Catalytic co-pyrolysis of torrefied yellow poplar and high-density polyethylene using microporous HZSM-5 and mesoporous Al-MCM-41 catalysts

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Abstract:

The catalytic pyrolysis of lignocellulosic biomass with aluminosilicate catalysts is a promising method for the direct production of liquid hydrocarbon fuels consisting mainly of aromatic compounds (e.g., benzene, toluene, and xylenes). On the other hand, the economic and commercial viability of this process is limited by the low yields of aromatic hydrocarbons. In this study, the effects of biomass torrefaction, co-feeding of plastic wastes, their combination, and the catalytic upgrading mode (in-situ vs ex-situ) on the aromatic formation efficiency during the catalytic pyrolysis of yellow poplar were evaluated systematically to maximize the production of aromatic hydrocarbons. Two representative catalysts for catalytic pyrolysis (i.e., microporous HZSM-5 and mesoporous Al-MCM-41) were used in this case study. The torrefaction of yellow poplar led to the enhanced production of aromatic hydrocarbons in the catalytic co-pyrolysis of yellow poplar and high-density polyethylene over both catalysts. The experimental yields of aromatic hydrocarbons from the catalytic co-pyrolysis of torrefied yellow poplar and high-density polyethylene were also higher than their theoretical yields, highlighting the synergistic aromatic formation by the interaction of torrefied yellow poplar and high-density polyethylene. Between the two catalysts, microporous HZSM-5 exhibited much higher activity for aromatic production from catalytic co-pyrolysis owing to its strong acidity and appropriate pore structure. Compared to ex-situ catalytic co-pyrolysis, the in-situ catalytic co-pyrolysis of torrefied yellow poplar and high-density polyethylene produced larger amounts of aromatic hydrocarbons due to the more effective contact between the pyrolysis vapors and HZSM-5.

Frontier Labs Products used:

Tandem µ-Reactor (RX-3050TR)