1980) studied the effect of the temperature of the outgoing flue gases, the velocity of air, length of dryer and annual profit with that of the percentage of moisture removed the mass of air flow and the width of the drier and the air heater. The air used for bagasse drying was first heated using flue gases and then passed through bagasse. Keenliside (1983) compared three different boiler configurations viz. i) boiler with no air preheater or bagasse dryer ii) boiler with air preheater and iii) boiler with bagasse dryer. He showed that the overall increase in steam production using a bagasse dryer is not significantly greater than when using air pre-heaters due to the extra peripheral equipment required to operate the drying systems. Massaram and Valenca (1981) They investigated in research scale to a pilot one. The pilot is compared to dryer of 0.40 x 0.50 x 2 m. These two steps led to satisfactory results.

The use of rotary dryers for bagasse drying was also reported by Guanzon (1980) and Sarnobat (1987)[6]. Guanzon (1980) plotted the capacity of dryer versus moisture content of bagasse as a function of inlet flue gas temperature. The moisture removal rate increases with an increase in the capacity of the bagasse dryer. Sarnobat (1987) calculated the heat transfer area for a rotary drum dryer inclined at 30°. He reported a bagasse saving of around 30% and pay back period of three months for a bagasse dryer.

In pneumatic transport, the velocity at which a gas will begin to transport a specific particle is called the terminal velocity. The terminal velocity for different bagasse size fractions were determined by Grobert (1971). They show that at a terminal velocity higher than 13.9 m/s, all the bagasse particles will be transported pneumatically. At a terminal velocity lower than 13.9 m/s the raw bagasse will be separated into two fractions. This separation could enable the use of more efficient systems of pneumatic transport, and storage in silos, which would be placed between the mill train and the boilers.

Arrascaeta and Friedman (1987) designed and constructed a bagasse dryer in 1983 that elutriates the bagasse, separating the particles in different sizes. This dryer could work with 7 ton/hr and was in operation until 1985. Later the design was patented in 1987, which used fluidized and pneumatic conceptions. Nebra and Macedo (1989), if the dryer design according this research report then developed
industrial area which is very effective experiment by the Centro de Tecnologia Copersucar, Brazil. It was a flash drier that could work with 25 tons of bagasse/hour. That is the biggest flash dryer reported until now.

Keller (1980) reported the advantages of a suspension dryer over a rotary drum dryer. He reported the effect of moisture content on combustion temperature in bagasse furnaces. It was found that with a decrease in moisture content, furnace temperature increases. He also reported an increase of heat transmitted to steam per kg of bagasse with a reduction of bagasse moisture content. Morales (1982) reported the use of a suspension type bagasse dryer consisting of two units. Each unit was designed for 17.5 ton/hr, with an initial moisture content of 56% to a final moisture content of 35%. He has reported bagasse dryer operating data over a period of one year.

In the past years there are a number of ways to increase boiler and boiler auxiliaries’ performance like air preheater, economizer, air infiltration reduction installation of variable frequency drives etc. but for better performance of sugar industry boiler and boiler auxiliaries like boiler feed pump FD,ID,SA Fans. Bagasse drying technology is in use nowadays in many sugar industries cogeneration power plant because it.

3.0 Objective Of This Work Are As Follows

- To evaluate the boiler performance without dryer and current boiler auxiliaries
- To find the major losses related to boiler and to find optimum combustion zone without dryer.
- To evaluate the boiler performance with bagasse dryer.
- To find the major losses related to boiler and to find out the optimum combustion zone with dryer.
- To find out the amount of fuel saving by applying bagasse dryer.

