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Standard Guide for Testing Varnishes[1]

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1. Scope

1.1 This guide covers the selection and use of procedures for testing varnishes. Some test methods are included, but most sections refer to specific ASTM test methods.

1.2 Varnishes may be applied under such diverse conditions to so many different surfaces and their dried films may be subjected to so many kinds of wear and exposure, that it is not possible to assure desired performance from a single selection of test methods and numerical results. Those skilled in varnish technology may find partial assurance of obtaining desired qualities in various types of varnishes through careful selection of the methods covered and intelligent interpretation of results.

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 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:*

D 56 Test Method for Flash Point by Tag Closed Cup Tester[2]

D 93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester[2]

D 445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)[2]

D 479 Test Method for Reactivity of Paint Liquids[3]

D 523 Test Method for Specular Gloss[4]

D 658 Test Method for Abrasion Resistance of Organic Coatings by Air Blast Abrasive[4]

D 968 Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive[4]

D 1200 Test Method for Viscosity by Ford Viscosity Cup[4]

D 1209 Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)[5]

D 1310 Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus[4]

D 1469 Test Method for Total Rosin Acids Content of Coating Vehicles[6]

D 1475 Test Method for Density of Liquid Coatings, Inks, Lacquer, and Related Products[4]

D 1542 Test Method for Qualitative Detection of Rosin in Varnishes[6]

D 1544 Test Method for Color of Transparent Liquids (Gardner Color Scale)[4]

D 1545 Test Method for Viscosity of Transparent Liquids by Bubble Time Method[6]

D 1546 Practice for Testing the Performance of Clear Floor Sealers[7]

D 1639 Test Method for Acid Value of Organic Coating Materials[6]

D 1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature[4]

D 1641 Practice for Conducting Outdoor Exposure Tests of Varnishes[7]

D 1644 Test Methods for Nonvolatile Content of Varnishes[4]

D 1647 Test Method for Resistance of Dried Films of Varnishes to Water and Alkali[6]

D 1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely Illuminated Opaque Materials[4]

D 2090 Test Method for Clarity and Cleanness of Paint and Ink Liquids[6]

D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates[4]

D 2369 Test Method for Volatile Content of Coatings[4]

D 2805 Test Method for Hiding Power of Paints by Reflectometry[4]

D 3278 Test Method for Flash Point of Liquids by Small Scale Closed Cup Apparatus[4]

D 3964 Practice for Selection of Coating Specimens for Appearance Measurements[4]

D 4039 Test Method for Reflection Haze of High-Gloss Surfaces[4]

D 4060 Test Method for Abrasion Resistance of Organic

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[2] Annual Book of ASTM Standards, Vol 05.01.

[3] Discontinued; see 1983 *Annual Book of ASTM Standards*, Vol 06.01.

[4] *Annual Book of ASTM Standards*, Vol 06.01.

[5] *Annual Book of ASTM Standards*, Vol 06.04.

[6] *Annual Book of ASTM Standards*, Vol 06.03.

[7] *Annual Book of ASTM Standards*, Vol 06.02.

Coatings by the Taber Abraser[4]
E 308 Practice for Computing the Colors of Objects by Using the CIE System[4]

LIQUID VARNISH PROPERTIES

3. Appearance

3.1 Appearance of the liquid varnish is important both for aesthetic reasons and because it indicates whether the dried film is likely to have a satisfactory appearance. Examine the liquid varnish for foreign matter, sediment or skins in accordance with Test Method D 2090.

4. Color

4.1 Most varnishes are predominantly yellow, but the color of the liquid varnish is only a preliminary indication of the color of the dried varnish film. The initial color may bleach or may darken depending upon the conditions of exposure. Determine approximately and quickly the liquid color of small specimens in Gardner-Holdt tubes by comparison with the Gardner Color Standards in accordance with Test Method D 1544.

4.2 Measure the color of extremely pale varnishes by using larger specimens in 100-mL cylinders, 300 mm deep, in accordance with Test Method D 1209.

4.3 A more precise measure of color, in terms of tristimulus values, may be made on small specimens in 10-mm cells with parallel walls in accordance with Practice E 308.

5. Viscosity

5.1 The viscosity of a varnish or clear vehicle is a property important in ease of application; varnishes for brush application are typically 1 to 2 St whereas varnishes with viscosities as high as 100 St may sometimes be added to lithography coatings or used as mixing vehicles for producing enamels. Viscosity is commonly measured at 77°F (25°C).

5.2 For the rapid, approximate measurement of the viscosity of transparent varnishes, determine the bubble time by Test Method D 1545. Report the viscosity either in stokes or in Gardner-Holdt letter designations as described in Table 1 of Test Method D 1545.

