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Removal of the uranium(VI) compounds from model solutions with sorbents of different nature

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The problem of uranium compounds removal from aqueous solutions remains valid for many years. To solve this problem, the sorption methods are used widely. A search of sorbents, which would combine availability, cheapness, possibility of regeneration, absorption efficiency in a wide range of pH, temperature, and concentration, is an important task.

The aim of this work was to establish an efficiency of sorbents of different nature towards removal of uranium compounds from model solutions.

The research objects were aqueous solutions of uranium(VI) acetate with concentration of $(0.1\text{-}2.0)\cdot10^{-4}$ mol l^{-1}, which contained also 0.02 M H_2SO_4, HNO_3, HCl (pH 2.0-2.5) or $NaHCO_3$ (pH 8.0). These reagents are used for treatment of uranium-containing minerals. Inorganic zirconium-silica sorbents, Dowex HCR-S cation exchange resin and organic-inorganic sorbents, which were obtained by modification of this resin with nanopartilces of zirconium hydrophosphate, FIBAN fibrous sorbents (cation exchanger FIBAN K-1, anion exchanger FIBAN A-6 and ampholyte exchanger FIBAN AK-22B) were used as sorbents. Sorption experiments were carried out under static conditions at 293K.

The studies have shown that all investigated sorbents remove uranium compounds effectively from the model solutions. The removal degree reaches 95-100% under optimal conditions, which were found for each particular system. Characteristics of the sorbents (specific surface, pore size, particle size, functional groups that are included) determine their optimal consumption. Constants of film diffusion rate, particle diffusion coefficients of U(VI), rate constants of pseudo-first and pseudo-second order have been determined. Sorption isotherms are processed using the Langmuir, Freundlich, Dubinin-Radushkevich and Frumkin-Fowler-Guggenheim equations. The calculated values of constants of these equations indicated a significant affinity of U(VI) compounds to the sorbents and ion exchange mechanism of sorption. It was found that the sorbents could be regenerated for 88-100% by 1 M solutions of NaCl, HCl, H_2SO_4 and $NaHCO_3$.