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Standard Guide for Testing Filiform Corrosion Resistance of Organic Coatings on Metal[1]

This standard is issued under the fixed designation D2803; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This guide covers three procedures for determining the susceptibility of organic-coated metal substrates to formation of filiform corrosion.

1.2 This guide is limited to the determination of whether filiform corrosion will occur between the organic coating and substrate.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

NOTE 1—Procedure B of this standard is equivalent to ISO 4623.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B117 Practice for Operating Salt Spray (Fog) Apparatus

D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products

D823 Practices for Producing Films of Uniform Thickness of Paint, Coatings and Related Products on Test Panels

D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers

D1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

D1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting

D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

E104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions

2.2 *International Standard:*[3]

ISO 4623–1 Paints and Varnishes—Determination of resistance to filiform corrosion–Part 1: On steel

ISO 4623–2 Paints and Varnishes—Determination of resistance to filiform corrosion–Part 2: On aluminum

ISO 4628–10 Paints and Varnishes—Evaluation of degradation of coatings—Designation of quantity and size of defects and of intensity of changes–Part 10: Assessment of filiform corrosion

3. Terminology

3.1 *Definitions:*

3.1.1 *filiform corrosion, n*—a special type of corrosion that occurs under coatings on metal substrates that is characterized by a definite threadlike structure and directional growth.

3.1.1.1 *Discussion*—Filiform corrosion usually occurs between 20 and 35°C (70 and 95°F), with a corresponding relative humidity range of 60 to 95 %; above 95 % humidity, blistering rather than filiform corrosion may occur.

4. Summary of Method

4.1 Coated metal specimens are scribed and placed in a corrosive atmosphere to initiate corrosion. The specimens are then exposed to controlled temperature and humidity conditions known to be conducive to filiform corrosion.

[1] This guide is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.27 on Accelerated Testing.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

4.2 In Procedure A, panels are subjected to a preliminary exposure in the salt spray cabinet to initiate corrosion, rinsed, and placed in a humidity cabinet. In Procedure B, based on ISO 4623, panels are either exposed to salt spray or dipped in a salt solution but not rinsed before placing in the humidity cabinet operated at a higher temperature than in Procedure A. In Procedure C, specimens are exposed as in Procedure A except the humidity cabinet is operated at a higher temperature.

4.3 The procedures contained in this guide differ significantly in method of initiation, and or temperature, or both, and humidity of exposure and therefore may not yield comparable results.

5. Significance and Use

5.1 Some organic coatings applied to metal substrates exhibit filiform corrosion when there is a break in the coating film and the relative humidity is in the 70 to 95 % range.

5.2 This guide can be used to determine the susceptibility of organic coated metal substrates to the formation of filiform corrosion.

6. Apparatus

6.1 *Salt-Spray Chamber* as described in Practice B117, for salt-spray (fog) testing.

NOTE 2—The preferred initiator of corrosion at the scribe is the salt-fog atmosphere described in Practice B117. Exposure of the specimens for 2 to 4 h in a closed cabinet to the atmosphere above a 1 % acetic acid solution is an acceptable alternative.

6.2 *Humidity Cabinet*—Any cabinet with suitable temperature and humidity controls with air circulation may be used. The size and detailed construction of the apparatus are optional, provided the conditions meet the requirements of this method.

7. Test Specimen

7.1 The composition, surface preparation, and number of test specimens shall be agreed upon between the producer and the user. Steel is the preferred substrate, but other metals such as aluminum, copper magnesium, and stainless steel may be used. Zinc and zinc-coated steel are not recommended because filiform corrosion generally does not occur on zinc.

NOTE 3—Applicable test panel description and surface preparation methods are given in Practice D609 and Practices D1730.

7.2 *Preparation of Test Specimens*—The method of application, film thickness, curing, and conditioning shall be agreed upon between the producer and user.

NOTE 4—Practices D823 gives application methods that can be used to produce films of uniform film thickness.

NOTE 5—Test Method D1005 and Practice D7091 give procedures that can be used for measurement of dry film thickness.

7.3 Scribe the test specimen in accordance with Test Method D1654 or as agreed upon between the producer and user.

7.4 The back and edges of the panel should be protected with an anti-corrosion coating or tape, unless edge failure is being evaluated.

8. Use of Control or Reference Materials

8.1 When several coatings are being compared, select a coating as a control. Apply the control coating to the same substrate as the test coatings. For best results there should be two controls, one known to perform well and one known to perform poorly.

9. Procedure A

9.1 Expose the test specimens to the salt-fog atmosphere in accordance with Practice B117 for at least 4 h and not more than 24 h, or as agreed upon between the producer and user.

9.2 Remove from the salt-fog cabinet and thoroughly rinse with distilled or demineralized water. Do not permit specimens to dry before placing in the humidity cabinet.

9.3 Place the specimens in the humidity cabinet so that they are no closer together than 40 mm (1.5 in.) and not in contact with any metal. Set the cabinet to operate at 25°C (77°F) and 85 % relative humidity unless otherwise agreed upon between the producer and user. The allowed operational limits are ±2°C (±3.5°F) and ±10 % relative humidity.

NOTE 6—The recommended means of maintaining the specified relative humidity is to utilize trays of saturated potassium chromate solution (650 g/L). Practice E104 describes other methods for maintaining relative humidity, but they may affect the degree and rate of filiform corrosion.

9.4 Inspect the specimens at intervals of approximately 168 h for development of threadlike filaments from the scribe. Exercise care to maintain wetness of specimens during inspection, since drying stops the original pattern of filiform corrosion. New filiform may develop on continued exposure but at different points.

9.4.1 Filiform corrosion will be noted as threadlike filaments (see Note 7), initiating at the scribe. A standard method of rating failure due to filiform is not available. The uniformity of filament growth in direction, width, height and frequency precludes a precise rating system. Photographs of filiform failure are preferred for recording test results. Otherwise, a brief description of the filament growth and their frequency can be made. ISO 4628–10 provides a method for the measurement of filiform filaments. Filiform corrosion may continue to develop after specimens are removed from the humidity cabinet.

NOTE 7—The nature of grinding and grain direction on panels can influence the direction of filiform growth.

9.5 The normal test period is 6 weeks (1008 h). Other periods may be used at the option of the producer and user.

10. Procedure B (ISO 4623)

10.1 Two alternative initiations of corrosion are available, based on initiation by dipping in sodium chloride solution (see Note 8) or exposure to salt fog. The dipping technique is generally preferable for air drying and low-durability materials. For high-durability systems such as automotive 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