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Influence of Heteroatom-Containing Contaminants in Polyolefin Waste Streams on Catalytic Pyrolysis

Aim

To investigate the influence of contaminants—PET, EVAH, PLA, and PVC—on product selectivity and catalyst stability during catalytic cracking of plastic waste pyrolysis vapors over phosphorus modified mesoporous HZSM-5.

Justification

The escalating plastic waste crisis demands immediate advancements in efficient recycling methods. Polyolefins, including polypropylene (PP) and polyethylene (PE), constitute a significant portion of municipal solid waste, underscoring the urgency of polyolefin recycling for sustainable chemical practices and circular economy promotion. Catalytic pyrolysis shows promise in selectively converting polyolefins into valuable light olefins (C_2-C_4), but successful implementation relies on factors like pyrolysis temperature, catalyst type, feedstock composition, and catalyst-vapor contact time. Prior researches have shown the effectiveness of phosphorus-modified ZSM-5 catalysts (P-mesoHZSM-5) in enhancing light olefin selectivity and resisting coking during polyethylene (PE) and mixed polyolefinic waste pyrolysis. However, their susceptibility to corrosive contaminants like PVC remains unexplored, as does the broader impact of heteroatom-containing contaminants on polyolefin waste pyrolysis.

This thesis aims to investigate the influence of common contaminants in plastic waste streams—such as PET, EVAH, PLA, and PVC—on product selectivity and catalyst stability during catalytic cracking of plastic waste pyrolysis vapors over P-mesoHZSM-5. Experiments will involve preparing PE and PP mixtures with varying contaminant levels and performing pyrolysis tests using a tandem micro-pyrolyzer unit coupled with comprehensive two-dimensional gas chromatography with flame ionization detection and time-of-flight mass spectrometry (GC x GC-FID/TOF MS). This analytical approach allows for real-time qualitative and quantitative analysis of pyrolysis products, facilitating a deeper understanding of cracking mechanisms and potential synergistic effects between contaminants and polyolefins, offering crucial insights into advancing sustainable polyolefin recycling technologies.

Program

1. Literature review on the effects of PET, EVAH, PLA, and PVC contamination on catalytic polyolefin pyrolysis.
2. Experimental investigation of the pyrolysis characteristics of PE and PP mixtures with varying contaminant compositions (PET/EVAH/PLA/PVC).
3. Synthesis of phosphorous modified mesoporous HZSM-5 catalyst and performing catalyst characterization techniques.

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