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Strategy of Ni Nanoparticle Confinement for Catalyst Stability Enhancement in Methane Reforming Using Industrial Flue Gas †

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Abstract: The utilization of CO_2 as a carbon source is key to sustainable development. Catalyst deactivation due to carbon deposition and metal sintering is a major problem in the tri-reforming of methane process. This study presents an effective strategy to enhance catalyst stability. As-synthesized SBA-15 material was used to disperse Ni nanoparticles in its ordered mesopores. The catalyst Ni/SBA-15 was tested in a tri-reforming methane reaction at 800°C, 1 atm, 17,220 mL/g.h GHSV. It exhibited 75% and 69% initial CH_4 and CO_2 conversions, respectively. It maintained its initial activity in a 10 h run with less than a 3% decrease in conversions. Ni/SBA-15 catalyst exhibited approximately 1 wt.% carbon deposition and 0.5 nm increase in Ni particle size in 10 h run. For comparison, a conventional catalyst Ni/Al_2O_3 was also tested under identical reaction conditions. Its CH_4 and CO_2 conversions decreased from 88% and 85% to 76% and 70% respectively in 10 h run. This significant activity loss was attributed to high carbon deposition (15 wt.%) and severe metal sintering (13.6 nm to 20.7 nm). Thus, Ni nanoparticle confinement in ordered mesopores could be a promising strategy to avoid carbon deposition and metal agglomeration in methane tri-reforming reactions.

Keywords: methane reforming; CO_2 conversion; catalyst deactivation: active metal confinment.

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Conflicts of Interest

The authors declare no conflict of interest.