

Procedia Environmental Science, Engineering and Management 7 (2020) (2) xxx-xxx

2nd Environmental Innovations: Advances in Engineering, Technology and Management,
EIAETM, 21st-27th September, 2020

BIOMASS FUEL FROM OIL PALM EMPTY FRUIT BUNCH PELLET: POTENTIAL AND CHALLENGES*

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Abstract

This study aims to determine the potential and challenges of oil palm empty fruit bunch (OPEFB) pellet as biomass fuel. The study was conducted by observing the process of commercial OPEFB pellets production and analysing some characteristics of the pellets. Proximate and ultimate analysis were carried out to determine the characteristics of pellets, namely mass specific, bulk density, water content, ash content, lignocellulose composition, and calorific value. In addition, XRF analysis was conducted to determine ash composition. Results showed that pressure applied during pellet production affected water content and density of the pellets. OPEFB pellets made with pressure of 90 MPa showed stronger characteristics than the pellet produced with 55 MPa. The pellets had a hexagonal cross section with diameter and mass density of 8.88 mm and 1.55 g/cm³ for pellet produced at 90 MPa, and 9.65 mm and 1.39 g/cm³ for pellet produced at 55 MPa. Calorific value of OPEFB pellet (15.82 MJ/kg) was still lower than the standard, while ash content was higher than the standard. High ash content and high mineral content are the main problems need to be addressed in order to safely use OPEFB pellet as fuel, especially for big industries or for generating electricity.

Keywords: biomass pellet, palm oil, renewable, sustainable

* Selection and peer-review under responsibility of the IATEM

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1. Introduction

Palm oil has become a leading commodity for Indonesia. Crude palm oil (CPO) exports generate significant amounts of foreign exchange. Good quality fruits harvested from large plantations can produce CPO up to 24% of fresh fruit bunch (FFB). Low quality oil palm fruits from smallholder plantations produce lower CPO yield. Generally, CPO yield is 22% of milled FFB. Therefore, almost 80% of the processed raw material will end up as solid and liquid wastes. Expressed in units per ton of FFB, in general waste generated from the CPO extraction process consists of empty fruit bunches (OPEFB) of 22%, mesocarp fiber of 13%, shell of 6%, and liquid waste called palm oil mill effluent (POME) of 0.6-0.8 m³ (Hasanudin *et al.*, 2015). Thus, following oil extraction processes, around 40% of the oil palm fruit remains as solid residual material consists of the OPEFB, shells, and fibers. While oil palm shells and fibers are already used in oil palm mills to generate power and heat required for oil palm fruit processing, OPEFB is still underutilized.

OPEFB is resulted from the stripping process that separates the oil palm nuts from its bunch. OPEFB is the largest solid biomass waste which is comparable to the amount of the produced CPO. This biomass is structured by very strong fibers consisting of main stalk around 20–25% and spikelets 75–80%. Therefore OPEFB biomass is difficult to decompose biologically. OPEFB has a such high moisture content up to 60% (Abdullah *et al.*, 2011) due to the steam sterilisation process at the palm oil mill. High moisture content lowers energy value of OPEFB and reduces the combustion efficiency. OPEFB is also oily with oil content may reach 12% an average of 8.6% of dry OPEFB. Some palm oil mills are equipped with machine for tearing and pressing OPEFB to decrease water content and take the oil remnant that reduces oil content by 3.61% (Md Yunos *et al.*, 2015). The water content, however, is still high at around 40%.

The most widely applied option in managing OPEFB is returning it to oil palm land as mulch, which is generally stacked between rows of plants. An integrated treatment for OPEFB and POME is beneficial in which POME is treated anaerobically to produce biogas, whereas OPEFB with addition of effluent from digested POME is composted to produce compost. The compost is returned to the palm oil plantation and the biogas is used as fuel to generate electricity and process steam. We recently reported that co-composting OPEFB and POME may reduce methane gas emissions by 35.92% and 53.22% for 30-day and 80-day composting period (Haryanto *et al.*, 2019). The high investment in modern composting facilities makes this practice is difficult to find in the field.

In the long term, the OPEFB application to the plantation is expected to be a source of organic material for the soil and can save the use of chemical fertilizers. For palm oil mills that do not have their own plantations, however, this option is a problem. In 2006 the number of POM without plantation was 219, which is about 20% of around 1100 mills. Now, with 14.33 million ha oil palm plantations and CPO yield of 40.57 million tons, it is estimated the number of palm oil mills without plantation occupy around 2.87 million ha with OPEFB equivalent to nine million tons. Long distances and high transportation costs will become obstacles to return the OPEFB to the partnership farmers. Recently, OPEFB was reported as good growing media for cultivating rice straw mushroom (Triyono *et al.*, 2019). Practicing this option, however, involves only little parts of the available OPEFB. Therefore it is necessary to find alternatives for better utilization of OPEFB. In dry conditions, OPEFB has a fairly high calorific value, so it has the potential to be developed as biomass fuel. Biomass from plants can serve as an alternative renewable and carbon-neutral raw material for the production of energy. But in the original condition, the biomass of OPEFB is difficult to handle, transport, store, and utilize.

The major limitation of OPEFB for energy purposes is its low bulk density. One method to make easy transportation and decrease the costs is to reduce the volume of the