A Study on Application of Hydrothermal Carbonization by Organic Waste Mixing and Energy Evaluation of Bio-coal as a Solid Fuel

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The demand for global energy is steadily increasing by advancement of industry. However, according to limited and shortage of fossil fuel energy, the securing of sustainable resources is recently becoming one of the biggest issues. In other words, the necessity of renewable energy is emerging. Food waste and sewage sludge, which are representative organic wastes, are matters that can be mass-distributed and commercialized in a short period compared to other renewable energy. Under the London Protocol, all dumping of organic wastes is prohibited, therefore, should be effectively converted into resources.

According to 14 thesis are conducted in our lab (Table. 1), in general carbonizing sewage sludge and food waste to solid fuel, respectively, food waste has a high calorific value but contains a large amount of chlorine, also sewage sludge has a low calorific value but a high ash content (Kim, 2012). Therefore, in this study, food waste, sewage sludge, and paper sludge were mixed in the ratio to produce bio-coal, which was evaluated as a solid fuel by characteristics.

As a result, hydrothermal carbonization process is suitable for food waste and sewage sludge of high moisture content of 80%. Also, the contents of heavy metals are satisfied with the standard of the Waste Management Act. The result of analysis of bio-coal, fixed carbon is 22.4%, and volatile matter is 66% showed the highest value in bio-coal of 100% food waste. As the mixing ratio of sewage sludge increased, fixed carbon and volatile contents gradually decreased, and ash content increased. As a result of calorific value measurement, bio-coal of 100% food waste was highest at 6,510kcal/kg and bio-coal of 100% sewage sludge was lowest at 3,260kcal/kg. As the mixing ratio of sewage sludge increased, the calorific value and volatile content decreased, but fuel ratio analysis showed that the fuel quality increased.

Through van krevelen diagram and fuel ratio analysis, the coal band was refined as mixing ratio of food waste increased, and the H/C ratio decreased deriving a fuel ratio close to the C-H-O ratio of coal species. As a result of industrial analysis of bio-coal 100% of its food waste, it showed the highest volatile and fixed carbon contents. Ash composition such as 100% of its sewage sludge and paper sludge were derived 41.14% and 46.49%,

respectively. In bio-coal according to mixing ratio, as the mixing ratio of food waste increased, the volatile and fixed carbon content increased, and the ash content decreased.

The elemental analysis results, as the mixing ratio of food waste increased, the content of carbon and hydrogen increased, and the content of oxygen decreased. High values of mixing ratio of food waste, was achieved high content of the volatile and fixed carbon, which increases the carbon content. Also the fuel characteristics are expected to improve owing to decrease in oxygen content and the increase in hydrogen content. In case of mixed bio-coal of sewage sludge and food waste, satisfied the calorific value (the solid fuel standard of 3,000 kcal/kg) was shown at all ratios regardless of the mixing ratio. Mixed bio-coal (paper sludge and food waste) satisfied the solid fuel standard of 3,000 kcal/kg only for less than 70% of the paper sludge mixed.

The TGA results showed that as increased the mixing ratio of food waste, the weight of bio-coal decreased between 180°C and 500°C. As stated by these results, ash was decreased as the mixing ratio of food waste increased. It is considered that the calorific value and combustion characteristics are improved by increasing the high volatile content and fixed carbon content. Paper sludge was found to have a high ash content of about 50% and a low heating value and fuel cost, so it was not suitable to use it as fuel, but in the case of sewage sludge, the heating value increased due to the increase in fixed carbon content (Kim, 2017).

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