
**Water quality — Application of
inductively coupled plasma mass
spectrometry (ICP-MS) —**

**Part 2:
Determination of 62 elements**

iTeh STANDARD PREVIEW

*Qualité de l'eau — Application de la spectrométrie de masse avec
plasma à couplage inductif (ICP-MS) —*

Partie 2: Dosage de 62 éléments

ISO 17294-2:2003

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Contents

Page

Foreword.....	iv
Introduction	v
1 Scope.....	1
2 Normative references	3
3 Terms and definitions.....	3
4 Principle	3
5 Interferences.....	4
6 Reagents	8
7 Apparatus	11
8 Sampling	12
9 Sample pre-treatment	12
10 Procedure	13
11 Calculation	14
12 Precision	15
13 Test report	15
Annex A (informative) Description of the matrices of the samples used for the interlaboratory trial.....	19
Bibliography	21

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17294-2 was prepared by Technical Committee ISO/TC 147, *Water quality*, Subcommittee SC 2, *Physical, chemical and biochemical methods*.

ISO 17294 consists of the following parts, under the general title *Water quality — Application of inductively coupled plasma mass spectrometry (ICP-MS)*:

- *Part 1: General guidelines and basic principles* [ISO 17294-2:2003](https://standards.iteh.ai/catalog/standards/sist/7cdc2ea7-9992-4682-adff-30561dbcb713/iso-17294-2-2003)
- *Part 2: Determination of 62 elements* <https://standards.iteh.ai/catalog/standards/sist/7cdc2ea7-9992-4682-adff-30561dbcb713/iso-17294-2-2003>

Introduction

When applying this part of ISO 17294, it is necessary in each case, depending on the range to be tested, to determine if and to what extent additional conditions should be established.

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Water quality — Application of inductively coupled plasma mass spectrometry (ICP-MS) —

Part 2: Determination of 62 elements

WARNING — Persons using this part of ISO 17294 should be familiar with normal laboratory practice. This part of ISO 17294 does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

IMPORTANT — It is absolutely essential that tests, conducted in accordance with this part of ISO 17294, be carried out by suitably qualified staff.

1 Scope

This part of ISO 17294 specifies a method for the determination of the elements aluminium, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, caesium, calcium, cerium, chromium, cobalt, copper, dysprosium, erbium, europium, gadolinium, gallium, germanium, gold, hafnium, holmium, indium, iridium, lanthanum, lead, lithium, lutetium, magnesium, manganese, molybdenum, neodymium, nickel, palladium, phosphorus, platinum, potassium, praseodymium, rubidium, rhenium, rhodium, ruthenium, samarium, scandium, selenium, silver, sodium, strontium, terbium, tellurium, thorium, thallium, thulium, tin, tungsten, uranium, vanadium, yttrium, ytterbium, zinc, and zirconium in water [for example drinking water, surface water, groundwater, wastewater and eluates (9.2)].

Taking into account the specific and additionally occurring interferences, these elements can also be determined in digests of water, sludges and sediments (for example digests of water as specified in ISO 15587-1 or ISO 15587-2).

The working range depends on the matrix and the interferences encountered. In drinking water and relatively unpolluted waters, the limit of application is between 0,1 µg/l and 1,0 µg/l for most elements (see Table 1).

The detection limits of most elements are affected by blank contamination and depend predominantly on the laboratory air-handling facilities available.

The lower limit of application is higher in cases where the determination is likely to suffer from interferences (see Clause 5) or in case of memory effects (see 8.2 of ISO 17294-1).