4.0 Methodology

- There are two methods to calculated the performance of boiler.
- Direct or input Method
- Indirect Method

4.1 Direct Method

This is very important method of calculated the performance of boiler. Direct method also called 'input-output method' heat input (i.e. fuel) for evaluating the efficiency. The formula of

- L1. Dry flue gas loss (sensible heat)
- L2. Hydrogen loss in fuel, (H₂)
- L3. Moisture loss in fuel, (H₂O)
- L4. Moisture loss in air, (H₂O)
- L5. Carbon monoxide loss, (CO)

5.0 Experimental Setup And Fuel Analysis

This chapter deals with the experimental setup used for fuel testing and fuel analysis for boiler performance evaluation

Bomb Calorimeter- A bomb calorimeter is the main parts of calculated efficiency of boiler.

$$\text{Efficiency} = \frac{\text{Heat addition to steam}}{\text{Gross Heat in fuel}}$$

$$\text{Boiler Efficiency} = \frac{\text{Heat Output}}{\text{Heat Input}} \times 100$$

4.1 Indirect Method

Indirect method is very simple and busily method which calculated the all losses of boiler which are increase the boiler performance. Indirect method is very advance and good compared to Direct method. Subtracting the heat loss let from 100 by The efficiency can be arrived. An important advantage of this method is that the errors in measurement do not make significant change in efficiency. Efficiency of boiler is 90%, an error of 1.01% in direct method will result in change in efficiency. i.e. 90 ± 0.9 = 89.101 to 90.901. In indirect method, 1% error in measurement of losses will result in Efficiency = 100 . (10 ± 0.101) = 90 ± 0.101 = 89.999 to 90.111

Losses in boiler:

Some losses are following applicable to liquid, gas & solid in fired boiler

- L7. fly ash loss(Carbon)
- L8. Unburnt losses (Carbon)

According to indirect, method efficiency of boiler = 100 - (L1 + L2 + L3 + L4 + L5 + L6 + L7 + L8)

boiler it is measured heat of combustion of a particular reaction. It is constant calorimeter. A bomb calorimeter is a type of constant volume calorimeter used measuring the heat of combustion of a particular reaction. Electrical energy is
used to ignite of the fuel resource are required so we are used electrical energy as ignite source; as the fuel is burning, it will heat the surrounding air, which expands and escapes through a tube that leads the air out of the tube. It is calculate the temperature of water calorie content of the fuel.

\[ \text{GCV} = \text{Water Constant} \times \text{Temperature Change Of Fuel} - (E1 + E2) \]

**5.1.1 Parameters**

From the above set-up we can measure temperature difference

\[ \text{GCV} = \text{Water Constant} \times \text{Temperature Change Of Fuel} - (E1 + E2) \]

**Taken Sample**

Where,

\[ E1 = \text{Weight Of Cotton Thread} \times 4.18 \times 1000 \]
\[ E2 = \text{Nichrome Wire Weight Loss} \times 0.335 \times 1000 \]

Water Constant = 2511

High temperature of this muffle furnace 1110-1200 °C.

The maximum working temperature of oven used in power plant to remove moisture is 250°C.

**5.1.2 SUGAR PROCESS DESCRIPTION AND STEAM DEMAND REDUCTION**

- The sugar production from sugar cane is done basically by several steps shown in Figure 5.2:
- Extraction of the raw juice and separation of the bagasse.
- Clarification of the raw juice with juice heating and addition of chemical reactants.
- Evaporation of the water content in the clarified juice for its concentration.
- Treatment of the syrup produced in the evaporation.
- Boiling, Crystallization.

Drying of the crystal, sugar. The bagasse produced at the extraction system is delivered to the cogeneration system (VII) as indicated in Figure 5.2.

For the analysis of the process steam demand reduction, data from real sugar factories and from the literature [7 - 10] were used to elaborate a base case and the improved case.

- Raw juice leaving the extraction system at 35°C;
- Juice heating up to 103°C for the clarification;
- Treated juice entering the first effect of evaporation at 97°C;
- Five effect evaporation station with juice concentration from 15 to 65°Brix;
- Absolute pressures (bar) of the evaporation stages: 1.69; 1.34; 0.98; 0.51; 0.16.
- Syrup heating up to 80°C for the treatment.
- Juice and syrup heating with steam from the first effect of evaporation station.
- Decrease the Bagasse is the cane, with 45-50% moisture content.
- Bagasse drying by using flue gases from boilers are mostly used in plant.
- The bagasse dryer allows cooling of the gases to 90°C the only limit being imposed by the necessity to avoid cooling to the dew point of 60 – 70°C.)
- After taking bagasse from sugar cane (In fig 5.2), we use it as a fuel in a boiler and find its calorific value with the help of bomb calorimeter.
- This bagasse is used to convert steam from water.
- This steam is expanded in turbine and produce electricity to run different auxiliaries which improve the efficiency of the plant.
- The flue gases flowing from bagasse fired boilers have temperatures around 300°C.
- This flue gases are used to drying the bagasse and also reducing the load of boiler auxiliaries like ID, FD, SA fans.
5.2 FUEL ANALYSIS AND LOSSES

Fuel analysis can be done by proximate and ultimate analysis without dryer.

