Processing Of Palm Oil Waste Based On Alternative Energy Sources Through Bricket Technology For Farmers In Palm Oil Production Center (Efforts to Reduce the Potential of Environmental Pollution from Waste Abundance Towards Environmental Sustainable)

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Abstract. The abundance of palm oil waste in the environment as residual oil palm production has an adverse impact for the environment. The palm waste comes from midribs, shells and empty bunches that are dumped into the soil and water. The existence of oil waste causes damage to the surrounding environment. Energy crisis, especially energy derived from fossil fuels such as petroleum, encourages alternative energy sources to be sought. This study aims to determining the motivation and behavior of the community in managing waste, Developing briquettes from palm oil waste (shells, midribs, empty bunches), and knowing the quality of energy with its parameters: water content, ash content, volatile matter content, heating value of each part. The method used in this study is explorative descriptive research. Waste samples come from the central areas producing palm oil waste. The results of the study indicate that the motivation of the community to manage waste is very high 98.86%. The highest moisture content was obtained from empty bunches 0.53%; the highest ash content was 0.74% in palm fronds; the longest ignition was in empty bunches 38.22 seconds; boiling time was found in 9 minutes palm fronds; the largest calorific value was found in palm shells 6024 / kcal / kg. The target to be achieved is the production of briquettes from palm oil waste materials that can be used as alternative energy sources for the community, thus reducing dependence on fossil fuels and gas.

1. Introduction

Indonesia is known as the largest oil producing country in the world. According to the data center and agricultural information system (2016: 1) world palm oil production is dominated by Indonesia and Malaysia which produce around 85-90% of the world's total palm oil production and Indonesia is the largest palm oil producer and exporter in the world. The area of oil palm in each year experienced an increase in 1998, initially Indonesia only had an area of 3,560,196 hectares with a total palm oil production of 1,186,083 tons, and in 2015 the area of palm oil in Indonesia reached 11,300,370 ha with production of 6,256,861 tons (Central Bureau of Statistics, 2015: 15-16). Nearly 70% of oil palm plantations are located in Sumatra and 30% on the island of Kalimantan. Jambi as one of the palm oil production centers also contributes as the largest exporter of palm oil production. Jambi Province has
the fourth largest palm oil area in Sumatra and the 6th largest in Indonesia, with an area of 755,522 Ha with a total production of 2,078,463 tons. The palm oil area and production can be seen as follows:

Oil Palm Area and Production up to 2015 for Jambi Province:

| Type of Plantation         | Area / Ha | Production / Ton |
|----------------------------|-----------|-----------------|
| Community plantation       | 450,075   | 998,243         |
| State Plantation           | 23,758    | 84,713          |
| Private Plantations        | 240,566   | 711,919         |
| **Total**                  | 714,399   | 1,794,874       |

**Source:** Directorate General of Plantations, Indonesian Ministry of Agriculture 2016.

Referring to the data, the amount of production is certainly accompanied by the amount of waste produced. Moreover, only 10 percent is used as wasted biomass. Increasing production will certainly result in more waste produced. Damanhuri & Padmi (2010: 5) argues waste is all the waste produced by human and animal activities in the form of solid, sludge, liquid or gas that is disposed of because it is no longer needed or unwanted. Haryanti, et al., (2014: 20-21) states that palm oil waste is the residual yield of oil palm plants that are not included in the main product or by-product of the palm oil process, either as solid waste or liquid waste. According to Loekito (2002: 242) in operational activities at the palm oil mill, or to produce the main products in the form of CPO and PKO, a by-product will also be produced in the form of solid waste and liquid waste as well as pollutants into the free air. Liquid waste has a large contribution of 55% to 67% of the total FFB processed. A PKS that is built with a capacity of 60 tons/hour, for operational 20 hours will produce 1200 tons of liquid waste and 300 tons of solid waste. Within 1 year, the average VFD with a capacity of 60 tons FFB / hour produced 241,200 tons of liquid waste and 90,000 tons of solid waste. Of this large amount, if the waste is not treated properly it will cause environmental pollution.

if it is not managed wisely, the existence of the waste has the potential to cause environmental pollution whether in water, air or soil. According to data from Directorate General of Estate Crops (2016: 11), With the large amount of palm oil produced, the amount of waste produced by the oil palm is produced. Oil palm waste is usually in the form of liquid or solid waste, including coir, shells and empty bunches. So far, palm oil waste, either waste, is midrib, empty shell and bunches are dumped into the ground, and water. So that the existence of this waste makes the environment damaged. Water bodies are like rivers, the pool turns black. And waste that is discharged to the soil causes pollution of odors that cause unpleasant odors in the waste area. And this is certainly prone to breeding the seeds of disease.

