
**Vpliv cementnih proizvodov na pitno vodo – Preskusne metode – 3. del:
Prehod snovi iz cementnih, tovarniško izdelanih proizvodov**

Influence of cementitious products on water intended for human consumption - Test methods - Part 3: Migration of substances from factory-made cementitious products

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English Version

**Influence of cementitious products on water intended for human
consumption - Test methods - Part 3: Migration of substances
from factory-made cementitious products**

Influence des produits à base de ciment sur l'eau destinées
à la consommation humaine - Méthodes d'essais - Partie 3
: Migration de substances à partir des produits fabriqués en
usine

Einfluss zementgebundener Produkte auf Wasser für den
menschlichen Gebrauch - Prüfverfahren - Teil 3: Migration
von Substanzen aus fabrikmäßig hergestellten
zementgebundenen Produkten

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Foreword

This document (prEN 14944-3:2005) 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 is Part 3 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 of factory made cementitious products on organoleptic parameters
- 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.

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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 are adopted.

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1 Scope

This document specifies a method to determine the migration of substances from factory made cementitious products into test waters after contact with the products.

This document 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 intended for human consumption, including raw water used for the production of drinking water.

2 Normative references

The following referenced documents are indispensable for the application 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.

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

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

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

EN 10088-1, *Stainless steels — 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 ISO 3696, *Water for analytical laboratory use — Specification and test methods*

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

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

ISO 10523, *Water quality — Determination of pH*

3 Definitions

For the purpose of this European Standard, the following 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

a 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 (25µm - 200µm thickness) surface layer to a cement mortar lining in order to restrict (but not prevent) interactions between the mortar and conveyed water (ISO 16132 ^[1])

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

test

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

3.10

test procedure

specified technical method for performing a test

3.11

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

3.12

test piece

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

3.13

nominal diameter (DN/ID) or (DN/OD)

numerical designation of the size of a component, which is a whole number approximately equal to the actual dimensions in millimetres. This applies to either the internal diameter (DN/ID) or the external diameter (DN/OD).

3.14

preconditioning

succession of contact periods of a test piece with the preconditioning water (3.15) before contact with the test water

3.15

preconditioning water

water used for preconditioning prepared as described in 5.3.1

3.16

test water

water used for testing purposes prepared as described in 5.3.2 and used in accordance with 5.3.3 and 5.3.4

3.17**migration water:**

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

3.18**blank water**

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

3.19**disinfection treatment water**

preconditioning water containing chlorine as described in 5.2.2

3.20**tap water**

drinking water distributed by a public supplier.

NOTE 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.

3.21**demineralised water**

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

4 Principle

Each test piece is subjected to a specified preconditioning procedure where the surface which is exposed in practice 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 {with 50 mg/l Cl_2 (5.2.2) if requested to simulate chlorine disinfection treatment}.

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 $(23 \pm 2)^\circ\text{C}$ 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.

Migration rates are calculated after each contact period by determination of the content of specified substances in the corresponding migration water.

NOTE 1 The test is carried out under conditions that ensure that reliable migration rates are calculated. These conditions are not meant to simulate any service condition. Relating the results obtained from this European Standard to the service condition is carried out using a conversion procedure. This procedure will be specified in regulations.

NOTE 2 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**5.1 General requirements**

Use only reagents of analytical quality unless otherwise stated.

5.2 Disinfection reagents

5.2.1 Sodium hypochlorite solution, prepared from a technical or general purpose reagent grade of sodium hypochlorite (NaOCl), using test water (5.3.2) and having 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.

NOTE: Unless tests have proved otherwise the sodium hypochlorite solution should be considered unstable and be prepared on the day of use.

5.2.2 Disinfection treatment water, shall consist of a batch of preconditioning water (5.3.1) with a free chlorine content of (50 ± 5) mg/l as Cl_2 , determined in accordance with either EN ISO 7393-1 or EN ISO 7393-2, after addition of sodium hypochlorite solution (5.2.1).

5.3 Waters to be used for testing

5.3.1 Preconditioning water prepared by dissolving (222 ± 2) mg anhydrous calcium chloride (CaCl_2) and (336 ± 2) mg sodium hydrogen-carbonate (NaHCO_3) in one litre of demineralised water (3.21). The pH is determined in accordance with ISO 10523 and adjusted to $7,4 \pm 0,1$ by bubbling air and/or CO_2 into the solution.

NOTE The target total hardness is 200 mg/l as CaCO_3 and the target alkalinity is 244 mg/l as HCO_3^- .

