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# The Making of Biobriquettes with Carbonization Method by Utilizing Sludge Cake and Wood Dust from the Pulp Industry

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**Abstract:-**
Sludge cake as a solid waste that is rarely used from residual sludge from Waste Water Treatment Plants is one source of biomass from the pulp and paper industry which has the potential to be used as renewable energy. Analysis of biobriquette characteristics includes: moisture content, ash content, volatile matter, bound carbon, and calorific value. The results of this research show that the best combination of biobriquettes is biobriquettes with a composition of 40% sludge cake, 50% *Eucalyptus pellita* Wood dust, and 10% black liquor adhesive which has a moisture content of 2.12%, ash content of 19.33%, volatile matter 28 .99%, calorific value of 4915.69 kJ/gr, and fixed carbon content of 49.63%.

**Keywords:-**briquettes, sludge cake, wood dust, *Eucalyptus pellita*, black liquor

## 1. Introduction

Energy plays a very important role in supporting the economy to continue running, both as raw materials, as fuel, and as export products. Nearly 80% of the world's energy needs are met from fossil fuels which tend to be environmentally unfriendly and are threatened with running out because natural resources are limited [1]. On this basis, researchers are trying to find alternative energy sources in the form of renewable energy that are able to meet these energy needs so that the use of non-renewable energy can be reduced or even stopped.

Indonesia has many potential renewable alternative energy sources, including biomass or organic waste materials. The pulp and paper industry is one of the industries that contributes a lot of biomass waste which has the potential to be used as a renewable energy source. Black liquor, wood residue, bark, knots, rejected pulp, and sludge cake are examples of several types of biomass waste that are often found in pulp and paper mills [2].

One source of biomass from the pulp and paper industry that is still rarely utilized is solid waste from the remaining sludge from Waste Water Treatment Plants (WWTP) which is usually called sludge cake [1]. Sludge cake handling in industry is generally only stored in landfills with the process based on the rules of Kep-04/BapedaI/09/1995 and Kep-03/BapedaI/09/1995 regarding technical requirements for B3 waste management and procedures for storing B3 waste in landfills. Even though you have followed the B3 waste storage procedures set by the government, in the long term the sludge cake still has the potential to cause serious environmental pollution problems because over time the landfill area will fill up while production must continue. Thus, waste processing is very necessary and required for every industry to reduce the negative impact on reducing environmental quality [3]. In order to overcome this problem, it is necessary to make various development efforts to utilize sludge cake waste as an alternative for environmental management so that there is no more wasted waste and at the same time provide selling value to sludge cake waste.

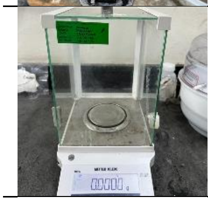
In general, the sludge that comes from the drying tank is biomass that has an organic material content of at least 66.71% so it can be used as raw material for biobriquette production [4]. Therefore, this research will focus on utilizing sludge cake by making it into biomass. To make it easier to use, the sludge cake will be transformed into a biobriquette product. The sludge cake that will be used in this research is sludge cake that comes from the IPAL PT Tanjungenim Lestari Pulp and Paper. In the process of making it into biobriquettes, the sludge cake will also be mixed with *Eucalyptus pellita* Wood dust waste. *Eucalyptus* *pellita* Wood dust is an example of waste from the pulp and paper industry which comes from the process of cutting wood into chips. Black liquor as waste from the digestion process will also be used as an adhesive in making biobriquettes because it has a high resin content. The ingredients contained in black liquor include water, 50% lignin, inorganic materials in the form of sodium salts originating from chemical cooking liquids, and 60% organic materials from the total black liquor solids obtained during the cooking and washing processes [5] It is hoped that the results of this research will provide information regarding whether sludge cake originating from the pulp and paper industry can be used as a good alternative energy source.

## 2. Research Methodology

### 2.1 Tools and materials

The equipment used in the research consisted of a beaker, furnace, oven, spatula, analytical balance, 70 mesh sieve, stopwatch, crusibles, briquette mold, mortar, pestle and bomb calorimeter.

