

# JP 5

*by Ellyta Sari*

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**Submission date:** 21-Dec-2023 09:31PM (UTC+0700)

**Submission ID:** 2263665939

**File name:** Sari\_2018\_IOP\_Conf.\_Ser.\_Mater.\_Sci.\_Eng.\_316\_012021.pdf (657.55K)

**Word count:** 3480

**Character count:** 20478

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To cite this article: Elyta Sari *et al* 2018 *IOP Conf. Ser.: Mater. Sci. Eng.* **316** 012021

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## STUDIES OF CARBONIZATION PROCESS ON THE PRODUCTION OF DURIAN PEEL BIOBRIQUETTES WITH MIXED BIOMASS COCONUT AND PALM SHELLS

Ellyta Sari<sup>1</sup>, Pasymi<sup>1</sup>, Umar Khatab<sup>2</sup>, Reni Desmiarti<sup>1</sup>, Rian Ariansyah<sup>1</sup>, Hariadi<sup>1</sup>, Sutra<sup>1</sup>

<sup>1</sup> Departement of Chemical Engineering, Universitas Bung Hatta, Padang West Sumatra, Indonesia

<sup>2</sup> Department of Civil Engineering, College of Technology Payakumbuh, West Sumatra, Indonesia  
E-mail : sariellyta@yahoo.com

**Abstract.** Biobriquettes as alternative energy that can replace the role of kerosene. Biobriquettes made from agricultural waste biomass. Biobriquettes durian peel has been researched and developed continuously to obtain optimal quality in terms of calorific value, compressive strength and duration of ignition. In making durian peel biobriquettes needed other biomass mix to sustain duration of Ignition for biobriquettes durian skin quickly burned out. Stages of making biobriquettes durian skin are: material of drying, carbonization of biomass, grinding, mixing with adhesives, and printing. Carbonization process is a process that is important in obtaining the biomass charcoal. Carbonization is done by means of karbonisator pyrolysis. The purpose of this research is to study the process of carbonization to obtain biobriquettes durian skin that of quality in terms of value compressive strength, calorific value, and duration of ignition. Variations that done was kind mix of biomass, coconut shells and palm shells with the massa ratio 2 : 1, type of adhesive used tapioca powder and banana peels, carbonization of temperature 200°C, 300°C and 400 °C . The results showed that the highest compressive strength of the durian skin with a mixture of coconut shell and adhesive tapioca powder and carbonization temperature of 300 °C namely 12,7 g/cm<sup>2</sup>. The calorific value of the highest on the mix of skin durian with coconut shells and adhesive banana skin with temperature of carbonization 400 °C ie 6040 cal/g, and duration of ignition highest on a mixture of skin durian with coconut shell and adhesive banana skin at a temperature of carbonization 300 °C is 73 minutes.

**Keywords :** Biobriquettes, Durian peel , Carbonization.

### 1. Introduction

Renewable alternative energy sources is being developed in Indonesia. One of these is biobriquettes from biomass. Biomass is composed of cellulose, hemicellulose and lignin that is commonly found in plant parts. Biomass is a renewable reseources that can be used sustainably.

Durian peel waste is one of biomass that could be used as a raw material source of renewable energy. Several studies of Biobriquettes of durian peel has been conducted. (Pramudya, et al.,2011) studied the variation of biomass and adhesive mixture. However, these studies without using the carbonization process of durian peel. In the biobriquettes manufacture, carbonization is a very important process because it is the main process in the biobriquettes manufacture which can affect the biobriquettes quality.

Carbonization process is done by burning biomass in open condition, the burning process then stopped when the charcoal formed, by spraying water on the charcoal that has been formed. This kind of process generated a lot of ash and smoke so that the charcoal making process is not optimal and produced only a little charcoal. Therefore it is necessary to look for solutions, so



that the carbonization process authoring maximum results, which produces little ash, it also can take advantage of combustion smoke as liquid smoke which can be used as a natural food preservative, which is not harmful.

This is known as pyrolysis process (Mira, M, 2002). The characteristics of durian peel as an alternative fuel by the pyrolysis process has been investigated (Wahidin, 2014). In this study, the ash content obtained is still high (18.8%), caused not using a mixture of biomass. The process of making biobriquettes by pyrolysis carbonization been done by (Feri Fuji, 2010), at a temperatures of 210, 250, 300, 350, and 390°C using rice husk as raw materials, and the highest calorific value obtained at 5609.453 cal/g. In addition (Warapon R, *et.al*, 2011) also examined biobriquettes durian peel with a mixture of rice straw (9: 1) the calorific value obtain is 24,674MJ/kg (5902 cal/g). While (G. Siresh, *et al*, 2016) examined the types of palm briquette powder and binder, providing a calorific value of 20 945 MJ /kg (5010 cal/g) at 80.79% efficiency.

