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Ethanol Dry Reforming for Syngas Production over Ce-promoted Ni/Al_2O_3 Catalyst

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ABSTRACT

Ce-promoted and unpromoted 10%Ni/Al_2O_3 catalysts were prepared by co-impregnation method and evaluated for ethanol dry reforming in a quartz fixed-bed reactor at different CO_2:C_2H_5OH ratios of 2.5:1 to 1:2.5 and temperature of 923–973 K under atmospheric pressure. Thermogravimetric studies indicated that both catalysts were completely calcined and subsequently reduced to metallic Ni° phase. The addition of Ce promoter facilitated the reduction process and decreased reduction temperature by about 315 K. Stronger metal-support interaction was observed with Ce addition. NiO and $NiAl_2O_4$phases were formed on catalyst surface during calcination for both catalysts whilst CeO_2form was identified on promoted catalyst. Significant enhancement of ethanol conversion up to 75.2% with reaction temperature was observed and catalytic activity appeared to be stable with time-on-stream at beyond 5–7 h for both promoted and unpromoted catalysts. C_2H_5OH and CO_2 conversions increased with growing CO_2 partial pressure whilst the optimal C_2H_5OH partial pressure was obtained at about 30–40 kPa for both catalysts. C_2H_5OH conversion was always greater than that of CO_2 indicating the co-existence of side reactions, namely; ethanol decomposition and dehydrogenation during ethanol dry reforming reaction. Ce-addition improved both C_2H_5OH and CO_2conversions irrespective of reactant partial pressure. Although both carbon nanofilament and graphitic carbon were detected on the surface of spent catalysts by SEM, TEM and Raman measurements, the proportion of carbon nanofilament was dominant and the percentage of amorphous carbon was increased with Ce promoter.

KEYWORDS: Ni-based catalysts; Ethanol dry reforming; Hydrogen; Co-impregnation; Carbon nanofiber

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