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CALORIFIC VALUE OF THE SEWAGE SLUDGE IN THE THERMAL DRYER

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ABSTRACT

Recently, the increasing population as well as tremendous of industrial development has caused the production of sewage sludge rise sharply and the available solution for their disposal cannot afford the amount of sludge produced. In Malaysia, the main solution for sewage sludge disposal is by landfill. However, most of the landfill reaches its capacity and the production of sewage sludge continuously increasing. The available land space for disposal of sewage sludge is limited due to high demand for population for housing and urban. Therefore, there is a needed for a new disposal method for treating sewage sludge that can sustain and environmentally friendly. Converting this waste into energy can resolve the disposal problem of sewage sludge and generate the new sources of energy to human kind. However, the moisture content is sewage sludge is high which more than 85% of moisture content. In order to convert into energy, the small scale disc dryer was developed in order to reduce the moisture content of the sewage sludge which into acceptable level is less than 20% of moisture content for conversion into solid fuel. In this paper, the basic characteristic of the dried sewage sludge for conversion into energy was studied. Besides that, the effect of the temperature of the thermal dryer on the calorific value of the sewage sludge also being investigated. The higher temperature of the thermal dryer will reduce the calorific value of the sewage sludge.The maximum calorific value of the sewage sludge was obtained from the lowest power rating of the burner which is 135 kW which is 12.51 MJ/kg whereas the lowest calorific value of the sewage sludge was obtained from the highest power rating of the burner which is 315 kW which is 4.57 MJ/kg.

Keywords: thermal dryer, industrial production, sewage sludge, disposal method.

INTRODUCTION

In Malaysia, there is no proper sewerage system since there are still low population and very slow urbanization development. Most of the waste effluent at that time will discharge into rivers and seas. A few years later, the country needs proper sludge management and treatment for the development starting to rise due to changing in the base economy from agriculture to industry.

Nowadays, the production of sewage sludge increases drastically with annual production of 4.9 million tons [1]. This value expected to be double in the next 6 years [2]. Rapid development as well as increase in population has led the increasing of sewage sludge produced. Recently, most of the treated sewage sludge from the sewage sludge treatment plant (STP) disposed by landfill. However, the available solution required space as well as higher operating cost caused this solution to not be relevant anymore [3]. Converting this waste into useful energy is one of the solutions to solve the sludge disposal problem as well as produced the useful energy for the mankind.

Presently, sewage treatment plants have to deal with large volume of sewage sludge that accumulated over the years due to years of neglecting the sludge management issue. Sewage sludge need to be given special consideration in handling and treatment as it contains toxic element, such as harmful pathogens which can seriously affect the human health [4]. Malaysian sewage sludge has been proven its potential to convert into solid fuel as it has a high heating value. Based on previous work done by the local researcher, the heating value of Malaysian sewage sludge predicted between 14-18 MJ/kg [1]. However, the drying method that used to dry the sludge is ineffectively since using microwave oven.

The conventional drying method such oven dryer as used by Mokhtar *et al*. [5] required a long time to dry the sludge and only applicable for research purpose only, but not in practice for application since required high energy, required larger space and takes time to dry the sludge.

Mechanical dewatering of sewage sludge usually not sufficient to remove the moisture content of the sewage sludge into acceptable level hence required thermal drying for further process [6]. Thermal dryer often used to dry the sewage sludge as it isn't just removing the moisture content, but also able to stabilize the sludge, removes the harmful pathogen and eliminate the odors of the sludge. Thermal processing of wastewater sludge includes thermal conditioning, thermal drying, and incineration. Municipal sewage sludge is the final product from the waste water treatment plant. This product has high moisture content which is more than 85%, hence required most of the thermal process in order to reduce the moisture content of the sewage sludge into acceptable level for converting into solid fuel [7-9].

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METHODOLOGY

The sample of treated sewage sludge was collected from the sewage treatment plant at Bunus waste water treatment plant. The small sample of sewage sludge was taken and subjected to full drying in order to determine the initial moisture content of the wet sewage sludge that taken from the treatment plant. After that, the wet sewage sludge will dried using proposed thermal dryer for dewatering process. The temperature profile and fuel consumption were recorded for analyzing process.

The schematic of thermal dryer as presented in Figure-1. There are two main components in the proposed thermal dryer which is the feeder and the dryer. The sewage sludge from the feeder will transport to the dryer by using screw conveyor which is driven by the electric motor. The wet sewage sludge that enters to the dryer will convey into the outlet using the screw conveyor.

