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AN EXPERIMENTAL STUDY TO EVALUATE THE CALORIFIC VALUES OF BAGASSE AFTER OPEN SUN DRYING

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***ABSTRACT*- In the present research work experiments are performed to calculate the calorific value of bagasse fuel after open sun drying in a traditional jaggery making plant. Experiments are performed on a fixed mass (1312 grams) of freshly crushed bagasse. The calorific values of bagasse are calculated by using mathematical formulas based on the percentage of major contents like moisture, ash and brix. It was found that both HCV and LCV of bagasse are much influenced by the content of moisture in it. After open sun drying of bagasse it was found that the average value of moisture content decrease from 52.15 % to 35.48% as result of which the average values HCV and LCV are increases from 8667.08 kJ/kg to 11936.64 kJ/kg and 6763.88 kJ/kg to 10226.552 kJ/kg respectively.**

***Keywords*- Sugarcane, Bagasse, Jaggery plant, Moisture content, Calorific value of bagasse.**

I. INTRODUCTION

Bagasse is the fibrous part of sugarcane left after crushing. It is the main residue of sugarcane left after extraction of juice. Bagasse is directly used as a fuel in all sugar and jaggery manufacturing plants. Sugarcane is one of the best natural converters of solar energy into biomass and sugar [1]. It contains fibers and sugar having high calorific values 19259 kJ/kg and 16747 kJ/kg respectively [2]. Depending upon the variety of sugarcane the percentage of bagasse in sugarcane varies from 23% to 37% [3]. The calorific value of bagasse is much influenced by the percentage of moisture content. The fresh bagasse coming from crusher contains moisture 50%, fibers 47%, sugar 2.5% and minerals 0.5% [4]. In order to remove moisture from fresh bagasse open sun drying is used, which is a most traditional method used in all Jaggery making plants [5]. The cost of bagasse as a fuel is 1/3rdof the other available fuels [6]. In India sugarcane is an important cash crop, so it also plays an important role in the economic development of rural areas in which jaggery manufacturing plants are established [7].The crushers used in traditional jaggery making plants have low crushing efficiencies [8]. The calorific value of bagasse is much influenced by the content of moisture in it. Bagasse is also used to manufacture Kraft papers, printing papers, particle board and to generate bio-electricity etc. [9]. Bagasse is a renewable source of energy and can be used to generate electricity at lowest cost [10].

In this research paper experiment were performed to calculate the calorific value of bagasse after open sun drying in a traditional Jaggery making plant.

II. STUDY APPROACH

The study is approached towards the calculation of calorific value of open sun dried bagasse. Generally, there are two types of calorific values Gross Calorific Value (GCV) or High Calorific Value (HCV) and Net Calorific Value (NCV) or Low Calorific Value (LCV). The GCV is the total heat energy released per unit mass at atmospheric pressure and at 20°C with complete combustion. It can be accurately measured by using bomb calorimeter. The NCV is the GCV of fuel without the latent heat of water formed by the combustion process [11]. However, both of these values can also be calculated by using experiment based formulas listed in ISO1928 [12].

III. MATHEMATICAL MODELING

According to Southern African Sugar Technologists Association Laboratory Manual the HCV and LCV of bagasse can be calculated by using following formulas:

HCV= [19605 - 196.05 (moisture % sample) - 196.05 (ash % sample) - 31.14 (brix % sample)] kJ.kg^{-1}

LCV= [18260 - 207.63 (moisture % sample) - 182.6 (ash % sample) - 31.14 (brix % sample)] kJ.kg^{-1}

IV. MATERIALS AND METHODS

In this research work experiments were performed on a sample of freshly crushed bagasse taken from a traditional jaggery making plant in Haryana. The size ($50\times50\times6\,cm^3$) and mass (1312grams) of the sample remains constant in all experiments. The samples are tested in a laboratory to calculate the percentage of moisture, ash and brix in it.

Determination of moisture content:

The moisture content in a bagasse sample was determined by using Microwave oven (KENSTAR, Model No. OM 20 DGQ), where a sample of bagasse (50 grams) was kept for a period of 20 to 25 minutes. Then the percentage of moisture content was calculated by using the equation:

$$Moisture\,content\,(\%)=\frac{(W_i-W_f)}{W_i}\times100$$

Where:

W_i = Initial mass of bagasse sample.

W_f = Final mass of bagasse sample.

Determination of Ash content:

The Ash content in a bagasse sample was determined by using Muffle Furnace (SKU LA.LA.Co.FU.1424562, Model No. RSW 126) where the sample of (5 gram) bagasse at a temperature of 550° C kept until the complete bagasse sample was converted into ash. The crucible was then cooled and weighted again. The ash content of the bagasse sample was calculated by using the equation:

$$Ash\ content\,(\%)=\frac{(W_2-W_C)}{(W_1-W_C)}\times100$$

Where:

W_C = Weight of Crucible.

W_1 = Initial weight (Crucible + Bagasse sample).

