Contribution ID: **56** Type: **Poster report**

APPLICATION OF NUCLEAR SPECTROSCOPY METHODS FOR ANALYTICAL SUPPORT AND CORRECTION OF THE EXPERIMENT ON LIQUID EXTRACTION OF TPE AND REE

Friday, 24 September 2021 19:20 (5 minutes)

In August last year, the Radium Institute (ROSATOM) conducted an experiment on the extraction of transplutonium and lanthanides. In the experiment, a system consisting of centrifugal extractors was used, similar to the work 1. To monitor the extraction of transplutonium elements, we used the estimation of the volume activity of solutions using gamma spectra from various stages of extractors, underwater and outgoing lines, and bypasses. As a result of the measurements, the flows were adjusted. The experiment was carried out according to a scheme similar to that described in 1: the classical PUREX process consisting of extraction, re-extraction and washing. Extraction was carried out with 30% TBF, diluted with C13, from an aqueous nitric acid solution. The purpose of such experiments is usually to select nitric acid concentrations and organic and aqueous phase fluxes for these model solutions, including transplutonium elements(TPE) and rare earths (REE). The final results of the experiment are the distribution of the concentrations of elements in the stages of extractors. For the analysis of concentrations, the volume activities of solutions are found, the concentration is calculated by the formula:
\(n = \left| \frac{\text{dN}}{\text{dt}} \right| \bullet \frac{1}{V} \bullet \frac{T_{\frac{1}{2}}}{ln2} \bullet \frac{M}{N_{A}}\),
where \emph{n} is concentration of TPE in solution,
\(\left| \frac{\text{dN}}{\text{dt}} \right|\) is activity of sample,
\emph{V} is volume of sample, \(T_{\frac{1}{2}}\) is half-life TPE,
\emph{M} is its molar mass, \(N_{A}\) is Avogadro constant.
At the disposal of the organizers of the experiment, the following capabilities were available : a gamma-ray spectrometer with a semiconductor detector (HPGE), which has a high resolution, but low recording efficiency in the required energy range of X-ray and gamma radiation (10–100 keV) and a scintillation spectrometer with a large crystal and a well, which has a high efficiency and low energy resolution, as well as an alpha spectrometer.

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Since the experiment was carried out on model solutions, and did not assume the presence of other gamma emitters other than 241Am, it was not assumed that in the gamma spectra it would be necessary to separate closely lying lines from various elements (isotopes), so a scintillation method was proposed for registration, both for monitoring during the experiment and for the final calculation of concentrations. The use of an alpha spectrometer was not considered due to the lengthy sample preparation.
For activity calibration, calibrated solutions and simulations in the PHITS neutron transport program were used.

1. B. Ya. Zilberman et al, SolventSolv. Ext. Ion Exch. (2019), Issue 6 ,V 37, p 435-445, DOI: 10.1080/07366299.2019.1674467

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Session Classification: Poster session

Track Classification: Section 3. Modern nuclear physics methods and technologies.