Syngas production from methane dry reforming over Ni/SBA-15 catalyst: Effect of operating parameters

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Abstract

The influence of operating conditions including reactant partial pressure and reaction temperature on the catalytic performance of Ni/SBA-15 catalyst for methane dry reforming (MDR) has been investigated in this study. MDR reaction was carried out under 1 atm with varying CO_2/CH_4 ratios from 1/2.5 to 2.5/1 at gas hourly space velocity (GHSV) of 24 L g_{cat}^{-1} h^{-1} and 923-1023 K. The catalyst was characterized using XRD, FESEM, H_2-TPR, BET surface area and TPO measurements. FESEM results showed that Ni particles were well dispersed on nanorod-shaped SiO_2 support. Both CH_4 and CO_2 conversions increased with rising reaction temperature and reached to about 88.2% and 92.9%, respectively at 1023 K and CO_2/CH_4=1:1. Catalytic activity appeared to be stable with time-on-stream at 973-1023 K whilst a slight drop in activity was observed at 923 K reasonably due to deposited carbon formed by thermodynamically favoured Boudouard and CH_4 decomposition reactions. The increase in H_2/CO ratio from 1.2-1.4 with growing reaction temperature was ascribed to the enhancement of H_2 production through CH_4 dehydrogenation. Interestingly, the ratio of CH_4 to CO_2 conversions increased linearly with CO_2 partial pressure whilst an opposite trend was observed for H_2/CO ratio suggesting the rising CO_2 consumption through concomitant CO_2 gasification reaction at CO_2-rich environment.

Keywords: Methane dry reforming; Ni/SBA-15; Syngas; Hydrogen