International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 09 | Sep 2018 www.irjet.net p-ISSN: 2395-0072

THE EFFECT OF DENSITY AND HARDNESS AT THE RATE OF BURNING COCONUT SHELL BRIQUETTES AND WATER HYACINTH

Artian Sirun[1], Herotje Siwi[2], Markus Karamoy Umboh[3]

[1,2]Manado State Polytechnic, Manado, Indonesia
[3]Sam Ratulangi University, Manado, Indonesia

Abstract - *The purpose of this study was to determine the characteristics of briquettes produced, including water content, volatile substance content, combustion rate, density, hardness, and to find the appropriate comparison from a mixture of water hyacinth and coconut shell with variations in tapioca adhesive levels. The mass ratio between water hyacinth and coconut shell in this study is 1 0: 0 1: 0.25 0.75; 0.5: 0.5; 0.75: 0.25 with a variation of tapioca adhesive content of 4% of the weight of the raw material. From the results of this study it was found that the ideal composition of briquettes was obtained in a mixture of water hyacinth and coconut shell at a ratio of 0.25: 0.75 with 4% tapioca adhesive content with 4.95% moisture content. volatile substance content 10.363%, density value 0.613 gr / cm, combustion rate 0.826 g / minute and hardness 0.716 HL.*

***Key Words*: Water hyacinth, shell, volatile, tapioca, coconut shell**

1. INTRODUCTION

Petroleum is the main buffer of the world's energy needs to date. Almost all of the world's needs depend on these non-renewable energy sources including Indonesia. In 2006, the Department of Energy and Mineral Resources (ESDM) released a statement that the use of fossil fuels dominated its use, which amounted to 52.5%. While the use of Liquefied Petroleum Gas (LPG) is 19%, coal is 21.5%, water is 3.7%, geothermal is 3% and renewable energy is only 2% of the total national energy use [1]. If petroleum is continuously consumed and no new oil reserves are found or no new technology is found in the energy sector, it is estimated that Indonesia's petroleum reserves will run out in the next twenty-three years. This phenomenon is very logical due to massive use of BBM without accompanying availability source of human fulfillment needs. Based on the Energy Information Center in 2003, the largest use of fossil fuels was in the household sector, namely the use of kerosene fuels for cooking activities with an achievement of 46% followed by the industrial sector by 25%, transportation 19% and other uses by 9%.

Bio mass can be obtained from agricultural waste, household waste and industrial waste. In order to be used as fuel, the waste can be processed into solid fuel in the form of briquettes. One of the biomass that can be used as briquettes is water hyacinth and coconut shell. The selection of this material is done because the utilization of water hyacinth and coconut shell waste has the potential to increase the economic value of the waste. This study aims to investigate experimentally the effect of briquette density and hardness with a variety of mixture of shell charcoal and water hyacinth with adhesive tapioca flour and water to determine the quality of briquettes.

The problem is whether the density and hardness of briquettes from the process of making water hyacinth, shell charcoal and tapioca flour adhesives affect the quality of briquettes. To answer these problems is to study the performance of briquettes by comparing the time needed to boil one liter of water at room temperature between the briquette stove and kerosene stove.

RESEARCH METHODS

2.1. Research Materials and Tools

This Research uses raw water hyacinth and coconut shell ingredients using tapioca adhesive for making briquettes. In this study used equipment such as: coconut shell charcoal and water hyacinth milling machines, coconut shell charcoal and water hyacinth grinding machines, briquette molding machines, briquette dryers, briquette stoves, digital scales, measuring cups, pans, thermometers, and time gauges .

The variables used in this study are as follows.

A. Fixed variables, namely:

- Size of shell charcoal and water hyacinth using mesh sieve 60.
- Carbonization temperature of shell charcoal and water hyacinth 400 °C.
- The mass ratio of tapioca flour and water is 1: 3
- Dimensions of briquettes such as figure below 15 mm 100 mm.

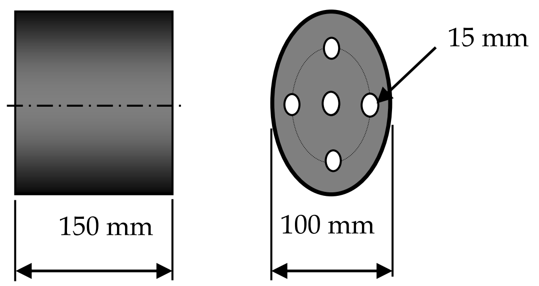


Figure 1. Briquette dimensions

B. Variable changes, namely:

Comparison between water hyacinth and coconut shell and the percentage of taploka adhesive from the total weight of briquettes is shown in Table 1

