A Study on the Kinetics of Syngas Production from Glycerol Over Alumina-Supported Samarium–Nickel Catalyst

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ABSTRACT

The current paper reports on the kinetics of syngas production from glycerol pyrolysis over the alumina-supported nickel catalyst that was promoted with samarium, a rare earth element. The catalysts were synthesized via wet-impregnation method and its physicochemical properties were subsequently characterized. Reaction studies were performed in a 10 mm-ID stainless steel fixed bed reactor with reaction temperatures maintained at 973, 1023 and 1073 K, respectively, employing weight-hourly-space-velocity of 4.5×10^4 ml g^{-1} h^{-1}. The textural property examination showed that BET specific surface area was 2.09 m^2 g^{-1} for the unpromoted catalyst while the samarium promoted catalyst has 2.68 m^2 g^{-1}. Interestingly, the results were supported by the FESEM images which showed that the promoted catalyst has smaller particle size compared to the unpromoted catalyst. Furthermore, the NH_3- and CO_2-TPD analyses proved that the strong and weak acid-basic sites were present. During glycerol pyrolysis, the syngas was produced directly from the glycerol decomposition. This has created H_2:CO ratios that were always lower than 2.0, which is suitable for Fischer-Tropsch synthesis. The activation energy based on power law modeling for the unpromoted catalyst was 35.8 kJ mol^{-1} and 23.4 kJ mol^{-1} for Sm-promoted catalyst with reaction order 1.20 and 1.10, respectively. Experimental data were also fitted to the Langmuir–Hinshelwood model. Upon subjected to both statistical and thermodynamics consistency criteria, it can be conclusively proved that single-site mechanisms with associative adsorption of glycerol best describe the glycerol pyrolysis over both unpromoted and Sm promoted catalyst in the current work, with regression coefficient values of more than 0.9.

KEYWORDS: Glycerol; Pyrolysis; Nickel; Samarium; Kinetics; Syngas

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