Calorific value of tibarau cane bio-briquette

H Nurdin*, Hasanuddin, Darmawi, Y Setiadhi, and M Saddikin
Mechanical Engineering Department, Faculty of Engineering, Universitas Negeri Padang, Indonesia

*hens2tm@yahoo.com

Abstract. Tibarau sugar cane is a renewable energy plant that is very likely to be processed into solid fuel in the form of bio-briquettes. Development of bio-briquette tibarau as an effort in the effort of alternative fuels to reduce the energy of oil-fueled energy. In producing bio-briquette tibarau fuel, which has a measurable quality and performance with its calorific value. The use of bio-briquettes tibarau is a potential in developing renewable energy to achieve national energy security. Through the process of making bio-briquette products with carbonization technology in the furnace at certain temperatures that occur in the increase of heat. From this study, the results were obtained in the form of developing a bio-briquette tibarau model which is recommended as an alternative fuel. Characteristics of bio-briquette of tibarau content using tapioca adhesive were 32270.26 kJ/kg at carbonization 300°C and composition percentage 80 : 20. While bio-briquettes tibarau by using damar adhesive amounted to 36943.08 kJ/kg. Carbonization temperature affects the calorific value of bio-briquettes tibarau sugar cane. The carbonization process of briquettes developed into bio-briquettes were very important in improving the performance of bio-briquette fuels.

1. Introduction

People in daily life need energy sourced from nature for various activities. One of the energy from nature is fuel oil. In line and increasing human population and increasing energy requirements, this causes scarcity of fuel oil. The impact felt by the community was increasing the price of fuel oil, which also has an effect on world oil prices. Petroleum prices that were difficult to predict in recent years have encouraged the development of biomass as an alternative energy source that can be continuously produced, apart from increasingly scarce fossil energy. Efforts made to reduce oil-based energy consumption are by encouraging renewable energy use. The Center for Energy Studies of Asia Pacific (APERC) estimates that Indonesia will depend on imports to meet domestic energy needs by 2030 (http://edukasi.kompas.com/). Presidential Regulation of the Republic of Indonesia Number 79 of 2014 concerning the National Energy Policy, which states that the government invites all parties and the people of Indonesia to succeed in the development of alternative energy sources instead of fuel oil. This has prompted scientists to conduct research in finding alternative energy sources as a substitute for fossil fuel energy such as petroleum and coal. Waste and residues from agriculture and industry can be used as alternative renewable sources to produce energy and raw materials such as chemicals, cellulose, carbon and silica [1]. So far the scientists have been working to exploit agricultural waste and livestock waste and food industry waste to produce alternative energy known as Biomass. Biomass is an organic material derived from plants which includes leaves, grasses, twigs, weeds, agricultural waste, livestock waste, forestry waste and peat produced through photosynthetic
processes, both in the form of products and waste [2]. Biomass energy sources have several advantages, among others, are renewable energy sources that can provide sustainable energy sources. As in the policy of renewable energy development and energy conversion of the Department of Energy and Mineral Resources (2016) [3] mentioned that the potential of biomass energy in Indonesia is quite large reaches 49.8 GWe.

The development and use of biomass has not been carried out optimally because some people have not understood how to use waste into something more useful. Tibetan sugar cane as an untapped plant is used as a candidate for raw material for briquettes in the development of renewable energy to achieve national energy security [4]. Sugar cane plant tibarau (Saccharum Spontaneum Linn) is a plant whose life is often found around the banks of the river, and also in swamps or swamps [5]. These plants are shrubs on the banks of the river and landed, most people do not use them, and are only left as scrub. The recommended development of sugar cane as a substitute for an environmentally friendly and economical alternative fuel can be in the form of briquettes as solid fuels which are further processed into bio-briquettes.

The research on tibarau sugar cane briquette has been carried out which produces the calorific value characteristics of 11221.72 kJ / kg with a density of 0.565 gr/cm$^3$ in the composition of the percentage ratio of 80:20 [4]. Lalit K Singh, et al. [6] from Pelgia Research Library-Indian Institute of Technology reported that tibarau cane plant has chemical content. The potential of this can be used for the plant can be recommended for raw materials for the development of biofuels.

Continued development of tibarau sugar cane briquettes that have been obtained can continue. Subsequent research leads to bio-briquettes by carrying out the carbonization process of existing briquettes so as to find more promising characteristics. Experiments and quality evaluations obtained become innovations that can be applied as a contribution to achieving sustainable national energy security.

2. Research Methods
In this study, an experimental study was carried out on bio-briquette tibarau sugar cane samples by observing the characteristics of calorific values. The orientation of the implementation focused on making and developing bio-briquettes made from tibarau sugarcane raw materials (Figures 1, and 2). The raw material is processed by chopping into particles or granules (mesh).

![Figure 1. Tibarau Sugar Cane Plant](image1)

![Figure 2. Tibarau Sugar Cane Bagasse](image2)

The process of making bio-briquettes requires an adhesive that can provide strength so it is not easily broken. The adhesive used in this study is tapioca and resin. Tapioca is a starch extracted from cassava, which is used as a food processing material, the glue material is easily sticky (Figure 3).
Damar (Figure 4) is a *titerpenoid* resin, containing many low molecular weight compounds containing a polymer fraction, composed of polycadinene, resin properties including fragile and easily adherent to room temperature, nonpolar organic solvents, flammable.