Based on the results of an interview to the leaders of the palm oil processing plant in Jambi, PT SPBU in 2016, palm oil waste from one part of the plant, such as empty bunches, produced palm oil waste of approximately 360 tons per day. During this time the processing of waste is only limited to be used as fertilizer on a small scale, burning and landfilling. The rest is discharged to the ground and water. This certainly can cause soil and water pollution and eventually the environment becomes damaged. If this continues to be allowed to happen then the environmental damage will increase uncontrollably. Surely threatening the survival of living things around it and also humans.

On the other hand, along with the reduced availability of petroleum fuels requires finding alternative energy sources to reduce dependence on oil. The production of palm briquettes is expected to be a solution to overcome these two problems, namely pollution problems due to the abundance of waste and energy crisis problems. The use of palm briquettes can help reduce the use of petroleum fuels and fuel wood commonly used by the community. The use of palm briquettes can streamline time and costs because briquettes have a relatively high heating value (Stanley: 2012) (Richard Stanley, 2012).

The threats explained above brings the researcher to conduct a study entitled: "Palm Waste Processing Based on Alternative Energy Sources through Briquette Technology for Farmers in Palm Production Centers (efforts to reduce the potential for environmental pollution from abundance of waste towards sustainable environment)"
2. Research Methods

2.1 Theoretical Approach
The method used in this study is explorative descriptive method. Descriptive method is the process of solve the investigated problem by describing the state of the object of the research at the present time, based on the facts this method focuses on finding the facts as they really are. "Exploratory research itself has the purpose of exploring extensively about the causes or things that influence the occurrence of something" (Suharsimi Arikunto, 2002: 7). Thus, the explorative descriptive aims at solving the problem by extensively explored the causes that influence the occurrence of something based on facts.

2.2 Research design
This research is explorative descriptive research. This explorative descriptive study describes the existing symptoms of the object being observed. Observations of this study included the quality of energy from briquettes made from palm waste with several parameters of observation.

2.3 Palm Briquette Making Methodology.

![Diagram of the process of making palm waste briquettes according to the research stage](Putra (2013: 30).

2.3.1 Material
The materials used in this study are:
- The portion of oil palm plantations that are wasted as palm oil industry waste.
- Starch for palm charcoal briquettes.
- Aquades for the heat value testing process and testing the specific gravity of palm charcoal briquettes.
- Benzoic acid for the introduction of caloric bombs on the calorific value of charcoal briquettes palm oil.
- Methyl orange for the titration process for testing the calorific value of charcoal briquettes.
- 99.5% pure oxygen to fill the pressure of the calorimeter bomb in the value testing process heat of palm charcoal briquettes.
- Sodium carbonate (Na2CO3) for making titration solutions in the value testing process heat charcoal briquettes.
- Nickel wire for testing the heat value of charcoal briquettes.

2.3.2 Research equipments
The equipments are:
- 45 mesh size filter.
- Ohauss brand electric analyzer balance with accuracy of 10-3 grams for weighing powder.
charcoal and test samples
- Retorts to fabricate sawdust into charcoal powder
- Cylinder-shaped briquette printing device with a diameter of 4.5 cm
- Press machine to press charcoal briquettes
- It's to remove charcoal briquettes
- Hand saws to cut charcoal briquette test samples
- Small drill to replace the test sample
- Oxygen bomb calorimeter No. 3403 for measuring charcoal heat values
- Stopwatch for measuring time increase in calorific value testing
- 50 ml Erlenmeyer as a methyl orange indicator container
- Pipette to drip the methyl orange solution
- 50 ml burette for acid titration measurements on calorific value measurements
- A 100 ml glass cup to add washing water from the bomb cylinder to be titrated
- Porse1in plate for test sample container
- Oven to dry samples of moisture content and specific gravity of charcoal briquettes
- Desiccators to cool the test sample after being removed from the oven
- 500 ml glass cups as a container of distilled water on specific gravity measurements
- Electric furnace for testing ash content, volatile content and bonded carbon content

