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DETERMINATION OF LOW LEVEL NP-237 BY VARIOUS TECHNIQUES

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Content

Np-237, a long-lived (t1/2 = 2.14 E+06 y) alpha emitting radionuclide, is present in the environment primarily as a result of atmospheric weapons testing and discharges from nuclear fuel reprocessing facilities. Np-237 from the decay scheme of Am-241 on the other hand presents only a small portion of the total neptunium in the environment. The aim of this study was to determine the activity of Np-237 in environmental samples by a) a direct gamma-ray spectrometry, b) an alpha-particle spectrometry and c) a radiochemical neutron activation analysis using pre-separated samples. A direct gamma ray spectrometry via Pa-233 daughter is a useful method for determination of neptunium activities higher than 1.5 Bq kg-1. Its detection depends on amount of the sample and an appropriate measuring time. For low level activities of neptunium alpha-particle spectrometry and radiochemical neutron analysis were applied. For both techniques, the samples were ashed, decomposed by a Li Borates fusion and finally radionuclides were coprecipitated with iron hydroxide and the addition of ammonia solution to pH 8. When Np-237 is determined by an alpha-particle spectrometry, samples require extensive chemical separation prior to counting to remove peak interferences from other alpha emitters with similar energies such as U-234, Pa-231 and Th-230. In this work we compared separation procedures by using ion exchange chromatography and extraction chromatography. The alpha spectra obtained after extraction chromatography, however, showed presence of thorium impurities in the neptunium fraction independently of the volume of acids used for washing the resins. The recovery of radiochemical procedure was checked by addition of gamma emitter Np-239, which was prepared by irradiation of μg quantities of uranium solution in our TRIGA reactor. Low level of neptunium was also determined by radiochemical neutron activation analysis. Neptunium fraction was firstly separated from the bulk sample and then irradiated. When Np-237 is irradiated in a reactor the following capture reaction is induced: 237Np(n,γ)238Np. Np-238 is formed by neutron capture with an exceptionally large thermal cross section of 170 barns and resonance integral of 600 barns, possesses a favourable half-life (t1/2 = 2.2 days) and gamma energies at 984.4, 1026 and 1028.5 keV. In the case of a very low activity of the sample additional purification had to be done before γ-ray measurement. The methods used were applied to IAEA soil and sediment reference materials (IAEA 135, IAEA 300, IAEA 326, IAEA 327, IAEA soil 6, IAEA 368), Moss soil IAEA 447, Seaweed NIST SRM 4359 sample and two sediment samples, one from the Cumbrian Coastline, the other from the river Ribble. Results obtained showed good agreement with scarce literature data on activities of Np-237 in environmental samples.

About the Presenter

Prof. Ljudmila Benedik works as a senior research associate at the Department of Environmental Sciences at Jožef Stefan Institute She obtained her PhD from University of Ljubljana in 1994. Her scientific research work was mainly devoted to research in the field of determination of trace elements by neutron activation analysis as well as determination of natural and man-made radionuclides using alpha-particle, beta and gamma-ray spectrometry and liquid scintillation technique. During 2003 to 2008 she has been working at Institute for Reference Materials and Measurements of the Joint Research Centre of the European Commission (EC JRC IRMM) where she was involved, amongst over, in the projects connected to nuclear safeguard, radionuclide metrology and metrology in chemistry. She published over 60 publications in international peer reviewed scientific journals. She was leading or participating in several national and international project and have experiences in organizing the workshops and conferences. In last years she has supervised several undergraduate and PhD students.

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