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Porosity of inorganic ion-exchangers and their sorption selectivity towards the ions of heavy metals and radionuclides.

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The report presents data about the new method of synthesis of inorganic ion-exchangers in continuous mode of sol-gel process, which provides the possibility of obtaining the spherically granulated hydrogels and xerogels of highly porous oxides, silicates and phosphates of polyvalent metals. The basis of the process –the reactions of templating competitive interactions between Fe and Al salts and the basic components in the reaction mixture, namely, with Ti and Zr salts, as well as phosphoric and silicic acids and sodium, potassium, ammonium hydroxides etc. [1,2].

Using the washing procedure of gel spherical particles (d = 0,2 ~ 1,2 mm) by water with different pH values and organic solvents, it is possible, after drying, to obtain the inorganic ion-exchangers with bimodal nanoporosity, in particular, with transport ultramicro- and meso-pores and with the specific surface area values around 200- 600mg/g

It was shown that due to the factors of structural compliance (between the size of ultramicropores and diameter of sorbed ions) and also complex formation with functional and hydroxyl groups in the matrix of ion-exchangers, the selective sorption of cations of d- metals and trace amount of radionuclides 137Cs, 90Sr, 239Pu, 241Am, and uranium is carried out from solutions with complex composition.

It was also found that in case of the uranium sorption from the model solutions of uranyl acetate on the highly porous titanium phosphates is occured the formation of a separate phase of uranyl phosphate in mesopores at pH range ~ 5-7, wherein the sorption equilibrium is reached only during ~ 3000 hours.

In the report is also presented data that demonstrate the effect of various factors on the sorption selectivity of radionuclides Cs and Sr, and also uranium and transuranic elements by powdered forms of ion-exchangers on the basis of amorphous titanium silicates. It was found that this inorganic ion-exchanger has, in some way, the properties of universal sorbent, capable to selective sorption of the most long-lived radionuclides from solutions with complex composition. Finally, it was shown that the combined use of some inorganic coagulants, based on titanium compounds, and the inorganic ion-exchangers investigated in this project enables to purify, almost completely, the liquid radioactive waste of destroyed 4th block of the Chernobyl nuclear power plant from the entire spectrum of radionuclides. In the report is also presented the field data of our investigations at the Chernobyl nuclear power plant.

1. V.Strelko. Method of Completing for Sol-Gel Processing of Sorbents and Catalysts in Aqueous Solutions of Inorganic Salts. Focusing on Materials for Pollution Control, Water Purification, and Soil Remediation, Edts. P.Innocenzi, Yu. L.Zub, V.G.Kessler. Sprsnger. 2008, p.p. 227-251.

2. V.V.Strelko. New Sol-Gel Processes in the Synthesis of Inorganic Sorbents and Exchangers Based on Nanoporous Oxides and Phosphates on Polyvalent Metals. J. Sol-Gel Sci. Technol. 2013, (on line).

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