



## Standard Test Methods for Magnet-Wire Enamels<sup>1</sup>

This standard is issued under the fixed designation D 3288; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 These test methods cover testing liquid enamel coatings used to produce film-insulated magnet wire.

1.2 The values stated in either lbs/gal or SI units are to be regarded separately as standard.

1.3 The test methods appear as follows:

	Sections
Density	5-9
Determined Solids	15-21
Effective Solids	30-36
Flash Point	10-14
Infrared Analysis	41-46
Stack Loss	22-29
Viscosity	37-40

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.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- D 29 Test Methods for Sampling and Testing Lac Resins<sup>2</sup>
- D 56 Test Method for Flash Point by Tag Closed Tester<sup>3,4</sup>
- D 476 Specification for Titanium Dioxide Pigments<sup>2</sup>
- D 1298 Practice for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method<sup>3</sup>
- D 1475 Test Method for Density of Paint, Varnish, Lacquer, and Related Products<sup>5</sup>
- D 1638 Methods of Testing Urethane Foam Isocyanate Raw Materials<sup>6</sup>
- D 5423 Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation<sup>7</sup>

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee D-9 on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee D09.10 on Magnet Wire Insulation.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 06.03.

<sup>3</sup> Annual Book of ASTM Standards, Vol 05.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 04.09.

<sup>5</sup> Annual Book of ASTM Standards, Vol 06.01.

<sup>6</sup> Discontinued; see 1990 Annual Book of ASTM Standards, Vol 06.03.

<sup>7</sup> Annual Book of ASTM Standards, Vol 10.02.

E 131 Terminology Relating to Molecular Spectroscopy<sup>8</sup>

E 168 Practices for General Techniques of Infrared Quantitative Analysis<sup>8</sup>

### 3. Significance and Use

3.1 These tests are useful for specification and control purposes during the manufacture, purchase, and use of the magnet-wire enamels, and for determining uniformity of batches.

### 4. Sampling

4.1 Take a representative sample of liquid enamel and store for future testing. Store the sample at room temperature in a tightly sealed, nearly full container, unless otherwise specified. Use a container that is inert and impermeable to the wire enamel. These precautions avoid either the escape of solvent or reaction with the container and atmosphere. Glass and some metals are suitable materials. Copper, iron, and aluminum are unsatisfactory. After removing test specimens, use care to restore these storage conditions.

## DENSITY

### 5. Scope

5.1 This test method covers the determination of the density of magnet-wire enamel in terms of specific gravity or weight per gallon.

### 6. Significance and Use

6.1 Density is useful for specification and control purposes during the manufacture and use of magnet-wire enamel.

6.2 The preferred method is Procedure A, hydrometer method.

### 7. Procedure A—Hydrometer Method

7.1 Determine the specific gravity of the magnet-wire enamel in accordance with Test Method D 1298 at  $25.0 \pm 0.1^\circ\text{C}$ .

7.2 If weight per gallon is required, multiply the specific gravity by the weight per gallon of distilled water at the same temperature (8.31 lb/gal at  $25.0^\circ\text{C}$ ).

<sup>8</sup> Annual Book of ASTM Standards, Vol 14.01.

## 8. Procedure B—Weight per Gallon Method

8.1 Determine the weight per gallon of the magnet-wire enamel in accordance with Test Method D 1475 at  $25.0 \pm 0.1^\circ\text{C}$ .

## 9. Report

9.1 Report the following information:

9.1.1 Identification of the magnet-wire enamel, and

9.1.2 When using Procedure A, report the specific gravity to the third decimal place, or

9.1.3 When using Procedure B, report the weight per gallon.

## FLASH POINT

## 10. Scope

10.1 This test method covers the determination of the flash point of magnet-wire enamel.

## 11. Terminology

11.1 *Definitions of Terms Specific to This Standard:*

11.1.1 *flash point, of magnet-wire enamel, n*— the lowest temperature at which magnet-wire enamel gives off flammable vapor in sufficient quantity to ignite in air on application of a flame under specified conditions.

## 12. Significance and Use

12.1 The flash point reveals the upper temperature limit at which a magnet-wire enamel may be stored or used without presenting a fire hazard.

## 13. Procedure

13.1 Determine the flash point in accordance with Test Method D 56.

## 14. Report

14.1 Report the following information:

14.1.1 Identification of magnet-wire enamel, and

14.1.2 Flash point, degrees Celsius or Fahrenheit, preferably in degrees Fahrenheit.

## DETERMINED SOLIDS

## 15. Scope

15.1 This test method covers the determination of a particular measured value for the solids content in a magnet-wire enamel.

## 16. Terminology

16.1 *Definitions of Terms Specific to This Standard:*

16.1.1 *determined solids, of magnet-wire enamel, n*—the portion of a magnet-wire enamel which is not volatilized when exposed to specified conditions.

## 17. Significance and Use

17.1 Determined solids is one of the critical factors in a magnet-wire enamel that affects film build on a conductor.

17.2 The determined solids is also useful for control purposes during the manufacture and use of magnet-wire enamel and in determining uniformity of batches.

17.3 The Effective Solids Procedure (see 34.1 and 35.1) requires the Determined Solids value as an input.

## 18. Apparatus

18.1 *Forced-Convection Oven*, capable of maintaining  $200 \pm 2^\circ\text{C}$  at the specified specimen location. Refer to Specification D 5423 for a representative oven.

18.2 *Weighing Dishes*, aluminum, approximately 2 in. (51 mm) in diameter, and  $\frac{5}{8}$  in. (16 mm) height.

18.3 *Analytical Balance*, capable of weighing to  $\pm 0.1$  mg.

## 19. Procedure

19.1 Preheat dishes to remove oil. Five minutes at  $200^\circ\text{C}$  is adequate.

19.2 Test not less than two specimens.

19.3 Place a 2.0 g specimen ( $\pm 0.1$  mg) into a tared aluminum dish and weigh immediately.

19.4 The weighed specimen must thoroughly cover the entire bottom surface of the weighing dish. Accomplish this by warming the more viscous materials.

19.5 Place the dish and its contents in a  $200 \pm 2^\circ\text{C}$  forced-convection oven for a predetermined period of time.

19.6 Remove the dish from the oven and cool to room temperature in a desiccator.

19.7 Weigh the dish and its contents ( $\pm 0.1$  mg).

## 20. Report

20.1 Report the following information:

20.1.1 Ratio of the weight of residue to that of the specimen, expressed as a percentage, as the determined solids content,  $S$ , calculated as follows:

$$S = (\text{Weight of residue/weight of specimen}) \times 100 \quad (1)$$

20.1.2 Number of tests and individual values,

20.1.3 Average determined solids of all tests made, and

20.1.4 Identification of the magnet-wire enamel.

## 21. Precision and Bias

21.1 *Precision:*

21.1.1 The results of all measurements on the sample should agree within  $\pm 0.5\%$ .

21.2 *Bias:*

21.2.1 Statements of bias are not applicable in view of the unavailability of a standard reference material for this property.

## STACK LOSS

## 22. Scope

22.1 This test method covers the determination of the stack loss of magnet-wire enamel applied to AWG No. 18 (1.02-mm) electrical conductor using an inorganic material as a reference.

NOTE 1—With other sizes of electrical conductor, expect a variation in stack loss. This is particularly true with smaller diameter wire. Expect difficulty in removing the coating from fine wire.

## 23. Terminology

23.1 *Definitions of Terms Specific to This Standard:*

23.1.1 *stack loss, of magnet-wire enamel, n*— that portion of the magnet-wire enamel solids which are lost during the conductor-coating process.