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Renewable hydrogen generation via steam reforming of glycerol over Magnesium based catalysts

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Abstract:

The depleting fossil fuels with their ever increasing prices have paved way for alternative fuels. Biodiesel is one of those alternative fuels which have picked up keen interest of the people due to its similar properties of diesel. Use of biodiesel and its production are expected to grow steadily in the future. With the increase in production of biodiesel, there would be a glut of glycerin in the world market .Glycerin is a potential feed stock for hydrogen production because one mole of glycerin can produce 7 moles of hydrogen. The most efficient method for obtaining hydrogen from glycerol is the steam reforming. This study focuses on hydrogen production from steam reforming of glycerol over magnesium based catalyst using various supports Al_2O_3, La_2O_3, and ZrO_2 in fixed bed catalytic reactor. Catalysts was prepared by the wet-impregnation method and characterized by X-ray diffraction technique, BET surface analysis, scanning electron microscopy analysis. The performance of the catalyst was evaluated in terms of hydrogen yield, selectivity and glycerol conversion in the range of temperature 600-850 °C. Glycerol conversion and hydrogen yield were obtained maximum at 800°C for magnesium supported on Al_2O_3.

Keywords

Biodiesel, Hydrogen, Steam reforming, Glycerol, Magnesium.

1. Introduction

At present almost 95% of the hydrogen is being produced from fossil fuel based feed stocks and most is used as a chemical ingredient in petrochemical, metallurgical, food, and electronics processing industries. The depleting fossil fuels with their ever increasing prices have paved ways for alternative fuels. Recent years have seen the rapid development of biodiesel as alternative to nonrenewable energy resources, and it is forecasted that biodiesel could make up as much as 20% of all transportation fuel by2020.Use of biodiesel and its production are expected to grow steadily in future. With the increase in production of biodiesel, there would be a glut of glycerol in the world market [I]. Glycerol is a potential feed stock for hydrogen production because one mole of glycerol on steam reforming produces 7 moles of hydrogen. Production of hydrogen from glycerol is environmentally friendly because it adds value to glycerol generated from biodiesel plants [II, III]. The various methods used for production of hydrogen from glycerol are steam reforming, liquid phase reforming, partial oxidation, supercritical water reforming, and auto thermal reforming [IV,V]. Steam reforming is the most energy efficient technology available, and it is the most cost-effective. It is strongly endothermic and ideally, it must be carried out at high temperature, low pressure and at high steam to glycerol ratio to achieve higher conversion [VI]. The steam reforming of glycerin proceeds according to the following reaction [VII,VIII].

$$C_3H_8O_3+3H_2O_3CO_2+7H_2,\ (\Delta H^0 = 128KJ/mol)\ (I)$$

The effective utilization of glycerol as source of hydrogen depends critically on the invention of new catalysts with high selectivity towards hydrogen, low deactivation and a sufficient reaction rate under mild conditions [IX, X].

In the present study. In this research magnesium catalyst loaded on Al_2O_3, La_2O_3 and ZrO_2 were prepared for hydrogen production from glycerol. Magnesium is preferred because it has good activity for C-C, O-H, and C-H bond cleavage in the hydrocarbon and it also catalyzes the water gas shift reaction in order to remove adsorbed carbon monoxide from the surface [XI]. The catalysts were characterized by BET surface area, XRD and SEM Techniques.

2. Experimental

2.1. Catalyst preparation

The catalysts were prepared by incipient wetness impregnation method. Magnesium catalysts were prepared over there different supports (1) γ- Al_2O_3 . (2) La2O3. (3) ZrO2 Purchased from central drug house private limited, New Delhi. For this purpose aqueous solution of $Mg(NO_3)_2.6H_2O$ (99% Merek) was prepared. γ-Al_2O_3, La_2O_3 and ZrO_2 were

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