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Management of Plastic Waste Through Pyrolysis: The Potential Environmental and Economic Benefits

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Abstract

We have highlighted the significance of the biomass-to-plastic ratio in the co-pyrolysis of waste plastics, which helps regulate the levels of aromatic compounds and oxygenated substances in hydrocarbon-rich fuels, ultimately enhancing engine performance. The study demonstrated that varying the biomass-to-plastic ratio can effectively influence the composition of aromatics. The resulting products were analyzed using various instrumental techniques, including NMR, FTIR, and GCMS, to identify the types of hydrocarbons present in the liquid product. The findings indicated a presence of carbon compounds ranging from C8 to C24, with a predominance of aromatic compounds, as confirmed by 1H NMR and FTIR analyses. The pyro-oils contained various hydrocarbons such as olefins, paraffins, aromatics, esters, and alcohols. Notably, the inclusion of biomass in the co-pyrolysis process resulted in oxygenated compounds comprising approximately 12.08% and enhanced the calorific value from 48.3 MJ/kg to 55.4 MJ/kg, attributed to the longer hydrocarbon chains of esters in the pyro-oil. Additionally, biomass co-pyrolysis improved fuel properties, achieving a pour point below -25°C and a 4°C increase in the flash point. Engine performance tests showed that blending biomass pyro-oil, specifically B25PS75, reduced fuel consumption and improved brake thermal efficiency (BTE).

Keywords: Waste Valorization; Waste Management; Pyrolysis; Economic Analysis