



SLOVENSKI STANDARD
oSIST ISO/DIS 22171:2023

01-junij-2023

Kakovost tal - Določanje potencialne kationske izmenjalne kapacitete (CEC) in izmenljivih kationov z uporabo pufrske raztopine amonijevega acetata s pH 7

Soil quality - Determination of potential cation exchange capacity (CEC) and exchangeable cations buffered at pH 7, using a molar ammonium acetate solution

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Qualité du sol - Détermination de la capacité d'échange cationique (CEC) potentielle et de la teneur en cations échangeables, à l'aide d'une solution molaire d'acétate d'ammonium tamponnée à pH 7

Ta slovenski standard je istoveten z: ISO/DIS 22171

ICS:

13.080.10	Kemijske značilnosti tal	Chemical characteristics of soils
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Soil quality — Determination of potential cation exchange capacity (CEC) and exchangeable cations buffered at pH 7, using a molar ammonium acetate solution

ICS: 13.080.10

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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ISO/DIS 22171:2022(E)

Foreword

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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).

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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 190, Soil quality, Subcommittee SC 3, Chemical and physical characterization.

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Introduction

Cation exchange capacity (CEC) is an intrinsic property of soil defining the concentration of negatively charged sites on soil colloids that can adsorb exchangeable cations. Cation exchange capacity can be a good indicator of soil productivity and is useful for making recommendations of phosphorus (P), potassium (K), and magnesium (Mg) if testing soils of different textures. Cation exchange capacity is also used for regulatory purposes in monitoring land application of biosolids.

Cation exchange capacity is a measure of exchangeable bases and soil acidity at some specific soil pH. The exchangeable bases and acidity neutralize negative charges arising from permanent charges due to isomorphous substitution in clays, or pH-dependent charges from hydroxyl groups on clay and oxides or carboxyl groups on soil organic matter. A common method for determining CEC uses 1 M ammonium acetate at pH 7 (neutral NH_4OAc) and is a standard method used for soil surveys by the Natural Resource Conservation Service (Burt, 2004; Hendershot et al., 2008; Sumner and Miller, 1996). An advantage of CEC measured at a constant pH of 7 is elimination of CEC variability due to differences in soil pH. Thus, comparisons of CEC can occur across varied soil types and lime applications. A disadvantage of the neutral NH_4OAc method is that it may not provide a realistic depiction of the actual CEC at the natural pH of the soil, particularly with soils having considerable pH-dependent charge and a soil pH that is significantly different from 7. An unbuffered salt extract can be used to determine CEC at the natural pH of soil, for example by using a hexamine chloride solution ISO 23470, see also Burt, 2004; Sumner and Miller, 1996; Pansu and Gautheyrou, 2006.

The method described here determines potential cation exchange capacity (CEC) buffered at pH 7 and exchangeable cations Ca, Mg, K, and Na. Molar ammonium acetate is added to soil to saturate exchange sites with NH_4^+ and release exchangeable cations in a leachate which are measured. The exchanged NH_4^+ is then released either with 1 M KCl or 1 M NaCl and measured to quantify the potential cation exchange capacity at pH 7.

Ammonium acetate, due to its complexing effect, can contribute to the dissolution of part of soil carbonates and other salts present in the soil. Calcium concentrations (or even magnesium) are thus no longer limited to exchangeable quantities. Presence of other soluble salts such as gypsum, sodium chloride or else would also inflate exchangeable cation quantities.

Soil quality — Determination of potential cation exchange capacity (CEC) and exchangeable cations buffered at pH 7, using a molar ammonium acetate solution

1 Scope

This International Standard specifies a method for the determination of potential cation exchange capacity (CEC) and the content of exchangeable cations (Ca, K, Mg, Na) in soils using a molar ammonium acetate solution buffered at pH 7 as extractant.

