Designation: ~~D4060 – 14~~ D4060 – 19

Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser[1]

This standard is issued under the fixed designation D4060; 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 test method covers the determination of the resistance of organic coatings to abrasion produced by the Taber Abraser on coatings applied to a plane, rigid surface, such as a metal panel.

1.2 The values stated in SI units are to be regarded as the standard, with the exception of mils when determining coating thickness.

1.3 This standard is similar in content (but not technically equivalent) to ISO 7784–2.

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~~ safety, health, and ~~health~~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]

D16 Terminology for Paint, Related Coatings, Materials, and Applications

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

D968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive

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

~~D2240~~D1475 Test Method for ~~Rubber Property—Durometer Hardness~~Density of Liquid Coatings, Inks, and Related Products

D3924 Specification for Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials (Withdrawn 2016)[3]

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

G195 Guide for Conducting Wear Tests Using a Rotary Platform Abraser

2.2 *Other Standards:*

ISO 7784–2 Paints and varnishes—Determination of resistance to abrasion—Part 2: Rotating abrasive rubber wheel method[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 Abrasion resistance can be expressed as one or more of the following terms:

3.1.2 *wear index, n*—~~1000 times~~ the average loss in weight in milligrams per ~~cycle.~~thousand cycles of abrasion.

3.1.3 *weight loss, n*—the loss in weight in milligrams, determined at a specified number of cycles.

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[1] This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.23 on Physical Properties of Applied Paint Films.

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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] The last approved version of this historical standard is referenced on www.astm.org.

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

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

3.1.4 *wear cycles per mil, n*—the number of cycles of abrasion required to wear a film through to the substrate per mil (0.001 in.) of film thickness.

3.2 For definitions of other terms used in this standard, refer to Terminology D16.

4. Summary of Test Method

4.1 The organic coating is applied at uniform thickness to a plane, rigid panel and, after curing, the surface is abraded using rotary rubbing action under controlled conditions of pressure and abrasive action. The test specimen, mounted on a turntable platform, turns on a vertical axis, against the sliding rotation of two abrading wheels. The wheels shall be mounted in such a way that when they are in contact with the rotating test specimen, they rotate in opposing directions. One abrading wheel rubs the specimen outward toward the periphery and the other, inward toward the center. The resulting abrasion marks form a pattern of crossed arcs over an area of approximately ~~30 cm~~30 cm^2.

4.2 Abrasion resistance is calculated as loss in weight at a specified number of abrasion cycles, as average loss in weight per ~~cycle,~~ thousand cycles of abrasion, or as number of cycles required to remove a unit amount of coating thickness.

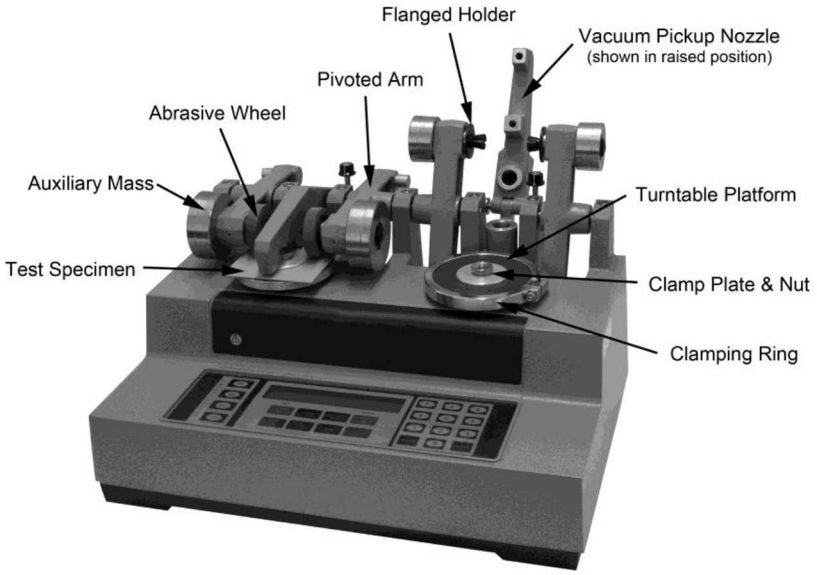
5. Significance and Use

5.1 Coating on substrates can be damaged by abrasion during ~~manufacturing and service.~~its service life. This test method has been useful in evaluating the abrasion resistance of coatings. Ratings produced by this test method have correlated well with ratings produced by the falling abrasive values in Test Method D968.

5.2 For some materials, abrasion tests utilizing the Taber Abraser may be subject to variation due to changes in the abrasive characteristics of the wheel during testing. Depending on abradant type and test specimen, the wheel surface may change (that is, become clogged) due to the adhesion of debris generated during the test and must be resurfaced at more frequent intervals as agreed upon by the interested parties. To determine if more frequent resurfacing is required, plot the total weight loss every 50 cycles. If a significant negative change in slope is observed prior to 500 cycles, the point at which the slope changes determines the resurfacing frequency.

5.3 When evaluating resistance to abrasion of two or more coatings, other factors may need to be considered for an accurate comparison. Flexible coatings that include air entrainment bubbles could alter the mass loss during comparison tests. Coatings that include dense fillers may result in greater mass loss but have less change in coating thickness. Coatings that include silica, metal oxides or other extremely dense particulates, may wear the abrasive wheel. Wear debris that includes extremely dense particulates may cause three-body abrasion that contributes to the break-down of the coating if not removed by the vacuum suction system. Coatings that have a hardness value or coefficient of friction greater than the abrasive wheel may cause the abrasive wheel to break down faster. Coatings that have different coefficient of friction ratings, must be taken into consideration during comparison tests. Examples of coatings that may be impacted include, but are not limited to; epoxies, polymethyl-methacrylate (PMMA), polyurethane-methacrylate (PUMA), methyl-methacrylate (MMA), and carbon resin.

