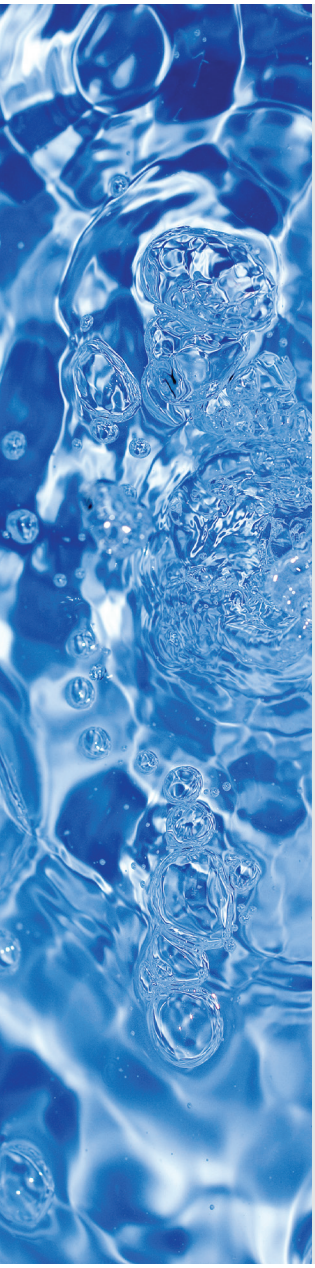
AN APPLICATION BRIEF FROM
SPECTRO ANALYTICAL INSTRUMENTS

When results matter



Analyzing Aqueous Solutions Using ICP-OES

Introduction

The multi-element analysis of unpolluted aqueous solutions is an important and often critical task for spectrographic instruments. A multitude of aqueous matrix samples are routinely analyzed for virtually all elements of the periodic table.

Inductively coupled plasma optical emission spectrometry (ICP-OES) instruments are frequently used for aqueous solution analysis tasks. Recent advances in technology have rendered some models more affordable than ever. These instruments provide advantages such as multi-element determination capability, large linear dynamic range, excellent stability, and enhanced sensitivity.

This paper covers the analysis of unpolluted aqueous solutions using an ICP-OES analyzer. Testing examined whether this instrument displayed required characteristics — such as high precision, exceptional stability, low detection limits, and efficient sample preparation — for fast, simultaneous determination of metals and other elements of interest.

The analyzer

All measurements were performed using a SPECTRO GENESIS ICP-OES with radial plasma observation, from SPECTRO Analytical Instruments.

This analyzer utilizes a series of 15 charge coupled device (CCD) linear detector arrays with a concave grating arrangement. The device's flexible, proprietary Optimized Rowland Circle Alignment (ORCA) optical design covers the entire relevant spectrum from 175 to 777 nanometers (nm). The analyzer's high-speed readout system can read all detectors simultaneously, capturing the complete emission spectrum within only 3 seconds. With a minimum number of optical components to attenuate light throughput, the ORCA polychromator is highly luminescent; this contributes to analytical sensitivity and low detection limits.

The analyzer's Intelligent Calibration Logic (iCAL) normalizes the wavelength scale, and automatically monitors the state of the optical system. This ensures optimum conditions at all times, along with fast, simple calibration. Uniquely, the system offers a complete set of factory-calibrated methods for industrial applications and environmental tasks. This includes solutions such as aqueous solution analysis. It also allows master methods to be transferred between individual instruments.

For measurement of the UV elements below 200 nm, the optical system can be purged with a small volume of argon. Only 0.5 liters per minute are consumed during normal operation. An air-cooled ICP generator, based on a free-running 27.12 MHz design, ensures power stability even under rapidly changing sample loads. All relevant ICP operating parameters are software-controlled, allowing easy selection of optimum operating conditions.

SPECTRO GENESIS analyzer: Providing accurate, high-productivity analysis — along with low operating and consumables costs plus an optional automated sample introduction system.

Wavelengths and detection limits

Table 1 shows the selected wavelengths and the associated limits of detection (LODs). The LODs were calculated according to this equation*:

LOD = 3 RSD_b c/100 SBR

Where:

RSD_b — relative standard deviation of 10 replicates of the blank

c — concentration of the standard

SBR — signal to background ratio

Conclusions

The SPECTRO-GENESIS ICP-OES analyzer offers a simple, fast, accurate, precise, and cost-efficient method for the analysis of aqueous solutions.

The instrument's simple sample dilution allowed easy, reliable sample preparation. In conjunction with an autosampler, this instrument can be fully automated. Independent of the number of lines and elements, it can perform an analysis (including three replicates pre-flush, plus a method rinse) in less than 4 minutes.

Advanced ICP-OES optics: the ORCA system in a SPECTRO GENESIS analyzer separates light emitted in the plasma, and enables fully simultaneous measurement of the relevant spectrum and elements.

