CO-PYROLYSIS OF EMPTY FRUIT BUNCH AND HIGH-DENSITY POLYETHYLENE FOR BIOFUEL PRODUCTION

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ABSTRACT

CO-PYROLYSIS OF EMPTY FRUIT BUNCH AND HIGH-DENSITY POLYETHYLENE FOR BIOFUEL PRODUCTION

The increasing global energy demand and environmental concerns associated with fossil fuel consumption have driven research into alternative biofuel production. This study investigates the co-pyrolysis of empty fruit bunch (EFB), a lignocellulosic biomass waste from the palm oil industry, and high-density polyethylene (HDPE), a common plastic waste, as a promising route for producing valuable biofuels. Co-pyrolysis offers potential synergistic effects, leveraging the hydrogen-rich nature of HDPE to enhance the conversion of EFB into liquid hydrocarbons. In this research, co-pyrolysis of EFB and HDPE was carried out in a fixed bed reactor at a temperature ranging from 400 to 800 °C and EFB:HDPE ratio of 25 - 75% with heating time ranging from 30 - 90 minutes. The co-pyrolysis of EFB and HDPE was optimized to maximize oil production with selected parameters, such as blending ratio, temperature, and time, using response surface methodology (RSM). The result verified that the effect of the independent variables on the response variable of gas yield, oil yield, and char yield was significant due to the P-value of less than 0.05. The optimum condition was obtained at a 41% EFB blending ratio and 474 °C temperature for 73 minutes, with desirability being 100%. These optimum conditions produced an oil yield of 29.30% with char and gas yield of 67.74% and 2.96%, respectively. Besides, the FTIR analysis was conducted to identify the functional groups in the bio-oils produced from the pyrolysis of EFB, HDPE, and their co-pyrolyzed blends. FTIR analysis showed distinct differences in bio-oil composition. EFB bio-oil exhibited strong O-H stretching (3600 - 3000 cm^{-1}), less intense in the co-pyrolysis bio-oil. C-H stretching (3000 - 2800 cm^{-1}) was prominent in HDPE bio-oil and enhanced in the co-pyrolysis bio-oil. The carbonyl peak (around 1650 cm^{-1}) was significant in EFB bio-oil but diminished in the co-pyrolysis product. The fingerprint region (1500 – 1000 cm^{-1}) showed decreased intensity in the co-pyrolysis bio-oil compared to EFB. These results demonstrate that co-pyrolysis with HDPE effectively reduces oxygen content and increases hydrocarbon content in the resulting bio-oil, enhancing its potential as a fuel source. Thus, the co-pyrolysis of EFB and HDPE produces the optimum oil yield, with FTIR analysis providing valuable insights into the chemical composition of the resulting oil.

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