Renewable Syngas Production from Thermal Cracking of Glycerol over Praseodymium-Promoted Ni/Al2O3 Catalyst

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ABSTRACT

In this study, the kinetics of glycerol pyrolysis over a 3wt%Pr-20wt%Ni/77wt%α-Al_2O_3catalyst was investigated. The catalyst was synthesized via wet-impregnation method and was characterized using temperature-programmed calcination (TPC), temperature-programmed reduction (TPR), N_2-physisorption, FESEM imaging, X-ray diffraction and CO_2-/NH_3-temperature-programmed desorption (TPD). The catalytic activity of the as-synthesized 3 wt% Pr-Ni/α-Al_2O_3 catalyst was evaluated in a stainless steel fixed bed reactor at temperatures that ranged from 973 K to 1073 K and a weight-hourly-space-velocity (WHSV) of 4.5×10^4 ml g^{-1} h^{-1} under the atmospheric condition. The main gaseous products from catalytic glycerol pyrolysis were H_2, CO, CO_2 and CH_4(descending ranking) with the highest H_2 formation rate and H_2 yield of 0.02593 mol g cat^{-1} s^{-1} and 29.04%, respectively. The analysis of the kinetic data obtained from the glycerol pyrolysis showed activation energy of 37.36 kJ mol^{-1}. Based on the mechanistic modeling, it can be deduced that the rate determining step of the glycerol pyrolysis was via a single site associative adsorption with molecular surface reaction as the rate-determining step.

KEYWORDS

Glycerol; Kinetics; Nickel; Praseodymium; Pyrolysis; Syngas

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