Performance of NiO Doped on Alkaline Sludge from Waste Photovoltaic Industries for Catalytic Dry Reforming of Methane

ABSTRACT

Alkali sludge (AS) is abundantly waste generated from solar PV solar cell industries. Since this potential basic material is still underutilized, a combination with NiO catalyst might greatly influence coke resentence, especially in high-temperature thermochemical reactions (Arora and Prasad 2016). This paper investigated alkaline sludge containing $3CaO\text{-}2SiO_2$ doped with well-known NiO to enhance the dry reforming of methane (DRM) reaction. The wet-impregnation method was carried out to prepare the xNiO/AS ($x = 5–15\%$) catalysts and tested them to determine their physicochemical properties. The catalytic performance of xNiO/AS catalysts was investigated in a fixed bed reactor/GC-TCD at a CH_4 : CO_2 flow rate of 30 $ml-1$ during a 10h reaction by following (Shamsuddin et al. 2021c). For optimization parameters, the effects of NiO concentration (5, 10, and 15%), reaction temperature (700, 750, 800, 850, and 900°C), catalyst loading (0.1, 0.2, 0.3, 0.4, and 0.5g), and GHSV (3000, 6000, 9000, 12000, and 15000$h-1$) were evaluated. The results showed that while physical characteristics such as BET surface area and porosity do not significantly impact NiO percentages of dispersion and chemical characteristics like reducibility are crucial for the catalysts' efficient catalytic activity. Due to the active sites on the catalyst surface being more accessible, increased NiO dispersion results in higher reactant conversion. The catalytic performance on various parameters shows 15%NiO/AS exhibits high reactant conversion up to 98% and 40–60% product selectivity in 700oC, 0.2g catalyst loading, and 12000$h-1$ GHSV (see Fig. 1). According to spent catalyst analyses, the catalyst is stable even after the DRM reaction. Meanwhile, increased reducibility resulted in more and better active site formation on the catalyst. Synergetic effect of efficient NiO as active metal and medium basic sites from AS enhanced DRM catalytic activity and stability with low coke formation.