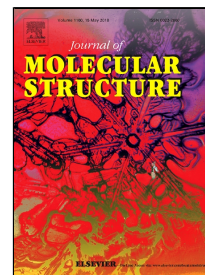


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Characterization of zeolites synthesized from porous wastes using hydrothermal agitational leaching assisted by magnetic separation

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Abstract

In this study, zeolite Na-P1 synthesis from the fly ashes (FA) taken from dust catcher in Sugözü thermic power plant was researched. The structural and magnetic characteristics of the synthesized materials were studied by using the XRD, SEM, EDS, CEC, TGA, DTA, DSC and M-H techniques. High intensity wet magnetic separation was applied to the ashes at different magnetic field intensities. 61% of the iron oxide impurity (Fe_2O_3) was removed by single-stage high intensity wet magnetic separation at 1.5 Tesla. Non-magnetic phase was accumulated in order to leach in alkali medium. 2M NaOH was used as the synthesizing solution. Solid-liquid ratio was 0.3 kg:1 L. It was determined that the zeolitization degrees of the products depend on the reaction time. Zeolite Na-P1 ($\text{Na}_6\text{Al}_6\text{Si}_{10}\text{O}_{32}\cdot 12\text{H}_2\text{O}$) which is the member of the group P zeolites was the dominant species after 10 hours reaction time. Additionally, gismondine ($\text{Ca}_2\text{Al}_4\text{Si}_4\text{O}_{16}\cdot 9\text{H}_2\text{O}$) presence was observed in the products. It was found out that the ferromagnetisms of the products were weakened by elapsed time. The CEC values of the synthesized products were the superior grades ranging from 269.63 meq/100 g to 388.85 meq/100 g.

Keywords: Fly ash, Zeolite Na-P1, Hydrothermal synthesis, Ferromagnetism, Microporous structure.

Introduction

Zeolites are crystalline, microporous and hydrated alumina silicates built on three dimensional complexes of XO_4 ($\text{X} = \text{Si}, \text{Al}$) tetrahedral linked with atoms of oxygen at the edges [1]. The microporous specifications of natural zeolites and their effectiveness in ion-exchange and adsorption are gradually known. Since natural zeolites could not meet the demands in industry, it became an urgent requirement to use synthesized zeolites in addition to the natural ones [2]. Compared with natural zeolites, the synthesized ones have desired benefits like uniform pore dimension, enhanced ion-exchange capacity that saving molecular sieve specification to zeolites, and high purity [3-5]. Even the hydrogen storage systems can be produced from the synthetic zeolites [6]. The basic resources for synthetic zeolite production are commercial chemicals quite rich in alumina and silica, mining reserves existing on earth or else industry by-products [7].

FA is a fine sized material which is a by-product from burning pulverized coal in electricity generation processes. Also, FA is a pozzolan, a substance containing aluminous and siliceous material. There are known common two zeolite synthesis route: alkaline-fusion and hydrothermal. Among them, the hydrothermal method appears as the most significant. The hydrothermal term is used in a wide-ranging and includes zeolite crystallization from aqueous systems comprising the necessary chemical components [8]. Besides, alkaline fusion method is mostly followed by hydrothermal route. Zeolites can be classified or graded as low silica ($\text{Si}/\text{Al} \leq 2$), intermediate silica ($\text{Si}/\text{Al} = 2-5$) and high silica ($\text{Si}/\text{Al} > 5$) zeolites according to the Si/Al

molar proportion in the activated FA [9-10]. Zeolite Na-P1 is a recognised phase of zeolite P group categorized as synthetic members of the gismondine type zeolites. The gismondine zeolite structure has a four dual-connected 4-ring constructive units comprising of $(\text{Si},\text{Al})\text{O}_4$ tetrahedra. The four 2-ring units form “crankshaft” chains around a screw tetrad, to set up the three-dimensional framework [11-12]. Zeolite composites, composed of two or more types of zeolite materials, can thus combine the different pore structures at the nanoscale. These structures enhance the synergetic effect between the acid sites of the different zeolites [13]. Production of coal FAs from the thermic power plants in the world is annually 0.75 billion tons while Turkey’s annual production is 13 million tons [14]. The transformation of coal FA to worthwhile zeolites is an alternative way of reducing the troubles related to FA tailings [15-16]. Adamczyk and Bialecka (2005) were showed zeolite Na-P1 and analcime from Poland FA. The tests were carried out in the autoclave at 6 hours. Effects of temperatures (from 80 to 320 °C) on synthesis were investigated. Zeolite Na-P1 was observed at 140 °C while analcime was detected at higher temperatures. Synthesized zeolite was characterized by cation exchange capacity (CEC) values, x-ray diffraction (XRD) analysis, scanning electron microscopy (SEM), thermal analysis and magnetic properties [17]. Musyoka *et al.* (2012) were synthesized high purity zeolite Na-P1 from South African FAs. For this research, the optimal hydrothermal condition was 48 hours at 140 °C. Stirring speed was 800 rpm [18]. Also, microwave assisted zeolite synthesis was mostly investigated by researchers to reduce the synthesizing time

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