International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 10 | Oct -2017 www.irjet.net p-ISSN: 2395-0072

Improvement of Boiler Efficiency Using Bagasse Dryer

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Abstract - In most sugar industry, sugarcane bagasse is used as fuel to generate steam for sugar Milling and electricity generation. It consists of cellulose, hemicellulose, lignin, ash and moisture Content. The bagasse Moisture content is an important parameter to control combustion in boilers. Simulated bagasse was used to monitor the effects of moisture content on gross calorific value (GCV) and net calorific Value (NCV) and equilibrium analysis. So burning of bagasse at suitable level of moisture is Essential from the viewpoint of boiler performance.

Key Words: Bagasse, Fuel, Sugar cane residue, moisture content.

1 Introduction:-

Sugarcane based industry has a tremendous potential and its future is bright in many countries including Egypt. It is an old idea to concentrate on producing sugar alone from sugarcane. The by- products of sugar industry (such as bagasse, filter cake and molasses) today attract as much attention as the conventional main product, sugar. The trend in *the* sugar producing nations now is to concentrate more and more on by-products - thus rendering sugar ironically, as the by-product.

In the past, bagasse was considered as waste material. Today, bagasse has become valuable material. Aside from being used as a fuel, it is a starting material for different products such as paper, paper board, fiberboard, particle board, animal feed, etc. In Brazil, today's leader of sugar industry, the emphasis is on developing a variety of cane having up to 25 % of fibre content since more bagasse signifies higher profits.

Moreover, in Pakistan, the price of bagasse per ton is higher than the price of sugar cane. The value of bagasse may be more than the value of sugar. So it is necessary to optimize the use of bagasse, because of the competition between its use as fuel in boilers and as starting material.

The moisture content in bagasse varies considerably with the degree of extraction, but under average conditions it may be taken as 50 % of the total weight leaving the mills (The average value of the moisture content in bagasse reaches 52 % in almost all the cane sugar factories of the Sugar and Integrated Industries Company SIIC of Egypt in the 1998 harvesting season. The higher the moisture content, the lower is the amount of combustible material per unit weight of bagasse and the total available heat, therefore, varies inversely with the moisture content. Furthermore, the portion of heat which is used to evaporate the bagasse moisture and to superheat the resulting steam to the temperature of the flue gases must be deducted from the total available heat. (Each kg of water in bagasse requires 418 kJ (100 kcal) to reach its boiling point and
2,259 kJ (540 kcal) to convert it into steam.

1.1 Problem Statement

During the combustion process in a boiler considerable amount of furnace energy is wasted in evaporating the water contained in the fresh bagasse; therefore decrease the efficiency of combustion. Due to this, it decrease the calorific value, furnace temperature, reduces stability of boilers operation, decreasing the vaporization coefficient and combustion velocity, decreasing the speed of boilers response to load changes and also increment of the losses and decreasing steam production giving rise to flue gases. So in present, work design of such model is necessary which overcomes above parameter up to some extent.

1.2 Objective

Objective of this project is to dry the wet bagasse or remove moisture in the bagasse by using bagasse dryer.

To improve the efficiency of combustion, increase the calorific value, increasing the furnace temperature, increasing the energy production, increasing the stability of boiler operation, increasing the vaporization coefficient, increasing the combustion velocity,

Increasing the speed of boiler response to load changes, reduction of losses, increasing steam production, decreasing flue gases volume. So, above all efficiency improvement parameter can help to increase the output of boiler efficiency.

2. Methodology

1) Firstly determine the moisture content level in wet bagasse & also determine the calorific value & efficiency of boiler.
2) Discuss alternating methods to reduce moisture content up to large extent.
3) Selection proper method.
4) Design of bagasse dryer system.

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5) Evaluation of bagasse dryer system.
6) Availability of various parts of dryer model.
7) Actual construction of dryer model. Testing of dryer.
8) Calculation of moisture content level in bagasse.
9) Calculation of calorific value & efficiency of boiler

2.1 Drying Mechanism

For the drying process, heat is necessary to evaporate moisture from the surface and a flow of air is needed to carry away the evaporated moisture. During drying, moisture from the interior has to migrate towards the surface, where the evaporation of moisture has to take place. Water vapor diffuses through a boundary film of air and is carried away by the surrounding air. This creates a region of lower water vapor pressure at the surface of the material and a water vapor pressure gradient is established from the moist interior of the material to the dry air. This gradient provides the driving force for the removal of water from the material. Water movement to the surface of the product may be effected due to the following mechanisms;

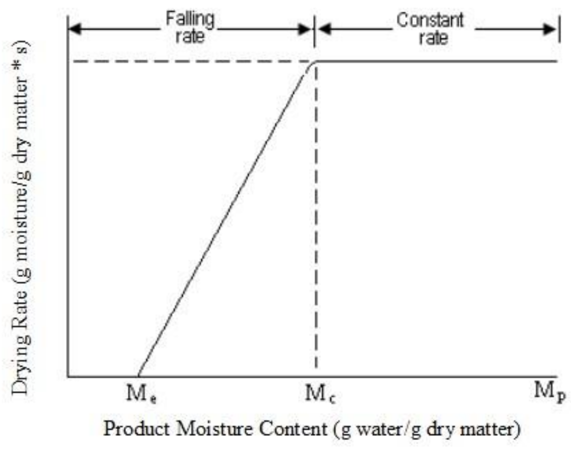
Liquid movement by capillary forces. Diffusion of liquid, caused by differences in the concentrations of solutes in different regions of the materials. Diffusion of liquid which is adsorbed in layers at the surface of the solid components of the material. Water vapor diffusion in air spaces within the material caused by vapor pressure gradients. Typical drying is divided into constant rate and falling rate periods.

