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 10%Ni/SBA-15 catalyst for methane dry reforming (MDR) reaction has been investigated in this study. MDR reaction was carried out under atmospheric pressure at varying CH4/CO2 volume ratios of 3:1 to 1:3 and 923–1023 K in a tubular fixed-bed reactor. SBA-15 supported Ni catalyst exhibited high specific surface area of 444.96 m2 g−1 and NiO phase with average crystallite size of 27 nm was detected on catalyst surface by X-ray diffraction and Raman measurements. H2 temperature-programmed reaction shows that NiO particles were reduced to metallic Ni0 phase with degree of reduction of about 90.1% and the reduction temperature depended on the extent of metal-support interaction and confinement effect of mesoporous silica support. Catalytic activity appeared to be stable for 4 h on-stream at 973 K whilst a slight drop in activity was observed at 923 K probably due to deposited carbon formed by thermodynamically favored CH4 decomposition reaction. Both CH4 and CO2 conversions increased with rising reaction temperature and reaching about 91% and 94%, respectively at 1023 K with CO2 and CH4 partial pressure of 20 kPa. CH4 conversion improved with increasing CO2 partial pressure, PCO2 and exhibited an optimum at PCO2 of 30–50 kPa depending on reaction temperature whilst a substantial decline in CO2 conversion was observed with growing PCO2. Additionally, CH4 and CO2 conversions decreased significantly with rising CH4 partial pressure because of increasing carbon formation rate via CH4 cracking in CH4-rich feed.