
**Water quality — Determination of trace
elements using atomic absorption
spectrometry with graphite furnace**

*Qualité de l'eau — Dosage des éléments traces par spectrométrie
d'absorption atomique en four graphite*



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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.

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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 15586 was prepared by Technical Committee ISO/TC 147, *Water quality*, Subcommittee SC 2, *Physical, chemical and biochemical methods*.

Water quality — Determination of trace elements using atomic absorption spectrometry with graphite furnace

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This International Standard 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.

1 Scope

This International Standard includes principles and procedures for the determination of trace levels of: Ag, Al, As, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, Ti, V, and Zn in surface water, ground water, drinking water, wastewater and sediments, using atomic absorption spectrometry with electrothermal atomization in a graphite furnace. The method is applicable to the determination of low concentrations of elements.

The detection limit of the method for each element depends on the sample matrix as well as of the instrument, the type of atomizer and the use of chemical modifiers. For water samples with a simple matrix (i.e. low concentration of dissolved solids and particles), the method detection limits will be close to instrument detection limits. The minimum acceptable detection limit values for a 20- μ l sample volume are given in Table 1.

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 5667-4, *Water quality — Sampling — Part 4: Guidance on sampling from lakes, natural and man-made*

ISO 5667-5, *Water quality — Sampling — Part 5: Guidance on sampling of drinking water and water used for food and beverage processing*

ISO 5667-6, *Water quality — Sampling — Part 6: Guidance on sampling of rivers and streams*

ISO 5667-10, *Water quality — Sampling — Part 10: Guidance on sampling of waste waters*

ISO 5667-11, *Water quality — Sampling — Part 11: Guidance on sampling of groundwaters*

ISO 5667-15, *Water quality — Sampling — Part 15: Guidance on preservation and handling of sludge and sediment samples*

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

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

Table 1 — Approximate characteristic masses, instrument detection limits and optimum working ranges for water samples using a 20 µl sample volume

Element	Characteristic mass m_0^a pg	Detection limit ^b µg/l	Optimum working range ^c µg/l
Ag	1,5	0,2	1 to 10
Al	10	1	6 to 60
As	15	1	10 to 100
Cd	0,4	0,1	0,4 to 4
Co	10	1	6 to 60
Cr	3	0,5	2 to 20
Cu	5 ^d	0,5	3 to 30
Fe	5	1	3 to 30
Mn	2,5	0,5	1,5 to 15
Mo	10	1	6 to 60
Ni	13	1	7 to 70
Pb	15	1	10 to 100
Sb	20		10 to 100
Se	25	2	15 to 150
Tl	10 ^d	1	6 to 60
V	35	2	20 to 200
Zn	0,8	0,5	0,5 to 5

^a The characteristic mass (m_0) of an element is the mass in picograms, corresponding to a signal of 0,004 4 s, using the integrated absorbance (peak area) for evaluation.

^b The detection limits are calculated as three times ($3 \times$) the standard deviation of repeated measurements of a blank solution.

^c The optimum working range is defined as the concentration range that corresponds to integrated absorbance readings between 0,05 s and 0,5 s.

^d If Zeeman effect background correction is used, the m_0 -value will be higher.

3 Principle

Water samples are preserved by acid treatment, filtered and preserved by addition of acid, or digested. Sediment samples are digested. A small sub-sample of sample solution is injected into a graphite furnace of an atomic absorption spectrometer. The furnace is electrically heated. By increasing the temperature stepwise, the sample is dried, pyrolyzed and atomized. Atomic absorption spectrometry is based on the ability of free atoms to absorb light. A light source emits light specific for a certain element (or elements). When the light beam passes through the atom cloud in the heated graphite furnace, the light is selectively absorbed by atoms of the chosen element(s). The decrease in light intensity is measured with a detector at a specific wavelength. The concentration of an element in a sample is determined by comparing the absorbance of the sample with the absorbance of calibration solutions. If necessary, interferences may be overcome by adding a matrix modifier to the samples before analysis, or by performing the calibration with the standard addition technique.

The results are given as the mass of analyte (micrograms, µg, or milligrams, mg) per litre of water, or per kilogram of dried material in sediments.