The controlling resistance for a drying study may be of energy or mass transfer due to internal or external conditions. The drying rate in the constant rate period is determined by conditions external to the material being dried including temperature, gas velocity, total pressure and partial vapor pressure.

2.2 Drying Kinetic

For each and every product, there is a representative curve that describes the drying characteristics for that product at specific temperature, velocity and pressure conditions. This curve is referred to as the drying rate curve for a specific product. The drying rate refers to the rate of evaporation of water from the material. A plot of the drying rate versus product moisture content (MP) is called the drying rate curve. Figure 3.1.3 shows a typical drying rate curve displaying an initial constant rate period, and at the critical moisture content the drying rate begins to fall with a further decrease in moisture content.

The mechanism underlying this phenomenon depends both on the material and the drying conditions. The drying rate in the constant rate period is governed fully by the rates of external heat and mass transfer, since a film of free water is always available at the evaporating surface. The drying rate in this period is essentially independent of the material being dried.



3. DESIGN DATA

3.1 Data collected from Karmayogi Sahakari Sakhar Karkhana

Fuel firing	5599.17kg/hr
Steam generation rate	21937.5kg/hr
Steam Pressure	43kg/cm^2
Generated steam pressure	485^{0}C
Feed water temperature	96^{0}C
Co_2 in flue gas	14%
Co in flue gas	0.55
Average flue gas temperature	190^{0}C
Ambient temperature	31^{0}C
Humidity in ambient air	0.0204kg/kg dry air
Surface temperature of boiler	70^{o}C
Wind velocity around the boiler	3.5m/s

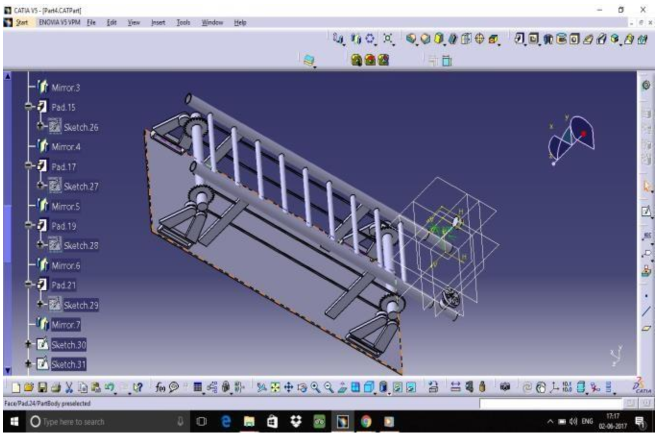
3.2 Fuel Analysis (in %).

Carbon	22.16
Hydrogen	2.84
Oxygen	21.0
Nitrogen	0
Sulphur	0
Ash	4
Moisture	50

3.3 Ultimate analysis of bagasse(in %):

Ash content in fuel	8.63
Moisture in fuel	31.6
Carbon content	41.65
Hydrogen content	2.0413
Nitrogen content	1.6
Oxygen content	14.48
GCV of coal	3501Kcal/kg

3.4 Design Of Bagasse Dryer Model In CATIA



3.5 Specification of component for experimentation

Sprocket	Teeth=40 Pitch=12.7mm Diameter=161.84mm
Dryer	Small steam tube=10 Length=701.04mm External Diameter=34mm Internal Diameter=27mm Large steam tube=2 Length=1371.6mm Outer Diameter=72mm Internal Diameter=65mm
Chain	Length=3435mm Chain pitch=15.875mm No of links=216

4. Boiler efficiency

The efficiency of a boiler is the energy imparted to the boiler feed water in its conversion to superheated steam as a percentage of the energy in the fuel. It can be expressed either in terms of the net or gross calorific value. Because the latent heat in the flue gas is not normally recovered, only the boiler efficiency on NCV is of practical value and the one commonly used. For the purpose of boiler calculations, calorific values must be corrected to ambient temperature. One of the standards for determining boiler efficiencies is BS 845 (Anon 1987) but there are other methods being practiced, often with different results. Whichever way it is done it is based either on the 'direct method' or the 'indirect loss method'

4.1 Direct method

This method calculates boiler efficiency by using the basic efficiency formula-

η=(Energy output)/(Energy input) X 100
In order to calculate boiler efficiency by this method, we divide the total energy output of a boiler by total energy input given to the boiler, multiplied by hundred.

Calculation of direct efficiency- E= [Q (H-h)/q*GCV]*100

Where,
Q= Quantity of steam generated (kg/hr) H= Enthalpy of steam (Kcal/kg)
h= Enthalpy of water (kcal/kg)
GCV= Gross calorific value of the fuel.

L2 = Sensible heat loss in flue gas
L3 = Loss due to unburned carbon
L4 = Radiation loss
L5 = other losses

4.1 Result

1) The moisture reduction of bagasse is 10-15 %
2) Due to reduction of moisture of bagasse by 10-15 % the, GCV of bagasse is increased from 4522 kCal/kg at 50 % moisture to 4628 kCal/kg at 35 % bagasse moisture.
3) The boiler efficiency is improved from 69% to 81%.

5. CONCLUSION

The aim of the introduction of dryer was to reduce the moisture content in wet bagasse in order to improve boiler efficiency and reduce device costs. The obtained results show clearly that these aims were succeeded. The boiler efficiency was improved from 69% to 81%.

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