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Hydroisomerization performance of platinum supported on ZSM-22/ZSM-23 intergrowth zeolite catalyst

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Abstract: Hydroisomerization catalysts Pt/ZSM-22, Pt/ZSM-23, and Pt/ZSM-22/ZSM-23 were prepared by supporting Pt on ZSM-22, ZSM-23, and intergrowth zeolite ZSM-22/ZSM-23, respectively. The typical physicochemical properties of these catalysts were characterized by X-Ray Diffraction (XRD), N_2 absorption-desorption, Pyridine-Fourier Transform Infrared (Py-FTIR), Transmission Electron Microscopy (TEM), X-Ray Fluorescence (XRF), Scanning Electron Microscopy (SEM) and NH_3-Temperature Programmed Desorption (NH_3-TPD), and the performance of these catalysts in *n*-dodecane hydroisomerization was evaluated in a continuous down-flow fixed bed with a stainless steel tubular reactor. The characterization results indicated that the intergrowth zeolite ZSM-22/ZSM-23 possessed the dual structure of ZSM-22 and ZSM-23, and the catalyst Pt/ZSM-22/ZSM-23 had similar pores and weak acidity to Pt/ZSM-22 and Pt/ZSM-23 catalysts. Moreover, Pt/ZSM-22/ZSM-23 catalyst showed a high selectivity in hydroisomerization of long chain *n*-alkanes to mono-branched isomers. The evaluation results for *n*-dodecane hydroisomerization indicated that the activity of Pt/ZSM-22/ZSM-23 was the lowest, while the hydroisomerization selectivity was the highest among the three catalysts. The maximum yield of *i*-dodecane product was 68.3% over Pt/ZSM-22/ZSM-23 at 320 ºC.

Key words: ZSM-22/ZSM-23 intergrowth zeolite, platinum catalyst, *n*-dodecane, hydroisomerization

1 Introduction

Environmental regulation is becoming increasingly stringent and the demand for clean gasoline, diesel oil, high-quality lubricants and other products is increasing (Kerby et al, 2005). Hydroisomerization became a revolutionary technology in the world's oil refining industry in the twentieth century (Marcilly, 2003), and hydroisomerization can convert *n*-alkanes into isoparaffins with same carbon number, which improves the octane number of gasoline oil (Geng et al, 2004). For diesel oil and lubricating oil production, isoparaffins also can reduce the freezing point or pour point, and improve the viscosity-temperature properties of lubricating oil while maintaining high product yields (Martens et al, 2001; Miller, 1987).

Isomerization catalysts play an important role in the hydroisomerization process. Generally, bifunctional catalysts are used in hydroisomerization of *n*-alkanes. The bifunctions include hydrogenation-dehydrogenation activity and acidic components (Saberi et al, 2001; Yang et al, 2007; Ramos et al, 2007; Woltz et al, 2006). The metal component of a catalyst is always the hydrogenation-dehydrogenation active component, while zeolite provides the acidic centers for isomerization and cracking reactions. Although regulation of acidity and metal loadings of catalysts can improve the selectivity of isomerization reaction to a certain extent, but it will still lack selectivity and controllability for structure and composition of the products. Introduction of shape-selective molecular sieve into the isomerization catalyst can effectively control the conversion from mono-carbonium ions and di-carbonium ions to tri-carbonium ions, and prohibit tri-carbonium ions from diffusing into the molecular sieve to undertake secondary cracking reactions. Hence the isomerization selectivity is enhanced.

Silicoaluminophosphate molecular sieves, such as SAPO-11, with tubular 10-membered ring channels with elliptical pore openings, are widely used as support with acid sites and shape-selective pore openings. However, some other zeolites, such as ZSM-22 and ZSM-23, are also good choices for their

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