Thermo-catalytic conversion of greenhouse gases (CO_2 and CH_4) to CO-rich hydrogen by CeO_2 modified calcium iron oxide supported nickel catalyst

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ABSTRACT

In this study, the thermo-catalytic conversion of two principal greenhouse gases (methane and carbon dioxide) to carbon monoxide (CO)-rich hydrogen (H_2) is investigated over cerium oxide (CeO_2) promoted calcium ferrite supported nickel ($Ni/CaFe_2O_4$) catalyst. The CeO_2 promoted $Ni/CaFe_2O_4$ catalyst was prepared using wet-impregnation technique. To ascertain the physicochemical properties, the as-prepared catalyst was characterized using various instrument techniques. The characterization of the catalysts reveals that CeO_2-$Ni/CaFe_2O_4$ possesses suitable physicochemical properties for the conversion of methane (CH_4) and carbon dioxide (CO_2) to CO-rich H_2. The thermo-catalytic reaction revealed that the CeO_2 promoted $Ni/CaFe_2O_4$ catalyst displayed a higher CH_4 and CO_2 conversions of 90.04% and 91.2%, respectively, at a temperature of 1073 K compared to the unpromoted catalyst. The highest H_2 and CO yields of 78% and 76%, respectively, were obtained over the CeO_2-$Ni/CaFe_2O_4$ at 1073 K and CH_4/CO_2 ratio of 1. The CeO_2 promoted $Ni/CaFe_2O_4$ catalyst remained stable throughout the 30 hours time on stream (TOS) while that of the unpromoted $Ni/CaFe_2O_4$ catalyst sharply decreased after 22 hours TOS. The characterization of the used catalysts confirms the evidence of carbon depositions on the unpromoted $Ni/CaFe_2O_4$ which is solely responsible for its deactivation. Whereas, there was a slightly gasifiable carbon deposited on the CeO_2 promoted $Ni/CaFe_2O_4$ catalyst which could be ascribed to the interaction effect of the CeO_2 promoter on the $Ni/CaFe_2O_4$ catalyst.

KEYWORDS

Calcium iron oxide; Ceria promoter; hydrogen; Methane dry reforming; Syngas

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