(Paisal, 2014) conducted a study of biobriquettes made from durian peel using an adhesive with banana peel waste without mixing other biomass, and the calorific values obtained 5074 cal/g. (Sari, E, *et.al*, 2015) also did research on biobriquettes durian peel with a mixture of biomass palm shells and rubber shell, using starch as an adhesive. From this study, the highest calorific value obtained of 5118 cal/g. (Merry, *et.al*, 2015) also examined using an adhesive calcium hydroxide and obtained calorific value of 4968 cal/g. Accordingly it is need to do research with the pyrolysis carbonization process of durian peel, so that the higher ash levels can be reduced by using a mixture of other biomass.

Moreover carbonization pyrolysis also produces liquid smoke which can be used as a preservative. This research will be carried out at a pyrolysis carbonization temperature of 200-400°C with adhesive from banana peels waste and starch as a comparison, by add biomass from coconut shell and palm shell to increase the calorific value of biobriquettes.

The purpose of this study was to determine the effect of carbonization temperature to the biobriquettes result, the effect of biomass mixture with biomass durian peel to the calorific value, and the effect of adhesive type to quality of biobriquettes produced.

## 2. Methodology/ Experimental

This research was conducted at the Laboratory of Chemical Engineering, Universitas Bung Hatta Padang. The research parameters consist of Fixed Parameters, Variable Parameters, and Output Parameters. Fixed Parameters are biomass of durian peel, adhesive: 10% from the total biomass mixture, biomass mixture with composition ratio 2: 1, with a total weight of biomass at 140 grams. Variable parameters is another biomass mixture,: palm shells, coconut shells; different types of adhesives: starch and banana peels; Carbonization temperature at 200, 300, and 400°C. Output parameters are compression strength, porosity, calorific value, ash content and burning time.

### 2.1. Tools

Pyrolysis carbonization reactor, condenser, biomass cutlery, sifter, Mixers, grinding, Biobriquettes Molds, basin, Zinc for drying, Stove, Pots, Spatula, scales, oven, desiccator and porcelain dish.

### 2.2. Materials

Durian peels from Padang, Biomass mixture consist of palm shells, Coconut shell, adhesive from starch flour, banana peel, and water.

### 2.3. Working Procedures

#### 2.3.1. Carbonization Stage by means of Pyrolysis Carbonization

- a. The durian peel was chopped up small, so that the drying process can be faster and more volume of material can be fed into the reactor
- b. All material is dried under the sun for 4-5 days.
- c. once the ingredients dry, biomass was entered in the carbonization reactor, then temperatur of heating was set and biomass was entered until almost full and then reactor was covered tightly.
- d. The heater is switched on and the carbonization temperature is adjusted (according to variations at 200, 300 and 400°C) with a heating time of 2 hours each.
- e. After two hours, pull out the carbonization results, then crush until smooth at size of 60 mesh.
- f. The same thing is done on another biomass mixture; palm shell and coconut shell

#### 2.3.2. Adhesives Manufacturing Phase

##### A. Making Adhesives From Starch

Starch weighed as much as 10% of the total biomass feedstock, next insert the water at a ratio of 1: 10, then stirred. Starch solution was then heated on a stove until thickened.

##### B. Making Adhesives from Banana Peel

Banana peel retted  $\pm$  10 days, then was mashed. The smooth banana peel is mixed with 10% of the total weight of the biomass feedstock, then was add water gradually until homogeneous.

#### 2.3.3. Briquetting Phase

The smooth durian peels charcoal is weighed according to the specified weight and the specified biomass variation. The refined durian peel is mixed with the adhesive in the container while stirring until evenly Further the mixture were molded using biobriquettes mold. Biobriquettes then dried under the sun until completely dry.

### 2.4. The tools image series can be seen in Figure 1.



Figure 1. The series of pyrolysis carbonisator dual function tool

Information :

1. Reactor; 2. Furnace; 3. Thermometer; 4. Pressure Gauge; 5. Condenser; 6. The Hot Water flow; 7. The Cold Water flow in; 8. Condensate Flow; 9. Liquid smoke Container; 10. The cooling water hose

### 3. Results and Discussion

Biobriquettes shape produced from the research of Manufacturing of biobriquettesdurian peel from the mixture of biomass and adhesive, can be seen in Figure 2.