Table 1 — Limits of application for unpolluted water

Element	Isotope often used	Limit of application ^a µg/l	Element	Isotope often used	Limit of application ^a µg/l	Element	Isotope often used	Limit of application ^a µg/l
Ag	¹⁰⁷ Ag	1	Ho	¹⁶⁵ Ho	0,1	Se	⁷⁷ Se	10
	¹⁰⁹ Ag	1	In	¹¹⁵ In	0,1		⁷⁸ Se	10
Al	²⁷ Al	5	Ir	¹⁹³ Ir	0,1		⁸² Se	10
As	⁷⁵ As	1	K	³⁹ K	50	Sm	¹⁴⁷ Sm	0,1
Au	¹⁹⁷ Au	0,5	La	¹³⁹ La	0,1	Sn	¹¹⁸ Sn	1
B	¹⁰ B	10	Li	⁶ Li	10		¹²⁰ Sn	1
	¹¹ B	10		⁷ Li	1	Sr	⁸⁶ Sr	0,5
Ba	¹³⁷ Ba	3	Lu	¹⁷⁵ Lu	0,1		⁸⁸ Sr	0,3
	¹³⁸ Ba	0,5	Mg	²⁴ Mg	1	Tb	¹⁵⁹ Tb	0,1
Be	⁹ Be	0,5		²⁵ Mg	10	Te	¹²⁶ Te	2
Bi	²⁰⁹ Bi	0,5	Mn	⁵⁵ Mn	3	Th	²³² Th	0,1
Ca	⁴³ Ca	100	Mo	⁹⁵ Mo	0,5	Tl	²⁰³ Tl	0,2
	⁴⁴ Ca	50		⁹⁸ Mo	0,3		²⁰⁵ Tl	0,1
	⁴⁰ Ca	10	Na	²³ Na	10	Tm	¹⁶⁹ Tm	0,1
Cd	¹¹¹ Cd	0,1	Nd	¹⁴⁶ Nd	0,1	U	²³⁸ U	0,1
	¹¹⁴ Cd	0,5	Ni	⁵⁸ Ni	10	V	⁵¹ V	1
Ce	¹⁴⁰ Ce	0,1		⁶⁰ Ni	3	W	¹⁸² W	0,3
Co	⁵⁹ Co	0,2	P	⁶⁰ P	5,0		¹⁸⁴ W	0,3
Cr	⁵² Cr	1	Pb	²⁰⁶ Pb ^b	0,2	Y	⁸⁹ Y	0,1
	⁵³ Cr	5		²⁰⁷ Pb ^b	0,2	Yb	¹⁷² Yb	0,2
Cs	¹³³ Cs	0,1		²⁰⁸ Pb ^b	0,1		¹⁷⁴ Yb	0,2
Cu	⁶³ Cu	1	Pd	¹⁰⁸ Pd	0,5	Zn	⁶⁴ Zn	1
	⁶⁵ Cu	2	Pr	¹⁴¹ Pr	0,1		⁶⁶ Zn	2
Dy	¹⁶³ Dy	0,1	Pt	¹⁹⁵ Pt	0,5		⁶⁸ Zn	3
Er	¹⁶⁶ Er	0,1	Rb	⁸⁵ Rb	0,1	Zr	⁹⁰ Zr	0,2
Eu	¹⁵¹ Eu	0,1	Re	¹⁸⁵ Re	0,1	^a Depending on the instrumentation significantly lower limits can be achieved. ^b In order to avoid mistakes due to the different isotope ratios in the environment, the signal intensities of ²⁰⁶ Pb, ²⁰⁷ Pb and ²⁰⁸ Pb shall be added.		
	¹⁵³ Eu	0,1		¹⁸⁷ Re	0,1			
Ga	⁶⁹ Ga	0,3	Rh	¹⁰³ Rh	0,1			
	⁷¹ Ga	0,3	Ru	¹⁰¹ Ru	0,2			
Gd	¹⁵⁷ Gd	0,1		¹⁰² Ru	0,1			
	¹⁵⁸ Gd	0,1	Sb	¹²¹ Sb	0,2			
Ge	⁷⁴ Ge	0,3		¹²³ Sb	0,2			
Hf	¹⁷⁸ Hf	0,1	Sc	⁴⁵ Sc	5			

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

ISO 5667-1, *Water quality — Sampling — Part 1: Guidance on the design of sampling programmes*

ISO 5667-2, *Water quality — Sampling — Part 2: Guidance on sampling techniques*

ISO 5667-3, *Water quality — Sampling — Part 3: Guidance on the preservation and handling of water samples*

ISO 8466-1, *Water quality — Calibration and evaluation of analytical methods and estimation of performance characteristics — Part 1: Statistical evaluation of the linear calibration function*

ISO 15587-1, *Water quality — Digestion for the determination of selected elements in water — Part 1: Aqua regia digestion*

ISO 15587-2, *Water quality — Digestion for the determination of selected elements in water — Part 2: Nitric acid digestion*

ISO 17294-1:—¹⁾, *Water quality — Application of inductively coupled plasma mass spectrometry (ICP-MS) for the determination of elements — Part 1: General guidelines and basic principles*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17294-1 and the following apply.

3.1

limit of application

lowest concentration of an analyte that can be determined with a defined level of accuracy and precision

4 Principle

Multi-element determination of 62 elements by inductively coupled plasma mass spectrometry (ICP-MS) consists of the following steps:

- introduction of a measuring solution into a radiofrequency plasma (for example by pneumatic nebulization) where energy transfer processes from the plasma cause dissolution, atomization and ionization of elements;
- extraction of the ions from plasma through a differentially pumped vacuum interface with integrated ion optics and separation on the basis of their mass-to-charge ratio by a mass spectrometer (for instance a quadrupole MS);

1) To be published.

- transmission of the ions through the mass separation unit (for instance a quadrupole) and detection, usually by a continuous dynode electron multiplier assembly, and ion information processing by a data handling system;
- quantitative determination after calibration with suitable calibration solutions.