5.3 For a rapid, approximate measurement of the viscosity of translucent varnishes, determine the Ford cup efflux time in accordance with Test Method D 1200.

5.4 For the precise measurement of viscosity, use capillary viscometers as described in Test Method D 445.

6. Specific Gravity

6.1 Specific gravity of a varnish is the ratio of the weight of a given volume of the varnish at a given temperature to the weight of an equal volume of distilled water at the same temperature. Determine specific gravity or density at 77°F (25°C) or other agreed temperature in accordance with Test Method D 1475 which allows use of either a pycnometer or a weight per gallon cup.

7. Volatile Content

7.1 Volatile matter determination is an indication of the amount of material in the coating that will be given off to the atmosphere in the area where the coating is applied. Depending upon the method of application, the time required to vaporize the volatile, and the conditions of the atmosphere surrounding the application, it is recommended that Test Method D 2369 be used to determine the volatile content of a varnish.

TABLE 1 List of Test Methods

Test Method	Section	ASTM Designation
Liquid Varnish Properties:		
Appearance	3	D 2090
Color (Gardner)	4.1	D 1544
Color, Platinum-Cobalt Scale	4.2	D 1209
Color, tristimulus	4.3	E 308
Viscosity:	5	
Bubble time (Gardner-Holdt)	5.2	D 1545
Ford cup efflux	5.3	D 1200
Kinematic, high precision	5.4	D 445
Specific gravity	6	D 1475
Volatile content	7	D 2369
Nonvolatile matter	8	D 1644
Flash point:	9	
Tag closed-cup		D 56
Pensky Martens		D 93
Tag open-cup		D 1310
Setaflash closed tester		D 3278
Skinning	10	
Acid value	11	D 1639
Reactivity of paint liquids	12	D 479
Rosin content, quantitative	13	D 1469
Rosin content, qualitative (Lieberman-Storch and Halphen-Hicks)	13	D 1542
Drying and Curing Properties:		
Drying time	14	D 1640
Print free time	15	D 1640
Dry Varnish Properties:		
Gloss:	16	
Specular gloss		D 523
Reflective haze		D 4039
Resistance of dried films to water and alkali	17	D 1647
Abrasion resistance:		
Carborundum air blast	18	
Falling abrasive		D 658
Taber abraser		D 968
Exterior durability		D 4060
Color of dried film	19	D 1641
	20.1	D 2244
	20.2	D 1729
Clear floor sealers	21	D 1546

8. Nonvolatile Matter

8.1 Nonvolatile content is an indication of the amount of permanent film-forming material contained in a varnish. The normal drying of a varnish film may involve varying amounts of absorption of oxygen from the air, loss of volatile solvents, and continuing decomposition of the dried film. The net result of this process may differ somewhat from a nonvolatile determination at a temperature higher than the normal drying conditions.

8.2 With due regard to the composition of the varnish, determine the nonvolatile matter in accordance with either Method A (3 h at 220°F (105°C)) or Method B (10 min at 300°F (149°C)) of Test Methods D 1644.

8.3 As noted in Test Method D 2369, nonvolatile matter can also be calculated by subtracting the volatile content from 100.

9. Flash Point

9.1 Determine the flash point of varnishes having a viscosity of less than 9.5 cSt at 77°F (25°C) (45 SUS at 100°F) by Test Method D 56, and of varnishes having a viscosity of more than 9.5 cSt at 77°F by Test Methods D 93. Alternatively, use Test Method D 3278, which gives comparable results to Test Methods D 56, D 93, and Test Method D 1310.

NOTE 1—Due to various U.S. Government and State regulations, it is now necessary to check with appropriate departments to determine which ASTM Test Method is applicable.

10. Skinning

10.1 Varnishes, which dry by oxidation, may form a skin in a partially filled can or in a filled can that is stored for a long time. Since skins are insoluble in the varnish, they must be removed before use if a satisfactory film is to be obtained. Use the following test to determine if a varnish has an objectionable tendency to early skin formation:

10.1.1 *Container*—A wide-mouth jar with a capacity of 8 fluid oz (235 mL) and dimensions of 4½ in. (115 mm) in height and 2 in. (50 mm) in diameter.

10.1.2 *Procedure*—Measure a 6-fluid oz (180-mL) specimen of the varnish into the glass container. Screw the cover on tightly, invert the jar, and leave in an inverted position, at rest, and in the dark (placing under a box or in a drawer is satisfactory). Examine the varnish for skinning at specified time intervals.

11. Acid Value

11.1 The acid value of a varnish is an indication of reactivity with basic pigments and, within any one type of composition, may indicate conformity to a standard method of preparation. It is not a general criterion of excellence in a protective coating.

