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Efficient Depolymerization of Polyethylene terephthalate (PET) Using Bimetallic Catalysts

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Abstract : Polyethylene terephthalate (PET) recycling stands as a pivotal solution in combating plastic pollution and fostering a circular economy. This study addresses the catalytic glycolysis of PET, a key step in its recycling process, using synthesized catalysts. Our focus lies in elucidating the catalytic mechanism, optimizing reaction kinetics, and enhancing reactor design for efficient PET conversion. We synthesized anionic clays tailored for PET glycolysis and comprehensively characterized them using XRD, FT-IR, BET, DSC, and TGA techniques, confirming their suitability as catalysts. Through systematic parametric studies, we optimized reaction conditions to achieve complete PET conversion to bis hydroxy ethylene terephthalate (BHET) with over 75% yield within 2 hours at 200°C, employing a minimal catalyst concentration of 0.5%. These results underscore the catalysts' exceptional efficiency and sustainability, positioning them as frontrunners in catalyzing PET recycling processes. Furthermore, we demonstrated the recyclability of the obtained BHETs by repolymerizing them back to PET without the need for a catalyst. Heating the BHETs in a distillation unit facilitated their conversion back to PET, highlighting the closed-loop potential of our recycling approach. Our work embodies a significant leap in catalytic glycolysis kinetics, driven by sustainable catalysts, offering rapid and high-impact PET conversion while minimizing environmental footprint. This breakthrough not only sets new benchmarks for efficiency in PET recycling but also exemplifies the pivotal role of catalysis and reaction engineering in advancing sustainable materials management.

Keywords : polymer recycling, catalysis, circular economy, glycolysis
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