The relationship between signal intensity and mass concentration is usually a linear one over at least five orders of magnitude.

5 Interferences

5.1 General

In certain cases, isobaric and non-isobaric interferences may occur. The most important interferences in this respect are coinciding masses and physical interferences from the sample matrix. For more detailed information, refer to ISO 17294-1.

Common isobaric interferences are given in Table 2 (for additional information see ISO 17294-1). In order to detect these interferences, it is recommended that several different isotopes of an element be determined. All the results should be similar. If they are not, mathematical correction is then necessary if, for a given element, there is no isotope which can be measured without interferences.

Small drifts or variations in intensities should be corrected by the application of the reference-element technique. In general, in order to avoid physical and spectral interferences, the mass concentration of dissolved matter (salt content) shall not exceed 2 g/l.

NOTE Under cool plasma conditions some interferences will not occur. But the inevitable lower stability of cool plasma has to be considered accordingly. Also with reaction cell instruments (for example DRC ICP-MS) some interferences are overcome.

5.2 Spectral interferences

5.2.1 General

For more detailed information on spectral interferences, refer to ISO 17294-1:—, 6.1.

5.2.2 Isobaric elemental and polyatomic interferences

Isobaric elemental interferences are caused by isotopes of different elements of the same nominal mass-to-charge-ratio and which cannot be separated due to an insufficient resolution of the mass spectrometer in use (for example ^{114}Cd and ^{114}Sn).

Element interferences from isobars may be corrected for taking into account the influence from the interfering element (see Table 3). In this case, the isotopes used for correction shall be determinable without any interference and with sufficient precision. Possible proposals for correction are often included in the instrument software.

Table 2 — Important isobaric interferences

Element	Isotope	Inter-element interferences caused by isobars and doubly charged ions	Interferences caused by polyatomic ions
Ag	¹⁰⁷ Ag ¹⁰⁹ Ag	—	ZrO NbO, ZrOH
As	⁷⁵ As	—	ArCl, CaCl
Au	¹⁹⁷ Au	—	TaO
B	¹¹ B	—	BH
Ba	¹³⁸ Ba	La ⁺ , Ce ⁺	—
Ca	⁴³ Ca	—	CNO
	⁴⁴ Ca	—	COO
Cd	¹¹¹ Cd	—	MoO, MoOH, ZrOH
	¹¹⁴ Cd	Sn ⁺	MoO, MoOH
Co	⁵⁹ Co	—	CaO, CaOH, MgCl
Cr	⁵² Cr	—	ArO, ArC, ClOH
	⁵³ Cr	Fe ⁺	ClO, ArOH,
Cu	⁶³ Cu	—	ArNa, POO, MgCl
	⁶⁵ Cu	—	SOOH
Eu	¹⁵¹ Eu	—	BaO
	¹⁵³ Eu	—	BaO
Ga	⁶⁹ Ga	Ba ⁺⁺	CrO, ArP, ClOO
Ge	⁷⁴ Ge	Se ⁺	ArS, ClCl
In	¹¹⁵ In	Sn ⁺	—
Ir	¹⁹³ Ir	—	HfO
Mg	²⁴ Mg	—	CC
	²⁵ Mg	—	CC
Mn	⁵⁵ Mn	—	NaS, ArOH, ArNH
Mo	⁹⁸ Mo	Ru ⁺	—
Ni	⁵⁸ Ni	Fe ⁺	CaO, CaN, NaCl, MgS
	⁶⁰ Ni	—	CaO, CaOH, MgCl, NaCl
Pd	¹⁰⁸ Pd	Cd ⁺	MoO, ZrO
Pt	¹⁹⁵ Pt	—	HfO
Re	¹⁸⁷ Re	Os ⁺	—
Ru	¹⁰² Ru	Pd ⁺	—
Sb	¹²³ Sb	Te ⁺	—
Sc	⁴⁵ Sc	—	COO, COOH
Se	⁷⁷ Se	—	CaCl, ArCl, ArArH
	⁷⁸ Se	Kr ⁺	ArAr, CaCl
	⁸² Se	Kr ⁺	—
Sn	¹²⁰ Sn	Te ⁺	—
V	⁵¹ V	—	ClO, SOH, ClN, ArNH
W	¹⁸⁴ W	Os ⁺	—
Zn	⁶⁴ Zn	Ni ⁺	AlCl, SS, SOO, CaO
	⁶⁶ Zn	Ba ⁺⁺	PCI, SS, FeC, SOO
	⁶⁸ Zn	Ba ⁺⁺ , Ce ⁺⁺	FeN, PCI, ArS, FeC, SS, ArNN, SOO

In the presence of elements in high mass concentrations, interferences may be caused by the formation of polyatoms or doubly charged ions which are not listed above.