The use of calix[6]arene molecules for actinides analysis in urine: an alternative to current procedures

C. Bouvier-Capely, A. Manoury, A. Legrand, F. Cuenot and F. Rebière
IRSN, DRPH/SDI BP 17, 92 262 FONTENAY-AUX-ROSES, France
celine.bouvier@irsn.fr

Individual monitoring of workers exposed to a risk of internal contamination with actinides is achieved through in vivo measurements (anthroporadiametry) and in vitro measurements (urine and feces). The procedures currently used for analyzing actinides in urine require lengthy separation associated with long counting times by alpha spectrometry due to low activity levels. Their main drawback is thus that they are time-consuming, which limits the frequency and flexibility of individual monitoring. In this context, the aim of this work, carried out by the Radiochemistry Laboratory at the Institute for Radiological Protection and Nuclear Safety (IRSN), is to propose alternative radiochemical procedures for the analysis of actinides U, Pu and Am in urine. In order to selectively extract actinides from urines, it is of interest to use calix[n]arene molecules. Indeed, the preorganized structure of these macrocyclic molecules is suitable for the complexation of ions and they can be easily functionalized to be more specific. Thus, the p-tertbutylcalix[6]arenes bearing three carboxylic acid groups or three hydroxamic acid groups are excellent extractants for uranium, and they have also a very good affinity for plutonium and americium. The extraction of actinides by these calixarene has been studied experimentally, and also by computational study for uranium. From these results, a new radiochemical procedure has been proposed for U, Pu, Am analysis in urine. For an application to bioassays laboratories, it was decided to immobilize the calix[6]arene molecules on an inert solid support, for implementation with a chromatographic column. This technique makes it possible to combine the extraction performances of the calix[6]arenes with the practical advantages of the chromatographic column. Consequently, this new radiochemical is well suited for routine analysis. Furthermore, the actinides separation is quantitative and reproducible, and is faster and easier than the current procedures.

Article published by EDP Sciences and available at http://www.radioprotection.org
or http://dx.doi.org/10.1051/radiopro:2008535