5.3.2 Test water, prepared by dissolving (110 ± 1) mg anhydrous calcium chloride (CaCl_2), (140 ± 1) mg sodium hydrogen carbonate (NaHCO_3) and (48 ± 1) mg sodium silicate ($\text{Na}_2\text{SiO}_3 \cdot 9\text{H}_2\text{O}$) in one litre of demineralised water.

The pH is determined in accordance with ISO 10523 and adjusted to $7,0 \pm 0,1$ by bubbling air and/or CO_2 into the solution.

NOTE The target total hardness is 100 mg/l as CaCO_3 , the target alkalinity is 122 mg/l as HCO_3^- and the silica concentration is 10 mg/l as SiO_2 .

5.3.3 Test water without chlorine content (chlorine-free), shall consist of a batch of test water (5.3.2) used for contact with test pieces and preparation of the blank water (3.18).

5.3.4 Test water with chlorine content (chlorinated), shall consist of test water (5.3.2) with a free chlorine content of $(1,0 \pm 0,2)$ mg/l as Cl_2 , determined in accordance with either EN ISO 7393-1 or EN ISO 7393-2, after addition of sodium hypochlorite solution (5.2.1).

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 demineralised water.
- b) Clean the inner surface of the glassware with hydrochloric acid (5.4) and rinse it with demineralised water. For stainless steel, clean with nitric acid (5.4) and then rinse with demineralised water.
- c) Before use, rinse the glassware, and appropriate apparatus, at least three times using preconditioning water before preconditioning (8.3) or test water before the test procedure (clause 9).

6.2 Apparatus and materials for test piece preparation (see normative 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 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 normative annexes A, B and C of this European Standard).

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 mm² and 90 000 mm². 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 normative annexes A, B or C and informative 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 normative annexes A, B or C and informative 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 by the appropriate normative annex A, B or C of this European Standard.

Clean moulds and any filling frame used with a mould, by thoroughly washing with non-perfumed detergent (5.4) and tap water (3.20), rinsing with copious amounts of tap water, followed by a final rinse with demineralised water (3.21) and dry before use.

Where a factory made cementitious product has been formed in a process where its entire contact surface has been in contact with a release agent then where 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 by this European Standard.

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.

NOTE The material PTFE should only be used when 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 ± 2 °C for the duration of the test.

6.3.3 where required, use only **sealants** that do not affect the determinations under the specified test conditions (see clause 9).

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 normative 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 are 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 normative 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 normative annex A, B or C to this European Standard and an appropriate test arrangement given in informative 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 shall not be smaller than the S/V ratio of the product in the service condition;
- 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. dm^{-1} .

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

7.3.2 Pipes and fittings

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

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

where:

[DN/ID] (3.8) is the nominal internal diameter, in mm.

Test pipes and fittings of DN/ID less than 80, at the actual S/V ratio of the pipe diameter.

Test pipes and fittings of DN/ID equal to 80 and less than 300, at an S/V ratio of $(5,0 \pm 0,2) \text{ dm}^{-1}$.

Test pipes and fittings of DN/ID 300 or greater, at an S/V ratio of $(1,3 \pm 0,1) \text{ dm}^{-1}$.

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

7.3.3 Storage systems (cement mortar, cement mortar lined or concrete)

Test storage systems at an S/V ratio of $(1,3 \pm 0,1) \text{ dm}^{-1}$.

8 Pre-treatment of samples (curing, preconditioning and disinfection)

8.1 General

The procedures for curing cementitious products are given in 8.2.

The procedures for preconditioning and disinfection at $(23 \pm 2) ^\circ\text{C}$ are given in 8.3.

8.2 Curing

Ensure that test pieces have been subject either to the curing conditions used in manufacture of the factory made product or, in the case of test pieces formed from proxy samples (3.6), to curing conditions that are representative of those used in the manufacture of the factory made product (see the relevant normative annex A, B or C to this European Standard).

8.3 Preconditioning

8.3.1 General

Precondition test pieces at the appropriate S/V ratio given in 7.3.

If disinfection treatment is required, carry out preconditioning in accordance with 8.3.3. If it is not required follow the procedure in 8.3.2.

8.3.2 Preconditioning without disinfection treatment

Fill test pieces with, or immerse them in, or otherwise bring them into contact with (see the test arrangements in informative annex E), preconditioning water (5.3.1) for a succession of five contact periods, without rinsing between contact periods, at a temperature of $(23 \pm 2) ^\circ\text{C}$ as follows:

- three periods of $(24 \pm 1) \text{ h}$;
- one period of $(72 \pm 1) \text{ h}$;
- one period of $(24 \pm 1) \text{ h}$.

After the fifth contact period determine the pH of the preconditioning water in accordance with ISO 10523. If the pH exceeds 9,5 stop the testing.