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**Vpliv cementnih proizvodov na pitno vodo - Preskusne metode - 1. del: Vpliv industrijsko izdelanih cementnih proizvodov na organoleptične parametre**

Influence of cementitious products on water intended for human consumption - Test methods - Part 1: Influence of migration from factory made cementitious products on the organoleptic parameters

Einfluss von zementgebundenen Produkten auf Wasser für den menschlichen Gebrauch - Prüfverfahren - Teil 1: Einfluss fabrikmäßig hergestellter zementgebundener Produkte auf organoleptische Parameter (standards.iteh.ai)

Influence des produits à base de ciment sur l'eau destinée à la consommation humaine - Méthodes d'essai - Partie 1 : Influence sur les paramètres organoleptiques et migration de substances organiques à partir des produits fabriqués en usine

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## Influence of cementitious products on water intended for human consumption - Test methods - Part 1: Influence of migration from factory made cementitious products on the organoleptic parameters

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 164.

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

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## Foreword

This document (prEN 14944-1:2015) has been prepared by Technical Committee CEN/TC 164 "Water supply", the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14944-1:2006.

In comparison with EN 14944-1:2006, the following changes have been made:

- provisions for testing the influence of materials on TOC have been added,
- the test method for TON /TFN according to EN 1622 has been specified according to the revised prEN 1420,
- requirements for disinfection (preconditioning with 50 mg/L Chlorine) have been removed,
- a procedure for extending the number of migration periods has been included.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document describes a test method to determine the influence(s) of factory made cementitious products on organoleptic parameters and the migration of organic substances (TOC) in water intended for human consumption.

This European Standard will result in one of a series of standards that support appropriate standards.

This European Standard is part of a series dealing with the influence of cementitious and associated non-cementitious products/materials on water intended for human consumption, including:

- *Part 1: Influence on organoleptic parameters and migration of organic substances (TOC) from factory made cementitious products*
- *Part 2: Influence of site-applied cementitious materials and associated non-cementitious products/materials on organoleptic parameters*
- *Part 3: Migration of substances from factory made cementitious products.*
- *Part 4: Migration of substances from site-applied cementitious materials and associated non-cementitious products/materials.*

prEN 14944-1:2015 (E)

## Introduction

With respect to any potential adverse effects of products and materials on the quality of water intended for human consumption, it should be understood that relevant national regulations remain in force until verifiable European acceptance criteria have been adopted.

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## 1 Scope

This European Standard specifies a method to determine the influence of factory made cementitious products on the odour, flavour, colour, turbidity and total organic carbon (TOC) of test waters after contact with the products.

This European Standard is applicable to factory made cementitious products, e.g. cement mortar linings to metallic pipes, tanks, concrete pipes, etc. intended to be used for the transport and storage of water for human consumption, including raw water used for the production of drinking water.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 196-1, *Methods of testing cement - Part 1: Determination of strength*

prEN 1420:2014, *Influence of organic materials on water intended for human consumption - Determination of odour and flavour assessment of water in piping systems*

EN 1484, *Water analysis - Guidelines for the determination of total organic carbon (TOC) and dissolved organic carbon (DOC)*

EN 1622:2006, *Water quality - Determination of the threshold odour number (TON) and threshold flavour number (TFN)*

EN 1015-2, *Methods of test for mortar for masonry - Part 2: Bulk sampling of mortars and preparation of test mortars*

EN 1015-11, *Methods of test for mortar for masonry - Part 11: Determination of flexural and compressive strength of hardened mortar*

EN 10088-1:2014, *Stainless steels - Part 1: List of stainless steels*

EN 12350-1, *Testing fresh concrete - Part 1: Sampling*

EN 12390-1, *Testing hardened concrete - Part 1: Shape, dimensions and other requirements for specimens and moulds*

EN 12390-2, *Testing hardened concrete - Part 2: Making and curing specimens for strength tests*

EN 27888, *Water quality - Determination of electrical conductivity (ISO 7888)*

EN ISO 3696:1995, *Water for analytical laboratory use - Specification and test methods (ISO 3696:1987)*

