International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 10 ǁ October 2023 ǁ PP. 123-126

Effect of Inert Gas Treatment on the Quality of Biocharcoal Briquettes

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Abstract
Research was carried out to obtain alternative energy as an effort to reduce dependence on petroleum. Biocharcoal briquettes are a renewable and environmentally friendly alternative energy source. The raw material in this research used dried horse manure with a drying percentage of 26.4%. Next, the horse manure is mixed with starch with a ratio of horse manure to starch of 3:1. The mixture is pressed with a pressure of 10 bar to obtain biomass briquettes weighing 10 gr each, then dried in the sun for 3 days. so that a drying percentage of 59.3% is obtained, then processed into biocharcoal briquettes through a pyrolysis process. The pyrolysis process is carried out using a retort with a constant heating temperature, namely around 300°C. In the pyrolysis process, inert gas is added and the pyrolysis time varies from ½, 1, 1½, 2 and 2½ hours. The research results showed that biocharcoal briquettes with the addition of inert gas experienced an average increase in low heating value of 3% compared to biocharcoal briquettes without inert gas for every 0.5 hour increase in the time of the pyrolysis process. Biocharcoal briquettes with the addition of inert gas experienced an average increase in high heating value of 5% compared to biocharcoal briquettes without inert gas for every 0.5 hour increase in the time of the pyrolysis process.

Keywords: *Horse manure, Biocharcoal, Starch, Inert gas, Heating value*

Date of Submission: 02-10-2023 Date of acceptance: 13-10-2023

I. INTRODUCTION

Energy needs both on a national and international scale continue to increase from time to time in line with the increasing industrialization process throughout the world. The increasing progress of the industrial sector can be seen from the number of factories that continue to appear, both on a small scale (home industry) and on a large scale involving thousands of employees. As a result of changes in economic patterns, it is necessary to think together about how to save energy in addition to looking for alternative energy to replace fuel oil. One effort to find alternative energy is to use horse manure to make biocharcoal briquettes.

Bioarang is charcoal obtained from burning dry biomass in an airless system. Biomass is organic material produced through the photosynthesis process, either in the form of products or waste. Examples of biomass include plants, trees, grass, sweet potatoes, agricultural waste, forest waste, feces and livestock manure. Common biomass used as fuel is one that has low economic value or is waste after the primary product has been taken. Biomass energy sources have several advantages, including being a renewable energy source so that it can provide a sustainable energy source.

Horse manure contains a lot of carbohydrates, especially cellulose or fiber, in addition to protein and fat. This chemical compound has great potential as a carbon source which is the main constituent of biocharcoal briquettes. The way to obtain this carbon source is by burning organic materials in anaerobic conditions or known as pyrolysis, this method is intended to increase the energy value and improve combustion properties [1].

Heat analysis of a fuel is intended to obtain data about the heat energy that can be released by a fuel through the reaction/combustion process. The heating value of fuel can be interpreted by carrying out tests on an adiabatic bomb calorimeter, various data from the heating value test can then be used to form empirical / semi-empirical equations [2].

Heating value is a value to express the amount of heat contained in fuel. Briquettes will have good quality if they have a high heating value. The combustion process is said to be perfect if the end result of combustion is whitish ash and all the energy in the organic material is released into the environment [3]. The highest heating value was in the treatment using goat dung briquettes (3525 cal/gr) followed by cow dung (3139 cal/gr) and the lowest heating value was in chicken dung briquettes (2991 cal/gr). The heating value needs to be known when making biocharcoal briquettes, because this is to know the value of the heat of combustion that can

be produced by the briquettes as fuel. Testing the heating value aims to determine the extent of the combustion heat value produced by biocharcoal briquettes [4].

The heating value of briquettes depends on the composition of the ingredients. The high or low heating value is influenced by several factors. The first factor is the raw material, because each raw material will certainly have a different heating value according to its characteristics [4]. Another factor that influences the heating value is the carbonization temperature. The lower the carbonization temperature, the lower the heating value because the water content, ash content and volatile matter content will be high but the carbon content is bound, causing a decrease in the heating value [5]. However, the carbonization temperature cannot be too high, meaning it is only at the optimum carbonization temperature limit. This is proven by research which states that there can be a decrease in heating value above a temperature of 500°C, because at this temperature biomass decomposes into ash. The results of research show a heating value of 5666 cal/gr at a temperature of 500°C and a temperature of 500°C produces a heating value of 5011 cal/gr [6].

