

Energy Conversion for Sewage Sludge by Microwave Heating Pyrolysis and Gasification

Authors : Young Nam Chun, Soo Hyuk Yun, Byeol Ri Jeong

Abstract : The recent gradual increase in the energy demand is mostly met by fossil fuel, but the research on and development of new alternative energy sources is drawing much attention due to the limited fossil fuel supply and the greenhouse gas problem. Biomass is an eco-friendly renewable energy that can achieve carbon neutrality. The conversion of the biomass sludge wastes discharged from a wastewater treatment plant to clean energy is an important green energy technology in an eco-friendly way. In this NRF study, a new type of microwave thermal treatment was developed to apply the biomass-CCS technology to sludge wastes. For this, the microwave dielectric heating characteristics were examined to investigate the energy conversion mechanism for the combined drying-pyrolysis/gasification of the dewatered wet sludge. The carbon dioxide gasification was tested using the CO₂ captured from the pre-combustion capture process. In addition, the results of the pyrolysis and gasification test with the wet sludge were analyzed to compare the microwave energy conversion results with the results of the use of the conventional heating method. Gas was the largest component of the product of both pyrolysis and gasification, followed by sludge char and tar. In pyrolysis, the main components of the producer gas were hydrogen and carbon monoxide, and there were some methane and hydrocarbons. In gasification, however, the amount of carbon monoxide was greater than that of hydrogen. In microwave gasification, a large amount of heavy tar was produced. The largest amount of benzene among light tar was produced in both pyrolysis and gasification. NH₃ and HCN which are the precursors of NO_x, generated as well. In microwave heating, the sludge char had a smooth surface, like that of glass, and in the conventional heating method with an electric furnace, deep cracks were observed in the sludge char. This indicates that the gas obtained from the microwave pyrolysis and gasification of wet sewage sludge can be used as fuel, but the heavy tar and NO_x precursors in the gas must be treated. Sludge char can be used as solid fuel or as a tar reduction adsorbent in the process if necessary. This work supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (No. 2015R1R1A2A2A03003044).

Keywords : microwave heating, pyrolysis gasification, precombustion CCS, sewage sludge, biomass energy

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