

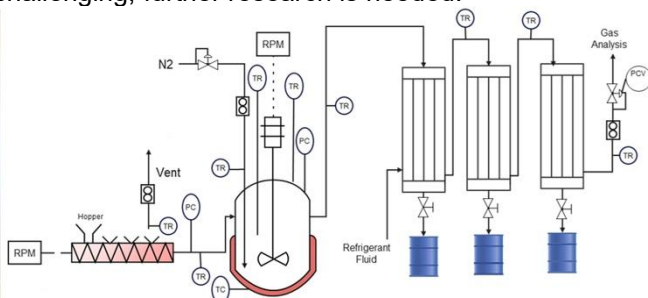
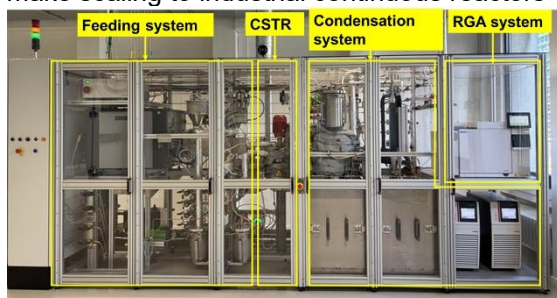
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Mapping the Molecular Complexity of Plastic Waste Pyrolysis Products Through Experimental Investigation

Aim: To investigate the influence of feedstock composition and pyrolysis temperature on the pyrolysis product distribution with a pilot scale continuous pyrolysis unit.

Justification

Global plastic waste generation reached approximately 225 million tons in 2025 and continues to increase, posing major environmental and resource management challenges [1]. Plastic waste consists of diverse polymers, particularly polyolefins (HDPE, LDPE, and PP). These materials contain additives and contaminants that produce heteroatom-containing compounds during processing, and limit the direct use of recycled products in petrochemical applications. Thermochemical recycling technologies offer a promising alternative by converting plastic waste into valuable hydrocarbons. Pyrolysis is performed at temperatures ranging from 400 to 600 °C in an oxygen-free environment, producing oil, gas, and char. Product distribution depends strongly on process parameters such as temperature, residence time, and feedstock composition. Since the complex gas-liquid reaction dynamics of pyrolysis make scaling to industrial continuous reactors challenging, further research is needed.



This study aims to evaluate how feedstock composition and operating temperature influence product distribution and contaminant transfer during thermal pyrolysis. Simulated post-consumer plastic mixtures will be prepared and assessed for their processability in a pilot-scale pyrolysis system. Experiments will be conducted in the RQChem unit equipped with a continuous feeding system (extruder) and a continuous stirred-tank reactor (CSTR). Heavy and light oil fractions will be collected through a condensation system, while non-condensable gases will be analyzed online using a refinery gas analyzer. Pyrolysis oils will be characterized using comprehensive two-dimensional gas chromatography coupled with flame ionization detection and time-of-flight mass spectrometry. Ultimately, this research will contribute to optimizing pyrolysis by improving the understanding of how compositional variability influences the development of scaling-up continuous reactors.

Program

1. Literature review on the thermal pyrolysis of plastic wastes over different process parameters.
2. Performing feedstock characterization techniques to determine thermal (TGA/DTG, DSC) and physicochemical (proximate and ultimate analysis, FTIR, ICP-OES, CIC) properties.
3. Thermal pyrolysis experiments of plastic mixtures at various temperatures at the RQChem unit.
4. The detailed characterization of the noncondensable pyrolysis gases with an online refinery gas analyzer (RGA) and pyrolysis oils by using a GC x GC-FID/TOF MS unit.

[1] Plastic Overshoot Day – Report 2025, EA-Earth Action, 2025.