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BSI Standards Publication

Influence of metallic materials on water intended for human consumption — Method to evaluate the passive behaviour of stainless steels

National foreword

This British Standard is the UK implementation of EN 16056:2012.

The UK participation in its preparation was entrusted to Technical Committee EH/6, Effects of materials on water quality.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Influence of metallic materials on water intended for human consumption - Method to evaluate the passive behaviour of stainless steels

Influence des matériaux métalliques sur l'eau destinée à la consommation humaine - Méthode d'évaluation du comportement passif des aciers inoxydables

Einfluss metallischer Werkstoffe auf Wasser für den menschlichen Gebrauch - Verfahren zur Ermittlung des Passivverhaltens von nichtrostenden Stählen

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 16056:2012) has been prepared by Technical Committee CEN/TC 164 “Water supply”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by January 2013, and conflicting national standards shall be withdrawn at the latest by January 2013.

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

This document is one of a series of test methods which support associated product standards.

This document has been prepared under the mandate given to CEN by the Commission of the European Communities and the European Free Trade Area.

With respect to the potential adverse effects on the quality of water intended for human consumption caused by metallic materials, attention is drawn to the fact that the relevant national regulations remain in force until the adoption of verifiable European acceptance criteria. Water intended for human consumption is hereafter referred to as "drinking water" and means the same as the definition given at Article 2(1) of the Council Directive 98/83/EC on the quality of water intended for human consumption.

This document describes the method to evaluate the passive behaviour of stainless steels in contact with water. The passive layer is the cause for the negligible release of metal ions from stainless steels into the drinking water.

According to the CEN/CENELEC Internal Regulations, the national standards organisations 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The test methods in this series are designed to provide information on metal release over time from metallic materials into drinking water.

When tested in a test rig as described in EN 15664-1 stainless steels show very low metal release rates and the resulting metal concentrations in the water are in most cases below the detection limits of available analytical instruments. The reason for these small metal release rates is the formation of a passive layer on the surface on stainless steels.

It was therefore decided to test stainless steels for the properties of the passive layer and not metal release. The material under consideration is tested in an electrochemical test. For verification of the correct performance of the test protocol, the test is also performed in parallel on material 1.4404 which is passive in contact with drinking water but shows a clear pitting potential under the conditions of this test.

This test is terminated when the pitting potential of the material or the break-through potential is reached.

1 Scope

This European Standard specifies a procedure to evaluate the passive behaviour of stainless steels used in construction products intended to come into contact with drinking water.

The passive state of stainless steels is the reason why no relevant amounts of metals are released from these materials into the drinking water. This test is used to verify whether the stainless steel under consideration is passive under conditions which can occur in drinking waters.

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 12502-1:2004, *Protection of metallic materials against corrosion — Guidance on the assessment of corrosion likelihood in water distribution and storage systems — Part 1: General*

EN 15664-1:2008, *Influence of metallic materials on water intended for human consumption — Dynamic rig test for assessment of metal release — Part 1: Design and operation*

EN ISO 8044:1999, *Corrosion of metals and alloys — Basic terms and definitions (ISO 8044:1999)*

EN ISO 17475:2008, *Corrosion of metals and alloys — Electrochemical test methods — Guidelines for conducting potentiostatic and potentiodynamic polarization measurements (ISO 17475:2005/Cor 1:2006)*

3 Terms and definitions

For the purposes of this document the terms and definitions given in EN ISO 8044:1999, EN 12502-1:2004 and EN 15664-1:2008 apply.

4 Test cell

The test equipment shall be used as described in EN ISO 17475. The test cell shall be constructed according to EN ISO 17475:2008, Annex A, flushed port cell. To ensure that the salt concentration remains constant during the test, the test cell shall be modified according to the scheme shown in Figure A.1. This modification allows the chloride content to remain constant despite the addition of the demineralised water by adding a solution with (440 ± 1) mg/l chloride with the same pumping rate. The overflow system is necessary due to the long testing time and the continuous addition of demineralised water and chloride solution.

Depending on the geometry of the material and the test samples, it may be necessary to alter the geometry of the test cell base. If this is the case, it is important that a crevice-free sealing is made to ensure that only pitting corrosion is induced in this cell.

The exposed surface of the material to be tested shall be 5 cm^2 to 10 cm^2.

The pumping rate for the demineralised water and the concentrated chloride solution ((440 ± 1) mg/l, see Figure A.1) shall be adjusted to 6 ml/h to 8 ml/h.

