

Application News

No. A446

Spectrophotometric Analysis

Measurement of Cesium in Tap Water and Soil by Atomic Absorption Spectrometry

■ Introduction

Recently, technologies that can efficiently remove radioactive cesium (chiefly Cs-137) from water and soil have been actively researched.

The study and evaluation of these removal technologies can be conducted using Cs-133, an easy-to-handle, stable substance, yet chemically similar to Cs-137. Cesium can be analyzed using atomic absorption spectrometry and ICP emission spectroscopy, which are therefore effective for researching and evaluating the various removal technologies.

Here, we introduce examples of analysis of cesium in tap water and soil using the AA-7700 atomic absorption spectrophotometer.

■ Sample Preparation

The tap water was used as is, without pretreatment. As for the soil, 1 g of sample was accurately weighed into a beaker, and after adding aqua regia and heating on a hot plate to decompose, the mixture was filtered through 5B filter paper, and 50 mL of the filtrate was used as the process solution.

■ Analytical Method and Conditions

(1) Tap Water

Measurement was conducted by the calibration curve method using the furnace technique (electric furnace, ETAAS). The measurement samples consisted of tap water and tap water spiked with 1 µg/L cesium. In addition, a solution containing a mixture of Na, Ca, and Mg was added as an interference suppression agent.

(2) Soil

The soil was measured by the calibration curve method using both the flame and furnace techniques. With the flame technique, the process solution and standard solution were measured after sodium was added as an interference suppression agent to both at a final concentration of approximately 0.1 %.

With the furnace technique, measurement was conducted after diluting the process solution by a factor of 10. A solution containing a mixture of Na, Ca, and Mg was added as an interference suppression agent.

The main spectrometer parameters are shown in Table 1, and the main atomization conditions using the furnace and flame techniques are shown in Table 2 and 3, respectively.

Table 1 Optics Parameters

Analysis wavelength	852.1 nm
Slit width	0.7 nm
Current value	16 mA
Lighting mode	NON-BGC

Table 2 Atomization Parameters by ETAAS

	Temperature °C	Time sec	Mode	Sensitivity	Gas Flowrate L/min	
Temperature program	1	120	20	Ramp	Reguler	0.1
	2	250	10	Ramp	Reguler	0.1
	3	600	10	Ramp	Reguler	0.2
	4	600	10	Step	Reguler	0.2
	5	600	3	Step	High	0.0
	6	2000	3	Step	High	0.0
	7	2500	2	Step	Reguler	0.5
Atomization stage: 6						
Tube type	Pyrolytic graphite tube					
Interference suppressant	Mixture of Na, Ca, Mg					
Sample injection volume	20 µL (tap water), 10 µL (soil)					

Table 3 Atomization Parameters by Flame AAS

Flame type	Air-C ₂ H ₂
Burner height	7 mm
Interference suppressant	Na 0.1 %

■ Measurement Results

(1) Tap Water

The calibration curve and peak profiles are shown in Figs. 1 and 2, respectively.

The measurement results for the unspiked and spiked samples are shown in Table 4.

Cesium was not detected in the unspiked tap water, and excellent recovery was obtained for the cesium-spiked tap water.

(2) Soil

The calibration curve obtained by the flame technique is shown in Fig. 3.

Figs. 4 and 5 show the calibration curve obtained by the furnace technique, and the peak profiles, respectively.

The measurement results for the soil sample are shown in Table 5. The lower limit of quantitation was 3 µg/g (ppm) by the flame technique, and 0.2 µg/g (ppm) by the furnace technique, converted to the concentration in solid soil.

The flame technique offers rapid analysis, while high sensitivity measurement is possible with the furnace technique, thus permitting selection of the type of analysis depending on the purpose. The AA-7000 permits automatic switching between the flame and furnace measurement techniques, and because troublesome adjustment of the optical axis is eliminated, switching between atomization methods is quickly accomplished. Moreover, space-saving is achieved by the back-to-front placement of the two atomizers.

