Application of combined alpha spectrometry and neutron activation analysis for the determination of isotopic thorium in urine.

Abstract

The determination of actinides by alpha spectrometric methods is standard practice for bioassay and environmental measurements. However, insoluble compounds of thorium are not currently monitored by urinalysis methods because alpha spectrometry does not have adequate detection limits to provide appropriate evaluation of individual dose. This forces reliance on air sampling data that may not be representative of the workers true environment. This paper presents a method for the determination of isotopic thorium. By using a suitable source preparation material (e.g. high purity vanadium), alpha spectrometric methods may be combined with neutron activation analysis which is one of the most sensitive methods for the determination of ^{232}Th. Urine samples are spiked with ^{229}Th and thorium is isolated from the sample using alkaline earth co-precipitation and anion exchange. The sample is then mounted by electrodeposition from a sulfate based media on a suitable planchet (i.e. high purity vanadium), counted by alpha spectrometry for determination of ^{228}Th, ^{229}Th, and ^{230}Th, and then analyzed by neutron activation analysis for ^{232}Th using a neutron flux of 6.5×10^{12} cm^{-2} s^{-1} for 6 hours. The induced ^{233}Pa is determined by measuring the 312 keV gamma ray with gamma-ray spectrometry and the ^{232}Th is quantified by comparison to standard activated at the same time with a known amount of ^{232}Th with a detection limit of approximately 1 mBq of ^{232}Th. The radiochemical yield is determined from the alpha spectrometric method. The detection limit can be reduced to nearly 10^{-7} Bq by radiochemically isolating the ^{233}Pa (with recovery correction using ^{231}Pa and alpha spectrometry), electroplating the sample, and then determining the activity by gamma-ray spectrometry. These techniques allow quantification of thorium in urine and other bioassay samples to levels appropriate for radiation protection purposes.

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