Test solution is in contact to air and agitated.

5 Test water

The test water shall consist of a solution containing (220 ± 1) mg/l chloride. The solution shall be prepared by using demineralised water (conductivity < 1 mS * m^{-1}) and sodium chloride p.a.

6 Sample Preparation

The test samples shall, if available, be taken from sheet or plate material and have dimensions of about 50 mm × 50 mm corresponding to the size of the sample holder of the electrochemical cell used. Any other material shape may be used if the appropriate size of sample can be machined.

Test samples shall be marked for identification on the rear surface of each.

The surface to be tested shall be ground under flowing water using successively finer SiC paper starting with grade 80 and finishing with grade 320. This is achieved by mounting the test samples, using double-sided adhesive tape, on a sample holder to facilitate surface preparation. The test samples shall be rinsed under flowing water and turned 90 degrees when changing to the next finer grade of SiC paper in accordance with standard grinding procedures.

Grinding shall be followed by a degreasing and cleaning procedure as follows. The test samples shall be immersed for 10 min in an alkaline detergent (e.g. RBS detergent) in an ultrasonic bath at (50 ± 5) ^{o}C, rinsed with demineralised water (conductivity < 1 mS * m^{-1}) and then with ethanol. Finally dry with pressurized grease-free air.

If the above preparation procedure results in exposure of sensitive areas in the material which are irrelevant to practical use, an adapted preparation method may be applied, provided the requirements for grinding and cleaning are fulfilled.

NOTE Such an adaption might be needed for odd geometries like rods or cast products.

Samples are left for (24 ± 4) h in desiccators before starting the test.

7 Test procedure

The tests shall be performed at ambient temperature, i.e. (25 ± 2) °C.

At the beginning of the test measure the free corrosion potential (time for stabilisation 60 min).

The slow polarization test can then begin. Starting potential shall be U_{SHE} = 250 mV. Slow polarization shall proceed in anodic direction, either with a stepwise increase of the potential 25 mV/1,5 h or with a constant polarization rate in the range between 17 mV/h and 36 mV/h.

Potential and current shall be recorded continuously.

The test shall be terminated when the current density clearly exceeds 30 µA/cm².

After demounting the sample shall be examined. If the sample suffered from crevice corrosion (see EN ISO 8044), the test results shall be rejected.

The chloride content of the test water shall be checked after the test. If it is not in the range (220 ± 25) mg/l the results of the test must be rejected and the test repeated.

The test shall be performed in triplicate for material 1.4404 and for the material under consideration.

8 Evaluation of test results

The results of the tests shall be provided as current density versus potential curves for all single tests (as shown in Figures A.2 and A.3).

From these curves the pitting potential (or the break-through potential if the material does not suffer from pitting corrosion) shall be evaluated. For the purpose of this standard the pitting potential is defined as the potential at which the current density exceeds 10 µA/cm².

The pitting potentials, with reference to the standard hydrogen electrode (U_{SHE}), shall be reported as single values and in form of arithmetic average for material 1.4404 and the material under consideration.

