



Designation: D4142 – 89 (Reapproved 2017)

## Standard Guide for Testing Epoxy Resins<sup>1</sup>

This standard is issued under the fixed designation D4142; 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 This guide covers methods for testing epoxy resins as listed in **Table 1**. All of the methods were tested by interlaboratory participation in accordance with usual ASTM guidelines. Each method specifies a recommended amount of sample for starting a separate analysis, but several of the procedures can be conducted on the same starting material if so desired. For example, viscosity, color, and density could be run on the same specimen.

1.2 *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.*

1.3 *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:<sup>2</sup>

- D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- D1209 Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)
- D1259 Test Methods for Nonvolatile Content of Resin Solutions
- D1475 Test Method For Density of Liquid Coatings, Inks, and Related Products
- D1544 Test Method for Color of Transparent Liquids (Gardner Color Scale)

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.33 on Polymers and Resins.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- D1545 Test Method for Viscosity of Transparent Liquids by Bubble Time Method
- D1639 Test Method for Acid Value of Organic Coating Materials (Withdrawn 2005)<sup>3</sup>
- D1652 Test Method for Epoxy Content of Epoxy Resins
- D1726 Test Methods for Hydrolyzable Chlorine Content of Liquid Epoxy Resins
- D1847 Test Methods for Total Chlorine Content of Epoxy Resins (Withdrawn 2007)<sup>3</sup>

### 3. Significance and Use

3.1 This guide directs the user to test methods that determine properties generally accepted as standard test items for classification of epoxy resins.

### 4. Epoxy Content

4.1 The epoxy content of epoxy resins is determined by reacting a solution of the resin with a standard solution of hydrogen bromide in glacial acetic acid. The quantity of acid consumed is a measure of the epoxy content. Test Methods D1652 was found to have a repeatability of 2 % of the epoxy content and a reproducibility of 6 % of the epoxy content.

### 5. Hydrolyzable Chlorine

5.1 Test Method D1726 covers the determination of the easily hydrolyzable chlorine content of liquid epoxy resins in concentrations below 1 weight %. The specimen is refluxed with a known amount of a standard alcoholic potassium hydroxide solution. The amount of hydroxide consumed is measured by titration and corresponds to the hydrolyzable chlorine content of the resin. By interlaboratory testing, the repeatability was found to be 0.02 %, and the reproducibility was found to be 0.05 %, both absolute.

### 6. Total Chlorine

6.1 Organic and inorganic chlorine compounds are determined in epoxy resins in accordance with Test Methods D1847. The resin specimen is oxidized by combustion in a bomb containing oxygen under pressure. The chlorides formed are dissolved in a sodium carbonate solution and then either

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

**TABLE 1 Methods for Testing Epoxy Resins**

Test Method	Section	ASTM Designation
Epoxy content	4	D1652
Hydrolyzable chlorine	5	D1726
Total chlorine	6	D1847
Viscosity	7	D445, D1545
Color	8	D1544, D1209
Density	9	D1475
Nonvolatile content	10	D1259
Acid value	11	D1639

titrated or determined gravimetrically. The absolute repeatability and reproducibility for the titration method are 0.02 and 0.05 weight %, respectively. For the gravimetric method, the repeatability and reproducibility are both reported to be 0.05 weight %, absolute.

## 7. Viscosity

7.1 Kinematic viscosity is determined by measuring the time for a volume of liquid to flow under gravity through a calibrated glass capillary viscometer in accordance with Test Method D445. The dynamic viscosity can be obtained by multiplying the measured kinematic viscosity by the density of the liquid. The limits of precision at the three sigma level of confidence were found to be 0.35 % relative within one laboratory and 0.70 % relative between laboratories.

7.2 It is also possible to measure viscosity by the bubble time method described in Test Method D1545. The rise time of a bubble in the resin contained in an ASTM viscosity tube is measured. The rise time in seconds is approximately equal to the viscosity in stokes. In the range from 4.5 to 440 St, duplicate runs by one operator should be considered suspect if they differ by more than 4.9 % relative. Two results, each the mean of duplicates obtained by different operators should be considered suspect if they differ by more than 9.0 % relative.

## 8. Color

8.1 Test Method D1544 covers the measurement of the color of transparent liquids by means of comparison with

arbitrarily numbered glass standards. Two results obtained by a single operator should be considered suspect if they differ by more than two thirds of a color number. Two results, each the mean of duplicate measurements obtained by operators in different laboratories should be considered suspect if they differ by more than four thirds of a color number.

8.2 The color of epoxy resins having light absorption characteristics nearly identical with those of the platinum-cobalt color standards can be measured by the use of Test Method D1209.

## 9. Density

9.1 Test Method D1475 is applicable to liquid epoxy resins. This test method makes use of a weight-per-gallon cup and is particularly useful where the fluid to be measured has a high viscosity or where a component is too volatile for a specific gravity balance determination. The limits of precision at the three sigma level of confidence were found to be  $\pm 0.008$  lb/gal within one laboratory and  $\pm 0.015$  lb/gal between laboratories.

## 10. Nonvolatile Content

10.1 Since epoxy resins tend to release solvent slowly, it is preferred to use a thin film or “foil method,” in which the resin is pressed between sheets of aluminum foil to spread it to a thin film. Method B of Test Methods D1259 is applicable to epoxy resins. The repeatability is 0.3 % and the reproducibility is 0.5 %, both absolute.

## 11. Acid Value

11.1 Acid value of an epoxy resin as determined by Test Method D1639 is expressed as the number of milligrams of potassium hydroxide required to neutralize the free acidity of 1 g of nonvolatile material under the condition of the test.

## 12. Keywords

12.1 epoxy resins

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