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An American National Standard

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins[1]

This standard is issued under the fixed designation F 1473; 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.

ϵ^1 NOTE—Section 8.4 was corrected editorially in November 1998.

1. Scope

1.1 This test method determines the resistance of polyethylene materials to slow crack growth under conditions specified within.

1.2 The test is generally performed at 80°C and at 2.4 MPa, but may also be done at temperatures below 80°C and with other stresses low enough to preclude ductile failure and thereby eventually induce brittle type of failure. Generally, polyethylenes will ultimately fail in a brittle manner by slow crack growth at 80°C if the stress is below 2.4 MPa.

1.3 The test is for compression molded plaques and for pipe sizes 16 mm and greater.[2]

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 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[3]

D 1248 Specification for Polyethylene Plastics Molding and Extrusion Materials[3]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[3]

D 1928 Practice for Preparation of Compression-Molded Polyethylene Test Sheets and Test Specimens[3]

D 3350 Specification for Polyethylene Plastics Pipe and Fitting Materials[3]

F 412 Terminology Relating to Plastic Piping Systems[4]

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions are in accordance with Terminology F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.1.2 *brittle failure*—a pipe failure mode which exhibits no visible (to the naked eye) permanent material deformation (stretching, elongation, or necking down) in the area of the break (F 412).

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *slow crack growth*—the slow extension of the crack with time.

4. Summary of Test Method

4.1 A specimen is taken from a pipe with a specified orientation relative to the extrusion direction or from compression molded plaques. It is precisely notched and then exposed to a constant tensile stress at elevated temperatures in air. The time for complete failure is recorded.

5. Significance and Use

5.1 This test method is useful to measure slow crack growth resistance of molded plaques of resins and extruded pipe at accelerated conditions such as 80°C, 2.4-MPa stress, and with a sharp notch.

5.2 The time to failure depends on the following test parameters: temperature; stress; notch depth; and specimen geometry. Increasing temperature, stress, and notch depth decrease the time to failure. Thus, in reporting the time to failure, all the conditions of the test must be specified.

6. Apparatus

6.1 *Lever Loading Machine*, with a lever arm ratio of about 5:1. The tensile load may also be applied directly using dead weights or any other method for producing a constant load. The pull rods on the grips shall have universal action to preventing bending. The grips shall be serrated to prevent slippage. The load on the specimen shall be accurate to at least ±0.5 %.

6.2 *Furnace*, heated by ordinary incandescent light bulbs covered with aluminum foil or any other suitable heating element.

6.3 *Temperature Controller*, shall be able to control the temperature within ±0.5°C with respect to the set point.

6.4 *Temperature-Measuring Device*, a thermometer or a

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[1] This test method is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.40 on Test Methods.

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[2] Lu, X., and Brown, N., "A Test for Slow Crack Growth Failure in Polyethylene Under a Constant Load," *Journal of Polymer Testing*, Vol 11, pp. 309–319, 1992.

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

[4] *Annual Book of ASTM Standards*, Vol 08.04.

thermocouple which can measure the temperature with an accuracy better than 0.5°C.

6.5 *Timer*, shall have an accuracy of at least 1 % and shall automatically stop when the specimen fails.

6.6 *Alignment Jig*, as shown in Fig. 1, which aligns the grips and the specimen when the specimen is being tightened in the grips. Alignment jigs which produce the same function may be used.

6.7 *Notching Machine* for notching the specimen is shown in Fig. 2 or other machines which produce the same results may be used. The notching machine presses a razor blade into the specimen at a speed less than 0.25 mm/min. The depth of the notch is controlled within ±0.01 mm. The machine is designed so that the main notch and the side notches will be coplanar and the plane of the notching is perpendicular to the tensile axis of the specimen. The thickness of the razor blade is approximately 0.2 mm.

7. Precautions

7.1 The load shall be carefully added to avoid shocking the specimen. When the specimen is inserted in the grips, bending and twisting shall be avoided in order to prevent the premature activation of the notch. Avoid exposure to fluids such as detergents.

8. Test Specimens

8.1 Specimens may be machined from a compression molded plaque of the resin or from sections taken from a pipe.

8.2 *Specimen Geometry*—Representative geometries of the specimens are shown in Fig. 3. Fig. 3(*a*) is a longitudinal specimen from a pipe whose tensile axis is parallel to the extrusion direction and the notch is perpendicular to the extrusion direction. Fig. 3(*b*) is for a transverse specimen with the tensile axis parallel to the hoop direction and the notch parallel to the extrusion direction. Fig. 3(*c*) is for a compression molded specimen. Fig. 3(*d*) is for pipe diameters less than 25 mm.

