Kinetics and adsorption isotherms of zeolite-MBT selective adsorbent towards Cd(II) ions in mixed systems

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Abstract

The adsorption of Zeolite-MBT toward Cd(II) Ion in mixed systems has been investigated in batch mode. Effect of time and initial concentration of adsorbent on metal ion selective adsorption was investigated. The zeolite-MBT adsorbent was synthesized previously by impregnation of MBT to zeolite dealumination at at pH 8, temperature 80°C and zeolit-MBT ratio is 0,12. The result showed that the adsorption of zeolite-MBT to Cd(II) ion in mixed system favourable the first-order kinetic model with correlation coefficient, R² are 0.758 and 0.635 respectively for Cd(II) and Cr(III) metal ions. Freundlich’s and Langmuir’s mathematical models were used to describe batch adsorption equilibrium data and the constant of adsorption were evaluated. The adsorption was found to be favourable in both isotherms. The correlation coefficient, R² of Langmuir isotherm are 0.993 and 0.929, and the Freundlich’s isotherm are 0.943 and 0.920 respectively for Cd and Cr metal ions.

Keywords: Kinetics, adsorption Isotherms, selective adsorption, Zeolite-MBT

Introduction

Many industrial processes produce aqueous effluents containing toxic metal contaminants. According to the World Health Organization (WHO), the metals most of immediate concern are aluminum, chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium, mercury and lead. In particular, cadmium and cadmium compounds are especially dangerous and highly toxic. Cadmium toxicity contributes to a large number of health conditions, including the major killer diseases such as heart disease, cancer and diabetes. Cadmium concentrates in the kidney, liver and various other organs and is considered more toxic than either lead or mercury (El-Sayed et al., 2010).

Recovery of heavy metal from wastewater and industrial waste has become a very important environmental issue (Saravanan et al., 2009; Ghazy et al., 2008). Inorganic effluent from the industries contains toxic metals such as Ni, Cu, Zn and Cd which tend to accumulate in the food chain. Because of their high solubility in the aquatic environments, heavy metal can be adsorbed by living organism. Once they enter the food chain, large concentrations of heavy metals may accumulate in the human body. Therefore, it is necessary to treat metal contaminate wastewater prior to its discharge to the environment (Panneerselvam et al. 2009; Kurniawan et al. 2006).

Many processes for the removal of heavy metals from water and wastewater have been investigated (Panneerselvam et al. 2009; Buasri et al., 2008; Kurniawan et al. 2006). Various treatments have been developed for purification of water and wastewater contaminated by heavy metals, including precipitation, coagulation – flocculation, electrochemical treatment, chelation, biosorption, adsorption, membrane filtration, solvent extraction, reverse osmosis, and ion exchange model (Lesmana et al., 2009; Panneerselvam et al. 2009; Vázquez, 2009; Barakat, 2008; and Kurniawan et al., 2006).

Efforts to adsorb of heavy metal ions in the environment by using natural materials have been widely reported. Buasri at.al (2008) using natural zeolite Clinoptololit to remove Pb (II) from wastewater. Halima Husain and Ramlawati (2007) using natural zeolite to reduce the levels of peroxide in cooking oil.

Optimization of the purification process of waste materials or require development of new materials based on the availability of raw materials are plentiful and inexpensive and has a high effectiveness in removing heavy metals. The complexity types of industrial wastes require proper handling techniques.

The use of natural zeolite as an adsorbent for the adsorption of heavy metals in waste water has been done, because the zeolite qualified as a good adsorbent, cheap and easy to find. However, in some cases, to a certain practical purpose is to be collected or separated from one or several specific metals in mixed metal waste system, sometimes less selective use of natural zeolite as separation power is still relatively low (Tsitsishvili et al, 1992). One method that is being developed to increase selectivity is to modify the surface of natural zeolite by impregnation with certain organic materials. The organic materials have been impregnated into zeolite characterized favourable to bond with one or several specific metal ions than other, hence resulting a selective adsorption.