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Utilizing Organic Waste (Sugarcane Bagasse and Sugarcane Leaves) as Bio Briquettes through Pyrolysis Process

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ABSTRACT

The energy crisis is approaching, not only Indonesia but also all around the world. This requires technological innovation to overcome it, such as; making alternative fuels that are cheap and easy to produce. One alternative way to overcome this problem is to make alternative fuels in the form of bio briquettes by utilizing organic waste (sugarcane bagasse and sugarcane leaves). This study aims to study the effect of the ratio of leaves and bagasse as main sources and using lignin as the adhesive, to produce bio briquettes. The ratio of leaves and bagasse used in this research were (30: 70). The pyrolysis process is carried out to obtain charcoal and sieved at 30 mesh. The charcoal is then mixed with the adhesive. The ratio of the amount of lignin with a mixture of sugarcane bagasse and leaves were (10: 90); (15: 85); (20: 80); (25: 75); (30: 70), and mold. The briquettes formed dried in an oven at 105 °C for 1 hour. The results of this study showed that the lowest calorific value was 4860 cal/kg at 10% lignin content and the highest calorific value at 25% was 5876 cal/kg. The results of the analysis of the lowest moisture content (%) were at 10% lignin content of 0.0781% and the highest moisture content was 0.1387% at 25% lignin content.

Keywords: Adhesive, bio briquettes, sugarcane bagasse, sugarcane leaves.

Introduction

The consumption of oil fuels is increasing in the last decade while the supply of oil or natural gas is very limited and non-renewable. Due to the limitation of the oil and natural gas, the sustainable energy sources is an alternative way to overcome this problem (Fang *et al.*, 2008; Oyelaran *et al.*, 2018; Qi *et al.*, 2017; Saputro & Farid, 2018; Zhongyang *et al.*, 2001). Apart from that, the production of renewable energy should concern about the environmental issue as well to avoid ecological problems (Puthikitakawiwong *et al.*, 2007; Raju *et al.*, 2014; Saputro *et al.*, 2019; Saputro & Farid, 2019).

Biomass is one of the renewable energy resources. The energy generated from biomass is cheap, environmentally friendly and simply obtained from the environment (Amalinda *et al.*, 2020; Jamradloedluk & Wiriyumpaiwong, 2007; Nasution *et al.*, 2006). The production and characteristic of bio briquettes from Agricultural Waste or Biomass have been investigating by researchers all around the world (Lunjian & Hongguang, 2007; Qi *et al.*, 2017; Yuliansyah *et al.*, 2019). Pyrolysis is one of the main processes to make coal as a base for bio-briquettes (Erliyanti *et al.*, 2015). The bio briquettes could be produced from elephant grass and wood (Onuegbu *et al.*, 2012), rice husk (Jamradloedluk & Wiriyumpaiwong, 2007), corncobs (Amalinda *et al.*, 2020), and sugarcane bagasse (Cardona *et al.*, 2010).

Based on the dry condition, sugarcane bagasse consists of elements C (carbon) 47%, H (hydrogen) 65%, Oxygen (Oxygen) 44%, and ash (ash) 2.5%. The type of leaf used is sugarcane leaves which have

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parallel leaf bones (Hasanuddin & Nurdin, 2010; Nugraha, 2013). Based on that, the sugarcane bagasse is promising organic waste for bio briquettes production (Agunsoye & Aigbodion, 2013; Garcia-Perez et al., 2002; Montoya et al., 2015). However, the production of bio briquettes from sugarcane bagasse and leaves seems to be limited, so this research aim is to find the best composition bio briquettes from mixed sugarcane bagasse and sugarcane leaves through the pyrolysis process based on moisture content and caloric value.

Research Method

The raw materials used in this study were sugarcane bagasse and leaves from Sugar Factory Waste in Indonesia. The research variables used in this research are the ratio of leaves and bagasse, which are (30: 70) and the ratio of the amount of lignin to the mixture of bagasse and sugarcane leaves are (%) : (10: 90); (15: 85); (20: 80); (25: 75); (30: 70). All experiments were carried out using 10% NaOH concentration, oven drying temperature of 105 °C, 1 hour drying time, Lignin density 1.3424 g / Lt, the weight of dry bagasse were 600 grams and the weight of dry leaves was 250 grams.

The equipment used in this research is a set of pyrolysis tools connected to the temperature control indicator which functions to regulate the pyrolysis temperature. Furthermore, to mold the bio briquettes a briquette mold from a plastic pipe is used.

The research procedure is divided into two major processes. The first one is lignin production, and the other is briquettes production. In the lignin production, firstly, cutting the bagasse into small pieces with a size of ± 0.5 to 1 cm, then crushed to form fibers, then dried under the sun. Secondly, heating 250 grams of fiber that has been dry for 1 hour to undergo the softening process. Thirdly, the softened fiber was added with an 18% NaOH solution in a ratio of 1: 4, heated for 2 hours at 100 °C to produce lignin as an adhesive for briquettes. The obtained lignin is then separated from the cellulose by a filtering process.

The cleaned leaves and bagasse are then dried under the sun, crushed, and sieved with a size of 30 mesh. The ratio of leaves and bagasse according to the variables was mixed until homogeneous. After obtaining a homogeneous mixture in pyrolysis, the mixture of bagasse and sugarcane leaves that had been pyrolyzed was mixed with lignin according to the variables. The mixture of these variables is put into a briquette mold and then molded. Drying the briquettes in the oven at 105 °C for 1 hour.

