
Kakovost vode - Uporaba masne spektrometrije z induktivno sklopljeno plazmo (ICP-MS) - 1. del: Splošne smernice (ISO/DIS 17294-1:2022)

Water quality - Application of inductively coupled plasma mass spectrometry (ICP-MS) - Part 1: General guidelines (ISO/DIS 17294-1:2022)

Wasserbeschaffenheit - Anwendung der induktiv gekoppelten Plasma-Massenspektrometrie (ICP-MS) - Teil 1: Allgemeine Anleitung (ISO/DIS 17294-1:2022)

Qualité de l'eau - Application de la spectrométrie de masse avec plasma à couplage inductif (ICP-MS) - Partie 1: Lignes directrices générales (ISO/DIS 17294-1:2022)

Ta slovenski standard je istoveten z: prEN ISO 17294-1

ICS:

13.060.50	Preiskava vode na kemične snovi	Examination of water for chemical substances
-----------	---------------------------------	--

oSIST prEN ISO 17294-1:2022

en,fr,de

DRAFT INTERNATIONAL STANDARD

ISO/DIS 17294-1

ISO/TC 147/SC 2

Secretariat: DIN

Voting begins on:
2022-05-18

Voting terminates on:
2022-08-10

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

Part 1: General guidelines

ICS: 13.060.50

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[oSIST prEN ISO 17294-1:2022](https://standards.iteh.ai/catalog/standards/sist/39316dcc-3ef4-4cfa-be7d-03733f311606/osist-pren-iso-17294-1-2022)

<https://standards.iteh.ai/catalog/standards/sist/39316dcc-3ef4-4cfa-be7d-03733f311606/osist-pren-iso-17294-1-2022>

This document is circulated as received from the committee secretariat.

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

ISO/CEN PARALLEL PROCESSING



Reference number
ISO/DIS 17294-1:2022(E)

© ISO 2022

iTeh STANDARD PREVIEW (standards.iteh.ai)

[oSIST prEN ISO 17294-1:2022](https://standards.iteh.ai/catalog/standards/sist/39316dcc-3ef4-4cfa-be7d-03733f311606/osist-pren-iso-17294-1-2022)

<https://standards.iteh.ai/catalog/standards/sist/39316dcc-3ef4-4cfa-be7d-03733f311606/osist-pren-iso-17294-1-2022>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2022

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	5
5 Apparatus	6
5.1 General.....	6
5.2 Sample introduction.....	6
5.2.1 General.....	6
5.2.2 Pump.....	7
5.2.3 Nebulizer.....	7
5.2.4 Spray chamber.....	8
5.2.5 Other systems.....	8
5.3 Torch and plasma.....	8
5.4 Gas and gas control.....	9
5.5 Generator.....	9
5.6 Transfer of the ions to the mass spectrometer.....	9
5.7 Mass spectrometer.....	10
5.7.1 General.....	10
5.7.2 Lens system.....	10
5.7.3 Collision or reaction cell.....	10
5.7.4 Analyser.....	11
5.7.5 Detector.....	11
5.7.6 Alternative mass spectrometers/types of instruments.....	12
5.8 Signal processing and instrument control.....	13
6 Interferences by concomitant elements	14
6.1 General.....	14
6.2 Spectral interferences.....	14
6.2.1 General.....	14
6.2.2 Possible elimination strategies for polyatomic ion interferences.....	14
6.3 Non-spectral interferences.....	15
6.3.1 General.....	15
6.3.2 Interferences in the nebulization process.....	16
6.3.3 Interferences in the plasma.....	16
6.3.4 Interferences in the interface/lens area.....	17
6.3.5 Possible elimination strategies for non-spectral interferences (matrix effects).....	17
7 Adjustment of the apparatus	20
7.1 General.....	20
7.2 Tuning the apparatus.....	20
7.2.1 General.....	20
7.2.2 Alignment of the plasma.....	20
7.2.3 Mass calibration.....	21
7.2.4 Resolution.....	21
7.2.5 Detector.....	21
7.3 Verification of instrument performance criteria.....	22
8 Preparatory steps	22
8.1 General.....	22
8.2 Choice of isotopes.....	23
8.3 Choice of instrumental settings.....	23

ISO/DIS 17294-1:2022(E)

8.4	Choice of integration time	24
8.5	Choice of reference elements (internal standards).....	25
8.6	Linearity and working range.....	25
8.7	Composition of calibration solutions.....	26
8.8	Method development for cool plasma conditions.....	26
8.9	Determination of the method performance.....	27
8.9.1	General.....	27
8.9.2	Instrument detection limit.....	27
8.9.3	Method detection limit	27
8.9.4	Precision of the method.....	27
9	Procedure.....	27
9.1	General.....	27
9.2	Calibration.....	28
9.3	Necessary solutions.....	28
9.4	Measurement.....	29
Annex A (informative) Spectral interferences, choice of isotopes and method detection limits for quadrupole ICP-MS instruments.....		30
Bibliography.....		37

iTeh STANDARD PREVIEW (standards.iteh.ai)

[oSIST prEN ISO 17294-1:2022](https://standards.iteh.ai/catalog/standards/sist/39316dcc-3ef4-4cfa-be7d-03733f311606/osist-pren-iso-17294-1-2022)

<https://standards.iteh.ai/catalog/standards/sist/39316dcc-3ef4-4cfa-be7d-03733f311606/osist-pren-iso-17294-1-2022>

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 17294-1:2004), which has been technically revised.

