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Paints and varnishes — Corrosion protection by protective paint systems — Assessment of porosity in a dry film

Peintures et vernis — Anticorrosion par systèmes de peinture — Évaluation de la porosité d'un feuil sec

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 29601 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 14, *Protective paint systems for steel structures*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Introduction

This International Standard supplements the ISO 12944 series (see the Bibliography) with regard to the detection of porosity in a dry film. If specified or agreed, the standard can also be used for other applications.

The objective of this International Standard is to achieve uniformity of practice for the detection of porosity in a dry film. The methods chosen entail the detection of porosity using one of two types of equipment, a low-voltage pinhole detector or a high-voltage spark tester.

This International Standard complements ISO 19840, which concerns the measurement of the thickness of dry films on rough surfaces, and ISO 16276-1 and ISO 16276-2, which concern the measurement of the adhesion of a coating by pull-off testing (Part 1) and by cross-cut and X-cut testing (Part 2).

Paints and varnishes — Corrosion protection by protective paint systems — Assessment of porosity in a dry film

1 Scope

This International Standard specifies procedures for detecting the presence of porosity in a protective paint system of any thickness on a steel or other metallic substrate. The procedures given in this International Standard are based on methods using two different types of test equipment, the choice of equipment depending on the dry film thickness. These procedures are only applicable to the testing of electrically non-conductive parts of a paint system.

The test methods specified are mainly intended for use with new coatings, but can also be used for coatings which have been in service for some time. In the latter case, it is important to bear in mind that the coating might have been penetrated by substances in contact with the coating during service.

2 Terms and definitions

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

2.1
porosity
presence of one or more discontinuities in a coating

2.2
discontinuity
hole, pit, pinhole, void, crack, thin spot, inclusion, contamination or other flaw in a coating that significantly lowers the dielectric strength of the coating

NOTE Certain types of discontinuity can also be described as a holiday.

2.3
nominal dry film thickness
NDFT
dry film thickness specified for each coat or for the whole paint system

[ISO 19840:2004]

2.4
mean dry film thickness
arithmetic mean of all the individual dry film thicknesses in the inspection area

[ISO 19840:2004]

2.5
inspection area
designated area for inspection as defined in the specification

NOTE If inspection areas are not defined, the whole structure is a single inspection area.

3 Principle

Porosity in a protective paint system applied to a conductive metal surface is detected either by low-voltage wet-sponge testing or high-voltage spark testing. Low-voltage pinhole detectors use moisture to conduct electrical current through any discontinuity in the coating. High-voltage spark testers generate a spark in a discontinuity when the discontinuity has a lower dielectric strength than the paint system.

In both cases, the apparatus is connected to the metal substrate by means of a signal return cable, and a DC voltage is applied by means of a probe. When a discontinuity is detected, an alarm is triggered.

The test voltage is determined by the thickness of the non-conductive part of the coating.

4 Test equipment

4.1 Low-voltage pinhole detectors

4.1.1 Low-voltage pinhole detectors are normally battery-operated for portability. They can either be single-voltage, 9 V or 90 V, or dual-voltage, switchable between 9 V and 90 V. To provide an electrically conductive path through any discontinuity in the coating, an open-cell sponge moistened with tap water is used to apply the voltage.

4.1.2 A cable with a suitable spring-operated connector (crocodile clip) is required to make contact to the bare substrate to form the signal return.

4.1.3 The low-voltage pinhole detector needs either a visual or audible alarm to indicate when a discontinuity has been detected. Some designs have both types of alarm.

4.2 High-voltage spark testers

4.2.1 High-voltage spark testers normally have an adjustable output voltage in the range 1 kV to 30 kV. A fixed output voltage is acceptable providing that the coating has sufficient electrical strength to insulate the substrate at the fixed voltage except where discontinuities are present. High-voltage spark testers in which the voltage can be varied shall have a voltage display to ensure that the correct test voltage is applied.

4.2.2 Equipment shall be operated either by DC or pulsed DC. High-voltage AC generators shall not be used for testing.

4.2.3 A cable with a suitable spring-operated connector (crocodile clip) is required to make contact to the bare substrate to form the signal return.