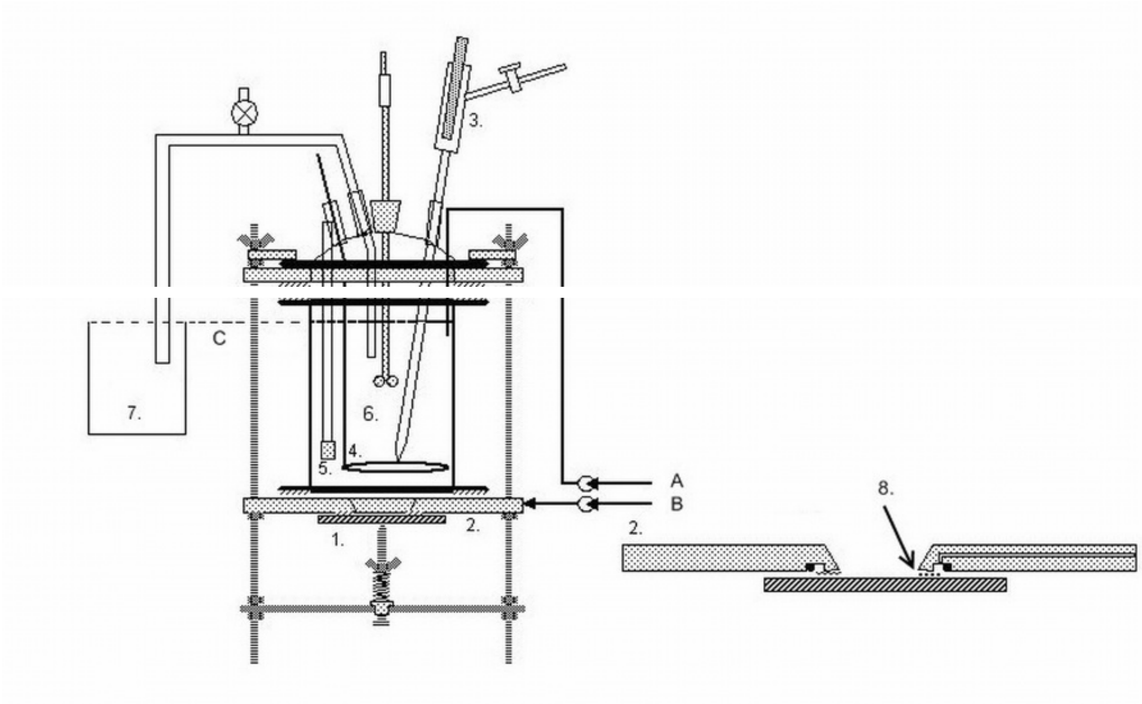
9 Report

The test report shall contain:

1) name and address of the test institute;
2) name(s), function(s) and signature(s) or equivalent identification of person(s) authorizing the test report;
3) registration mark or number of the test report;
4) name and address of the customer and/or producer of the tested material;
5) number of this standard and year of its publication;
6) description of the candidate material to be tested and the reference material 1.4401:
    i) chemical composition of the materials;
    ii) heat treatment;
7) preparation of test samples and surface finishing of the samples;
8) size of test area of the sample;
9) description of the applied test cell and electrodes;
10) composition of the test solution, its volume and temperature;
11) time of contact with the test solution prior to start of the test;
12) value of the free corrosion potential (U_{SHE}), indicate whether it was constant;
13) type and rate of potential increase;
14) chloride content of the test water after the test;
15) description of any deviations from the specified procedure;
16) occurrence of pitting or crevice corrosion;
17) test results (see Clause 8);
18) date of report.

Annex A
(normative)

