

Steam Reforming of Tar Model Compounds Over Nickel Catalysts Supported on Barium Hexaaluminate

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Abstract Barium hexaaluminate was prepared by coprecipitation method and used as support for nickel catalysts, with 7 and 14 wt% of NiO. After calcination at 1,200 °C the hexaaluminate support consisted of different crystalline phases with specific surface area of 22 m² g⁻¹. The catalysts exhibited nickel reduction peaks in the range of 400–540 °C. The catalysts were evaluated in steam reforming of different tar model compounds: benzene, toluene and naphthalene (in solution with toluene). The conversions obtained in benzene and toluene reforming at 650 °C were quite similar, while naphthalene is much more difficult to be converted and inhibits toluene conversion at 800 °C. Both catalysts showed good stability with time on stream despite the high amount of carbon deposit. The coke amount and morphology are dependent on the nature of aromatic compound.

Keywords Tar · Steam reforming · Nickel · Barium hexaaluminate

1 Introduction

Biomass is one kind of promising new energy sources, due to its extensive distribution, great reserves and renewable capacity [1]. Gasification of biomass is regarded as one of

the most promising way to produce syngas, which can be used not only in gas turbines for power generation, but also for catalytic synthesis of methanol, dimethyl ether, liquid hydrocarbons via Fischer–Tropsch reactions and other chemical products [2].

Tar is an inevitable byproduct of biomass gasification that can bring several problems in the downstream process equipment and deposition on catalyst surface [2, 3]. Tar is a complex mixture of aromatic hydrocarbons that depends on biomass composition and gasification conditions; its concentration ranges from 1 to 150 g Nm⁻³ [4]. The typical composition of tar contains 65 wt% mono-aromatics, 20 wt% di-aromatics, 10 wt% phenolic and heterocyclic compounds with 5 % of high molecular weight. Representative compounds for each of these classes are benzene or toluene, naphthalene, phenol, and pyrene [5, 6]. Most studies in the literature use tar model compounds, such as benzene, toluene and naphthalene, to simulate a real gasification stream; however, few studies compare their reactivity [6–9].

Tar may be removed using the catalytic steam reforming process, because the gas produced in gasification has a high temperature ($T > 750$ °C) and a high moisture content (20–60 %), favoring the steam reforming [10]. Several catalysts have been proposed in the literature for the catalytic removal of tar, including natural minerals, alkali metal catalysts and Ni-based catalysts [3, 11, 12]. The majority of published work concerns commercial available nickel catalysts designed for steam reforming of natural gas. When reforming aromatic hydrocarbons, the coke formation is particularly severe; moreover, the sintering of the active phase is also critical because of the high temperatures required [13]. Therefore, development of supported Ni catalysts which have high activity, thermal stability and coking tolerance is necessary.

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