Designation: D 6053 – 0~~0~~3

An American National Standard

Standard Test Method for Determination of Volatile Organic Compound (VOC) Content of Electrical Insulating Varnishes[1]

This standard is issued under the fixed designation D 6053; 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 ~~is used to determine~~ covers the determination of the amount of volatile organic compounds emitted during cure of electrical insulating varnishes.

1.2 The values stated in SI units are the standard.

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.* See Section 7 for specific precautions.

[1] This standard is 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 Varnishes, Powders, and Encapsulating Compounds.

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2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 115 Test Methods for Testing Solvent Containing Varnishes Used for Electrical Insulation
D 1711 Terminology Relating to Electrical Insulation
D 3960 Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
D 4733 Test Methods for Solventless Electrical Insulating Varnishes
D 5423 Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation
E 691 Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definition of Term Specific to This Standard:*

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

3.1.1.1 *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 pertaining to this test method, refer to Terminology D 1711.

4. Significance and Use

4.1 This test method determines the volatile organic content of an electrical insulating varnish. It utilizes a procedure where dishes containing a known amount of varnish are baked and the amount of volatile organic compound is measured. Calculations are performed to express this in g/L or lb/gal. This test method is applicable to all types of varnishes. However, waterborne varnishes while baked under the same conditions need to have water content determined and calculations performed in accordance with Practice D 3960.

4.1.1 During the cure of electrical insulating varnishes some organic material is volatilized. A determination of the amount that is volatilized is useful for estimating the amount of cured varnish on electrical units and volatile organic emissions from a manufacturing facility.

5. Interferences

5.1 The amount of volatile organic content determined by this test method is known to be affected by the rate of air exchange in the baking oven.

6. Apparatus

6.1 *Weighing Dishes*, aluminum, approximately 60 mm (2⅜ in.) in diameter and 15 mm (⅝ in.) high on the sides.

6.2 *Forced-Convection Oven*, see Specification D 5423-Type II.

6.3 *Desiccator*.

7. Hazards

7.1 **Precaution**—Do not use varnish at temperatures above the flash point when inadequate ventilation, and the possibility of flames or sparks exist. Store varnish in sealed containers.

8. Procedure

8.1 Weigh three aluminum dishes to the nearest 0.01 g.

8.2 Add approximately 2 to 10 g of the varnish to be tested to each dish.

8.3 Weigh each dish and varnish to the nearest 0.01 g.

8.4 Roll the resin around in the dishes to ensure an even coating.

8.5 Place the dishes in a forced-convection oven at 150° ± 2°C. Other temperatures may be used when agreed to by interested parties.

8.6 After 61 ± 1 min remove the dishes from the oven.

8.7 Cool in desiccator.

8.8 Weigh each dish to the nearest 0.01 g.

8.9 Calculate the volatile organic compound (VOC) content for each dish as follows except for waterborne varnishes. For waterborne varnishes determine the water content and perform the VOC calculations in accordance with Practice D 3960.

Weight of Liquid Varnish, (1)

[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, ~~Vol 10.01.~~ volume information, refer to the standard's Document Summary page on the ASTM website.

A = Weight of dish and varnish (before baking) − Weight of dish

Weight of Baked Varnish,

B = Weight of dish and varnish (after baking) − Weight of dish

Weight of VOC, $C = A - B$

$$\text{Volume of Liquid Varnish, } V = \frac{A}{D}$$

where:

D = the density of the varnish in g/L as determined by Test Methods D 115 or D 4733.

$$\text{VOC} = \frac{C}{V} \text{ expressed in g/L} \quad (2)$$

8.10 To convert VOC in g/L to lb/gal multiply the VOC in g/L by 0.00833.

8.11 Calculate the average VOC of the three dishes.

9. Report

9.1 Report the following information:

9.1.1 Identity of the varnish used,

9.1.2 Average VOC in g/L or lb/gal,

9.1.3 Temperature that dishes were baked, and

9.1.4 Approximate mass of resin tested.

10. Precision and Bias

10.1 *Precision*—~~Data from~~ Table 1 lists the results based on a round robin test conducted in accordance with Practice E 691 involving five laboratories ~~that participated in an interlaboratory study~~ and three materials at three different weights. Each test result was the average of three specimens. Each laboratory obtained three test ~~method are as follows:~~[3]

TABLE 1 Results in Grams/Litre (g/l)

Materials	Sample Size	Average	Standard Deviation	Repeatability Standard Deviation	Reproducibility Standard Deviation	Repeatability Limit	Reproducibility Limit
Unsaturated Polyester in styrene	2 grams	226.8	30.44	5.08	28.18	14.22	78.90
	6 grams	169.8	14.22	2.66	13.21	7.45	36.99
	10 grams	151.3	13.51	3.83	12.82	10.72	35.90
Unsaturated Polyester in vinyl toluene	2 grams	282.1	29.02	3.68	26.71	10.30	74.79
	6 grams	211.0	5.32	6.89	7.95	19.29	22.26
	10 grams	192.5	7.26	4.93	8.01	13.80	22.43
Unsaturated Polyester in DAP	2 grams	349.3	38.92	8.02	36.01	22.46	100.8
	6 grams	288.7	12.48	6.50	12.84	18.20	35.95
	10 grams	268.2	10.59	9.00	12.69	25.20	35.53

~~Unsaturated Polyester Varnish 1~~ | ~~Unsaturated Polyester Varnish 2~~

~~Sample Size~~	~~Average~~	~~Standard Deviation~~	~~Average~~	~~Standard Deviation~~
~~2 grams[A]~~	~~88.8 g/L~~	~~7.20 g/L~~	~~248.5 g/L~~	~~16.8 g/L~~
~~4 grams~~	~~66.9 g/L~~	~~7.27 g/L~~	~~183.1 g/L~~	~~6.98 g/L~~
~~7 grams~~	~~51.1 g/L~~	~~7.03 g/L~~	~~134.9 g/L~~	~~5.13 g/L~~

~~[A] Data are from four laboratories.~~ results for each material at each weight.

10.2 *Bias*—This test method has no bias because the value for VOC is determined solely in terms of this test method.

11. Keywords

11.1 electrical insulating varnish; VOC; volatile organic compound