
**Kakovost tal - Določevanje šestvalentnega kroma Cr (VI) v trdnem mediju z
alkalnim razklopom in ionsko kromatografijo s spektrofotometrično detekcijo (ISO
15192:2010)**

Soil quality - Determination of chromium(VI) in solid material by alkaline digestion and
ion chromatography with spectrophotometric detection (ISO 15192:2010)

Charakterisierung von Abfällen und Boden - Bestimmung von sechswertigem Chrom in
Feststoffen durch alkalischen Aufschluss und Ionenchromatographie mit photometrischer
Detektion (ISO 15192:2010)

Qualité du sol - Dosage du chrome(VI) dans les matériaux solides par digestion alcaline
et chromatographie ionique avec détection spectrophotométrique (ISO 15192:2010)

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INTERNATIONAL STANDARD

**ISO
15192**

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Soil quality — Determination of chromium(VI) in solid material by alkaline digestion and ion chromatography with spectrophotometric detection

*Qualité du sol — Dosage du chrome(VI) dans les matériaux solides par
digestion alcaline et chromatographie ionique avec détection
spectrophotométrique*

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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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ISO 15192 was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 3, *Chemical methods and soil characteristics*.

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Introduction

Under environmental conditions, chromium in compounds exists in the trivalent, Cr(III), or the hexavalent, Cr(VI), state. Cr(III) is an essential trace element for mammals, including man, whereas it is presumed that Cr(VI) compounds are genotoxic and potentially carcinogenic in humans. Interconversion of trivalent and hexavalent chromium species can occur during sample preparation and analysis, but these processes are minimized, to the extent possible, by the sample preparation methods specified in this International Standard.

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Soil quality — Determination of chromium(VI) in solid material by alkaline digestion and ion chromatography with spectrophotometric detection

1 Scope

This International Standard specifies a method for the determination of Cr(VI) in solid waste material and soil by alkaline digestion and ion chromatography with spectrophotometric detection. This method can be used to determine Cr(VI) mass fractions in solids greater than 0,1 mg/kg.

NOTE In the case of reducing or oxidizing waste matrix, no valid Cr(VI) mass fraction can be reported.

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, *Water for analytical laboratory use — Specification and test methods*

ISO 9174:1998, *Water quality — Determination of chromium — Atomic absorption spectrometric methods*

ISO 11464, *Soil quality — Pretreatment of samples for physico-chemical analysis*

ISO 11885:2007, *Water quality — Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES)*

ISO 15586:2003, *Water quality — Determination of trace elements using atomic absorption spectrometry with graphite furnace*

ISO 17294-2:2003, *Water quality — Application of inductively coupled plasma mass spectrometry (ICP-MS) — Part 2: Determination of 62 elements*

EN 15002, *Characterization of waste — Preparation of test portions from the laboratory sample*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

alkaline digestion

process for obtaining a solution containing the analyte of interest from a sample under alkaline conditions

NOTE Alkaline digestion may or may not involve complete dissolution of the sample.

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3.2

speciation analysis

activities for measuring the quantity of one or more individual chemical species in a sample

EXAMPLE Cr(VI) in a particular sample or matrix.

4 Safety

SAFETY PRECAUTIONS — Anyone dealing with waste and soil analysis has to be aware of the typical risks of the material, irrespective of the parameters determined. Waste and soil samples may contain hazardous (e.g. toxic, reactive, flammable, infectious) substances, which can be liable to biological and/or chemical reaction. Consequently, it is recommended that these samples be handled with special care. The gases which may be produced by microbiological or chemical activity are potentially flammable and can pressurize sealed bottles. Bursting bottles are likely to result in hazardous shrapnel, dust and/or aerosol. National regulations should be followed with respect to all hazards associated with this method.

Avoid any contact with the skin, ingestion or inhalation of Cr(VI) compounds. Cr(VI) compounds are genotoxic and potentially carcinogenic to humans.

5 Principle

5.1 Digestion

This International Standard describes an alkaline digestion procedure for extracting Cr(VI) from soluble, adsorbed and precipitated forms of chromium compounds in solid waste materials and soil. To quantify the mass fraction of Cr(VI) in a solid matrix, three criteria shall be satisfied:

- a) the digestion solution shall solubilize all species of Cr(VI);
- b) the conditions of the digestion shall not induce reduction of native Cr(VI) to Cr(III);
- c) the method shall not cause oxidation of native Cr(III) contained in the sample to Cr(VI).

