
International Standard



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Paints and varnishes — Filiform corrosion test on steel

Peintures et vernis — Essai de corrosion filiforme sur acier

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Descriptors : paints, varnishes, steel, tests, corrosion tests, filiform corrosion tests.

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4623 was developed by Technical Committee ISO/TC 35, *Paints and varnishes*, and was circulated to the member bodies in July 1982.

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It has been approved by the member bodies of the following countries :

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Australia	Iran	South Africa, Rep. of
Canada	Iraq	Sri Lanka
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Czechoslovakia	Jamaica	Switzerland
Egypt, Arab Rep. of	Kenya	Thailand
France	Korea, Rep. of	United Kingdom
Germany, F. R.	Mexico	USSR
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India	Portugal	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Belgium
Italy

Paints and varnishes — Filiform corrosion test on steel

0 Introduction

This International Standard is one of a series of standards dealing with the sampling and testing of paints, varnishes and related products.

This International Standard describes a test procedure for assessing the protective action of coatings of paints or varnishes on steel against filiform corrosion arising from a scribed mark cut through the coating. This corrosion tends to develop when the relative humidity is high and when traces of salts are present either under the paint coating or at breaks in the coating. A certain amount of under-rusting of the substrate, starting from the scribed mark, will always occur. Filiform corrosion, however, is considered to be present only if the typical pattern in the form of threads is obvious (see figure 2).

For any particular application, the test method described in this International Standard needs to be completed by the following supplementary information. This information shall be derived, in part or totally, from the (inter)national standard or other document related to the product under test or, if appropriate, should be agreed between the interested parties.

- a) Material and surface preparation of the substrate.
- b) Method of application of the test coating to the substrate, including duration and conditions of drying between coats in the case of a multi-coat system.
- c) Duration and conditions of drying of the coat (or conditions of stoving and ageing, if applicable) before testing.
- d) Thickness, in micrometres, of the dry coating and method of measurement in accordance with ISO 2808, and whether it is a single coating or a multi-coat system.
- e) Procedure for initiation of corrosion including, in the case of the salt fog technique, the period of exposure.
- f) Duration of the test.

1 Scope and field of application

This International Standard describes a method for assessing the protective action of coatings of paints or varnishes against filiform corrosion on steel.

2 References

- ISO/R 483, *Plastics — Methods for maintaining constant relative humidity in small enclosures by means of aqueous solutions.*
- ISO 1512, *Paints and varnishes — Sampling.*
- ISO 1513, *Paints and varnishes — Examination and preparation of samples for testing.*
- ISO 1514, *Paints and varnishes — Standard panels for testing.*
- ISO 2409, *Paints and varnishes — Cross-cut test.*
- ISO 2808, *Paints and varnishes — Determination of film thickness.*
- ISO 7253, *Paints and varnishes — Determination of resistance to neutral salt spray.*

3 Definition

filiform corrosion : A type of corrosion proceeding under a coat of paint, varnish or related product, in the form of threads, generally starting from bare edges or from local damage to the coating.

NOTE — Usually the threads are irregular in length and direction of growth, but they may also be nearly parallel and of approximately equal length. It should be noted that filiform corrosion can also occur under other protective coatings.

4 Principle

Scribing of a mark on the coated test panel. Introduction of a small amount of sodium chloride into the scribed mark, either by dipping the panel in a solution of the salt or by exposure to salt-fog. Storage of the test panel in a test cabinet at 40 °C and a relative humidity of 80 %. Assessment of the amount of filiform corrosion developed from the scribed mark.

5 Test solutions

5.1 Sodium chloride solution, 1 g/litre (for the dipping technique)

Prepare this solution by dissolving 1 g of sodium chloride (see 5.2) in 1 litre of distilled or demineralized water. Place this solution in a vessel suitable for complete immersion of the test panel (see clause 8).

5.2 Sodium chloride solution, 50 g/litre (for the salt-fog technique)

Prepare this solution by dissolving 50 ± 5 g of sodium chloride in 1 litre of distilled or demineralized water, as described in ISO 7253. The sodium chloride shall be white, of minimum assay 99,6 % (m/m), substantially free from copper and nickel and contain not more than 0,1 % (m/m) of sodium iodide.

