# Plastic pyrolysis: an experimental study on the circularity of organic-rich fraction from mechanical recycling of refrigerators

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Chemical recycling of plastic waste through pyrolysis is an essential option for closing the carbon cycle and contributing to a circular economy. Complementary to the existing collection and mechanical sorting systems, pyrolysis can achieve higher product quality and avoid the downgrading effects of stand-alone mechanical recycling technologies. Under atmospheric pressure and an inert atmosphere, pyrolysis is a thermochemical process in which plastic waste is converted to three product fractions: gases, condensate and solids. Depending on the polymer types, their composition in the starting material, and pre- and post-treatment, the gaseous product and condensate can be used in petrochemical processes to produce new plastics.

The present talk provides an overview of the experimental research platform regarding the chemical recycling of plastics with the pyrolysis technology at the Institute of Technical Chemistry (ITC) at KIT, with an exemplary objective to chemically recycle the organic fraction of shredded refrigerators. The composition of the plastic waste, including a variety of different plastic types and additives, impacts the quality of the pyrolysis products. This is the case for flame retardants added to polymers to satisfy strict fire safety requirements, of which halogenated flame retardants constitute a large share. Therefore, heteroatom contamination is a highlighted issue in chemical recycling and has to be investigated for each specific mixed plastic waste under pyrolysis conditions. With corresponding pre and post processes, it is possible to separate a large fraction of contaminants from the products.

The exemplary research is being carried out within a collaborative research framework with the Helmholtz Institute Freiberg for Resource Technology (HIF). The Helmholtz Institute Freiberg has shredded 100 refrigerators in a representative study to define and optimize recycling from household appliances using conventional mechanical recycling. The organic-rich fraction, which is considered a suitable feedstock for pyrolysis, was obtained after the removal of metallic components (steel, copper, aluminium) as well as light materials (e.g. from Polyurethane-based isolation materials).

Through the pyrolysis of about 15 kg of this feedstock, the mass balance of the three conventional product fractions was measured and closed with satisfactory results. Subsequently, the product fractions were analyzed for impurities and suitable measures for their removal were evaluated. Within the collaboration, the results of the pyrolysis product will be compared with quantitative analysis of input material and its polymer types using the continuous conveyor belt equipped with various online sensor systems developed at the Helmholtz Institute Freiberg.