The screw conveyor in the dryer was equipped with the burner in order to increase the temperature of the sewage sludge for drying purpose. There are 5 different speed of the screw conveyor in the dryer which is 2.04, 4.08, 6.12, 8.16 and 10.20 round per minute (RPM). This dryer was equipped with the burner with power rating of 135, 170, 205, 240, 275 and 310 kW in order to supply heat to evaporate the moisture in sludge. The temperature profile of the dryer was investigated by attaching the K-type thermocouples along the dryer and the location of the thermocouple as presented in Figure-2.

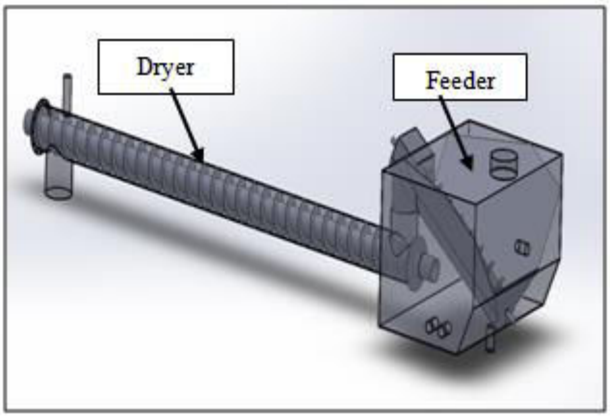

Figure-1. Schematic of the thermal dryer.

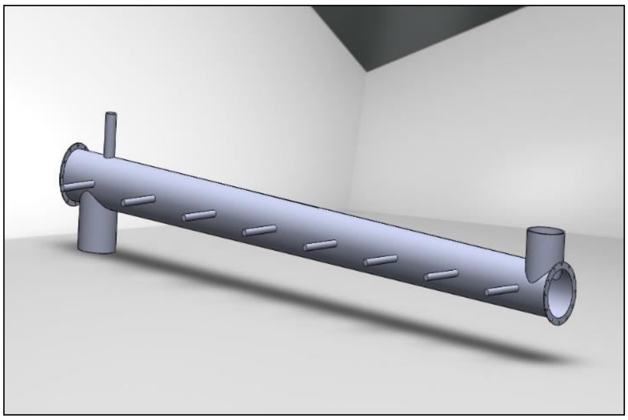

Figure-2. Thermocouple location in the thermal dryer.

The different power ratings gave different temperature of the thermal dryer since high power rating of the burner will supply more heat to the thermal dryer and vice versa. Therefore, the temperature profile of the thermal dryer was investigated by using data logger which is connected to the thermocouple that placed to the thermal dryer. The electric motor that used to drive the screw conveyor in the dryer was similar to the electric motor that used in the feeder. However, the output shaft of the electric motor at drying process was attached to the train gear with a ratio of 28:78 in order to further reduce the rotation of screw conveyor in the dryer. This is because the sewage sludge takes time to dry hence, the speed of the screw conveyor must be reduced in order to allow the drying process running smoothly. Therefore, the rotation of screw conveyor in dryer slower than output shaft of the electric motor due to drying purpose. The details rotation of screw conveyor in the dryer as presented in Figure-3. The minimum speed of the screw conveyor in the dryer was 2.04 RPM and the maximum speed was 10.19 RPM. The minimum speed of the screw conveyor will give higher drying time and increase the speed will result reducing the drying time of the sewage sludge.

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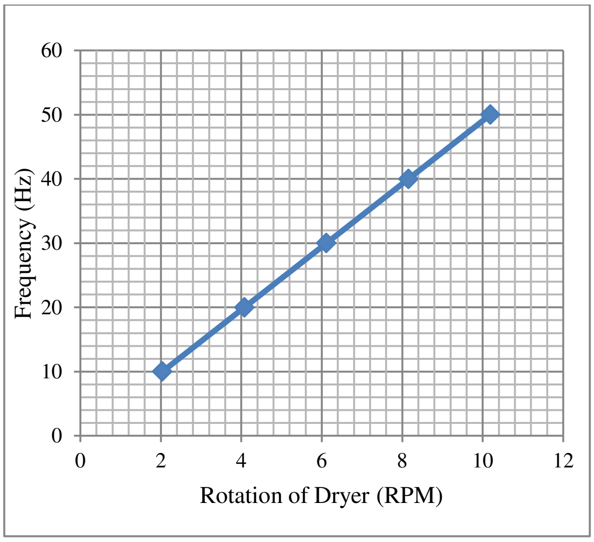

Figure-3. The rotation of the dryer with different frequency of electric motor.