Proximate Analysis of fuel i.e bagasse

5.2.1 Data collected from Triveni Engineering and industries ltd. Without dryer ( 24 hr. )

<table>
<thead>
<tr>
<th>O₂ %</th>
<th>Unburnt Fly %</th>
<th>Flue gas temperature (Tₚ)</th>
<th>Unburnt bottom %</th>
<th>GCV (kcal/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>11</td>
<td>130</td>
<td>35.67</td>
<td>2150.42</td>
</tr>
<tr>
<td>4.25</td>
<td>10.97</td>
<td>129</td>
<td>36.82</td>
<td>2182.72</td>
</tr>
<tr>
<td>4.22</td>
<td>12.52</td>
<td>132</td>
<td>38.44</td>
<td>2192.72</td>
</tr>
<tr>
<td>3.5</td>
<td>14.20</td>
<td>128</td>
<td>42.00</td>
<td>2160.64</td>
</tr>
<tr>
<td>3.2</td>
<td>11.56</td>
<td>130</td>
<td>40.4</td>
<td>2220.50</td>
</tr>
<tr>
<td>4.0</td>
<td>10.90</td>
<td>131</td>
<td>36.7</td>
<td>2170.82</td>
</tr>
<tr>
<td>4.02</td>
<td>12.44</td>
<td>127</td>
<td>42.8</td>
<td>2240.46</td>
</tr>
<tr>
<td>5.2</td>
<td>14.40</td>
<td>129</td>
<td>35.9</td>
<td>2170.24</td>
</tr>
<tr>
<td>3.9</td>
<td>12.20</td>
<td>132</td>
<td>36.27</td>
<td>2230.42</td>
</tr>
<tr>
<td>4.4</td>
<td>11.82</td>
<td>130</td>
<td>38.8</td>
<td>2160.24</td>
</tr>
<tr>
<td>5.6</td>
<td>11.56</td>
<td>128</td>
<td>40.23</td>
<td>2210.50</td>
</tr>
<tr>
<td>3.8</td>
<td>14.10</td>
<td>129</td>
<td>42.28</td>
<td>2180.30</td>
</tr>
</tbody>
</table>

1. Test for moisture of bagasse has been conducted, M=50%
2. Volatile matter test for bagasse has been conducted. VM=40%
3. Ash test for bagasse has been conducted, ASH=1.75%
4. Fix carbon for bagasse can be calculated as
5. FC% = 100 – (VM% + M% + ASH%)
6. =100 – (40% + 50% + 1.75%) = 8.25% on dry basis

Ultimate Analysis of fuel.

Conversion formula
- Percentage of carbon = 0.97 C + 0.7 (VM + 0.1A) - M(0.6 - 0.01M) = 31.125%
- Hydrogen (H₂) percentage = 0.036C + 0.086 (VM - 0.1xA) - 0.0035M2 (1 - 0.02M) = 3.7219%
- Percentage of Nitrogen (N₂) = 2.10 - 0.020 , VM = 1.3%
- Percentage of Oxygen (O₂) = 13.8531%
- where C = % of fixed carbon
- A = % of ash
- Percentage of H₂O = 50%
- VM = % of volatile matter
- M= % of moisture

Theoretical air required for combustion = 4.3032 kg/kg of fuel
% of Excess Air supplied = 23.67%
Actual air supplied per kg of fuel = 5.32 kg / kg of fuel,
Mass of dry flue gas, mₕₐₙₜ = 5.48 kg / kg of fuel

