Catalytic Pyrolysis of Poly(ethylene terephthalate) in the Presence of Metal Oxides for Aromatic Hydrocarbon Recovery Using Tandem μ-Reactor-GC/MS

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Abstract:

Poly(ethylene terephthalate) (PET) pyrolysis products and those produced from their subsequent catalytic reactions under various metal oxides (ZnO, MgO, TiO_2, and ZrO_2) were evaluated qualitatively and semiquantitatively using a tandem μ-reactor gas chromatography–mass spectrometry (TR-GC/MS) system. The catalytic reaction products were analyzed *in situ* to determine the duration and temperature dependence of their production. In the TR-GC/MS, a reactor with two-tier, independent heat sources was linked directly to a GC/MS device. PET pyrolysis was carried out at 450 ºC, whereas the pyrolysis products were reacted in the presence of metal oxides at 700 ºC. ZnO, which has a high base strength, promoted decarboxylation of the principal pyrolysis products of benzoic acid and terephthalic acid (TPA) selectively and at a low temperature. The proportion of oil components made up by benzene was up to 88.8 area%. On the other hand, MgO, TiO_2, and ZrO_2 have lower base strengths than ZnO. Hence, their capabilities for benzoic acid and TPA decarboxylation were low, and carboxylation using these oxides required temperatures 50–70 ºC higher than that using ZnO. In summary, the present study found that benzene-rich aromatic hydrocarbons can be obtained by the catalytic pyrolysis of PET using various metal oxides and that the product composition depends on the acid–base properties of the metal oxides. These findings will help promote feedstock recycling to convert PET waste materials or mixed plastics that contain PET into raw chemical materials by pyrolysis.

Frontier Labs Products used:

Tandem μ-Reactor Rx-3050 TR, Ultra ALLOY⁺-1, UADTM