W_2 = Final weight (Crucible + Bagasse sample).

Determination of Brix:

The brix of sugarcane juice was calculated by using a hand-held Refractometer (ATAGO). In this experimental work a constant value of brix 1.5% is used.

V. RESULTS SAND DISCUSSIONS

Numbers of experiments were performed on constant mass of bagasse (1312 grams). The effect of

moisture content on calorific value of bagasse is shown in the graphs given below. It can be clearly seen from the graph that both HCV and LCV are increase with the decrease in percentage of moisture content.

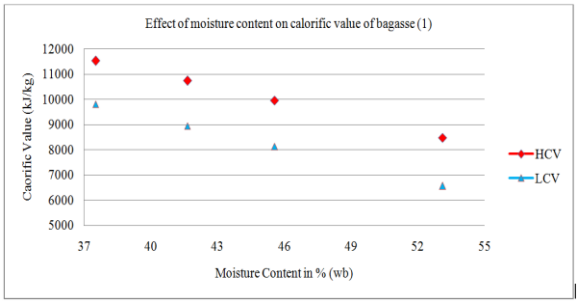

Fig.1. Effect of moisture content on calorific value of bagasse.

[Source: Results are based on experimental data]

Fig.1. Shows that under open sun drying of bagasse, when the moisture content decreases from53.125% to 37.525% then the both HCV and LCV values increases from 8476.564 kJ/kg to 11534.992 kJ/kg and 6562.106 to 9801.186 kJ/kg respectively.

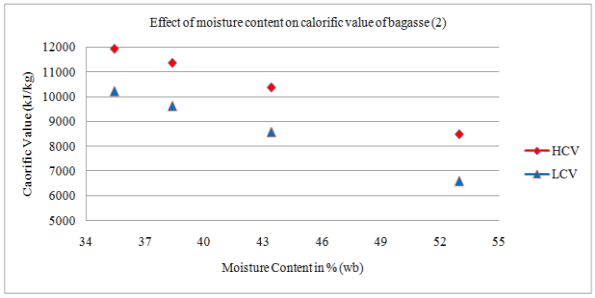

Fig.2. Effect of moisture content on calorific value of bagasse.

[Source: Results are based on experimental data]

Fig.2. Shows that under open sun drying of bagasse, when the moisture content decreases from 52.973% to 35.423% then the both HCV and LCV values increases from 8506.449 kJ/kg to 11947.063 kJ/kg and 6593.757 to 10237.596 kJ/kg respectively.

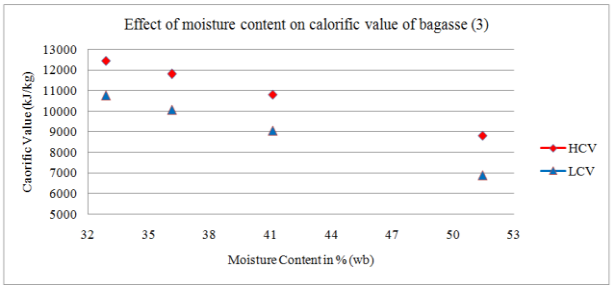

Fig.3. Effect of moisture content on calorific value of bagasse.

[Source: Results are based on experimental data]

Fig.3. Shows that under open sun drying of bagasse, when the moisture content decreases from 51.448% to 32.896% then the both HCV and LCV values increases from 8805.306 kJ/kg to 12442.446 kJ/kg and 6910.266 to 10762.240 kJ/kg respectively.

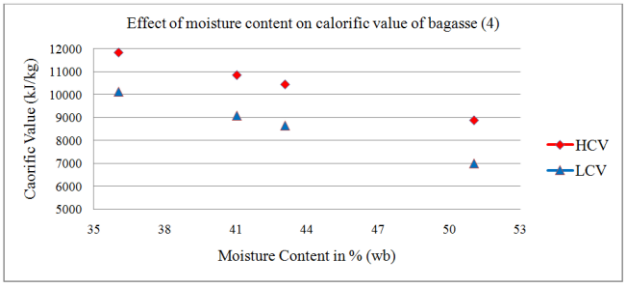

Fig.4. Effect of moisture content on calorific value of bagasse.

[Source: Results are based on experimental data]

Fig.4. Shows that under open sun drying of bagasse when the moisture content decreases from 51.067% to 36.061% then the both HCV and LCV values increases from 8880.020 kJ/kg to 11822.038 kJ/kg and 6989.394 to 10105.186 kJ/kg respectively.

VI. LIMITATIONS

The present research work was performed under climatic conditions of Hisar (Haryana) in the months of February and March 2016.

VII. CONCLUSIONS

From the analysis of present research work it is concluded that:

1. The average value of moisture contents was observed to decrease from 52.40 % to 35.48%.
2. The average values of HCV and LCV are found to increase from 8667.13 kJ/kg to 11936.64kJ/kg and 6763.88kJ/kg to 10226.552kJ/kg respectively.

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