Table 1. Tools Used

| Picture | Tool's name |
| --- | --- |
|  | Oven |
|  | Burning furnace |
|  | Briquette mold |
|  | Analytical scales |
|  | Crusible |
|  | 70 mesh sieve |
|  | Mortar and pestle |

| | |
|---|---|
|  | *Bomb calorimeter* |

Then the materials used in this research were sludge cake, *Eucalyptus pellita* Wood dust, and black liquor from PT Tanjungenim Lestari Pulp and Paper, South Sumatra.

Table 2. Materials Used

| Picture | Material Name |
|---|---|
|  | Black liquor |
|  | *Eucalyptus pellita* Wood dust |
|  | Sludge cake |

## 2.2 Research sites

The collection of raw materials, the process of making biobriquettes, and testing the quality of biobriquettes will be carried out in the PT Tanjungenim Lestari Pulp and Paper laboratory.

Figure 1. Research Location (PT Tanjungenim Lestari Pulp and Paper Lab)

## 2.3 Research design

The research design includes variations in raw material composition between sludge cake, *Eucalyptus pellita* Wood dust, and black liquor adhesive as follows:

- Adhesive composition: 10% & 20%
- Composition of sludge cake and *Eucalyptus pellita* Wood dust: 60%:30%, 50%: 40%, 40%:50% for 10% adhesive and 60%:20%, 50%:30%, 40%:40% for adhesive 20%

## 2.4 Biobriquette Making Process

a) In this research, sludge cake and *Eucalyptus pellita* Wood dust were first dried in an oven at a temperature of 40°C for ± 12 hours until moisture ≤ 10%.

b) The next process is that the sludge cake and *Eucalyptus pellita* Wood dust are carbonized in a furnace at a temperature of 300$^{o}$C for ± 30 minutes. The principle of carbonization here is the process of incomplete combustion of organic material with a very limited amount of oxygen to produce carbon [6].
c) Making and printing biobriquettes with sludge cake composition: *Eucalyptus pellita* Wood dust at 60%:30%, 50%:40%, 40%:50% for 10% black liquor adhesive and 60%:20%, 50%:30%, 40%:40% for 20% black liquor adhesive.

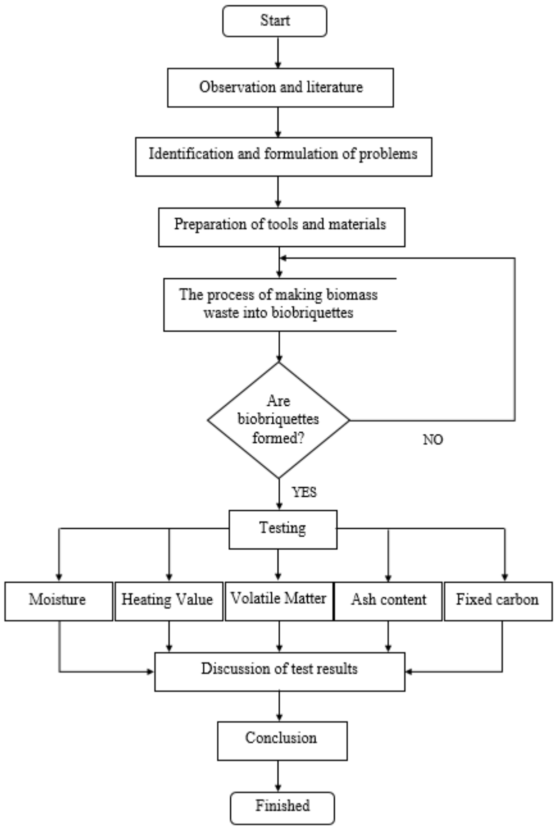



Figure 2. Block diagram for making biobriquettes

## 2.5 Biobriquette Characteristics Test

The characteristic tests used in this research include tests for moisture content, calorific value, volatile matter, ash content and fixed carbon.

