

<b>STN</b>	<b>Kvalita pôdy</b> <b>Stanovenie efektívnej výmennej kapacity katiónov (CEC) a obsahu vymeniteľných katiónov pomocou roztoku trichloridu hexamínkobaltnatého (ISO 23470: 2018)</b>	<b>STN</b> <b>EN ISO 23470</b>  46 5242
------------	--	--

Soil quality - Determination of effective cation exchange capacity (CEC) and exchangeable cations using a hexamminecobalt trichloride solution (ISO 23470:2018)

Táto norma obsahuje anglickú verziu európskej normy.  
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 03/19

Obsahuje: EN ISO 23470:2018, ISO 23470:2018

Oznámením tejto normy sa ruší  
STN EN ISO 23470 (46 5242) z októbra 2011

**128255**

EUROPEAN STANDARD

**EN ISO 23470**

NORME EUROPÉENNE

EUROPÄISCHE NORM

October 2018

ICS 13.080.20

Supersedes EN ISO 23470:2011

English Version

## Soil quality - Determination of effective cation exchange capacity (CEC) and exchangeable cations using a hexamminecobalt trichloride solution (ISO 23470:2018)

Qualité du sol - Détermination de la capacité d'échange cationique (CEC) effective et des cations échangeables à l'aide d'une solution de trichlorure de cobalthexammine (ISO 23470:2018)

Bodenbeschaffenheit - Bestimmung der effektiven Kationenaustauschkapazität (KAK) und der austauschbaren Kationen mit Hexammincobalt-trichlorid-Lösung (ISO 23470:2018)

This European Standard was approved by CEN on 10 September 2018.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

**EN ISO 23470:2018 (E)**

<b>Contents</b>	<b>Page</b>
<b>European foreword.....</b>	<b>3</b>

## **European foreword**

This document (EN ISO 23470:2018) has been prepared by Technical Committee ISO/TC 190 "Soil quality" in collaboration with Technical Committee CEN/TC 444 "Test methods for environmental characterization of solid matrices" the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2019, and conflicting national standards shall be withdrawn at the latest by April 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 23470:2011.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## **Endorsement notice**

The text of ISO 23470:2018 has been approved by CEN as EN ISO 23470:2018 without any modification.

# INTERNATIONAL STANDARD

**ISO**  
**23470**

Second edition  
2018-09

---

---

## **Soil quality — Determination of effective cation exchange capacity (CEC) and exchangeable cations using a hexamminecobalt(III)chloride solution**

*Qualité du sol — Détermination de la capacité d'échange cationique  
(CEC) effective et des cations échangeables à l'aide d'une solution de  
trichlorure de cobaltihexammine*



Reference number  
ISO 23470:2018(E)

© ISO 2018

**ISO 23470:2018(E)****COPYRIGHT PROTECTED DOCUMENT**

© ISO 2018

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  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

Page

<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Principle</b> .....	<b>1</b>
<b>5 Reagents</b> .....	<b>2</b>
<b>6 Apparatus</b> .....	<b>3</b>
<b>7 Procedure</b> .....	<b>4</b>
7.1 Test portion.....	4
7.2 Exchange reaction.....	4
7.3 Determination of CEC.....	4
7.3.1 General.....	4
7.3.2 Determination of ammonia nitrogen by distillation.....	4
7.3.3 Spectrophotometric determination.....	5
7.3.4 Spectrometric determination of cobalt.....	7
7.4 Determination of cobalt and exchangeable cations.....	7
7.4.1 General.....	7
7.4.2 Standard solutions for exchangeable cations.....	8
7.4.3 Standard solutions for cobalt.....	8
7.4.4 Spectrometric determination of exchangeable cations.....	9
7.4.5 Spectrometric determination of cobalt.....	9
7.4.6 Calculation of exchangeable cations.....	9
<b>8 Test report</b> .....	<b>10</b>
<b>9 Validation</b> .....	<b>10</b>
<b>Annex A (informative) Comparison of different methods for the determination of effective CEC</b> .....	<b>11</b>
<b>Annex B (informative) Results of the interlaboratory comparison for extraction with hexamminecobalt(II)chloride</b> .....	<b>15</b>
<b>Annex C (informative) Results of the interlaboratory comparison for extraction with calcite saturated hexamminecobalt(III)chloride solution</b> .....	<b>17</b>
<b>Annex D (informative) Carbonate and sulfate field model</b> .....	<b>18</b>
<b>Annex E (informative) Effect of minimization of Ca errors by calcite saturation of hexamminecobalt</b> .....	<b>20</b>
<b>Bibliography</b> .....	<b>22</b>

**ISO 23470:2018(E)****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)).

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](http://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 on 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 the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

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 23470:2007), which has been technically revised.

