Enhanced syngas production from glycerol dry reforming over Ru promoted -Ni catalyst supported on extracted Al_2O_3

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ABSTRACT

Crude glycerol, a by-product of biodiesel production, has drawn considerable attention to the importance of glycerol valorization through dry reforming reaction to obtain syngas. The selection of suitable catalysts is significantly important to enhance the catalytic activity in glycerol dry reforming (GDR) reactions. Hence, Ru with different loadings (i.e. 1%, 2%, 3%, 4%, 5%) doped in 15% Ni-extracted Al_2O_3(EA) was evaluated as catalyst via GDR process in this study. The catalyst prepared by ultrasonic-impregnation assisted technique was subjected to 8 h of CO_2 reforming of glycerol. The reactant conversions and products yield was in the order of 3%Ru-15%Ni/EA > 5%Ru-15%Ni/EA > 4%Ru-15%Ni/EA > 2%Ru-15%Ni/EA > 1%Ru-15%Ni/EA > 15%Ni/EA, while the quantity of carbon deposited was in the order 15%Ni/EA > 1%Ru-15%Ni/EA > 2%Ru-15%Ni/EA > 4%Ru-15%Ni/EA > 5%Ru-15%Ni/EA > 3%Ru-15%Ni/EA. 3%Ru-15%Ni/EA attained the greatest glycerol conversions of 90%, H_2 yield of 80% and CO yield of 72% with the lowest carbon deposition of 7.38%. The dispersion of Ni particles on EA support evidently improved after the promotion step with Ru, which minimized the agglomeration of Ni and smaller crystallite size. In addition, the introduction of Ru increased the oxygen storage capacity which significantly reduced the formation of carbon during the reaction. GDR's optimal reaction temperature obtained over 3%Ru-15%Ni/EA catalysts was at 1073 K (i.e. 93% glycerol conversion; 87% H_2 yield; 79% CO yield). Over a 72 h time on stream at 1073 K, 3%Ru-15%Ni/EA catalyst had superior catalytic activity and stability. Overall, 3%Ru-15%Ni/EA catalyst was more coke-resistant than other promoted catalysts due to its accessible structure, higher oxygen storage capacity, moderate basicity, uniformly dispersed Ni phase and stronger Ru/Ni-EA interaction.

KEYWORDS

Glycerol; Dry reforming; Syngas; Hydrogen; Ni-based catalyst; Nobel-metal promoter

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