

EVALUATION OF SEMI-PARAMETRIC NAA RESULTS USING STANDARD REFERENCE MATERIALS

Laura C. Oliveira, Cibele B. Zamboni, Guilherme S. Zahn, Frederico A. Genezini

*Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP*

The semi-parametric procedure of neutron activation has been applied to determine the concentration of chemical elements in Standard Reference Materials (SRMs). The principles, advantages and limitations of this procedure, as well as the sources of errors, are discussed based on the accuracy and precision determinations in SRMs.

Keywords: Neutron Activation Analyses, Standard Reference Materials

PACS: 82.80.Jp

INTRODUCTION

Neutron Activation Analysis (NAA) is an analytical tool that has been thoroughly used in analyses of different materials. The semi-parametric variation has the advantage that it doesn't require the simultaneous use of standard reference materials with each sample analyzed, for each element evaluation. This procedure requires knowledge of parameters such as the physical constants associated with the nuclear activation and decay processes and an adequate experimental setup [1]. In order to verify the accuracy, precision and the overall reliability of the semi-parametric procedure, samples of different SRM's were analyzed using this methodology and the results were statistically analyzed and compared to the nominal values from standards.

STANDARD REFERENCE MATERIALS

In order to compare the results from semi-parametric NAA with the certified values, the following SRMs were analyzed: NIST 8414 Bovine Muscle; Second-generation Biological reference material Freeze-Dried Human Serum and NIST 1573a Tomato Leaves. Aliquots of 250 mg were used for the solid samples, and for the liquid sample 100 μ l aliquots were pipetted onto filter paper and dried for a few minutes using an infrared lamp.

EXPERIMENTAL PROCEDURE

In the semi-parametric NAA procedure, the samples are irradiated with neutrons together with two Au foils, one bare and the other covered with Cd foil, for the thermal neutrons flux determination. The irradiations were performed in the pneumatic station of the IEA-R1 nuclear reactor at IPEN/SP (2-4 MW, pool type). The measurements of the gamma induced activity of the samples were carried out using an ORTEC Model GEM-60195 detector and an ORTEC 671 amplifier, in pile-up rejection mode, coupled to an ORTEC Model 919E MCA connected to a PC.

RESULTS AND DISCUSSION

Table 1 shows the results obtained in the present work. The Z score values (standardized differences) obtained were $|Z \text{ score}| < 2$, indicating that our results are satisfactory and are within the range of certified data at the 95% confidence level.

Table 1. Results of the present analysis compared to the certified values.

Element	Certified values	NAA	RSD, %	Relative Error, %	Z score
Br, g L ⁻¹	⁽²⁾ 0.044 ± 0.013	0.049 ± 0.017	34.7	11.4	0.2
Ca, g kg ⁻¹	⁽¹⁾ 0.145 ± 0.020	0.132 ± 0.014	10.6	8.9	0.5
	⁽²⁾ 0.161 ± 0.013	0.153 ± 0.048	31.3	4.9	0.2
	⁽³⁾ 50.5 ± 0.9	53.6 ± 3.4	6.3	6.1	0.9
Cl, %	⁽¹⁾ 0.188 ± 0.015	0.202 ± 0.013	6.4	7.4	0.7
Mn, g kg ⁻¹	⁽³⁾ 0.246 ± 0.008	0.245 ± 0.017	6.9	0.4	0.05
K, g kg ⁻¹	⁽¹⁾ 15.17 ± 0.37	14.76 ± 1.04	7	2.7	0.4
	⁽³⁾ 27.0 ± 0.5	26.9 ± 1.6	5.9	0.4	0.06
Na, g kg ⁻¹	⁽¹⁾ 2.10 ± 0.08	2.11 ± 0.10	4.7	0.5	0.08
	⁽³⁾ 0.136 ± 0.004	0.135 ± 0.013	9.6	0.7	0.07

⁽¹⁾ NIST 8414 Bovine Muscle

⁽³⁾ NIST 1573a Tomato Leaves

⁽²⁾ Freeze - Dried Human Serum

RSD: Relative Standard Deviation

CONCLUSION

This work shows that nuclear data and neutron flux parameters can be applied to calculate directly the elemental concentrations; the results obtained show that the semi parametric procedure of neutron activation is precise since uncertainties in nuclear data, the major source of errors, are well established.

REFERENCE

1. L.C. Oliveira, C.B. Zamboni, F.A. Genezini, A.M.G. Figueiredo, G.S. Zahn, *J. Radioanal. Nucl. Chem.* **263**, 783-786 (2005).