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Thermal Performance Evaluation of a Small-Scale Drying Machine for Palm Oil Mill Sludge

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Abstract: Malaysia is one of the major contributors of palm oil production globally with large amount of palm oil production. This has significantly contributed to large amount of palm oil mill effluent that eventually affect the environment. A small-scale drying machine for palm oil mill is evaluated on its thermal performance to assess the suitability of the machine to produce organic fertilizer from the palm oil mill sludge. Evaluation was performed with computational fluid dynamics simulation and experiment on design configuration options of the drying machine. The effect of air flow to the thermal performance was also studied in conjunction with the design configurations of the drying machine. The results showed promising potential of a design configuration over another in term of thermal performance and functionality.

Keywords: Small-scale drying machine, thermal evaluation, palm oil sludge

1. Introduction

Malaysia and Indonesia contributed to about 85 - 90% production of palm oil globally [1]. The large amount of palm oil production also significantly contributes to the large amount of palm oil mill effluent produced that will eventually affect the environment. In current practice, more than 85% of palm oil mills manage their effluent with lagoons that require a large area of land for continuous operation [2]. Unfortunately, the by-product of the effluent treatment especially for palm oil mill sludge is biogas that contain about 60% of methane [3]. Methane is the second largest contributor to global warming after carbon dioxide but with higher effect as compared to carbon dioxide by more than 20 times for a span of over 100 years [4, 5]. Hence, there is a necessity for the control of methane emission starting with a small effort on the palm oil mill sludge treatment control.

Palm oil mill effluent (POME) is in the form of condensate water and normally is acidic with pH between 4.0 to 5.0 [6, 7]. Dried or semi dried sludge of palm oil mill wastewater have potential for reuse in various applications due to the high nutrient content of the sludge such as calcium, nitrogen, magnesium, and phosphorus [8, 9]. Anaerobically treated palm oil mill sludge with mixture of additional organic nutrients such as chicken manure is good for soil condition improvement [10]. Additionally, composting bacteria is also present in the palm oil mill sludge that indicates the high suitability for the application as organic fertilizer [11]. The idea of small-scale drying machine for palm oil mill sludge is to enable small and medium sized farmers or planters to benefit from the production of organic fertilizer from the palm oil mill sludge for own usage or as income generator. Additionally, the effort will allow the community to work towards environmental conservation efforts in reducing the usage of land for sludge treatment, as an example.

2. Machine Design

Available sludge drying machines are mostly designed to dry the sludge at maximum dryness to almost a powder for or in a form commonly called dewatered sludge cake [12]. As an example, combination of rotary drum dryer and heating

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