



SLOVENSKI STANDARD
SIST EN 13368-1:2002

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Fertilizers - Determination of chelating agents in fertilizers by ion chromatography - Part 1: EDTA, HEDTA and DTPA

Düngemittel - Bestimmung von Chelatbildnern in Düngemitteln durch Ionenchromatographie - Teil 1: EDTA, HEDTA und DTPA

Engrais - Détermination des agents chélatants dans les engrais par chromatographie ionique - Partie 1: EDTA, HEDTA et DTPA

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65.080 Gnojila Fertilizers

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EUROPEAN STANDARD
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English version

Fertilizers - Determination of chelating agents in fertilizers by ion chromatography - Part 1: EDTA, HEDTA and DTPA

Engrais - Détermination des agents chélatants dans les engrais par chromatographie ionique - Partie 1: EDTA, HEDTA et DTPA

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This European Standard was approved by CEN on 1 January 2001.

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 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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 260 "Fertilizers and liming materials", the secretariat of which is held by DIN.

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 July 2001, and conflicting national standards shall be withdrawn at the latest by July 2001.

EN 13368 consists of two parts dealing with the quantitative determination of chelating agents in fertilizers by ion chromatography:

- Part 1 : EDTA, HEDTA and DTPA
- Part 2 : EDDHA and EDDHMA

The annexes A and B are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom

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1 Scope

This method describes the procedure for the ion chromatographic determination of the total amount of each of the individual chelating agents EDTA, HEDTA, and DTPA in fertilizers containing one or more of these substances. The method allows the identification and the determination of the total water soluble fraction of each of these chelating agents. It does not allow to distinguish between the free form and the metal bound form of the chelating agents.

NOTE EDTA, HEDTA and DTPA are abbreviations used in the standard for the sake of simplicity. For complete names see annex A.

This method applies to fertilizers containing chelates of one or more of the following micro-nutrients: cobalt, copper, iron, manganese, zinc and with a mass fraction of at least 0,1 %.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 1482, *Sampling of solid fertilizers and liming materials*.

EN ISO 3696, *Water for analytical laboratory use – Specification and test methods (ISO 3696 : 1987)*.

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3 Principle

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The micro-nutrients associated with the chelating agents present in an aqueous extract of the sample are replaced by iron (III). The iron chelates are separated and determined by ion chromatography. The separation is based on anion exchange, by elution with a nitrate acetate solution. The detection is based on UV photometry at 330 nm, after post-column reaction with dilute perchloric acid.

4 Interferences

Several substances can interfere, to a degree largely dependent on the type of column used. With the column described in 6.2, the following phenomena have been observed.

- a) Injection of solutions having high concentrations of salts can cause shifts in the retention times, mostly decreasing the retention when compared to the standard solutions. In these cases, the identity of the peaks can be confirmed by standard addition.
- b) Solutions having high concentrations of salts can also create a large signal at the void volume, poorly resolved from the HEDTA peak.
- c) High concentrations of nitrate, carbonate, sulfate, and phosphate do not interfere. On the other hand, large amounts of chloride create a negative fronting peak poorly resolved from the DTPA peak, and altering its peak shape.
- d) Compounds, related to the group of polyamino polycarboxylic acids can interfere. While signals for EDDHA, EDDHMA, and EDDHSA are not detected, relatively weak signals are observed for NTA and CDTA. Under some conditions NTA may coelute with HEDTA or EDTA.

NOTE EDDHA, EDDHMA, EDDHSA, NTA and CDTA are abbreviations used in the standard for the sake of simplicity. For complete names see annex A.

- e) No signals have been detected for the following complexing agents : citrate, oxalate, tartrate, phthalate, and 20 naturally occurring amino acids.

5 Reagents

5.1 General

- all reagents should be of recognized analytical grade ;
- all water should conform to EN ISO 3696 and be degassed by boiling before use.

5.2 Nitric acid, $c(\text{HNO}_3) = 7,2 \text{ mol/l}$

Nitric acid, diluted 1 + 1 with water.

5.3 Sodium hydroxide solution, $c(\text{NaOH}) = 0,5 \text{ mol/l}$

Dissolve 20 g of NaOH in pellet form in a 1 litre volumetric flask with water. Dilute to the mark and homogenize.

