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ORGANIC TEMPLATE FREE HIERARCHICAL ZSM-5 PREPARED BY DESILICATION

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ABSTRACT

Organic template free hierarchical ZSM-5 were synthesized using desilication. X-Ray Diffraction (XRD), Fourier Transform Infra Red (FTIR) spectrometry, and N_2 adsorption/desorption analytical techniques were applied to characterize the physicochemical properties of the solid synthesized. Hierarchical ZSM-5 of a molar composition of $100SiO_2$:$1.25Al_2O_3$:$1800H_2O$ was obtained at a hydrothermal temperature of 175°C for 36 h. The analytical results showed that the hierarchical ZSM-5 had a mesopore surface area, a pore volume, and a pore diameter of 42.752 m^2/g, 0.186 cc/g, and 3.810 nm, respectively.

Keywords: hierarchical ZSM-5, desilication, organic template free.

INTRODUCTION

Zeolites are microporous crystalline solids of unique properties such as a thermal stability, a high acidity, a good selectivity, and a high ion exchange capacity. Therefore, they can be used as catalysts, adsorbents, and ion exchange agents [1]. Natural zeolites often contain impurities that can cover the pores or active sites, so activation is required for their elimination [2].

Synthetic zeolites are generally made through a crystallization process of sodium aluminosilicates gels. In this case, a mixture of sodium silicates and sodium aluminates [3] is the source of silica and alumina for zeolites synthesis. Synthetic zeolites are commonly applied in industries because of their high purity and uniformity of particle size.

In general, ZSM-5 zeolites are synthesized using structure directing agents (SDA). Tetraprophylammonium hydroxide (TPAOH) is the most effective substance as a SDA [4]. Although TPAOH provides a good crystal structure, it also causes economical, health, and enviromental problems because it is expensive, toxic [5], and promotes air pollution in the the course of the calcination process [6, 7].

Most of ZSM-5 zeolites are prepared of a micropore size. Microporous ZSM-5 has limitations in respect to molecular diffusion due to steric effects, especially in case of bulky molecules [8]. There are many attempts to overcome this problem referring to the development of mesoporous ZSM-5 and hierarchical (microporous and mesoporous) ZSM-5. Meso-sized pores are expected to facilitate the reactants mass transport into the active site of the zeolite.

Mesopores can be obtained in zeolites with the addition of a cationic surfactant as a mesophase template. The surfactant can be eliminated, as is done by Goncalves et al. [9], Barakov et al. [10], Hartati et al. [11], or Jian et al. [12] upon completion of the synthesis process. However, the use of cationic surfactant results in air pollution, and which is why alternative methods are needed. Desilication is an easy method applied to the synthesis of various types of mesoporous zeolites, for example Mobile Five-1 (MFI) [13], Mordenite (MOR) [14], and Beta Polymorph A (BEA) [15]. Desilication can provide a controlled mesoporous structure maintaining Bronsted acidity [13].