

Determination of As³⁺, Sb³⁺ and Se⁴⁺ metal ions in drinking water using HG-ICP-EOS technique

Ecaterina Anca Serban, Gina Alina Catrina (Traistaru), Gabriela Geanina Vasile, Cristina Dinu, Toma Galaon

National Research and Development Institute for Industrial Ecology – ECOIND Bucharest, 71-73 Drumul Podul Dambovitei Street, 060652, Bucharest, Romania, katyserban@yahoo.com

INTRODUCTION

The abundance of metals in drinking water can have adverse effects on human health. Therefore continuous monitoring of drinking water quality is essential. Metals that have been detected in potentially harmful concentrations in drinking water systems are caused by industrial pollution, anthropogenic pollution or as a result of corrosion processes of the component materials of drinking water supply networks.

The Law No. 311 of 2004, imposes 10 µg/L as concentration limit for arsenic in water intended for human consumption, 5 µg/L for antimony and 10 µg/L for selenium. Drinking water and mineral water can be contaminated with toxic metals, such as: antimony, by degradation of polyethylene terephthalate (PET) used in the composition of plastic bottles, due to damage processes and due to improper storage. The presence of arsenic in drinking water is due to both groundwater and surface water contamination through discharges of industrial effluents containing arsenic. Selenium is toxic only in large quantity, its presence in drinking water being mainly related to mining activities and industrial emissions. Usually, these volatile metallic elements are found in low concentrations, and their determinations require the use of sensitive analytical techniques.

MATERIALS AND METHOD

PRINCIPLE OF THE METHOD

The hydride generation technique involves the reaction of acidic aqueous solutions (HCl 10%), containing volatile metal ions As³⁺, Sb³⁺ and Se⁴⁺ with a reducing agent (0.2% NaBH₄ in 0.05% NaOH).

SAMPLE PREPARATION

In order to generate the hydride, the initial pretreatment of the samples with a mixture of potassium iodide and ascorbic acid is necessary, in hydrochloric acid medium for reducing the As⁵⁺ to As³⁺, Sb⁵⁺ to Sb³⁺. In order to generate Se⁶⁺ hydride ions the samples are pre-treated only with hydrochloric acid. The subsequent formation of the hydride from As³⁺, Sb³⁺, Se⁴⁺ ions was performed in a continuous-flow cell, using sodium borohydride and hydrochloric acid.

EQUIPMENT

The experimental study was performed with an inductively coupled plasma optical emission spectrometer ICP–EOS AVIO 500 Perkin Elmer and a FIAS 400 Perkin Elmer automatic flow injection system for hydride generation.

REAGENTS

For the determination of As³⁺, Sb³⁺ and Se⁴⁺ the following reagents and chemicals were used: sodium borohydride purum, ≥96%; sodium hydroxide puriss ≥ 98%, pellets; potassium iodide puriss 99-100.5%; L-Ascorbic acid puriss 99.7-100.5% were acquired from Sigma-Aldrich; hydrochloric acid 37%; nitric acid ultrapure grade 69% were acquired from Merck. For calibration, a Certified Reference Material (CRM) Arsenic, antimony and selenium standard for ICP, 1000 mg/L (Sigma-Aldrich) and a Reference Material (RM) Quality Control Standard 21, 100 mg/L (LGC) were used.

RESULTS AND DISCUSSIONS

Method validation

The experimental tests required for validation of the method involved the assessment of the following performance parameters: detection limit (LOD), quantification limit (LOQ), precision tests (reproducibility, intermediate precision), linearity (parameters of the calibration curve, homogeneity of dispersions test) and recovery test (table 1).

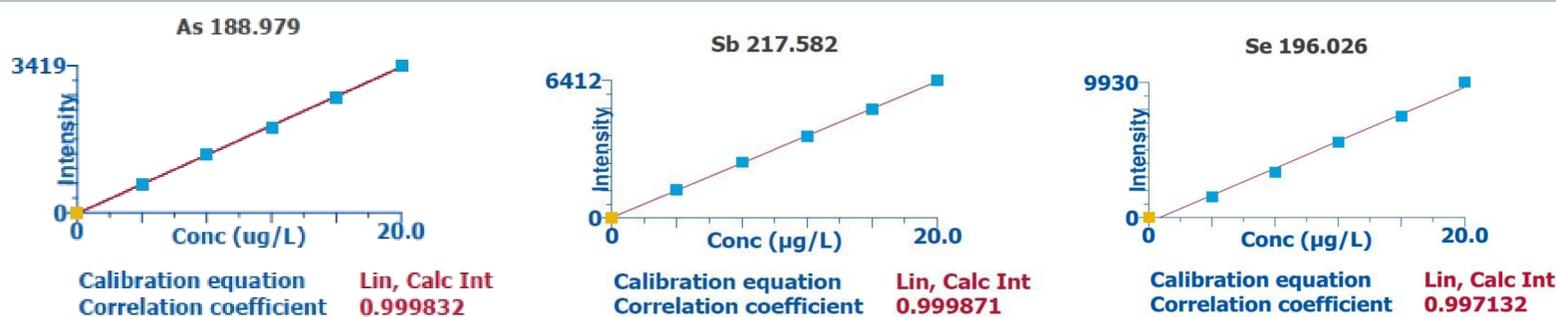


Table 2. Arsenic, antimony and selenium concentration in different types of water, µg/L

Sample ID	As ³⁺	Sb ³⁺	Se ⁴⁺	Sample ID	As ³⁺	Sb ³⁺	Se ⁴⁺
TW ₁	<0.43	1.81	1.52	TW ₁₁	<0.43	<1.18	<1.40
TW ₂	<0.43	<1.18	<1.40	TW ₁₂	2.23	<1.18	<1.40
TW ₃	6.13	1.73	<1.40	GW ₁	<0.43	<1.18	<1.40
TW ₄	<0.43	<1.18	<1.40	GW ₂	<0.43	1.33	1.63
TW ₅	<0.43	<1.18	<1.40	GW ₃	7.21	4.33	<1.40
TW ₆	<0.43	2.44	1.90	GW ₄	0.83	<1.18	2.01
TW ₇	0.53	1.84	<1.40	GW ₅	4.23	<1.18	1.63
TW ₈	1.23	<1.18	1.41	MW ₁	<0.43	2.31	<1.40
TW ₉	<0.43	1.72	1.64	MW ₂	1.42	2.42	<1.40
TW ₁₀	9.20	<1.18	<0.42	MW ₃	<0.43	2.21	<1.40

Table 1. Instrumental and performance parameters of the applied methods

Element	λ (nm)	LOD (µg/L)	LOQ (µg/L)
As ³⁺	188.979	0.13	0.43
Sb ³⁺	217.582	0.35	1.18
Se ⁴⁺	196.026	0.42	1.40

CONCLUSIONS

The obtained results are presented in table 2. The values represent the mean of three determinations, all the analysed samples having results below the maximum admissible values according to in force legislation.