Characterization of Natural Zeolite from Gunung Kidul, Yogyakarta, Indonesia and Its Modification, and Its Use to Reduce the Contamination of Zinc in Waste Water

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Abstract: This study was aimed to characterize the natural zeolite from Gunung Kidul, Yogyakarta, Indonesia and its acid modification, evaluate the time required to reach equilibrium in the adsorption process of Zn^{2+}, measure the maximum concentration of the ion that could be adsorbed per unit mass of adsorbent (adsorption capacity of the adsorbent). It was shown from the data and the figure that the adsorption equilibrium was attained after 60 minutes of time with the adsorption capacity of 4.1 ± 0.03 mg/g. From the infrared spectra, it was clear that treatment with HCl 1 N did not change the functional group of the zeolite used. Comparing X-ray diffraction pattern of natural zeolite used and that of standard zeolite, it could be stated that the natural zeolite from Gunung Kidul, Yogyakarta, Indonesia, is zeolite of mordenite type. It was also demonstrated from the X-ray diffraction patterns that treatment with HCl 1 N did not destroy the crystalline structure of zeolite.

Key words: Natural zeolite, adsorption equilibrium, adsorption capacity, mordenite-type.

1. Introduction

Structurally, zeolite is a crystalline polymer composed of primary building unit SiO_{4}^{4-} and AlO_{4}^{5-} tetrahedral, and has a general formula of:

\[ M_{x/n} (AlO_2)_{y} (SiO_2) \]

Where, n is the valence of cation M, x + y is the number of tetrahedral per unit cell, y can vary from 2 to unlimited [1].

Tetrahedral units SiO_{4} dan AlO_{4} are interconnected to form secondary building unit. The interconnection of SiO_{4} and AlO_{4} tetrahedrals take place through the linkage of O atoms located at the edge of the hedral, as shown by Fig. 1 [1].

The frame of the silica-alumina constitutes a porous solid structure and a canal system in zeolite, inside it there is water molecule and cation attached on the active site of zeolite and it is exchangeable. The pore and canal size differs for different type of zeolite, depending on the crystalline unit arrangement. The pore and canal system of certain size along with the active site of zeolite make the material can be used as a material for filtering molecule and cation binding with certain selectivity [2]. In Indonesia, the amount of zeolite is abundant and it is distributed on several region, at Java Island, Sumatera, and Sulawesi [3].

Free Zn^{2+} in water at high concentration are very toxic for plant, invertebrate and vertebrate fishes [4].

Fig. 1 The structure of zeolite.