



Designation: **D 2951 – 9500**

An American National Standard

Standard Test Method for Resistance of Types III and IV Polyethylene Plastics to Thermal Stress-Cracking¹

This standard is issued under the fixed designation D 2951; 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 determination of the susceptibility of Types III and IV polyethylene plastics (as defined in the table on Classification of Polyethylene Plastics Molding and Extrusion Materials According to Type, in Specification D 1248) to thermal stress-cracking.

NOTE 1—It has also been found useful in testing specimens from fabricated items such as pipe or conduit.

1.2 The values stated in SI units are to be regarded as the standard, except in cases where materials, products, or equipment are available only in inch-pound units. The values in parentheses are given for information only.

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.* Specific precautionary statements are given in Note ~~6~~ 7.

NOTE 2—There is no similar or equivalent ISO standard.

2. Referenced Documents

2.1 ASTM Standards:

A 276 Specification for Stainless ~~and Heat-Resisting~~ Steel Bars and Shapes²

¹ This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.125 on ~~Olefin Plastics~~ Thermoplastic Materials.

Current edition approved ~~June 15, 1995; July 10, 2000~~. Published ~~August 1995; September 2000~~. Originally published as D 2951 – 71. Last current edition ~~D 2951 – 71 (1988)~~ ^{ϵ 1}.

An ISO equivalency statement, Section 3, Terminology, and Section 12, Keywords, were added in 1995; D 2951 – 95.

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

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing³

D 883 Terminology Relating to Plastics³

D 1248 Specification for Polyethylene Plastics Molding and Extrusion Materials³

~~D 1928 Practice 4703 Practice for Preparation of Compression-Molded Polyethylene~~ Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets and Test Specimens^{3,4}

E 145 Specification for Gravity-Convection and Forced-Ventilation Ovens⁵

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms see Terminology D 883.

4. Summary of Test Method

4.1 Strips of material 127 by 6.4 by 1.3 mm (5.0 by 0.25 by 0.050 in.) are cut from a molded test sheet. The strips are helically wrapped and fastened to a 6.4-mm (0.25-in.) diameter metal rod. The assembly is then placed in the specified test environment. The specimens are examined at the end of specified time intervals and the cumulative number of those which have failed is recorded for each time interval.

5. Significance and Use

5.1 Resistance to thermal stress-cracking is a property that is of importance in material used for jacketing and insulation of wire and cable.

5.2 As a general correlation between test results and field performance has been recognized, this test may be considered suitable for specification acceptance.^{6, 7}

5.3 Some polyethylenes embrittle or crack if they are exposed to elevated temperatures. This embrittlement may result in severe cracking, especially if the polymers are stressed during exposure. The phenomena causing thermal-stress cracking are not clearly understood. It is evident that either increasing the density or decreasing the molecular weight has a detrimental effect on the resistance to thermal-stress cracking.

5.4 This is a go pass or no-go fail test, not intended for arranging various Type III and IV polyethylene plastics in a series.

6. Apparatus

6.1 *Blanking Die*, with a rectangular opening, 127 by 6.4 mm (5.0 by 0.25 in.). The cutting edges shall be sharp and free of nicks so that clean cuts are made.⁸

6.2 *Leather Punch, Drill or Equivalent*, capable of producing clean holes approximately 1.6 mm ($\frac{1}{16}$ in.) in diameter.

6.3 *Specimen Mandrels*—Stainless steel or brass rods, 6.40 ± 0.05 mm (0.25 ± 0.002 in.) in diameter by 165 mm (6.5 in.) long with three pairs of 1.6-mm ($\frac{1}{16}$ -in.) diameter holes spaced 34.9 mm (1.375 in.) apart (center-to-center) and each pair separated from adjacent pairs by 12.7 mm (0.50 in.). The holes in the mandrel must be parallel. See Fig. 1.

NOTE 3—Type 316 stainless steel, Specification A 276 is satisfactory.

6.4 *Machine Screws*, stainless steel or brass, size 0-80, 0.50 in. long (or approximately 1.4-mm diameter, 0.3-mm pitch, 12.5 mm long) with nuts and washers. Stainless steel or brass cotter pins are also acceptable.

6.5 *Vise*, for holding the mandrels of 6.3, mounted on a table or bench.

6.6 *Test Tubes*, glass, nominally 200 mm long and 32 mm in outside diameter; with rubber or cork stoppers, vented.

6.7 *Test Tube Rack*, wire, for the test tubes of 6.6.

6.8 *Liquid Bath or Air Oven*—Circulating air oven consistent with ovens prescribed in Specification E 145 or liquid bath capable of controlling the temperature at 100 ± 1 C or equivalent.

7. Interpretation of Results

7.1 For purposes of this test, any crack visible to the unaided eye shall be interpreted as a failure, except, those cracks within 6.4 mm (0.25 in.) of the mounting holes.

² *Annual Book of ASTM Standards*, Vol 01.053.

³ *Annual Book of ASTM Standards*, Vol 08.01.

⁴ *Annual Book of ASTM Standards*, Vol 14.02: 08.03.

⁵ Heiss, J. H., and Lanza, V. L., *Wire and Wire Products*

⁵ *Annual Book of ASTM Standards*, Vol 33, pp 1182–87 (1958); 14.04.

⁶ Heiss, J. H., and Lanza, V. L., and Martin, W. M., *Wire and Wire Products*, Vol 33, pp 592–593, pp 626–627, May 1959. ASTM Round Robin, RR:D20-1000: 1182–87 (1958).

