

Ethanol Dry Reforming for Syngas Production over Ce-promoted Ni/Al₂O₃ Catalyst

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ABSTRACT

Ce-promoted and unpromoted 10%Ni/Al₂O₃ catalysts were prepared by co-impregnation method and evaluated for ethanol dry reforming in a quartz fixed-bed reactor at different CO₂:C₂H₅OH 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 Ni⁰ 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 NiAl₂O₄ phases were formed on catalyst surface during calcination for both catalysts whilst CeO₂ form 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. C₂H₅OH and CO₂ conversions increased with growing CO₂ partial pressure whilst the optimal C₂H₅OH partial pressure was obtained at about 30–40 kPa for both catalysts. C₂H₅OH conversion was always greater than that of CO₂ indicating the co-existence of side reactions, namely; ethanol decomposition and dehydrogenation during ethanol dry reforming reaction. Ce-addition improved both C₂H₅OH and CO₂ conversions 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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