EN ISO 7027:1999, *Water quality - Determination of turbidity (ISO 7027:1999)*

EN ISO 7393-1, *Water quality - Determination of free chlorine and total chlorine - Part 1: Titrimetric method using N, N-diethyl-1,4-phenylenediamine (ISO 7393-1)*

EN ISO 7393-2, *Water quality - Determination of free chlorine and total chlorine - Part 2: Colorimetric method using N, N-diethyl-1,4-phenylenediamine, for routine control purposes (ISO 7393-2)*

EN ISO 7887:2011, *Water quality - Examination and determination of colour (ISO 7887:2011)*

EN ISO 9963-2, *Water quality - Determination of alkalinity - Part 2: Determination of carbonate alkalinity (ISO 9963-2)*

EN ISO 16264, *Water quality - Determination of soluble silicates by flow analysis (FIA and CFA) and photometric detection (ISO 16264)*

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ISO 6058, *Water quality - Determination of calcium content - EDTA titrimetric method*

ISO 10523, *Water quality - Determination of pH*

**3 Terms and definitions**

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

**3.1****appropriate body**

certification body, inspection body or test laboratory, as relevant to a particular requirement

**3.2****cementitious product**

factory made product containing a cementitious material supplied in the hardened state with a formed surface prior to its incorporation into the construction works

**3.3****cementitious material**

material that contains a hydraulic cement in sufficient proportion to act as the main binder by forming a hydrate structure which governs the performance of the material

**3.4****associated non-cementitious product**

product which is applied to the surface of a cementitious product, directly or indirectly, during manufacture (or construction) and which either provides a porous seal to the product or which remains as a residue in contact with water, e.g. porous seal coats, formwork release agents and curing compounds

**3.5****porous seal coat**

polymeric (usually organic) materials applied in a thin (25 µm – 200 µm thickness) surface layer to a cement mortar lining in order to restrict (but not prevent) interactions between the mortar and conveyed water

Note 1 to entry: See ISO 16132:2004, 3.6.

**3.6****proxy sample**

sample of fresh mortar or fresh concrete taken from material to be used for the production of a factory made product, either spray-applied to a laboratory test plate (mortar only) or cast into a mould (mortar or concrete) of appropriate dimensions (e.g. standard cube, cylinder or prism, etc.) and compacted (where appropriate), cured and hardened under conditions representative of those intended for the product

**3.7****fresh concrete**

concrete that is fully mixed and still in a condition capable of being compacted by the chosen method

**3.8****fresh mortar**

cement mortar that is fully mixed and still in a condition of being applied to a substrate by the chosen method

**3.9****odour**

sensation perceived by means of the olfactory organ in sniffing certain volatile substances

[SOURCE: ISO 5492:2008, 3.18]

**3.10****flavour**

complex combination of the olfactory, gustatory, and trigeminal sensations perceived during tasting

Note 1 to entry: The flavour may be influenced by tactile, thermal, painful and/or kinaesthetic effects.



[SOURCE: ISO 5492:2008, 3.20]

### 3.11

#### **colour of water**

optical property that causes the changing of the spectral composition of transmitted visible light measured at three wavelengths

[SOURCE: EN ISO 7887:2011, 3.2]]

### 3.12

#### **turbidity**

reduction of transparency of a water due to the presence of undissolved matter

Note 1 to entry: See EN ISO 7027:1999, 3.1.

### 3.13

#### **threshold odour number**

##### **TON**

dilution ratio of the migration water with the reference water at the same temperature, beyond which this diluted sample does not have any perceptible odour

Note 1 to entry: See EN 1622.

### 3.14

#### **threshold flavour number**

##### **TFN**

dilution ratio of the migration water with the reference water at the same temperature, beyond which this diluted sample does not have any perceptible flavour

Note 1 to entry: See EN 1622.