The main changes compared to the previous edition are as follows:

- revision of the scope to be in line with ISO 17294-2;
- the document has been revised to be in line with the current available instruments used in routine daily practice in many laboratories;
- [Clauses 5](#) and [6](#) have been revised to be in line with the state of the art equipment used to measure elements according to part 2 of this document;
- the abbreviations in [Clause 9](#) were reviewed and were brought in line with the generally used terms in other standards;
- [Table A.1](#) has been updated.

A list of all parts in the ISO 17294 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

ISO/DIS 17294-1:2022(E)**Introduction**

Since the last version new developments for the metal analyses with inductively coupled plasma mass spectrometry (ICP-MS) took place. The use of the collision cell inductively coupled plasma mass spectrometer (CC-ICP-MS) and triple quad ICP-MS has increased in the laboratories. For this reason ISO 17294-1 has been revised and new items have been added.

The intention for the revision of this document was to focus on the instrumentation that is currently available and in use for the determination of elements according to ISO 17294-2 in daily practice in laboratories. The consequence of this starting point is that the use of correction formulae has been moved to [Annex A](#) because of reduced importance in modern instrumentation. Many principles also apply for high resolution or accurate mass instrumentation although they are not described in detail in this document.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[oSIST prEN ISO 17294-1:2022](#)

<https://standards.iteh.ai/catalog/standards/sist/39316dcc-3ef4-4cfa-be7d-03733f311606/osist-pren-iso-17294-1-2022>

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

Part 1: General guidelines

1 Scope

This document specifies the principles of inductively coupled plasma mass spectrometry (ICP-MS) and provides general directions for the use of this technique for determining elements in water, digests of sludges and sediments (for example, digests of water as described in ISO 15587-1 or ISO 15587-2). Generally, the measurement is carried out in water, but gases, vapours or fine particulate matter can be introduced too. This document applies to the use of ICP-MS for aqueous solution analysis.

The ultimate determination of the elements is described in a separate International Standard for each series of elements and matrix. The individual parts of this document refer the reader to these guidelines for the basic principles of the method and for configuration of the instrument.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 3534-1, *Statistics — Vocabulary and symbols — Part 1: General statistical terms and terms used in probability*

ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

ISO 6206, *Chemical products for industrial use — Sampling — Vocabulary*

ISO 8466-1, *Water quality — Calibration and evaluation of analytical methods — Part 1: Linear calibration function*

ISO Guide 30, *Reference materials — Selected terms and definitions*

ISO Guide 32, *Calibration in analytical chemistry and use of certified reference materials*

ISO Guide 33, *Reference materials — Good practice in using reference materials*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5725-1, ISO 6206, ISO Guide 32 and the following apply.

ISO/DIS 17294-1:2022(E)

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1**accuracy**

closeness of agreement between test result and the accepted reference value

Note 1 to entry: The term accuracy, when applied to a set of test results, involves a combination of random components and a common systematic error or bias component.

[SOURCE: ISO 5725-1:1994, 3.6]

3.2**analyte**

element(s) to be determined

3.3**blank calibration solution**

solution prepared in the same way as the calibration solution but leaving out the *analyte* (3.2)

3.4**calibration solution**

solution used to calibrate the instrument, prepared from (a) stock solution(s) or from a certified standard

3.5**calibration check solution**

solution of known composition within the range of the *calibration solution* (3.4), but prepared independently

3.6**determination**

entire process from preparing the test sample solution up to and including measurement and calculation of the final result

3.7**instrument detection limit**

L_{DI}

smallest concentration that can be detected with a defined statistical probability using a contaminant-free instrument and a blank calibration solution

3.8**laboratory sample**

sample sent to the laboratory for analysis

[SOURCE: ISO 6206:1979, 3.2.10]

3.9**linearity**

straight line relationship between the (mean) result of measurement (signal) and the quantity (concentration) of the component to be determined

3.10**linearity verification solution**

solution with a known concentration of the matrix components compared to the *calibration solutions* (3.4), but having an analyte concentration half that of the (highest) calibration solution

3.11**mean result**

mean value of n results, calculated as intensity (ratio) or as mass concentration (U)

Note 1 to entry: The mass concentration is expressed in units of milligrams per litre.

3.12**method detection limit**

L_{DM}

smallest analyte concentration that can be detected with a specified analytical method with a defined statistical probability

3.13**net intensity**

I

signal obtained after correction for background signal

3.14**net intensity ratio**

I_R

net intensity divided by the net signal of a reference element

3.15**optimization solution**

solution serving for mass calibration and for the optimization of the apparatus conditions

EXAMPLE Adjustment of maximal sensitivity with respect to minimal oxide formation rate and minimal formation of doubly charged ions.