⁷ Round-robin data for this test method may be obtained from

⁷ Heiss, J. H., Lanza, V. L., and Martin, W. M., *Wire and Wire Products*, pp 592–593, pp 626–627, May 1959. ASTM Headquarters. Request RR:D20-1000; Round Robin, RR:D20-1000.

⁸ Round-robin data for this test method may be obtained from ASTM Headquarters. Request RR:D20-1008.

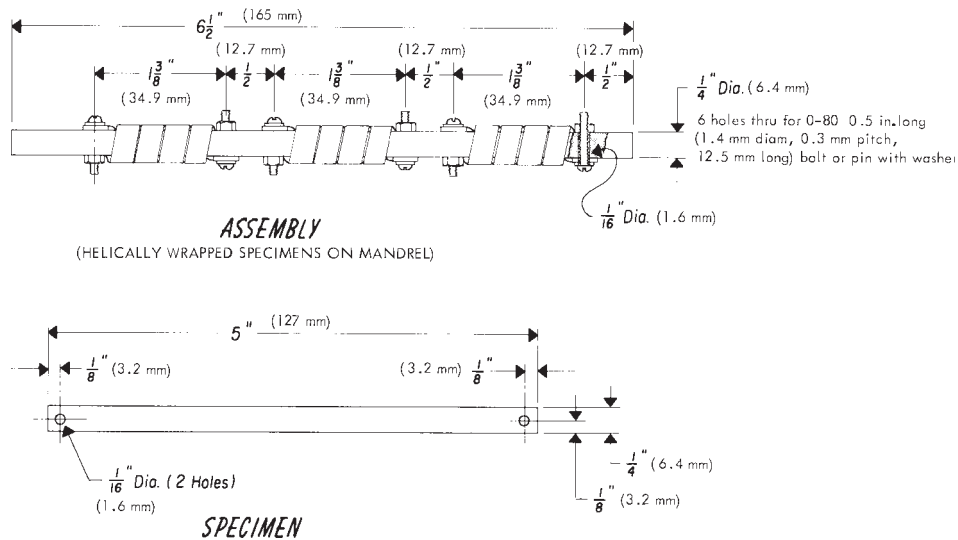


FIG. 1 Helically Wrapped Specimens on Mandrel

NOTE 4—For natural-color polyethylene plastic specimens, flaws generally appear as small white dots. These dots indicate discontinuities in the refractive index and act as small light-scattering centers. The white area enlarges with time as the temperature is held constant and a crack appears within the region. The crack is always transverse to the direction of the applied stress and propagated in the transverse direction.

8. Specimen Preparation and Conditioning

- 8.1 Prepare a sheet 1.27 ± 0.13 mm (0.050 ± 0.005 in.) thick by Procedure C of ~~Method D 1928~~ Annex A1 of Practice D 4703.
- 8.2 Within 8 h after molding, prepare nine test specimens from the sheet by use of the blanking die, each specimen being nominally 127 by 6.4 by 1.27 mm (5 by 0.25 by 0.05 in.). Punch two holes nominally 1.6 mm ($1/16$ in.) in diameter in each specimen 3.2 mm (0.125 in.) from each end.
- 8.3 *Conditioning*—Condition the test specimens at 23 ± 2 C (73.4 ± 3.6 F) and $50 \pm$ % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618 for those tests where conditioning is required. In cases of disagreement, the tolerances shall be ± 1 C (± 1.8 F) and ± 2 % relative humidity.

9. Procedure

- 9.1 Clamp the end of the mandrel securely in a vise and fasten one end of a specimen loosely at one hole position by means of a machine screw, washer, and nut. Wrap the specimen $4\frac{1}{2}$ turns helically around the mandrel. Fasten the other end at the other hole position with a screw, washer, and nut, then tighten the two screws securely. See Fig. 1.
- NOTE 5—Excessive tightening of the sample at the mounting holes may cause premature failure.
- 9.2 Mount two more specimens on the mandrel in the same manner as 9.1. Place the mandrel with specimens in a properly labeled test tube; stopper the tube tightly and place it in a test tube rack.
- 9.3 Mount the remaining six specimens on two mandrels in the same manner and place in test tubes.
- 9.4 Place the test tube rack with its three test tubes of mounted specimens in a circulating air oven or liquid bath at 100 C and record the time and date for the beginning of test.

NOTE 6—Ensure that the specimens are kept immersed during the testing period, as the water level in an uncovered bath can be significantly reduced at 100°C.

- 9.5 Inspect the specimens for failure at intervals of 48, 96, and 168 h, or as otherwise specified (Note 5). Remove the rack from the oven and inspect each tube of specimens, in turn. Record the time, date, and the cumulative number of failures.

NOTE 7—**Precaution:** Use care when handling hot (100°C) test tubes. Leather or cloth gloves have been found satisfactory for this operation.

10. Report

- 10.1 The report shall include the following:
 - 10.1.1 Complete identification of material tested,
 - 10.1.2 ~~€~~ Date, time, and cumulative number of specimen failures observed at each inspection time, and,
 - 10.1.3 Date the test was begun.

11. Precision and Bias

- 11.1 No statement is made about either the precision or bias of this test method since the result merely states whether there is conformance to the criteria for success specified in the procedure.

12. Keywords

12.1 embrittlement; stress-cracking; thermal stress-cracking

SUMMARY OF CHANGES

This section identifies the location of selected changes to this test method. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of this test method. This section may also include descriptions of the changes or reasons for the changes, or both.

D 2951-95:

(1) Added an ISO equivalency statement, Section 3, Terminology, and Section 12, Keywords.

D 2951-00:

(1) Changed Section 5.4.

(2) Added note under Section 9.4.

(3) Changed Section 10.1.2.

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