Figure 2. Biobriquettes of Mixture of Biomass and Adhesives

#### 3.1. Effect of Raw Materials to the Biobriquettes Porosity/ Density

Porosity/density is the ratio between the weight to the volume of briquettes. Density size is influenced by the size and homogeneity of the briquettes materials. Based on observations and calculations performed on the density value of each treatment, smaller particle size can expand the field of bonding between powders, thus increasing the density of briquettes (Masturin 2002). The effect of a biomass mixture to porosity can be seen in Figure 3 and Figure 4.

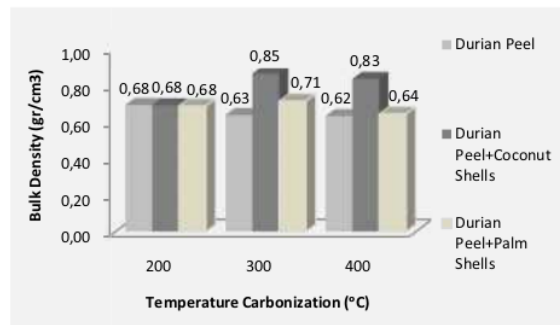


Figure 3. Effect of Biomass Mixture Using Adhesives Starch To The Porosity

From Figure 3 and Figure 4 can be seen that the mixing of biomass coconut shell and palm shells charcoal with durian peel (agricultural waste) at a smaller size (60 mesh) could expand the bonding between particles, thereby increasing the biobriquettesdensity, since the bonds between powder are stronger and more compact.

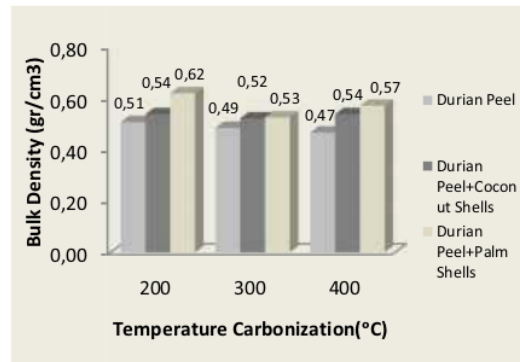


Figure 4. Effect of Biomass Mixture Using Adhesives Banana Peel to the Porosity

Figure 3 and Figure 4 show that biobriquettes porosity values ranged from 0.47 to 0.85 g/cm<sup>3</sup>. Biobriquettes with adhesive starch obtained the best porosity of 0.85 g/cm<sup>3</sup> with a mix of biomass durian peel and coconut shell, while biobriquettes with adhesive banana peel earned best porosity of 0.62 g/cm<sup>3</sup> with a mixture of durian peel biomass and palm shells. Adhesive banana peel does not have a strong bond between the fibers, it is because the banana peel adhesion is not as strong of starch adhesion. This leads to a lower density value. Thus, the composition of the constituent material effect the biobriquettes density.

### 3.2 Effect of the Mixture of Biomass and Adhesive on Compression Strength

Effect of biomass mixture and adhesive on biobriquettes compression strength can be seen in Figure 5 and Figure 6.

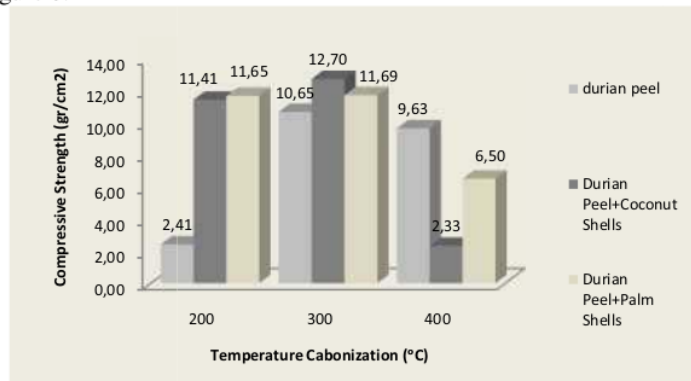


Figure 5. Effect of Biomass Mixture using Adhesives Starch To The Compression Strength

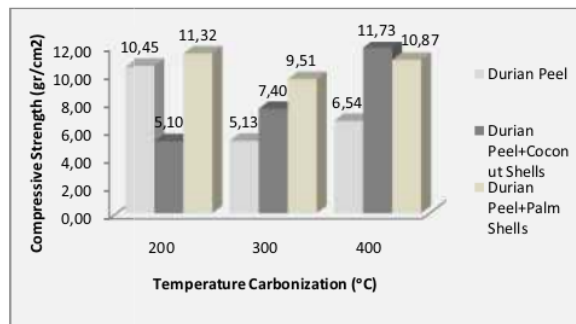


Figure 6. Effect of Biomass Mixture Using Adhesives Banana Peels To The Compression Strength

Figure 6 and 7 shows that the highest compression strength at  $12.70 \text{ g/cm}^2$ , using adhesive starch with a mixture of coconut shell biomass at temperatures of  $300^\circ\text{C}$ , while the highest compression strength using adhesive banana peel with a mixture of biomass palm shell at temperature of  $400^\circ\text{C}$ , namely  $11.73 \text{ g/cm}^2$ .

