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Contaminant effects in end-of-life plastics waste pyrolysis and subsequent steam cracking

Aim

The assessment of the effect of end-of-life plastic contaminants on the composition of the resulting plastic pyrolyzates using various analytic techniques. The steam cracking potential of the pyrolyzates will be investigated using advanced simulation.

Justification

Plastic waste recycling plays a key role in the transition towards a circular economy due to plastics' energy and material intensive production, their abundant use and their long lifetime as a pollutant. Post-consumer plastic waste is a mixture of several different polymers such as Polyethylene (PE), Polypropylene (PP), Polystyrene (PS), Polyvinylchloride (PVC) and Polyethyleneterephthalate (PET) including a number of additives such as flame retardants, stabilizers and colorants. Since mechanical recycling holds certain limitations regarding feedstock purity and re-use of materials, thermochemical decomposition of plastic waste into chemical feedstocks presents a promising technology towards a circular economy. However, contaminants such as metals and other heteroatoms may lead to severe issues in the subsequent process steps towards chemical feedstocks such as ethylene and propylene via steam cracking. Problems such as corrosion, catalyst poisoning or fouling may occur.
In this study, the composition of post-consumer plastic waste pyrolyzates and virgin plastic pyrolyzates will be compared in order to assess the effect of contaminants. For this, pyrolysis experiments will be performed at the pilot pyrolysis setup at LCT. Subsequently, products will be analyzed using analytical techniques such as comprehensive two dimensional GC×GC-FID,-ToF-MS, elemental analysis (CHNSO) or ICP-OES/MS. The obtained data will be compared with special emphasis on the fate of contaminants. By this, contaminants present in post-consumer plastic waste can be tracked and identified. The obtained knowledge may be used to identify upgrading methods to produce high-quality feedstocks for the production of light olefins from plastic waste via steam cracking.

Program

- Literature study: upgrading of plastic pyrolyzates to reach industrial quality standards
  - Hydrotreatment
  - Distillation
  - Removal of metals
- Pyrolysis experiments:
  - Mixed virgin plastics simulation the composition found in post-consumer plastic waste samples (such as PE-foils, PP/PE mix)
  - Post-consumer plastic waste streams under the same conditions
- Analysis of the obtained pyrolyzates using GC×GC-FID,-TOF-MS, elemental analysis (CHNSO) or ICP-OES/MS with special emphasis on contaminants such as metals and heteroatoms (N, S, O, Cl)
- Estimating the potential of the pyrolyzates for olefin production via steam cracking by Simulation using COILSIM1D