Heat is energy transferred across the boundaries of a system caused by temperature differences between a system and its surroundings. The heating value of fuel can be determined using a calorimeter. The fuel whose heating value will be tested is burned using a coil of wire that is electrified in a chamber called a bomb and immersed in water. Fuel that reacts with oxygen will produce heat, this causes the calorimeter temperature to rise. To prevent the heat produced from the reaction of fuel with oxygen from spreading to the external environment, the calorimeter is coated with an insulating material. The heating value of fuel includes the amount of heat produced or generated by a gram of fuel by increasing the temperature of 1 gram of water from 3.5°C-4.5°C in calorie units, in other words the heating value is the amount of heat obtained from burning a certain amount fuel in acidic substances, the higher the specific gravity of the fuel, the higher the heating value obtained.

II. RESEARCH METHODS

In this research, an experimental method was used, namely direct testing of biomass briquettes. The test material used was horse manure biomass mixed with starch which was formed into biomass briquettes. 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 weighing 10 gr each, then dried in the sun for 3 days.

Table 1: Tools and materials

Tools and materials	Specifications
Biomass	Horse manure
Adhesive	Starch glue
Inert gas	Nitrogen
Briquette press	10 bar
Analytical balance	0,1 mgr
Adiabatic Bomb Calorimeter	Model-IKA C2000

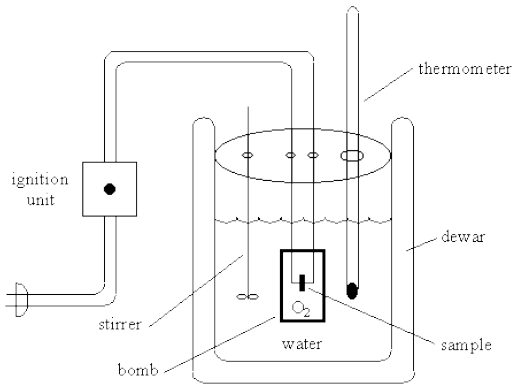

Figure 1: Adiabatic Bomb Calorimeter

The stages of the research procedure are making biomass briquettes by mixing starch with sufficient boiling water until the mixture changes like glue. Mix dried horse manure with starch glue in a ratio of 10 gr of starch to 30 gr of horse manure. Next, the mixture is formed or pressed with a pressure of 10 bar into biomass briquettes weighing 10 gr each and then dried in the sun for 3 days. In this study, the variables studied were the moisture content of biomass briquettes, dry weight of biomass briquettes, gross energy of biomass briquettes. Testing the quality of horse manure biomass briquettes includes water content, dry matter and gross energy.

Testing for water content and dry matter uses proximate analysis, while for gross energy testing uses a bomb calorimeter Model-IKA C2000 (Fig 1).

III. RESULT AND DISCUSSION

This research was conducted to determine the characteristics of briquettes, carrying out several analyses, namely proximate analysis and heating value. There was a decrease in the moisture content of horse manure biomass when it was made into briquettes. The moisture content of raw horse manure biomass is 26.4%, when it becomes briquettes the average moisture content is 12.6%.

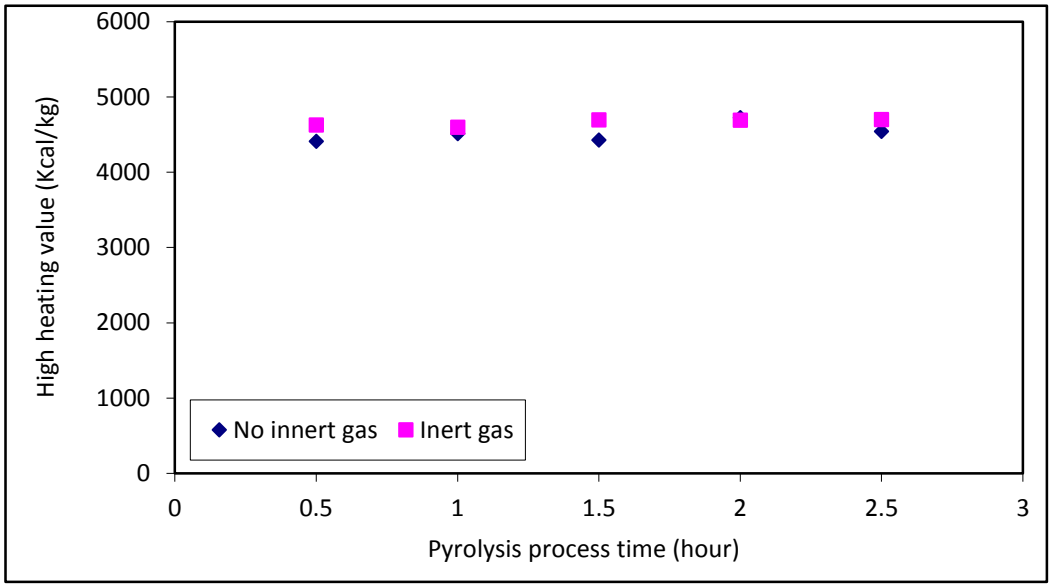

Figure 2: Relationship between High Heating Value and Pyrolysis Process Time

The main influence in determining the high and low energy levels of biocharcoal briquettes is that apart from the basic ingredients of the briquettes, the duration of the pyrolysis process is also determined. There are 5 variations in the time of the pyrolysis process, namely ½, 1, 1½, 2 and 2½ hours. Fig 2 shows that the longer the pyrolysis process, the higher the high heating value (HHV). This happens because horse manure contains a lot of carbohydrates and fats, where if these two elements are pyrolyzed they will turn into carbon, so that if the carbon content in biocharcoal briquettes is greater, the high heating value content will be greater.

