Designation: D3377 – 04 (Reapproved 2013)

Standard Test Method for Weight Loss of Solventless Varnishes[1]

This standard is issued under the fixed designation D3377; 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 test method covers the determination of the percent weight loss of cured solventless electrical varnishes when exposed to elevated temperatures for prescribed periods of time.

1.2 Results of this test method are based on 6-mm (¼-in.) thick specimens and will not be applicable to specimens appreciably thinner or thicker than 6 mm.

1.3 The values stated in SI units are to be regarded as the standard.

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.*

NOTE 1—This standard resembles IEC 60216–2 "Guide for the determination of thermal endurance properties of electrical insulating materials. Part 2: Choice of test criteria" in a number of ways, but is not consistently similar throughout. The data obtained using either standard will possibly be technically equivalent.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1711 Terminology Relating to Electrical Insulation

D5423 Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation

2.2 *IEC Standard:*

IEC 60216–2 Guide for the determination of thermal endurance properties of electrical insulating materials. Part 2: Choice of test criteria[3]

3. Terminology

3.1 *Definitions:*

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

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

3.1.2 For definitions of other terms relating to electrical insulation, see Terminology D1711.

4. Significance and Use

4.1 The amount and composition of by-products produced by exposure of insulating varnishes to elevated temperatures can possibly:

4.1.1 Deteriorate other insulations in the system,

4.1.2 Cause cracking of insulation due to pressure, buildup in thick cross sections, or

4.1.3 Corrode other parts in the assembly.

4.2 Amount and rate of weight loss will possibly affect the thermal rating of a varnish.

5. Apparatus

5.1 *Metal Mold,* consisting of two flat sheets 300 by 300 by 6 mm (12 by 12 by ¼ in.) separated by 6.4 ± 0.5-mm (¼ ± 0.02-in.) thick spacers along three sides. The spacers also seal the edges of the mold and the assembly is held together with "C" clamps or bolts. Aluminum or polished steel plates are permissible.

5.2 *Laboratory Balance,* with accuracy of ± 1 mg.

5.3 *Forced-Convection Laboratory Oven,* meeting requirements of Specification D5423, Type II for each test temperature.

5.4 *Screening Platform,* 6-mm (¼-in.) mesh, with 50-mm (2-in.) legs.

5.5 *Mold Release.*

NOTE 2—Fluorocarbon-type release agents are satisfactory.

5.6 Desiccator.

[1] This test method is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materialsand is direct responsibility of Subcommittee D09.01 on Electrical Insulating Varnishes, Powders and Encapsulating Compounds.

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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] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

TABLE 1 Standard Deviation and Weight Loss

Hours at Temperature	Weight Loss, %			Standard Deviation		
	Exposure Temperatures, °C					
	180	200	220	180	200	220
24	0.119	0.331	0.618	0.028	0.048	0.029
48	0.150	0.420	0.772	0.047	0.056	0.056
72	0.170	0.475	0.849	0.054	0.074	0.110
96	0.190	0.525	0.977	0.060	0.076	0.103
168	0.229	0.734	1.34	0.049	0.102	0.194

6. Procedure

6.1 Apply a thin, uniform coating of release agent to the contact surfaces of the mold.

6.2 Assemble the mold, taking precautionary measures to avoid leaks.

6.3 Pour the sample into the open edge of the mold, using care to avoid bubbles.

NOTE 3—In some cases, it will be necessary to prevacuum the sample before pouring.

6.4 Cure the sample using the recommended cure cycle.

6.5 After curing, remove the mold and contents from the oven and allow to cool to room temperature.

6.6 Carefully disassemble the mold and remove the cast sheet.

6.7 From the cast sheet, cut at least three specimens approximately 50 by 50 mm (2 by 2 in.) for each test temperature.

6.8 Dry the specimens for 1 h ± 5 min at 110 ± 2 °C to remove surface moisture.

6.9 Remove specimens from the oven and place them immediately into the desiccator.

6.10 After cooling to room temperature in the desiccator, weigh each specimen to the nearest 1 mg.

6.11 Lay the specimens on the screen platform so that they are at least 3 mm (⅛ in.) apart.

6.12 Place the loaded platforms in the oven.

6.13 *Exposure Temperatures:*

Anticipated End Use Temperature, °C	Temperature Range, °C
105	125 to 180
130	150 to 200
155	175 to 225
180	200 to 250
200	220 to 275
220	250 to 300

Choose three temperatures within the above ranges at least 20 °C apart.

6.14 *Exposure Times:*

Hours—24 48 72 96 168

NOTE 4—If desired, longer exposure times are permitted.

6.15 After each test period, remove the specimens from the oven and place immediately into the desiccator to cool to room temperature.

6.16 Weigh the specimens to the nearest 1 mg.

7. Calculation

7.1 Calculate the percent weight loss as follows:

$$\text{weight loss, } \% = [(A - B)/A] \times 100 \quad (1)$$

where:

A = initial weight, and
B = weight after thermal exposure period.

8. Report

8.1 Report the following information:

8.1.1 Identity of compound,

8.1.2 Cure cycle used, and

8.1.3 Percent weight loss after each exposure period and for each test temperature.

9. Precision and Bias

9.1 *Precision*—The standard deviation of testing at five laboratories, for different times and temperatures, is shown in Table 1.[4]

9.2 *Bias*—This test method has no bias because the value for weight loss is defined solely in terms of this test method.

10. Keywords

10.1 solventless varnish; varnish; weight loss

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D09-1014.