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Recovery of actinides and lanthanides on solid-phase extractants from nitric acid solution

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Recovery of trivalent actinide and rare earth elements from complicated nitric acid solutions is important and difficult task of radiochemistry. Sorption materials for radionuclide recovery must possess the high sorption efficiency, selectivity of recovery, chemical stability and good kinetic properties. Solid-phase extractants (SPEs) prepared by impregnation of solid supports with ligands are the most appropriate for this purpose. Compounds for impregnation provide formation of complexes with actinides and lanthanides in nitric acid solution and ensure the possibility of their recovery. New types of solid supports for impregnation –high-porous and fine-dispersive polymers and carbon nanomaterials –are very promising for the SPE preparation. These materials ensure strong retention of impregnated ligands, efficiency and stability of SPEs in solutions with high content of nitric acid as well as good kinetic and other properties.

This report is focused on sorption ability and efficiency of application of novel SPEs developed by us for recovery of actinide and lanthanide from nitric acid solution. As solid supports we have used Taunit carbon nanomaterial (NanoTech-Center, Russia) and polystyrene polymers –high crosslinked (Isolute, Sweden) or hyper cross-linked (Macronet, UK). For impregnation the phosphorus and nitrogen containing ligands have been used: diphenyldibutylcarbamoylmethylphosphine oxide, tetraoctyldiglycolamide, tri-n-octylphosphine oxide, di-2-ethylhexylmethylphosphonate; these ligands possess of the high efficiency in nitric acid solution also applied in liquid-liquid extraction processes. Impregnation was carried out by solutions of ligands in organic solvents (dichloroethane) or by ligands in nitric acid solution. Impregnation in nitric acid is more advanced technique because it provides high stability of SPEs and efficiency of their application in solution with high content of nitric acid.

Novel SPEs have demonstrated high sorption ability toward actinides and lanthanides (distribution coefficients in 3 mol/L HNO₃ are 10³-10⁴ mL/g, good kinetic properties and high efficiency of recovery in batch or column mode. On the base of experimental data we have developed the regimes of sorption preconcentration of actinide and lanthanide elements from 1-3 mL 3 mol/L HNO₃ and determined conditions of their elution.

The selectivity of actinide and lanthanide recovery is conditioned by properties of impregnated ligand and conditions of experiment. In this report we demonstrate examples of selective recovery of trivalent lanthanides with their separation from uranium and thorium. For this purpose we have used solid-phase extractants obtained by impregnation of various types of ligands. By use of multicomponent model solution, the effect of several elements that can be present in solutions of spent fuel reprocessing in nitric acid was examined.

Reference: E.A. Zakharchenko, D.A. Malikov, N.P. Molochnikova, G.V. Myasoedova, and Yu.M. Kulyako. Sorption Recovery of U(VI), Pu(IV), and Am(III) from Nitric Acid Solutions with Solid-Phase Extractants Based on Taunit Carbon Nanotubes and Polystyrene Supports. *Radiochemistry*, 2014, Vol. 56, No. 1, pp. 27–31

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