SLOVENSKI STANDARD

oSIST ISO 30011:2026

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Zrak na delovnem mestu - Določanje kovin in polkovin v lebdečih delcih z masno spektrometrijo z induktivno sklopljeno plazmo

Workplace air - Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma mass spectrometry

Air des lieux de travail - Détermination des métaux et métalloïdes dans les particules en suspension dans l'air par spectrométrie de masse avec plasma à couplage inductif

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Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma mass spectrometry

Air des lieux de travail — Détermination des métaux et métalloïdes dans les particules en suspension dans l'air par spectrométrie de masse avec plasma à couplage inductif

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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 document 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).

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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 146, *Air quality*, Subcommittee SC 2, *Workplace atmospheres*.

This second edition cancels and replaces the first edition (ISO 30011:2010), which has been technically revised.

The main changes are as follows:

- references and definitions have been updated;
- data in Tables 2 and 4 have been updated;
- a new Annex B has been added containing example instrument operating parameters for standard and collision modes (the previous Annexes B and C have been renumbered as Annexes C and D, respectively);
- a new Annex E has been added containing substrate-specific detection and quantification data.

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.

Introduction

The health of workers in many industries is at risk through exposure by inhalation of toxic metals and metalloids. Industrial hygienists and other public health professionals need to determine the effectiveness of measures taken to control workers' exposure, and this is generally achieved by taking workplace air measurements. This document has been published in order to make available a method for making valid ultra-trace exposure measurements for a wide range of metals and metalloids in use in industry. It is intended for:

- agencies concerned with health and safety at work;
- industrial hygienists and other public health professionals;
- analytical laboratories;
- industrial users of metals and metalloids and their workers.

This document specifies a method for the determination of the mass concentration of metals and metalloids in workplace air using quadrupole inductively coupled plasma mass spectrometry (ICP-MS). For many metals and metalloids, analysis by ICP-MS is advantageous when compared to methods such as inductively coupled plasma atomic emission spectrometry, due to its sensitivity and the presence of fewer spectral interferences.

The execution of the provisions of this document and the interpretation of the results obtained is assumed to be entrusted to appropriately qualified and experienced people.

Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma mass spectrometry

1 Scope

This document specifies a procedure for the use of quadrupole inductively coupled plasma mass spectrometry (ICP-MS), including single-quadrupole instruments and tandem ICP-MS/MS, for analysing test solutions prepared from samples of airborne particulate matter collected as specified in ISO 15202-1. Method development, performance checks and a routine analysis method are specified in this document

NOTE 1 Other types of ICP-MS (e.g. magnetic sector) are outside of the scope of this document.

Test solutions for analysis by this document are prepared as specified in ISO 15202-2.

This document is applicable to the assessment of workplace exposure to metals and metalloids for comparison with limit values (e.g. see EN 689[10] and ASTM E1370[8]).

This document is not applicable to the determination of elemental mercury, since mercury vapour is not collected using the sampling method specified in ISO 15202-1.

The procedure specified in this document is suitable for the assessment of exposure against the long-term exposure limits for most of the metals and metalloids for which occupational exposure limit values have been set, when sampling at a typical flow rate of at least 2 l min^{-1} for sampling times in the range 0,25 h to 8 h and for the assessment of exposure against the short-term exposure limits, where applicable.

NOTE 2 The procedure is subject to no significant spectral interferences (see Clause A.3), provided that suitable analytical isotopes are used. However, inadequate matrix-matching can adversely affect results.

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 1042, *Laboratory glassware — One-mark volumetric flasks*

ISO 3585, *Borosilicate glass 3.3 — Properties*

ISO 8655-1, *Piston-operated volumetric apparatus — Part 1: Terminology, general requirements and user recommendations*

ISO 8655-2, *Piston-operated volumetric apparatus — Part 2: Pipettes*

ISO 8655-5, *Piston-operated volumetric apparatus — Part 5: Dispensers*

ISO 8655-6, *Piston-operated volumetric apparatus — Part 6: Gravimetric reference measurement procedure for the determination of volume*

ISO 15202-1, *Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma atomic emission spectrometry — Part 1: Sampling*

ISO 15202-2:2020, *Workplace air — Determination of metals and metalloids in airborne particulate matter by inductively coupled plasma atomic emission spectrometry — Part 2: Sample preparation*

ISO 18158, *Workplace air — Terminology*

ISO 20581, *Workplace air — General requirements for the performance of procedures for the measurement of chemical agents*

ISO 21832:2018, *Workplace air — Metals and metalloids in airborne particles — Requirements for evaluation of measuring procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18158 and the following apply.

ISO and IEC maintain terminology 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 Terms related to analysis

3.1.1
blank solution
solution prepared by taking a *reagent blank* (3.1.6), laboratory blank or field blank through the same procedure used for sample dissolution

Note 1 to entry: A blank solution can require undergoing further operations, such as addition of an *internal standard* (3.2.9), if the *sample solutions* (3.1.8) are subjected to such operations in order to produce *test solutions* (3.1.11) that are ready for analysis.

3.1.2
calibration blank solution
calibration solution (3.1.4) prepared without the addition of any *stock standard solution* (3.1.10) or *working standard solution* (3.1.12)

Note 1 to entry: The concentration of the analyte(s) of interest in the calibration blank solution is taken to be zero.

[SOURCE: EN 14902:2005,[11] 3.1.3, modified — "without addition" has been replaced with "without the addition" and "for which the concentration of the analyte(s) of interest is considered to be zero" has been deleted from the definition.]

