Optimization of renewable hydrogen-rich syngas production from catalytic reforming of greenhouse gases (CH_4 and CO_2) over calcium iron oxide supported nickel catalyst

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ABSTRACT

Multi-response optimization of hydrogen-rich syngas from catalytic reforming of greenhouses (methane and carbon dioxide over Calcium iron oxide supported Nickel (15 wt%Ni/$CaFe_2O_4$) catalyst was performed by varying reaction temperature(700–800 °C), feed ratio (0.4–1.0) and gas hourly space velocity (10,000–60,000 h^{-1})) using response surface methodology. Four response surface methodology (RSM) models were obtained for the prediction of reactant conversion and the product yield. The analysis of variance (ANOVA) conducted on the model showed that the parameters have significant effect on the responses. Optimum conditions for the methane dry reforming over the 15 wt%Ni/$CaFe_2O_4$ catalyst were obtained at reaction temperature, feed ratio and gas hourly space velocity (GHSV) of 832.45 °C, 0.96 and 35,000 mL g^{-1} h^{-1} respectively with overall desirability value of 0.999 resulting in the highest methane (CH_4) and carbon dioxide (CO_2) conversions of 85.00%, 88.00% and hydrogen (H_2) and carbon monoxide (CO) yields of 77.82% and 75.76%, respectively.

KEYWORDS:

Calcium iron oxide; Catalytic reforming Greenhouse gases; Response surface methodology; Multi-response optimization; Nickel