THE DETERMINATION OF BROMINE IN DRY BIOLOGICAL MATERIAL BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS

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Procedures for the determination of bromine by the reactions \( ^{81}\text{Br}(n, \gamma)^{82}\text{Br} \) (\( T = 35.4 \) h) and \( ^{79}\text{Br}(n, \gamma)^{80m}\text{Br} \) (\( T = 4.4 \) h). In the case of \( ^{82}\text{Br} \) a flat coaxial Ge(Li) crystal is used to measure the 619 keV photopeak. For \( ^{80m}\text{Br} \) a planar Ge(Li) detector is applied to measure the 39 keV \( \gamma \)-ray. The agreement between the data obtained with both techniques for some Standard Reference Materials is satisfactory.

Introduction

The determination of bromine by thermal neutron activation is possible by the \((n, \gamma)\) reactions on \( ^{79}\text{Br} \) or \( ^{81}\text{Br} \) which result in four radionuclides, of which three are of analytical interest: \( ^{80m}\text{Br}, \ ^{80}\text{Br} \) and \( ^{82}\text{Br} \).

In the case of dry plant material, the application of \( ^{80}\text{Br} \) is not attractive due to the high activities of other short-lived radionuclides, in particular \( ^{38}\text{Cl} \) (\( T = 37.2 \) m). The determination by way of \( ^{82}\text{Br} \) is well known. That by means of \( ^{80m}\text{Br} \) was first discussed in connection with X-ray measurements. It should now be possible, however, to use a planar Ge(Li) detector and to measure the 37 keV \( \gamma \)-line.

This text deals with the comparison of the two methods. For this purpose Standard Reference Materials issued by NBS or IAEA have been analysed.

Determination by way of \( ^{80m}\text{Br} \)

Apparatus

- A 0.15 cm\(^3\) planar Ge(Li) detector with an Ortec preamplifier, an Elscint amplifier and an Ortec research pulser, connected to a 1024 Northern Scientific channel analyser with magnetic tape read out.
- A 3" \( \times \) 3" NaI crystal connected to a 400-channel analyser with magnetic tape read out.
A perspex sample holder with trays at adjustable heights to fix cylindrical polythene capsules of 18.5 X 9.4 mm outer dimensions.

Polythene capsules with snap cap. Outer dimensions: 18.5 X 9.4 mm. Inner dimensions: 16.5 X 8.0 mm.

Annular flux monitors of 25.3 ± 0.1 mg pure iron.

Influence of selfabsorption

Absorption measurements on a point source of \(^{80}\text{Br}\) give a mass-absorption coefficient of \((0.80 \pm 0.03)\, \text{cm}^2 \cdot \text{g}^{-1}\). The influence of the specific gravity of the sample, \(\rho\), and its height, \(D\), in the result is given by a factor \(f\):

\[
f = \frac{1 - e^{-\mu \rho D}}{\mu \rho D}
\]

At a specific gravity of \(\rho = 0.38\), observed for Standard Kale, and a sample height of 1.60 cm, this implies an absorption of \(\sim 20\%\) and a 0.2\% variation of the result with each percent of change in \(\rho\).

Procedure

Polythene capsules are completely filled with the dried material which is condensed by gentle tapping. Flux monitors are mounted.

Standards are prepared by addition of aliquots of an \(\text{NH}_4\text{Br}\)-solution to active carbon or to powdered samples, followed by homogenizing and weighing out of aliquots.

Irradiation is performed in the pneumatic rabbit system (PRS) of the HFR at \(\Phi_{\text{th}} \approx 5 \cdot 10^1\, \text{cm}^{-2} \cdot \text{s}^{-1}\) during 30 s.

After return in the laboratory the flux monitors are separated from the capsules. Measurement of the samples starts \(\approx 2\) hours after the end of the irradiation. It takes 15–20 minutes per sample at a channel width of 0.36 keV. The monitors are connected with a NaI detector in the region of the \(^{59}\text{Fe}\) photopeaks, that is from 0.80 to 1.50 MeV.

The areas under the photopeaks are determined by a computer programme applying a linear interpolation of the background. They are corrected for decay. The sample weights and flux-monitor data are fed into the computer and used to calculate the specific count rates under standard conditions. Finally the concentrations are obtained from the – already available – data for the standards at \(\rho = 0.38\, \text{g} \cdot \text{cm}^{-3}\). The connection for differences in specific gravity is applied separately, using Eq. (1). It is usually not more than 1\%.