Abstract

This work focuses on the development of inexpensive nickel based catalysts for steam reforming of ethanol and glycerol to produce hydrogen rich synthesis gas (syngas). The cerium promoted Ni-Mg-Al hydrotalcite and Ni/Olivine catalysts were prepared for ethanol steam reforming process. Ni/γ-Al_2O_3 and Ni/Fly ash catalysts were prepared for glycerol steam reforming process. The physio-chemical characteristics of develop catalysts were determined by XRD, SEM coupled with EDS, BET, TPR and FTIR. Temperature, feed molar ratio and space-time were selected as process parameters. Steam reforming of ethanol and glycerol was carried out over developed catalysts in a fixed bed vertical tubular reactor. The optimum cerium and nickel loading was estimated for all the developed catalysts. The optimum process conditions were obtained for each steam reforming processes. Under the optimum conditions, the yield of H_2 and selectivity of other carbon containing gases were estimated along with the conversions of ethanol and glycerol.

The optimum process conditions for ethanol steam reforming over cerium promoted Ni-Mg-Al catalyst are: temperature 540 °C; H_2O/ethanol molar ratio, 9:1; space-time, 22.04 kg cat. h/kmol of ethanol fed. Under this condition, the conversion of ethanol is 97% and yield of H_2 is 4.13 mol of H_2/mol of ethanol reacted. In case of ethanol steam reforming over Ni/Olivine catalyst, the optimum process conditions are: temperature 550 °C; H_2O/ethanol molar ratio, 10:1; space-time, 7.94 kg cat. h/kmol of ethanol fed. A yield of 4.62 mole of hydrogen per mole of ethanol reacted and 97.11% ethanol conversion were obtained at the optimum condition.

For glycerol steam reforming over Ni/γ-Al_2O_3 catalyst, the hydrogen yield was optimized as 5.13 mol of H_2/mol of glycerol fed with 95.4% conversion of glycerol at 550 °C temperature with steam/glycerol molar feed ratio of 10:1 and space-time of 8.43 kg cat. h/kmol of glycerol fed. In case of glycerol steam reforming over Ni/Fly ash catalyst, a maximum yield of 5.8 mol of hydrogen per mole of glycerol fed was obtained at 550◦C with steam to glycerol molar ratio of 12 and a space-time of 8.4 kg cat. h/kmol of glycerol fed with 98.6% conversion of glycerol.

Keywords: Steam reforming, Ethanol, Glycerol, H_2 production, Syngas, Nickel catalyst, Hydrotalcite, Fly ash, Olivine, Kinetic model, Activation energy