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Influence of waste feedstock composition on thermo-catalytic conversion products

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Waste generation has become a significant challenge, leading to environmental, health, and economic impacts. Waste streams that are unsuitable for material recycling can instead be utilized for energy and material recovery. Significant issue with treatment of the waste feedstocks is their heterogeneous composition, which varies on a daily basis. This work investigates effect of feedstock composition on the gasification product properties, with the aim to achieve constant product properties from feedstocks with variable composition. Feedstock samples containing different ratios of refuse derived fuel (RDF), anaerobic digestion digestate, lignocellulosic biomass (sawdust) and mixed plastics were prepared and pelletized. All the samples have similar key parameters (heating value, ash content, contaminant concentrations etc.), even though ratios of their components vary. Each sample was gasified in a continuous three-stage pyrolysis/split product reactor. In the first stage, pyrolysis took place in the screw reactor at 650°C. Pyrolysis char entered the second stage, where it was gasified at 800°C in the presence of air. Produced gas entered third stage, where catalytic cracking occurred at 850°C in the presence of 3 wt.% nickel on activated carbon catalyst. Distribution of the gasification products from different feedstocks was similar, while yield of produced gas was the highest among the products. Main components of the gas were H_2, CO, CO_2, CH_4 and C_2H_x hydrocarbon fraction, which resulted in gas with high heating value. Gas was contaminated with high amounts of tar despite the use of tar-cracking catalyst, as well as H_2S, COS and HCl originating from sulfur and chlorine present in feedstock. Solid product of the gasification (char) consisted of mainly ash and carbon. Yields of ash in this product were similar after gasification of different samples, meaning that variations in total char yield were caused by different carbon content. Overall product properties were similar to each other, even though they were produced by different feedstock samples. Achieving consistent product properties is important for waste treatment processes and ensures smooth operation of the gasification unit.

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