Designation: D870 – 15

Standard Practice for Testing Water Resistance of Coatings Using Water Immersion[1]

This standard is issued under the fixed designation D870; 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.

1. Scope*

1.1 This practice covers the basic principles and operating procedures for testing water resistance of coatings by the partial or complete immersion of coated specimens in distilled or de-mineralized water at ambient or elevated temperatures. Although the apparatus and procedure could be employed in immersion tests using solutions of various materials in water, this practice is limited to tests in water alone.

1.2 This practice is limited to the methods of obtaining, measuring, and controlling the conditions and procedures of water immersion tests. It does not specify specimen preparation, specific test conditions, or evaluation of results.

NOTE 1—Alternative practices for testing the water resistance of coatings include Practices D1735, D2247, and D4585.

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

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

D610 Practice for Evaluating Degree of Rusting on Painted Steel Surfaces

D714 Test Method for Evaluating Degree of Blistering of Paints

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

D1193 Specification for Reagent Water

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

D1735 Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus

D2247 Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity

D2616 Test Method for Evaluation of Visual Color Difference With a Gray Scale

D3359 Test Methods for Measuring Adhesion by Tape Test

D3363 Test Method for Film Hardness by Pencil Test

D4541 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

D4585 Practice for Testing Water Resistance of Coatings Using Controlled Condensation

3. Summary of Practice

3.1 Coated specimens are partially or wholly immersed in water in a container that is resistant to corrosion. The exposure conditions are varied by selecting: (*a*) the temperature of the water, and (*b*) the duration of the test. Water permeates the coating at rates that are dependent upon the characteristics of the coating and upon the temperature of the water. Any effects such as color change, blistering, loss of adhesion, softening, or embrittlement are observed and reported.

4. Significance and Use

4.1 Immersion in water can cause the degradation of coatings. Knowledge on how a coating resists water immersion is helpful in predicting its service life. Failure in a water immersion test may be caused by a number of factors including a deficiency in the coating itself, contamination of the substrate, or inadequate surface preparation. The test is therefore useful for evaluating coatings alone or complete coating systems.

4.2 Water immersion tests are used for research and development of coatings and substrate treatments, specification acceptance, and quality control in manufacturing. These tests

[1] This practice 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.

***A Summary of Changes section appears at the end of this standard**

typically result in a pass or fail determination, but the degree of failure may also be measured. A coating system is considered to pass if there is no evidence of water-related failure after a specified period of time.

4.3 Results obtained from water immersion tests in accordance with this practice should not be represented as being equivalent to a period of exposure to water in the natural environment, until the degree of quantitative correlation has been established for the coating or coating system.

4.4 Corrosion tests of a scribed coating on a ferrous substrate are impractical in water immersion tests as the corrosion products tend to contaminate the water bath. Continuous overflow of the test tank is sometimes required to maintain consistent water quality.

4.5 The apparatus for the test is relatively inexpensive and can be as simple as a glass beaker with a stirrer. It is also possible to use very large tanks for testing coated pipe or other large coated products.

5. Apparatus

5.1 *Tank Cover,* required for some test specifications. The cover is not to touch the test specimens. The reason for the cover is to help maintain water temperature and water level.

5.2 *Gabled Cover for Tank*—The cover should be made of corrosion-resistant materials. The cover should not touch any of the test specimens nor interfere with the air circulation around the specimens.

5.3 *System,* for circulation of the water with pressurized air, a stirrer, or a pump.

5.4 *Supports for the Test Specimens,* constructed of nonconductive materials to hold the specimens 30 mm apart and 30 mm from the bottom and sidewalls of the tank.

NOTE 2—The circulating system is for the purpose of exposing all the water in the tank to room air so the water does not become stratified and oxygen-depleted at the lower levels.

6. Test Specimens

6.1 This practice does not cover the preparation of test specimens. The substrate composition and surface preparation, specimen preparation, and the number of specimens should be agreed upon prior to testing.