Result and Discussion

The results obtained from this research discussed in this section. The results cover the analysis of the calorific value and moisture content according to the variation of the concentration of lignin to a mixture of bagasse and sugarcane leaves.

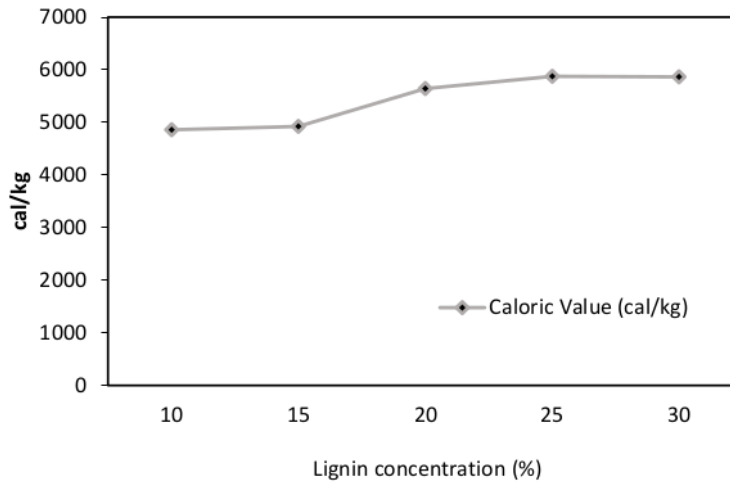


Figure 1. Lignin concentration (%) vs caloric value

In Figure 1, it shows that the increasing lignin concentration in the mixture of pulp and sugarcane bio briquette, effect in the increased caloric value. At 10% lignin content, a low calorific value is obtained because the ratio of the mixture of bagasse and sugarcane leaves is more than lignin so that the calorific value obtained is low at 4860 cal/kg. For 20% lignin, the calorific value begins to rise, and the maximum point of the highest calorific value is at 25% lignin, which is 5876 cal/kg. At a lignin level of 30%, the calorific value is stable because at the time of pressing lignin there is a reduction which causes the resulting calorific value to be stable with a lignin level of 25%. The results of the calorific value obtained have met the requirements of the bio briquette quality standard. Coal quality standards as raw material for Coal Briquettes and coal-based solid fuels, namely a minimum heating value of 4400 cal/kg. Comparing with previous researchers, who made bio briquettes but with different materials, namely the making of bio briquettes from a mixture of *jatropha curcas* cake (*jatropha curcas l.*) With husks as an alternative fuel resulted in the highest calorific value of 4320 cal/kg (Budiman et al., 2010). In the other study, bio briquettes from a ground nutshell, the highest calorific value was 2918.26 cal/kg (Akuma & Charles, 2017). According to the highest calorific value, this research has a better caloric value among those research.

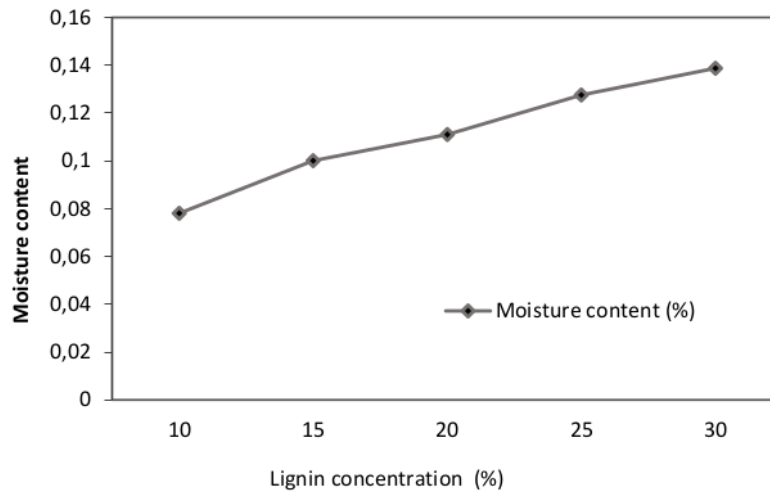


Figure 2. Lignin concentration (%) vs moisture content (%)

The moisture content of bio briquettes is explained in Figure 2. It shows that the higher the lignin content, the higher the moisture content. At 10% lignin content, low moisture content of 0.0781% was obtained because the lignin mixing ratio was only 10% of the mixing of ingredients. At 30% lignin content is the highest point of moisture content contained in bio briquette at 0.1387%. This is because the more lignin is added to the bio briquette mixing, the less weight of the ingredients is so that the moisture content increases. With the results obtained that the moisture content at 30% is 0.1387%, it has met the quality standards of coal as raw material for coal briquettes and coal-based solid fuels should have a maximum moisture content of 15%.

Conclusion

Sugarcane bagasse and leaves can be used for bio briquette materials as alternative fuels without adding other adhesives because the adhesive can be derived from bagasse. When the concentration of lignin increasing, the calorific value increases as well. The lowest calorific value in this research is 4860 cal/kg at 10% lignin concentration and the highest calorific value is at 25% lignin concentration of 5876 cal/kg. The lowest moisture content (%) was at 10% lignin content of 0.0781% and the highest moisture content was 0.1387% at 25% lignin concentration. Finally, this research reveals that the best composition lignin concentration for the adhesive is 25%.

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