Clean Solid Biofuel Production from High Moisture Content Biomass Waste by Employing Hydrothermal Treatment Technology

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Reducing the dependence on fossil fuel is a common social challenge all over the world. Biomass is unique among renewable energy sources because it can be used to produce solid and liquid fuels with conventional conversion pathways in chemical industries. Wet biomass (organic waste and sewage sludge) is a partially unutilized resource with very low fuel price, if not zero or negative, in the market. However, such biomass is hard to utilize due to high moisture and ash content as well as low density. Hydrothermal treatment technology (HTT) is an efficient pretreatment technology for solid biomass wastes to increase density and heating value and to decrease moisture content which employs saturated steam as a media for the different degrees of hydrolysis as well as mechanical destruction of cell walls. The treatment begins by loading raw material into a reactor, followed by steam injection into the reactor. Mixing is then conducted by a stirrer in the reactor, while maintaining the temperature and pressure.

In this study, HTT processes of typical biomass wastes (municipal solid waste (MSW), sewage sludge (SS), and rice straw (RS)) were carried out for biomass hydrochar preparation using 3 L hydrothermal reactor. MSW was composed of chicken meat, wood waste, bread, cheese, and plastics, which was the common waste components in Japan. Moisture content in MSW, SS, and rice straw were around 20 wt.%, 80 wt.%,15 wt.%, respectively. Effects of varied holding time (5min, 15min, 30min) and different final temperatures (160 oC, 180 oC, 200 oC, 220 oC, 240 oC) on HTT processes and the corresponding solid fuel characters were compared MSW. The results showed that feedstock type, reactor pressure and holding time at the target temperature are three key factors affecting the solid solubility and dewatering efficiency after HTT process. Solid solubility for all the feedstock increased with HTT pressure and holding time, which was not favorable for realizing high sold fuel yield. The lowest temperature and pressure conditions for the powdered fuel production from MSW and RS were 200 oC and 1.4 MPa, and 220 oC and 2.4 MPa, respectively, while HTT of SS could produce powdered solid even at low temperature and pressure of 160 oC, 0.7 MPa. It is noted that the dewatering efficiency by using vacuum filtration system of SS decreased dramatically with decreasing HTT temperature, and showed worst at 160 oC (240 oC ~220 oC＞200 oC~180 oC＞160 oC). Moreover, biochemical oxygen demand (BOD) and chemical oxygen demand (COD) of waste water after HTT all increased with increasing HTT temperature for all the feedstock, while the liquid PH after the HTT process and the reactivity and the lower heating value of solid fuel showed opposite trends. In conclusion, considering the solid fuel characters and HTT process efficiency, the optimal powdered HTT products formed at 200 oC and 1.4 MPa, 180 oC and 1.1 MPa, and 220 oC and 2.4 MPa for MSW, SS, and RS, respectively.

Keywords: *Hydrothermal treatment; biomass wastes; solid fuel*