Removal of Mn(II), Fe(III) and Cr(III) from aqueous solutions using Bulgarian clinoptilolite

Paunka Vassileva and Dimitrinka Voykova

Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria. *E-mail:* pnovachka@svr.igic.bas.bg

Zeolites, which represent the largest group of microporous materials, are crystalline inorganic polymers based on a three-dimensional arrangement of SiO_2 and AlO_4 tetrahedra connected through their oxygen atoms to firm large negatively-charged lattices with Bronsted and Lewis acid sites. The use of zeolitic materials for the environmental protection is stimulated by good physico-chemical properties, e.g. selective sorption, by non-toxic nature, availability and low cost. A great deal of research on natural zeolites has been focused on the most commonly occurring types, especially clinoptilolite and mordenite. Natural zeolites are used in a wide range of environmental applications, including water purification, with the emphasis on the ammonia and heavy metal removal. Most technologies using natural zeolites for water and soil purification are based on the unique cation-exchange behaviour of zeolites through which dissolved cations are removed from water or soil by exchanging with cations on a zeolites exchange sites.

Adsorption of Mn(II), Fe(III) and Cr(III) from aqueous solutions onto natural and pretreated Bulgarian clinoptilolite from Beli plast deposit is studied. Batch adsorption studies are carried out to evaluate the effect of contact time, temperature, solution pH and initial concentration of investigated ions. The treatment with NaCl improves both the adsorption capacity and the removal efficiency of natural clinoptilolite. Comparison of the experimental data with Langmuir, Freundlich and Dubinin–Radushkevich isotherm models show the Freundlich model described the process more accurately. Pseudo-first-order, pseudo-second-order and intraparticle diffusion models are used to analyze the kinetic data. The values of adsorption standard free energy, enthalpy and entropy for Mn(II), Fe(III) and Cr(III on both adsorbents are determined. The removal of all investigated ions from multi-component aqueous solution is significantly affected by the presence of competing ions.

Based on the experimental results, it can be concluded that Mn(II), Fe(III) and Cr(III) ions can be effectively removed from aqueous solutions using natural and NaCl treated Bulgarian clinoptilolite. Hence, Bulgarian clinoptilolite may be used as a low cost source for the removal of Mn(II), Fe(III) and Cr(III) and it may be an alternative to more expensive materials.