Table 1. Variation in Tapioca Adhesive Levels with Comparison of Shell Raw Materials Coconut and Water Hyacinth

Sample	Tapioca Adhesive (%)	The Comparison of Coconut Shell Charcoa: Water hyacinth (%)
A	4	1 : 0
B	4	0 : 1
C	4	0,25 : 0,75
D	4	0,5 : 0,5
E	4	0,75 : 0,25

2.2. Making Briquettes

- Coconut shells and water hyacinth Pyrolysis was carried out to get charcoal
- charcoal from water hyacinth and coconut shell milled into charcoal powder
- Charcoal powder is filtered with 60 mesh sizing powder to get uniform material
- The composition of raw materials is varied according to the research variables. The comparison between coconut shell charcoal and water hyacinth in this study is; 1: 0; 0 1: 0.25: 0.75; 0.5: 0.5; 0.75: 0.25 with 4% adhesive content. In this study the number of samples of each variation amounted to 5 specimens.
- Adhesive from tapioca flour is made by mixing tapioca flour with water and then heated at a temperature of t 75 C to become a slurry-like mixture. The comparison between tapioca and water is 1: 3.
- The mixture is stirred until the ingredients are evenly mixed.
- The printed briquette dough using a briquette printing device is then pressed to reach the height size determined.
- The briquette is dried in an oven at a temperature of 80^0 C for hours.

2.3. Testing Procedure

A. Hardness Test

Tests of samples to test hardness, density, and time needed to boil water are carried out 5 times. Testing of briquette hardness was carried out using hardness tester Type TH160 on the HL scale

B. Density Test

This test is carried out by determining the density of briquette masses through the briquette mass ratio with the magnitude of the briquette volumetric dimension. Mathematically the determination of density can be written as follows :

$$\rho = \frac{m}{v} \left({}^{Kg}/_{cm^3} \right)$$

C. Burning Rate

While to determine the combustion rate of briquettes is calculated by the weight of the briquettes that have been ignited divided by the burning time until the briquettes run out burned or to ashes.

D. Volatile Matter Test

Testing of volatile substances is carried out based on SNI 06-3730-1995.

E. Water content Test

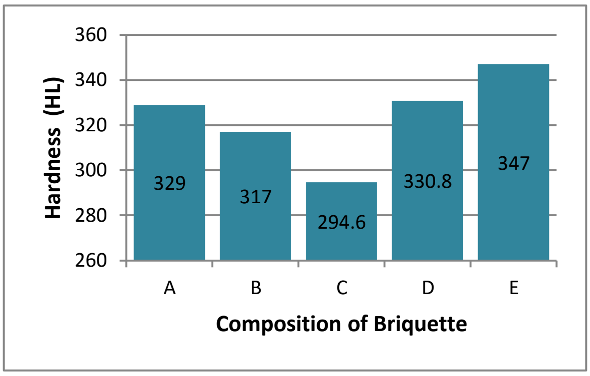
Water content in briquettes by measuring the weight of empty porcelain dishes, then the sample of briquettes or charcoal is ground into flour and put into a cup as much as 5 grams. Then the sample was put in an oven with a temperature of 105 ° C for 3 hours. The cup is removed from the oven and cooled in a desiccator so that the outside air is not affected for 1 hour. Then weighed. The method of determining the water content is carried out three times. The equation used is

$$\text{Moisture Content } (\%) = \frac{M_1 - M_2}{M_1} \text{ x } 100 \%$$

3. RESULTS AND DISCUSSIONS

3.1. Briquette Hardness

Test results of briquette hardness are presented in Figure 2 below:



From the data obtained from the hardness test, it can be seen that the optimum hardness value in type E briquettes is a mixture of 75% coconut shell charcoal and 25% water hyacinth with 4% tapioca adhesive at 347 HL. Whereas the lowest value in type C composition with a mixture of 25%

shell charcoal and 75% water hyacinth which is 294.6 HL. This condition occurs because charcoal hardness is more intense than charcoal. The picture above shows that the smallest hardness in the composition of the mixture of 100% water hyacinth and 0% coconut shell.

3.2. Briquette Density value

Based on the picture 3. The density value with a mixture of 100% shell charcoal has the highest density of 0.823 gricm compared to other mixed compositions. The lowest density value of 0.543 gr / cm is found in briquettes with a mixture composition of shell charcoal and water hyacinth 0.5 : 0.5 (%). The addition of shell charcoal powder will increase the density value in water hyacinth powder. High density values will affect the calorific value of briquettes. However, the density value that is too high will cause the briquette to be difficult to burn, while the briquette which has a low density value will be easier to burn because the air cavity is large so that oxygen can be passed through the combustion process. Briquettes with a low density will run out faster because there are too many air cavities [2]. The increase in the number of coconut shells in briquettes can expand the bond between particles, so as to increase the density of briquettes because the bond between the charcoal powder becomes more compact [3]. Increasing the level of adhesive which is higher will cause the briquette to have a higher density because the adhesive will enter the pores of the briquette.