2.3.3 Observing Palm Briquette Quality Parameters:

2.3.3.1 Water Content
Water content is the percentage of water content of a material that can expressed based on wet weight (wet basis) or based on dry weight (dry base). Wet weight moisture content has a theoretical maximum limit of 100 percent, while water content based on dry weight can be more than 100 percent (Syarif and Halid, 1993). The procedure for testing the moisture content of palm briquettes follows ASTM D-3173 and the calculation follows the equation:

\[ KA = \left( \frac{a - b}{a} \right) \times 100 \]  
with:  
a: sample weight (gram)  
b: sample weight after drying in furnace (gram)

2.3.3.2 Calorific Value
Testing of charcoal briquette calorific values follows the procedures as stipulated in ASTM D-2015 and ASTM D-5865-03 (discontinuous ASTM D-2015 in 2000 and entered into ASTM D-5865-03). Heat capacity is calculated by the equation:

\[ E = \frac{[Hc \times m + e1 + e2]}{t} \]  
with:  
E: calorimeter heat capacity, (J / oC)  
Hc: heat of bensoic acid combustion, (J / gr)  
m: weight of bensoic acid (gr)  
e1: correction of acid (ml Na2CO3 standard)  
e2: correction of combustion heat from the wire  
t: corrected temperature rise (oC)

\[ e1 \text{ is the volume of sodium carbonate (Na2CO3) used in the titration (ml). 1 ml of this solution is equivalent to 4.2 J (1.0 calories) in acid titration.} \]

\[ e2 = K1 \times l \]  

2.3.3.3 Ash Content
Ash in a biomass consists of minerals that cannot evaporate or disappear and will remain during the ignition process. The procedure for testing and calculating ash content refers to ASTM D-3174. The equation used is:

\[ \text{Ash level} = \left( \frac{A-B}{C} \right) \times 100 \]  
with:  
A: weight of cup and ash (gram)
B: weight of empty cup (gram)
C: sample weight (gram)

2.3.3.4 Volatile substances
The procedure for testing and calculating volatile content refers to ASTM D-3175. The equation used is:

\[ \text{Volatile levels} = \left( \frac{A - B}{A} \right) \times 100 \] (7)

with: A: sample weight used (gram)
B: sample weight after heating (gram)

(Source: C: thermometer correction, emergent stem
Cr: radiation correction
Cs: correction of thermometer settings)

2.3.3.5 Power Burn
Observing combustion is carried out to determine the length of time burning material, that is by burning briquettes to appear coals. The time calculation starts when the briquette burns to ashes. Power charcoal briquette fuel needs to be tested because this will show how much big use of fuel, the longer charcoal briquettes run out, the more less fuel is used and more economical or smaller household expenditure on fuel. (Sudarja: 2007)

3 Result
The preliminary research result planned for year 1 which is emphasized on the preliminary exploration in the form of motivation and behavior of the community analysis in managing waste and knowing the profile of the community in Niaso Village and Lamo Lake Village:

3.1 Community Profile
1. Work

![Figure 2. Percentage of Community Work](image)

2. Income

![Figure 3. Percentage of Income](image)
3. Education

![Percentage of Community Education Level](image)

**Figure 4.** Percentage of Income

4. Fuel used

![Fuel Percentage](image)

**Figure 5.** Percentage of Fuel

5. Community of Palm Plantation Owners

![Community Owners of Palm Oil](image)

**Figure 6.** Percentage of Community Work
3.2 Impact Of Palm Waste

1. Negative Impact of Palm Oil Waste

2. Use of Palm Waste

3. Briquette Creation

3.3 Questionnaire of Motivation
1. Initial and Final Weight Tables of Briquette Material

| No | Type of Briquette Material | Early Weight (gr) | Briquette Weight (gr) |
|----|---------------------------|-------------------|----------------------|
| 1. | Palm Empty bunch          | 10.000 gr         | 1.900 gr             |
|    | Bread                     | 20.000 gr         | 2.400 gr             |
|    | Shell                     | 3.000 gr          | 1.150 gr             |
| 2. | Coconut Coir              | 10.000 gr         | 2.100 gr             |
| 3. | Rice Husk                 | 5.000 gr          | 2.900 gr             |

2. Table of Briquettes Moisture Content

| No | Type of Briquette Material | Moisture Up to Air |
|----|---------------------------|--------------------|
| 1. | Palm Empty bunch          | 0.53 %             |
|    | Bread                     | 0.28 %             |
|    | Shell                     | 0.21 %             |
| 2. | Coconut Coir              | 0.85 %             |
| 3. | Rice Husk                 | 0.52 %             |

Briquette moisture content that has been determined by SNI is 8% in maximum, whereas the research shows that the water content for all berries is below 8%. It shows that briquettes from shell waste, midrib, empty palm oil bunches, and coconut fiber and rice husk for moisture content are in accordance with the values that have been determined by SNI.

