

Study of NiCeZr and BNiCeZr Mixed Oxides on the Steam Reforming of Ethanol

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The catalytic activity of NiCeZr and BNiCeZr fluorite-type oxides has been studied in the steam reforming of ethanol (SRE). The mixed oxides are prepared via co-precipitation [assigned as NiCeZr(C) and BNiCeZr(C), respectively] and impregnation [assigned as NiCeZr(I) and BNiCeZr(I), respectively] methods using $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ (10 wt%), $\text{Ce}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$, $\text{ZrOCl}_2 \cdot 8\text{H}_2\text{O}$ (molar ratio of Ce/Zr is 1) and H_3BO_3 (0.5 wt%) as precursors, characterize by XRD, TPR/TPO, TEM, BET, TG and EA techniques, and evaluated in the SRE reaction. The results revealed a solid solution and/or a highly dispersed nickel oxide in ceria can be obtained by co-precipitation method, and larger particles of NiO obtained with the impregnation method. The active nickel species belongs to the Ni and B-Ni alloy nanoparticles and/or to the cerium nickel solid solution where Ni species are in strong interaction with ceria. Pathway of SRE reaction is different for both NiCeZr and BNiCeZr oxides with the reaction temperature (T_R). Acetone is formed over NiCeZr(C) and NiCeZr(I) catalysts while disappears over the BNiCeZr(C) and BNiCeZr(I) catalysts. For NiCeZr(C) and NiCeZr(I) catalysts, as the T_R higher than 300 °C acetone appears that comes from the decarbonylation of acetaldehyde and disappears as the T_R above 350 °C, and accompanies simultaneously steam reforming of acetone to increase the production of hydrogen and direct decomposition of ethanol to produce CH_4 . While, the dehydrogenation of ethanol to form acetaldehyde, then decomposition into CH_4 and CO with the T_R , and follows the water gas shift at low temperature is the main reaction over the BNiCeZr(C) and BNiCeZr(I) catalysts. The behavior of coke for the used catalysts was characterized with TG and EA methods. Since the formation of B-Ni alloy nanoparticles are preferential on the cleavage of C-C and C-H bonds, the BNiCeZr(C) and BNiCeZr(I) catalysts accumulate more deposited

carbon than the NiCeZr(C) and NiCeZr(I) catalysts.

Keywords: Steam reforming of ethanol; Nickel catalyst; Hydrogen production; Coke; Deactivation.

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