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Hydrothermal Treatment of Postconsumer Aseptic Packaging Material: Solid Fuel Production and Aluminum Recovery

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Abstract

In this study, Tetra Brik from Tetra Pak Company was used to produce solid fuel. Tetra Brik consists of paper, LDPE, and Aluminum arranged in 6 different layers. Aluminum should be recovered to obtain high-quality solid fuel. Hydrothermal treatment was used to separate aluminum from the solid fuel. Temperature and time were controlled and observed to get the best result. The temperature was varied between 200 °C and 240 °C, while time was ranged from 0 and 60 minutes. The result showed that composite of aluminum and LDPE was formed in the process, and full separation occurred in the experiment other than 200 °C in 0 minutes. Ultimate and Proximate analysis were done to understand solid fuel characteristic. As the temperature and time got higher, the calorific value also increase.

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Keywords: hydrothermal, solid fuel, tetra pak, recycling

1. Introduction

As one of the largest food packaging company on the planet earth, Tetra Pak has served more than 175 countries and produced around 180 billion packs annually, means that almost all inhabitant area in the world whether rural or urban region have this product. The arrangement of paper, LDPE, and aluminum form an aseptic environment and gives protection for the food inside and prolong the lifetime of the product. Despite those advantages of Tetra Pak, their rapid production leads to the rise of their post-consumer product. Less than 25% of their product are recycled every year [1]. The problem is no ordinary machinery could separate the paper, LDPE, and aluminum thus makes it hard to recycle.

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For the one-liter package, the weight is only 28 grams although consist of 6 layers. From outside to inside, the first layer of Tetra Pak is LDPE, which is used to protect the printed brand and information and to abide from damp and bacteria. The second layer is paper, primary material of Tetra Pak, which gives support and rugged structure to the packaging, and media to print the brand and information of the product. The third layer is thin polyethylene to bond paper and aluminum. The fourth layer is aluminum, which gives protection against UV rays, oxygen, odor and bacteria. It also helps to preserve the temperature of the product. The fifth layer is another thin polyethylene to bind aluminum and inner LDPE. The last layer is LDPE to seal the product thoroughly and make sure there is no leak in the packaging. The high temperature was used to stick all of the layers together, which means no glue or adhesive is needed. The paper sheet did not have direct contact with liquid inside. Therefore, the quality of the paper will always as good as new [2].

Tetra Pak uses virgin fiber for the paper. In South America, Europe, Africa and Asia, they used the unbleached duplex board from sulfate pulp. Occupying over 70% of the whole packaging, those fibers is an excellent source of solid fuel as they possess the quality of virgin wood [3].

As the global energy demand rises, the needs of alternative fuels also increase. Biomass has been one of potential renewable energy sources. Hydrothermal Treatment is a process utilizing steam under high pressure and temperature to destroy biomass chain to become a product with high calorific value. Hydrothermal Treatment possesses wide scalability range from the portable reactor into power plant size reactor, makes it easier to use this treatment to process material according to user's needs. Hydrothermal treatment gives advantages to converting biomass into solid fuel by avoiding an energy -extensive drying process, high conversion efficiency and relatively low operation temperature compare to other thermal methods [4,5]. Hydrothermal treatment is also applicable to process inorganic waste such as plastic, fabric, and rubber. On poly-vinyl-chloride (PVC), about 96 % of its inorganic chlorine could be reduced in the washing process after hydrothermally treated at temperature 255 °C [6].

The research on Hydrothermal Treatment of Tetra Brik Postconsumer wastes to produce solid fuel has not been conducting yet. Most studies focused on separation of paper, aluminum and LDPE using hydropulper which produces paper fibers and composite of polyethylene and aluminum. The composite then goes to separation process again using an organic solvent. Those processes take a long time and require chemical [2,3,7,8]. By this study, alternatives on processing Tetra Brik waste is given. The aim of this work is to produce high-quality solid fuel and separate the material in each layer of Tetra Brik product. This work will focus on characterization of product from Hydrothermal Process using ultimate and proximate analysis to understand the potential as a solid fuel source.

2. Experimental

Tetra Brik sample employed in this work was obtained from Tetra Pak Japan. Tetra Pak Japan collects Tetra Pak waste from municipalities to be recycled in their plant. The sample was received in open and clean condition. The sample then chipped into about 1cm2 using scissors then dried overnight.

Hydrothermal Treatment was carried out in lab scale reactor series MMJ-500 made by OM Lab-tech Co., Ltd., Japan. The reactor vessel is made of glass with 500 ml of volume capacity. Motor stirrer, pressure gauge, and PID Temperature Controller was equipped in the reactor.

9 grams of solid samples mixed with 81 grams of distilled water was constantly used for all experiment The reactor was sealed, purged with argon, then heated to 200-240 C by the electric heater for 0-60 minutes. The pressure was not controlled but monitored from pressure gauge. The motor stirrer was set at 400 RPM.

After the reaction is finished and reactor cooled down to 80 C. The sample was discharged from the reactor to be dried at 105 C overnight. Dried sample contain two materials; hydrochar and composite of aluminum and polyethylene. Those materials could be separated easily because they are in different phase. After separation, the sample was stored in a sealed bag before characterization. The total of nine