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The Influence of Pirolysis Process Time on the Quality of Horse Feses Bioarang Brickets

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Abstract**—** *Energy demand on an international scale continues to increase from time to time in line with the increasing process of industrialization around the world. The economic pattern, which initially focused on the agricultural sector, has become an economic pattern that relies on the industrial sector. So it is necessary to think together is how to save energy in addition to looking for alternative energy sources to reduce dependence on petroleum. So this requires creative efforts to use horse dung into bioarang briquettes. Bioarang briquettes are a renewable and environmentally friendly alternative energy source. The raw material in this study used dried horse manure with a drying percentage of 26.4%. Furthermore, horse manure mixed with starch with the ratio between horse manure and starch is 3: 1. Next, the mixture is pressed with a pressure of 10 bar to obtain biomass briquettes with a weight of 10 grams each then dried under the sun for 3 days. so that the percentage of drying is obtained at 59.3%, then processed into bioarang through the pyrolysis process. The pyrolysis process is carried out using a heating oven (retort) with a constant heating temperature of around 300oC with variations in the length of the pyrolysis time (holding time) ½, 1, 1½, 2, 2½ hours. The results showed that the gross energy of bioarang briquettes increased by an average of 3% for every 0.5 hour increase in the length of the pyrolysis process, while the water content of bioarang briquettes decreased by 0.5%.*

Keywords**—***Pyrolysis, horse feses, bioarang, briquettes, energy levels.*

I. INTRODUCTION

Energy demand both on a national and international scale continues to increase from time to time in line with the increasing industrialization process around the world. The economic pattern, which initially focused on the agricultural sector, has now changed to an economic pattern that relies on industrial patterns. The increasing progress of the industrial sector can be seen from the number of factories that continue to emerge both on a small scale (home industry) and on a large scale involving thousands of employees. With changes in economic patterns, it is necessary to think together how to save energy in addition to finding alternative energy to replace fuel oil. One of the efforts is to utilize horse manure for the manufacture of bioarang briquettes.

Bioarang is charcoal obtained by burning dry biomass without air. Meanwhile, biomass is organic materials derived from living bodies, both animals and plants such as leaves, grass, twigs, weeds, agricultural waste, livestock waste and peat.

Biomass can actually be used directly as a source of heat energy, because it contains energy produced in the photosynthesis process when the plant is still alive. However, the use of biomass directly as a fuel is less efficient, so it needs to be converted into bio-chemical energy first [1].

Bioarang has a higher fuel value than biomass. As an illustration, the heating value of biomass is 3300 kcal / kg, while the fuel value of bioarang is 5000 kcal / kg [2].

Briquettes are lumps made of soft, hardened material. The most recommended raw material for making briquettes is livestock waste, especially horse manure. The use of this fuel is quite flexible because it can be printed in various shapes and sizes as needed. In addition, this fuel can be utilized with simple technology, but the heat obtained is large enough, long enough and safe.

Bioarang briquettes are an alternative fuel that is suitable for use as a substitute for fuel oil and is very suitable for use by traders and entrepreneurs who require continuous combustion in a relatively long period of time. Heating with briquettes includes natural heating in the sense that it is without oil.

Horse dung bioarang briquettes are products obtained from incomplete combustion of horse manure biomass briquettes. As a fuel, bioarang briquettes are more profitable than firewood or kerosene fuel. Bioarang briquettes provide a higher combustion heat, less smoke and are more practical than firewood or kerosene fuel. Incomplete combustion of horse manure biomass briquettes (feces) causes complex carbon compounds not to be oxidized to carbon dioxide (CO_2). This event is known as pyrolysis. During pyrolysis, heat energy encourages oxidation so that the complex carbon molecules break down mostly into carbon or charcoal. Pyrolysis for charcoal formation occurs at temperatures of 300 - 700^oC. The formation of charcoal is referred to as primary pyrolysis. Charcoal can undergo further changes into carbon monoxide (CO), hydrogen gas (H_2) and hydrocarbon gases. This event is referred to as primary pyrolysis.

In terms of air pollution, bioarang briquettes are relatively safe compared to fuels from coal or kerosene. Kerosene or coal fuels will produce excess CO_2 in the atmosphere. This excess CO_2 will cause air pollution resulting in acid rain or damage to the ozone layer which can endanger the sustainability of all creatures on earth [2].

