Catal Lett (2016) 146:1435–1444
DOI 10.1007/s10562-016-1773-y

Coking Study of Nickel Catalysts Using Model Compounds

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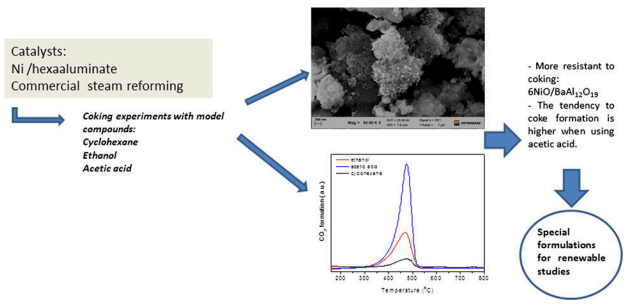
Received: 13 March 2016 / Accepted: 18 May 2016 / Published online: 25 May 2016

Abstract The tendency of coke formation was investigated using nickel catalysts supported on calcium and barium hexaaluminates, compared with a commercial catalyst of natural gas steam reforming. It was developed a methodology in a microactivity unit using cyclohexane as model compound and hydrogen as gas carrier, at low temperature (300–500 °C). After the coking tests, the catalysts were characterized by elemental analysis (CHN) and thermogravimetric analysis using air and steam. 6NiO-BaAl presented the lowest coke removal rate with air. After that, the methodology was modified for ethanol and acetic acid, important model compounds used in studies of biofuels, steam reforming and bio-oil pyrolysis. All model compounds lead to carbon formation with the same chemical nature, as indicated by the temperature of the oxidation peak. So, the methodology can be used as a tool for selection of catalysts. Additionally, cyclohexane and acetic acid are ideal model compounds, because of the lowest and highest coke removal rates with air.

Graphical Abstract



Keywords Nickel · Hexaaluminate · Coking · Model · Compounds

1 Introduction

Coking is a big problem in development of steam reforming catalysts; some authors use in their investigations model compounds of the process of interest, employing conditions of fast deactivation [1, 2]. For this purpose, hydrocarbons that have high rates of coking can be used, as olefins, aromatic compounds and cycloalkanes [3].

Lobo and Trimm [1] used some olefins, paraffins and acetylene in coking experiments with nickel foil using nitrogen and hydrogen as carrier gases, for 1 h at several different temperatures. Deposition from acetylene was found to be rapid, while deposition from olefins is autocatalytic and accelerated by hydrogen. Carbon formation from paraffins is comparatively slow. In another study, a mixture of n-hexane (13.5 mol%), hydrogen (25 mol%) and nitrogen (61.5 mol%) was passed over the catalysts (nickel

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