The alkaline digestion described in this International Standard meets these criteria for a wide spectrum of solid matrices. Under the alkaline conditions of the digestion, neglectable reduction of Cr(VI) or oxidation of native Cr(III) is expected. The addition of Mg^{2+} in a phosphate buffer to the alkaline solution prevents air oxidation of trivalent chromium (References [7], [12] and [38] in the Bibliography).

NOTE Background information on methods for the determination of Cr(VI) in solid samples is given in Annex D and References [10], [11] and [12] in the Bibliography.

5.2 Determination

Quantification of Cr(VI) in the alkaline digestion solution should be performed using a suitable technique with appropriate accuracy. For this purpose, ion chromatography is used to separate Cr(VI) from interferences. Following this ion chromatographic separation, Cr(VI) is measured spectrophotometrically, either at 365 nm [direct ultraviolet (UV) detection] or after post-column derivatization with 1,5-diphenylcarbazide in acid solution at 540 nm. Post-column derivatization involves reaction of 1,5-diphenylcarbazide with Cr(VI) to produce trivalent chromium and diphenylcarbazone. These then combine to form a trivalent chromium-diphenylcarbazone complex containing the characteristic magenta chromagen ($\lambda_{max} = 540$ nm).

NOTE 1 The choice of the detection method is based upon the required sensitivity. Direct UV detection is less sensitive than detection after post-column derivatization with 1,5-diphenylcarbazide.

NOTE 2 Hyphenated methods with ion chromatographic separation and detection techniques, such as inductively coupled plasma/mass spectrometry (ICP/MS) or inductively coupled plasma (atomic emission spectroscopy (ICP/AES), can be used once validation of the chosen analytical method has been performed.

5.3 Interferences and sources of error

Use of ion chromatography is necessary for the separation of Cr(VI) from possible interferences in the alkaline digestion solution from solid material (Reference [13] in the Bibliography) (see also D.3).

For waste materials or soils, where the Cr(III)/Cr(VI) ratio is expected to be high, Cr(VI) results may be biased due to method-induced oxidation. This can be particularly expected in soils high in manganese (Mn) content and amended with soluble Cr(III) salts or freshly precipitated Cr(OH)₃ (Reference [10] in the Bibliography) (see also D.2).

Cr(VI) can be reduced to Cr(III) during digestion of the sample, due to reaction with reducing agents such as, for example, divalent iron. This problem is minimized in the described procedure using alkaline digestion solution (Reference [12] in the Bibliography) (see also D.2).

Cr(III) can be oxidized to Cr(VI) in hot alkaline solutions. This problem is minimized in the described procedure by adding magnesium to the alkaline digestion solution (References [9], [10], [12] and [38] in the Bibliography) (see also D.2).

Overloading the analytical column capacity with high concentrations of anionic species (e.g. chloride) may cause underestimation of Cr(VI) (Reference [49] in the Bibliography).

6 Apparatus

Use ordinary laboratory apparatus and the following.

6.1 Digestion equipment, hotplate with a magnetic stirrer, thermostatically controlled, with a digestion vessel of 250 ml covered with a watch-glass; or a heating block with a magnetic stirrer, thermostatically controlled with a digestion vessel of 250 ml covered with a watch-glass.

NOTE Other thermostatically controlled digestion equipment with a magnetic stirrer can be used once validation has been performed.

6.2 Filtration equipment, suitable for using 0,45 µm membrane filters.

6.3 Membrane filters, of pore size 0,45 µm, chemically inert.

6.4 Ion chromatographic system, all components which come into contact with the sample or eluent stream shall be comprised of inert materials, e.g. polyetherether ketone (PEEK), as shall all connecting tubing (see Annex B).

6.5 Ion chromatographic column, suitable for chromate separation with a sufficient ion-exchange capacity.

6.6 Detection system, ultraviolet/visible light (UV/VIS) spectrophotometer at 365 nm; or VIS spectrophotometer at 540 nm after post-column derivatization.

7 Reagents

During the analysis, only use reagents of recognized analytical grade, and water as specified in 7.1.

7.1 Water.

Water complying with the requirements of ISO 3696 for grade 2 water (electrical conductivity less than 0,1 mS·m⁻¹ equivalent to a resistivity greater than 0,01 MΩ·m at 25 °C). It is recommended that the water