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Torrefaction to Improve Biomass Pellet Made of Oil Palm Empty Fruit Bunch A Haryanto1,*, R Nita1, M Telaumbanua1, S Suharyaun1, U Hasanudin2, D A Iryani3, W Hidayat4, S Triyono1, Amrul5, F K Wisnu1 1 Agricultural Engineering Department, Faculty of Agriculture, The 2University of Lampung. Soemantri Brojonegoro Rd #1, Bandar Lampung, Indonesia. 35145 2 Agro-Industrial Technology Department, Faculty of Agriculture, The University of Lampung. Soemantri Brojonegoro Rd #1, Bandar Lampung, Indonesia. 35145 3 Chemical Engineering Department, 3Faculty of Engineering, The University of Lampung. Soemantri Brojonegoro Rd #1, Bandar Lampung, Indonesia. 35145 4 Forestry Management Department, Faculty of Agriculture, The University of Lampung. Soemantri Brojonegoro Rd #1, 2Bandar Lampung, Indonesia. 35145 5 Mechanical Engineering Department, Faculty of Engineering, The University of Lampung. Soemantri Brojonegoro Rd #1, Bandar Lampung, Indonesia. 35145 * E-mail: agus.haryanto@fp.unila.ac.id Abstract. 1This study aims at determining the effect of the torrefaction process on the fuel quality of biomass pellet made from oil palm empty fruit bunches (EFB). The torrefaction process was carried out using a rotary reactor which has a cylinder with a diameter of 15 cm and a length of 15 cm made from iron plate. The cylinder was heated externally using a horizontal heater fuelled with LPG. To homogenize the heat and prevent pellets from colliding during the process, the reactor cylinder was filled with 1.5 kg of clean sand. The torrefaction process was conducted with a load of 300 grams of EFB pellets at temperatures around 240310°C at variations of reaction time (20, 30 and 45 minutes) and the reactor cylinder rotation speed (16, 31, and 37 RPM). The results showed that the torrefaction process improved the quality of the EFB pellet fuel. This was reflected from the very low moisture content (0.320.52%) of torrefied pellets and its calorific value, which increased from 15.82 MJ/kg (without torrefaction) to 17.59 MJ/kg (with torrefaction for 45 minutes). Torrefied pellets showed good hydrophobicity where pellet was not broken when immersed in water for 24 hours. Pellet without torrefaction was destroyed in water in just one minute.

1. Introduction Indonesia is the largest CPO producer in the world, with contributions reaching around 60% of world CPO production. With plantation area reaching 14.33 million

ha of palm oil plantations, CPO production in 2018 reaches 40.57 million tons [1]. The process of producing palm oil at a palm oil processing plant provides CPO of around 21.8% [2] as the main product plus around 13% palm kernel as additional product. Because of the small amount, palm kernel is usually processed in a separate palm kernel oil (PKO) mill. Besides, the palm oil processing factory also produces large amounts of waste in form of empty fruit bunches (EFB), fiber, palm kernel shell (PKS), and palm oil mill effluent (POME) [3]. Calculated based on the weight of the processed fresh fruit bunch (FFB), each ton of FFB will produce around 200-230 kg of empty fruit bunches (EFB), 50-60 kg of the shell, 120-130 kg of fiber and 0.77-0.84 m3/ton of palm oil mill (POME) [2]. The amount of EFB waste is proportional to the amount of CPO product, so this means that in 2019 there will be around 40 million tons of OPEFB in Indonesia. EFB is a waste with a high water content reaching 60% [4,5] to 64.17% [6]. Some palm oil mills are equipped with shredder machines that will rip and squeeze EFB so that the water content is reduced to around 40%. In general, the EFB is returned to plantation, both as mulch or compost after EFB composting process. Composting of EFB through open windrow method which watered with POME every another day can reduce methane emissions up to 35.92% for the composting duration of 30 days and 53.22% for 80 days period [7]. Application of EFB into plantations can return carbon and soil nutrients because EFB has 42% C, 0.8% N, 0.06% P, 2.4% K and 0.2% Mg [5]. The problem is that not all palm oil processing factories have their own plantations that can accommodate EFB. It is estimated that currently there are around 20% of palm oil processing factories which only rely on fruit supply from farmers and do not have their own plantations, which means covering approximately 2.8 million ha of plantations or the equivalent of eight million tons of EFB in the year 2019. Therefore, there has to be a better alternative to handle the EFB. Recently our team reported that EFB can be used as a medium for mushroom cultivation [8]. Field surveys around palm oil mills operating in East Lampung (Indonesia) show that the cultivation of mushrooms using EFB media provides high income for farmers. However, this practice only covers a small part of the available EFB. Therefore it is uegent to promote more environtmentally friendly ways in

utilizing the EFB to improve sustainability of the palm oil industries. Densification of EFB into pellets is one alternative need to be considered for EFB utilization. With high water content, EFB is challenging to use as fuel. In dry conditions, EFB has a calorific value of about 13.82 MJ/kg [9] so that it has the potential as a source of energy. But EFB is very bulky because it has a low bulk density of around 555 kg/m3, which will make it difficult to handling and need more transportation cost. One alternative for the utilization of EFB for energy sources is to change the physical EFB into more compact pellets. If the pelletizing process is carried out around a palm oil processing plant, then the EFB drying can utilize the waste heat of flue gas or the residual heat of steam from the crude palm oil extraction process. Densification of EFB at a pressure of 55 MPa can produce good EFB pellets with bulk density reaching about 1.5 t/m3 [10]. Nevertheless, this pellet still has shortcomings because it is easily damaged when stored in open spaces since the pellets are still hygroscopic, making it easy to absorb moisture from the environment. Heat released from large-scale biomass fuel piles includes microbial, chemical, and physical processes. In the early stages, the microbial processes proved to be the most important contributor of heat production during biomass storage [11]. One way to improve the nature of biomass pellets is to use a torrefaction pretreatment. Torrefaction is a thermochemical process carried out at temperatures between 200 to 300°C in conditions without oxygen [12–15]. It was recently reported that oxidative torrefaction carried out in the presence of limited oxygen has a positive effect in the torrefaction process [16–19]. The process will produce torrefied biomass which has hydrophobic properties so that the pellet is not easily damaged in storage. Besides, torrefied biomass also has a higher calorific value than biomass without torrefaction. This study aims to determine the effect of torrefaction treatment on the fuel quality improvement of the EFB pellet.

Sources

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