NOTE 1—*Example*—A urethane coating of 20 mil thickness, embedded with 1.2 µm titanium particles resulted in a 2.1 mil loss in coating thickness



Note: Vacuum Suction System not shown.

FIG. 1 Taber Abraser

and 110 mg mass loss. A similar urethane coating without titanium particles, resulted in a 2.9 mil to 3.1 mil loss in coating thickness and 44 mg mass loss.

6. Apparatus

6.1 *Taber Abraser*[5] (Fig. 1), as described in Guide G195 and consisting of the following elements:

6.1.1 A horizontal turntable platform; comprised of a rubber pad, clamp plate, and nut to secure the specimen to the turntable. A clamping ring is provided to secure the resurfacing ~~medium~~medium.

6.1.2 A motor capable of rotating the turntable platform at a speed of either 72 r/min ± 2 r/min for 110v/60Hz or 60 r/min ± 2 r/min for ~~230v/50Hz,~~230v/50Hz.

6.1.3 A pair of pivoted arms, to which the abrasive wheels and auxiliary masses may be attached; loads of ~~250, 500,~~ 250 g, 500 g, or 1000 g on each wheel may be obtained by use of these changeable masses. Counterweight attachments of 125 g or 175 g are available to reduce the load against the specimen, and can be used with or without the auxiliary masses.

NOTE 2—Without auxiliary masses or counterweights, each arm will apply a load against the specimen of 250 g per wheel (exclusive of the mass of the wheel itself).

6.1.4 A vacuum suction system and vacuum pick-up nozzle to remove debris and abrasive particles from the specimen surface during testing. The height of the vacuum pickup nozzle shall be adjustable, and the nozzle openings shall be 8 mm in diameter. The vacuum system shall operate when testing commences.

6.1.5 A counter to record the number of cycles (revolutions) made by the turntable platform.

6.2 *Abrasive ~~Wheels~~ Wheels*[6]—Resilient Calibrase wheels ~~No.~~ CS-10 or CS-17, as required, shall be used unless otherwise agreed upon by the interested parties. Because of the slow hardening of the bonding material, resilient wheels ~~should~~shall not be used after the date marked on ~~them, or one year after their purchase if the wheels are not dated.~~them.

NOTE 3—The CS-17 wheels produce a harsher abrasion than the CS-10 wheels.

6.2.1 The wheels shall be ~~12.7 ± 0.3 mm thick and have an external diameter of 51.9 ± 0.5 mm when new, and in no case less than 44.4 mm.~~cylindrically shaped, have a diameter between 52.4 mm and 44.4 mm, a width of 12.7 mm ± 0.3 mm, and an axial hole 16.0 mm ± 0.1 mm in diameter to allow the wheel to be mounted to the flanged holder on the pivoted arms.

~~NOTE 2—The hardness of the wheels can be checked by Test Method D2240. Measure at least four points equally spaced on the side surface of the wheel. The reading shall be taken 10 s after full application of the pressure, and then averaged. An acceptable hardness for both types of wheels is 81 ± 5 units on Shore Durometer A-2 Scale.~~

~~NOTE 3—The CS-17 wheels produce a harsher abrasion than the CS-10 wheels.~~

6.3 *Resurfacing Medium,* an S-11 abrasive disk, used for resurfacing the abrasion wheels. The resurfacing disk shall be silicon carbide coated abrasive with an average particle size of 92 µm (150 grit CAMI-grade), approximately 102 mm diameter with a 7 mm center hole.

7. Test Specimens

7.1 Apply a uniform coating of the material to be tested to a rigid panel having both surfaces substantially plane and parallel. Specimens shall be a disk or a square plate with a ~~6.5 mm~~ 6.5 mm hole centrally located on each panel. Typical dimensions for a test panel are 100 mm in diameter or 100 mm by 100 mm. Thickness of the specimen should be no greater than ~~6.3~~6.5 mm unless an S-21 extension nut[5] or arm height extension kit[5] is utilized. ~~Prepare a minimum of two coated panels for the material.~~

~~NOTE 4—While the minimum of two coated panels is acceptable, evaluating three or more panels per material will provide greater confidence in your test results.~~

NOTE 4—The coatings should be applied in accordance with Practices D823, or as agreed upon between the interested parties.

NOTE 5—The thickness of the dry coatings should be measured in accordance with Test Method D1005 or Practice D7091.

NOTE 6—For those materials greater than 6.3 mm but less than 12.7 mm thick, the S-21 extension nut may be used to affix the specimen to the turntable. This requires a 9.5 mm center hole in the specimen. Alternatively, an arm height extension kit will permit testing of specimens up to 40 mm thick and requires the center hole to be 14.5 mm.

8. Calibration

8.1 Verify calibration of the Taber Abraser as directed by the equipment manufacturer (see Appendix X1).

9. Standardization

9.1 To ensure that the abrading function of the wheels is maintained at a constant level, prepare the abrading wheels prior to each ~~test.~~test and after every 500 cycles unless otherwise agreed to by the interested parties.

NOTE 7—Inorganic coatings do not require the abrasive wheels to be resurfaced after every 500 test cycles.

[5] Available from Taber Industries, 455 Bryant St., North Tonawanda, NY 14120.

[6] The sole source of supply of the apparatus known to the committee at this time is Taber Industries, 455 Bryant Street, North Tonawanda, NY 14120. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.