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**Ohranjanje kulturne dediščine - Zaščita površine poroznih anorganskih materialov - Laboratorijske preskusne metode za vrednotenje učinkovitosti vodoodbojnih sredstev**

Conservation of Cultural Heritage - Surface protection for porous inorganic materials - Laboratory test methods for the evaluation of the performance of water repellent products

Erhaltung des kulturellen Erbes - Oberflächenschutz für poröse anorganische Materialien - Laborprüfverfahren für die Ermittlung der Wirksamkeit von wasserabweisenden Produkten

Conservation du patrimoine culturel - Protection de surface des matériaux inorganiques poreux - Méthodes d'essai en laboratoire pour l'évaluation des performances des produits hydrofuges

**Ta slovenski standard je istoveten z: EN 16581:2014**

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EUROPEAN STANDARD

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## Conservation of Cultural Heritage - Surface protection for porous inorganic materials - Laboratory test methods for the evaluation of the performance of water repellent products

Conservation du patrimoine culturel - Protection de surface des matériaux inorganiques poreux - Méthodes d'essai en laboratoire pour l'évaluation des performances des produits hydrofuges

Erhaltung des kulturellen Erbes - Oberflächenschutz für poröse anorganische Materialien - Laborprüfverfahren für die Ermittlung der Wirksamkeit von wasserabweisenden Produkten

This European Standard was approved by CEN on 18 October 2014.

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## Foreword

This document (EN 16581:2014) has been prepared by Technical Committee CEN/TC 346 "Conservation of Cultural Heritage", the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by June 2015, and conflicting national standards shall be withdrawn at the latest by June 2015.

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.

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**EN 16581:2014 (E)****Introduction**

As part of the conservation of built heritage, a variety of surface treatments can be carried out to delay the decay processes.

This document focuses on water repellent treatments of porous inorganic materials. The main goal of a water repellent is to reduce the penetration of liquid water and the substances dissolved in the water into porous material by changing its surface properties.

A water repellent product when applied to the surface of a material decreases its surface tension and prevents wetting of the surface. The water repellent treatment is applied to the surface and penetrates into the pores of the material, the depth of penetration being dependent on the capillary properties of the material, the properties of the hydrophobic, the type and duration of application as well as the moisture content of the substrate and the temperature.

Many deterioration mechanisms result from the presence of water and therefore the reduction of water absorption without significantly decreasing water vapour permeability may positively influence the preservation of porous inorganic materials.

Coatings including varnishes and paints are not considered within this European Standard.

A water repellent should fulfil the following requirements to:

- reduce the absorption of liquid water in the substrate,
- minimize change of water vapour permeability of the substrate,
- minimize change in colour and gloss of the substrate,
- produce no harmful by-products after the application,
- maintain its physical and chemical stability.

Water repellent products should be applied on the surface of heritage objects only after they have been tested on representative samples of porous inorganic materials in the laboratory. Field trials on small areas are strongly recommended prior to final application.

This European Standard for the evaluation of water repellent treatments is based on the measurement of appropriate parameters to assess the performance of the product using standardized test methods.

*In situ* application methods include brushing, spraying, immersion, capillary rise absorption and poultice. Due to the dimensions of samples and the requirements to perform reproducible treatment procedures for laboratory testing, the capillarity method is specified. Where a treatment cannot be applied according to the standard method (for example when an emulsion is used) the application method should be clearly described in the test report.

Technical and chemical data sheets of treatment under evaluation should be provided; the data sheets which detail at least the chemical formulas of the active substances and concentrations, the names and the ratio of solvents, if applicable.

In order to evaluate the durability and in service performance of a water repellent product applied on the substrate, ageing tests representing the environment in which the porous inorganic material is located can be carried out.

## 1 Scope

This European Standard specifies the methodology for laboratory evaluation of the performance of water repellent products on porous inorganic materials.

It is based on the measurement of several parameters which assess the performance of the product using standard test methods before and after ageing.

