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Hydrogen production from glycerol steam reforming over nickel catalysts supported on alumina and niobia: Deactivation process, effect of reaction conditions and kinetic modeling

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ABSTRACT

Ni catalysts were prepared by wet impregnation of three different supports: alumina, niobia and 10 wt.% niobia/alumina, prepared by (co)precipitation. The catalysts were evaluated on steam reforming of glycerol at 500 °C, for 30 h. The catalyst supported on Nb_2O_5/Al_2O_3 presented the best performance, with higher conversion into gas (80%) during all reaction time and hydrogen yield of 50%. Alumina supported catalyst showed higher deactivation and lower hydrogen yield. All catalysts showed coke formation, but it was formed in larger amount on the catalysts supported on single oxides. A depth study was conducted to evaluate the effect of reaction variables as space velocity, glycerol concentration in feed and temperature on the catalytic performance of the Nb_2O_5/Al_2O_3 catalyst. Kinetic study was also performed for this catalyst using two different approaches, obtaining glycerol and steam orders, as well as the apparent activation energy.

Introduction

Currently, fossil fuels are responsible for the major energy supply in the world, playing an essential role in developing various sectors of the economy. However, these resources are non-renewable and related to emission of pollutant gases, especially those associated with global warming. These gases cause a disturbance in fauna and flora and can affect human health, as they are responsible for respiratory and skin diseases and may also affect the nervous system.

Thus, considering the increasing concern about environmental issues and the expected increase in energy demand, the development of alternative fuels is urgent and essential [1]. Hydrogen is a potential alternative, because it can be produced from a variety of feedstocks and different processes and its use in fuel cells does not release significant amount of pollutant gases. Furthermore, hydrogen has a high calorific value (122 $kJmol^{-1}$), which is almost three times higher than the calorific value for hydrocarbons [2]. Hydrogen is also employed in a variety of chemical industry processes, as for the ammonia synthesis, oil refining and Fischer Tropsch reaction.

Most of the hydrogen production nowadays is through natural gas (48%), heavy oils (30%) and coal (17%). Only a small

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