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ORIGINAL PAPER

Hydrogen production by steam reforming of glycerol over Ni/Ce/Cu hydroxyapatite-supported catalysts

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Hydroxyapatite-supported Ni–Ce–Cu catalysts were synthesised and tested to study their potential for use in the steam reforming of glycerol to produce hydrogen. The catalysts were prepared by the deposition–precipitation method with variable nickel, cerium, and copper loadings. The performance of the catalysts was evaluated in terms of hydrogen yield at 600 °C in a tubular fixed-bed microreactor. All catalysts were characterised by the BET surface area, XRD, TPR, TEM, and FE-SEM techniques. The reaction time was 240 min in a fixed-bed reactor at 600 °C and atmospheric pressure with a water-to-glycerol feed molar ratio of 8 : 1. It was found that the Ni–Ce–Cu (3 mass %–7.5 mass %–7.5 mass %) hydroxyapatite-supported catalyst afforded the highest hydrogen yield (57.5 %), with a glycerol conversion rate of 97.3 %. The results indicate that Ni/Ce/Cu/hydroxyapatite has great potential as a catalyst for hydrogen production by steam reforming of glycerol.
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Keywords: hydroxyapatite, glycerol, steam reforming, catalyst, deposition–precipitation, hydrogen

Introduction

Global market trends have seen a rapid increase in the production of glycerol through the biodiesel industry; this waste product would be more economically viable if it could be converted into a value-added product. Hence, it is essential to find useful applications for glycerol. One possible use for crude glycerol ($C_3H_8O_3$) is as a promising renewable source of hydrogen. In comparison with other hydrogen sources such as methanol and ethanol, glycerol steam reforming (GSR) can produce greater amounts of hydrogen (Sánchez et al., 2010).

Using hydrogen as an energy resource for fuel cell-powered electric vehicles has been extensively studied as an environmentally friendly and sustainable source of energy. With the use of hydrogen in fuel cell systems, there is very low (almost zero) emission of carbon-containing substances and no emissions of other air pollutants such as nitrogen oxides and sulphur dioxide (Yacobucci & Curtright, 2004; European Commission, 2003).

The steam reforming reaction of glycerol for hydrogen production occurs in accordance with the following equations:

Glycerol decomposition reaction:

$$C_3H_8O_3(g) \xrightarrow{H_2O} 3CO(g) + 4H_2(g) \qquad \Delta H^0 = +250\,kJ\,mol^{-1} \tag{1}$$

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