6 Apparatus

Test cabinet, capable of being maintained at 40 ± 2 °C and a relative humidity of 80 ± 5 %, and having provision for placing or hanging the test panels in an approximately vertical position so that the distance between the faces of adjacent panels is at least 20 mm.

NOTE — If a cabinet with automatic humidity control is not available, the specified humidity may be obtained by means of a saturated aqueous solution of ammonium sulfate. This gives a constant relative humidity of 79 % at 40 °C (see ISO/R 483). Further details and guidance are given in annex A.

7 Sampling

Take a representative sample of the product to be tested (or of each product in the case of a multi-coat system) as described in ISO 1512.

Examine and prepare the sample for testing as described in ISO 1513.

8 Test panels

8.1 Material and dimensions

Unless otherwise specified or agreed the test panels shall be of burnished steel complying with the requirements of ISO 1514 and approximately 150 mm × 100 mm.

8.2 Preparation and coating

Burnish the test panels as described in ISO 1514, unless otherwise specified, and then coat them by the specified method with the product or system under test.

Protect the back and edges of each panel with the product or system under test or, for example, with a suitable anti-corrosive paint.

8.3 Thickness of coating

Determine the thickness, in micrometres, of the dry coating on each panel by one of the procedures described in ISO 2808.

NOTE — It may be preferable to use one of the non-destructive procedures given in ISO 2808.

9 Procedure

Carry out the following procedure on at least two panels.

9.1 Scribing the test panels

Using a suitable tool (see the note), make two scribed marks at least 50 mm long on each test panel. Make the scribed marks perpendicular to each other and arranged in such a way that their distance from each other or from the edge of the panel is not less than 20 mm (see figure 1). Ensure that the cutting edge completely penetrates the coating. Remove the debris from the scribed marks. Ensure that the metal is clearly visible over the entire length of the scribed marks.

NOTE — The precise nature of the scribing tool is not critical provided that it produces a thin line with well-defined edges. A sharp blade or the single cutter defined in ISO 2409 have been found to be suitable.

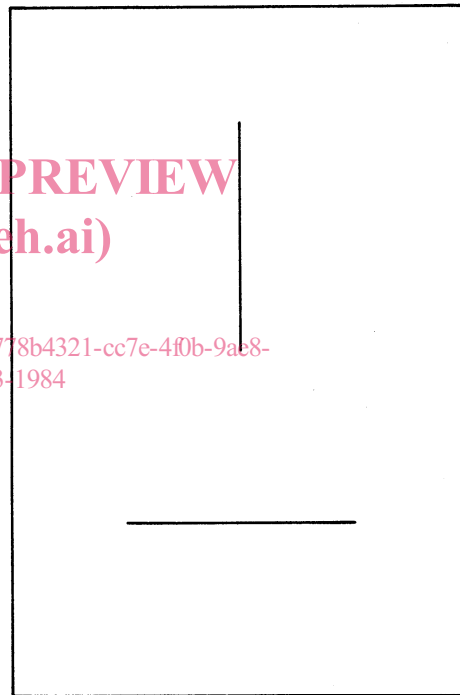


Figure 1 — Position of scribed marks on test panel

9.2 Testing

NOTE — Two alternative procedures are available, based on initiation by dipping in sodium chloride solution or exposure to salt-fog respectively. The dipping technique is generally preferable for air-drying and low-durability materials. For high-durability systems such as automobile finishes applied to phosphated steel, the dipping technique may not produce filiform corrosion and for these systems it is preferable to adopt the salt-fog technique. In such cases, the necessary period of exposure to salt-fog will depend on the durability of the material under test but should rarely need to exceed 24 h.

It should be noted that salt-fog exposure is not normally suitable for low-durability materials since with such systems it commonly produces heavy general corrosion spreading from the scribed marks and the filiform corrosion is suppressed.

9.2.1 Dipping technique

Immerse the scribed test panels for 30 to 60 s in the sodium chloride solution (5.1).

Take the panels out of the solution and remove any drops of liquid remaining on the surface, taking care not to remove the solution from the scribed marks.

Place the panels in the test cabinet (clause 6) maintained at 40 ± 2 °C and 80 ± 5 % relative humidity. Repeat the immersion procedure, as specified above, every 3 or 4 days until the end of the specified or agreed test period.

9.2.2 Salt-fog technique

Expose the scribed test panels to neutral salt-fog as described in ISO 7253 for the agreed period.

