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# Vitreous and porcelain enamels — Low-voltage test for detecting and locating defects —

## Part 2: Slurry test for profiled surfaces

*Émaux vitrifiés — Essai à basse tension pour la détection et la localisation des défauts —*

*Partie 2: Essai à la barbotine pour surfaces profilées*



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# Contents

Page

# Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.



 

# Vitreous and porcelain enamels — Low-voltage test for detecting and locating defects —

# Part 2:
# Slurry test for profiled surfaces



## 1 Scope

This document specifies a low-voltage test method for detecting and locating defects (pores, cracks or pop-offs) that occur in enamel coatings of corrugated and/or undulated profiles and that extend down to the metal base.

The method is based on colour effects (optical method) and is applicable to the precise detection of defects and their exact position. It can be used for non-flat, more profiled shapes such as corrugated or undulated surfaces.

NOTE The low-voltage test is a non-destructive test for detecting defects extending down to the metal base and is, therefore, completely different in comparison to the high-voltage test in accordance with ISO 2746.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 19496-1, *Vitreous and porcelain enamels — Terminology — Part 1: Terms and definitions*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19496-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

## 4 Principle

The defects are detected by means of an optical method, which is based on colour effects. The test is performed with low voltage where the contact at the defect is made by a conducting liquid (electrolyte).

## 5 Test medium

### 5.1 General

The test medium is a sprayable thixotropic mixture (slurry), which consists of titanium dioxide (anatase), polysaccharide, additive, electrolyte (sodium chloride) and alcoholic (ethanolic) solution of phenolphthalein and which is obtained by grinding.

### 5.2 Formulation

Add 1 per cent by volume of the 0,5 % alcoholic solution of phenolphthalein and 0,1 per cent by volume of any detergent to a 3 % solution of sodium chloride ("combined solution"). The combined solution prepared in this manner has an unlimited storage life.

To prepare the slurry, 75 parts by mass of the combined solution are intensively mixed with the following parts in a ball grinder for approximately 10 min:

— 1 part by mass of titanium dioxide (e.g. Kronos A[1)]),

— 0,5 parts by mass of pyrogenic silicic acid (e.g. Aerosil[1)]),

— 1 part by mass of quartz 400 mesh (e.g. Sikron[1)]), and

— 0,05 parts by mass of a polysaccharide (e.g. Rhodopol MD 50[1)]).

If necessary, the slurry shall be adjusted with water to a specific weight of (1,1 ± 0,1) g/cm$^3$ so that the slurry can be easily applied with a spray gun to the substrate area to be tested.

**CAUTION — The storage time of the slurry is limited (due to bacteriological decomposition) to approximately three months if stored in a cool and dark environment.**

**WARNING — Take care when handling the phenolphthalein solution.**

The saline solution shall be used in such an amount that the test solution has a conductivity of (0,475 ± 0,025) S/m and a pH value of (8 ± 0,5).

Sodium nitrite may be used instead of sodium chloride if, after testing, the articles are to be enamelled again.

## 6 Apparatus

### 6.1 Power source

The power source shall be a direct-voltage source that can be adjusted to ±1 V within the range of 10 V to 24 V. A stabilized power supply unit with digital voltage display should be used. Alternatively, a voltage divider or batteries in accordance with EN 60086-2 that are connected in series may be used.

### 6.2 Test electrode

A metal broom electrode shall be used as a test electrode (an anode, positive pole of the power source). The test electrode shall be constituted such that it remains completely unaffected by the electrochemical reaction.

## 7 Test specimens

The test specimen may be a commercial article with a random structured surface. The test method is particularly suitable for testing corrugated and/or undulated metal sheets, which are used as heat-transfer surfaces in regenerative heat exchangers.

There shall be a non-enamelled metal surface area in order to make contact with the negative electrode (cathode). When testing enamelled heating element sheets, it is beneficial to give the edge of a suspension hole a metallic bright finish and to fix the negative electrode at this hole such that the electrical contact is ensured.

1) These products examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products. Equivalent products may be used if it can be demonstrated that they lead to the same results.

The surface to be tested shall be cleaned with a detergent solution, rinsed with tap water and dried with a cloth or paper by dabbing so that the surface is free of grease and dust. If the test specimen is tested within 24 h after firing, cleaning with detergent solution is not necessary. The temperature of the enamel coating shall not be higher than 30 °C.

## 8 Procedure

The area to be tested shall be defined with tape (e.g. masking tape). This can also be accomplished by means of a mask. When testing heat-exchanger profiles, the test area should be defined so that the fringe areas with 1 cm distance to the sheet edges are not evaluated.

The area to be tested should be sprayed with the test medium (slurry) in a conventional spraying cabin until the entire surface area to be tested is substantially covered, i.e. until a covering, preferably even film, of test slurry has been applied.

Immediately afterwards, connect the metallic substrate of the test specimen with the negative pole of the power source (for heating element sheets, fix the contact in a suspension hole, see Clause 7). Subsequently, the contact between the test electrode and the positive pole of the power source shall be made by placing the test electrode flat on the test specimen.

Then, switch on the power source, which has been set at 12 V, and switch it off after 1 min. Count the defects within 1 min after switching it off. Each defect is indicated by a visibly red coloured spot in the white test slurry.

## 9 Evaluation

The number of defects per unit area shall be calculated as shown by Formula (1):

$$N = \frac{S}{A} \tag{1}$$

where

$N$ is the number of defects per square meter;

$S$ is the number of defects detected;

$A$ is the test area in square meters.

The maximum permissible number of defects is given in the corresponding quality standards.

## 10 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8289-2;

b) identification of the article tested;

c) the number of defects per square meter;

d) the description of the position of defects, where appropriate;

e) test medium used (manufacturer, formulation);

f) the date of test;

g) the name of the person who performed the test.

# Bibliography

[1] ISO 2746, *Vitreous and porcelain enamels — High voltage test*

[2] EN 60086-2, *Primary batteries — Part 2: Physical and electrical specifications*



 