3.1.3
calibration curve
plot of instrument response versus concentration of standards

[SOURCE: United States Environmental Protection Agency, Document Number EPA 540-R-04-004[13], modified — "A" has been deleted.]

3.1.4
calibration solution
solution prepared by dilution of the *stock standard solution(s)* (3.1.10) or *working standard solution(s)* (3.1.12), containing the analyte(s) of interest at a concentration(s) that is suitable for use in calibration of the analytical instrument

Note 1 to entry: The *matrix-matching* (3.2.12) technique is normally used when preparing calibration solutions.

3.1.5
linear dynamic range
range of concentrations over which the *calibration curve* (3.1.3) for an analyte is linear

Note 1 to entry: The linear dynamic range extends from the detection limit to the onset of calibration curvature.

3.1.6
reagent blank

reagents used in *sample dissolution* (3.1.7), in the same quantities used for preparation of the *blank solution* (3.1.1) and *sample solutions* (3.1.8)

Note 1 to entry: The reagent blank is used to assess contamination from the laboratory environment and to characterize spectral background from the reagents used in sample preparation.

3.1.7
sample dissolution

process of obtaining a solution containing all analytes of interest from a sample, which can involve complete dissolution of the sample

[SOURCE: EN 14902:2005,[11] 3.1.25, modified — the definition has been structurally revised and "the analytes" has been changed to "all analytes".]

3.1.8
sample solution

solution prepared from a sample by the process of *sample dissolution* (3.1.7)

Note 1 to entry: A *sample solution* (3.1.8) can require undergoing further operations, e.g. dilution or addition of an *internal standard(s)* (3.2.9), in order to produce a *test solution* (3.1.11).

[SOURCE: EN 14902:2005,[11] 3.1.22, modified — Note 1 to entry has been replaced.]

3.1.9
spiked media blank

media blank that is spiked with a known amount of the analyte(s) of interest

3.1.10
stock standard solution

solution used for preparation of *working standard solutions* (3.1.11) or *calibration solutions* (3.1.4), containing the analyte(s) of interest at a certified concentration(s) traceable to national standards

3.1.11
test solution

blank solution (3.1.1) or *sample solution* (3.1.8) that has been subjected to all operations required to bring it into a state in which it is ready for analysis

Note 1 to entry: "Ready for analysis" includes any required dilution or addition of an *internal standard* (3.2.9). If a blank solution or sample solution is not subject to any further operations before analysis, it is a test solution.

3.1.12
working standard solution

solution, prepared by dilution of the *stock standard solution(s)* (3.1.10), that contains the analyte(s) of interest at a concentration(s) better suited for preparation of *calibration solutions* (3.1.4) than the concentration(s) of the analyte(s) in the *stock standard solution(s)* (3.1.10)

[SOURCE: EN 14902:2005,[11] 3.1.32, modified — "than the concentration(s) of the analyte(s) in the stock standard solution(s)" has been added.]

3.2 Terms related to inductively coupled plasma mass spectrometry (ICP-MS)

3.2.1
collision cell

chamber in the ion path between mass-to-charge ratio (m/z) separation elements, or between ion source acceleration region and the first analyser, in tandem mass spectrometry in space configurations

Note 1 to entry: See Reference [14] for a more detailed description of collision cells and their function.

3.2.2

collision reaction cell

collision cell (3.2.1) for removal of interfering ions by ion/neutral reactions in inductively coupled plasma mass spectrometry (ICP-MS)

Note 1 to entry: Collision reaction cells make use of kinetic energy dispersion, reaction chemistry or a combination of both, to remove interfering species. A variety of applications of collision reaction cell technology are available.

Note 2 to entry: See Reference [14] for a more detailed description of collision reaction cells and their function.

3.2.3

corrosion-resistant sample introduction system

sample introduction system that features a *nebulizer* (3.2.13), *spray chamber* (3.2.16) and *ICP torch* (3.2.4) *injector tube* (3.2.6) that are resistant to corrosion by hydrofluoric acid (6.2.6)

3.2.4

inductively coupled plasma torch

ICP torch

device used to support and introduce a sample into an ICP discharge

Note 1 to entry: An ICP torch usually consists of three concentric tubes, the outer two usually made from quartz.

3.2.5

inductively coupled plasma

ICP

high-temperature discharge generated in flowing argon by an alternating magnetic field induced by a radio frequency (RF) load coil that surrounds the tube carrying the gas

3.2.6

injector

injector tube

centre tube

innermost tube of an *ICP torch* (3.2.4), through which the sample aerosol is introduced to the plasma

Note 1 to entry: The injector is usually made of quartz, ceramic material or platinum.

3.2.7

inner argon flow

nebulizer argon flow

sample argon flow

flow of argon gas that is directed through the *nebulizer* (3.2.13) and carries the sample aerosol through the *injector* (3.2.6) and into the plasma

Note 1 to entry: The inner argon flow rate is typically 0,5 l min^{-1} to 2 l min^{-1}.

3.2.8

intermediate argon flow

auxiliary argon flow

flow of argon gas that is contained between the intermediate and centre [*injector* (3.2.6)] tubes of an *ICP torch* (3.2.4)

Note 1 to entry: The intermediate argon flow rate is typically 0 l min^{-1} to 2 l min^{-1}.

3.2.9

internal standard

non-analyte element, present in all solutions analysed, the signal from which is used to correct for *matrix interferences* (3.2.11) or improve analytical precision

3.2.10

load coil

length of metal tubing wound around the end of an *ICP torch* (3.2.4) and connected to the radio frequency (RF) generator, used to inductively couple energy from the RF generator to the plasma discharge