Methods for pre- and posttreatment of feedstocks for chemical recycling of plastic wastes – different methods and novel approaches

Fraunhofer UMSICHT

Abstract

Chemical recycling of plastic waste offers the advantage of complementing established mechanical recycling and of being able to produce high-quality recyclates from previously non-recyclable feedstocks. Therefore, especially the chemical recycling via pyrolysis gains increasing interest as it has the potential to reach ambitious political goals towards a circular plastics economy. The most generic approach in the field of the chemical recycling of plastic waste is producing steam cracker feasible feedstocks from low quality wastes. This pathway has not yet been demonstrated in commercially viable plants, and it remains questionable whether this route is economically and ecologically sustainable. However, the mentioned contaminants (e.g. chlorine, bromine, nitrogen and oxygen) are undesired in petrochemical processing and therefore need to be reduced to achieve specific limiting values of steam-crackers. The crude oils from the pyrolysis of mixed packaging plastics generally exceed the limit values for contaminants such as chlorine and bromine for use in steam crackers. These and several other contaminants enter the oil via PVC and flame retardants, but in the case of chlorine also via food residues as for phosphorus. In the cracker, they lead to corrosion, catalyst damage and the formation of undesirable halogenated hydrocarbons. In addition to aliphatic compounds, pyrolysis oils from plastics also contain a wide range of aromatic compounds, which can lead to coke formation and fouling in heat exchangers of steam crackers. To keep contaminants such as chlorine and bromine out of the pyrolysis oil, upstream and downstream approaches can be selected. Upstream, a significant reduction in the chlorine concentration can already be achieved through mechanical processing and sorting out of PVC, for example. Downstream, one option to remove chlorine and bromine and other heteroatomic contaminants is filtration and fractional distillation. Subsequent hydrotreatment constitutes another powerful approach to remove heteroatoms from pyrolysis oils. Several investigations showed that pyrolysis oils from mixed plastic waste contain a variety of heteroatomic compounds that influence the individual hydrotreatment steps and can partially inhibit the removal efficiency of each other. A selective removal of single contaminants is therefore challenging.

This contribution will cover different examples of pre- and posttreatment methods for the upgrading of pyrolysis oil from different origins. A novel method for the auto-catalytic reforming of pyrolysis oils from plastic packaging waste sorting residues developed by Fraunhofer UMSICHT will be presented.