- Heat loss, due to dry flue gas:
  \[ L₁ = \frac{m \times Cₚ \times (Tₚ - Tₐ)}{GCV} \times 100 \] 
  \[ = \frac{5.48 \times 2.1 \times (127 - 51)}{2240.46} \times 100 \] 
  \[ = 5.40 \% \]

- Heat loss due to moisture in fuel:
  \[ L₃ = \frac{(M \times (384 - Cₚ \times (Tₚ - Tₐ)))}{GCV} \times 100 \] 
  \[ = \frac{5 \times (384 - 45 \times 96)}{2240.46} \times 100 \] 
  \[ = 13.99\% \]

- Partial conversion loss of C to CO:
  \[ L₅ = 2.5\% \] (standard)

- Heat loss, due to unburnt in fly ash:
  \[ L₇ = \frac{Total \ fuel \ burnt \times GCV \times 6.6 \times 6 \times 100}{GCV \ of \ fuel} \] 
  \[ \frac{L₇}{GCV \ of \ fuel} = .53\% \]

- Heat loss, due to formation of water from H₂ in fuel:
  \[ L₂ = \frac{9 \times H₂ \times (384 - Cₚ \times (Tₚ - Tₐ))}{GCV} \times 100 \] 
  \[ = \frac{32 \times 584 - 45 \times 96}{2240.46} \times 100 \] 
  \[ = 9.23\% \]

- Heat loss due to moisture in air:
  \[ L₄ = \frac{A \times S \times Humidity \times Cₚ \times (Tₚ - Tₐ)}{GCV} \times 100 \] 
  \[ = \frac{5.92 \times 0.024 \times 45 \times 96}{2240.46} \times 100 \] 
  \[ = .20\% \]

- Heat loss, due to unburnt in Bottom ash :-
Fuel analysis can be done by proximate and ultimate analysis with bagasse dryer

- **Proximate Analysis of fuel i.e. bagasse**
  1. Test for moisture of bagasse has been conducted, M=40%
  2. Volatile matter test for bagasse has been conducted, VM= 48%
  3. Ash test for bagasse has been conducted, ASH= 2.1%

Fix carbon for bagasse can be calculated as:

\[
\text{FC\%} = 100 - (\text{VM\%} + \text{M\%} + \text{ASH\%})
\]
\[
= 100 - (48\% + 40 \% + 2.1\%) = 9.9\% \text{ on dry basis}
\]

- **Ultimate Analysis of fuel with bagasse dryer.**

Conversion formula for proximate analysis to ultimate analysis:

\[
\%C = 0.97C + 0.7 (\text{VM} + 0.1A) - M(0.6 - 0.01M) = 35.35\%
\]
\[
\%H_2 = 0.036C + 0.086 (\text{VM} - 0.1xA) - 0.0035M2 (1 - 0.02M) = 3.33\%
\]
\[
\%N_2 = 2.10 - 0.020 VM = 1.14\%
\]
\[
\%O_2 = 20.18\%
\]
\[
\%H_2O = 40\%
\]

- where C = % of fixed carbon
- A = % of ash
- VM = % of volatile matter
- M = % of moisture

Theoretical air required for combustion = 4.38 kg/kg of fuel
% of Excess Air supplied = 22.09%

## RESULTS AND DISCUSSIONS

### 6.1 Performance Of Boiler

- In this section a comparative study is shown between performance of bagasse fired boiler by using bagasse dryer and without using the bagasse dryer in the form of heat balance sheet, bar chart for major losses and efficiency variation with excess air and oxygen percentage inside the furnace.
120 TPH Boiler heat balance without bagasse dryer:

<table>
<thead>
<tr>
<th>Input / output parameter</th>
<th>kCal / kg of fuel</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat input in fuel</td>
<td>2240.46</td>
<td>100</td>
</tr>
</tbody>
</table>

Various heat losses in boiler

1. Dry flue gas loss 120.98 5.4
2. Loss due to hydrogen in fuel 206.79 9.23
3. Loss due to moisture in fuel 313.44 13.99
4. Loss due to moisture in air 4.48 20
5. Partial conversion of C to Co 56.011 2.5
6. Surface heat losses 5.6 25
7. Loss due to unburnt in fly ash 11.87 .53
8. Loss due to unburnt in bottom ash 14.33 .64

Total losses 733.97 32.74

Boiler efficiency = 100 – (1+2+3+4+5+6+7+8) = 67.26%

The above heat balance sheet shows the different losses in bagasse fired boiler when bagasse dryer is not used at this moment the moisture content of bagasse is 50 %. The major losses are dry flue gas loss, loss due to hydrogen in fuel and loss due to moisture in fuel.

