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VOLUMETRIC HEAT CAPACITY ANALYSIS OF SUGARCANE BAGASSE POWDER

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Abstract. *To supply the increasing energy demand in Brazil, academy is supporting researches on the field of biomass as an energetic source. Looking forward to utilize the Brazilian sugarcane industry residues as an alternative fuel, a comparative study on the briquetting process were done. The objectives of the study were to generate sugarcane bagasse briquettes, to perform measurements of the briquettes volumetric heat capacity, and finally to analyze the influence of compaction pressure on the thermal property in focus. Thus, the residues were collected, grinded, dried, densified with a briquetting machine and then thermally analyzed. Subsequently the results were compared and submitted thought an analysis of variance test, resulting that between the 3 compaction pressures tested the pressure of 150 bar was the most indicated as an alternative fuel, due to its significantly higher volumetric heat capacity.*

Keywords: *Sugarcane, bagasse, residues, briquetting*

1. INTRODUCTION

According to CONAB (2016), the moment is very favorable for the sugarcane industry due to the oil price growth and the awareness of the population about the undesirable effects of the use of fossil fuels. Regarding energy production, sugarcane is considered one of the great alternatives for the biofuels sector due to the great potential of ethanol yield and its by-products (CONAB, 2016).

Sugarcane is cultivated in more than 110 countries, between those Brazil leads the ranking as the world's largest producer of this commodity. In addition, the production of this goods continues with a sharp increase, according to CONAB (2016), sugarcane production for the 2016/2017 harvest was estimated at 694 million tons, growing by 4.4% in relation to previous crop.

While the broth is already widely exploited globally, both in quantity and in quality, it is known that the cane residues use for biomass fuel has only recently been gaining notoriety for its exploitation. According to the IPEA (2012) it is estimated that the bagasse originated by cane industry represents approximately 280kg per ton of processed cane, that is, approximately 30% of the total. Following this estimate, the 2016/2017 harvest would have generated approximately 208 million tons of residues.

According to Purohit et al. (2006), apud Paula (2014) untreated plant residues have the following characteristics: difficulty in controlling the rate of combustion, rapid burning requiring frequent replenishment, difficulty in continuous mechanization, large storage area, problems in transportation and distribution. According to the authors many of these disadvantages are attributed to the low density of residues of agricultural products.

Bagasse storage in the mill yards is one of the factors that contribute to the inefficiency of its exploitation. After the extraction of the broth, the bagasse leaves the mills with high moisture content which boost microbial action, which destroys wall cell polysaccharides (cellulose and hemicellulose) and lignin, directly affecting the characteristics of the substrate. In addition, fermentation is an exothermic process, which often causes spontaneous and unwanted combustion. (TEIXEIRA and COSTA, 1997 apud SANTOS et al., 2011)

Therefore, in this context the briquetting can be used as a possible option of energy exploitation of the residues coming from the sugarcane processing. Quirino (ND) states that briquetting process consists of residues densification, which meet a granulometry and controlled moisture content.

According to Fontes et al. (1984), through the briquetting process it is possible to obtain a fuel with granulometric homogeneity, higher density and resistance to fines generation in handling and transport. The density increase provided by the compacting process is capable of producing a fuel with a higher energy concentration per unit volume, thus, together with the strength acquired by the material, there is a technical and economic feasibility for transport over longer distances.

2. METHODOLOGY

The sugarcane bagasse used in the research was obtained from a commercial food establishment at Natal / RN. When collected it was soaked in its extremely sugary broth, so water washing of the material was carried out in order to avoid problems with insects during the storage and handling of the bagasse. After washing and drying in the sun, the material was grinded with the aid of the 1.5-cv AB Garthen forage chopper of figure 1.

Figure 1. Forage chopper

After the bagasse was grinded, the powder was dried in SPLABOR brand forced air circulation oven (Figure 2). Drying was carried out for 24 hours at a temperature of 103 °C. After removal of the material from the furnace in order to achieve the approximately 8% moisture indicated by the references water was sprinkled on the powder.

Figure 2. Forced air circulation oven

A briquetting machine of the brand LIPPEL (Figure 3), model LB-32, of 3cv electric motor, maximum force of compaction of 10 tons and temperature control up to 300 ° C was used to manufacture the briquettes.

Figure 3. Briquette machine

The briquettes were made with 5 minutes compaction at 120 ° C, divided into 3 treatments, 50, 100 and 150 Bar, with 7 samples each (Figure 4).

Figure 4. Briquettes

The determination of the volumetric heat capacity was performed with the KD2 PRO thermal analyzer, whose operation is based on the transient linear heat source method. Following the recommendations of the equipment manufacturer, two holes were opened in each briquette and the SH-1 probe was inserted with the thermal paste coating, indicated for solid materials.

