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Co-pyrolysis of PVC and PE for synergistic production of fuels and chemicals: Effect of thermal dechlorination

Aim

To investigate the effect of thermal dechlorination on PVC pyrolysis with the micro-pyrolyzer facility. To study the co-pyrolysis of raw/dechlorinated PVC and PE to better understand the synergistic effect.

Justification

The global plastic waste was ~6.3 billion tons in 2015 and is scheduled to 40 billion tons in 2050 [1]. The common plastic waste mainly include polyethylene (PE), polystyrene (PS), polyvinyl chloride (PVC), etc. Pyrolysis is considered as a high technology readiness level method that can convert plastic waste into high-value products, which shows both environmental and economic benefits. However, PVC with high Cl content contributes 80% organic Cl and 50% total Cl in municipal solid waste, resulting in the PVC pyrolysis to be an intractable issue. It is urgent to develop the novel pyrolysis technology coupled with dechlorination process for PVC upcycling. On the other hand, HCl that formed from PVC pyrolysis may have some catalytic effect during co-pyrolysis. The synergistic effect was observed for co-pyrolysis of PVC and biomass, such as the HCl-catalyzed dehydration of anhydrosugars [2]. Whereas the co-pyrolysis of PVC and PE is rarely reported in literature. It is very significant to clarify the autocatalytic or synergistic effect during co-pyrolysis of plastic mixtures.

PVC pyrolysis can be divided into two stages. The dechlorination usually occurs in the first stage, and two-stage pyrolysis of PVC was proposed in literature [3]. The Cl-containing long-chain hydrocarbon radicals can fracture to form Cl-containing short-chain or aromatics through different pathways, such as radical reaction or Diels-Alder reaction [4]. The reactive HCl is also the key for synergistic effect during co-pyrolysis, which would affect the final product distribution. PVC pyrolysis and thermal dechlorination have been reported in the literature [4,5], yet detailed online analysis of pyrolysis products was limited. Besides, co-pyrolysis of PVC and PE with the consideration of thermal dechlorination was not intensively investigated. The micro-pyrolyzer facility combined with comprehensive two-dimensional gas chromatography with flame ionization detector and time-of-flight mass spectrometer (GC×GC-FID/TOF-MS) allows online qualitative and quantitative analysis of pyrolysis products. This project aims to investigate the co-pyrolysis of raw/dechlorinated PVC and PE in miro-pyrolyzer to better understand the fate of Cl evolution during PVC pyrolysis and the synergistic effect during co-pyrolysis.

Program

1. Literature review on PVC pyrolysis and co-pyrolysis.
2. Online characterize the pyrolysis volatiles of PVC using micro-pyrolyzer.
3. Investigate the effect of thermal dechlorination on PVC pyrolysis.
4. Study the synergistic effect during PVC and PE co-pyrolysis.

References

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