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Utilizing Faujasite-type zeolites prepared from waste aluminum foil for competitive ion-exchange to remove heavy metals from simulated wastewater

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ABSTRACT

The pollution by heavy metal ions is a severe risk for aquatic and earthy living creatures. Ion-exchange is an easy way to eliminate heavy metal pollution. Different ion-exchangers have been developed and applied for wastewater and other environmental treatments, such as zeolites. The synthesis of zeolites from inexpensive sources is very important in the minerals industry. The recycling of the waste aluminum foil to obtain the alumina source for the preparation of NaY zeolite and NaX zeolite was investigated in this study. Both Faujasite-type zeolites were obtained by a conventional hydrothermal treatment of the gel at 100°C for 24 h. The prepared zeolites were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive analysis by X-ray (EDAX), and nitrogen adsorption/desorption isotherms. The synthesized NaY zeolite and NaX zeolite based on aluminum foil had a Si/Al ratio of 2.28 and 1.35, and a specific surface area of 476.248 and 610.256 m^2/g, respectively. Also, the treatment of the individual, binary, and ternary metals solutions containing Cd(II), Cu(II) and Hg(II) ions was carried out using ion-exchange by NaY zeolite and NaX zeolite. The affinity of both zeolites to the selected metal ions was in the following order: Cd(II) > Cu(II) > Hg(II). The ion-exchange results highly adapted to the pseudo-second-order kinetic model with high correlation coefficients ($R^2 > 0.96$). Furthermore, stabilization of the removed ions inside the spent zeolites was conducted by geopolymers prepared from ordinary Portland cement and fly ash as cement material. Fly ash showed high potential as a solidifying material for the samples examined in the leaching test by H_2SO_4 solution. The ratio of 1 cement:3 fly ash gave the least leached metals concentration at all testing conditions.

Keywords: Zeolite; Waste aluminum foil; Competitive ion-exchange; Heavy metals; Kinetics

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