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SBA-15 Supported Bimetallic Catalysts for Enhancement Isomers Production During n-Heptane Decomposition

Abstract: Santa Barbara Amorphous (SBA)-15 supported 1% (Pt–Ni), 1% (Pt–Co) and 1% (Ni–Co) bimetallic catalysts in a heterogeneous reaction for enhancement hydroisomerization and hydrocracking production during reforming or decomposition of n-heptane. The structural and textural features of the nanoporous silicas, both with and without encapsulated nanoparticles, were characterized using small-angle X-ray diffraction, scanning electron microscopy, EDAX, nitrogen adsorption–desorption porosimetry (Brunauer–Emmett–Teller) surface area analysis, Fourier-transform infrared spectroscopy and transmission electron microscopy. The catalytic performance was evaluated at 250–400°C under atmospheric pressure in a plug-flow reactor in a catalyst testing rig under tightly controlled conditions of temperature, reactant flow rate and pressure. The species leaving the reactor were analysed by Gas Chromatography. The results show that 1% (Pt–Ni)/SBA-15, 1% (Pt–Co)/SBA-15 and 1% (Ni–Co)/SBA-15 had a high activity for conversion of n-heptane (around 85%). The selectivity of isomerization is not high, so further studies have to be carried out in the future.

Keywords: nanoporous material, SBA-15, n-heptane, bimetallic catalyst, hydroisomerization, hydrocracking

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1 Introduction

Catalytic reforming of alkanes which is the conversion of conventional petroleum light naphtha feeds (C_6 and C_7 hydrocarbons) into branched aliphatic hydrocarbons and aromatics has been studied extensively in the last two decades, because at the same time the requirements to the gasoline quality are toughened [1]. It has been widely accepted that this reactions are achieved over bifunctional catalysts consisting of noble metal particles supported on a matrix which contains acid sites [2]. The major reactions promoted by bifunctional catalysts are hydrogenation, dehydrogenation, isomerization, cyclization and hydrocracking [3]. Hydroisomerization and hydrocracking of linear alkanes over bifunctional catalysts are considered as an efficient method for evaluating the acidity and catalytic activity of the catalyst [4, 5].

In the last decade, researchers paid more attention to hydro conversion of alkanes over solid acid catalysts with large pore diameter including mesoporous molecular sieves in order to prepare new catalysts for the conversion of heavier hydrocarbons [6–9].

Zhao et al. [10, 11] extended the family of highly ordered mesoporous silicates by synthesizing Santa Barbara Amorphous (SBA) type materials. Since its discovery in 1998, SBA-15 has attracted considerable attention as a potential catalyst support, adsorbent, hydrogen storage and drug delivery media and as a hard template for other nanostructure materials [12] because of its remarkably high thermal stability and variable pore size. SBA-15 possesses high surface area in the range of 600–1,000 $m^2\ g^{-1}$ and consists of hexagonal arrays of cylindrical channels with tunable pore diameters between 5 and 30 nm. Micropores located inside the pore walls interconnect these channels. Moreover, SBA-15 exhibits higher thermal and hydrothermal stability and thicker pore walls 2–8 nm [13] as shown in Figure 1.

The purpose of this research is to prepare the order nanoporous material SBA-15 and modify by supporting Pt–Ni, Pt–Co and Ni–Co bimetallic catalysts by the method of incipient wetness impregnation (IWI) for enhancement isomers production during n-heptane reforming or decomposition.

2 Experimental

2.1 Chemicals

All chemicals viz. triblock copolymer poly(ethylene glycol)-block-poly(propylene glycol)-block-poly(ethylene glycol) (Pluronic P123, molecular weight = 5,800,

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