NOTE 3—Applicable methods for the preparation of test panels and substrates are given in Practices D609 and D1730. Practices D823 covers application techniques for the production of uniform films.

6.2 It is recommended that a control specimen of a paint with known durability be included with each test. Such control specimens can provide warning of changes in test severity in a given apparatus, and can indicate variations in test severity between different apparatuses.

6.3 It is recommended that at least two replicate specimens of each different coating be used, to compensate for variations between specimens and variations in test conditions within the apparatus.

7. Procedure

7.1 Fill the tank with water to a depth such that the test specimens are immersed for approximately three-quarters of their length. Reagent water conforming to Type IV of Specification D1193 is suitable for use.

7.2 Heat the water to the desired temperature with the circulating system in operation. If no temperature is specified, heat the water to 38 ± 2°C (100 ± 4°F). Maintain the temperature throughout the test.

7.2.1 Other temperatures that are commonly used are 32°C (90°F) and 40°C (104°F).

7.2.2 During equilibrium conditions, the maximum allowable deviation from the desired water temperature indicated by the device or display measuring water temperature is ±2°C (±4°F). If the display shows a water temperature outside these limits, stop the test and correct the problem before proceeding.

7.2.3 For some tests where increased oxygen content of the water is desired to accelerate failure, air may be bubbled through the water. When air is bubbled through the water, the minimum rate for introduction of air shall be one bubble per second through a 6 mm hose made of a material that does not contaminate the DI water.

7.3 Place the test specimens in the tank so that the plane of the specimens is parallel to the flow of water in the tank. Protect the edges and backs of the specimens from corrosion if these surfaces are not to be tested.

7.3.1 To control for variability within the apparatus, reposition the specimens on a regular basis so that all specimens spend equivalent amounts of time in the various areas of the apparatus (front, back, left, right, and center).

7.4 Replace the water if it becomes cloudy or colored. Continuous replacement of the water is permitted. If needed , add water to maintain original water level.

7.4.1 Measure water conductivity once per week. Replace the water if conductivity is greater than 20 µS/cm at 20°C (resistivity less than 50 kΩ/cm). Alternatively change the water once per week without measuring conductivity.

7.5 Conclude the test after a specified period of time, or after effects from water immersion have been observed.

7.6 Wipe the test specimens dry. Rate specimens for changes in color, blistering, etc. Evaluate specimens no less than 5 min and no more than 10 min after removal from test, as the effects from water exposure can change within a short time. Remove only as many specimens as can be rated within the specified time.

NOTE 4—The 0 to 10 scale described in ASTM STP 500[3] is preferred for rating. Relevant procedures for evaluating water effects are described in Test Methods D610, D714, D1654, D2616, D3359, D3363, and D4541.

7.6.1 If possible, rate the specimens again after they have been removed from the test for a recovery period long enough that moisture absorbed within the specimens dries out and the specimens reach moisture equilibrium with room air. A recovery period from 12 to 24 h is generally sufficient. The post-recovery rating allows evaluation of the permanent effects of the exposure as distinct from the transient effects, and is especially important for evaluation of color and gloss.

[3] *Paint and Coating Testing Manual*, 14th ed., ASTM, 1995.

8. Report

8.1 Report the following information:
8.1.1 Sample identification.
8.1.2 Results of the evaluation(s).
8.1.3 Reference to Practice D870.
8.1.4 Hours of test duration.
8.1.5 Test temperature.
8.1.6 Brief description of water quality and water replacement procedure.
8.1.7 Special conditions of test or any deviations in test procedure.

9. Keywords

9.1 adhesion; blistering; immersion; resistance-water; rust

SUMMARY OF CHANGES

Committee D01 has identified the location of selected changes to this standard since the last issue (D870–09) that may impact the use of this standard. (Approved February 1, 2015.)

(1) Replaced 32.2°C in section 7.2.1 with 32°C.