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

- the scope has been broadened for soils with a pH > 6,5;
- a new [Annex C](#) has been added;
- a new [Annex D](#) has been added;
- a new [Annex E](#) has been added;
- the document has been editorially revised.

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).



## Introduction

The cation exchange capacity (CEC) of soils and clays as well as the exchangeable cation population are essential features of soil fertility. Various attempts have been made in the literature to measure these parameters accurately and efficiently. The completeness of cation exchange on the other hand is not absolute but should be comparable between different methods. Traditional methods used ammonium or barium as exchangeable cations which require repeated treatments to ensure complete cation exchange. The oldest one-step CEC method is based on hexamminecobalt(III)chloride solution which has a much stronger affinity to soil clay minerals than the typical cations of the soil solution (usually Ca, Mg, Na and K). The principle of this method was published by Morel (1958)[11] and has been modified by Ciesielski and Sterckeman (1997)[2]. This method, as described in this document, is very efficient and comparable to the established CEC methods. It determines the effective CEC when used for soils with pH value of <6,5.

All CEC methods including hexamminecobalt(III)chloride have typical limitations such as inflation of exchangeable cations caused by dissolution of carbonates, sulfates or other soluble minerals (compare also ISO 13536). Carbonate dissolution is one of the most frequently occurring source of error (e.g. in the procedure described in ISO 13536), hence, many studies focused on minimization of their dissolution or correction of the dissolved fraction. Reference [13] summarized the discussion and presented solutions for this analytical problem. For calcareous soils or clays, the authors used exchange solutions that were previously equilibrated with calcite. In the course of the extraction, dissolution of carbonates present in the samples was minimized largely and resulting exchangeable Ca values were nearly free of errors. It was a great success compared to methods used in the past ([Annex E](#)). This method using calcite-saturated hexamminecobalt(III)chloride exchange solutions was published as VDLUFA-method[6]. The resulting exchangeable cation values agreed well with the total CEC when tested in a round robin ([Annex C](#)) which is a good measure for the plausibility of the results. Using different solution/solid ratios, identical exchangeable cation values were measured indicating absence of systematic errors caused by mineral dissolution (compare the model described in Reference [12], for detection of inflated exchangeable Ca values as described in [Annex D](#)). This calcite-saturated hexamminecobalt(III)chloride exchange solution should be used for calcareous soils and clays only, practically for soils with pH values of  $\geq 6,5$  in which only Ca, Mg, Na and K are present as “exchangeable bases”. Thus, the results are comparable to the determination of potential CEC (for example according to ISO 13563). This method was introduced to avoid erroneous (inflated) Ca values.

Hexamminecobalt(III)chloride is recommended as extractant for non-calcareous soils with a pH value of  $\leq 6,5$ . As the pH value of a soil suspension in the hexamminecobalt(III)chloride solution is close to the pH value of the suspension in water, this method is considered to give the effective CEC, i.e. the CEC at the soil pH value (e.g. according to ISO 11260).

# Soil quality — Determination of effective cation exchange capacity (CEC) and exchangeable cations using a hexammincobalt(III)chloride solution

**WARNING** — Persons using this document should be familiar with usual laboratory practice. This document 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.

**IMPORTANT** — It is absolutely essential that tests, conducted in accordance with this document, be carried out by suitably qualified staff.

## 1 Scope

This document specifies a method for the determination of cation exchange capacity (CEC) and the content of exchangeable cations (Al, Ca, Fe, K, Mg Mn, Na) in soils using a hexammincobalt(III)chloride solution as extractant. For soils containing calcium carbonate a calcite saturated hexammincobalt(III) chloride solution is specified particularly for determination of exchangeable Ca. This document is applicable to all types of air-dry soil samples which have been prepared according to ISO 11464.

## 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, *Soil quality — Determination of dry matter and water content on a mass basis — Gravimetric method*

**koniec náhľadu – text ďalej pokračuje v platenej verzii STN**