The effect of adding inert gas (nitrogen) in the pyrolysis process shows an increase in all treatment variations in the time of the pyrolysis process. This situation occurs more because there is no oxygen element in the pyrolysis process, so that all carbohydrate and fat elements turn into carbon and no elements turn into ash. Meanwhile, in the pyrolysis process without the addition of inert gas, there is still oxygen in the pyrolyzer oven for treatment without inert gas, so that some of the briquettes react with oxygen and turn into ash during the pyrolysis process. Biocharcoal with the addition of inert gas experienced an increase in heating value of an average of 5% compared to biocharcoal without inert gas for every 0.5 hour increase in the time of the pyrolysis process (Fig 2).

Fig 3 shows that the longer the pyrolysis process, the higher the low heating value. This happens because horse manure contains a lot of carbohydrates and fats, where if these two elements are pyrolyzed they will turn into carbon, so that if the carbon content in biocharcoal briquettes is greater, the low heating value (LHV) content will also be greater.

The pyrolysis process without adding inert gas still contains the oxygen element in the pyrolyzer oven for treatment without inert gas so that some of the briquettes react with oxygen and turn into ash during the pyrolysis process. However, this is different from inserting inert gas into the pyrolyzer oven, it will force oxygen to come out of the oven, so that during the pyrolysis process the briquettes tend not to react with oxygen, this is because there is no longer any oxygen in the pyrolyzer oven. Fig 3 shows that biocharcoal with the addition of inert gas experienced an average increase in low heating value of 3% compared to biocharcoal without inert gas for every 0.5 hour increase in the time of the pyrolysis process.

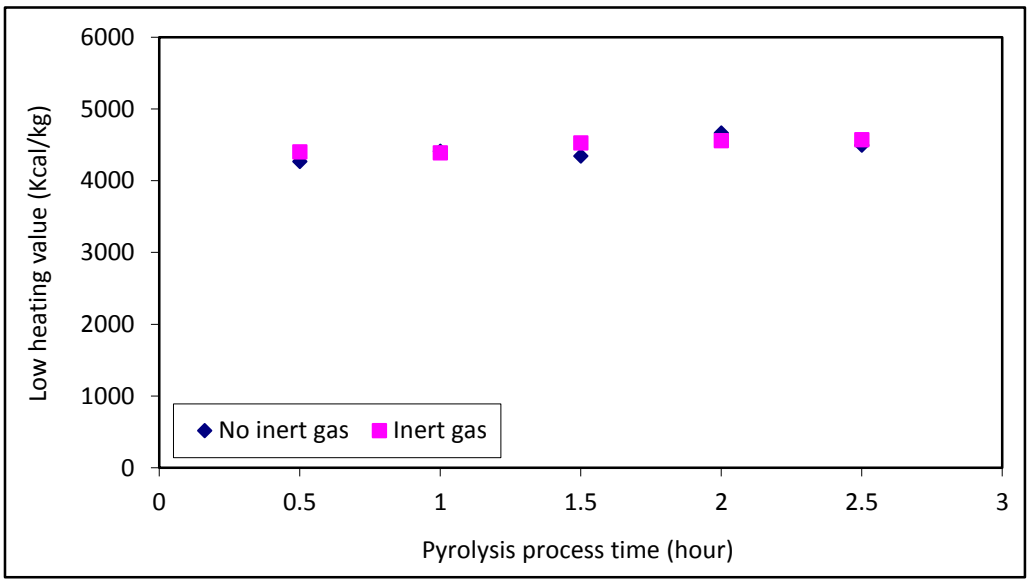

Figure 3. Relationship between Low Heating Value and Pyrolysis Process Time

IV. CONCLUSION

The research results showed that biocharcoal with the addition of inert gas experienced an increase in low heating value by an average of 3% compared to biocharcoal without inert gas for every 0.5 hour increase in the time of the pyrolysis process. Biocharcoal with the addition of inert gas experienced an increase in high heating value by an average of 5% compared to biocharcoal without inert gas for every 0.5 hour increase in the time of the pyrolysis process.

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