120 TPH Boiler heat balance with bagasse dryer:

<table>
<thead>
<tr>
<th>Input / output parameter</th>
<th>Kcal / Kg of fuel</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat input in fuel</td>
<td>2672.75</td>
<td>100</td>
</tr>
</tbody>
</table>

Various heat losses in boiler

1. Dry flue gas loss 134.43 5.03
2. Loss due to hydrogen in fuel 187.62 7.02
3. Loss due to moisture in fuel 240.28 8.99
4. Loss due to moisture in air 5.61 .21
5. Partial conversion of C to Co 66.81 2.5
6. Surface heat losses 6.68 .25
7. Loss due to unburnt in fly ash 11.49 .43
8. Loss due to unburnt in bottom ash 21.38 .80

Total losses 674.33 25.23

Boiler efficiency = 100 – (1+2+3+4+5+6+7+8) = 74.77%

The above heat balance sheet is for the bagasse fired boiler when bagasse dryer is used as we can compare the efficiency of boiler with and without the use of bagasse dryer the losses gets minimize when bagasse dryer is used specially the moisture loss which was around 14% when dryer was not used after using dryer this loss becomes around 9 % so overall the performance of bagasse fired boiler increased when bagasse dryer is used. The above data is collected from two different sugar mills cogeneration power plants.

- Triveni Engineering and Industries Ltd.
- Dhampur Sugar Mill

6.2 Losses In Boiler Without Dryer (Tph):

![Fig. 5 Losses In Boiler Without Dryer](image)

The above graph shows the different losses which occurs in boiler without dryer. There are 8 losses in boiler some are major losses and some are minor losses.

6.3 Losses In Boiler With Dryer (Tph):

![Fig. 6 Losses In Boiler With Dryer](image)

The above graph shows the different losses which occurs in boiler with dryer. There are 8 losses in boiler some are major losses and some are minor losses.

6.4 Comparison Of Major Losses In Boiler
5.4
9.25
14.01
1.09
5.03
7.02
8.99
1.23
0
2
4
6
8
10
12
14
16
L
o
s
s
%
Losses
losses without 
dryer
losses with 
dryer

Fig. 6 Comparison of major losses
There are 3 major losses in bagasse fired boiler which are shown by the above bar graph. Here the comparison of all the major losses is shown for best performance of bagasse fired boiler we can see with bagasse dryer all the major losses gets minimize and performance of bagasse fired boiler gets increase. The bar graph gives the idea of comparison of the major losses which occurs in boiler.

6.5 Variation Of Efficiency of Boiler:
In the graphs shown below the variation of boiler efficiency is shown with respect to oxygen and excess air

6.5.1 When bagasse dryer is not used:

Fig. 7 Variation of boiler efficiency with O2 and excess air (without dryer)
The above graph shows the variation of boiler efficiency with oxygen and excess air supplied in the furnace so from here we can observe that best boiler performance is obtained when oxygen percentage is 3.8 % and excess air supplied in the furnace is 22.09 % so according to our results this is the optimum combustion zone on which boiler should operate to obtain best performance when bagasse dryer is not used.

6.5.2 When bagasse dryer is used:

Fig. 8 Variation of boiler efficiency with O2 and excess air (with dryer)
The above graph shows the variation of boiler efficiency with oxygen and excess air supplied in the furnace so from here we can observe that best boiler performance is obtained when oxygen percentage is 3.8 % and excess air supplied in the furnace is 22.09 % so according to our results this is the optimum combustion zone on which boiler should operate to obtain best performance when bagasse dryer is used.

