



Contribution ID: 581

Type: Poster

Combination of an automated isolation method and gamma spectrometry for determination of Fe-55 in complex samples

Monday, 14 May 2018 18:30 (15 minutes)

Radioactive Fe-55 is generated by neutron activation of stable iron and, therefore, it can be found in materials from nuclear power plant, which should be decommissioned. It decays by electron capture and emits x-ray of 5.9 keV (24.5% probability). Because of the low energy of emitted ray, the attenuation effect is large and it occurs already in the sample itself, therefore it is the most often measured via liquid scintillation counting (LSC). However, modern HPGe detectors allow the determination of gamma emitters in a wide range of energies (3 keV - 3 MeV). In case of LSC, prior determination, isolation of pure iron from the sample is essential. Most of the samples may contain higher amounts of iron, so chemical and color quenching effects are important since they can significantly decrease detection efficiency. Therefore, within this study, especially for samples with higher amounts of iron, the method for Fe-55 determination by gamma spectrometry is developed. In this case, chemical isolation from the sample is also desirable to decrease attenuation effect and if present, to remove Co-58 and Mn-54 which emit x-rays in the same range (5.4 keV for Mn-54 and 6.4 keV for Co-58). The geometry of the sample is optimized to minimize the attenuation effect. For the chemical isolation of Fe-55 from complex samples an automated method which includes separation of iron from interfering elements on Sr resin or Pb resin column will be described (Sr and Pb resin consist of 4,4'(5')-di-t-butylcyclohexano 18-crown-6 in 1-octanol or isodecanol loaded on an inert chromatographic support). The Sr and/or Pb resin are chosen since they can be used for simultaneous separation of strontium isotopes 89,90Sr which are also present in different kind of materials from nuclear power plant. In almost all published methods, isolation and determination of Sr-89,90 and Fe-55 are separated, while here it will be shown how Sr and/or Pb resin enables simultaneous isolation of 89,90Sr and Fe-55 in one step. This work will also include optimization of the sample preparation method in the sense of achieving a detection limit of Fe-55 as low as possible.

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Session Classification: Poster NAM

Track Classification: Nuclear Analytical Methods