

ICP-OES depends on Type I ultrapure water for multi-element trace analysis

Abstract

Inductively coupled plasma optical/atomic emission spectroscopy (ICP-OES/AES) is an analytical technique that enables rapid, sensitive multi-elemental determinations. High purity water is an essential requirement for ICP-OES, ensuring that any compounds which could potentially interfere with the determination of the elements under investigation are eliminated.

Introduction

ICP-OES is a technique typically used for the determination of trace metals. In many cases, it is replacing flame atomic absorption spectroscopy (FAAS) due to its multi-element capability and wide dynamic range. The inductively coupled plasma generates excited atoms which emit electromagnetic radiation at characteristic wavelengths for a particular element. These atomic emission lines are sharp and can usually be resolved from other elements. ICP-OES is typically used in the aerospace, chemical, environment, food and beverage, geological, pharmaceutical and alloy production industries.

The use of high purity water¹ for the preparation of samples, blanks and standards is essential if inaccurate results are to be avoided, since all reagents and solvents used for ICP-OES must be free of the elements being measured and of any elements or compounds which could potentially interfere with the assay.

Ions

Trace levels of the metal ions of interest are the major concern. They can result in artificially high concentrations in samples, blanks and standards, leading to errors and poor quantification. Higher levels of other ions can cause matrix effects – such as sensitivity shifts – seriously affecting accuracy.

Organic compounds

Organic compounds can stick to nebulizer, tubing and spray chamber surfaces, resulting in poor reproducibility and the need for increased frequency of cleaning. Additionally, metals associated with organic moieties can cause elemental contamination.

Bacteria

Bacteria can release ions which may interfere with the analysis, and organic by-products can stick to the nebulizer surface. Bacteria may also behave as particulates, blocking the nebulizer and preventing efficient sample introduction, leading to increased signal noise and reduced sensitivity.

Particulates and colloids

Particulates and colloids may block the nebulizer and tubing, preventing efficient sample introduction into the system.

Purifying water for ICP-OES

ICP-OES analysis requires the use of highly purified water for the preparation of all reagents, standards, blanks and samples². The sensitivity of ICP-OES varies markedly for different elements (Table 1), but detection limits for metals, semi-metals, phosphorus and sulphur are typically in the low ppb range. TOC requirements are not generally critical, but water with resistivity 18.2 MΩ.cm, such as Type I ultrapure water from ELGA's PURELAB[®] Ultra Analytic or PURELAB flex, is preferred.

In producing purified water suitable for ICP-OES, the key requirements are passage through a reverse osmosis membrane and the highest purity ion exchange resins. Ultraviolet (UV) radiation will also reduce levels of organic contaminants and bacteria.



Reverse osmosis

Reverse osmosis membranes remove water contaminants that are less than 1 nm in diameter. Typically they remove in excess of 5 % of ionic contamination, most organic contamination and virtually all particulate contamination.

Media

The media cartridges in the PURELAB Ultra Analytic and PURELAB flex contain synthetic, activated carbon beads, which adsorb a wide variety of organic compounds, and the highest purity ion exchange resins to minimise the release of impurities.

Filtration

Point-of-use filtration removes the inorganic particles, macromolecules and bacteria which can interfere with analysis. ELGA's PURELAB flex combines point-of-use filters with high purity purification cartridges for effective particle removal.

Element	Detection limit (µg/l)		Water from PURELAB Ultra Analytic (µg/l)	Water from PURELAB flex 2 fed from PURELAB Pulse (µg/l)
	FAAS	ICP-OES		
Aluminium	45	1	<0.001	<0.001
Arsenic	150	2	<0.002	<0.002
Boron	1000	1	<0.01	<0.010
Calcium	1.5	0.05	<0.002	<0.002
Chromium	3	0.2	<0.001	<0.001
Iron	5	0.1	<0.002	<0.002
Lead	15	1	<0.0002	<0.0002
Lithium	0.8	0.3	<0.0002	<0.0002
Magnesium	0.15	0.04	<0.001	<0.001
Mercury	300	1	<0.005	<0.005
Molybdenum	45	0.5	<0.0005	<0.0005
Nickel	6	0.5	<0.002	<0.002
Platinum	60	1	<0.005	<0.005
Silver	1.5	0.6	<0.0005	<0.0005
Sodium	0.3	0.5	<0.002	<0.002
Strontium	3	0.05	<0.0002	<0.0002
Tin	150	2	<0.0005	<0.0005
Uranium	15000	10	<0.002	<0.002

Table 1: Comparison of the detection limits of FAAS and ICP-OES with the levels of elemental impurities detected in water from ELGA's PURELAB Ultra Analytic and PURELAB flex purification systems. Analysis of water from the PURELAB Ultra Analytic and PURELAB flex purification systems demonstrates results well below the detection limits for all elements analysed.

Conclusion

The use of ultrapure water with high resistivity (18.2 MΩ.cm), free from particulates, bacteria, organic and ionic compounds, is essential to ensure accurate ICP-OES results are achieved.

To find out more about ELGA LabWater's water treatment technologies and solutions for analytical applications, visit www.elgalabwater.com

References

1. Whitehead, P. Getting the best results from ultrapure water.
<http://www.laboratorynetwork.com/article.mvc/Getting-The-Best-Results-From-Ultrapure-Water-0004>
2. ASTM Standard Guide for Bio-applications Grade Water D 5196-06.

About ELGA LabWater

ELGA LabWater manufactures supplies and services laboratory, healthcare and clinical water purification systems. ELGA offices and distributors are located in more than 60 countries worldwide. ELGA is the global laboratory water brand name of Veolia Water Solutions & Technologies.

ELGA is an integral part of Veolia Water Solutions and Technologies. Veolia Water Solutions & Technologies (VWS), subsidiary of Veolia Water, is a leading design & build company and a specialized provider of technological solutions in water treatment. With over 9,500 employees in 57 countries, Veolia Water Solutions & Technologies recorded revenue of €2.15 billion Euros in 2010.

Veolia Water, the water division of Veolia Environment, is the world leader in water and wastewater services. Specialized in outsourcing services for municipal authorities, as well as industrial and service companies, Veolia Water provides water service to 95 million people and wastewater service to 66 million. With 96,260 employees in 66 countries, its 2010 revenue amounted to €12.1 billion.