Horse manure contains a lot of carbohydrates, especially types of cellulose or fibers, in addition to protein and fat. These chemical compounds are very potential for carbon sources, which are the main constituents of bioarang briquettes. The way to get this carbon source is by burning organic material in anaerobic conditions or known as

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pyrolysis, this method is intended to increase the energy value and improve combustion properties [3].

The heat analysis of a fuel is intended to obtain data about the heat energy that can be released by a fuel with the occurrence of the reaction / combustion process. The calorific value of the fuel can be interpreted by carrying out tests on the adiabatic bomb calorimeter, various data from the calorific value test results can then be used to form empirical / semi-empirical equations [4].

II. Research Methods

In this study, an experimental method was used, namely direct bioarang briquette testing. The test material used is horse manure mixed with starch which is formed into briquettes. The ratio between horse manure and starch is 3: 1. Then the mixture is pressed with a pressure of 10 bar to obtain biomass briquettes with a weight of 10 grams each then dried under the sun for 3 days. so that the percentage of drying is obtained at 59.3%, then processed into bioarang through the pyrolysis process. The pyrolysis process is carried out using a heating oven (retort) with a constant heating temperature of around 300^{o}C with variations in the length of the pyrolysis time (holding time) ½, 1, 1½, 2, 2½ hours.

TABLE 1. Tools and materials

No	Tool and material	specifications
1	Biomass	Horse waste
2	Adhesive	Starch glue
3	Briquette maker	10 bar
4	Analytical balance	0,1 mg
5	*Adiabatic Bomb Calorimeter*	Model-IKA C2000

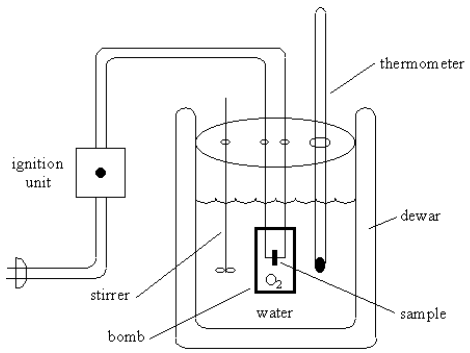

Fig. 1. Adiabatic bomb calorimeter.

The stages of the research procedure were to make biomass briquettes by mixing starch with enough boiling water until the mixture turned like glue. Mixing dried horse manure with starch glue in a ratio of 10 grams of starch to 30 grams of horse manure. Then the mixture is formed or pressed with a pressure of 10 bar into biomass briquettes with a weight of 10 grams each then dried under the sun for 3 days. Furthermore, biomass briquettes are processed into bioarang briquettes through the pyrolysis process. The pyrolysis process is carried out using a heating oven (retort) with a constant heating temperature of around 300^{o}C with variations in the length of the pyrolysis time (holding time) ½, 1, 1½, 2, 2½ hours.

In this study, the variables studied were moisture content of bioarang briquettes, dry weight of bioarang briquettes, and gross energy of bioarang briquettes. Testing the quality of horse manure bioarang briquettes includes moisture content, dry matter and gross energy. Testing of moisture and dry matter content used proximate analysis, while gross energy testing used the Model-IKA C2000 bomb calorimeter (Fig 1).

III. Results and Discussion

This research was conducted to determine the characteristics of briquettes. Several analyzes were carried out, namely proximate analysis and calorific value. There was a decrease in the moisture content of the horse manure biomass when it was made into briquettes. Moisture content of raw horse dung biomass was 26.4%, when it became bioarang briquettes, the average moisture content was 2.1%. Water content for bioarang briquettes from the five variations of the pyrolysis process time treatment, namely 0.5, 1, 1.5, 2 and 2.5 hours, that the longer the time needed, the more water content is lost with an average loss of water content of 0.5%. This can happen because the longer the pyrolysis process takes place, the more heating will be given to the briquettes, this encourages more water contained in the briquettes to evaporate (Fig 2).

The greater the water content in horse manure biomass briquettes, the lower or less dry content of bioarang briquettes, this is as shown in Fig 3.