8.3 *Dimensional Requirements*:

8.3.1 The side groove shall be 0.5 ± 0.10 mm for pipe sizes less than 75 mm diameter and 1.0 ± 0.10 mm for pipe sizes 75 mm and greater.

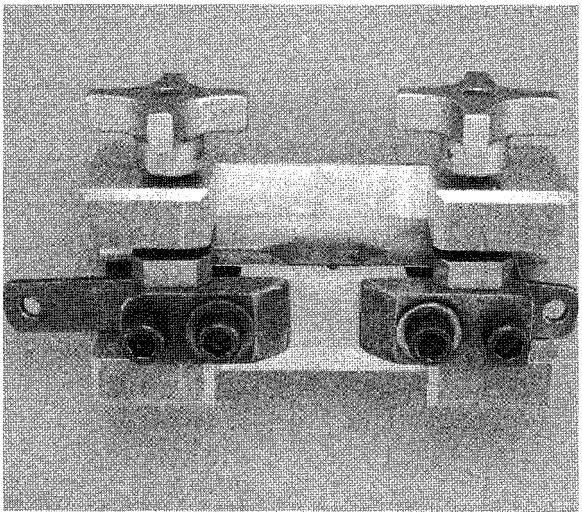

FIG. 1 Alignment Jig

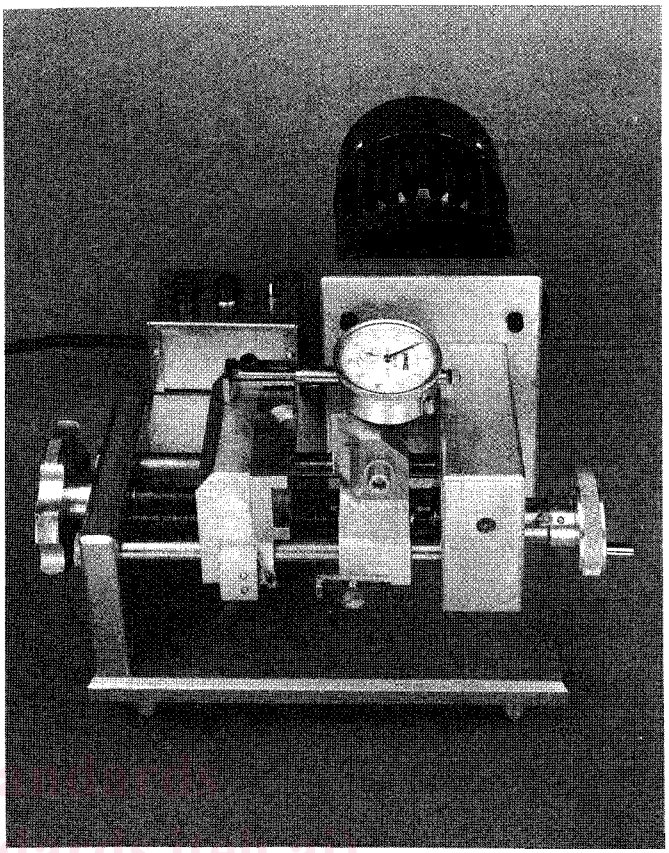

FIG. 2 Notching Machine

8.3.2 The width of the specimen shall be 15 ± 2 mm for pipe diameters smaller than 75 mm and 25 ± 2 mm for pipe diameters 75 mm and greater.

8.3.3 For pipes larger than 200 mm, machine the specimen from the pipe with dimensions corresponding to the compression molded specimen in Fig. 3(*c*).

8.3.4 For pipe diameters less than 25 mm, specimen (Fig. 3(*d*) shall be used.

8.3.5 The overall length is not critical except that the distance between the notch and the end of a grip should be more than 10 mm. Thicker specimens should have a greater overall length so that the gripped area will be greater in order to avoid slippage in the grip. The gripped area of specimens taken from the pipe should be machined to an approximately flat surface so that the grip does not introduce bending stresses.

8.4 *Preparation of Compression Molded Plaques*—Polyethylene resins shall be evaluated by using specimens that are machined from compression molded plaques using Test Method D 1928, except for the following procedures. After the resin is heated to 140 to 160°C, apply and remove the pressure three times. Increase the temperature to 170 to 190°C for 10 to 15 min without pressure. Then apply and remove the pressure three times. The specific temperatures that are used depend on the melt index of the resin, that is, a higher temperature for a lower melt index. The purpose of applying and removing the pressure is to eliminate voids. Turn off the heat and apply pressure. The time to cool between 130 and 90°C shall be greater than 80 min. Alternatively, the time to cool from the molding temperature to about room temperarture shall be