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Light olefins production via steam cracking of plastic-waste pyrolysis oils: Experimental and modeling study

Aim

This master thesis aims to investigate the steam cracking of pyrolysis oils derived from circular feedstocks, specifically plastic waste, through a combination of experimental and modeling techniques.

Justification

The demand for plastics continues to rise, necessitating a shift from the current open-ended use to a more sustainable closed-loop approach. Despite this, only 10% of plastic is currently recycled globally, leaving the majority as waste, either ending up in landfills, being incinerated, or polluting the environment.

Thermochemical recycling of plastic waste to light olefins through consecutive pyrolysis and steam cracking of pyrolysis oils is a promising technology adopted by industry leaders such as Shell, BP, Total-Energies, SABIC, and ExxonMobil. However, the complex nature of pyrolysis oils, including contaminants, hinders their direct use in steam crackers. Hence, pyrolysis oils require thorough treatment via upgrading techniques to produce naphtha-like feedstocks, necessitating a profound understanding of the components that need treatment.

Within this thesis project, a comprehensive study will be conducted, integrating experimental and modeling approaches, on the steam cracking of pyrolysis oils derived from plastic waste. Key components of pyrolysis oils and their impact on the steam cracking process will be investigated, and product yields and coke formation will be analyzed using the bench-scale steam cracking (BBSC) setup at LCT. Comprehensive analytical techniques will be applied to examine pyrolysis oils and steam-cracking products. The study will conclude by modeling the results obtained from the BBSC setup for a more nuanced interpretation.

Program

- **Literature study:**
  - Key contaminants in pyrolysis oil and their impact on the steam cracking.
  - Applicable upgrading and decontamination techniques.
  - Valorization of waste-derived Py-oils.
  - Kinetics of product yield distribution and coke formation in steam cracking.
- **Analytical Techniques:**
  - Utilization of GC × GC techniques for analyzing pyrolysis oil and the online effluents of steam cracking.
- **Experimental Phase:**
  - Optimization of conditions for the steam cracking of pyrolysis oil.
  - Assessment of coke formation.
- **Modeling Phase:**
  - Simulation using COILSIM1D for steam cracking of pyrolysis oil.
  - Modeling for the coking tendency in the steam cracking of pyrolysis oil.