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An experimental study of sorption properties of natural zeolite-containing rocks and their ability for purification of aquatic solutions contaminated with Ni and Zn

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Sorption parameters of natural zeolite-containing tripolite from the Khotynetsky deposit (Russia, Oryol region) were studied in a series of experiments to evaluate possibility of its usage as a geochemical barrier for technogenic Ni^{2+} and Zn^{2+} contaminating soils and ground waters.

Firstly, the tripolite total ion-exchange capacity was established by its saturation with ammonium ion and evaluating its content in the initial and ammonium forms with the help of X-ray fluorescence method. Secondly, the kinetic characteristics, namely the time necessary to reach the equilibrium state of the rock-water system containing Ni^{2+} and Zn^{2+} ions were determined in batch experiments using the method of "limited volume". The latter experiment was conducted using 0.5 g tripolite with 250 ml model solutions simulating natural river water (0.003 n CaCl_2) and filtration water from solid domestic waste landfill (0.06 n CaCl_2) and containing 2 mg/l Ni^{2+} and Zn^{2+} . The time of contact between the sorbent and the model solution varied from 2 hours to 21 days. Thirdly, basing on reference data on the real content of heavy metals in the filtrates of various landfills, an experiment on determination of the tripolite equilibrium exchange (and adsorption) capacity was carried out. The prepared model solutions in the latter experiment contained 2, 5, 7 and 10 mg/l of Ni^{2+} and Zn^{2+} . The amount of Ni^{2+} and Zn^{2+} in solutions was determined by the ICP-AES.

According to the obtained results, the total ion-exchange capacity of the natural tripolite equaled to 1.18 mg-eq/g. The sorption isotherms based on kinetic experiments showed that equilibrium in the studied rock-solution system took place after 200 to 500 hours of interaction. Despite natural scattering of experimental points in the range of the used Ni^{2+} and Zn^{2+} concentrations in the third experiment which lasted 21 days, the sorption of the studied ions by the natural tripolite can be approximated by a linear isotherm, zinc being sorbed much better than nickel. The average values of distribution coefficients (K_d) obtained for 0.003 n CaCl_2 aquatic solution equaled to $2.7 \cdot 10^3$ ml/g for Ni^{2+} and $6.7 \cdot 10^3$ ml/g for Zn^{2+} .

Therefore, natural tripolite of the Khotinetsky deposit may well be used as a natural geochemical barrier for extraction of technogenic Ni^{2+} and Zn^{2+} from natural waters draining landfills and contaminated by these ions.