From the results of testing all types of briquettes that were obtained did not meet the density values of the ISSNI (0.5 0.6 g / cm) and. But briquettes with a variety of mixed compositions meet British quality standards (0.46 0.85 g / cm), Japan and America (1.0 -1.2 g / cm2) [2].

3.3. Burning Rate

The rate of burning of briquettes from each type of mixture can be seen in table 2. The largest combustion rate of 1.397 grams / minute occurs in the mixture of 100% shell charcoal briquettes with an initial weight of 585 grams. Whereas the smallest combustion rate occurs in briquettes with a mixture.

Table 2 shows that the physical and thermal properties of briquettes for all mix compositions have different values even though the volume of briquettes is relatively equal. Briquette with composition of 100% shell produces the longest flame between other mixed compositions. The time needed to burn briquettes to ashes is 360 minutes with a burning rate of 1,397 gr / min. While briquettes with 100% water hyacinth composition give the smallest value with time to burn briquettes until they run out 180 minutes with a burning rate of 0.556 gr / min. The speed of combustion is affected by the structure of the material, the content of the bound carbon and the degree of hardness of the material. Theoretically if the content of volatile compounds is high, the briquettes will be easily burned with high combustion .

The results of this study indicate that the more coconut shells and the levels of tapioca adhesive in briquettes, the longer the combustion time will be. This is because coconut shells have a higher heating value than water hyacinth. The higher the heat value of briquettes, the longer the burning time. In addition, the higher adhesive content increases the density value. The greater the density value of briquettes, the longer the combustion time, because the more dense the briquettes, the smaller the air cavity will become more difficult for oxygen to pass during the combustion process. This condition also occurs in briquette hardness, the harder a briquette is, the briquette will be longer to become the burning ash. Likewise the combustion rate, the harder the briquette is, the smaller the combustion speed.

Table 2. Combustion Rate of Water Hyacinth and Coconut Shell Briquettes

Composition mixture **(%)**	Briquettes volume **(cm^3)**	Before the residual combustion briquette ash is burned **(gr)**	Mass briquette before is burned **(gr)**	Time Of burning **(min)**	Speed of burning **(g/min)**
Coconut shell charcoal 100	981,83	585	40	390	1,397
Water hyacinth 100	981,68	160	60	180	0,556
Coconut shell charcoal 25 Water hyacinth 75	981,65	225	35	230	0,826
Coconut shell charcoal 50 Water hyacinth 50	981,74	398	30	345	0,956
Coconut shell charcoal 75 Water hyacinth 25	981,78	465	30	386	1,048

3.4. Water Content

Percentage of moisture content for each type of briquette is presented in Figure 4 below:

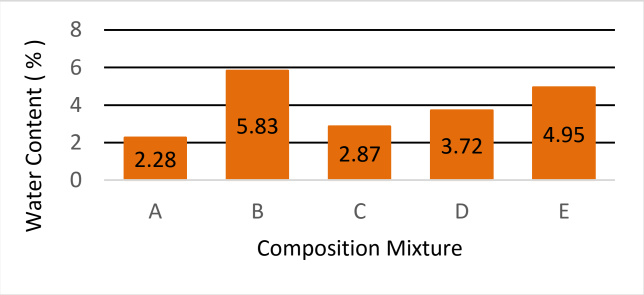


Figure 4. Effect of Composition on % to Water Content

The difference in water content values shown in the figure above is caused by: the type of raw material, the type of adhesive, and the method of testing carried out. The water content contained in briquettes is 2,283-5,834%. The highest moisture content was found in sample B, namely briquettes with a ratio of coconut shell and water hyacinth 0: 1 or 100% water hyacinth with 4% adhesive content. The lowest moisture content is found in sample A briquettes with a ratio of 1: 0 or 100% charcoal shell with 4% adhesive content. The fewer coconut shells and the higher levels of tapioca adhesive contained in briquettes, the higher the water content. This is because the water content in water hyacinth is greater that is 90% in fresh water hyacinth [4], while the coconut shell has 8% moisture content [5].

Tapioca adhesive levels that are used also affect the water content because the water contained in the adhesive will enter and be bound in the charcoal pores. Briquettes that contain high water content will be easily overgrown with fungi and difficult to ignite [6]. Overall, the briquettes produced are in accordance with Japanese, British and American quality standards. Briquette moisture content according to SNI and Japanese quality standards is a maximum of 8%, American quality standards a maximum of 6% and UK quality standards 3-4% [1].

