



# Cesium and americium extraction from carbonate-alkaline media with O-substituted *p*-alkylcalix[8]arenes

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**Abstract**  $^{137}\text{Cs}$  and  $^{241}\text{Am}$  extraction with perchloroethylene solutions of O-substituted *p*-alkylcalix[8]arenes (alkyl: *tert*-butyl, *iso*-nonyl) from carbonate-alkaline media is studied. Dependence of distribution ratios on pH values of the aqueous phase in the range 11–13.9 and on the nature of functional groups in the calixarene platform is confirmed. Composition of cesium and americium solvates with calix[8]arenes is determined. *Tert*-butylcalix[8]arene with oxybis(ethane-1,2-diyl) bridging group possesses superior efficiency towards cesium in alkaline media. The most efficient extractants for americium are “mixed” *iso*-nonyl-*tert*-butylcalix[8]arenes with ethane-1,2-diyl and oxybis(ethane-1,2-diyl) bridging groups.

**Keywords** Extraction ·  $^{137}\text{Cs}$  ·  $^{241}\text{Am}$  · Alkaline medium · O-substituted calix[8]arenes

## Introduction

Large amount of liquid alkaline high-level wastes (HLW) is a challenge for modern atomic industry. All technological approaches to the HLW management reduce to several ways, which are not without shortcomings. The first way is direct vitrification, it is rather expensive because of the need to dispose significant volumes of highly active glass in deep geological formations. Another way—preliminary HLW purification from radionuclides—is more economic. It was realized at the Savannah River (USA) by using calixarene-crown ether as a selective cesium complexing agent in a mixture with a fluoroorganic solubilizer and amine modifier in a paraffin diluent [1]. However, this extractant is very difficult to synthesize and allows only cesium extraction from alkaline HLW.

This method of HLW treatment can't be entirely accepted for the processing of alkaline HLW, located in storage tanks at the Production Association “Mayak”, because they differ from those of Savannah River by their origin and composition. These wastes are pulps with total volume of about 18,000 m<sup>3</sup>, containing  $^{137}\text{Cs}$ ,  $^{90}\text{Sr}$  and transuranium elements (TUE) at the background of high amounts of sodium hydroxide and nitrate (both—about 3 mol L<sup>-1</sup> in the liquid part of pulp) and nitrite [2–4]. The main  $\gamma$ -activity is due to the presence of  $^{137}\text{Cs}$  ( $3.45 \times 10^{10}$  Bq L<sup>-1</sup>) and  $^{90}\text{Sr}$  ( $1.71 \times 10^8$  Bq L<sup>-1</sup>), whereas  $\alpha$ -activity ( $3.6 \times 10^7$  Bq L<sup>-1</sup>) is due to the presence of plutonium and americium isotopes [5]. These pulps have been accumulated during long period up to 1986, and several attempts to partially dissolve them and to reduce the temperature of the precipitate were carried out from 1988 to 1995 [2].

According to the Russian legislation, cementation and disposal in surface sites is allowed only for radioactive

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