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# Testing Pellets Fuel Production from Sewage Sludge of Palm Oil Industry

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**ABSTRACT**

The wastes from the palm oil production process were used in this study, such as wastewater sludge and cake decenter or decanter waste. That moisture was less than 40% and increased density by the cold pelletizing process. The aim is to use pellet fuel for heating. Analysis of pellet fuel consists of physical properties, proximate (moisture, ash, volatile matter and fixed carbon) and heating value. The results showed that cake decenter and wastewater sludge had similar high volatile matter. The decenter cake had a higher heating value than the wastewater sludge at 26.649 and 14.965 MJ/kg, respectively. The ash of decenter cake was lower than wastewater at 11.71% and 22.34%, respectively. Blending both raw materials for pelletization increased the volatile matter that did not mix with another material. Therefore, both materials can be used to produce pellet fuel that has an optimal shape and size. That was hard to break. The results of chemical property testing show that it is within acceptable limits and can be used as pellet fuel.

## 1. Introduction

In 2022, Thailand has palm planting of 1.8 million rai, which is more than in 2012. The demand for palm oil produced for both domestic and export sales, is a result of the energy crisis, political problems and war at present. Currently, Thailand has 131 palm industries and a total production capacity of 5.6 million tons per year. That affects the trend towards expanding investment in planting palm to supply factories [1]. After, the post-harvesting palm bunches are to the palm oil extraction factory for the palm oil, there is more waste from the production process consist empty bunch, fiber, shell, wastewater and cake decenter [2]. The waste of palm can be used to biogas liquid biofuel and fuel (pellet and charcoal) for heat generated in electricity and industry [3].

At present, sludge waste is processed into fuel in many forms as producing fuel briquettes such as waste sludge from a dairy factory [4], fuel pelletizing between sewage sludge and biomass [5], production of mixed fuel pellets from sewage sludge and agricultural waste from animal remains and olive fruit [6] and using industrial wastewater sludge from canned tuna processing to produce fuel pellets [7].

This research aims to produce pellet fuel from wastewater sludge from the palm oil production process that has a large amount remaining that has a direct impact on the environment. The pellet is fuel for heat generated. That was test physical property, proximate analysis (Fixed Carbon, Moisture, Ash and Volatile Mater) and heating value).

## 2. Experimental detail

### *2.1 Design of experiment*

The design of the experiment started with the moisture of wastewater and cake decenter, which is less than 40%. That was increased density by the cold pelletizing process. Analysis pellet properties were physical property, proximate analysis (Fixed Carbon, Moisture, Ash and Volatile Mater), and heating value, as shown in Fig. 1.

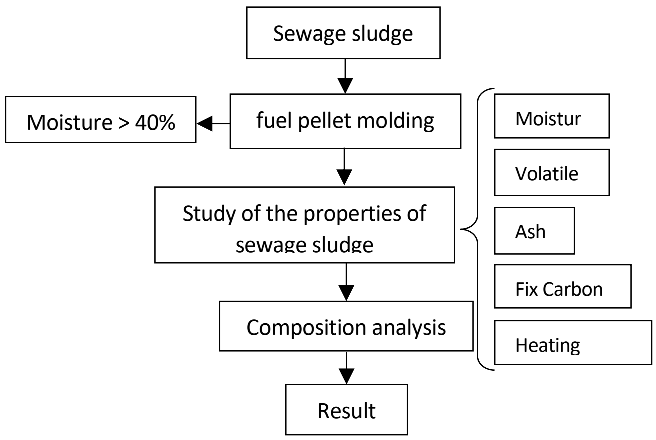



Fig 1. Design of the Experiment.

