



Designation: D4733 – 24

Standard Test Methods for Solventless Electrical Insulating Varnishes¹

This standard is issued under the fixed designation D4733; 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 These test methods cover solventless varnishes used primarily as electrical, mechanical, and environmental protection for electrical equipment.

1.2 These test methods are used on solventless varnishes that are applied by dipping (at atmospheric pressure conditions or under vacuum followed by pressure or under pressure only), spraying, or brushing for the purpose of impregnating or sealing electrical equipment. The following test methods are included:

Property Tests (Uncured):	Section
Density	7
Flash Point	8
Gel Time	9
Monomer Content	10
Rheological Properties (Non-Newtonian)	11
Rotational Viscosity	12
Performance Property Tests (cured):	
Bond Strength	13
Coating Thickness	14
Dielectric Strength	15
Dielectric Strength-Using Metal Panels	16
Permittivity and Dissipation Factor	17
Build	18

1.3 The values stated in inch-pound units are to be regarded as the standard. The values 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in 8.3, 15.5.1, and 15.5.2.

NOTE 1—This test method is related to IEC 60455. Since both methods contain multiple test procedures, many procedures are technically equivalent while others differ significantly.

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

- D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D115 Test Methods for Testing Solvent Containing Varnishes Used for Electrical Insulation
- D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
- D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation
- D374/D374M Test Methods for Thickness of Solid Electrical Insulation
- D923 Practices for Sampling Electrical Insulating Liquids
- D1475 Test Method for Density of Liquid Coatings, Inks, and Related Products
- D1711 Terminology Relating to Electrical Insulation
- D2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational Viscometer
- D2519 Test Method for Bond Strength of Electrical Insulating Varnishes by the Helical Coil Test
- D3056 Test Method for Gel Time of Solventless Varnishes
- D3278 Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus
- D3312 Test Method for Percent Reactive Monomer in Solventless Varnishes
- D3487 Specification for Mineral Insulating Liquid Used in Electrical Apparatus
- D3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials
- D6054 Practice for Conditioning Electrical Insulating Materials for Testing (Withdrawn 2012)³
- D8561 Test Method for Gel Time of Solventless Varnishes by Plunger Method

¹ These test methods are under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.01 on Electrical Insulating Products.

Current edition approved Dec. 1, 2024. Published December 2024. Originally approved in 1987. Last previous edition approved in 2017 as D4733 – 17. DOI: 10.1520/D4733-24.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. 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.

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

E176 Terminology of Fire Standards

2.2 IEC Standards:⁴

IEC 60455 Resin Based Reactive Compounds Used for Electrical Insulation

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms used in these test methods, refer to Terminology **D1711**. For definitions of terms associated with fire issues, refer to Terminology **E176**.

3.1.2 *gel time, n—of solventless varnish*, the time required at a specified temperature for a solventless varnish to be transformed from a liquid state to a gel as measured with a suitable gel time apparatus.

3.1.3 *thixotropy, n*—the property of a material to thin upon isothermal agitation and to thicken upon subsequent rest.

3.1.4 *varnish, electrical insulating, n*—a liquid resin system that is applied to and cured on electrical components providing electrical, mechanical, and environmental protection.

3.1.4.1 *Discussion*—There are two types of electrical insulating varnish—solvent-containing and solventless. The solvent-containing varnish is solution, dispersion, or emulsion of a polymer or a mixture of polymers in a volatile, nonreactable liquid. The solventless type is a liquid resin system free of volatile, nonreactable solvents.

4. Significance and Use

4.1 The test methods referenced in these test methods are useful for control purposes during the manufacture and use of solventless varnishes.

5. Sampling

5.1 Accurate sampling, whether of the complete contents or only parts thereof, is extremely important from the standpoint of evaluating the quality of the product sampled. In most cases, the detection of contaminants that are not ordinarily dispersed uniformly through the liquid being sampled such as water or solid particles, necessitates taking samples at specific locations where the contaminants are likely to be found. For a liquid having a specific gravity less than one, water and other impurities are most likely to be found on the bottom; whereas in the case of liquids having a specific gravity greater than one, these impurities are most likely to be found on the surface.

5.2 Sampling Fluids Exhibiting Newtonian Viscosity:

5.2.1 Sample solventless varnishes having an approximate viscosity of 25 cP (0.025 Pa·s) or less at 100 °F (37.8 °C) using the sampling device shown in Fig. 1 of Test Method **D923**. However, if the temperature of the material is below room temperature or if the humidity is above 75 % relative humidity, sample using an aspirator-type sampling device as shown in Fig. 2 of Test Method **D923**.

5.2.2 Sample solventless varnishes having a viscosity from 25 cP to 650 cP (0.025 Pa·s to 0.65 Pa·s) at 100 °F (37.8 °C)

and where contact with the atmosphere must be avoided, use a pressure-type sampling device as shown in Fig. 3 of Test Method **D923**.

5.2.3 Sample solventless varnishes having a viscosity above 650 cP at 100 °F at 73 °F $\pm$ 10 °F (23 °C $\pm$ 5 °C). Open the container and mix slowly so as not to entrap air. When the material is homogeneous, take samples from two or three places on the surface and mix together.

5.3 Sampling Fluids Exhibiting Non-Newtonian Viscosity:

5.3.1 Sample solventless varnishes exhibiting non-Newtonian viscosity in accordance with **5.2.3**.

5.4 Use sample containers and sampling procedures in accordance with Test Method **D923**.

5.5 When a sampling method is needed to determine whether a lot meets the requirements of a material specification, use Practice **D3636** as a guide.

6. Conditioning

6.1 Condition test specimens at standard laboratory condition as specified in Practice **D6054**.

6.2 Deaerate specimens to be used for property evaluation before curing using the vacuum technique recommended by the varnish manufacturer.

TEST METHODS

7. Density

7.1 *Scope*—This test method covers the measurement of the density using a pycnometer. It is particularly applicable where the fluid has too high a viscosity for other methods of testing density. In this test method the density will be expressed as pounds per gallon (grams per millilitre) at 70 °F to 77 °F (20 °C to 25 °C).

7.2 *Procedure*—Test for density in accordance with Test Method **D1475**.

7.3 *Report*—Report the following information:

7.3.1 Identification of the test sample,

7.3.2 The test temperature to the nearest 0.2 °F (0.1 °C),

7.3.3 Density to the nearest 0.01 lb/gal (0.001 g/mL), and

7.3.4 The mean, the range, and the number of replicate determinations.

8. Flash Point

8.1 *Scope*—This test method covers the determination of the flash point of solventless varnishes. There are two types of materials involved:

8.1.1 Those varnishes having a flash point above 230 °F (110 °C), and

8.1.2 Those varnishes having a flash point below 230 °F (110 °C).

8.2 *Summary of Test Method*—A specified amount of sample is added to the instrument. The temperature of the material is increased at a constant rate until a small flame ignites the vapor of the specimen in the tester and propagates a flame across its surface. The temperature at ignition is taken as the flash point.

⁴ Available from International Electrotechnical Commission (IEC), 3, rue de Varembe, 1st floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, <https://www.iec.ch>.