6.5.3 Amount of bagasse save and estimation of dryer cost:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameters if Bagasse Dryer is Used</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Capacity of bagasse Dryer</td>
<td>50 ton/hr</td>
</tr>
<tr>
<td>2.</td>
<td>Bagasse Moisture</td>
<td>40%</td>
</tr>
<tr>
<td>3.</td>
<td>Steam produce</td>
<td>115 ton/hr</td>
</tr>
<tr>
<td>4.</td>
<td>Bagasse to steam ratio</td>
<td>2.5</td>
</tr>
<tr>
<td>5.</td>
<td>Bagasse used/hr</td>
<td>46 ton/hr</td>
</tr>
</tbody>
</table>

The above data shows the parameters when bagasse dryer is not used it shows the bagasse to steam ratio without dryer.

The above data shows the parameters when bagasse dryer is used it shows the bagasse to steam ratio with dryer.

In normal case the temp. of id fan outlet is about 120 deg
Celsius but in case of bagasse dryer it goes up to 140 degree for better result of bagasse dryer through this the efficiency. Of boiler decreases by 1% in both cases we consider this efficiency Matter

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Difference between in normal case and if bagasse dryer used</th>
<th>54.8-46 = 8.8 Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>If rate of bagasse is</td>
<td>Rs 3000/ton</td>
</tr>
<tr>
<td>2.</td>
<td>Net saving in one hr is</td>
<td>8.8x3000 = Rs 26,400</td>
</tr>
<tr>
<td>3.</td>
<td>Net saving in one Day is</td>
<td>26400x24 = Rs 6,33,600</td>
</tr>
<tr>
<td>4.</td>
<td>If Season is about 120 Days</td>
<td>633600 x 120 = Rs 7,60,32000</td>
</tr>
</tbody>
</table>

The above table shows the amount of bagasse saved and the revenue generated by using bagasse dryer in a complete season which is around 120 days in any sugar industry.

<table>
<thead>
<tr>
<th>Estimated cost of bagasse dryer installation (50 ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
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<tr>
<td>5.</td>
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<td>6.</td>
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<td>7.</td>
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<td>8.</td>
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<tr>
<td>9.</td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>TOTAL INSTALLATION COST</td>
</tr>
</tbody>
</table>

The above analysis shows the amount of bagasse saved and cost estimation of bagasse dryer based upon which we can calculate the payback period of bagasse dryer. Here installation cost is shown and the amount of bagasse is shown when dryer is used. The payback period of bagasse dryer is about 50 days.

7.0 Conclusions And Future Scope
In this dissertation an attempt has been made to account various losses occurs in bagasse fired boiler and to improve the performance boiler by using bagasse dryer. Different losses are taken in to consideration to analyze and compare the performance of boiler in cogeneration power plant.

On the basis of experimental work the following conclusions are drawn:

- The performance of boiler increase with bagasse dryer.
- The major losses like dry flue gas loss, loss due to formation of water from hydrogen in fuel and loss due to moisture in fuel is less when bagasse dryer is used.
- The aim of the introduction of dryer was to reduce the bagasse moisture content in order to improve the boiler performance. The results obtained show that these aims were succeeded.
- It is important for all sugar mills to install bagasse dryer.
- The bagasse drying by using the flue gases is an economic necessity for sugar mills where it can realizes self sufficiency of fuel.
- It is an environmental necessity where it reduces the air pollution.
- Bagasse has not become by-product of sugar industry, but it has become main product.
- Many types of bagasse dryers have been installed in different countries.
- Here we have shown the comparative study of boiler when it is used with dryer and without dryer and we clearly shown the amount of bagasse saved when dryer is used.
- So overall we can say that installation of bagasse dryer is beneficial for any sugar industry because it saves fuel as well as improve the performance of boiler by minimizing the major losses which occurs in bagasse fired boiler.
- The payback period of bagasse dryer is also very less it is around 50 days in normal working season.

References
5. ESCAP (2000), Guidebook on Cogeneration as a Means of Pollution Control and Energy Efficiency in Asia. Environment and Sustainable Development Division (ESDD), United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), Bangkok.