Take the panels out of the salt-fog cabinet and remove any drops of liquid remaining on the surface, taking care not to remove the solution from the scribed marks.

Place the panels in the test cabinet (clause 6) maintained at 40 ± 2 °C and 80 ± 5 % relative humidity for the specified or agreed test period.

9.3 Inspection of test panels

Where appropriate, at the specified intervals of re-immersion and on completion of the test, inspect the test panels for filiform corrosion. Do not allow the test panels to become thoroughly dry at any time during the test period or during inspection, as this may affect the development of the filiform corrosion. If appropriate, at the end of the test period remove the coating from the test area with a non-corrosive paint remover and inspect the substrate.

10 Evaluation of the degree of filiform corrosion

Evaluation of the degree of filiform corrosion should normally be carried out subjectively and reported in general terms such as "slight, moderate or severe". However, for critical comparisons of materials, tested on the same substrate within a single laboratory, the mathematical treatment described in annex B may be employed.

NOTE — Photographs of the test panels at the conclusion of the test may be advantageous in assessing the extent of filiform corrosion.

11 Test report

The test report shall contain at least the following information :

- a) the type and identification of the product tested;
- b) a reference to this International Standard (ISO 4623);
- c) the items of supplementary information referred to in the introduction to this International Standard;
- d) the (inter)national standard or other document supplying the information referred to in c) above;
- e) the test period;
- f) the degree of filiform corrosion at the specified test period and, if determined, the maximum extent M and the majority extent m (see annex B);
- g) any deviations, by agreement or otherwise, from the test procedure described;
- h) the dates of the test.

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Annex A

Notes for guidance on maintaining exposure conditions using saturated ammonium sulfate solution

A.1 General arrangements

A shallow dish filled with distilled or demineralized water and an excess of ammonium sulfate should be placed at the bottom of the cabinet which shall be airtight. A suitable arrangement is for the test cabinet to consist of a glass tank with a flat ground lip, closed with a plane sheet of glass. Alternatively, a desiccator vessel may be used, containing the saturated ammonium sulfate solution in the lower portion, in place of the desiccant. The test cabinet may be maintained at the specified temperature by placing it in a suitable laboratory oven.

A.2 Precautions

The following precautions need to be taken in order to ensure that the specified exposure conditions are maintained.

A.2.1 The dish containing the saturated ammonium sulfate solution should cover the greater part of the bottom of the cabinet but should not interfere with the arrangements for heating and air circulation.

A.2.2 The ammonium sulfate solution shall remain saturated. It is advisable to ensure that the solution is saturated at 50 °C and then allow it to cool to the specified test temperature.

A.2.3 The ammonium sulfate solution and the air in the test cabinet shall be at the same temperature. The solution should therefore not be separately heated.

A.2.4 The test panels should be as close as possible to the ammonium sulfate solution but shall not be allowed to come into contact with it.

A.2.5 The temperature and relative humidity should be measured inside the closed test cabinet.

A.2.6 The test cabinet should be as small as possible to assist in maintaining equilibrium. Cabinets much larger than 10 dm³ may need to be provided with air circulation. Observation of the relative humidity in the cabinet will indicate whether this is necessary.

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Annex B

Method for the quantitative evaluation of the degree of filiform corrosion

B.1 Maximum extent M

Measure the maximum distances M_L and M_R , in millimetres, from the scribed mark to the point to which the filiform corrosion has developed on the left side and on the right side respectively [see figure 2a)].

Calculate the mean M of the values M_L and M_R .

B.2 Majority extent m

Estimate the distances m_L and m_R , in millimetres, to which the majority of filiform threads have developed from the scribed line on the left and right sides respectively [see figure 2a)].

Calculate the mean m .

NOTE — If the filiform corrosion has developed in a very irregular pattern, the majority extent at one or both sides of the scribed mark (m_L and/or m_R) may be difficult to assess by direct measurement. It can be established in such cases by first measuring the extent of the corrosion at separate parts of the scribed mark and then calculating the overall value from the subvalues obtained at these parts [see figure 2b)].

