

Development of Green Energy Block Made from Paper Mill Waste Sludge

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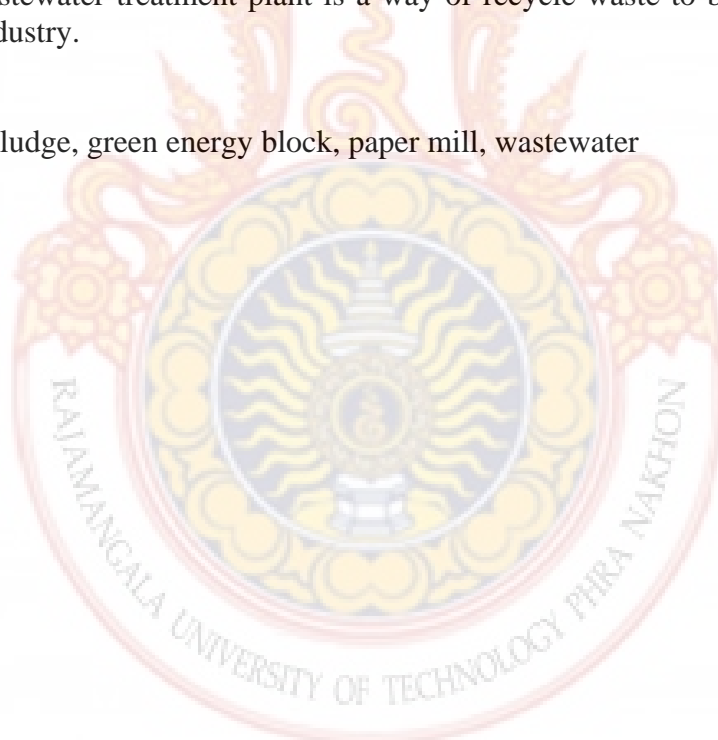
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Abstract

Sludge from paper mill wastewater treatment plant is the residual composed of fibres, fibre particles and miscellaneous debris. Sludge with high fibre contents were collected from BP paper mill industry. They were retreated by 2 days drying and mixing dried sludge with tapioca starch as ratios were: 100:0, 95:5, 90:10, 85:15 and 80:20(sludge: tapioca starch). To make the green energy block by using screw-press machine compressed sludge that mixed with various ratios of tapioca starch. A size of green energy block was 6 inches diameter, 2 inches high and 150 g. weight. Energy values were tested by using Bomb-calorimeter measurement instrument. The results of testing found: the best ratio of green energy compressed for high heating value was 95:5(sludge : tapioca starch by weight) and the maximum heating value was about 19,638 J/g. This green energy block made from waste of paper mill wastewater treatment plant is a way of recycle waste to be energy and reducing waste from industry.

Key words: sludge, green energy block, paper mill, wastewater



1. Introduction

Sludge is generated through the sewage treatment process or produced from the treatment of wastewater in on-site (e.g. septic tank) and off-site (e.g. activated sludge) systems [1,2]. Pulp and paper mill sludge consist of water treatment rejects separated from the mill effect and hold residuals from mill wastewater before the water is discharged into the environment, primary sludge comes from the primary clarifier and secondary sludge originated from the secondary water treatment [3,4]. Paper mill waste sludge composed of pulp fibres, fibre particles and pigments, together with miscellaneous debris. The cellulose fibers present in the residuals that useful to make the other by-products such as recycle low grade paper, micro fibre in concrete and renewable energy or conversion energy. The raw material of pulp and paper mill processes were taken from plants such as pine tree (*Pinus L.*), Eucalyptus (*Eucalyptus globulus* Labill.) or the other plants are rich of cellulose fibres. Sludge ash concentrates heavy metals, however, and if their concentration arises hazardous levels, the ash requires special handling [5,6].

The use of paper sludge as a bio-waste fuel for energy production has been recently considered in many European countries and the use of a bio-waste fuel for energy production but its low heating value, sludge must be co-fired with fuel higher heating value, as bark and wood residuals [7]. One ton of wastepaper combusted as fuel will produce 9.8 GJ of thermal energy [8]. The objectives of this research were establish technical, economical and environmental benefits by using sludge from paper mill wastewater treatment plant and mixed together with a

natural binder for making green energy block as a cheap renewable fuel.

2. Materials and Methods

2.1 Sludge sampling

Sludge (10 kg.) was taken from the activated sludge process (AS) of BP paper mill industry wastewater treatment plant at Ayutthaya Province in Thailand as shown in figure 1.

The activated-sludge process or AS process is a biological method of wastewater treatment that is performed by a variable and mixed community of microorganisms in an aerobic aquatic environment. These microorganisms derive energy from carbonaceous organic matter in aerated wastewater for the production of new cells in a process known as synthesis, while simultaneously releasing energy through the conversion of this organic matter into compounds that contain lower energy, such as carbon dioxide and water, in a process called respiration [9].

AS system wastewater treatment process include the following sequence of steps:

Screening to remove relatively large floating and suspended debris.

Mixing the water with chemicals that encourage suspended solids to coagulate into the larger particles that will more easily settle.

Flocculation, which is the process of gently mixing the water and coagulant, allowing the formation of large particles of floc.

Sedimentation in which the flow is slowed enough so that gravity will cause the floc to settle.

Sludge processing where the mixture of solids and liquids collected

from the settling tank are dewatered and disposed of[10].