3.16**precision**

closeness of agreement between independent test results obtained under prescribed conditions

Note 1 to entry: Precision depends only on the distribution of random errors and does not relate to true value or the specified value.

[SOURCE: ISO 5725-1:1994, 3.12]

3.17**"pure chemical"**

chemical with the highest available purity and known stoichiometry and for which the content of *analyte* (3.2) and contaminants should be known with an established degree of certainty

3.18**raw intensity**

I_{raw}

obtained uncorrected signal

3.19**reagent blank solution**

solution prepared by adding to the solvent the same amounts of reagents as those added to the test sample solution and with the same final volume

3.20**repeatability**

r

precision under *repeatability conditions* (3.21)

[SOURCE: ISO 5725-1:1994, 3.13]

ISO/DIS 17294-1:2022(E)

3.21

repeatability conditions

conditions where independent test results are obtained with the same method on identical test items in the same laboratory by the same operator using the same equipment within short intervals of time

[SOURCE: ISO 5725-1:1994, 3.14]

3.22

repeatability standard deviation

standard deviation of test results obtained under *repeatability conditions* ([3.21](#))

[SOURCE: ISO 5725-1:1994, 3.15]

3.23

repeatability limit

value less than or equal to which the absolute difference between two test results obtained under *repeatability conditions* ([3.21](#)) may be expected to be with a probability of 95 %

[SOURCE: ISO 5725-1:1994, 3.16]

3.24

reproducibility**R**

precision under *reproducibility conditions* ([3.25](#))

[SOURCE: ISO 5725-1:1994, 3.17]

3.25

reproducibility conditions

conditions where test results are obtained with the same method on identical test items in different laboratories with different operators using different equipment

[SOURCE: ISO 5725-1:1994, 3.18]

3.26

reproducibility limit

value less than or equal to which the absolute difference between two test results obtained under *reproducibility conditions* ([3.25](#)) may be expected to be with a probability of 95 %

[SOURCE: ISO 5725-1:1994, 3.20]

3.27

reproducibility standard deviation

standard deviation of test results obtained under *reproducibility conditions* ([3.25](#))

[SOURCE: ISO 5725-1:1994, 3.19, modified]

3.28

result

outcome of a measurement

Note 1 to entry: The result is typically calculated as mass concentration (U), expressed in milligrams per litre.

3.29

sensitivity**S**

ratio of the variation of the magnitude of the signal (dI) to the corresponding variation in the concentration of the analyte (dC) expressed by [Formula \(1\)](#):

$$S = \frac{dI}{dC} \quad (1)$$

3.30**stock solution**

solution with accurately known analyte concentration(s), prepared from “pure chemicals”

Note 1 to entry: Stock solutions are reference materials within the meaning of ISO Guide 30.

3.31**test sample**

sample prepared from the laboratory sample, for example by grinding or homogenizing

3.32**test sample solution**

solution prepared with the fraction (test portion) of the *test sample* (3.31) according to the appropriate specifications, such that it can be used for the envisaged measurement

3.33**trueness****bias**

closeness of agreement between the average value obtained from a large series of test results and an accepted reference value

Note 1 to entry: The measure of trueness is usually expressed in terms of bias, which equals the sum of the systematic error components.

[SOURCE: ISO 5725-1:1994, 3.7, modified]

3.34**uncertainty of measurement**

parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the analyte concentration

[SOURCE: ISO/IEC Guide 98-3:2008, 2.2.3, modified] 294-1:2022

<https://standards.iteh.ai/catalog/standards/sist/39316dcc-3ef4-4cfa-be7d-03733f311606/osist-pren-iso-17294-1-2022>

4 Principle

ICP-MS stands for Inductively Coupled Plasma Mass Spectrometry. In the present context, a plasma is a small cloud of hot (6 000 K to 10 000 K) and partly ionized (approximately 1 %) argon gas. Cool plasmas have temperatures of only about 2 500 K. The plasma is sustained by a radio-frequency field. The sample is brought into the plasma as an aerosol. Liquid samples are converted into an aerosol using a nebulizer. In the plasma, the solvent of the sample evaporates, and the compounds present decompose into the constituent atoms (dissociation, atomization). The analyte atoms are in most cases almost completely ionized.

In the mass spectrometer, typically equipped with collision reaction cell and quadrupole, the ions are separated and the elements identified according to their mass-to-charge ratio, m/z , while the concentration of the element is proportional to the number of ions.

ICP-MS is a relative technique. The proportionality factor between response and analyte concentration relates to the fact that only a fraction of the analyte atoms that are aspirated reach the detector as an ion. The proportionality factor is determined by measuring calibration solutions (calibration).

With instruments equipped with a magnetic sector field, higher mass resolution spectra can be obtained. This can help to separate isotopes of interest from interfering species.