Abstract

Hydrothermal carbonization (HTC) is recognized as an energy-saving thermochemical conversion method that increases the dewatering capacity of sewage sludge and allows it to be converted into economically valuable products. This process helps reduce the amount of sewage sludge waste produced and stored by converting it into less hazardous forms.

In this study, selected sewage sludge after the dewatering process was tested under HTC conditions. Sewage sludge samples were collected from the Municipal Sewage Treatment Plant in Aarhus, Denmark, and the Janówek Municipal Sewage Treatment Plant, located in Wrocław (3 types of sludge from Denmark and one from Poland). Sewage sludge samples, classified as primary, secondary, and anaerobic digested material, were subjected to hydrothermal carbonization (HTC) under various process conditions in a 450 mL reactor. The tests were carried out for temperatures of 180, 200, 250, and 300 ^{0}C and residence times of 5 minutes and 1 hour. The obtained research results showed the great importance of selecting the HTC process conditions for various source materials to optimize energy recovery (in the form of hydrocarbon or syngas) while considering the economic and environmental elements of the process. The gas phase produced in the HTC process consists mainly of CO2, but the solid product of the process is characterized by a higher calorific value, improved grindability, and hydrophobic properties compared to the feed material. The hydrochar obtained after dehydration and drying was used in the plasma gasification process. For this purpose, a Stanowski laboratory was built with a fixed bed plasma gasification reactor with a length of 125 mm, an internal diameter of 50 mm, and an external diameter of 65 mm. The products obtained after the plasma gasification process were synthesis gas and plasma ash. The resulting ash was also processed into new, valuable products in the form of tiles that can be used in construction.