INTERNATIONAL STANDARD

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Vitreous and porcelain enamels — High voltage test

Émaux vitrifiés — Essai sous haute tension

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

ISO 2746 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 262, *Metallic and other inorganic coatings*, in collaboration with Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 2746:1998) which has been technically revised. This edition has also been adopted as a European standard, which supersedes EN 14430:2004.

Introduction

There are two different objectives for high voltage testing of vitreous and porcelain enamels.

Test A is used to detect and locate defects, which extend down to the metal base (e.g. open pores). This is a non-destructive test usually applied to thin enamel coatings. The test serves to monitor either that the parts produced are free from defects at the chosen test voltage, or to count the number of existing defects, e.g. to determine the defect density (defects/m^2) of enamelled architecture panels.

Test B is used to detect and locate defects, which extend down to the metal base (e.g. open pores) and to detect weak spots. This is a destructive test, i.e. the test can generate open pores with an electric discharge through weak spots in the enamel coating. This test is usually applied to thick enamel coatings and serves:

a) to verify that an enamel coating is safe to be used under highly corrosive conditions, e.g. to test the enamel coating of vessels used in the chemical industry, or

b) to verify that the enamel coating is safe to be used as a dielectric.

Test A and test B require the same test equipment (see Clause 5) and follow the same test procedure (see Clause 8). However, for test B the applied voltage is higher than in test A (see Clause 7).

Vitreous and porcelain enamels — High voltage test

WARNING — This International Standard may not be compliant with some countries' health and safety legislations and calls for the use of substances and/or procedures that may be injurious to health if adequate safety measures are not taken. This International Standard does not address any health hazards, safety or environmental matters and legislations associated with its use. It is the responsibility of the user of this International Standard to establish appropriate health, safety and environmentally acceptable practices and take suitable actions to comply with any national and international regulations. Compliance with this International Standard does not of itself confer immunity from legal obligations.

1 Scope

This International Standard describes two test methods of high voltage testing:

— Test A is used to detect and locate defects in vitreous and porcelain enamels;

— Test B is used to detect and locate defects and weak spots in vitreous and porcelain enamels.

The tests are performed using DC or pulsed DC high voltage.

The tests are applicable to dry surfaces of enamel coatings. In the case of moist surfaces, care should be taken to ensure that the locating of any defects is correctly performed.

Since test voltages depend on the coating thickness, the test method, especially with test A, may not be suitable for test specimens for which the coating thickness varies to a large extent.

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.

ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method*

ISO 2360, *Non-conductive coatings on non-magnetic electrically conductive basis materials — Measurement of coating thickness — Amplitude-sensitive eddy-current method*

IEC/TS 60479-1, *Effects of current on human beings and livestock — Part 1: General aspects*

IEC/TS 60479-2, *Effects of current on human beings and livestock — Part 2: Special aspects*

3 Terms and definitions

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

3.1
defect
area of an enamel layer where an open path connects the enamel surface with the metal basis

Note 1 to entry: Examples of defects are cracks or pores.

3.2
weak spot
area of an enamel layer where the dielectric strength falls below the required value, as determined by the application of high voltage because of blisters, foreign body inclusions, spalling or cracks

4 Principle

A high voltage electrode is passed over the enamel surface. Defects (Test A) or defects and weak spots (Test B) are indicated by a spark and a simultaneous optical and/or acoustic signal. The applied voltage can be DC or pulsed DC. The test voltage might be different in each case.

At distances smaller than 2 cm of the edges/borders of the enamelled parts, an electrical arc can occur between the test electrode and edges/borders with no or only a limited enamel coating thickness. The high voltage technique may, therefore, not be applicable to such border areas.

5 Apparatus

5.1 High voltage generator.

5.1.1 Direct-current (DC)-voltage generator, conforming to the requirements of IEC/TS 60479-1, able to deliver a DC-voltage corresponding to the testing voltage, adjustable and measurable at the test probe with limiting deviation +5 %/-10 %. The total internal resistance shall be high enough to give the short circuit current of the generator an arithmetical mean from 2 mA to 3 mA maximum. The peak value of the current during a spark discharge shall be between 10 mA and 50 mA and the amount of charge per impulse shall be 25 µC maximum.

The negative pole of the generator shall be earthed (USA: grounded) and the positive pole shall be connected to the test electrode by a screened high voltage cable of suitable length.

5.1.2 Pulsed DC-voltage generator, conforming to the requirements of IEC/TS 60479-2 able to deliver a DC-voltage corresponding to the testing voltage. The voltage shall be adjustable and measurable at the test probe with limiting deviations +20 %/-10 % for test voltage greater than 10 kV and limiting deviations +40 %/-10 % for test voltages less than 10 kV.

5.2 Test electrode, made out of metal wire or conductive rubber that is unaffected by a spark discharge.

NOTE Alternative test electrodes can be used providing they are unaffected by a spark discharge.

5.2.1 Insulated hand-piece, provided externally with an earthed cover for DC-voltage and pulsed DC-voltage devices. Pulsed DC-voltage generators can produce an electric shock to users because of capacitive coupling between cable and hand-piece during operation.

5.2.2 Brush holder, of metal wire (used for the test brush), constructed such that it is completely unaffected by the spark discharge and covers as large an area as possible when sweeping the enamel surface.

5.3 Indicator device, able to give a clear optical and/or acoustic signal at each spark discharge.

5.4 Coating thickness measurement device, such as that described in ISO 2178 or ISO 2360.

6 Specimens

The specimens can be commercial items, parts thereof or test pieces which have been subjected to the same processing, and which for testing purposes are representative of the commercial item.

No special preparation of specimens is required.

7 Test voltage

7.1 Test A: Detection of defects (3.1) which extend down to the metal basis (e.g. open pores)

For a correct determination of these defects, the appropriate test voltage shall be used. This voltage depends on the length of the defect gap, which corresponds to the thickness of the enamel layer. Too low a voltage will not result in the determination of all defects. Too high a voltage will result in a breakdown of thin residual enamel layers (destructive testing). In order to look for defects which extend down to the metal base (e.g. open pores), the test voltage shall be as follows:

— DC-voltages shall be set to the values given in Table 1.

Other voltages may be chosen by mutual agreement between interested parties.

— voltage of pulsed DC-voltage generators shall be agreed between the interested parties.

Table 1 shows the minimum voltage needed to arc through a defect which is open to both the surface and the metal substrate. Note that the dielectric breakdown of air is based on measurement at 23 °C and 60 % maximum relative humidity.

Table 1 — Test voltage[1]

Layer thickness µm	Test voltage V
100	1 100
110	1 150
120	1 200
130	1 240
140	1 290
150	1 370
160	1 420
170	1 450
180	1 510
190	1 560
200	1 600
210	1 660
220	1 690
230	1 750
240	1 800
250	1 850
260	1 900
270	1 940
280	1 990
290	2 030
300	2 070
400	2 520
500	2 900