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ORIGINAL PAPER

The role of catalyst synthesis on the enhancement of nickel praseodymium (III) oxide for the conversion of greenhouse gases to syngas

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Abstract

Catalytic methane (CH_4) dry reforming (MDR) reaction proceeds with the formation of carbon; hence the effects of the catalyst preparation method on the type of carbon are worth investigating. This study investigated the performance of 20 wt% nickel praseodymium (III) oxide (20 wt% Ni/Pr_2O_3) catalysts prepared by incipient wetness impregnation (IWI), ultrasonic wet impregnation (US-WI), and Pechini sol–gel (PSG) methods. The catalysts crystallite size was approximately 21.3 nm, 21.3 nm, and 10.6 nm, for IWI, US-WI, and PSG catalysts, respectively. Study of the temperature effecton the MDR system showed that higher temperatures favored the MDR reaction with the side reaction playing vital roles. The catalyst synthesized by the PSG method showd higher carbon gasification rate with the stability up to 24 h, whereas catalysts from other synthesis methods were only active for less than 2 h, which could be due to the formation of higher amount of filamentous carbon, balance in oxygen species, and the smaller crystallite size of the PSG-20 wt% Ni/Pr_2O_3. The PSG-20 wt% Ni/Pr_2O_3 catalyst accumulated more filamentous carbon than graphitic carbon. In contrast, the IWI and US-WI catalysts accumulated mainly graphitic carbon which encapsulated the Ni^0 sites, resulting in excess carbon deposition and reactor clogging within 2 h on stream.

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