Test cell and presentation of test results

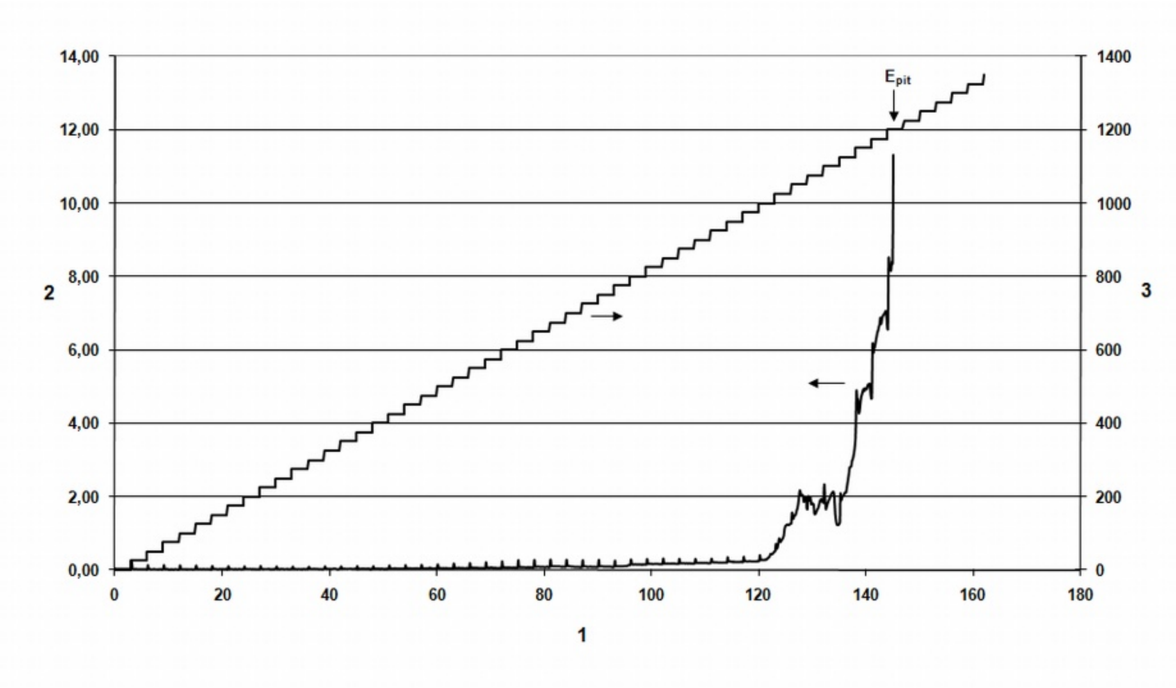


Key

1	test specimen
2	flush port plate
3	reference electrode
4	counter electrode
5	gas supply
6	stirrer
7	beaker
8	ring of filter paper
A	(440 ± 1) mg/l chloride solution
B	demineralised water
C	same water level in beaker and test cell

Figure A.1 — Scheme of test set-up for slow polarization test

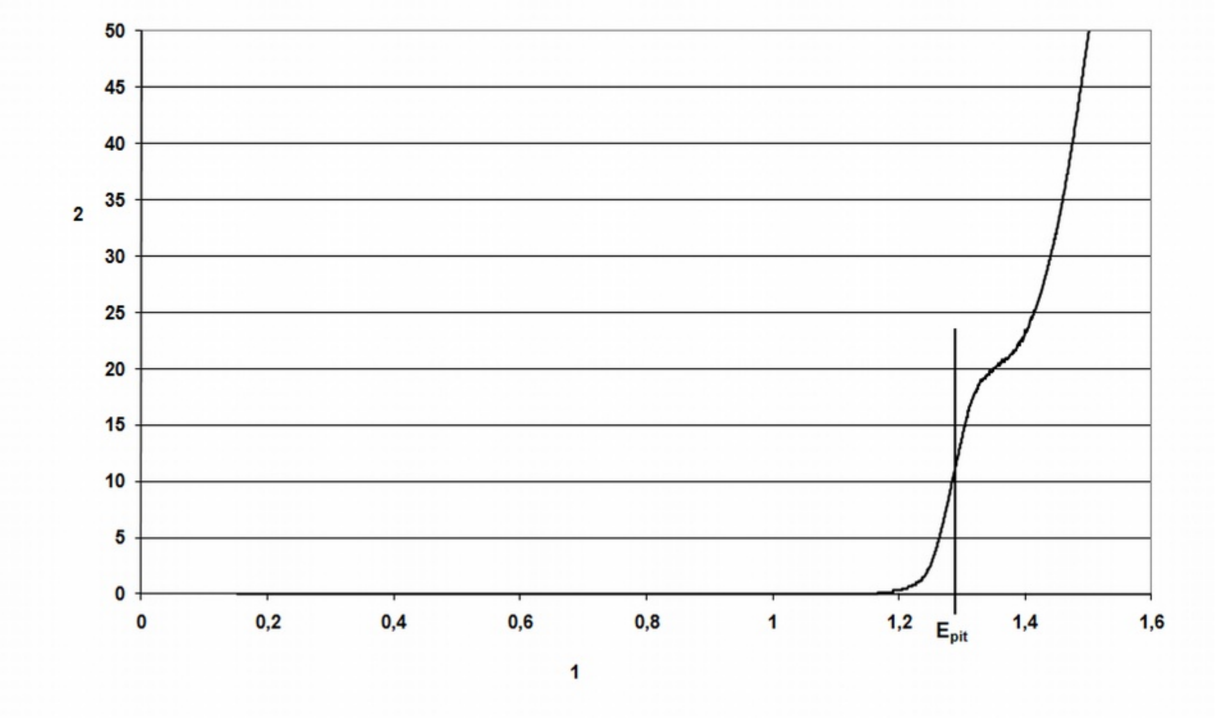
NOTE 220 mg/l chloride solution in the test cell and the beaker, additional pumping of demineralised water and (440 ± 1) mg/l chloride solution.



Key

1 test duration (h)
2 current density (µA/cm²)
3 potential U_{SHE} (mV)

Figure A.2 — Scheme of a current density versus potential curve (stepwise increase of potential)



Key

1 potential U_{SHE} (V)
2 current density (µA/cm²)

Figure A.3 — Scheme of a current density versus potential curve (constant polarization rate)

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