The principle of testing moisture content is to dry the material by evaporating the water contained until a constant weight is obtained. Moisture content testing is calculated based on equation [7]:

$$\text{Kadar Air }(\%) = \frac{\text{X1} - \text{X2}}{\text{X2}} \times 100\%$$

Where:
X1 = Initial sample weight (grams)
X2 = Sample weight after oven (grams)

Ash content is defined as the mineral content that is not burned. This test method includes determining the ash content expressed as the percentage of remaining dry oxidation of the test object at a temperature range of ±600°C after testing the moisture content. Ash content is calculated based on equation [7]:

$$\text{Kadar Abu }(\%) = \frac{\text{F} - \text{G}}{\text{W}} \times 100\%$$

Where:
F = Weight of crucible and ash (grams)
G = Weight of empty crucible (grams)
W = Initial sample weight (grams)

*Volatile*matter is defined as the amount of matter lost when a material is burned at a certain temperature and time. Volatile matter (VM) is calculated based on equation [7]:

$$\text{Volatile Matter (\%)} = \frac{B - C}{W} \times 100\%$$

Where:
B = Sample weight after drying at 105-110 ºC (grams)
C = Sample weight after burning (grams)
W = Initial sample weight (grams)

The fixed carbon value is obtained by subtracting the number 100 from the amount of moisture content, ash content and amount of volatile matter. To determine fixed carbon, it can be calculated using equation [7]:

$$FC = 100 - (MC + VM + AC)\ \%$$

Where:
FC = Fixed carbon (%)
MC = Moisture content (%)
VM = Volatile matter (%)
AC = Ash content (%)

Calorific value testing was carried out using a bomb calorimeter. This is a tool used to determine the heat released by fuel and oxygen at a fixed volume. **Result And Discussion**

The biobriquettes produced in this research are in the form of cubes with dimensions of 3 cm x 3 cm which can be seen in Figure 3 below.

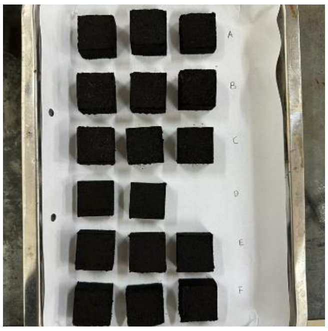


Figure 3. Biobriquettes from sludge cake and Eucalyptus pellita Wood dust with black liquor adhesive

The results of the initial characterization of the materials for making biobriquettes can be seen in Table 3 below.

Table 3. Initial Characterization Test Results of Raw Materials

| Parameter | Sludge Cake | *Eucalyptus pellita* Wood dust | Black Liquor |
|---|---|---|---|
| Moisture Content (%) | 72.07 | 38.14 | 61.62 |
| Ash Content (%) | 32.34 | 0.27 | 16 |
| Calorific Value (cal/gr) | 2601.53 | 4686.35 | 3437.71 |

The quality of the bio briquettes from sludge cake and saw dust waste with black liquor adhesive is presented in Table 4.

Table 4. Biobriquette Test Results

| Composition of Raw Materials | | | Result | | | | |
|---|---|---|---|---|---|---|---|
| Black Liquor | Sludge Cake | Saw Dust | MC (%) | AC (%) | VM (%) | HV (cal/gr) | FC (%) |
| 10% | 60% | 30% | 2.23 | 26.67 | 29.55 | 4506.43 | 41.55 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 50% | 40% | 2.16 | 24.49 | 29.16 | 4714.92 | 44.18 |
| | 40% | 50% | 2.12 | 19.33 | 28.92 | 4915.69 | 49.63 |
| 20% | 60% | 20% | 3.31 | 29.12 | 34.19 | 4178.66 | 33.38 |
| | 50% | 30% | 3.13 | 26.73 | 32.99 | 4275.55 | 37.16 |
| | 40% | 40% | 3.06 | 23.25 | 32.91 | 4505.15 | 40.78 |

