Designation: D1693 – 21

Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics[1]

This standard is issued under the fixed designation D1693; 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 U.S. Department of Defense.

1. Scope*

1.1 This test method covers the determination of the susceptibility of ethylene plastics, as defined in Terminology D883, to environmental stress-cracking when subjected to the conditions herein specified. Under certain conditions of stress and in the presence of environments such as soaps, wetting agents, oils, or detergents, ethylene plastics may exhibit mechanical failure by cracking.

1.2 The values stated in SI units are to be regarded as 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

1.4 *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:*[2]

D618 Practice for Conditioning Plastics for Testing
D883 Terminology Relating to Plastics
D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
D1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
D4976 Specification for Polyethylene Plastics Molding and Extrusion Materials
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *ASTM Adjuncts:*

Apparatus Drawings and Blueprints[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *stress-crack, n*—an external or internal rupture in a plastic caused by tensile stresses less than its short-time mechanical strength.

3.1.1.1 *Discussion*—The development of such cracks is frequently accelerated by the environment to which the plastic is exposed. The stresses which cause cracking may be present internally or externally, or may be a combination of these stresses. The appearance of a network of fine cracks is called crazing.

3.1.2 *stress-crack failure, n*—for purposes of this test method, any crack visible to an observer with normal eyesight shall be interpreted as a failure of the entire specimen (**1**).[4] Extension of the controlled imperfection shall not be construed as a failure. The appearance of more than one crack in a single specimen shall be construed as a single failure.

3.1.2.1 *Discussion*—Cracks generally develop at the controlled imperfection and run to the outer edge of the specimen approximately at right angles to it (**2**). The cracks need not extend completely through the specimen to constitute failure. Cracks sometimes develop under the polymer surface, manifesting themselves as depressions on the surface. The time when this occurs should be noted, and if the depression later develops into a crack, the time of dimpling should be considered as the failure time.

---

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

Current edition approved Oct. 1, 2021. Published October 2021. Originally approved in 1959. Last previous edition approved in 2015 as D1693 - 15$^{\varepsilon 1}$. DOI: 10.1520/D1693-21.

[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] Detailed drawings of the apparatus are available from ASTM Headquarters. Request ADJD169302, ADJD169303, or ADJD169304. For a complete set of all drawings, request ADJD1693CS.

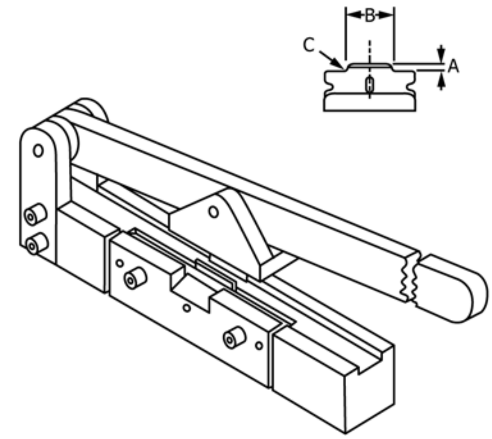
[4] The boldface numbers in parentheses refer to the list of references at the end of this test method.

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

TABLE 1 Standard Test Conditions

Condition		Specimen Thickness		Notch Depth		Bath Temperature, °C
		mm[A]	in.	mm[A]	in.	
A[B]	min	3.00	0.120	0.50	0.020	50
	max	3.30	0.130	0.65	0.025	
B[B]	min	1.84	0.0725	0.30	0.012	50
	max	1.97	0.0775	0.40	0.015	
C[C]	min	1.84	0.0725	0.30	0.012	100[C]
	max	1.97	0.0775	0.40	0.015	

[A]Dimensional values are not exactly equivalent. However, for referee purposes the metric units shall apply.
[B]For referee purposes, concentration of Igepal will be consistent with the appropriate material standard. If no concentration is given, then 10 % volume solution shall be used.
[C]At a temperature of 100°C, a full-strength reagent, rather than an aqueous solution of a reagent, is generally used because solutions tend to change their compositions by water evaporation losses during the period of test.



	mm	in.
A	3	1⁄8
B	18.9–19.2	0.745–0.755
C (radius)	1.5 max	1⁄16 max

FIG. 1 Nicking Jig

4. Summary of Test Method

4.1 Bent specimens of the plastic, each having a controlled imperfection on one surface, are exposed to the action of a surface-active agent. The proportion of the total number of specimens that crack in a given time is observed.