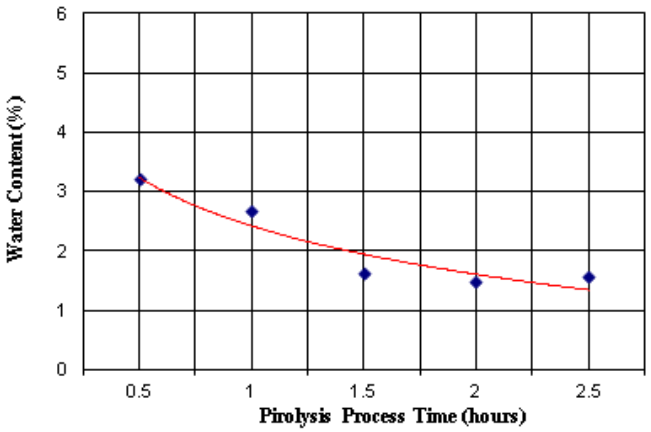

Fig 2. Relationship between pirolysis process time that water content

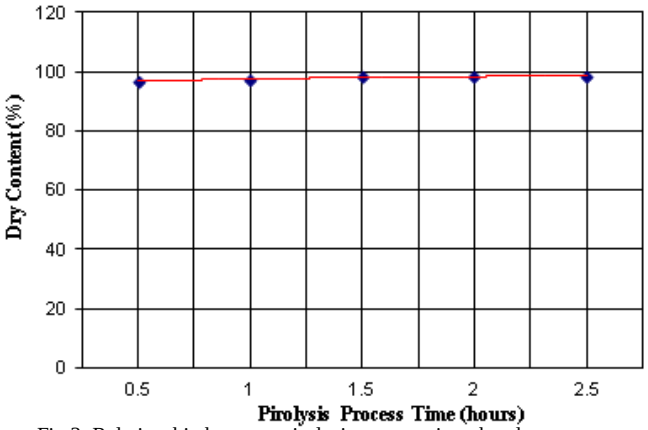

Fig 3. Relationship between pirolysis process time that dry content

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Fig 4 shows the quality of horse manure bioarang briquettes produced in this study has a calorific value that is still below the standard quality standard, namely the briquette quality standard based on SNI-01-6235-2000 of 5000 cal / g. Horse dung bioarang briquettes have higher gross energy along with the longer time needed to maintain the pyrolysis process. As shown in Figure 4. The gross energy of horse manure bioarang briquettes has an average increase of 3% for every 0.5 hour increase in the length of the pyrolysis process. The highest gross energy was obtained in bioarang briquettes with a length of time of 2.5 hours to maintain the pyrolysis process, namely 4432.2 kcal / kg. This happens because the volatile matter content is very high in biomass briquettes along with the longer time it takes to maintain the pyrolysis process. In addition, it is also influenced by the content of carbohydrates and fats which become carbon with the longer it takes to maintain the pyrolysis process. The carbon functions as an energy source in bioarang briquettes.

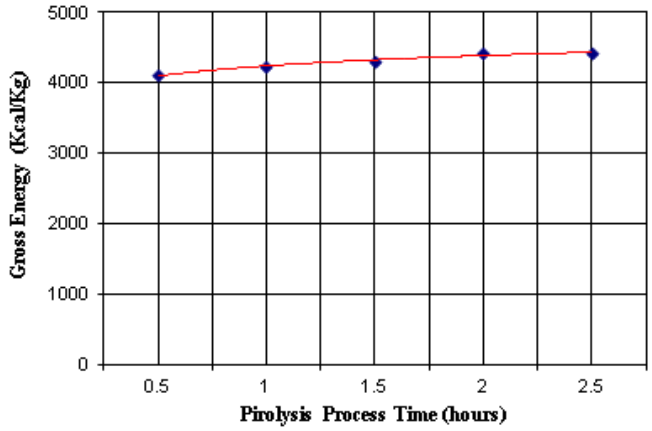

Fig 4. Relationship between pirolysis process time that gross energy

IV. CONCLUSION

Based on the results of the study, it can be concluded that the gross energy of horse manure biomass briquettes has increased by 3% for every 0.5 hour increase in the length of time required to maintain the pyrolysis process. Meanwhile, the decrease in water content in bioarang briquettes has an effect on the increase in the gross energy of the briquettes. This implies that the less water content contained in bioarang briquettes, the greater the gross energy level.

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