Chemical depolymerization of high- and low-density polyethylene using acid treatments and ozonation

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ABSTRACT

Economic depolymerization of polyolefins is largely limited to high temperature, energy intensive pyrolysis techniques. Achieving sustainable circularity for low-cost plastics requires inexpensive processes that are not energy intensive; two such promising candidates, acid treatment and ozonation, are investigated. These approaches are being investigated to create value-added products while minimizing the generation of carbon dioxide. The acid process utilizes a mixture of acids combined with a catalyst to oxidize high-density polyethylene (HDPE) to predominantly large molecular weight dicarboxylic acid products with acid numbers and mass yields ranging between 1.0-1.2 mmol/g and 70-110% (g product/g HDPE), respectively. The catalytic ozone technique processes low-density polyethylene (LDPE) to provide water-soluble dicarboxylic acids in yields up to 15% (g product carbon/ g LDPE carbon) and insoluble material at acid numbers averaging 2.4-4.8 mmol/g. Process optimization and the use of repeated stages can improve the carbon efficiency of these processes.