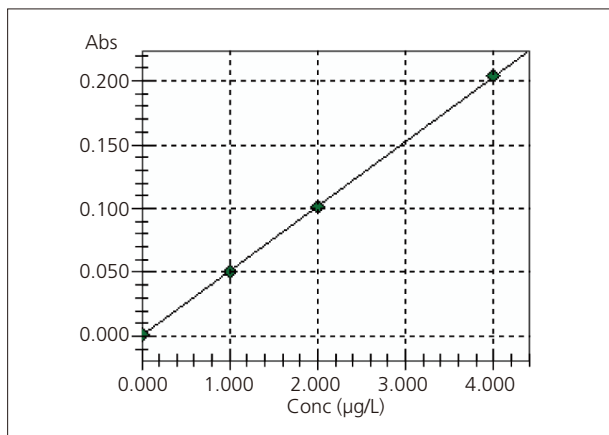


Fig. 1 Calibration Curve by ETAAS (Tap Water)

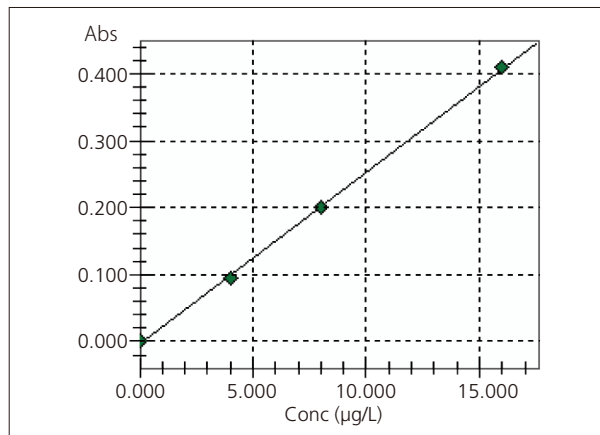


Fig. 4 Calibration Curve by ETAAS (Soil)

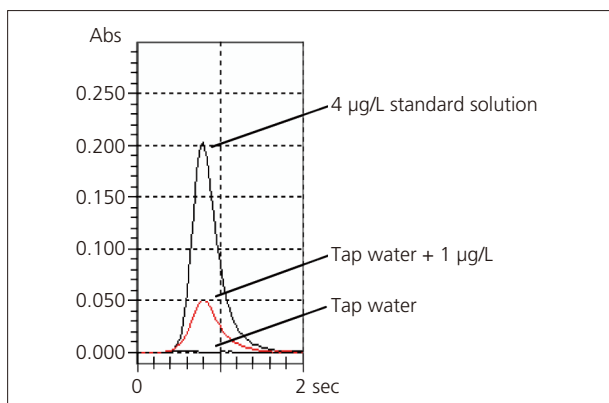


Fig. 2 Peak Profiles of Standard Solution and Tap Water Samples by ETAAS

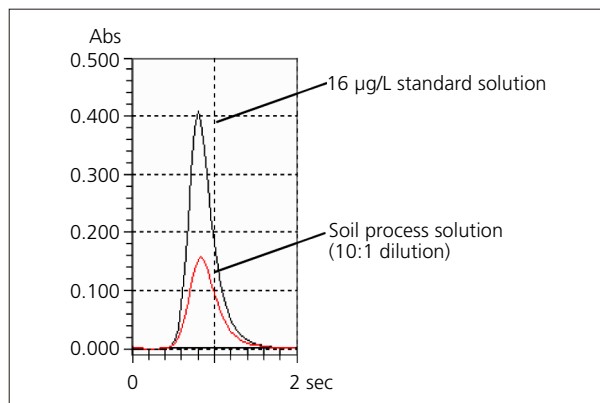


Fig. 5 Peak Profiles of Standard Solution and Soil Sample by ETAAS

Table 4 Measurement Results for Tap Water by ETAAS

Tap Water (Unspiked)	Tap Water (Spiked)	Spike Recovery
< 0.2 µg/L	0.97 µg/L	97 %

Table 5 Measurement Results for Soil by Flame AAS and ETAAS

Flame Technique	Furnace Technique
3 µg/g	3.1 µg/g

Values are converted to concentration in the solid.

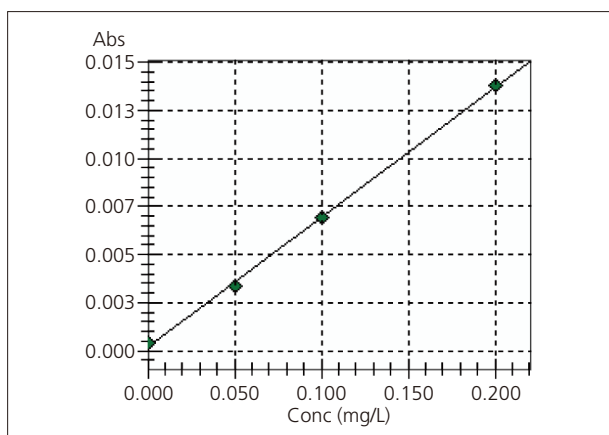


Fig. 3 Calibration Curve by Flame AAS (Soil)