



# Standard Test Methods for Solventless Electrical Insulating Varnishes<sup>1</sup>

This standard is issued under the fixed designation D 4733; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 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 or other certain pressure), 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
Brookfield 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
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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 and health 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.

## 2. Referenced Documents

### 2.1 ASTM Standards:

- D 93 Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester<sup>2</sup>
- D 115 Test Methods for Testing Solvent Containing Varnishes Used for Electrical Insulation<sup>3</sup>
- D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee D-9 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.01 on Electrical Insulating Varnishes, Powders, and Encapsulating Compounds.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 05.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 10.01.

- at Commercial Power Frequencies<sup>3</sup>
- D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials<sup>3</sup>
- D 168 Test Method for Coke Residue of Creosote<sup>4</sup>
- D 374 Test Methods for Thickness of Solid Electrical Insulation<sup>3</sup>
- D 923 Test Method for Sampling Electrical Insulating Liquids<sup>5</sup>
- D 1475 Test Method for Density of Paint, Varnish, Lacquer, and Related Products<sup>6</sup>
- D 1674 Methods of Testing Polymerizable Embedding Compounds Used for Electrical Insulation<sup>7</sup>
- D 1711 Terminology Relating to Electrical Insulation<sup>3</sup>
- D 2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield) Viscometer<sup>6</sup>
- D 2519 Test Method for Bond Strength of Electrical Insulating Varnishes by the Helical Coil Test<sup>8</sup>
- D 3056 Test Method for Gel Time of Solventless Varnishes<sup>8</sup>
- D 3278 Test Method for Flash Point of Liquids by Small Scale Closed-Cup Apparatus<sup>6</sup>
- D 3312 Test Method for Percent Reactive Monomer in Solventless Varnishes<sup>8</sup>
- D 3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus<sup>6</sup>
- D 3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials<sup>8</sup>
- D 6054 Practice for Conditioning Electrical Insulating Materials for Testing<sup>8</sup>

## 3. Terminology

3.1 *Definitions:* For definitions of terms used in these test methods, refer to Terminology D 1711.

3.1.1 *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.

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

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 04.10.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 10.03.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 06.01.

<sup>7</sup> Discontinued; see the 1992 *Annual Book of ASTM Standards*, Vol 10.01.

<sup>8</sup> *Annual Book of ASTM Standards*, Vol 10.02.

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

3.1.3.1 *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 D 923. 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 D 923.

5.2.2 Sample solventless varnishes having a viscosity from 25 to 650 cP (0.025 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 D 923.

5.2.3 Sample solventless varnishes having a viscosity above 650 cP at 100°F at  $73 \pm 10^\circ\text{F}$  ( $23 \pm 5^\circ\text{C}$ ). 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 D 923.

5.5 When a sampling method is needed to determine whether a lot meets the requirements of a material specification, use Practice D 3636 as a guide.

#### 6. Conditioning

6.1 Condition test specimens at standard laboratory condition as specified in Practice D 6054.

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 milliliter) at 70 to 77°F (20 to 25°C).

7.2 *Procedure*—Test for density in accordance with Test Method D 1475.

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.

8.3 *This test method should be used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire hazard assessment or a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.*

8.4 *Procedure:*

8.4.1 Test the materials of 8.1.1 in accordance with Test Methods D 93.

8.4.2 Test the materials of 8.1.2 in accordance with Test Method D 3278.

8.5 *Report*—Report information in accordance with the report section of the test method used.

### 9. Gel Time

9.1 *Scope*—This test method covers the determination of gel time of a solventless varnish mixed with a reactor or catalyst and exposed to elevated temperatures.

9.2 *Significance and Use*—Knowledge of gel time is important for determining shelf life, batch uniformity, and processing characteristics.

9.3 *Procedure*—Test for gel time in accordance with Test Method D 3056.

9.4 *Report*—Report the following information: