



**International  
Standard**

**ISO 13536**

**Soil quality — Determination of the  
potential cation exchange capacity  
and exchangeable cations using  
barium chloride solution buffered  
at pH = 8,1**

*Qualité du sol — Détermination de la capacité d'échange  
cationique potentielle et des teneurs en cations échangeables en  
utilisant une solution tampon de chlorure de baryum à pH = 8,1*

**Second edition  
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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 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](http://www.iso.org/directives)).

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This document was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 3, *Chemical and physical characterization*.

This second edition cancels and replaces the first edition (ISO 13536:1995), which has been technically revised.

The main changes are as follows:

- revision of the [Formula \(2\)](#) for the calculation of the cation exchange capacity (CEC) of the soil;
- addition of a note on possible misleading of the correction procedure in the analysis of calcareous soils;
- update of bibliography.

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](http://www.iso.org/members.html).

# Soil quality — Determination of the potential cation exchange capacity and exchangeable cations using barium chloride solution buffered at pH = 8,1

**WARNING** — Barium is a very toxic element if ingested. The barium ion has health risks for laboratory personnel working with this chemical; it is also harmful for the environment.

## 1 Scope

This document specifies a method for the determination of the potential cation exchange capacity (CEC) of soil buffered at pH = 8,1 and for the determination of the content of exchangeable sodium, potassium, calcium and magnesium in soil.

This document is applicable to all types of air-dried soil samples.

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

ISO 11465, *Sludge, treated biowaste, soil and waste — Determination of dry residue or water content and calculation of the dry matter fraction on a mass basis*

## 3 Terms and definitions

ISO 13536:2024

<https://standards.iteh.ai/catalog/standards/iso/799ec6a7-3a29-4b28-920b-0d45d7972423/iso-13536-2024>

No terms and definitions are listed in this document.

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/>

## 4 Principle

The determination of cation exchange capacity (CEC) as specified in this document is a modification of the method proposed by Mehlich<sup>[1],[2]</sup> and modified by Bascomb<sup>[3]</sup>. The CEC of soil samples is determined in barium chloride solution buffered at pH = 8,1 using triethanolamine.

The soil is first saturated with respect to barium by treating the soil three times with buffered barium chloride solution. Subsequently, a known excess of 0,02 mol/l magnesium sulfate solution is added. All the barium present, in solution as well as adsorbed, is precipitated in the form of highly insoluble barium sulfate and the sites with exchangeable ions are then readily occupied by magnesium. The excess magnesium is determined by either flame atomic absorption spectrometry (FAAS) or inductively coupled plasma atomic emission spectrometry (ICP-AES).

It is also possible to determine sodium, potassium, calcium and magnesium (and other elements) in the barium chloride extract of the soil.

NOTE 1 Besides sodium, potassium, calcium and magnesium, it is also possible to determine other cations, for example manganese, in the same extract.

NOTE 2 A yellowish-brown colour of the barium chloride extract indicates that some organic matter has been dissolved. Since organic matter contributes to the CEC, the measured value will be an underestimate of the potential CEC.

NOTE 3 The sum of exchangeable cations can give a result that is greater than the CEC due to the dissolution of salts present in the soil.

Preliminary washing of the soil with water to remove these salts should not be employed because it can change the relative proportions of cations in the CEC.

NOTE 4 In case the problem described under NOTE 3 is detected, the experiment can be repeated using a method which has a much lower solubility for calcium carbonate minerals. This procedure is described in ISO 23470:2018<sup>[4]</sup>.

## 5 Procedures

### 5.1 Leaching

#### 5.1.1 Reagents

Use only reagents of recognized analytical grade and distilled water or deionized water for all solutions.

**5.1.1.1 Water**, with a specific conductivity not higher than 0,2 mS/m at 25 °C.

**5.1.1.2 Barium chloride solution**,  $c(\text{BaCl}_2) = 1 \text{ mol/l}$ .

Dissolve 244 g of barium chloride dihydrate ( $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ ) in water and dilute to 1 000 ml with water.

**5.1.1.3 Hydrochloric acid**,  $c(\text{HCl}) = 2 \text{ mol/l}$ .

Dilute 166 ml of concentrated hydrochloric acid ( $\rho = 1,19 \text{ g/ml}$ ) with water to 1 000 ml.

**5.1.1.4 Triethanolamine solution**,  $\text{pH} = 8,1$ .

Dilute 90 ml of triethanolamine ( $\text{HOCH}_2\text{CH}_2$ )<sub>3</sub>N with water to approximately 1 litre and adjust the pH to  $8,1 \pm 0,02$  with about 140 ml to 150 ml of hydrochloric acid (5.1.1.3). Dilute with water to 2 litres.

**5.1.1.5 Extraction solution.**

Mix equal volumes of solutions 5.1.1.2 and 5.1.1.4. Protect this solution from exposure to carbon dioxide during storage.

**5.1.1.6 Magnesium sulfate solution**,  $c(\text{MgSO}_4) = 0,020 \text{ mol/l}$ .

Dissolve  $4,930 \text{ g} \pm 0,01 \text{ g}$  of magnesium sulfate heptahydrate ( $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ ) in water and dilute to 1 000 ml.

Magnesium sulfate heptahydrate can lose water of crystallization on standing. The reagent should be standardized by titration with ethylenediaminetetraacetic acid (EDTA) at  $\text{pH} = 10$  using Eriochrome Black T as the indicator. Alternatively, the reagent may be kept in a sealed polyethylene bag placed in a refrigerator.

#### 5.1.2 Procedure

Transfer 2,50 g to 5,00 g of air-dried soil with a high content of clay and/or humus, or 10 g of sandy soil or soil with a low content of humus (particle size  $\leq 2 \text{ mm}$ ), pretreated according to ISO 11464, into a tightly stoppered polyethylene centrifuge tube of approximately 50 ml. Note the mass of the tube with cover and