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### 3.15

#### **total organic carbon**

##### **TOC**

sum of organically bound carbon present in water, bonded to dissolved or suspended matter, including cyanate, elemental carbon and thiocyanate

[SOURCE: EN 1484:1997, 3.3, modified]

### 3.16

#### **testing panel**

group of people meeting the relevant requirements of EN 1622

### 3.17

#### **test**

technical operation that consists of the determination of one or more characteristics of a given product

### 3.18

#### **test procedure**

specified technical method for performing a test

### 3.19

#### **sample**

one or more units, or a specified quantity, drawn from a batch or lot, selected at random for inspection, e.g. at the factory or in a laboratory

### 3.20

#### **test piece**

the sample or portion which is to be conditioned, treated or otherwise prepared to be tested to obtain a single test result

**prEN 14944-1:2015 (E)****3.21****nominal diameter****DN/ID****DN/OD**

numerical designation of the size of a component, which is a whole number approximately equal to the actual dimensions in millimetres

Note 1 to entry: This applies to either the internal diameter (DN/ID) or the external diameter (DN/OD).

**3.22****preconditioning**

succession of contact periods of a test piece with the preconditioning water (3.22) before contact with the test water

**3.23****preconditioning water**

water used for preconditioning prepared as described in 5.3.1

**3.24****reference water**

water described as without odour, flavour, colour and turbidity conforming to the requirements in 5.3.2

**3.25****test water**

water used for testing purposes prepared as described in 5.3.3 and 5.3.4

**3.26****migration water:**

test water which has been in contact with a test piece under specified conditions

[SOURCE: EN 1622, 3.13]

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**3.27****blank water**

test water which has been kept at the same specified conditions as migration water but without contact with the test piece

**3.28****tap water**

drinking water distributed by a public supplier

Note 1 to entry: Tap water is used as a lubricant/coolant for the sawing and coring operations used to obtain test pieces generally from products of large dimensions. See normative Annexes A, B and C.

**3.29****demineralized water**

water conforming to the requirements in EN ISO 3696:1995 for Grade 3

**4 Principle**

Each test piece is subjected to a specified preconditioning procedure where the surface which, in practice, will be exposed to water intended for human consumption is brought into contact with preconditioning water during five sequential periods: three periods of 24 h, 1 period of 72 h and a final period of 24 h.

The preconditioned test piece is then brought into contact with test water, chlorinated and/or chlorine-free during three sequential migration periods. A migration period is either:

- a) 72 h at  $(23 \pm 2)$  °C for products intended to come into contact with chlorinated or chlorine-free cold water;
- b) 24 h at a specified elevated temperature for products intended to come into contact with warm or hot chlorine-free water.

After each contact period, each migration water is assessed for odour, flavour, colour, turbidity and TOC.

NOTE The selection of:

- a) the appropriate test water, chlorinated and/or chlorine-free, from those made available in this European Standard,
- b) the temperature of the test water,
- c) the need for chlorination during preconditioning

is specified in product or system standards or in national or European regulations, as appropriate.

## 5 Reagents

Use only reagents of analytical quality unless otherwise stated.

### 5.1 Chlorine neutralization reagents

**5.1.1 Ascorbic acid solution**, prepared by dissolving  $(4,0 \pm 0,1)$  g of ascorbic acid in one litre of reference water (5.3.2).

This ascorbic acid solution shall be replaced on a monthly basis.

**5.1.2 Sodium thiosulfate solution**, comprising a solution of 3,5 g/l of sodium thiosulfate pentahydrate ( $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ ) and stored in the absence of light at a temperature below 10 °C, for a maximum of 4 months.

Sodium hypochlorite solution, prepared from a commercial solution of sodium hypochlorite (NaOCl) and have a known concentration of  $\pm 0,1$  % by mass of free chlorine determined in accordance with either EN ISO 7393-1 or EN ISO 7393-2.

This sodium hypochlorite solution is unstable and shall be prepared on the day of use.

**5.2 Sodium hypochlorite solution**, prepared from a commercial solution of sodium hypochlorite (NaOCl) and have a known concentration of about 0,1 % by mass of free chlorine determined in accordance with either EN ISO 7393-1 or EN ISO 7393-2.