The following equations may be used to calculate the values of m_L and m_R and, hence, m :

$$m_L = \frac{x_1 m_{L1} + x_2 m_{L2} + x_3 m_{L3} + x_4 m_{L4}}{Z}$$

$$m_R = \frac{y_1 m_{R1} + y_2 m_{R2} + y_3 m_{R3} + y_4 m_{R4}}{Z}$$

where the terms m_{L1} , m_{R1} , x_1 , y_1 , etc., and Z are defined as shown in figure 2b).

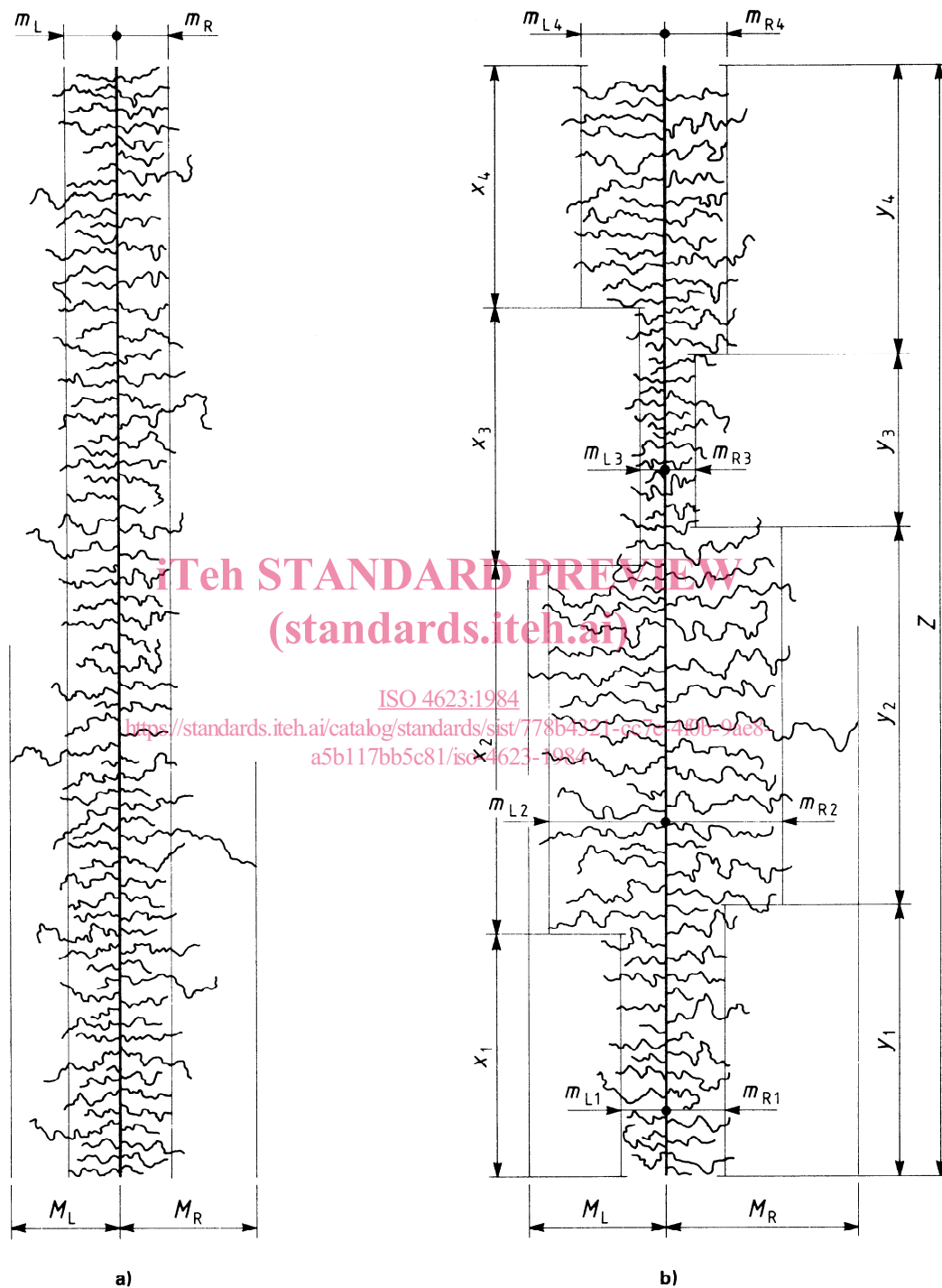


Figure 2 — Determination of maximum extent M and majority extent m

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