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n-Dodecane steam reforming over Ni catalysts supported on ZrO_2–$KNbO_3$

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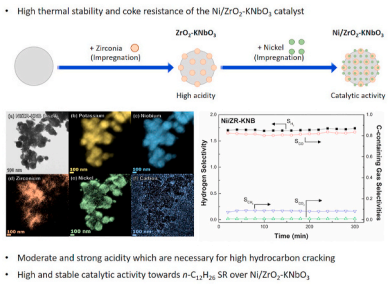
HIGHLIGHTS

- High thermal stability and coke-resistance of the $KNbO_3$ material.
- Moderate and strong acidic sites required for high hydrocarbon cracking.
- Impregnated zirconia increases moderate and strong acidity.
- High and stable catalytic activity towards n-$C_{12}H_{26}$ SR over Ni/ZrO_2–$KNbO_3$.
- Good stability and coke-resistance of Ni/ZrO_2–$KNbO_3$ towards n-$C_{12}H_{26}$ SR.

GRAPHICAL ABSTRACT



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ABSTRACT

Coke-resistant Ni catalyst supports are evaluated for steam reforming (SR) *n*-dodecane, the alkane used as a surrogate for diesel fuel in this study. Reactions are conducted at 800 °C for 5 h, with a molar steam-to-carbon ratio of 3.0 and a gas hourly space velocity of 20000 h^{-1}. Thermally stable, coke-resistant supports loaded with 15 wt% Ni are prepared using the following potassium oxides: $K_2Ti_2O_5$ (KTI), $K_4Zr_5O_{12}$ (KZR), $KNbO_3$ (KNB), $KTaO_3$ (KTA), and K_2WO_4 (KW). Ni/KZR and Ni/KW show the best catalytic performance in the SR reaction due to their moderate-to-strong acidities and lack of porosity, which are necessary features for hydrocarbon cracking. Unfortunately, these catalysts are poorly stable under the defined operating conditions. KNB is the most suitable support due to its excellent thermal stability and coke-resistance; however, it lacks acidity. The acidity of KNB is enhanced by impregnation with ZrO_2, which transforms it into an acidic oxide (ZR-KNB). ZR-KNB features high thermal stability and high coke-resistance during the SR of *n*-dodecane under the applied test conditions. The Ni/ZR-KNB catalyst delivers excellent SR performance with respect to both *n*-dodecane conversion and hydrogen selectivity.

1. Introduction

Steam reforming (SR) of diesel yields an effluent gas that provides an alternative economical source of H2 [1–6]. For example, hydrogen produced from the SR of diesel fuel can be used to provide the auxiliary or main power for fuel cells of road and marine vehicles. By applying SR to large-scale fuel cells, the produced hydrogen can also be used to supply stationary power to buildings and distributed power generation

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