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Standard Specification for Epoxy Resins[1]

This standard is issued under the fixed designation D1763; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers totally reactive epoxy resins supplied as liquids or solids which can be used for castings, coatings, tooling, potting, adhesives, or reinforced applications. The addition of hardeners in the proper proportions causes these resins to polymerize into infusible products. The properties of these products can be modified by the addition of various fillers, reinforcements, extenders, plasticizers, thixotropic agents, etc. The epoxy resins described also can be used as stabilizers and cross-linking agents; and they can be combined with other reactive products.

1.2 It is not the function of this specification to provide engineering data or to guide the purchaser in the selection of a material for a specific end use. Ordinarily the properties listed in Table 1 and Table 2 are sufficient to characterize a material under this specification, and it is recommended that routine inspection be limited to testing for such properties.

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.*

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

NOTE 1—ISO 3673–1:1980(E) is similar but not equivalent to this specification. Product classification and characterization are not the same.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D883 Terminology Relating to Plastics

D1209 Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)

D1544 Test Method for Color of Transparent Liquids (Gardner Color Scale)

D1652 Test Method for Epoxy Content of Epoxy Resins

D3104 Test Method for Softening Point of Pitches (Mettler Softening Point Method)

D3892 Practice for Packaging/Packing of Plastics

2.2 *ISO Standard:*[3]

ISO 3673–1:1980(E) Plastics—Epoxy Resins—Part 1

3. Terminology

3.1 *Definitions:*

3.1.1 *General*—Definitions of terms used in this specification are in accordance with Terminology D883.

4. Classification

4.1 The resins covered contain no hardeners. Resin types covered are divided into specific groups by their chemical nature:

4.1.1 *Type I*—Bisphenol A and epichlorohydrin.

4.1.2 *Type II*—Reaction product of phenol and formaldehyde (novolac resin) and epichlorohydrin.

4.1.3 *Type III*—Cycloaliphatic and peracid epoxies.

4.1.4 *Type IV*—Glycidyl esters.

4.1.5 *Type V*—Reaction product of epichlorohydrin and *p*-aminophenol.

4.1.6 *Type VI*—Reaction product of epichlorohydrin and glyoxal tetraphenol.

4.2 These types may be further subdivided by grades:

4.2.1 *Grade* 1—Resins containing no diluent.

4.2.2 *Grade* 2—Resins modified with a reactive diluent. Each class of Grade 2 resin can be made from any class of Grade 1 resin.

4.2.3 Each grade may include as many classes as are shown in the tables.

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.16 on Thermosetting Materials.

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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 (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

***A Summary of Changes section appears at the end of this standard**

TABLE 1 Requirements for Type I, Grade 1, Epoxy Resin

Class	Epoxy Content		Viscosity, cP at 25°C	Mettler Softening Point, °C	Color[A] Gardner-Holdt, max
	Equivalents/100 g	WPE[B]			
A[C]	0.500 to 0.588	170 to 200	3000 to 20 000		3
B	0.443 to 0.527	190 to 226	15 000 to 40 000		5
C	0.357 to 0.443	226 to 280	← semi-solid →		5
D	0.125 to 0.357	280 to 800		40 to 90	5
E	0.067 to 0.125	800 to 1500		90 to 110	5
F	0.040 to 0.067	1500 to 2500		110 to 140	5
G	0.017 to 0.040	2500 to 6000		134 to 180	6
H	0.010 to 0.020	5000 to 10 000		160 to 200	7

[A] Test Method D1209 with a maximum color of 100 defines low color Type I resins.
[B] WPE = weight per epoxy equivalent.
[C] Can exist as a supercooled liquid.

TABLE 2 Requirements for Type I, Grade 2, Epoxy Resin

Class	Epoxy Content	Viscosity, cP at 25°C
A	[A]	100 to 500
B	[A]	500 to 900
C	[A]	900 to 4000
D	[A]	4000 to 10 000

[A] The WPE of these diluted resins shall be agreed upon between the purchaser and the seller.

5. Requirements

5.1 The resin shall be of uniform quality and as free of contamination as can be achieved by good manufacturing practice.

5.2 The resin shall conform to the requirements prescribed in Tables 1-7 for the type, grade, and class of material specified.

6. Sampling

6.1 Take a representative sample sufficient for the test specified either from a well-blended bulk lot prior to packaging or by withdrawing samples with a thief from no less than 5 % of the containers comprising the lot or shipment.

6.2 Unless the samples taken from the containers show evidence of variability, blend them into a single composite sample on which to conduct the specified tests. Instead of the foregoing, adequate statistical sampling acceptable to the purchaser and the seller may be substituted.

