

DEVELOPMENT OF EFFECTIVE HETEROGENEOUS CATALYTIC PROCESS FOR CHEMICAL RECYCLING TECHNOLOGY FOR POLYETHYLENE

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Zoom: <https://udel.zoom.us/j/97676519842>, Password: recycle

Plastic chemical recycling is a critical technology for transforming plastics waste into valuable chemical products while reducing the accumulation of those wastes in the environment. Polyethylene (PE) accounts for the largest proportion of the global annual plastics waste stream, and it is a challenge in chemical recycling because of highly stable backbone C-C bonds. The research described in this thesis aims to develop innovative chemical recycling processes that can effectively activate the polymer's inert C-C bonds via two approaches.

The first approach investigates the *catalytic alkane metathesis process* for upgrading low-density PE (LDPE). Supported tungsten oxide was chosen as an olefin metathesis catalyst because its high-thermal stability enabled operating the alkane metathesis reactions at temperatures at which reaction kinetics were most favorable. A new batch reactor configuration was devised, implemented, and evaluated, and it was discovered that zeolite 4A, an adsorbent, was very influential in activating the tungsten oxide catalyst. The alkane metathesis reaction conducted between *n*-decane and LDPE (Mw ~ 75 kDa) at 300 °C can be run efficiently at short reaction times, significantly reducing the average molecular weight of the solid wax product and mass of solvent, which was distinguished compared to the results obtained from other catalytic systems using rhenium oxide metathesis catalyst at ~200°C. A parametric study conducted with the model reactions revealed that the type of zeolite-A and the nitrogen pressure could be used to improve the initial results for the alkane metathesis upgrading of PE.

The second approach investigates the *catalytic cracking* of LDPE over zeolite catalysts as a potential chemical recycling technology. An in-house-built semi-batch reactor was developed for this purpose. It was used to show that the thermal cracking of LDPE was consistent with results reported in the literature, thereby validating the operation of the semi-batch reactor. This reactor was used next to evaluate different materials for catalytic cracking: three zeolites (H/Al-Beta, H/Al-MCM-22, and H/Fe-Beta) having different Brønsted acid strength, Brønsted acid site density, zeolite topology, and morphology were used to compare the effects of these parameters on the catalytic results. H/Al-Beta catalyst showed the highest cracking reactivity among the three materials due to its strongest acid strength, whereas H/Fe-Beta showed the opposite trend because of the low acid strength and relative acid density. H/Al-MCM-22 resulted in intermediate reactivity due to its lower acid strength than H/Al-Beta.