Calorific Value of Oil Palm Frond Through Bio-Charcoal Briquette as Renewable Energy

Seri Maulina1,2*, M. Sarah1,2, F N Anwari1, A E Siregar1,
1Department of Chemical Engineering, Faculty of Engineering, University of Sumatera Utara, Indonesia
2Sustainable Energy and Biomaterial Center of Excellence, Faculty of Engineering, University of Sumatera Utara, Indonesia

*E-mail: maulina_harahap@yahoo.com

Abstract. By product of oil palm plantations such as oil palm fronds have the potential to be processed into more valuable products. The aim of this study to diversify these byproduct into natural products through the process of carbonization and briquetting. Around 50 grams of oil palm fronds were carbonized with a furnace at a temperature of 500 °C for 45, 60 and 90 minutes to produce bio-charcoal. Gluing process on the bio-charcoal is carried out using a starch-based adhesive mixed with water at 20% concentration, with the variation of the ratio of adhesives and bio-charcoal were 30:70, 50:50, and 70:30. Subsequently, the bio-charcoal briquettes were pressed using a hydraulic piston machine with a pressure of 30 kg/m². Calorific value analysis was conducted to test the performance and quality of wood charcoal briquettes.

1. Introduction
Indonesia has the largest palm oil plantation and reported to reach 12,307,677 Ha in the year of 2017 [1]. Palm oil byproducts which are available in large quantities and have not been optimally utilized are palm fronds, palm sludge and palm kernel mill [2]. Palm frond is a kind of solid waste generated throughout the year by oil palm plantations. Waste produced by oil palm plantations can be solid waste and liquid waste. Oil palm fronds are the highest solid waste as byproduct produce in palm oil plantations. The fronds are obtained when fresh fruit bunches harvested, one or two strands of oil palm fronds are cut down in order to facilitate fertilization and make the following harvest easier. One hectare of oil palm plantation is estimated to produce 6400-7500 oil palm fronds / year with 4.5 kilograms dry weight at each [3]. Palm oil waste can be reduced by utilizing it as an alternative material that will increase its economic value such as manufacturing of briquette fuel.

Charcoal briquettes are charcoal which further processed into briquettes that have high economic value and when compared to wood charcoal, briquettes have high heating value, odorless, aromatic, cleaner and durable. Charcoal briquettes can be made from a variety of biomass materials, such as rice husk, wood, sawdust, and coconut shell. The adhesive that can be used in the gluing processes such as starch, tapioca, and molasses [4].

Briquetting of biomass process is a densification of biomass materials to produce compact solid of different sizes through the utilization of pressure. Briquetting is done by applying heat, pressure and binder on the material to produce briquettes. Briquettes utilization can reduce pollution problems while being used as an industrial energy source. Briquettes can also be consumed for household purposes such as cooking, heating, baking, and also industrial needs namely agro-industry or food processing in urban or rural areas [5].
Hence, the aim of this research is to utilize fronds from oil palm into more value products, namely bio-briquette.

2. Materials and Method

This research used oil palm fronds as a raw material to manufacture briquette which obtained from local palm plantation in Sumatera Utara, Indonesia. In addition, other materials used in this research were starch as a binder and aquadest (H\textsubscript{2}O). This research was conducted by performing carbonization process at 500 °C for 45, 60, and 90 minutes to produce charcoal. Before the carbonization was carried out, fronds from oil palm were cut in the form of small size by using chopper equipment. The charcoal produced from the carbonization was smoothed by using a milling ball, sieved to acquire a particle with the size of 100 mesh. Bonding process was conducted by using 25 % starch at the 30:70 ; 50:50; 70:30 ratio charcoal : binder. The bio-charcoal briquettes were forged using a hydraulic piston machine with a pressure of 30 kg/m\textsuperscript{2}. Briquette was dried in the oven at the temperature of 105 °C for 3 hours. Calorific value analysis was conducted to highlight the performance and quality of wood charcoal briquettes.

3. Result

3.1. Calorific Value

The relationship between carbonization time and calorific value as shown in Figure 1.

![Figure 1. Calorific Value of Briquette](image)

The amount of heat liberated per unit mass of the briquette is caled as the calorific value or heating value. Heating value consists both HHV (high heating value) and also LHV (low heating value). Calorific value of fuel is a heating value that produces from heating [6]. The calorific value of the briquette, which is a strong indicator of the proper of a biofuel, ranged between a minimum 2690 cal/gr and maximum 6496 cal/gr. The calorific value of oil palm fronds briquette in this study, mostly fulfill the qualification of Indonesian National Standard (SNI) [7]. The binder concentration has an effect on the calorific value of the charcoal briquettes. Higher composition of charcoal to binder, result higher in calorific value. The heating value can produce enough heat for household cooking and small-scale industry [8].

Figure 1 describes the calorific value of various carbonization time and adhesives to briquette ratio. The calorific value increased at the time of 60 minutes and then decreased at 90 minutes. The longer the burning time, the average value of the resulting heat will be greater. This is due to the formation of
charcoal in the carbonization process can last longer, resulting in the better process of biomass decomposition [9].

Generally, the calorific value increases along with improving the addition of binder material. This is because the size of the adhesive is more smooth and uniform, so the bonds between the bio-charcoal particles are more leverage and resulting higher density [10] [11].

4. Conclusion
It was concluded that the conversion of oil palm fronds into briquette charcoal is effective to manage this solid wastes. Furthermore, due to the abundance of waste agricultural biomass and, which mostly fulfill the calorific value of SNI, briquetting by oil palm frond carbonized has the potential to develop.

5. References
[1] Direktorat Jendral Perkebunan (Dirjenbun) 2017 “Buku Statistik Kelapa Sawit (Palm Oil)” Kementerian Pertanian Republik Indonesia
[2] Mohamad, H., H.A. Halimand and T.M. Ahmad 1986 Palm Oil Research Institute of Malaysia (PORIM) 20: 1-17
[3] Purba A, S P Ginting, Z Poeloengan, K Simanihuruk and Junjunegan 1997 Jurnal Penelitian Kelapa Sawit 5(3) 161 – 170
[4] Hendra, D 2007 Puslitbang Hasil Hutan : Bogor
[5] Lingbeck, Jody M., Paola Cordero, Corliss A. O’Bryan, Michael G. Johnson, Steven C. Ricke and Philip G. Crandall. 2014 Meat Science 97(2014) 197-206
[6] A A Kencana and A Mursadin 2014 Proceedings of the 3rd Applied Science for Technology Innovation, ASTECNOVA
[7] SNI 01-6235-2000 Briket Arang Kayu Badan Standardisasi Nasional
[8] A I Raju, U.Praveena, M SatyA, K Ramya, S S Rao 2016 J. of Bioprocessing and Chemical Engineering Issue 1 / Volume 2
[9] E Fikri and C Sartika 2018 Journal of Ecological Engineering Vol 19 Issue 2 81–88
[10] Samsinar, A Saleh, and W Rustiah 2016 Jurnal Al-Kimia Vol 4 No. 2
[11] J Prasityoayil and A Muenjina 2013 Procedia Environmental Sciences 17 603 – 610

Acknowledgment
This research is funded by Universitas Sumatera Utara appropriate for TALENTA Research Implementation Contract at current budgeting year of 2018 No : 2590/UN5.1.R/PPM/2017 on March 16th, 2018.