5.4 EDTA stock solution, $c(\text{EDTA}) = 2 \text{ mmol/l}$

Dissolve 372 mg of the disodium dihydrogen salt of ethylene diamine tetraacetic acid dihydrate in 400 ml of water in a 500 ml volumetric flask. After dissolution, dilute to the mark with water and homogenize. Store in a plastics bottle.

5.5 HEDTA stock solution, $c(\text{HEDTA}) = 2 \text{ mmol/l}$

Dissolve 380 mg of the trisodium salt of hydroxyethyl ethylene diamine triacetic acid dihydrate in 400 ml of water in a 500 ml volumetric flask. After dissolution, dilute to the mark with water and homogenize. Store in a plastics bottle.

5.6 DTPA stock solution, $c(\text{DTPA}) = 2 \text{ mmol/l}$

Dissolve 393 mg of diethylene triamine pentaacetic acid in 10 ml of NaOH (5.3) in a 50 ml beaker. After dissolution, transfer quantitatively into a 500 ml volumetric flask, dilute to the mark with water and homogenize. Store in a plastic bottle.

5.7 EDTA/HEDTA/DTPA standard mixtures

Into a set of 3 volumetric flasks of 100 ml, pipette respectively. 2,5 ml, 5 ml and 10 ml of each stock solution of 2 mmol/l (5.4, 5.5 and 5.6). Dilute to the mark with water and homogenize. These solutions contain a mixture of EDTA, HEDTA and DTPA, in concentrations of respectively 0,05 mmol/l, 0,1 mmol/l and 0,2 mmol/l. They should be used within 2 days.

5.8 Eluent nitrate (50 mmol/l) and acetate (50 mmol/l)

Dissolve 4,10 g of anhydrous sodium acetate (NaCH_3COO) in a mixture of 800 ml of water and 6,95 ml of nitric acid (5.2) in a 1 litre volumetric flask. Dilute to the mark with water and homogenize. Adjust the pH of the eluent to $2,75 \pm 0,20$. Before use, filter the solution through a $0,45 \mu\text{m}$ membrane filter (6.3).

NOTE The concentration of the eluent influences the speed and the efficiency of the separation, which can be carried out with eluent concentrations varying between 25 mMol/l and 75 mMol/l of nitrate and acetate. At low concentrations, an improved separation between the void signal, the HEDTA and the EDTA peaks can be obtained, while at high concentrations a better DTPA peak shape is observed.

5.9 Iron (III) nitrate solution

Dissolve 5 g of ferric nitrate nonahydrate ($\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$) in a mixture of 800 ml of water and 21 ml of nitric acid (5.2) in a 1 litre volumetric flask. Dilute to the mark with water and homogenize. Store in a plastics bottle.

NOTE Nitric acid is added in order to stabilize the solution and to allow the complete replacement of other chelated micro-nutrients by iron (III).

5.10 Perchloric acid solution, 2 %

Dilute 29 ml of perchloric acid (70 % HClO_4 , $\rho = 1,67$ g/ml) to 1 litre with water.

6 Apparatus

Usual laboratory equipment, glassware, and :

6.1 Rotary shaker

Rotary shaker capable of operating at a rotational speed of about 35 min^{-1} to 45 min^{-1} .

6.2 Ion chromatograph

Ion chromatograph equipped with :

- a) an isocratic pump delivering the eluent (5.8) at a flow rate of 0,5 ml/min ;
- b) an injection valve with an injection loop of about 50 μl ;
- c) an anion exchange separator column 10 μm particles – 2 % substrate x – linking 100 meq capacity (per column) – alkyl quaternary ammonium – medium high (hydrophobicity)¹⁾ ;

NOTE 1 The column mentioned in c) is not exclusive. Any anion exchange column with comparable capacity, hydrophobicity, and selectivity can probably be used.

NOTE 2 Columns can, in their native state, exhibit some sensitivity towards various anions (e.g. nitrate, sulfate, phosphate) which can disappear after treatment with excess iron. It can be necessary to precondition the column prior to its use by repeated injections, at least 10, of the iron (III) solution (5.9), followed by equilibration under eluent flow for at least 6 h.

NOTE 3 After many injections, especially of products having complex matrices, the column may lose some of its capacity and its separating efficiency. Substances like phenolic compounds (e.g. EDDHA, humic acids) can be strongly adsorbed on the column particles. Suspended and colloidal matter can block the column entrance and disturb the eluent flow. The column manufacturer cleaning instructions are consulted for the suitable cleaning procedure.