4.2.4 A conductive, high-voltage probe suitable for the task is required to apply the voltage to the coating to be tested. Different probe configurations are available to deal with a variety of different surface shapes and areas. Probes are made using wire-brush, conductive helical coil or conductive-rubber materials to form the contact electrode. If there is a risk that the coating will be damaged by a metal electrode, conductive rubber materials should preferably be used for the electrode.

4.2.5 The equipment requires either an audible or visual alarm to indicate when a spark has been discharged, signifying that a discontinuity has been detected. Some designs have both types of alarm.

5 Procedure

5.1 Selection of test method

In order to determine which type of detector is appropriate, the mean dry film thickness of the paint system shall be determined and used as the criterion. If the primer coat is conductive, e.g. a zinc-rich primer, or if the paint to be tested is applied over a metal coating, such as hot-dip-galvanized or thermally sprayed metals,

then the value of the mean thickness of the coating system shall be adjusted by subtracting the thickness of the conductive primer or the non-ferrous metal layer.

For paint systems with a mean dry film thickness of up to 500 µm, low-voltage pinhole detectors shall normally be used. A high-voltage spark tester may, however, be used to test a paint system with a mean dry film thickness less than 500 µm, but not less than 300 µm, by agreement between the interested parties.

For paint systems with a mean dry film thickness greater than 500 µm, high-voltage spark testers shall be used.

5.2 Low-voltage pinhole detection

5.2.1 The test voltage shall normally be 90 V. A test voltage of 9 V may, however, be used for films with a mean dry film thickness of up to 300 µm by agreement between the interested parties.

5.2.2 If the coating to be tested has been applied recently, it shall be dried/cured in accordance with the manufacturer's instructions prior to testing. In the absence of manufacturer's recommendations, the coating shall be dried/cured for at least 10 days in well-ventilated conditions and at a substrate temperature in excess of 15 °C and a relative humidity of less than 80 % prior to testing.

5.2.3 The surface of the coating to be tested shall be dry and free of oil, dirt and other contaminants.

5.2.4 Ensure that the detector is in good working condition before starting the testing.

5.2.5 Wet the sponge with tap water or with tap water to which a wetting agent has been added. Squeeze the sponge so that excess water is removed and the sponge does not drip.

5.2.6 Connect the signal return cable to the bare metal substrate. Make sure that the area of coating to be tested is connected electrically to the point chosen for the contact of the signal return cable.

NOTE This can be checked by making contact with the sponge to another bare metal area of the substrate.

5.2.7 Test the alarm by touching the connector with the sponge.

5.2.8 Move the sponge over the area to be tested at a rate between 0,1 m/s and 0,3 m/s, ensuring a wet interface is maintained between the sponge and the surface. Use a double pass over the area to increase the probability of detection.

To avoid stray current flow paths across the surface of the coating to an already detected discontinuity, wipe any moisture from the discontinuity before continuing the test.

Completely remove any wetting agent by hosing the surface with tap water before attempting to repair the coating.

5.3 High-voltage spark testing

5.3.1 If the coating to be tested has been applied recently, it shall be dried/cured in accordance with the manufacturer's instructions prior to testing. In the absence of manufacturer's recommendations, the coating shall be dried/cured for at least 10 days in well-ventilated conditions and at a substrate temperature in excess of 15 °C and a relative humidity of less than 80 % prior to testing.

5.3.2 The surface of the coating to be tested shall be dry and free of oil, dirt and other contaminants.

5.3.3 Ensure that the spark tester is in good working condition before starting the testing.

5.3.4 Set the test voltage to the value given in Table 1 corresponding to the mean dry film thickness determined for the coating (see 5.1).

NOTE As a comparison, the dielectric strength of a column of air is typically 4 kV/mm.