5. Significance and Use

5.1 This test method may be used for routine inspection purposes by subjecting a required number of specimens to the test conditions for a specified time and noting the number that fail. The cracking obtained with the test reagent is indicative of what may be expected from a wide variety of surface-active agents, soaps, and organic substances that are not absorbed appreciably by the polymer.

5.2 Environmental stress-cracking is a property that is highly dependent upon the nature and level of the stresses applied and on the thermal history of the specimen (**1**). Under the conditions of the test method, high local multiaxial stresses are developed through the introduction of a controlled imperfection (**2, 3**). Environmental stress-cracking has been found to occur most readily under such conditions.

NOTE 2—Different types of polyethylene plastics as defined in Specification D1248 are generally tested under different levels of strain and stress. When it is expressly desired to compare the types at equal levels of strain, the specimens for all types should be tested under Condition B, Table 1 (**4**).

5.3 Information from this test method is not intended to be used for direct application to engineering problems.

NOTE 3—Caution should be used in comparing and ranking various ethylene plastics into distinct and separate groups by this test method (see Section 13 and Note 12).
As thermal history is recognized as an important variable, test results by this test method employing laboratory molded samples cannot necessarily be expected to show agreement with test results from samples obtained by other means. The true performance potential of a given ethylene plastic may, however, best be determined with specimens obtained from commercially prepared items (**5**).

6. Apparatus

6.1 *Blanking Die*—A rectangular die or other means suitable for cutting specimens 38 ± 2.5 mm by 13 ± 0.8 mm (1.5 ± 0.1 in. by 0.50 ± 0.03 in.). These specimens must be cut with square edges. Beveled ends in particular are to be avoided.

6.2 *Jig*—A jig for making a controlled imperfection in specimens of the dimensions shown in Table 1, parallel to the long edges of the specimen and centered on one of the broad faces. A jig as shown in Fig. 1 and capable of notching the specimens in accordance with 10.2 shall be used.

NOTE 4—It is recommended that the jig be permanently mounted to ensure notching consistency.

6.3 *Specimen Holders*—Lengths of hard or half-hard brass or stainless steel channel having the dimensions shown in (*B*) of Fig. 2 shall be used. The sides of the channel shall be parallel and the inside corners sharp and square. Any burrs present on the inside of the channel shall be removed. The inside width is critical (see Dimension F in Fig. 2).

6.4 *Test Tubes and Closures*—Hard glass tubes nominally 200 mm long with a preferred minimum inside diameter of 31.5 mm and a cork or rubber stopper. Alternatively, tubes with threaded ends and plastic caps are permissible.

NOTE 5—Some older test tubes have inside diameters of less than 31.5 mm. These are acceptable as long as there is adequate clearance to allow the filled specimen holder to be inserted into the tube without any interference.
NOTE 6—Hard glass (borosilicate) tubes and No. 15 corks have been found satisfactory.

6.5 *Aluminum Foil*—Approximately 0.08 to 0.13 mm (0.003 to 0.005 in.) thick, for wrapping.

6.6 *Constant-Temperature Bath*—A constant-temperature liquid bath maintained at 50.0 ± 0.5°C for Conditions A and B of Table 1 and 100.0 ± 0.5°C for Condition C of Table 1.

6.7 *Test Tube Rack*—A rack to hold test tubes immersed to reagent level.