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Processing Empty Palm Oil for New Green Energy

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Abstract
Palm oil industry waste in Indonesia is increasing due to the increasing area of oil palm plantations and increasing palm oil production in Indonesia. In 2017 the area of oil palm plantations amounted to 16 million hectares and the production of palm oil produced amounted to 38.17 million tons. Palm oil industry solid waste in the form of Processing Empty Palm Oil (PEPO) has a considerable amount. The number of processing empty palm oil is around 23% of the total fresh fruit bunches. One of the utilization of processing empty palm oil (PEPO) by making it an environmentally friendly fuel is Bio-Pellet. The research methods used in this study consisted of sorting raw materials, drying, cutting or counting, grinding or reducing the size or grinding, dust separation and sifting, pellet making, cooling, packing, pellet standard testing. The results showed that the quality of Bio-Pellet with 50% amylium concentration with 20 mess PEPO with the composition of 60 grams of PEPO and 40 ml of 50% amylium obtained water content is 8.75%, ash content 8.73%, fly matter content 75.46%, heating value 4151.67 cal / g, density 1.5 g / cm3 and carbon content bound 20.60%. After being compared with Indonesian National Standard (SNI), some of the mixtures did not meet SNI due to several factors, namely, adhesive concentration, type of adhesive, level of material smoothness, mixture composition between material and adhesive.

Keywords *– Bio-pellet, Palm Oil; green energy; new fuel*

1. INTRODUCTION

Fuel is an energy source to support household and industrial activities. People often use fossil fuels, which are oil, coal and gas. Increasing energy demand causes the supply of fossil fuels to decrease, so that fossil fuels have increased prices. This energy crisis problem needs to be solved by producing fuels that are able to replace fossil fuels from materials that are widely available in nature, cheap, and renewable. One way to reduce the negative impact of palm oil production is to follow the proper waste management of processing residues and ensure their subsequent utilization in an environmentally friendly manner [1]. Environmental- friendly approaches are required right from the harvesting to operation of the mills such as zero burning, waste minimization and recycling or re-use of the wastes [2]. One of the alternative fuels is biomass. The potential of biomass energy in Indonesia is 50,000 MW originating from various agricultural biomass wastes. Palm oil industry waste is one of the agricultural biomass wastes consisting of liquid waste, gas waste, and solid waste. Wastes resulted from palm oil processing industry still have economical values as they can be used as sources of alternative fuel, fertilizer, chemical compounds, and biomaterials [3]. Palm oil is a necessary ingredient in the manufacture of various products such as edible oil, biodiesel, cosmetics; cleaning products, hair care, soaps and others personal care items [4]. Palm oil is making an increasing contribution to Indonesia's national income; its production of palm oil has become the amazing growth from 752,000 tons in 1980, increase to 8.3 million tons in 2000 and become 34 tons in 2016, claiming as the largest producer of palm oil in the world [5].

Palm oil industry waste in Indonesia is increasing due to the increasing area of oil palm

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

plantations and increasing palm oil production in Indonesia. In 2017 the area of oil palm plantations was 16 million hectares [6] and the production of oil palm produced amounted to 38.17 million tons. Palm oil industry solid waste in the form of processing empty palm oil (PEPO) has a considerable amount. According to Singh et al [7] the number of processing empty palm oil is around 23% of the total fresh fruit bunches. Processing empty palm oil contains 36.81% cellulose, 27.01% hemicelluloses, and 15.07% lignin [8].

The high productivity of palm oil is accompanied with the overflowing production of waste as the side product [9]. So far the use of palm oil solid waste to produce new energy is limited as solid fuel in the boiler. Especially for processing empty palm oil, utilization as boiler solid fuel has constraints / inhibitors, namely the high water content (moisture) 60% and the resulting pollution. Processing empty palm oil so far have not been used as energy sources, so the problem that then arises is the abundant amount of waste piled up in the area around the palm oil processing industries [10]. Various attempts have been made to overcome this problem, including sending back the pile of waste to the plantation area and using it as mulch and natural fertilizer. Others then burn it in open areas without getting other benefits that may be far more valuable. According to Hamzah et al. [11] direct and unprocessed combustion will cause respiratory problems due to carbon monoxide, sulfur dioxide (SO_2), and particulate deposits, so new technologies are needed to process these wastes into environmentally friendly fuels and produce high added value. One of them is by making *Bio-Pellet*. *Bio-Pellet* is a form of biomass energy that was first produced in Sweden in the 80s.*Bio-Pellet* is a biomass based solid fuel in the form of solid tubes or pellets. The process used is high temperature and pressure compression, thus forming a uniform product [12]. This pellet fuel is between 3-12 mm in diameter and 6-25 mm in length [13].