This sodium hypochlorite solution is unstable and shall be prepared on the day of use.

### 5.3 Waters to be used for testing

**5.3.1 Preconditioning water** prepared by dissolving  $(222 \pm 2)$  mg anhydrous calcium chloride ( $\text{CaCl}_2$ ) and  $(336 \pm 2)$  mg sodium hydrogen-carbonate ( $\text{NaHCO}_3$ ) in one litre of demineralized water (3.29). The pH is determined in accordance with ISO 10523 and adjusted to  $7,4 \pm 0,1$  by bubbling air and/or  $\text{CO}_2$  into the solution.

NOTE The target total hardness is 200 mg/l as  $\text{CaCO}_3$  and the target alkalinity is 244 mg/l as  $\text{HCO}_3$ .

**5.3.2 Reference water**, a natural water without gas and with parameters that conform to the requirements given in Table 1.

When a reference water is chlorinated to 1,0 mg/l free chlorine and then dechlorinated after 72 h with either the ascorbic acid solution (5.1.1) or the sodium thiosulfate solution (5.1.2), its organoleptic parameters, odour, flavour colour and turbidity shall conform to the requirements given in Table 1.

Table 1 — Reference water

Parameter	Test method <sup>a</sup>	Requirement	Unit
Conductivity	EN 27888	500 ± 50	µS/cm
pH	ISO 10523	7,3 ± 0,2	pH unit
Calcium	ISO 6058	80 ± 10	mg Ca/l
Alkalinity	EN ISO 9963-2	350 ± 50	mg HCO <sub>3</sub> <sup>-</sup> /l
Silica	EN ISO 16264	15 ± 5	mg SiO <sub>2</sub> /l
Odour	EN 1622	< 2	TON
Flavour	EN 1622	< 2	TFN
Colour	EN ISO 7887 <sup>b</sup>	< 0,1	m <sup>-1</sup>
Turbidity	EN ISO 7027 <sup>c</sup>	< 0,1	FNU
TOC	EN 1484	< 0,2	mg C/l

<sup>a</sup> Alternative methods, either calibrated against the reference methods or which have proven comparable analytical performance, may be used.

<sup>b</sup> See Clause 5.

<sup>c</sup> See Clause 6.

**5.3.3 Test water without chlorine content (chlorine-free)**, shall consist of a batch of reference water (5.3.2) used for contact with test pieces and preparation of the blank water (3.27).

**5.3.4 Test water with chlorine content (chlorinated)**, consisting of reference water (see 5.3.2) with a free chlorine content of (1,0 ± 0,2) mg/l as Cl<sub>2</sub>, determined in accordance with either EN ISO 7393-1 or EN ISO 7393-2, after addition of sodium hypochlorite solution (5.2).

## 5.4 Cleaning liquids for apparatus

Use one of the following cleaning liquids:

- non-perfumed biodegradable detergent;
- hydrochloric acid, 2 mol/l;
- nitric acid, 10 % or 1,5 mol/l.

## 6 Apparatus

### 6.1 General

For cleaning the glassware, and appropriate apparatus, before use, the following general requirements apply:

- a) Clean the glassware to be used, using detergent (5.4). Rinse the glassware in demineralized water (3.29);
- b) Clean the inner surface of the glassware with hydrochloric acid (5.4) and rinse it with demineralized water. For stainless steel, clean with nitric acid (5.4) and then rinse with demineralized water;
- c) Before use, rinse the glassware, and appropriate apparatus, at least three times using preconditioning water before preconditioning (8.3) or reference water before the test procedure (Clause 9).

## 6.2 Apparatus and materials for test piece preparation (see Annexes A, B and C)

### 6.2.1 Stainless steel plates and cylinders

#### 6.2.1.1 Stainless steel

Stainless steel shall be austenitic, super austenitic or duplex grades in accordance with the corresponding numerical designations, 1.4301, 1.4436, 1.4429, 1.4259 or 1.4462 in EN 10088-1:2014 for stainless steels.

