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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 CH_4/CO_2 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 $m^2\ g^{-1}$ and NiO phase with average crystallite size of 27 nm was detected on catalyst surface by X-ray diffraction and Raman measurements. H_2 temperature-programmed reaction shows that NiO particles were reduced to metallic Ni^0 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 973–1023 K whilst a slight drop in activity was observed at 923 K probably due to deposited carbon formed by thermodynamically favored CH_4 decomposition reaction. Both CH_4 and CO_2 conversions increased with rising reaction temperature and reaching about 91% and 94%, respectively at 1023 K with CO_2 and CH_4 partial pressure of 20 kPa. CH_4 conversion improved with increasing CO_2 partial pressure, P_{CO_2} and exhibited an optimum at P_{CO_2} of 30–50 kPa depending on reaction temperature whilst a substantial decline in CO_2 conversion was observed with growing P_{CO_2}. Additionally, CH_4 and CO_2 conversions decreased significantly with rising CH_4 partial pressure because of increasing carbon formation rate via CH_4 cracking in CH_4-rich feed.

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