Modulating the Co-CoO_x Interface in Co-Nb-CeO_2 Catalysts through Controlling Titration Rate for Enhanced Performance in Water-Gas Shift Reaction

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ABSTRACT

Hydrogen is proposed as a promising alternative to address environmental issues from fossil fuels. In the waste gasification process, the Water Gas Shift (WGS) reaction is crucial for producing high-purity hydrogen. The WGS reaction are divided into the two steps as high temperature-water gas shift (HT-WGS) and low temperature-water gas shift (LT-WGS) reaction due to thermodynamic limitation and kinetic. Previously, the Co/Nb-CeO_2 catalyst for HT-WGS were designed prepared with co-precipitation method, but the effect of titration rate which is an important parameter relating to catalytic performance was not investigated. In this study, the different titration rates were applied to prepare Co/Nb-CeO_2 catalysts by controlling the addition rate of precipitant (KOH) from 1 mL/min to 25 mL/min. To understand the physicochemical properties of the catalysts various characterization techniques were used such as TEM, XPS and H_2-TPR analyses. As a Result, among the prepared Co/Nb−CeO_2 catalysts, 5-Co/Nb-CeO_2 prepared with precipitant addition rate as 5 mL/min exhibited the highest activity, with a CO conversion of 97.8% at a temperature of 450°C and a gas hourly space velocity of 315,282 h^{-1}. Moreover, long-term thermal stability was observed for the 5-Co/Nb-CeO_2 catalyst. Carbon formation and sintering, which deactivates the catalyst activity was minimal when 5-Co/Nb-CeO_2 catalyst was tested because of the favorable interactions between the CeO_2 and Co-CoO_x pairs. In contrast, the other catalysts underwent faster deactivation because of faster carbon deposition and pore blockage, ultimately limiting the H_2 production activity.

Keyword: Water-gas shift/ Hydrogen/ Co-Co_x pairs/ Metal-support interactions/ Waste-derived syngas

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