NOTE The grades above are specified for the use of stainless steel as reinforcement in concrete. Therefore, they are considered to be inert when used in contact with cementitious proxy samples (see Annexes A, B and C).

#### 6.2.1.2 Plates

In order to provide a sufficient volume of migration water for assessment, the surface area of one face of a plate should be between 10 000 mm<sup>2</sup> and 90 000 mm<sup>2</sup>. The length/width of the plates should be selected to be consistent with the dimensions of the test container and the volume of test water in which they will be immersed.

#### 6.2.1.3 Cylinders

The diameter and length of a cylinder should be consistent with the dimensions of the test piece (see Annexes A, B or C and Annexes D and E) and the volume of test water appropriate to the specified S/V ratio given in 7.3.

### 6.2.2 Glass cylinders

The diameter and length of a glass cylinder should be consistent with the dimensions of the test piece (see Annexes A, B or C and Annexes D and E) and the volume of test water appropriate to the specified S/V ratio given in 7.3. Glass cylinders should be provided with suitable external (opaque) shielding for use during migration procedures (test pieces and blanks), in order to minimize exposure of migration waters to ambient light.

### 6.2.3 Moulds for forming test pieces

Moulds for forming prisms of mortar shall conform to the requirements of EN 196-1, as specified for use in EN 1015-11, or to EN 12390-1 for forming cubes/cylinders of concrete, with modifications to materials and dimensional tolerances as specified in Annex A, B or C, as appropriate.

Clean moulds and any filling frame used with a mould, by thoroughly washing with non-perfumed detergent (5.4) and tap water (3.28), rinsing with copious amounts of tap water, followed by a final rinse with demineralized water (3.29) and dry before use.

If a factory made cementitious product has been formed in a process where its entire contact surface has been in contact with a release agent and if proxy samples (3.6) are used, the same release agent shall be applied to the internal surfaces of the mould, otherwise the use of release agents is not permitted.

## 6.3 Apparatus and materials for preconditioning and migration procedure

**6.3.1 Vessels, containers, covers, connectors and stoppers**, made of materials which do not affect the odour, flavour, colour and turbidity assessment under the specified test conditions such as glass, polytetrafluoroethylene (PTFE) or stainless steel.

The material PTFE should only be used if there is a small contact area with the test water. Thus PTFE is unsuitable for containers.

**6.3.2 Equipment**, capable of maintaining the test temperature within  $\pm 2^\circ\text{C}$  for the duration of the test.

**6.3.3** If required, **sealants** that do not affect the odour, flavour, colour and turbidity assessments under the specified test conditions.

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**6.4 Apparatus for odour and flavour assessment**

**6.4.1 Erlenmeyer and volumetric flasks, beakers, measuring cylinders, immersion tanks, volumetric pipettes, funnels and stoppers** made of glass, PTFE or stainless steel.

The material PTFE should only be used if there is a small contact area with the test water. Thus PTFE is unsuitable for containers.

**6.4.2 Testing vessels**, comprising the following glassware (which shall be reserved for odour and flavour assessment only and cleaned separately from other items): testing bottles for odour assessment and testing glasses for flavour assessment conforming to the requirements given in EN 1622.

**6.4.3 Waterbath or incubator**, conforming to the requirements of EN 1622.

**6.5 Apparatus for colour and turbidity assessment**

**6.5.1 Apparatus for the determination of colour**, conforming to the requirements of EN ISO 7887:2011, Clause 5.

**6.5.2 Apparatus for the determination of turbidity**, conforming to the requirements of EN ISO 7027:1999, 6.1.3.

**6.6 Apparatus for the determination of TOC**, conforming to the requirements of EN 1484.

**6.7 500 ml Erlenmeyer flasks** with ground stoppers shall be used for the determination of TON and TFN for the presentation of the dilution series to the panellists.

