Designation: D2454 – 14

Standard Practice for Determining the Effect of Overbaking on Organic Coatings[1]

This standard is issued under the fixed designation D2454; 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 determination of the time-temperature effect of overbaking on the physical and chemical properties of organic coatings.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D522 Test Methods for Mandrel Bend Test of Attached Organic Coatings

D523 Test Method for Specular Gloss

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, Varnish, and Related Products on Test Panels

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

D1308 Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes

D1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature

D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials

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

D1731 Practices for Preparation of Hot-Dip Aluminum Surfaces for Painting

D2197 Test Method for Adhesion of Organic Coatings by Scrape Adhesion

D2201 Practice for Preparation of Zinc-Coated and Zinc-Alloy-Coated Steel Panels for Testing Paint and Related Coating Products

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D2794 Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)

D3359 Test Methods for Measuring Adhesion by Tape Test

D3363 Test Method for Film Hardness by Pencil Test

D6386 Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware 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

D7396 Guide for Preparation of New, Continuous Zinc-Coated (Galvanized) Steel Surfaces for Painting

E805 Practice for Identification of Instrumental Methods of Color or Color-Difference Measurement of Materials

3. Terminology

3.1 *Definitions:*

3.1.1 *overbaking, n*—an exposure of the coating to a moderately higher temperature or to a longer period of baking, or both, than recommended by the manufacturer of the coating for normal curing.

3.1.1.1 *Discussion*—This condition is in contrast to "heat resistance" which is a parameter relating to the service life of a coating.

4. Summary of Practice

4.1 Four panels are prepared and baked at the schedule normally recommended for the coating. Two of the panels are then removed and the remaining two are subjected to an additional overbake in which the time and temperature are mutually agreed upon between the purchaser and the seller. The sets of panels, after a suitable conditioning interval, are

[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.

Current edition approved Feb. 1, 2014. Published March 2014. Originally approved in 1966. Last previous edition approved in 2008 as D2454 – 08. DOI: 10.1520/D2454-14.

[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

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then evaluated for the properties that are compatible with the substrate. Among these are gloss, color, flexibility, adhesion, impact resistance, and resistance to reagents. Note that glass substrates should not be tested for impact, and zinc-coated substrates can influence both flexibility and impact.

5. Significance and Use

5.1 Most coatings are designed for a specific baking time and temperature. For a variety of reasons (line stoppages, rerouting back through ovens, oven overheating, etc.) the prescribed time or temperature, or both, of the bake is often exceeded. This practice has been found to be useful in evaluating the effects of overbakes on coatings.

6. Materials

6.1 *Standard Baking-Type Coating* mutually agreed upon between the purchaser and the seller.

7. Hazards

7.1 The flash points of most solvents used in many organic coatings and related products are low enough that adequate ventilation is needed to avoid exceeding 25 % of the lower explosive limits of the solvents when test panels are being prepared and baked. As these materials are considered toxic, take care to avoid inhalation of solvent vapor and unnecessary contact of solvent with the skin.

8. Procedure

8.1 *Application of Organic Coating:*

8.1.1 Apply coatings to steel panels prepared in accordance with Practice D609.

8.1.2 Apply coatings to zinc-coated surfaces prepared in accordance with Guide D7396 or Practice D6386, when zinc has been applied by the hot-dip method or by electroplating.

8.1.3 Apply coatings to nonpassivated galvanized steel prepared in accordance with Guide D7396 Practice D2201, when the zinc is applied by a continuous galvanizing method using an aluminum-bearing zinc.

8.1.4 Apply coatings to aluminum surfaces on all-aluminum materials prepared in accordance with Practices D1730.

8.1.5 Apply coatings to hot-dip aluminum coated surfaces prepared in accordance with Practices D1731.

8.1.6 In cases where a primer is used in practice under the topcoat, apply the entire system to the panels. The film thickness of each coat shall be mutually agreed upon between the purchaser and seller, but, in the absence of such agreement, the total thickness shall be 2 ± 0.2 mils (50 ± 5 µm).