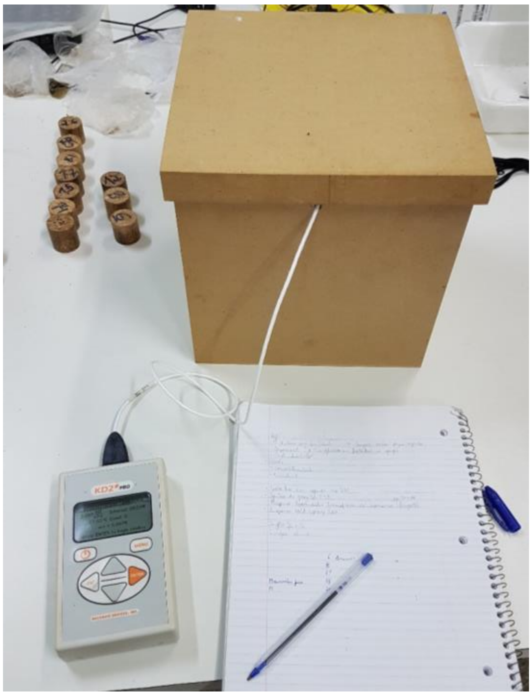

Figure 5. Data acquisition

The measurements were carried out inside a thermal insulation chamber as shown in Figure 5. Three measurements were taken in each of the test specimens, each lasting 10 minutes, in order to ensure greater precision, and at 15 minutes of interval between them for the thermal gradient to dissipate.

After obtaining the data, the analysis of the variance (ANOVA) was performed to verify the statistical significance of the data, adopting a level of significance of 5%.

3. PRELIMINARY RESULTS

From the collected data the comparative graph was generated, which relates the averages of the volumetric heat capacity obtained for the three different compaction pressures tested.

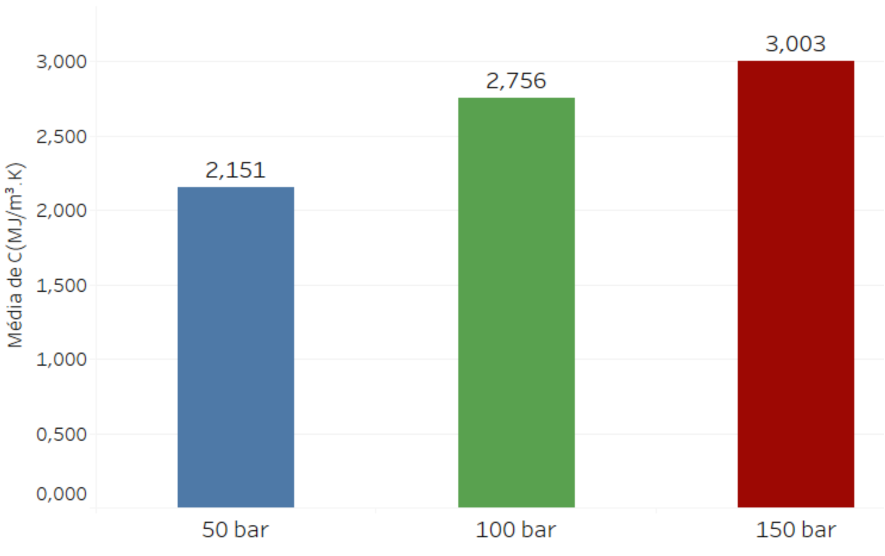

Figure 6. Volumetric heat capacity comparative chart

According to the values in figure 6, the volumetric heat capacity of the compressed samples at 150 bar pressure is 8.9% higher than that of the samples compacted at 100 bar and 39.6% higher than the compressed samples at 50 bar.

ANOVA analysis of variance was applied to the results obtained. The calculated p-value was 0.4%, that is, as it is within the adopted safety level of 5%, the values are statistically significant. In other words, the effect observed in the mean of the samples reflects the characteristics of the entire population, corroborating the results obtained.

4. CONCLUSION

The process of preparation of the sugarcane bagasse was effective and the material presented enough lignin for the briquetting to be executed without the need of binder addition.

The sugarcane bagasse powder allowed the briquetting at the three compaction pressures chosen, 50, 100 and 150 bar. Corroborating Brazil (2014) the viability of the use of sugarcane industry residues for briquetting was confirmed.

The volumetric heat capacity indicates the ability of one material to store energy per unit volume (INCROPERA et al., 2008), thus from the analysis of the volumetric heat capacity it can be observed that the samples compacted at 150 bar pressure presented considerably higher values than the other samples. Thus, according to Fontes et al. (1984), the compression pressure of 150 bar would be the most indicated among the pressures tested, because a higher energy concentration of the fuel increases the economic feasibility.

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6. RESPONSIBILITY NOTICE

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