This International Standard is applicable to all types of air-dry soil samples which have been prepared e. g. in accordance with ISO 11464.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological 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

Negatively charged sites on soil are saturated by ammonium ion, in leaching conditions, using a molar ammonium acetate solution. The leaching solution can be used to determine exchangeable cations by AAS or ICP AES measurements. An alcoholic solution is used to eliminate any remaining soluble ammonium ion. The soil test sample is then back extracted by a molar potassium chloride or sodium chloride solution, in order to liberate all ammonium cations fixed in the previous step. For practical reason, a single back extraction is performed. This is generally sufficient to assess the whole CEC as the molarity of the back-extraction solution is strong (molar solution of KCl), Ammonium cations are finally determined in the extract by a continuous flow spectrophotometric method.

5 Reagents

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

5.2 Ammonium acetate molar solution at pH 7,00.

Two ways are available to prepare ammonium acetate solution: [5.2.1](#) or [5.2.2](#).

5.2.1 From acetate ammonium solid

Dissolve 77,0 g ± 0,1 g of ammonium acetate in a 1 000 ml flask, containing approximately 900 ml of water. Adjust the pH to 7,00 ± 0,05 using ammonia solution or acetic acid solution depending on pH initial. Make up to the volume with water and mix.

ISO/DIS 22171:2022(E)**5.2.2 From acetic acid and ammonium hydroxide**

Make the solution in a fume hood to avoid breathing vapors of ammonia and acetic acid. Add 58 ml of concentrated glacial acetic acid (CH_3COOH) to approximately 500 ml of water. Add 68 ml of concentrated ammonium hydroxide (NH_4OH , 29 % NH_3 w/w). Add water to yield a volume of approximately 900 ml. Adjust pH to 7,00 with dropwise additions of either ammonium hydroxide or acetic acid. Transfer into a 1 000 ml flask and make up to volume with water. Thoroughly stir contents to ensure complete mixing.

5.3 Ethyl alcohol, 95° (free from amines)**5.4 Molar potassium chloride solution (KCl 1 M)**

Dissolve 74,5 g \pm 0,1 g of potassium chloride in a 1 000 ml volumetric flask. Make up to the volume with water and mix.

5.5 Sodium nitroprusside solution

Weigh 0,50 g \pm 0,05 g of sodium nitroprusside. Transfer into a 500 ml volumetric flask. Add 400 ml of water. Shake with a magnetic stirrer until complete dissolution. Then, adjust to volume.

This solution must be kept in a dark colored bottle.

5.6 Sodium salicylate solution

Weigh 12,5 g \pm 0,1 g of sodium hydroxide pellets. Transfer into a 500 ml volumetric flask. Add 300 ml of water. Stir with a magnetic stirrer until complete dissolution.

Weigh 40,00 g \pm 0,02 g of sodium salicylate. Add to previous sodium hydroxide solution. Stir until complete dissolution. Bring to volume with water.

This solution must be kept in a dark colored bottle.

5.7 Sodium dichloroisocyanurate solution

Weigh 0,50 g \pm 0,05 g of sodium dichloroisocyanurate. Transfer into a 500 ml volumetric flask. Add 400 ml of water. Shake with a magnetic stirrer until complete dissolution. Then, adjust to volume.

This solution shall be kept in a dark colored bottle.

5.8 Brij®- 35 solution 25 % (m/V) polyoxyethylene lauryl ether

Dissolve 250 g \pm 2 g of Brij-35 in a 1 000-ml beaker placed in a water bath at 60 °C and containing 800 ml of water. After cooling, transfer into a 1 000-ml flask. Adjust to the volume. Homogenize.

5.9 Buffer solution

Dissolve 33,0 g \pm 0,2 g of potassium sodium tartrate tetrahydrate and 24,0 g \pm 0,2 g of trisodium citrate in a 1 000-ml volumetric flask. Adjust to the volume with water. Homogenize. Add 2,5 g \pm 0,1 g of Brij-35 solution (5.8). Homogenize again.

5.10 Standard solution**5.10.1 Solution containing 1,400 g·l⁻¹ of N/NH₄⁺**

Weigh 6,620 g \pm 0,005 g of ammonium sulphate. Quantitatively transfer into 1 000 ml volumetric flask. Adjust to volume with molar potassium chloride solution (5.4). This solution contains 0,1 mol of positive charge (0,1 mol·l⁻¹).