*2.2 Physical Properties*

Physical Properties consist moisture and bulk density. Moisture is the percentage of water to raw material weight on a wet basis. The fuel has low moisture affects the impact performance of biomass combustion [8]. Bulk density is a key attribute of biomass feedstocks that affects both conversion processes and logistics [9]. The bulk density of the sample was calculated from the following equation (1) [10].

$$r_b = \frac{W_2 - W_1}{V} \quad (1)$$

Where $r_b$ is the bulk density of the sample (g /cm$^3$). $W_2$ is the weight of the container and sample (g). $W_1$ is the weight of the container (g). V is volume of the container (cm$^3$).

*2.3 Proximate Analysis*

Proximate analysis of a material fuel that burns in a gaseous state (volatile matter), in the solid state (fixed carbon), and the percentage of inorganic waste material as ash, and is therefore of fundamental importance for biomass energy use [11]. The standard of proximate was used volatile matter content (DIN51720), moisture content (DIN51718), ash (DIN51719), and fixed carbon content (ASTM E775-78) [12].

Fig 2. Bomb Calorimeter LECO with AC500 Model (Laboratory of RCSEE, RMURT).

*2.4* Heating value

The heating value of a fuel refers to the heat generated when a unit mass of fuel is completely burned, and it includes the latent heat of vaporization of water vapor generated when the fuel is burned. Fuel with a higher heating value has higher energy output. Heating value is the most important parameter used to evaluate biomass fuel quality [13]. Higher heating value (calorific value) is experimentally determined using a bomb calorimeter of Automatic calorimeter LECO (AC500) shown in Fig. 2.

**3. Experimental detail**

*3.1 Pellet Process*

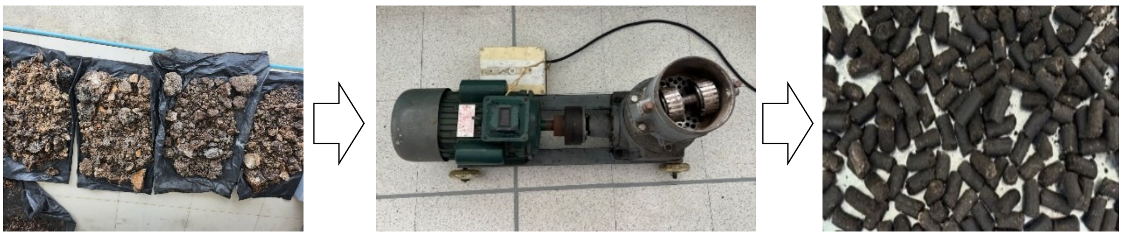
The process of fuel pellets by cold pressing with high compression, as shown in Fig. 3. The compression to a fixed shape without using a binder to make the raw material molecules compact until they can form a lump and no need to grind the raw materials before being pressed. The palletization process was started to prepare waste sludge of wastewater. It decreased moisture by less than 35% by sun drying, which is moisture between of 20-30%. The pelletizing of raw material was used force and compressing through the holes of the pellet sieve with a diameter of 0.7 cm by rotates with a shaft connected to a motor and roller, which revolve around it to help mix the material more thoroughly. The palletization of a pellet machine relies on the pressure of the rotation of the rollers and the rotation of the sieve plate until it becomes pellets according to the size of the sieve holes.

3.2 Physical Properties of Raw Material

The cake decenters were decreased moisture by sun drying, which is brown sludge similar to clay. The moisture of cake decenters was 25%. Then, it was pelleted at production capacity of 1-3 kg/hr. The result was found that, the pellet has a characteristic cylindrical shape dimeter of 7 mm and length of 18 mm. The pellet has durability of 99%. The moisture of the pellet was 21%, which decreased after the pelletization process as shown Fig. 4. The wastewater is white after sun drying similar powder mold. The moisture of wastewater was 14%. Then, it was pelleted and has a characteristic cylindrical shape dimeter of 7 mm and length of 18 mm like to cake decenters pellet. The pellet has durability of 95%. The moisture of the pellet was 4% which of 95%. The moisture of the pellet was 4%, which decreased after the pelletization process as shown in Fig. 5.