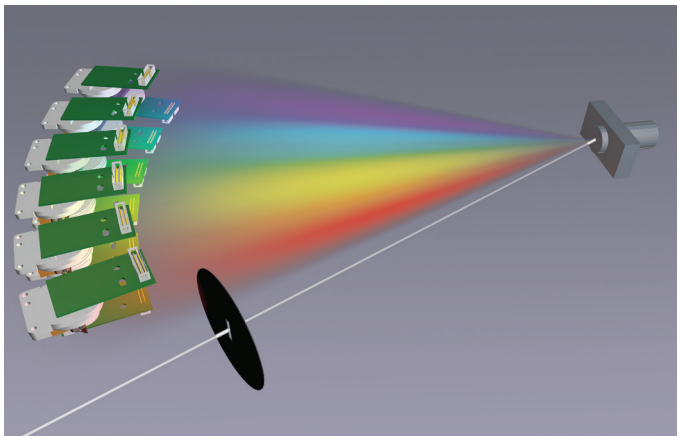


Table 1: Limits of detection (LODs) for selected wavelengths

Element	λ nm	LOD 3 σ [µg/L]
Ag	328.068	1.6
Al	308.215	14
Al	396.152	8
As	189.041	15
B	249.773	1.6
Ba	455.404	0.2
Be	313.042	0.1
Ca	315.887	3.2
Ca	317.933	1.5
Ca	396.847	0.4
Cd	214.438	0.6
Cd	226.502	0.8
Cd	228.802	1
Co	228.615	1.9
Cr	267.716	1.7
Cu	324.778	1.6
Fe	259.940	1.3
Hg	184.950	4.9
K	766.490	100
Li	670.784	1.6
Mg	279.078	15
Mg	279.553	0.2
Mn	257.610	0.28
Mo	202.095	3.9
Na	589.592	12
Ni	231.604	2.9
P	177.495	14
P	178.287	18
Pb	220.351	14
Sb	206.833	15
Se	196.090	19
Si	251.612	3.3
Sn	189.991	9
Sr	407.771	0.06
Tl	190.864	14
V	311.071	1.9
Zn	213.856	0.8

**P. W. J. M. Boumans, Spectrochim. Acta 46B, 431 (1991)*

Selecting an ICP-OES aqueous solution analyzer

High-quality ICP-OES analyzers are the instruments of choice for a wide variety of analytical applications. They offer just the right combination of precision, and productivity. However, not all devices in this class provide equal capabilities and performance. Look for an analyzer with the following characteristics:

High speed. Fully simultaneous analysis lets a good ICP-OES achieve sample cycle times as low as 90 seconds — independent of the number of elements to be analyzed.

Affordability. Some models have realized substantial design and technology efficiencies recently. Look for full ICP-OES functionality at competitively low operating, consumables, and investment costs.

Radial plasma design. Side-on plasma observation is robust, ideal for high and varying sample loads, and superior to axial designs for handling challenges such as organic matrices.

High linear dynamic range. Study the ranges for elements of interest. Make sure your analyzer can cope with wide variations in elemental concentration, and can avoid multiple and time-consuming sample dilutions.

Powerful generator. Organic and high-TDS matrix samples can challenge or even extinguish some systems' plasmas. The SPECTRO GENESIS generator remains stable even under heavy plasma loads.

www.spectro.com

SPECTRO
AMETEK

GERMANY
SPECTRO Analytical Instruments GmbH
Boschstrasse 10
D-47533 Kleve
Tel. +49.2821.892.0
spectro.sales@ametek.com

U.S.A.
SPECTRO Analytical Instruments Inc.
50 Fordham Rd
Wilmington 01887, MA
Tel. +1 800 548 5809
+1 201 642 3000
spectro-usa.sales@ametek.com

CHINA
AMETEK Commercial
Enterprise (Shanghai) CO., LTD.
Part A1, A4 2nd Floor Building No. 1 Plot Section
No. 526 Fute 3rd Road East; Pilot Free Trade Zone
200131 Shanghai
Tel. +86.400.022.7699
spectro-china.sales@ametek.com

Subsidiaries:
▶**FRANCE:** Tel. +33.1.3068.8970, spectro-france.sales@ametek.com ▶**GREAT BRITAIN:** Tel. +44.1162.462.950, spectro-uk.sales@ametek.com
▶**INDIA:** Tel. +91.22.6196.8200, sales.spectroindia@ametek.com ▶**ITALY:** Tel. +39.02.94693.1, spectro-italy.sales@ametek.com
▶**JAPAN:** Tel. +81.3.6809.2405, spectro-japan.info@ametek.co.jp ▶**SOUTH AFRICA:** Tel. +27.11.979.4241, spectro-za.sales@ametek.com

SPECTRO operates worldwide and is present in more than 50 countries. For SPECTRO near you, please visit www.spectro.com/worldwide