NOTE 4 The injection of undissolved matter severely decreases the lifetime of the column. Solutions should always be allowed to equilibrate, and then filter through a 0,2 μm membrane filter before injection.

- d) a post-column reagent delivery module, delivering the reagent (5.10) at a flow rate between 0,5 ml/min and 0,6 ml/min ;

NOTE 5 The post-column reagent stabilizes the eluting ferric chelates and suppresses the signal of some possibly interfering substances. For the analysis of samples with simple matrices, the post column reaction can be considered as superfluous.

- e) a UV/VIS detector with a 330 nm filter, output range set at an absorbance of 0,1 ;

NOTE 6 Ferric chelates of EDTA, HEDTA, and DTPA have a useful spectral absorbance between 250 nm and 350 nm. The absorbance at 254 nm offers a better sensitivity, but also produces a noisier background, more sensitive to interferences.

- f) an integrator.

6.3 Membrane filters

Micromembrane filters resistant to aqueous solutions, with porosity of respectively 0,45 μm and 0,2 μm .

¹⁾ A combination of IonPac AS 7 separator and Ion Pac AG 7 guard column from Dionex Co, Sunnyvale, CA USA, or equivalent are examples of suitable products available commercially. This information is given for the convenience of users of this European Standard and does not constitute an endorsement by CEN of these products.

7 Preparation of the sample

Prepare the sample according to EN 1482.

NOTE 1 Sample may also be prepared according to method 1 (see [1] of bibliography).

NOTE 2 For the size reduction of samples with a high amount of chelating agents, it is not recommended to use a high speed laboratory mill. It is more convenient to grind the sample in a mortar to a particle size less than 1 mm.

8 Procedure

8.1 Preparation of the sample solution

Weigh 5 g of the sample (m), to within 1 mg, into a 250 ml volumetric flask (V_0). Add 200 ml of water, and put on the rotary shaker (6.1) for 1 h. Make up to the mark with water, homogenize, and filter through a paper filter. If necessary, dilute the filtrate with water, in order to obtain a concentration of chelating agent between 0,02 mmol/l and 0,2 mmol/l. Let D be the dilution factor. Pipette 20 ml of the solution into a 100 ml beaker. Add 5 ml of the iron (III) solution (5.9), homogenize, and allow to stand for 15 min.

NOTE The addition of iron may cause precipitation, especially if phosphate is present in the sample solution. For this reason, the precipitate should be allowed to settle and the solution to equilibrate for 15 min.

8.2 Preparation of the standard solutions

Pipette 20 ml of each of the EDTA/HEDTA/DTPA standard mixtures of respectively 0,05 mmol/l, 0,1 mmol/l and 0,2 mmol/l (5.7) into a set of 100 ml beakers. Add 5 ml of the iron (III) solution (5.9), homogenize, and allow to stand for 15 min.

8.3 Ion chromatographic analysis

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Immediately before injection, all solutions shall be filtered through a 0,2 μm membrane filter (6.3). Inject the standard solutions (8.2) into the chromatographic system (6.2). The retention times of the iron chelates are in the order HEDTA < EDTA < DTPA. Adjust the attenuation on the integrator, in order to obtain about 75 % of the output range for the EDTA peak from the most concentrated standard solution. See typical chromatogram in annex B. Measure the retention times and the peak areas for the three chelating agents. Inject the sample solution (8.1). After elution, identify the chelating agent by the retention time, and measure the corresponding peak area. For each appropriate chelating agent, draw a calibration graph with the values of the peak area of the standard solutions versus the corresponding chelating agent concentration (C_s) (mmol/l). Determine the concentration of the chelating agent in the sample solution (mmol/l), using the corresponding calibration graph.

9 Expression of results

The mass fraction in percent of the chelating agent (EDTA, HEDTA, or DTPA), expressed as free acid, in the fertilizer is equal to :

$$\text{Chelating agent} = \frac{C_s \cdot D \cdot M_w \cdot V_0}{10^4 \cdot m} \quad \text{in \%} \quad (1)$$

where :

C_s is the concentration of the chelating agent in the sample solution (mmol/l), determined with the calibration graph (8.3) ;

D is the dilution factor (8.1) ;

M_w is the molar mass in grams per mol of the chelating agent in the acid form, being for :