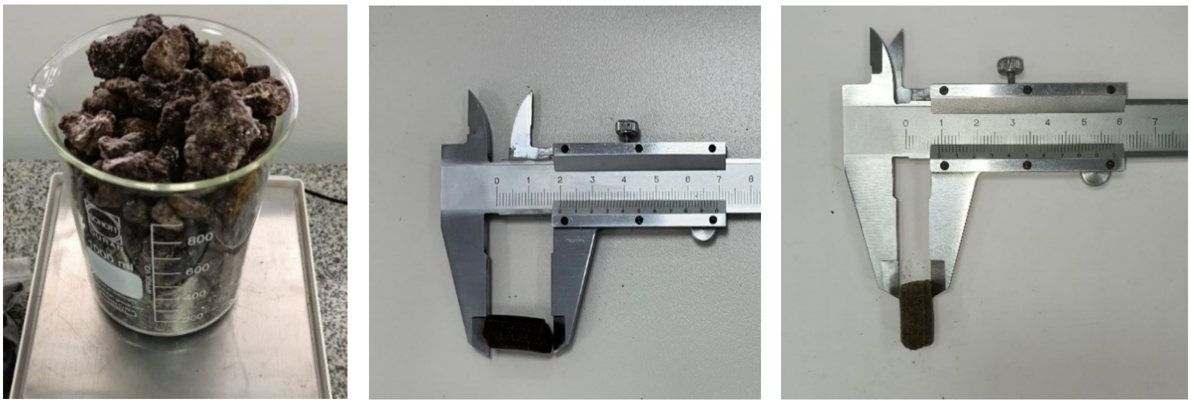
3.3 Chemical Properties of Raw Materials

Table 1. shows the chemical properties of decanter cake and wastewater. It was found that, the results showed that cake decenter and wastewater sludge had similar high volatile matter. The cake decenters had a higher heating value than the wastewater sludge at 26.649 and 14.965 MJ/kg, respectively. The ash of cake decenters was lower than wastewater at 11.71% and 22.34%, respectively. Blending both raw materials for pelletization increased the volatile matter.



(a) Material (b) Pellet Machine (c) Pellet

Fig 3. Pellet Process, (a) Material, (b) Pellet Machine and (c) Pellet.



(a) Decanter Waste (b) Length (c) Dimeter

Fig. 4 Pellet from Decanter, (a) Decanter Waste, (b) Length and (c) Dimeter.

(a) Wastewater (b) Length (c) Dimeter

Fig 5. Pellet from Wastewater, (a) Wastewater, (b) Length and (c) Dimeter.

Table 1 The Chemical Properties of Raw Materials.

| Parameter | Analysis | | | |
|---|---|---|---|---|
| | Decanter cake | Wastewater Sludge | Sewage Sludge [14] | Coal [14] |
| (%) Moisture | 4.39 | 21.11 | 13.29(±1.94) | 5.00-10.00 |
| (%) Volatile | 64.69 | 67.35 | 60.98(±1.58) | 25.00-40.00 |
| (%) Ash | 22.34 | 11.71 | 20.86(±1.38) | 8.50-11.30 |
| (%) Fix Carbon | 8.58 | -0.17 | 4.87(±1.02) | 38.70-61.50 |
| Heating Value | 26.649 MJ/kg | 14.965 MJ/kg | 11.84 | 26.00-28.30 |

**4. Conclusion**

The experiment of fuel pellets using two types of materials, consisting of decanter cake and wastewater without mixing other materials. These wastes pass through the preparation and forming process, which can storage without causing secondary environmental pollution which increase its potential application. It was found that both types of materials could be formed into pellets. The raw material has a moisture content higher than 30 percentage, it must be dried until the moisture is less than 30%, which can be molded well and has the appropriate shape and size. It was high durable, not easily broken and facilitates to transportation. The highest calorific value (HHV) of the pellets was 26.64 MJ/kg obtained from decanter cake of wastewater treatment process. The results of the test of chemical properties can be used as pellet fuel, which is within acceptable limits.

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