Acceptable performance within the laboratory does not constitute a blanket endorsement of application in every situation. The particular context of the heritage object, including such factors as material designation, condition, exposure, salt content and problems related to water ingress requires further investigation.

## 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 15801, *Conservation of cultural property - Test methods - Determination of water absorption by capillarity*

EN 15802, *Conservation of cultural property - Test methods - Determination of static contact angle*

EN 15803, *Conservation of cultural property - Test methods - Determination of water vapour permeability ( $\delta p$ )*

EN 15886, *Conservation of cultural property - Test methods - Colour measurement of surfaces*

EN 15898, *Conservation of cultural property - Main general terms and definitions*

EN 16085, *Conservation of Cultural property - Methodology for sampling from materials of cultural property - General rules* <https://standards.iteh.ai/catalog/standards/sist/ca805059-c2ed-425c-8aaf-85547a3e3df5/sist-en-16581-2015>

EN 16302, *Conservation of cultural heritage - Test methods - Measurement of water absorption by pipe method*

EN 16322, *Conservation of Cultural Heritage - Test methods - Determination of drying properties*

EN ISO 2813, *Paints and varnishes - Determination of specular gloss of non-metallic paint films at 20°, 60° and 85° (ISO 2813)*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 15898 and the following apply.

### 3.1

#### **water-repellency**

ability of the substrate to resist the ingress of liquid water

### 3.2

#### **water repellent product**

product increasing the water-repellency of the treated surface of porous inorganic materials

### 3.3

#### **water repellent treatment**

application of a water repellent product to the surface of a material by a specified methodology

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## 3.4

**protection degree by capillarity**

reduction of the amount of water absorption by capillarity before and after the treatment

## 3.5

**protection degree by pipe**

reduction of the amount of water absorption by pipe before and after the treatment

## 3.6

**specular gloss**

ratio of the luminous flux reflected from an object in the specular direction for a specified source and receptor angle to the luminous flux reflected from glass with a refractive index of 1,567 in the specular direction

## 4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply:

$m_{0B}$	dry mass after characterization tests and before the treatment, in kg;
$m_{0A}$	dry mass after the treatment, in kg;
$t_i$	time elapsed from the beginning of the test, in s;
$Q_i$	water absorbed by capillarity per unit area, in $\text{kg}/\text{m}^2$ ;
AC	capillary water absorption coefficient, in $\text{kg}/(\text{m}^2 \cdot \text{s}^{1/2})$ ;
$Q_p$	water repellent product absorbed, as a mass %;
PD <sub>ci</sub>	Protection Degree by capillarity at time $t_i$ , as a mass %;
$Q_{Bi}$	amount of absorbed water by capillarity of untreated specimen at time $t_i$ , in $\text{kg}/\text{m}^2$ ;
$Q_{Ai}$	amount of absorbed water of treated specimen at time $t_i$ , in $\text{kg}/\text{m}^2$ ;
$\bar{\delta}_p$	water vapour permeability, in $\text{kg}/(\text{m} \cdot \text{s} \cdot \text{Pa})$ ;
$\bar{\delta}_{pB}$	water vapour permeability before treatment, in $\text{kg}/(\text{m} \cdot \text{s} \cdot \text{Pa})$ ;
$\bar{\delta}_{pA}$	water vapour permeability after treatment, in $\text{kg}/(\text{m} \cdot \text{s} \cdot \text{Pa})$ ;
$\bar{\delta}_{p \text{ red}}$	reduction of water vapour permeability, as a %;
$L^*$	lightness coordinate. The scale for $L^*$ ranges from 0 (black) to 100 (white);
$a^*$	red/green coordinate, with $+a^*$ indicating redness and $-a^*$ indicating greenness;
$b^*$	yellow/blue coordinate, with $+b^*$ indicating yellowness and $-b^*$ indicating blueness;
$L^*_B$	Lightness coordinate before treatment;
$L^*_A$	Lightness coordinate after treatment;
$a^*_B$	red/green coordinate before treatment;
$a^*_A$	red/green coordinate after treatment;
$b^*_B$	yellow/blue coordinate before treatment;
$b^*_A$	yellow/blue coordinate after treatment;
$\Delta E^*$	total colour difference;
PD <sub>LP</sub>	Protection Degree by pipe method, as a %;
$(W_f)_B$	amount of absorbed water by pipe method at the end of the test before the treatment, in $\text{ml}/\text{cm}^2$ ;
$(W_f)_A$	amount of absorbed water by pipe method at the end of the test after the treatment, in $\text{ml}/\text{cm}^2$ ;