Adhesive starch has a better compression strength than adhesive banana peel, this is due to starch adhesion is higher than banana peel, moreover high density biomass would produce high compression strength biobriquettes as well, as proposed by (Sudrajat,1984), that charcoal biobriquettes from high density raw materials will also provide a high compression strength

### 3.3. The Effect of Biomass Mixture and Adhesive to the Calorific Value

The biomass mixture and adhesives used in biobriquettes manufacture also affect the calorific value. Each sample variation had been tested the calorific value.

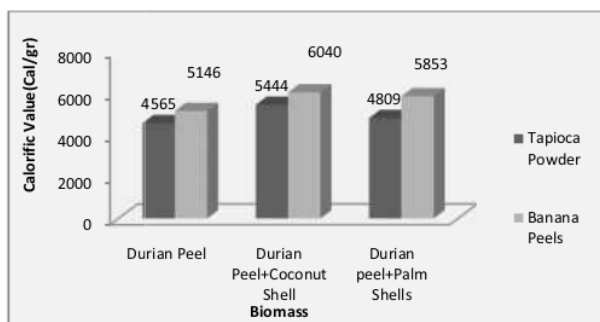


Figure 7. The Effect of Biomass Mixture and Adhesives To The Calorific Value

Figure 7 show that the increasing of calorific value is also influenced by a mixture of biomass used. Calorific value of Biobriquettes durian peel without other biomass mixture are 4564 and



5146 cal/g, and the calorific value were increased become 5444 and 6040 cal/g when biobriquettes durian peel mixed with coconut shell.

Calorific value of biomass using a mixture of palm shells decreased to 4809 and 5853 cal/g. In the research by Pramudya, et.al (2011), the highest calorific value obtained on durian peels and palm shells with jackfruit seed adhesive was 5495 cal / gr. Thereby it can be concluded that the used of adhesive type is can influenced the caloric value. Banana peel adhesive gives the highest calorific values than with the jackfruit seeds adhesive in research Pramudya ,et.al (2011).

The addition of biomass can increase the calorific value of biobriquettes durian peel. The addition of coconut shell biomass provides the best calorific value. This is due to coconut shell has a high carbon compound that gives additional calorific value to the durian peel biobriquettes produced. Adhesive type is also affects the calorific value obtained. Figure 7 shows that adhesive banana peel provides a higher calorific value than adhesive starch.

#### 3.4. Effect of carbonization temperature and biomass mixture to the Burning Time

Effect of carbonisation temperature and biomass mixtures to the biobriquettes burning time can be seen in Figure 8 and Figure 9.

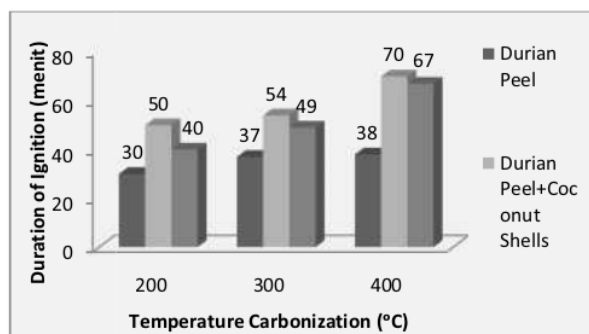


Figure 8. Effect of Carbonisation Temperature and Biomass Mixture Using Adhesives Starch To The Burning Time

Figure 8 and Figure 9 shows that the best burning time of biobriquettes obtained at carbonization temperature of 400°C ie 73 minutes on biobriquettes with adhesive banana peel and coconut shell mixture. This is because the burning temperature of 400 °C completely carbonized biomass as compared with 200°C and 300°C burning temperature, so that the carbon content tied will be higher at burning temperature of 400 °C, so the biobriquettes ignition time to ashes will be longer.