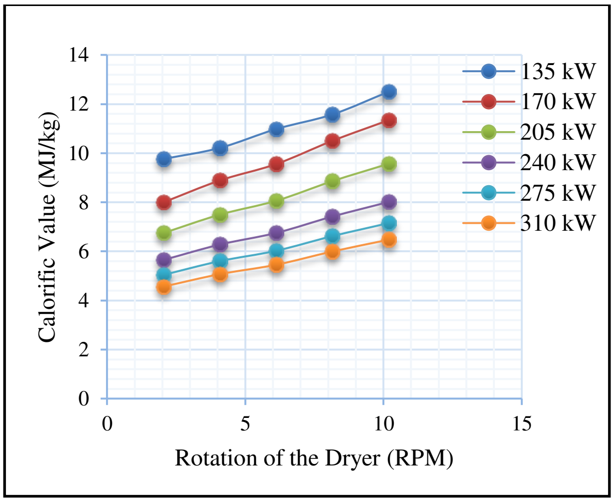

Figure-5. The calorific value of the sewage sludge with different power rating and speed of the screw conveyor in the dryer.

RESULT AND DISCUSSIONS

The Figure-4 represents the temperature of the thermal dryer with various power rating of the burner in different distance from the burner. The maximum temperature was obtain from the distance near to the burner with 316.5°Cwhereas the minimum temperature was obtain from the distance 6 meter from the burner with the lowest power rating which is 59.8°C.

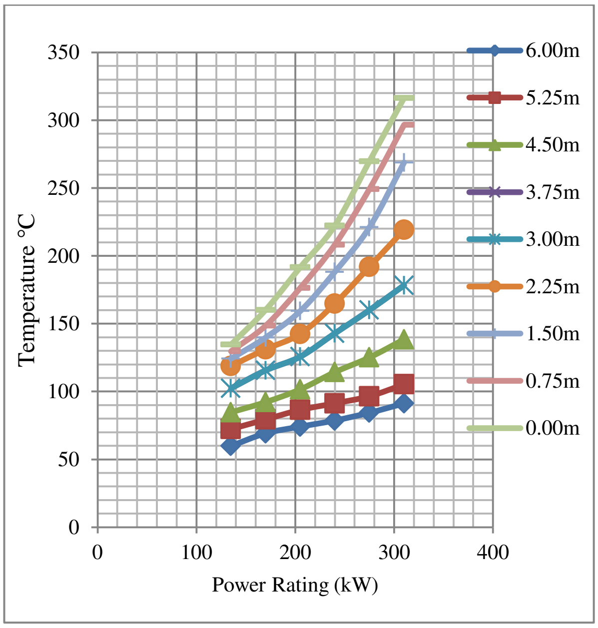

Figure-4. The temperature of the thermal dryer with various power rating of the burner.

Figure-5 represents the calorific value of the sewage sludge with different power rating and speed of the screw conveyor in the dryer. The maximum calorific value of the sewage sludge was obtained from the lowest power rating of the burner which is 135 kW which is 12.51 MJ/kg whereas the lowest calorific value of the sewage sludge was obtained from the highest power rating of the burner which is 315 kW which is 4.57 MJ/kg. This is because the sewage sludge travel faster in the drum dryer compared to lower speed of the screw conveyor, hence the volatile matter in sewage sludge less burned since exposed to the hot drum in the short time.

Higher power rating produces higher temperature of the drum dryer. The volatile matter in sewage sludge can burn easily with exposed into high temperature. Therefore, the lowest power rating has the highest calorific value since the volatile matter of sewage sludge less burned in lower temperature compared to the high temperature that delivered by the burner.

Furthermore, by using the lowest speed of the dryer, the drying process takes time and most of the volatile matter in sewage sludge was burned since expose to the high temperature with longer time. The volatile matter that diminishes by the high temperature in drum will becomes ash. Therefore, the quantity of the volatile matter will decrease while ash increased. Hence, the calorific value of the sewage sludge will become lower due to loss of volatile matter and increasing of ash content.

CONCLUSIONS

The calorific value of the sewage sludge that obtained from the thermal dryer was acceptable for conversion into the solid fuel. The temperature of the thermal dryer influenced the calorific value of the sewage sludge since the volatile matter in the sewage sludge

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diminish and produce the ash, hence the calorific value of the sewage sludge for the high temperature in the thermal dryer becomes less.

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