3.5. Folatile Substance

Fig. 5 shows a graph of the test results of folatile substances found in briquettes with various compositions of the mixture of raw materials

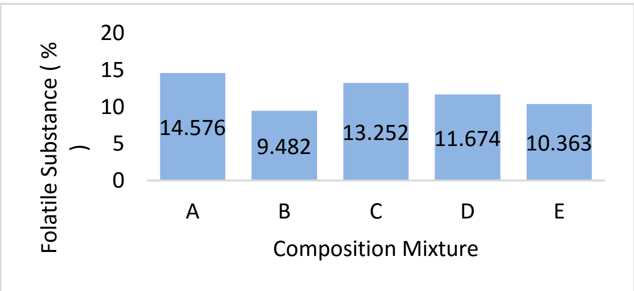


Figure 5. Effect of Composition Against Volatile Matter

Briquette A with a composition of 100% of shell charcoal and tapioca adhesive has the highest volatile price compared to other types of briquettes which is 14.576%. Whereas type B briquettes with a mixture composition of 100% enceng have the smallest volatile that is equal to 9482. However, all types of briquettes have volatile prices under the SNI standard of 15% [3,4]. The volatile substance content increases with the increasing number of coconut shells and the levels of tapioca adhesive in briquettes. This is due to the evaporating content such as CO, CO_2, H_2, CH_4 and H_2O found in coconut shell charcoal which is used to evaporate [7]. Tapioca adhesive levels which are used also affect the levels of volatile substances. When heating charcoal briquettes, the adhesive used is evaporated so that the resulting volatile substance content becomes greater with increasing levels of adhesive. The high content of volatile substances in briquettes will cause more smoke when burning briquettes [8].

4. CONCLUSION

The results of the research and biobriket testing of water hyacinth on the type of adhesive used can be concluded that the influence of adhesives and compositions gives a very significant influence on water content, density, hardness, volatile substances, and the resulting combustion rate. The highest moisture content in the type of briquette with a composition of 100% water hyacinth. The high water content in tapioca adhesive is due to the chemical bond of water in tapioca because the water structure of water hyacinth is more than that of shell. The combustion rate is affected by the density of the briquette, where the more tightly a briquette is, the longer the combustion rate will be. Likewise with briquette hardness.

REFERENCES

[1] A. Sugiyono, Anindhita, Laode M.A. Wahid, Adiarso (2017). Energy Development in Supporting Green Industry, Indonesia Energy Outlook 2016 (Jakarta: Ministry of Energy and Mineral Resources of Indonesia)

[2] Dian Fatmawati, Priyo Heru Adiwibowo (2014). Making Biobriquette from a mixture of Water Hyacinth and Coconut Shell with Sugarcane Drop Adhesive, Jurnal JTM, 3 (2) : 315-322.

[3] Sarjono (2013). Experimental Study on Comparison of Mixed Briquette Calorific Value of Bioarang Rice and Coconut Shell Husk, Jurnal Simetris, (17) : 11-18

[4] Kharis Akbar Rafsanjani, Sarwono, Roni Dwi Noriyanti (2012). Composition Test of Bioarang Briquette Maker Material Coconut Shell and Wood Powder Against Supporting Eco Campus Program at ITS Surabaya Produced Quality, Jurnal Teknik POMITS 1 (1) : 1-6

[5] Maryono, Sudding, Rahmawati (2013). Study of Biomass Potential from Organic Waste as Alternative Fuels (Briquette), Jurnal Chemical, 14 (1): 74-83.

[6] Nodali Ndraha (2009). Preparation and Analysis of the Quality of Coconut Shell Charcoal Briquettes Viewed from the Kanji Level, Program Sarjana Fakultas Pertanian USU, Medan : 16-38

[7] Y. Yuliah, M. Kartawidjaja, S. Suryaningsih, K. Ulfi (2017). Fabrication and characterization of rice husk and coconut shell charcoal based bio-briquettes as alternative energy source, International Conference on Biomass: Technology, Application, and Sustainable Development: 1-8.

doi :10.1088/1755-1315/65/1/012021

[8] Nodali Ndraha (2009). Preparation and Analysis of the Quality of Coconut Shell Charcoal Briquettes Viewed from the Kanji Level, Program Sarjana Fakultas Pertanian USU, Medan : 16-38

ACKNOWLEDGEMENT

The authors gratefully acknowledge the fellowship granted by Directorate of research and Community Service (DRPM). We are very grateful to experts for their appropriate and constructive suggestions to improve my research in the future.