Designing an Approach for Recovering Energy From Waste Polyethylene Terephthalate (PET) Bottles and Fibers

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Polyethylene terephthalate (PET), a widely used plastic polymer presents significant environmental challenges due to its extensive production and disposal. In this study, we investigated the efficiency of thermal pyrolysis without a catalyst and hydrogenation over NiFe2O4 catalyst for converting PET plastic and fiber wastes into oil products. A nano ferrite catalyst was prepared using a co-precipitation mechanism with aqueous extracts of Nickel nitrate and iron chloride. PET plastic and fiber waste were collected and processed through hydrogenation and thermal pyrolysis. The hydrogenation process was carried out in high-pressure reactor temperatures of 470 Celsius with flushing and purging of hydrogen gas, while thermal pyrolysis was conducted for an hour at a temperature of 470 Celsius at nitrogen atmosphere. The oil products were analyzed using FT-IR and GC-MS, feedstock and char using FT-IR, and catalyst using XRD, TGA, magnetic measurements, and FT-IR. The hydrogenation of PET wastes produced a dark viscous oil in addition to char products, while thermal pyrolysis resulted in the formation of a solidified wax-like oil. The oil products from hydrogenation contained a higher proportion of useful chemical compounds such as ethers, aromatics, esters, and carboxylic acids, as revealed by GC-MS and FT-IR analyses. These products have higher stability and potential for further processing and utilization compared to those obtained from thermal pyrolysis. Thus, hydrogenation of PET waste using NiFe2O4 catalyst is a promising waste-to-energy approach to be implemented in PET waste management.