ABSTRAK

KONVERSI LIMBAH PLASTIK CAMPURAN LDPE-HDPE MENJADI BAHAN BAKAR CAIR MELALUI PIROLISIS KATALITIK DENGAN VARIASI PERSENTASE KATALIS ZEOLIT ALAM TERAKTIVASI

(Mahdi Rahmadani, 2026 : 76 Halaman, 16 Tabel, 19 Gambar)

Peningkatan konsumsi energi dan akumulasi limbah plastik merupakan dua permasalahan serius yang perlu ditangani secara bersamaan. Penelitian ini bertujuan untuk menganalisis pengaruh variasi persentase katalis zeolit alam teraktivasi terhadap *yield*, karakteristik fisik, dan komposisi senyawa hidrokarbon bahan bakar cair yang dihasilkan dari proses pirolisis katalitik campuran limbah plastik *Low Density Polyethylene* (LDPE) dan *High Density Polyethylene* (HDPE). Proses pirolisis dilakukan menggunakan bahan baku campuran LDPE dan HDPE dengan perbandingan 1:1 sebanyak 2 kg per run pada suhu operasi 350°C selama 2 jam. Variasi persentase katalis zeolit alam teraktivasi HCl yang digunakan adalah 0%, 1%, 3%, 5%, dan 7% dari massa bahan baku. Karakteristik produk cair dianalisis meliputi densitas, viskositas kinematik, nilai kalor, titik nyala, dan komposisi senyawa hidrokarbon menggunakan *Gas Chromatography–Mass Spectrometry* (GC-MS). Hasil penelitian menunjukkan bahwa penggunaan katalis 3% menghasilkan yield tertinggi sebesar 9,89%. Nilai densitas produk berada pada rentang 0,817–0,838 gr/mL, viskositas kinematik 2,64–3,92 mm²/s, dan nilai kalor 10.959–11.030 kal/gr, yang seluruhnya memenuhi standar bahan bakar *diesel* berdasarkan SK Dirjen Migas. Namun, nilai titik nyala pada kisaran 30–43°C belum memenuhi standar minimum *diesel* sebesar 52°C akibat keberadaan fraksi hidrokarbon ringan. Analisis GC-MS menunjukkan produk didominasi fraksi *diesel* (C_{13}–C_{25}) sebesar 57,16%, diikuti *gasoline* (C_5–C_{10}) 24,20%, *kerosene* (C_{11}–C_{12}) 14,84%, dan fraksi berat (>C_{25}) 3,77%. Kesimpulannya, katalis zeolit alam teraktivasi 3% merupakan kondisi optimum yang menghasilkan bahan bakar cair dengan kualitas terbaik dan berpotensi dimanfaatkan sebagai bahan bakar alternatif setara solar.

Kata kunci: pirolisis, LDPE, HDPE, katalis zeolit alam, bahan bakar cair, *catalytic cracking*

ABSTRACT

CONVERSION OF MIXED LDPE-HDPE PLASTIC WASTE INTO LIQUID FUEL VIA CATALYTIC PYROLYSIS WITH VARYING PERCENTAGES OF ACTIVATED NATURAL ZEOLITE CATALYST

(Mahdi Rahmadani, 2026 : 76 Pages, 16 Tables, 19 Figures)

Rising energy consumption and the accumulation of plastic waste are two serious issues that need to be addressed simultaneously. This study aims to analyze the effect of varying percentages of activated natural zeolite catalyst on the yield, physical characteristics, and hydrocarbon composition of liquid fuel produced through the catalytic pyrolysis of a mixture of Low-Density Polyethylene (LDPE) and High-Density Polyethylene (HDPE) waste. The pyrolysis process utilized a 1:1 mixture of LDPE and HDPE (2 kg per run) at an operating temperature of 350°C for 2 hours. The variations in HCl-activated natural zeolite catalyst percentage used were 0%, 1%, 3%, 5%, and 7% of the raw material mass. The liquid product characteristics analyzed included density, kinematic viscosity, calorific value, flash point, and hydrocarbon compound composition (determined via Gas Chromatography–Mass Spectrometry/GC-MS). The results showed that the use of 3% catalyst yielded the highest output at 9.89%. Product density ranged from 0.817 to 0.838 g/mL, kinematic viscosity from 2.64 to 3.92 mm²/s, and calorific value from 10,959 to 11,030 cal/g; all these values met the diesel fuel standards set by the Directorate General of Oil and Gas (SK Dirjen Migas). However, the flash point values—ranging from 30°C to 43°C—did not meet the minimum diesel standard of 52°C due to the presence of light hydrocarbon fractions. GC-MS analysis revealed a predominance of diesel-range products (C_{13}–C_{25}) at 57.16%, followed by gasoline (C_5–C_{10}) at 24.20%, kerosene (C_{11}–C_{12}) at 14.84%, and heavy fractions (>C_{25}) at 3.77%. In conclusion, the use of a 3% activated natural zeolite catalyst represents the optimum condition for producing high-quality liquid fuel with the potential to serve as a diesel-equivalent alternative fuel.

Keyword: *pyrolisis, LDPE, HDPE, natural zeolite catalyst, liquid fuel, catalytic cracking*