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Nanostructured aluminosilicate sorbents of radionuclides based on clay-salt slimes of JSC "Belaruskali": Physicochemical properties and application

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Solving the problem of ensuring of the radioactive waste safe management from NPP is very relevant in the world due to the intensive development of nuclear energy, as well as environmental pollution because of technogenic accidents at NPP (Chernobyl, Fukushima). Natural aluminosilicates and modified products based on them can be promising materials for purification from radionuclides of technological solutions of nuclear power plants, including liquid radioactive waste, as well as contaminated with radionuclides of natural ecosystems.

One of the possible directions of utilization of clay-salt slimes (CSS) which are industrial wastes of potassium production of JSC "Belaruskali"is obtaining of nanostructured aluminosilicate sorbents of radionuclides on them. As a result of long-term studies of the composition and structure of sorbents based on CSS it was pointed out that they belong to clay minerals. Illite prevails in the composition of clay minerals, the content of which varies in the range of 44–54%, depending on the type of sorbent. The specific surface of sorbent samples varies from 21 to 32 m2/g. Water-acid treatment allows to increase the specific surface of sorbents by almost 2 times, and the content of the sorption-active mineral –illite up to 65% due to the decrease in the content of carbonate minerals and water-soluble salts.

On the basis of studying the sorption kinetics of 137Cs with aluminosilicate sorbents based on CSS at a ratio of solid : liquid = 1 : 100 phases, it has been established that sorption occurs rapidly and within 10 minutes and is about 95% [1]. Further increase in the time of interaction of the sorbent with the radioactive solution up to 30 days leads to an increase of sorption degree up to 98%. The sorption isotherm 137Cs, constructed in a wide range of concentrations from 10-10 to 10-1 mol/l, showed that it is possible to distinguish two sites of sorption, which differ in 137Cs distribution coefficient. These sections show that the sorption of 137Cs on samples of sorbents occurs on two types of sorption centers, differing in capacity and selectivity of 137Cs binding. An investigation of the acidity (pH) effect of the radioactive solution on 137Cs sorption by aluminosilicate sorbents showed that in 2–12 pH range the degree of sorption varies from 95 to 98%. It was found that the degree of sorption of 137Cs is significantly influenced by the presence of K+ and NH4+ cations in the solution. In the concentration range of the Na+ cation up to 0.5 mol/l, the 137Cs sorption on the aluminosilicate sorbents practically does not change. Studies of the sorption of Cs(I), Sr(II), Eu(III), Am(III) by sorbents obtained from CSS have been carried out at the Institute of Nuclear Chemistry and Technology (Warsaw, Poland) [2]. It was pointed out that the degree of sorption of Cs(I), Sr(II), Eu(III), and Am(III) radionuclides is 99, 99, 91 and 97%, respectively.

The results of the performed studies indicate that the aluminosilicate sorbents based on the CSS of JSC "Belaruskali"are very effective for both sorption of 137Cs and radionuclides of Sr(II), Eu(III) and Am(III). Sorption materials based on CSS can be effective sorbents for purification from radionuclides of liquid radioactive waste from NPP, aquatic environments and natural ecosystems.

References

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