1.1. Bio-Pellet

Pellet biomass is a renewable and solid green fuel, meaning pellet is a carbon neutral energy source. Carbon is consumed during the life cycle of trees, and then released again; the effect is an increase in zero carbon dioxide levels in the atmosphere. Therefore the results of burning biomass pellets can help overcome climate change. Handling in the combustion process is easier and cleaner, so it is very interesting to use. *Bio-Pellet* is a pellet biomass fuel that has a uniform size, shape, humidity, density, and energy content [14]. Biomass for fuel usually has low economic value such as bagasse, corn cob, coffee husk, coconut shell, palm oil shell, saw-dust and cocoa pod [15]. In the process of making *Bio-Pellet*, biomass is fed into a pellet mill that has dies with diameters of 6-8 mm and lengths of 10-12 mm [16]. Rusdianto et al [17] stated that there are 6 stages of the *Bio-Pellet* manufacturing process, namely: the pre-treatment of raw materials (pre-treatment), drying, size reduction, *Bio-Pellet* printing (pelletization), cooling, and silage. Forest residues, sawmills, agricultural crops and energy crops can be identified as pellets. The pelletization process can increase the specific density of biomass by more than 1000 kg / m3 [18].

The quality of *Bio-Pellet* is not only determined by the calorific value but also is determined from the value of *Bio-Pellet* endurance when resisting external pressure so as to facilitate the process of transportation and storage. Thus, the use of PEPO as a raw material for biomass energy will provide added value to the palm oil industry. Not only that, the use of PEPO as a raw material, *Bio-Pellet* will also be very strategic in providing environmentally friendly alternative energy, especially if related to efforts from the region and the country to play an active role in reducing global warming and climate change caused by emissions from fuel fossil. The technology of biomass utilization for modern energy purposes has been

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

developed for generating electricity and steam that emphasizes the medium and large scale of industries needs [19].

Bio-Pellet has the advantage of being able to increase the heating value resulting from the combustion process, and the size and uniformity of *Bio-Pellet* can facilitate the process of transportation from one place to another [20]. However, besides such bio-plellet advantages for fuels, there also occur their disadvantages, among others their vulnerable resistance against organism activities, such as fungi and microbes. Those organisms could degrade or decay the organic compounds inside, which are inherently flammable. Also, the bio-pellets with their hygroscopic nature, when stored in high humidity places could increase their moisture content. All those phenomena could lower the calorific value of bio-pellets and hence lower their heating efficiency. Moreover, the spores of fungi might endanger human health and cause human respiratory diseases as well as skin irritation [21].

Regarding biomass sources, besides having vast and varied forest areas, abundant agricultural products, this country is also known as the main producer of palm oil after Malaysia. At present the palm oil industry has become very important in the world, not only as a main ingredient in cooking oil production, but its use has also grown to become one of the founders in the biodiesel industry.

2. MATERIALS AND METHODS

2.1. Material

The equipment used in this study includes cutting or chopper PEPO (chaff cutter), mixers, pollinating machines / hammer mill, 80 mesh filter, *Bio-Pellet* (pelletizer), press, gasifier (down draft), thermometer, stainless container steel, furnace, measuring cup, digital scale, oven, caliper and bomb calorimeter.

The raw material used in this study is solid waste of Processing Empty Palm Oil (PEPO) which is a by-product of the processing of crude palm oil or Crude Palm Oil (CPO). PEPO is obtained from the *Adolina* Palm Oil Mill, SerdangBedagai District, North Sumatra, while the natural adhesive used is tapioca flour obtained from the local market with the trademark Rose Brand.

2.2. Method

Enumeration Work Procedure

Processing empty palm oil (PEPO) is taken from oil palm mills, processing empty palm oil are dried in the sun. Then the processing empty palm oil is chopped using a machete until the size becomes small. Furthermore, the small processing empty palm oil is reduced again using an automatic chopper machine. Processing empty palm oil that has been chopped then sifted or filtered using mess 6, 10, and 20.

Procedure for making 20% starch as an adhesive

Tools and materials are prepared, starch weighed in 20 grams of beaker glass. Aqua is added to 100 ml glass beaker volume. The mixture is stirred until completely mixed. Then the mixture is heated at 40°c, until the mixture starts to thicken. Furthermore, the mixture is cooled. Perform the same procedure to make 30%, 40%, and 50%.

3. RESULTS AND DISCUSSION

3.1. Analysis of Physical Characteristics of *Bio-Pellet*

Water content (%) Bio-Pellet

The highest average water content was 8.75% in *Bio-Pellet* treatments which had different powder sizes, the *Bio-Pellet* produced all met SNI 8021: 2014 standards, i.e. the water content value was below 12%. Based on the analysis of the diversity of water content in processing empty palm oil, it is known that the treatment of the adhesive type and powder size as well as the interaction of the two have no significant

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

effect on water content. The value of water content tends to decrease with the finer size of the powder; the adhesive factor also plays an important role in increasing the *Bio-Pellet* water content. The water content of tapioca flour is 9.84%.