In making bio-briquettes, it starts with making briquettes first. This briquette making method with the optimal mixture percentage as a variation of 80%: 20% comparison percentage between tibarau sugar cane and adhesive. A Variation of the mixture prepared and stirred in a mixture which is then printed with compaction of 100 kgf/cm². Then the briquettes were dried in a few days with the sun's heated. Dry briquettes, then proceed with the carbonization process using a heating furnace so that the products produced were charcoal briquettes or bio-briquettes. In the carbonization process the heating furnace uses different temperature variations with a holding time of 1 hour. Variations in temperature were 200°C, 250°C, 300°C, 400°C, and 500°C, It should be noted in making bio-briquettes, before the heating furnace first wrapped in aluminum foil.

After the carbonization process was complete, proceed with testing in the laboratory for each test sample. In laboratory testing, the tool used was "Bomb Calorimeter" (Figure 5). The test is done by conditioning the stable room temperature. Tests carried out were related to heat energy from combustion or heating value of bio-briquettes tibarau.

In conducting bio-briquette analysis, treatment parameters will be recorded and tabulated in a data collection table designed according to the needs. Analysis and calculation of heat value data using existing formulas. The calorific value (Nbb) of sugarcane briquettes can be calculated by the equation:
\[ N_{bb} = \frac{(t_2 - t_1) c_v}{m_{bb}} \quad (kJ/kg) \] (1)

3. Results and Discussion
In this study, prepared tibarau sugar cane and bio-briquette was made and printed by using tapioca and resin resin. The need for research raw materials in the form of tibarau sugar cane which is used as particles (mesh) was prepared and also the adhesive. Based on the flow of thought according to the technicalities of tibarau sugar cane and bio-briquette making as a physical prototype of the development results (Figures 6 and 7).

From testing the bio- briquettes tibarau sugar cane calorific value of using tapioca adhesives with variations in percentage of 80%: 20% at 300°C carbonization temperature obtained optimum calorific value of 32270.26 kJ / kg. The minimum heating value of bio-briquettes tibarau using tapioca adhesive at 500°C carbonization temperature is 21212.78 kJ / kg. These results indicate that the bio-briquette with 300°C carbonization temperature has a higher calorific value compared to other carbonization temperature treatments (Table 1).

| Carbonization Temperature (°C) | Initial Briquette’s Mass (gr) | Final Briquette’s Mass (gr) | Bio-Briquette’s Mass (gr) | Calorific Value KJ/kg |
|--------------------------------|-------------------------------|-----------------------------|----------------------------|------------------------|
| 200                            | 62                           | 21                          | 20                         | 22623.88               |
| 250                            | 63                           | 20                          | 19                         | 25608.01               |
| 300                            | 70                           | 22                          | 10                         | 32270.26               |
| 400                            | 71                           | 21                          | 6                          | 22369.42               |
While the bio-briquettes tibarau sugar cane calorific value of that used resin adhesive with a variation of 80%; 20% percentage at 300°C carbonization temperature was obtained at 36943,08 kJ / kg. The minimum calorific value of tibarau bagasse charcoal briquette using tapioca adhesive at 500°C carbonization temperature is 21004,58 kJ / kg. These results indicate that the bio-briquette with 300°C carbonization temperature is higher in calorific value compared to other carbonization temperature treatments (Table 2).

**Table 2.** Bio-Briquette Tobarau Sugar Cane Calorific Value of Adhesive Damar (Mixture 80%; 20%)

| Carbonization Temperature (°C) | Initial Briquette’s Mass (gr) | Final Briquette’s Mass (gr) | Bio-Briquette’s Mass (gr) | Calorific Value (kJ/kg) |
|--------------------------------|--------------------------------|------------------------------|---------------------------|-------------------------|
| 200                            | 62                             | 21                           | 20                        | 17060,44                |
| 250                            | 63                             | 20                           | 19                        | 28383,95                |
| 300                            | 61                             | 21                           | 10                        | 36943,08                |
| 400                            | 71                             | 21                           | 6                         | 24220,04                |
| 500                            | 63                             | 23                           | 4                         | 21004,58                |
Figure 9. Graph of Test Results Calorific Value of Bio- Briquette Tibarau Damar Adhesive

From the graph in Figure 8 and Figure 9 it can be seen that at carbonization temperatures of 200°C to 250°C the bio-sugar value of sugarcane briquettes increased to temperatures of 300°C. While at temperatures of 400°C and 500°C, the heating value decreases. This was due to the carbonization temperature> 300°C has formed an ash content that was greater than the temperature <300°C so that it can affect the bio-heat value of sugar cane briquettes tibarau. At temperatures of 400°C - 500°C bio-briquettes sugar cane have been completely carbonized but along with the increase in temperature in the carbonization process will result in increased ash content which will reduce the heating value. The effect of carbonization temperature, the higher the temperature, the smaller the amount of carbon produced and the resulting tar will increase. With a higher carbonization temperature, it tends to reduce heat values, moisture content, levels of flying substances and solid carbon content, but the ash content of briquettes tends to increase [7].

Percentage of moisture content shows that there was a large enough mass loss of raw material during the process. This shows that bagasse has a very high volatile material, which during the process takes place the release of volatile substances. If viewed from the variation of the activation temperature given, there was a tendency that the higher the activation temperature, the more the percentage of water content.

4. Conclusion

From this study can be concluded as follows:

- Successfully developing alternative fuels to achieve national energy security in the form of tibarau sugar cane briquettes as a form of renewable energy diversification.
- Characteristics of bio- briquette sugar cane tibarau with 80%: 20% mixing ratio using tapioca adhesive obtained at 32270.26 kJ / kg and using resin resin obtained at 36943.08 kJ / kg
- Carbonization temperature affects the bio-sugar value of sugar cane briquette with its carbonized temperature at 300°C, the higher the temperature, the smaller the amount of carbon produced.

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