**7 Samples and test pieces****7.1 Sampling, transport and storage of samples**

Carry out sampling of factory made products in accordance with the relevant product standard, system standard or the national or European regulations, or the relevant Annex to this European Standard, as appropriate.

Take care that the transport conditions do not influence the test results.

If it is necessary to store samples or test pieces before testing, ensure that they are protected from contamination taking into account any written instructions that have been provided.

Where appropriate, clean storage containers using the same procedures as are used for the test containers.

Ensure that the surfaces of the test pieces intended to come into contact with the test water are free from any contamination e.g. adhesive tape, labels, ink or pencil marks.

**7.2 Preparation of test pieces****7.2.1 General**

Prepare the test pieces in such a way that only the surface intended to come into contact with drinking water is exposed to the test water except as given in Annex C (see C.1.2.3.2.1) where stainless steel plates are coated with cement mortar on one face only prior to complete immersion during testing.

In the preparation of a test piece the following general principles apply:

- a) ensure that test pieces are representative of the finished product;
- b) during the preparation of test pieces, include any procedures which are performed in practice for curing and cleaning;

- c) ensure that the minimum age of the test piece, at test, conforms to that recommended by the manufacturer for the product to be ready for use;
- d) ensure that the surface area of the test piece is sufficient to fulfil the appropriate surface area to volume ( $S/V$ ) ratio in accordance with the requirements of 7.3.

### 7.2.2 Factory made pipes, fittings and storage systems

Where possible, use the product or test piece as the test vessel, with dimensions that provide sufficient migration water for assessment. In cases where this is not practicable (e.g. large pipes, storage systems etc.), and where alternatives are specified, use as appropriate, an alternative test piece described in the relevant Annex A, B or C to this document and an appropriate test arrangement given in Annex E.

NOTE Where it is required to discriminate between porous and non-porous coatings already applied to factory made products, use the test procedure given in informative Annex G of this European Standard.

## 7.3 Surface area-to-volume ratio ( $S/V$ ) for use in the test procedure

### 7.3.1 General

The following general principles apply for  $S/V$  ratios:

- a) the surface area to volume ratio ( $S/V$ ) of the test piece exposed to the test water relates to realistic service conditions;
- b) where no difference in material composition and production process exists in the range of sizes produced, only the largest  $S/V$  ratio is required to be tested;
- c) the ratio of the surface area,  $S$ , of the test piece intended to come into contact with volume,  $V$ , of the test water is expressed per decimetre, i.e.  $\text{dm}^{-1}$ .

NOTE The unit,  $\text{dm}^{-1}$ , can also be expressed as  $\text{dm}^2/\text{dm}^3$  or  $\text{dm}^2/\text{l}$ .

### 7.3.2 Pipes

Test pipes of sizes up to DN/ID 800 by this method at the actual  $S/V$  ratio of the pipe diameter.

The  $S/V$  ratio is calculated, in  $\text{dm}^{-1}$ , according to the formula:

$$S/V = \frac{400}{[\text{DN/ID}]} \quad (1)$$

where

$[\text{DN/ID}]$  (3.21) is the value of the nominal size related to the internal diameter, in mm.

Test pipes of sizes greater or equal to DN/ID 800 using an  $S/V$  ratio of  $(0,50 \pm 0,02) \text{ dm}^{-1}$ .

NOTE 1 See 7.3.1 (b) for the acceptable minimum requirement for testing pipes that are produced in a range of sizes.

NOTE 2 Migration from pipes full of water in the service condition is controlled by the intrinsic  $S/V$  ratio of the pipe. In the case of a pipe of diameter DN/ID 800 the intrinsic  $S/V$  ratio is  $0,5 \text{ dm}^{-1}$ . This  $S/V$  ratio is the same as that specified in 7.3.4 to be a worst-case test condition for factory made cementitious storage systems. In consequence, an  $S/V$  ratio of  $0,5 \text{ dm}^{-1}$  has also been specified to be a worst-case test condition for all large diameter cementitious pipes (generally precast concrete) of diameter greater than or equal to DN/ID 800.