

**PLATINA/NANOZIRKONIA TERSULFATASI: PREPARASI,
KARAKTERISASI DAN APLIKASINYA UNTUK KONVERSI LIMBAH
PLASTIK LDPE MENJADI BAHAN BAKAR CAIR**

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INTISARI

Telah dilakukan konversi limbah plastik *low-density polyethylene* (LDPE) menjadi bahan bakar cair menggunakan katalis platina/nanozirkonia tersulfatasi (Pt/nanoZS). Tujuan dari penelitian ini adalah untuk mempelajari pengaruh konsentrasi H_2SO_4 dan temperatur kalsinasi terhadap sifat keasaman nanoZS, mempelajari pengaruh konsentrasi logam Pt terhadap sifat fisik dan kimia katalis serta membandingkan aktivitas, selektivitas dan stabilitas katalitik nanoZ, nanoZS dan Pt/nanoZS pada reaksi hidrerenkang limbah plastik LDPE menjadi bahan bakar cair.

Material nanoZS dipreparasi melalui impregnasi basah dari nanoZ dan larutan H_2SO_4 (0,2; 0,5; 0,8 dan 1,0 M), diikuti oleh kalsinasi pada temperatur bervariasi, yaitu 500, 600, 700 dan 800 °C untuk memperoleh nanoZS1-600, nanoZS2-600, nanoZS3-500, nanoZS3-600, nanoZS3-700, nanoZS3-800 dan nanoZS4-600. Material nanoZS3-600 selanjutnya direfluks dalam larutan $PtCl_4$ (Pt 0,5; 1,0 dan 1,5% b/b), dikalsinasi pada temperatur 600 °C dan diikuti oleh reduksi H_2 untuk menghasilkan Pt1/nanoZS3-600, Pt2/nanoZS3-600 dan Pt3/nanoZS3-600. Sampel katalis dikarakterisasi oleh FTIR, XRD, GSA, XPS, EDXRF, HAADF-STEM, SEM dan TG/DTA, sedangkan fraksi cair yang diperoleh dari reaksi hidrerenkang dianalisis dengan menggunakan GC-MS.

Kondisi optimum proses preparasi nanoZS dicapai melalui penambahan H_2SO_4 0,8 M yang dikalsinasi pada temperatur 600 °C (nanoZS3-600) dengan jumlah situs asam total sebesar 1,06 mmol/g. Peningkatan konsentrasi logam Pt pada nanoZ menyebabkan peningkatan sifat keasaman katalis, dimana Pt3/nanoZS3-600 menunjukkan keasaman total tertinggi sebesar 11,14 mmol/g. Luas permukaan spesifik katalis meningkat secara bertahap dari 13,49 m^2/g untuk Pt1/nanoZS3-600 menjadi 29,48 m^2/g untuk Pt3/nanoZS3-600. Keberadaan logam Pt pada nanoZS3-600 dapat meningkatkan aktivitas, selektivitas dan stabilitas katalis. Reaksi hidrerenkang limbah plastik LDPE menggunakan Pt3/nanoZS3-600 dengan rasio katalis/umpan 1% b/b pada temperatur 250 °C selama waktu reaksi 60 menit menghasilkan persentase fraksi bensin tertinggi sebesar 67,51% b/b.

Kata kunci: platina, nanozirkonia tersulfatasi, limbah plastik LDPE, bahan bakar cair.

PLATINUM/SULFATED NANOZIRCONIA: PREPARATION, CHARACTERIZATION AND ITS APPLICATION FOR CONVERSION OF LDPE PLASTIC WASTE INTO LIQUID FUELS

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ABSTRACT

The conversion of low-density polyethylene (LDPE) plastic waste into liquid fuels over modified platinum/sulfated nanozirconia (Pt/nanoZS) catalyst was systematically studied. The aims of this research were to study the effect of H₂SO₄ concentration and calcination temperature on the acidity of nanoZS, study the effect of Pt metal concentration on the physical and chemical properties of catalysts and compare the catalytic activity, selectivity and stability of nanoZ, nanoZS and Pt/nanoZS in the hydrocracking reaction of LDPE plastic waste into liquid fuels.

The nanoZS material was prepared by wet impregnation of nanoZ and H₂SO₄ solution (0.2, 0.5, 0.8 and 1.0 M), followed by calcination at various temperatures, i.e. 500, 600, 700 and 800 °C to obtain nanoZS1-600, nanoZS2-600, nanoZS3-500, nanoZS3-600, nanoZS3-700, nanoZS3-800 and nanoZS4-600. The nanoZS3-600 material was then refluxed in aqueous solutions of PtCl₄ (0.5, 1.0 and 1.5 wt% Pt), calcined at 600 °C and followed by H₂ reduction to produce Pt1/nanoZS3-600, Pt2/nanoZS3-600 and Pt3/nanoZS3-600.

The catalyst samples were characterized by FTIR, XRD, GSA, XPS, EDXRF, HAADF-STEM, SEM and TG/DTA, while the obtained liquid fractions from hydrocracking reaction were analyzed by using GC-MS.

The optimum condition of nanoZS preparation process was obtained through the addition of 0.8 M H₂SO₄ calcined at temperature of 600 °C (nanoZS3-600) with total amount of acid sites of 1.06 mmol/g. A larger concentration of Pt metal on nanoZ led to increase the acidity of catalyst, where Pt3/nanoZS3-600 showed the highest total acidity of 11.14 mmol/g. The specific surface area of catalyst increased gradually from 13.49 m²/g for Pt1/nanoZS3-600 to 29.48 m²/g for Pt3/nanoZS3-600. The presence of Pt metal on nanoZS3-600 enhanced the activity, selectivity and stability of catalyst. The hydrocracking reaction of LDPE plastic waste over Pt3/nanoZS3-600 with catalyst-to-feed ratio of 1 wt% at temperature of 250 °C for reaction time of 60 min produced the highest percentage of gasoline fraction of 67.51 wt%.

Keywords: platinum, sulfated nanozirconia, LDPE plastic waste, liquid fuels.