$D_{1B}$	drying rate corresponding to the first drying phase before the treatment, in $\text{kg}/(\text{m}^2 \cdot \text{h})$ ;
$D_{1A}$	drying rate corresponding to the first drying phase after the treatment, in $\text{kg}/(\text{m}^2 \cdot \text{h})$ ;
$D_{1\text{red}}$	reduction of the drying rate, as a %;
$\theta$	contact angle, in $^\circ$ .

## 5 Test methods for evaluation

The methods listed here below are used for the evaluation of a water repellent product in relation to the possible changes of the characteristics of porous inorganic materials.

- 1) Determination of water absorption by capillarity (EN 15801)
- 2) Determination of static contact angle (EN 15802)
- 3) Determination of water vapour permeability (EN 15803)
- 4) Colour measurement of surfaces (EN 15886)
- 5) Determination of water absorption by pipe method (EN 16302)
- 6) Determination of drying properties (EN 16322)
- 7) Gloss measurement (EN ISO 2813)

## 6 Evaluation of long term performances

Water repellents are expected to demonstrate suitable durability on exposure to natural weathering or laboratory tests (such as light irradiation, freeze and thaw, wetting and drying, thermal cycles, salt crystallization, pollutant simulation, biological growth, etc.) representing the environment in which the object is located.

In the event that a specific methodology for the assessment of environmental degradation is standardised in the field of conservation of cultural heritage, it shall be used. Where these do not exist, a suitable assessment method for Cultural Heritage should be used and described in the test report.

It is important to monitor the performances of water repellent products after ageing repeating the tests listed in Clause 5, taking into account that different comparisons of the results are possible (i.e. after ageing-before treatment or after ageing-before ageing, etc...).

The comparison of the results allow to evaluate the durability of products.

## 7 Test equipment for the treatment (apparatus and reagents)

### 7.1 Crystallization vessel

7.2 **Bedding layer** such as filter paper, foam or cotton.

7.3 **Chronometer** with an accuracy of 1 s.

7.4 **Ventilated oven** which can maintain a temperature of  $(40 \pm 2) ^\circ\text{C}$ .

7.5 **Analytical balance** with an accuracy of at least 0,01 g.

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- 7.6 Linear measuring device (calliper)** with an accuracy of 0,1 mm.
- 7.7 Chamber** capable of maintaining a constant temperature of  $(23 \pm 2)$  °C.
- 7.8 Sand paper** with grain size of 82  $\mu\text{m}$  (corresponding to grit number P180 according to the FEPA <sup>1)</sup> classification).
- 7.9 Desiccator** filled with desiccant such as self-indicating silica gel or other drying agents.
- 7.10 Deionised water** (with max. conductivity of 6  $\mu\text{S/cm}$ ).
- 7.11 Soft bristle brush**
- 7.12 Ammonium chloride saturated solution**, or a climatic chamber capable of maintaining a relative humidity of  $(80 \pm 5)$  %.
- 7.13 Magnesium nitrate saturated solution**, or a climatic chamber capable of maintaining a relative humidity of  $(53 \pm 5)$ %.
- 7.14 Glass spheres or bars** (e.g. 3 mm to 4 mm diameter).