8.1.7 In instances where clear coatings are to be tested, they may be applied to aluminum or white carrara glass, one side of which has been polished to a smooth, high-gloss finish. Other selected substrata previously agreed upon between the purchaser and the seller may also be used. In the absence of a specific agreement between the purchaser and the seller in regard to film thickness, apply the coatings by automatic spray. (Refer to Practices D823, Method A) at a dry film thickness of 2 ± 0.2 mils (50 ± 5 µm). Multiple coats may be used to obtain this film thickness where necessary due to the nature of the coating material (Note 1). Manual spray application or the drawdown method with wire-wound draw bars may be used when automatic equipment is not available.

NOTE 1—Dry film thickness should be measured in accordance with Test Method D1005 or Practice D7091, whichever is applicable. The adhesion, flexibility, and color can vary considerably with thickness.

8.2 *Baking:*

8.2.1 The baking schedule for each coating including primer, topcoat, and primer/topcoat systems shall be mutually agreed upon between the purchaser and the seller and shall include the following:

8.2.1.1 *Normal Baking Schedule (Time and Temperature)* recommended for the development of optimum film properties, and

8.2.1.2 *Overbaking Cycle*—This cycle shall be within practical limits in order to simulate conditions that might be encountered in actual production where baking oven or conveyor lines, or both might malfunction temporarily due to mechanical or electrical failure.

8.3 Prepare four panels of each coating or coating system and bake them at the schedule normally recommended to obtain optimum properties. Conduct the baking of these panels in a mechanical recirculating air oven set to ±2°C of the specified baking temperature. At the end of the specified time remove two panels from the oven and subject the remaining two to the overbake cycle by:

8.3.1 A continuation of the normal bake but for a previously agreed upon time, for example, 50 or 100 % increase in time, or

8.3.2 Resetting the oven temperature to the agreed overbake temperature and then continuing the bake for a specified period of time after the overbake temperature has been reached, or removing the panels until the overbake temperature is reached and then baking them for the agreed upon time.

NOTE 2—The conditions described in 8.3.2 are not usually reproducible between laboratories or different ovens because of variations in the heating characteristics of ovens.

8.3.3 After the sets of panels have been baked according to the mutually agreed upon baking cycles, place them in a suitable rack and condition for 24 h at 23 ± 2°C and 50 ± 5 % relative humidity (see Test Methods D1640) prior to testing. Other conditioning terms may be agreed upon between the purchaser and the seller.

9. Test Methods

9.1 Determine the properties of both sets of panels in accordance with any or all of the following ASTM methods:

9.1.1 *Gloss*—Test Method D523.

9.1.2 *Color*—Practice D1729 (Visual), Practice E805 (instrumental), or Practice D2244.

9.1.3 *Flexibility*—Test Methods D522 (conical mandrel and cylindrical mandrel).

9.1.3.1 Heat-aged flexibility values should be determined in accordance with a baking cycle that is in agreement between the purchaser and the seller.

9.1.4 *Adhesion*—Test Methods D2197[3] (mechanical) or D3359 (tape), or both.

[3] This test method has been found to be inapplicable for powder coatings.

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9.1.5 *Impact Resistance*—Test Method D2794.[4]

9.1.6 *Hardness*—Test Method D3363 (pencil test).

9.1.7 *Exposure to Reagents*—If this test is desired, the choice of materials to which the coating is to be exposed shall be governed by the ultimate use of the coating and shall be agreed upon between the purchaser and the seller. The general procedure to be followed in this test is given in Test Method D1308.

9.1.8 Other tests agreed upon between the purchaser and the seller.

[4] It is suggested that impact resistance be determined by use of the Gardner Variable Impact Tester obtainable from the Gardner Laboratory, Inc., Bethesda, MD.

10. Report

10.1 Report the following information:

10.1.1 Substrate employed, including type and thickness,

10.1.2 Type of coating,

10.1.3 Film thickness, including primer, if any,

10.1.4 Normal bake schedule, or schedules,

10.1.5 Overbake cycle,

10.1.6 Test methods employed, and

10.1.7 Values determined, including the measured changes between the normal and overbake cycles.

11. Keywords

11.1 effect of overbake; organic coatings; overbake

SUMMARY OF CHANGES

Committee D01 has identified the location of selected changes to this standard since the last issue (D2454–08) that may impact the use of this standard. (Approved February 1, 2014.)

(1) Deleted D1400 and D2092 from Section 2.

(2) Added D6386 and D7396 to Section 2.

(3) Added keywords.

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