Plastic Pyrolysis Enthalpy and Valorization

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Motivation and Background

![Pyrolytic Shaker Reactor Diagram](image)

Figure 1: Plastic value chain and expected changes toward circularity (Volmer et al., 2020).

Objectives

Develop carbon-neutral technologies for plastic waste thermal recycling.
- Study pyrolysis of plastic films in Pyrolytic Shaker Reactor (PSR) at moderate temperatures (<550 °C)
- Valorize liquid and wax products
- Valorize products gases by catalyzed conversion to solid carbon and hydrogen gas.

Reference (for Figure 1)

Equipment

![Pyrolytic Shaker Reactor Diagram](image)

Methodology

- Ziploc bags as example of low-density polyethylene (LDPE) films.
- Measure yields of oil (including wax) at various temperatures
- Batch and continuous runs performed.

Enthalpy:
- Measure reactor power needed for constant temperature while injecting:
  - water, or
  - kerosene, or
  - Slurry of plastic particles in kerosene/toluene.
- Calculate Ziploc pyrolysis energy needs.

Results

![Graph](image)

Figure 3: Batch pyrolysis oil yields. 56 wt% by 500 °C, 56.1% final. Continuous pyrolysis at 500 °C gave 43.5 wt% oil yield.

Figure 4: New calibrations at 500 °C, heat losses predominate.

Conclusions

- Initial experiments calculated Ziploc bags required 590 kJ/kg to go from 16 °C to product vapors at 500 °C.
- Negligible solid residue found.
- More measurements of pyrolysis energy needs and gas yields.
- Continuous pyrolysis at different temperatures.

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