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論 文 要 旨

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The demand for energy-efficient and environmentally sound municipal solid waste (MSW) processing has increased in developing countries. The thermochemical process offers a fast and reliable solution to reutilize or reduce the volume of MSW. Hydrothermal treatment comes as a novel technology for MSW treatment, which compatible with high moisture content feedstock. It involves the thermal degradation of MSW in pressurized water or steam, which promotes the disintegration of cellulosic and polymer materials. Recent advances have shown effective MSW conversion into homogenous solid hydrochar with higher energy density. The washing effect of hydrothermal treatment successfully removed alkali and chlorine content, which causes trouble in the combustor. There is also the possibility of activated carbon production since the surface area significantly increased after the treatment. An overview of the latest development of hydrothermal treatment in the field of post-consumer waste and MSW processing, with a focus on operating conditions and physicochemical characteristics of the hydrochar, will be presented.

Aseptic packaging carton waste was chosen to model the behavior of composite waste during hydrothermal treatment. Tetra Pak contains a layer of cellulose, plastic, and aluminum with a composition of 75%, 20%, and 5%, respectively. The experiment was done at the three different holding times between 0 and 60 min and temperatures between 200 and 240 ° C. A total of nine experiments were conducted to understand the effects of holding time and temperature on the quality of solid fuel and composites. The results showed that hydrothermal treatment could effectively produce hydrochar, which is comparable to lignite after the aluminum part is removed. The aluminum part formed composite with polyethylene and could be removed easily. The holding time and temperature had a positive influence on the results of the analyses. As the carbon content increased, the high heating value (HHV) also increased, whereas the ash content decreased accordingly. The highest calorific value was found at an operating temperature of 240 ° C and a holding time of 60 min. Hydrothermal treatment can increase the calorific value of biomass from a Tetra Pak by up to 25.22 MJ/kg, which is comparable to lignite and coal.

Two landfill sites in Indonesia, Jatibarang landfill (JL) and Piyungan landfill (PL). The potential uses for waste-to-energy (WtE) and recycling were observed. On average, the waste composition in both landfills was dominated by soil-like (SL) material. The SL materials in Jatibarang Landfill and Piyungan Landfill were 52.2% and 70.2%, respectively. The second most found materials are plastics (JL=26.7% and PL=18%), followed by organic materials (JL=18.3% and PL=10%). Material flow analysis (MFA), coupled with process modeling, was conducted to simulate the material cycle and energy balance of landfill mining project in both landfills. From WtE process modeling, the Jatibarang landfill produces more power and higher CO2-e compared to the Piyungan landfill. The MFA estimates the life span extended landfill site operation by 15 years for the Jatibarang landfill and nine years for the Piyungan landfill. Direct landfill waste utilization is difficult; thus, additional treatment is necessary.

We proposed a method to enhance the quality of combustible excavated waste in an energy recovery point of view using the hydrothermal treatment. Two-level factorial screening design was used to determine the effect of temperature, solid load, and holding time towards the properties of the solid products. The results show that temperature plays the most significant role in shifting the volatile and fixed carbon content. As we increase the working temperature, more volatiles converted into fixed carbon, resulting in higher calorific value. The highest HHV and carbon content was found in the operating condition of 220 ° C, 0.3 solid load, and 30 min holding time. The lowest ash content was obtained in the operating condition of 200 ° C, 0.5 solid load, and 0 min holding time. The washing effect was also found in the lower solid load where some metals were detected in the liquid residue. Though, the hydrochar still retains a high amount of ash (16.1%-30.5%) and is not suitable for solid fuel. Another utilization method should be investigated further

Leachate emitted from landfill sites contains high chemical oxygen demand form active organic compounds.

Utilization of hydrochar as an adsorbent could be an alternative uses of hydrochar besides solid fuel. The hydrochar was activated using steam and CO2 to modify the surface properties and improve the adsorption capacities. Steam activation produces char with BET surface area up to 96.8 m2/g. The preliminary test using Methylene Blue shows that there is a significant increase in adsorption capacity after steam activation from 71 mg MB / g adsorbent to 99.5 mg MB / g. Leachate from the Piyungan landfill was sampled and used in the COD removal experiment. COD in the leachate was reduced from 5071 mg/l to 3634 mg COD / g adsorbent with removal performance up to 36% using steam activated hydrothermally treated excavated waste.