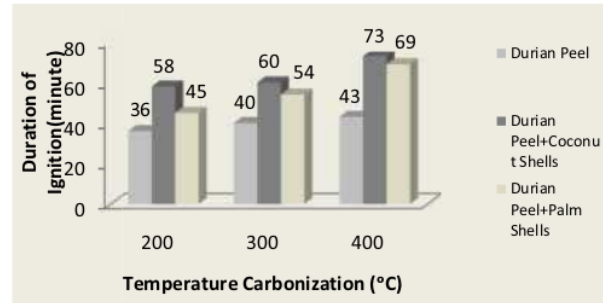


Figure 9. Effect of Carbonisation Temperature and Biomass Mixture Using Adhesive banana peels To The Burning Time

The effect of biomass mixture show that Biobriquettes mix with coconut shells provide the best ignition when compared with other. In research by Munas, et.all (2012) that the best burning time of biobriquettes is 40 minutes on biobriquettes with cocoa beans biomass without the addition of other biomass, but in this study the best burning time of biobriquettes is 73 minutes on biobriquettes with durian peels and coconut shells with banana peel s adhesive.

### 3.5. Effect of Carbonization Temperature and Biomass Mixture to Ash Content

Effect of carbonization temperature and the biomass mixture to ash content can be seen in Figure 10 and 11.

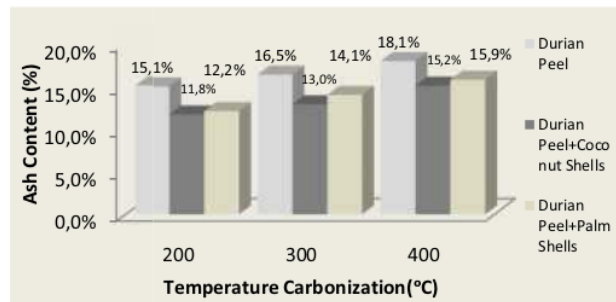
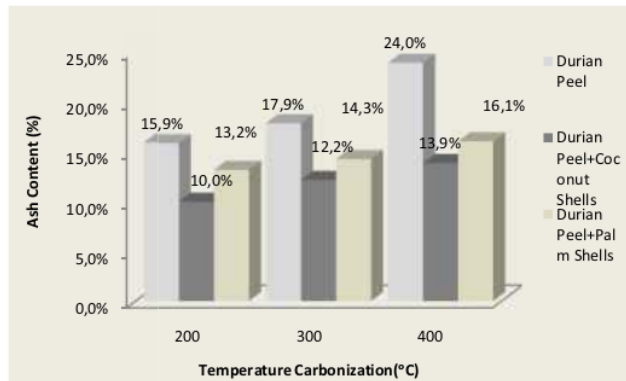


Figure 10. Effect of Carbonisation Temperature and Biomass Mixture using Adhesive starches To Ash Content

Figure 10 and 11 shows that ash content obtained ranged between 10% - 24%. Ash content obtained is not yet meet the standards of <10%. Carbonization temperature of 400 °C give the highest ash content compared to the carbonization temperature of 200 °C and 300 °C.



**Figure 11.** Effect of Carbonisation temperature and Biomass Mixture Using Adhesive banana peels To Ash Content

This is due to the ash content will increase at the higher carbonization temperature. Carbon will burn out at higher temperature and leave the ashes as a result from the combustion (Rosdiana, 2016), so it can be said that the carbonization temperature rise is directly proportional to the biobriquettesash content. On the influence of the biomass mixture, biobriquette mixture of durian peel with coconut shell biomass with adhesive banana peel provide the best ash content is 10%. In research by Pramudya, et. All (2011), biobriquettes mixture of durian peel with palm shell biomass with durian seeds adhesive provides the lowest ash content is 11.90%. This is due to mineral deposits that can not be burned in the coconut shell is lower compared to the others, so that the ash obtained is also low.

#### 4. Conclusion

Results from the study of biobriquettes durian peel give some following conclusions:

- Utilisation of durian peel waste, coconut shell, and palm shells on making biobriquettes may increase the economic value of raw materials.,
- Banana peel waste can be use as an adhesive in the biobriquettes manufacture, but the adhesiveness given still low compared than adhesive starch, but adhesive banana peel can improve the calorific value of biobriquettes.
- The addition of coconut shell and palm shell biomass improve the quality of biobriquettes durian peel.
- Biobriquettes has the highest calorific value at 400°C carbonization temperature, with a mixture of coconut shell and adhesive banana peel of 6040 cal/g. Calorific values obtained reached the calorific standard based on ISO (5000 cal/g).

#### 5. Acknowledgement

Thanks to all the parties concerned to this study: the Higher Education Research and

Technology which funded this research through grants applied, also to all students of guidance that help a lot of this research.

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