Determination of 226Ra in natural water samples by liquid scintillation counting

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Determination of 226Ra in natural water samples by liquid scintillation counting

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Abstract

Determination of 226Ra in waters, natural waters and other environmental samples is an important task due to its high radio-toxicity. It can be determined directly or using its progenies (e.g. 228Ra). According to the newest comprehensive papers (IAEA, 2010; Jia and Jia, 2012), a spectrometry, scintillation counting and liquid scintillation counting (LSC) are the most commonly used measurement techniques for determination of 226Ra. However, in another recent comprehensive paper (Dapille et al., 2010) only spectrometry, spectrometry and its emasure technatse are referred, while LSC is only menioned as a technique for determination of 228Ra.

The Waste 226Ra tracer and the 228Ra analyte were determined parallel using the same LSC measurement. Analyzing model solutions and real samples, 60(±15)% average recovery and 10 mBq of limit of detection were observed.

Introduction

Determination of 226Ra in drinking waters, natural waters and other environmental samples is an important task due to its high radio-toxicity. It can be determined directly or using its progenies (e.g. 228Ra). According to the newest comprehensive papers (IAEA, 2010; Jia and Jia, 2012), a spectrometry, scintillation counting and liquid scintillation counting (LSC) are the most commonly used measurement techniques for determination of 226Ra. However, in another recent comprehensive paper (Dapille et al., 2010) only spectrometry, spectrometry and its emasure technatse are referred, while LSC is only menioned as a technique for determination of 228Ra.

Results

Some results of 38 analysed water samples (bottled mineral waters, medicinal thermal waters and natural surface waters) can be seen in Tables 1 and 2. Our experiments have shown that the average chemical recovery was 60(±15)%, and we could not find correlation between recovery and sample composition (table value content).

According to 2.2 pm background between channels 100–150 of the LSC spectrum and applying 100 min detection time, typically 10 mBq of minimal detectable activity (MDA) was achieved. Therefore, analyzing a sample of 0.5–5 L, the first detection level in the Council Directive 2012/27/EU (Council of the European Union, 2013) for flowing or non-flowing water is easily achievable. Typical relative uncertainty of results (in cases where the sample was not MDA) was 8%, calculated using a coverage factor of (1–k). MDA.

Discussion 3: Method reliability

To verify the reliability of the method, 2 water samples of a provenance (Determination of activity concentration of 226Ra. 226Ra food and environmental samples; Institute of Nuclear Chemistry and Technology (NKTI), Warsaw, Poland 2014-16) were analyzed. The results show acceptable agreement with the reference values (see Table 3).

The well-known medicinal thermal waters of Spa Rudas were also analyzed, results are reported in Table 2. The result of sample "Hungária" was checked and confirmed by spectrometry. A 5L aliquot was evaporated and the residue was ashed. According to the p-value of the x2, activity concentration of 226Ra in this sample was 417±17 Bq L⁻¹. Earlier results are also presented in Table 2, taking into account their high variability, the results reported in this paper are acceptable.

Results of analysis of some popular bottled mineral waters (selected randomly) are reported in Table 3. Differences between older and newer values can be explained by changes in exploitation or processing technology (e.g. changing of the spring).