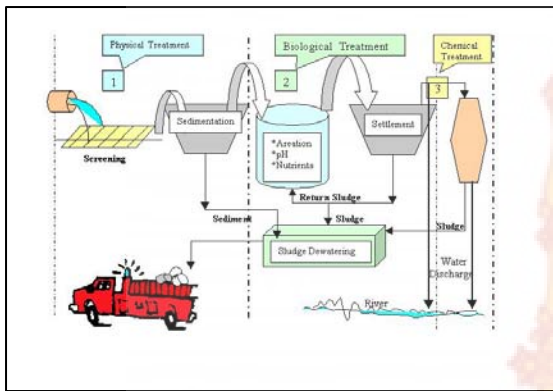


Fig1. Schematic diagram of BP paper mill industry wastewater treatment plant

Sludge residuals were retreated by 2 days drying and the characterized properties of dried sludge were determined. The samples were mixed with tapioca starch as ratios were: 100 : 0, 95:5, 90:10 and 85:15(sludge : tapioca by weight). Sludge residuals were taken from BP paper mill industry shown in figure2.



Fig.2 Sludge residuals

2.2 Green energy block preparation and testing analysis

The process for making a green energy block from sludge of paper mill

wastewater treatment plant are comprising :

2.2.1 Compressed the green energy block by using screw machine.

2.2.2.Determination of fuel thermal energy and statistical analysis

All samples were analyzed for fuel properties under American Society for Testing and Material (ASTM)[11] by using Bomb- calorimeter measurement instrument. The fuel thermal energy properties were tested such as heating value(%), moisture(%), ash(%), volatile substances(%), fixed carbon and sulfur(%). Experimental data were analyzed by analysis of variance (ANOVA) and Duncan's New Multiple Range (DMRT) at significant 5%.

3. Results and Discussion

3.1. Paper mill sludge sampling and characterization

The sludges were collected from BP paper mill wastewater treatment plant were testing the physical and chemical characteristics for proximity to selected composite fuel production. A summary of more important combustion properties is presented in table1.

Table1. Sludge samples characteristics

| Characteristics | % by weights of rice straw (one pieces) |
|---------------------------------|---|
| Moisture | 13.080 |
| Volatile Matter | 15.338 |
| Fixed Carbon | 20.400 |
| Sulfur | 0.975 |
| Heating Value | 4,366.301 |
| Ash | 7.410 |
| Organic Matter | 49.570 |
| Bulk Density, kg/m ³ | 134.000 |

3.2 Compressed fuel thermal energy

A size of green energy block made from paper mill wastewater treatment plant sludge is shown in figure 3. A normal size of green energy block is 6 inches diameter, 2 inches high and 150 g. weight.



Fig3. A normal size of green energy block

The best ratio of green energy block was 95:5(sludge : tapioca by weight).

3.2.1 Heating combustion value

Heat of combustion was transferred to cooling water around Bomb Calorimeter. Water temperature was measured by thermometer. Amount of heat transfer be calculated by equation 1.

$$Q = mc(T_1 - T_2) \quad (1)$$

Where Q = Fuel combustion heat
 m = mass of water in

Calorimeter

c = specific heat of water

T_1 = water temperature

before combustion

T_2 = water temperature

after combustion

Fuel thermal energy can be determined from equation 2.

$$HHV = \frac{(\Delta T \cdot w) - e}{g} \quad (2)$$

Where HHV = Combustion heat

ΔT = heat increasing temperature ($^{\circ}C$)

w = 1,724.187 (Cal/ $^{\circ}C$)

e = combustion heat

correction factor

= 2.3 (cal/cm) x

combustion wire length (cm)

g = fuel sample weight (g)

The heating value of various ratios of green energy block (sludge :tapioca) were tested and the results is shown in figure 4.

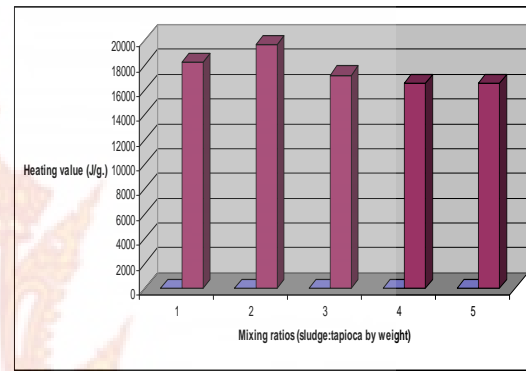


Fig4. The heating value of various ratios of green energy block (sludge :tapioca)

From the figure 4, the mixing ratios of sludge and tapioca 1,2,3,4 and 5 as 100:0, 95:5, 90:10, 85:15 and 80:10 respectively.

The maximum heating value by Bomb Calorimeter was about 19,638 J/g from the ratio of green energy block was 95:5(sludge : tapioca by weight).

4. Conclusions

The use of sludge from paper mill waste water treatment plant as a bio-waste fuel for energy production have been tested all important energy characteristics in laboratory. The results of testing found low heating energy value and high moisture contents that have been effected to the capacity of burning efficiency. To

develop the paper mill waste as a bio-energy should be comprising:

Co-fired with fuels having higher heating values such as saw dust, used paper, bark, wood residues and the other material residues that contains high cellulose.

Various binders should be tested for mixing green energy block such as sticky rice starch or molasses.

The size of green energy block should to have varied sizes and find the best size that can provide highest heating value from burning.

5. Acknowledgements

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