3. Table of Ash Content of Briquette Material

| No | Type of Briquette Material | Ash Content |
|----|---------------------------|-------------|
| 1. | Palm Empty bunch          | 0.52 %      |
|    | Bread                     | 0.74 %      |
|    | Shell                     | 0.17 %      |
| 2. | Coconut Coir              | 0.85 %      |
| 3. | Rice Husk                 | 0.52 %      |

The briquette ash content that has been determined by SNI is the same as the water content which is a maximum of 8%, from the results of the study for ash content in briquettes from shell waste, midrib and empty bunches are both under 1% while for briquettes from rice husks and coconut husks has an ash value below 2%. However, this study which involved the manufacture of shells, midrubs, empty bunches of oil palm, coconut fiber, and rice husk still fulfilled the requirements for ash content that has been determined by SNI.

4. Table of Duration of Ignition

| No | Type of Briquette Material | Initial Weight of Briquette (gr) | Duration of Ignition until it becomes ashes (seconds) | Heavy Ash (gr) |
|----|---------------------------|---------------------------------|------------------------------------------|---------------|
| 1. | Palm Empty bunch          | 5.12 gr                         | 38 : 22                                  | 0.59 gr       |
|    | Bread                     | 5.12 gr                         | 34 : 54                                  | 1.58 gr       |
2. Coconut Coir 5.12 gr 47:42 2.22 gr
3. Rice Husk

It can be seen that the longest ignition of briquettes in coconut coir briquettes with a time of ignition is 47 minutes 42 seconds. While the shell and rice husk briquettes are difficult to ignite.

5. Table of Duration of Boiling Time 10 ml of water with weight of briquette 31.00 gr

| No | Type of Briquette Material | Early hours | Final Hour | Boiling Duration (Minutes) |
|----|-----------------------------|-------------|------------|----------------------------|
| 1. | Empty bunch Palm Bread Shell | 16 : 40 | 16 : 45 | 5 minutes |
| 2. | Coconut Coir | 17 : 24 | 17 : 33 | 9 minutes |
| 3. | Rice Husk | 17 : 09 | 9 minutes |

The fastest boiling time for briquettes from empty oil palm bunches is 5 minutes, while for palm oil briquettes and coconut husk has the same boiling time of 9 minutes. For shells and rice husks, they cannot be ignited so that the boiling time test cannot be carried out.

6. Comparison Table of Basic Material Burning Time

| No | Type of Briquette Material | Burning Time (Minutes) | Burned Material |
|----|----------------------------|------------------------|-----------------|
| 1. | Kerosene Palm Bunches | 38:22 | 5. 12 gr |
| 2. | Gas Midrib | 34:54 | 5. 12 gr |
| 3. | Palm Shell | 47:42 | 5. 12 gr |

7. Comparison Table of Palm Briquette Calories Level with Other Briquettes

| No | Fuel Type | Caloric Level | water content | ash content |
|----|-----------|---------------|---------------|-------------|
| 1. | Palm Bunches | 0. 53 % | 0. 52 % |
| 2. | Coconut Fiber Briquettes Midrib Shell | 0. 28 % 0. 21 % | 0. 74 % 0. 17 % |
| 3. | Rice Husk Briquettes | 0. 52 % | 1. 84 % |
| 4. | Coal Briquettes | | 1. 96 % |

4. Conclusion
Palm oil (Elaeis guineesis jacq.) is a tropical palm species which includes bushland annual plants and their natural habitat. Oil palm plant waste was initially used as compost, but in line with research conducted, other plant parts of empty palm oil bunches can also be used as fuel for electricity generators. Briquettes derived from palm oil waste are made and developed to find alternative energy sources to replace petroleum so as to reduce dependence on the use of petroleum fuels. The research overcomes environmental damage caused by the abundance of palm waste which is much wasted in the area around the center of palm oil production.

Recommendation
The community can apply the technology in managing waste contained in the environment so the environment can be maintained from pollution and environmental damage.

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