Table 1 — Voltages for high-voltage spark testing

Mean dry film thickness µm	Test voltage kV
up to 500	2,3
above 500 but ⩽600	2,9
above 600 but ⩽700	3,5
above 700 but ⩽800	4,0
above 800 but ⩽900	4,5
above 900 but ⩽1 000	5,0
above 1 000 but ⩽1 100	5,5
above 1 100 but ⩽1 200	6,5
above 1 200 but ⩽1 300	7,0
above 1 300 but ⩽1 400	7,5
above 1 400 but ⩽1 500	8,0
above 1 500 but ⩽1 600	8,5
above 1 600 but ⩽1 700	9,0
above 1 700 but ⩽1 800	10,0
above 1 800 but ⩽1 900	10,5
above 1 900 but ⩽2 000	11,0
above 2 000 but ⩽2 100	11,7
above 2 100 but ⩽2 200	12,4
above 2 200 but ⩽2 300	13,0
above 2 300 but ⩽2 400	13,5
above 2 400 but ⩽2 500	14,0
above 2 500 but ⩽2 600	14,5
above 2 600 but ⩽2 700	15,0
above 2 700 but ⩽2 800	15,5
above 2 800 but ⩽2 900	16,0
above 2 900 but ⩽3 000	16,5
above 3 000 but ⩽3 100	17,0
above 3 100 but ⩽3 200	17,5
above 3 200 but ⩽3 300	18,0
above 3 300 but ⩽3 400	18,5
above 3 400 but ⩽3 500	19,0
above 3 500 but ⩽3 600	19,5
above 3 600 but ⩽3 700	20,0
above 3 700 but ⩽3 800	21,0
above 3 800 but ⩽3 900	21,5
above 3 900 but ⩽4 000	22,0
above 4 000 but ⩽4 100	22,5

Table 1 (*continued*)

Mean dry film thickness µm	**Test voltage** kV
above 4 100 but ⩽4 200	23,0
above 4 200 but ⩽4 300	24,0
above 4 300 but ⩽4 400	25,0
above 4 400 but ⩽4 500	25,8
above 4 500 but ⩽4 600	26,4
above 4 600 but ⩽4 700	26,8
above 4 700 but ⩽4 800	27,4
above 4 800 but ⩽4 900	28,0
above 4 900 but ⩽5 000	28,5
above 5 000 but ⩽5 300	29,0
above 5 300 but ⩽8 000	30,0

5.3.5 Move the probe over the area to be tested at a rate between 0,1 m/s and 0,3 m/s. Do not repeat the test on the same surface to avoid the risk of damage to the coating.

NOTE With some types of coating, false alarms can occur as small currents can flow from the high-voltage probe on to the surface.

6 Expression of results

Report the results of testing as the number of discontinuities detected in the inspection area.

7 Test report

The report shall contain at least the following information:

a) a reference to this International Standard (ISO 29601);

b) information necessary to identify the inspection areas, such as:

   1) the name of the owner of the structure,

   2) identification of the structure, including its location,

   3) the location of the inspection area,

   4) any other relevant information;

c) information necessary to identify the protective paint system inspected, such as:

   1) the manufacturer,

   2) the product names and identifying code numbers of the paint system,

   3) details for the substrate and the surface preparation,

4) the nominal dry film thickness of the paint system,

5) the mean dry film thickness of the paint system,

6) the presence of any conductive coating layers (see 5.1),

7) in the case of high-voltage spark testing, the mean coating thickness value used to select the test voltage,

8) if the coating had been applied recently, the length of time and ambient conditions used for the drying/curing process;

d) the test method and voltage used;

e) details of the equipment used, such as:

1) equipment identification, including the serial number,

2) all relevant equipment verification data confirming the suitability of the equipment for the test;

f) details of any wetting agent used;

g) the number of discontinuities detected in the inspection area;

h) any deviation from this International Standard;

i) any unusual features (anomalies) observed during the inspection;

j) the date of the inspection;

k) the name of the inspector and the authority which commissioned the inspection.

Bibliography

[1] ISO 12944-1, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 1: General introduction*

[2] ISO 12944-2, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 2: Classification of environments*

[3] ISO 12944-3, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 3: Design considerations*

[4] ISO 12944-4, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 4: Types of surface and surface preparation*

[5] ISO 12944-5, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint systems*

[6] ISO 12944-6, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 6: Laboratory performance test methods*

[7] ISO 12944-7, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 7: Execution and supervision of paint work*

[8] ISO 12944-8, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 8: Development of specifications for new work and maintenance*

[9] ISO 16276-1, *Corrosion protection of steel structures by protective paint systems — Assessment of, and acceptance criteria for, the adhesion/cohesion (fracture strength) of a coating — Part 1: Pull-off testing*

[10] ISO 16276-2, *Corrosion protection of steel structures by protective paint systems — Assessment of, and acceptance criteria for, the adhesion/cohesion (fracture strength) of a coating — Part 2: Cross-cut testing and X-cut testing*

[11] ISO 19840:2004, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces*

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