11.2 Determine the acid value in accordance with Test Method D 1639.

12. Reactivity of Paint Liquids

12.1 Reactivity of a varnish with zinc oxide is a partial indication of the stability of the consistency of enamels made from it and various basic pigments.

12.2 Determine the reactivity in accordance with Test Method D 479.

13. Rosin Content

13.1 Improper use of rosin and its derivatives is sometimes associated with inferior performance of varnishes containing them. Qualitative tests for rosin may be employed to detect the use of a significant amount in varnishes. Quantitative determination of rosin may be used to control rosin content within limits agreeable to the purchaser and the seller.

13.2 Determine the rosin content quantitatively in accordance with Test Method D 1469 and qualitatively with Test Method D 1542.

DRYING AND CURING PROPERTIES

14. Drying Time

14.1 Small variations in film thickness, air temperature and humidity, and exposure to light and other radiation may affect drying times by ±5 %.

14.2 Determine the drying stages appropriate to the varnish under test in accordance with the applicable sections of Test Methods D 1640.

15. Print-Free Time

15.1 Varnishes intended for floors, furniture, etc., are expected to bear heavy objects for long periods without marring of the surface or adhering to the object.

15.2 Determine the print-free time in accordance with that section of Test Methods D 1640.

DRY VARNISH PROPERTIES

16. Gloss

16.1 Because varnishes are transparent or translucent, gloss must be measured on films applied to a nonreflecting substrate. The usual material is plane, black glass as described in Test Method D 2805 and similar to the gloss standards used in Test Method D 523. Gloss measurements of varnishes on wood substrates are generally not valid because the reflectance of the substrate can affect the result, but comparative tests in one laboratory of different varnishes on the same substrate may be helpful.

16.2 Gloss is usually measured in accordance with Test Method D 523 using 60° geometry. For greater sensitivity in evaluating high gloss varnishes, the 20° geometry may be used or Test Method D 4039 which uses both 20° and 60° geometries.

16.3 Prepare specimens in accordance with Practice D 3964, applying the varnish to black glass panels with a film applicator that has a clearance of 3 mils (75 µm) for varnishes with a nonvolatile content of 35 % or more and 6 mils (150 µm) for those with a nonvolatile content less than 35 %.

16.4 Allow the films to dry under the conditions specified in Test Methods D 1640 for at least 24 h. For a rapid control test the films may be force dried at 120°F (50°C) for 1 h, providing it has been established that heat acceleration does not affect the gloss of the varnish.

16.5 Measure the gloss in accordance with Test Methods D 523 or D 4039 and report.

17. Resistance of Dried Films to Water and Alkali

17.1 Performance of varnish films is indicated in part by measurement of resistances of their dried films to water, alkali, and other reagents.

17.2 Determine the resistance to water and alkali in accordance with Test Method D 1647.

18. Abrasion Resistance

18.1 The durability and general performance of varnish films on floors is influenced by many factors such as mechanical properties, film thickness, and exposure to light, cleaning materials, various types of soil, and foot or vehicular traffic, so that no one set of tests are adequate to ensure universally satisfactory service.

18.2 An indication of the resistance to abrasion in service may be determined by Test Methods D 658, D 968, or D 4060.

All these test methods are suitable for interlaboratory use only when results are compared by ranking instead of numerical values.

19. Exterior Durability

19.1 Durability of varnish films varies so widely with exposure to varying conditions of atmosphere and light or other radiation, that any one set of conditions is only a preliminary indication of general durability.

19.2 Determine the exterior durability in accordance with Test Method D 1641.

20. Color of Dried Film

20.1 The color of the dry film is usually more significant than that of the liquid varnish in establishing whether the color of a varnished object will be acceptable. This can be evaluated by determining, in accordance with Test Method D 2244, the color difference of white structural glass before and after application and drying of a varnish film.

20.2 If a varnish with a dry color known to be satisfactory is available, a standard panel can be prepared and used for visual color comparison in accordance with Practice D 1729.

21. Clear Floor Sealers

21.1 Clear floor sealers are varnishes of relatively low viscosity for application to wooden or other porous surfaces and are variously used as either the sole coating or for making the substrate more uniform for application of wax, varnish, or other coatings.

21.2 Evaluate clear floor sealers in accordance with Test Method D 1546.

22. Precision

22.1 No specific precision statement is made for this guide since this information is included in the referenced methods, if available.

23. Keywords

23.1 drying and curing properties; varnish acid value; varnish flash point; varnish nonvolatile contents; varnish physical properties; varnish specific gravity; varnish volatile contents; varnish viscosity