### 3.1 Bio briquettes with 10% Black Liquor

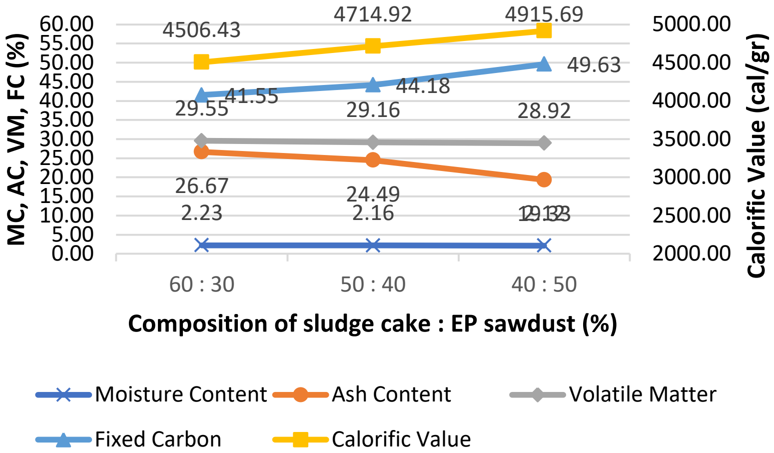



Figure 4. Result of Biobriquette Analysis with 10% Black Liquor

Based on the graph in Figure 4, it can be seen that the composition of sludge cake and Eucalyptus pellita wood powder greatly influences the quality of the biobriquettes produced. The greater the composition of the sludge cake used, the greater the value of the moisture content, ash content and volatile matter. This increase in moisture content value is influenced by the fact that sludge cake has a larger pore size compared to Eucalyptus pellita Wood dust, so making biobriquettes with a higher sludge cake composition will more easily absorb water from the surrounding air. Furthermore, the high or low value of volatile matter can be influenced by a less than optimal carbonization process, where the high temperature and inappropriate length of time during the carbonization process will result in the substance not completely evaporating into charcoal, which ultimately causes the high value of volatile matter during testing [8].

Meanwhile, the greater the composition of Wood dust used, the higher the calorific value and carbon content will be. This is because Eucalyptus pellita Wood dust has a higher cellulose and lignin content compared to sludge cake, where the higher the content of chemical components such as cellulose and lignin in a material, the higher the carbon content will be, which in the end will also increase the calorific value [9].

### 3.2 Bio briquettes with 20% Black Liquor

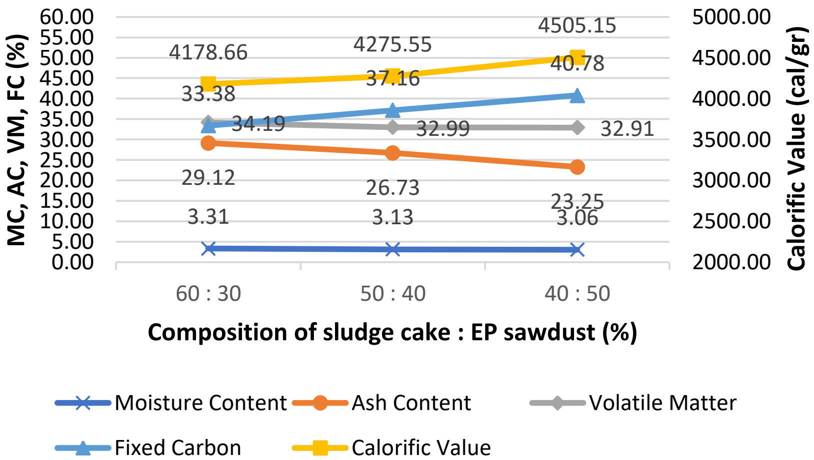



Figure 5. Result of Biobriquette Analysis with 20% Black Liquor

Based on the graph in Figure 5, it can be seen that the composition of sludge cake and Eucalyptus pellita wood powder greatly influences the quality of the biobriquettes produced. The same thing applies to biobriquettes with a 10% black liquor adhesive composition, in biobriquettes with a 20% black liquor adhesive composition, it can also be seen that the greater the sludge cake composition used, the greater the value of moisture content, ash content, volatile matter, and the greater the the calorific value and fixed carbon are also small. Meanwhile, the greater the composition of Eucalyptus pellita Wood dust used, the smaller the value of the moisture content, ash content, volatile matter, and the greater the calorific value along with the fixed carbon. The difference is that the values for moisture content, ash content and volatile matter in biobriquettes with a 20% black liquor adhesive composition tend to be higher than in biobriquettes with a 10% black liquor adhesive composition.

