Hydrogen production from CH_4 dry reforming over bimetallic Ni–Co/Al_2O_3 catalyst

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ABSTRACT

Bimetallic 5%Ni–10%Co/Al_2O_3 catalyst was synthesized using impregnation method and evaluated for methane dry reforming reaction at different reaction temperatures. NiO, $Co_3O_4$and spinal metal aluminates, namely, $CoAl_2O_4$ and $NiAl_2O_4$ phases were formed on γ-Al_2O_3support surface during calcination process. 5%Ni–10%Co/Al_2O_3 catalyst exhibited reasonable surface area of 86.93 $m^2\ g^{-1}$ with small crystallite dimension of less than 10 nm suggesting that both Co_3O_4 and NiO phases were finely dispersed on the surface of support in agreement with results from scanning electron microscopy (SEM) measurement. Temperature-programmed calcination measurement indicates the complete thermal decomposition and oxidation of metal precursors, viz. $Ni(NO_3)_2$ and $Co(NO_3)_2$ to metal oxides and metal aluminates at below 700 K. Both CH_4 and CO_2 conversions were stable over a period of 4 h on-stream and attained an optimum at about 67% and 71%, respectively at 973 K whilst H_2 selectivity and yield were higher than 49%. The ratio of H_2/CO was always less than unity for all runs indicating the presence of reverse water–gas shift reaction. The activation energy for CH_4 and CO_2 consumption was computed as 55.60 and 40.25 kJ mol^{-1}, correspondingly. SEM micrograph of spent catalyst detected the formation of whisker-like carbon on catalyst surface whilst D and G bands characteristic for the appearance of amorphous and graphitic carbons in this order were observed on surface of used catalyst by Raman spectroscopy analysis. Additionally, the percentage of filamentous carbon was greater than that of graphitic carbon.

KEYWORDS:

Bimetallic Ni–Co catalyst; Methane dry reforming; Hydrogen; Syngas