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Extraction and separation of cesium and strontium by crown ethers in organic solvents

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Extraction and separation of cesium and strontium is an important issue in radiochemistry, how to solve problems relative to the treatment of liquid radioactive waste (LRW), and for analytical purposes. The best extractants suggested for solving this problem are solutions of crown ethers in organic solvents.

This paper presents the results of researches on the extraction of cesium and strontium by various substituted crown ethers from nitric acid solutions, and also from neutral solutions in the presence of activating additives. The following macrocycles: dibenzo-18-crown-6 (DB18C6), dibenzo-21-crown-7 (DB21C7), dibenzo-24-crown-8 (DB24C8), 4,4'(5')-di-tert-butyl-dibenzo-18-crown-6 (DTBDB18K6), dicyclohexyl-18-crown-6 (DCH18C6) and 4,4'(5')-di-tert-butyl-dicyclohexyl-18-crown-6 (DTBDCH18K6) were examined. Polar solvents: 1,2-dichloroethane (DCE), nitrobenzene (NB), chloroform (CL), 1,1,7-trihydrododecafluorheptanol (FH) were selected for researches. The effect of the crown ether structure, the solvent nature and the acid concentration was determined in the extraction of cesium and strontium from nitric acid solution containing 100 mg/L Cs and Sr and 0.1 - 5 mol/L of HNO₃ into 0.1 mol/L crown ethers in organic solvents. It has been established that all investigated dibenzocrown ethers considerably extract cesium and don't extract strontium. At the same time dicyclohexyl derivatives are the effective extractants for strontium and don't extract cesium. The dependence of the distribution coefficients of metals (DCs and DSr) on the concentration of nitric acid has an extreme character with the maximum at 1 - 3 mol/L HNO₃ depending on the solvent nature. The difference in the extraction ability of dibenzo- and dicyclohexyl derivatives of crown ethers may be used for the separation of radionuclides of cesium and strontium from nitrate media.

Also, the processes of extraction of cesium and strontium by 0.01 M solutions of macrocyclic polyethers in organic solvents from neutral nitrate, chloride and sulfate aqueous solutions in the presence of activating additives were studied in this work. Under these conditions, DCs and DSr in the absence of activating additives are close to zero for all examined crown ethers. The introduction of various metal salts as activators into the extraction system doesn't change this situation. Only in the presence of lithium bis(trifluoromethylsulfonyl)imide (CF₃SO₂)₂NLi both dibenzo and dicyclohexyl crowns extract cesium from the aqueous into the organic phase with noticeable DCs. Under these conditions strontium is extracted insignificantly only by dicyclohexyl derivatives.

Our studies have shown that the application of the proposed (CF₃SO₂)₂NLi activator allows to solve the task of the efficient separation of cesium and strontium by extraction with dibenzocrown ethers from neutral solutions. These systems can be used for developing analytical techniques and solving problems in radiochemistry.

Primary author: Ms TSARENKO, Nadezhda (JSC «Scientific-research institute of chemical technology»)

Co-authors: Ms STREL'NIKOVA, Aleksandra (JSC «Scientific-research institute of chemical technology»); Dr ANAN'EV, Aleksey (JSC «Scientific-research institute of chemical technology»); Prof. TSIVADZE, Aslan (Frumkin Institute of Physical Chemistry and Electrochemistry, Russian Academy of Sciences)

Presenter: Ms TSARENKO, Nadezhda (JSC «Scientific-research institute of chemical technology»)

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