The increase in the value of moisture content which increases with the addition of the black liquor adhesive composition is because the adhesive material itself contains water so that the more adhesive that is added, the higher the moisture content in the biobriquettes produced. Meanwhile, the increase in the ash content value is due to the fact that black liquor contains quite high levels of inorganic components, which causes the ash content produced by black liquor itself to tend to be high because these inorganic components cannot burn completely [5]. Then the increase in the value of the volatile matter in biobriquettes is because the more adhesive composition used, the higher the moisture content will be, so the value of the volatile matter will increase. This high level of volatile substances can reduce the quality of biobriquettes because with higher levels of volatile substances, the carbon value will be smaller so that the calorific value produced will be lower and the high levels of volatile substances can cause biobriquettes to have more smoke soot when ignited [10]. Therefore, biobriquettes with lower volatile matter levels have better quality compared to biobriquettes which have higher volatile matter values.

### 3.3 Best Quality of Biobriquettes

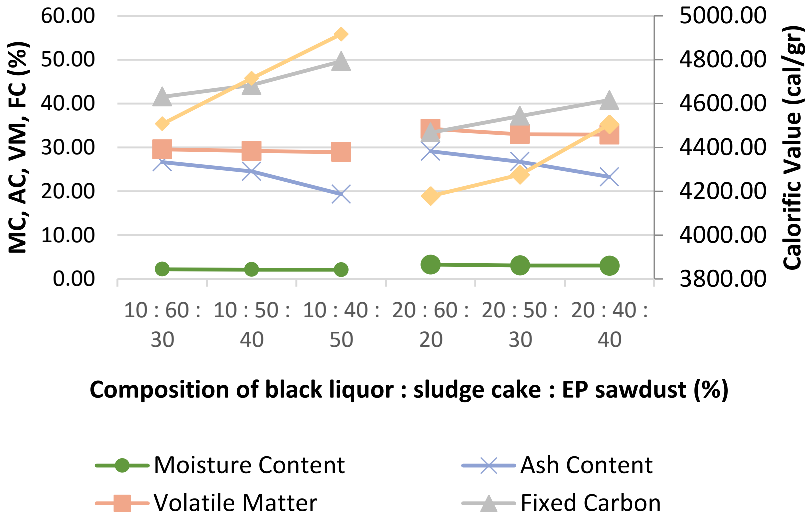



Figure 1. Comparison of Biobriquette Analysis Results

Based on the graph in Figure 3 above, it can be seen that the best quality biobriquettes are biobriquettes in the composition of 10% black liquor with a composition of sludge cake: *Eucalyptus pellita* Wood dust of 40%: 50%. The selection of biobriquettes with the best quality is based on the fact that they have the lowest value of moisture content, ash content, and volatile matter content, and have the highest fixed carbon content and calorific value

### 3. Conclusion

- *Sludge cake*as sludge resulting from waste water processing and Eucalyptus pellita Wood dust is solid waste from the pulp industry which can be used as raw material in making solid fuel in the form of biobriquettes with the addition of black liquor as an adhesive.
- The addition of sludge cake composition and black liquor adhesive causes an increase in moisture content, ash content, volatile matter content, as well as a decrease in heating value and fixed carbon content. Meanwhile, the addition of Eucalyptus pellita Wood dust composition

causes an increase in calorific value, fixed carbon content, as well as a decrease in moisture content, ash content and volatile matter content.

- The best combination of biobriquettes from a mixture of sludge cake and Eucalyptus pellita wood powder with black liquor adhesive is found in biobriquettes with a composition of 40% sludge cake, 50% Eucalyptus pellita wood powder, and 10% black liquor adhesive which has a moisture content of 2.12% , ash content 19.33%, volatile matter content 28.99%, calorific value 4915.69 cal/gr, and fixed carbon content 49.63%.

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