**8 Test procedure****8.1 Steps of evaluation of water repellent products**

The evaluation of water repellent products applied on porous inorganic materials should be carried out according to the following steps (Figure 1). (standards.iteh.ai)

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<sup>1)</sup> Federation of European Producers of Abrasives

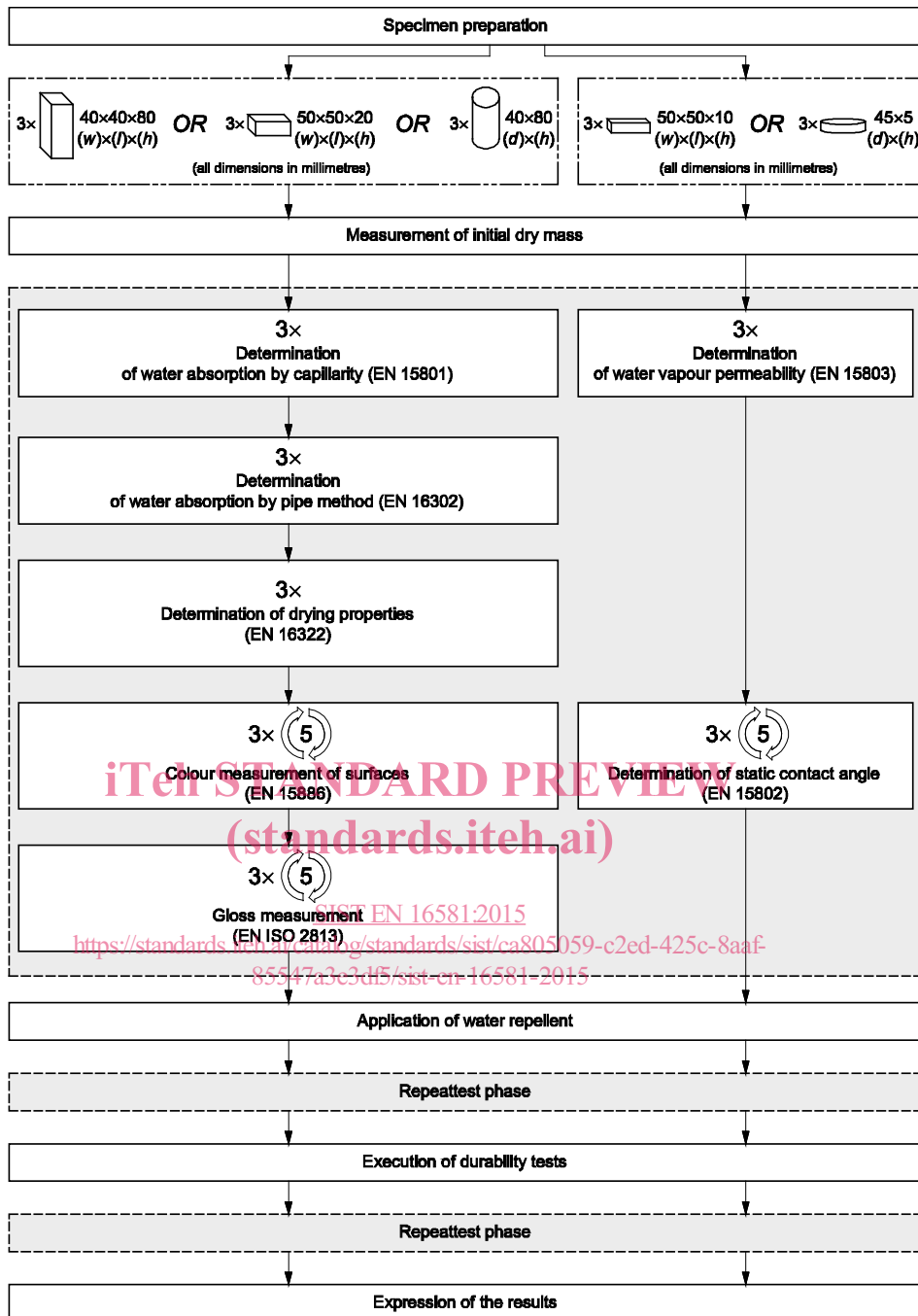


Figure 1 — Flow diagram for recommended test procedure

## 8.2 Specimen preparation and determination of dry mass

### 8.2.1 Number and dimensions of the test specimens

Specimens shall have a regular shape such as cubes, parallelepipeds or cylinders (see Table 1).