Topic: Development of Water Gas Shift Catalysts For Converting Synthesis Gas to Hydrogen Rich Gas

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ABSTRACT

The water gas shift reaction is generally applied to produce hydrogen from the reaction of carbon monoxide and water. In the present work, the water gas shift reaction over several ceria-based catalysts (i.e. CeO_2, GDC and YDC) was studied. It is noted that two catalyst preparation methods (i.e. precipitation and low temperature preparation) were compared. Furthermore, the effect of Ni impregnation to promote the reaction was also carried out.

From both preparation techniques, the fluorite oxide-type of CeO_2 was observed, according to XRD characterization. The Gd_2O_3 and Y_2O_3 peaks were not found in GDC and YDC patterns indicating that Gd^{3+} and Y^{3+} incorporated into subsurface region of CeO_2 lattice to form solid solution. An addition of Ni did not cause any change in XRD patterns, presuming that Ni was highly dispersed on the surface of the supports. From the water gas shift activity test, it was found that the impregnation of Ni significantly promoted the catalyst activity. Among the catalysts prepared by low temperature method, 5%Ni/20YDC showed the best activity, from which the CO conversion started at the temperature above 250 °C and reached 75% conversion at 350 °C before dropping at higher temperature as it reached the equilibrium condition. In case of catalysts prepared by co-precipitation method, 5%Ni/CeO_2 showed the highest activity, from which the CO conversion reached 92% conversion at 400 °C. The activation energy and reaction orders of H_2, CO and CO_2 of 5%Ni/CeO_2 were predicted by the kinetics study. From the study, the activation energy (E_a) of 5%Ni/CeO_2 was 27 kJ/mol, while the reaction orders of H_2, CO and CO_2 were 0.69, -0.13 and -0.13, respectively. This indicates the weak negative effect of H_2 and CO_2 on the reaction due to the promotion of reverse water gas shift reaction by both compounds.

Keywords: CeO_2; water gas shift reaction; catalyst; low temperature preparation technique