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Optimization of Thermochemical Conversion Feedstock Parameters for an Integrated Waste (Bio)refinery

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Waste generation is a growing environmental problem that requires ideas and new research for its solution. Energy and material recovery are suitable for mixed waste, which cannot be recycled easily. To increase the total conversion and efficiency of mixed waste processing, it is necessary to integrate several waste treatment methods, creating an integrated waste (bio)refinery. Thermochemical conversion unit, i.e. gasification process, is an integral part of such (bio)refinery. Gasification unit is suitable mainly for processing of residual waste streams with low moisture content and high calorific value, such as refuse-derived fuel (RDF) or lignocellulosic biomass. Feedstock for the gasification in an integrated waste (bio)refinery contains a mixture of waste types combined with the waste streams from different processing units in the (bio)refinery. The main challenge in processing such feedstock is its always changing composition, which implies the changing properties of products and operating conditions. Therefore, this work investigates optimization methods to achieve constant parameters for the mixed gasification feedstock. This is done by changing the ratios of different components in the feedstock. Feedstock for gasification in an integrated waste (bio)refinery typically consists of RDFs from municipal solid waste and mixed plastic waste, lignocellulosic biomass, solid residue from biological waste treatment in the (bio)refinery (e.g. digestate from anaerobic digestion) and various waste streams generated in the (bio)refinery. The most important parameters of the mixed feedstock for thermochemical conversion, which have to be fixed, are heating value, moisture and ash content, concentrations of S, N and Cl contaminants and ratios between oxygen, hydrogen and carbon. Mathematical model was developed in MATLAB environment, which optimizes the amounts of lignocellulosic biomass and RDF from plastic waste in the mixed feedstock. It was confirmed that using this method it is possible to fix the parameters of the feedstock to desired values. This is very important to ensure the smooth operation of the gasification unit and production of the desired products.

Keywords: waste biorefinery; gasification; feedstock optimization

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