Ash content (%) Bio-Pellet

The ash content of processing empty palm oil has the highest average of 8.73%. Average ash content does not meet SNI 8021: 2014 standard which requires a maximum of 1.5%. Based on the results of the diversity analysis, it is known that the treatment of the adhesive type, powder size, and the interaction between the two factors did not significantly affect the levels of *Bio-Pellet* ash. Based on the results of this study, the ash content produced is quite high due to the raw materials used.

Levels of Substance (%) Bio-Pellet

The results of research on oil content of empty processing empty palm oil have the highest average value of 75.46%. The average value of *Bio-Pellet* flying substance content meets SNI 8021: 2014 standard which requires a maximum value of flying substance content of 80%. Based on the results of the analysis of the diversity of adhesive types, powder size, and their interactions did not significantly affect the levels of *Bio-Pellet* flying substances. This study uses processing empty palm oil that have not undergone a carbonization process so that the flying substances produced are relatively high and produce quite a lot of smoke.

Density (g / cm^3)

Density shows the ratio of mass and volume of solid fuels. Density affects the quality of solid fuels, because high densities can increase the heating value of solid fuels. The size and density of solid fuels are affected by the pressure of the press, the size and the homogeneity of the constituent solid fuel itself. The density obtained from this study is 1.5 g / cm3.

Calorific Value (cal / g) Bio-Pellet

The results showed that the highest average heating value (4151.67 cal / g) was in the 50% starch mixture where the composition was 60 PEPO mixed with 40 ml of 50% starch. The results showed that the heating value of the processing empty palm oil had largely met the standard SNI 8021: 2014 which requires a minimum of 4000 cal / g, the calorific value of processing empty palm oil does not meet the SNI 8021: 2014 standard, among others, namely because of a mixture where the adhesive concentration is too liquid and the PEPO is still not smooth. The results of the diversity analysis showed that the type of adhesive and the size of the powder and their interactions had a very significant effect on the heating value of the *Bio-Pellet* produced.

Binding Carbon Level (%) Bio-Pellet

The results showed that the carbon content of bound processing empty palm oil has the highest average value of 20.60% The results showed that the carbon content of bound oil palm bunches *Bio-Pellet* meets SNI 8021: 2014 standard which requires a minimum value of 14% but not all *Bio-Pellet* results of research that meet standard because there is a value of more than 14%. Based on the results of the diversity analysis, it is known that the type of adhesive and the size of the powder and their interactions do not significantly affect the value of carbon-bound *Bio-Pellet* levels.

4. DISCUSSION

Fuel is an energy source to support household and industrial activities. People often use fossil fuels, which are oil, coal and gas. Increasing energy demand causes the supply of fossil fuels to decrease, so that fossil fuels have increased prices. Palm oil industry solid waste in the form of processing empty palm oil (PEPO) has a considerable amount. *Bio-Pellet* is a pellet biomass fuel that has a uniform size, shape, humidity, density, and energy content. In the process of making *Bio-Pellet*, biomass is fed into a pellet mill that has dies with a diameter of 6-8 mm and a length of 10-12 mm. The results of research that have been carried out to make *Bio-Pellet* and tested several parameters of the test quality are water content, ash

November-December 2019
ISSN: 0193-4120 Page No. 3672 - 3680

content, levels of flying substances, heat content, density and bound carbon content results obtained are those that meet the criteria based on SNI 8021: 2014 i.e. on a mixture of starch 50 % with mess 20 where the composition is 60 grams of PEPO with 40 ml of 50% starch. Where the water content was obtained 8.75%, ash content 8.73, 75.46% flying substance content, the caloric content was 4151.67 cal / g, the density was 1.5 g / cm3 and the carbon content was bound to 20.60%.

Some of the mixtures do not meet SNI due to several factors, namely, the concentration of the adhesive, the type of adhesive, the degree of fineness of the material, the composition of the mixture between the material and the adhesive. The concentration of the adhesive here is the level of purity of the adhesive itself, the type of adhesive also affects the results obtained, namely from the texture of the adhesive, the level of fineness of the material here is based on the mess used, where the mess used in this study is mess 6, mess 10, and mess 20, among the mess that is used that meets the criteria in accordance with the set standards that best meet the mess 20.

5. CONCLUSION

From the research that has been done it can be concluded that:

1. Utilization and development of oil palm empty fruit bunch waste by processing empty palm oil into *Bio-Pellet* where the *Bio-Pellet* is processed by mixing with various concentrations of starch adhesive and various variants of the mixture between oil palm empty bunches and starch.
2. *Bio-Pellet* processed from oil palm empty fruit bunch waste mixture with starch adhesive mixture has a heating value of 4151.67 cal / g.

6. SUGGESTION

In further research, please add the type of adhesive, the type of material for making *Bio-Pellet* in order to get varied results and get more results.

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November-December 2019
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