Direct steam cracking of heterogeneous plastic waste - a pathway to transform chemical clusters

Martin Seemann

Martin Seemann (Assoc. Prof.) Chalmers University of Technology, Department of Space, Earth and Environment, Division of Energy Technology, S-412 96 Göteborg

The heterogeneity of plastic waste is troublesome for many recycling technologies and meticulous sorting is applied to maintain homogeneous fractions with limited contents of contaminants for e.g. mechanical recycling or pyrolysis. To address the recyclability of such heterogeneous polymer mixtures a direct steam cracking process based on a fluid bed was developed in collaboration with chemical industries in Sweden. The 150kg/h pilot was tested with a variety of polymer rich wastes with the feedstock for those trials ranging from uncleaned food packaging and reject fractions of a mechanical recycling plant to non-hydrogenated pyrolysis oil. The product stream of the direct steam cracking unit is analyzed and compared to runs with pure polyethylene and actual naphtha. As the thermal conditions are similar to those of a traditional naphtha cracker (750-850 °C) the aliphatic structures of the plastic waste decompose in a similar manner leading to a comparable product mixture as the effluent from a naphtha cracker. Heteroatoms such like oxygen or chlorine are under the conditions applied transferred into removable species such as carbon dioxide and hydrogen chloride. In that way, direct steam cracking relies on sorting molecules similar to the traditional steam cracking of naphtha instead of excessive sorting of plastic waste. Implemented into a chemical cluster, a direct steam cracking unit for plastic waste can replace existing naphtha crackers and extend the flexibility of the site to feedstocks like polymeric waste but as well pyrolysis oils with a tendency to charring.

More information on the approach can be found under the open access links below:

https://doi.org/10.1016/j.fuel.2023.127660

https://doi.org/10.1016/j.fuproc.2023.108030