7. Test Methods

7.1 Determine compliance with the requirements specified in Table 1 in accordance with the following methods:

7.1.1 *Viscosity*—Test Method D445.

7.1.2 *Weight per Epoxy Equivalent*—(*WPE*)—Test Method D1652.

7.1.3 *Color*—Test Method D1544, except for Classes IV through VII, where a 40 % solids solution in butyl carbitol shall be used.

7.1.4 *Color*—Test Method D1209 is used to characterize the low color Type I and Type III resins.

7.1.5 *Softening Point*—Test Method D3104.

8. Packaging and Package Marking

8.1 *Packaging*—The material shall be packaged in a standard commercial container so constructed as to protect the product from contamination and ensure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery, unless otherwise specified in the contract or order.

8.2 *Package Marking*—Shipping containers shall be marked with the name of the product and its manufacturer, its type and grade, lot or control number, and the quantity contained as defined by the contract or order under which shipment is made.

8.3 All packing, packaging, and marking provisions of Practice D3892 shall apply to this specification.

9. Keywords

9.1 epoxy; resins

TABLE 3 Requirements for Type II, Grade 1, Epoxy Novolac Resins

Class	Epoxy Content		Viscosity, cP at 25°C	Mettler Softening Point, °C	Color[A], Gardner-Holdt, max
	Equivalents/100 g	WPE[B]			
A	0.500 to 0.588	170 to 200	35 000 to 100 000		3
B	0.537 to 0.575	174 to 186	12 000 to 19 000		7
C	0.476 to 0.555	180 to 210	16 to 30[C]		...
D	0.455 to 0.525	190 to 220	4000 to 10 000 at 55°C	48 to 60	4
E	0.333 to 0.370	270 to 300		70 to 80	9
F	0.294 to 0.345	290 to 340	B–D[A]	90 to 100	10[A]

[A] Test Method D1209 with a maximum color of 300 defines low color Type III resins.
[B] Fifty percent solution in acetone.
[C] Forty percent in diethylene glycol mono *n*-butyl ether.

TABLE 4 Requirements for Type III, Grade 1, Cycloaliphatic Resins

Class	Epoxy Content		Viscosity, cP at 25°C	Color, Gardner-Holdt, max
	Equivalents/100 g	WPE		
A	1.35 to 1.43	70 to 74	13 max	1
B	1.250 to 1.350	74 to 80	7	1
C	0.98 to 1.09	91 to 102	<100 at 45°C	2
D	0.625 to 1.000	100 to 160	80 to 500	3
E	0.833 to 0.909	110 to 120	80 to 150	...
F	0.699 to 0.763	131 to 143	350 to 450	1
G	0.649 to 0.751	133 to 154	7000 to 17 000 at 38°C	2
H	0.465 to 0.488	205 to 216	500 to 1500	2
I	0.462 to 0.487	210 to 221	500 to 1000	1
J	0.238 to 0.270	370 to 420	50[A]	...
K	0.233 to 0.256	309 to 430	300 to 600 at 40°C	2[B]
L	0.232 to 0.256	390 to 430	450 at 40°C	2

[A] Forty percent solution in acetone.
[B] At 40°C.

TABLE 5 Requirements for Type IV, Grade 1, Glycidyl Esters

Class	Epoxy Content		Viscosity, cP at 25°C	Color, Gardner-Holdt, max
	Equivalents/100 g	WPE		
A[A]	0.790 to 0.835	120 to 130	300 to 500	6
B[A]	0.625 to 0.668	150 to 160	200 to 400	3
C[B]	0.625 to 0.668	150 to 160	1000 to 1300	5
D[C]	0.391 to 0.438	244 to 256	5 to 10	1

[A] Cycloaliphatic.
[B] Aromatic.
[C] Saturated monocarboxylic acid.

TABLE 6 Requirements for Type V, Grade 1, Reaction Product of Epichlorohydrin and of *p*-Aminophenol

Class	Epoxy Content		Viscosity, cP at 25°C	Color, Gardner-Holdt, max
	Equivalents/100 g	WPE		
A	0.990 to 1.03	95 to 107	550 to 850	...
B	0.869 to 0.952	105 to 115	1500 to 5000	...

TABLE 7 Requirements for Type VI, Grade 1, Reaction Product of Epichlorohydrin and Glyoxal Tetraphenol

Class	Epoxy Content		Viscosity, cP at 25°C	Color, Gardner-Holdt, max
	Equivalents/100 g	WPE		
A	0.416 to 0.526	190 to 240	10[A]	...

[A] Fifty percent solution in acetone.