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An American National Standard

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Slow Crack Growth Resistance of Notched Polyethylene Plastic Pipe[1]

This standard is issued under the fixed designation F 1474; 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 determines the resistance to slow crack growth [2,3] of polyethylene pipe expressed in terms of time to failure of the pipe with machined axial notches in a hydrostatic stress rupture test.

1.2 The values stated in inch-pound units are to be regarded as the standard.

1.3 *This standard does not purport to address all of the safety problems, 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.*

NOTE 1—A similiar test method is described in ISO 13479.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure[4]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[5]

D 2122 Method for Determining Dimensions of Thermoplastic Pipe and Fittings[4]

F 412 Terminology Relating to Plastic Piping Systems[4]

2.2 *ISO Standards:*

ISO 1167 Plastics pipes for the transport of fluids—Determination of resistance to Internal Pressure[6]

ISO 3126 Plastics pipes—Measurement of dimensions[6]

ISO 13479 Polyolefin Pipes for the Conveyance of Fluids–Determination of Resistance to Crack Propagation–Test Method for Slow Crack Growth on Notched Pipes (Notch Test)[6]

3. Terminology

3.1 General—Definitions are in accordance with Terminologies in F 412, unless otherwise specified. Abbreviations are in accordance with Terminology D 1600.

4. Significance and Use

4.1 Pipe test samples with four external axial machined notches are subjected to a constant pressure hydrostatic stress rupture test while immersed in a water tank at 80°C (176°F). The time to failure is recorded. The test is applicable to pipe of wall thickness >0.2 in. (5 mm).

5. Apparatus

5.1 *Pipe Test Equipment*, as described in ISO 1167 or Test Method D 1598.

5.2 *Milling Machine*, which has a horizontal mandrel rigidly fixed to the bed to enable the pipe to be securely clamped to give a straight specimen. The mandrel shall support the pipe bore beneath and along the full length of the notch to be machined. The milling cutter mounted on a horizontal arbor shall be a 60° included angle 'V' cutter, 0.5 in. (12.5 mm) wide having a cutting rate of 0.00040 ± 0.00008 in. (0.010 + 0.002 mm)/rev/tooth.

NOTE 2—For example a cutter with 20 teeth rotating at 700 rpm, traversed along at a speed of 6 in./min (150 mm/min) has a cutting rate as follows:

$$6/(20 \times 700) = 0.00042 \text{ (in./rev)/tooth}$$

$$150/(20 \times 700) = 0.011 \text{ (mm/rev)/tooth}$$

6. Procedure

6.1 *Specimen Preparation*—Take a pipe sample with a minimum free length between the end caps of 3 × pipe outside diameter ±0.2 in. (5 mm).

6.1.1 *Pipe Measurement*:

6.1.1.1 The minimum pipe wall thickness shall be located and marked for machining the initial notch.

6.1.1.2 The positions shall be marked for machining three additional notches equally spaced around the pipe circumference at the same axial position as the initial notch (see Fig. 1).

6.1.1.3 The average wall thickness shall be recorded from measurements taken at either end of the specimen in line with the positions for each of the four notches.

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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] Denning, J. A., *Eleventh Plastic Fuel Gas Pipe Symposium*, San Francisco, CA, 1989, p. 249.

[3] Dickinson, A. and Ewing, L., *International Gas Research Conference*, Toronto, Canada, Vol 1, 1986, p. 52.

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

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

[6] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

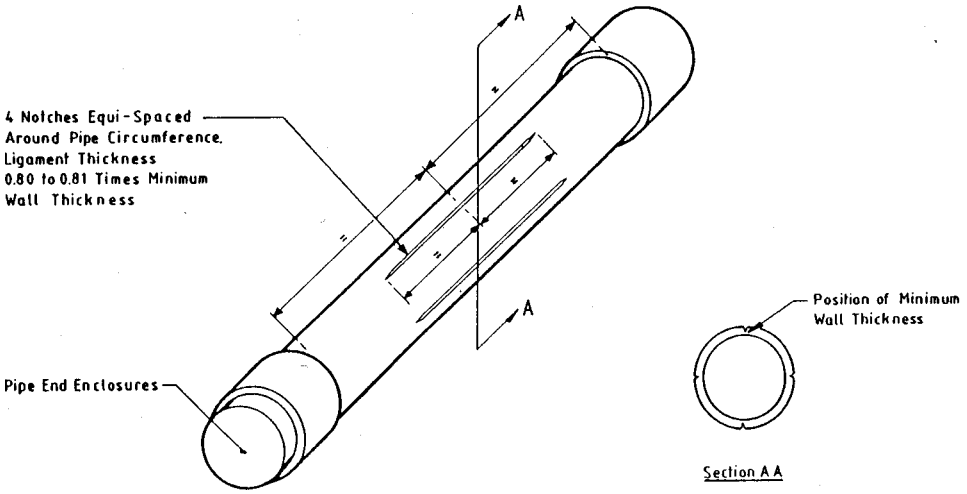

FIG. 1 Machined Notch Locations

6.1.2 *Machining Notches*:

6.1.2.1 Machine a notch with a ligament thickness between 0.78 and 0.82 times the measured minimum wall thickness of the specimen, as shown in Fig. 2.

NOTE 3—To achieve a remaining ligament within the required tolerance range, it is advisable to aim for a remaining ligament at the top of the tolerance range. This is because the pipe wall can move due to release of residual stresses, resulting in a deeper than anticipated notch.

6.1.2.2 The length of the notch, at full depth, shall be equal to the pipe outside diameter, ±0.04 in. (1 mm).

6.1.2.3 The three other notches at the positions indicated shall be machined to give a ligament thickness identical to the initial notch, Fig. 1 and Fig. 3.

6.1.2.4 In order to machine notches in thick-walled pipe, >2 in. (50 mm), the material shall be machined away with a 0.6 to 0.8-in. (15 to 20-mm) diameter slot drill to leave approximately 0.4 in. (10 mm) to be removed by the 'V' cutter.

6.1.2.5 The milling cutter shall be carefully protected against damage at all times and not be used for any other material or purpose. The cutter has a finite lifetime and shall be replaced after 4000 in. (100 m) of notching.

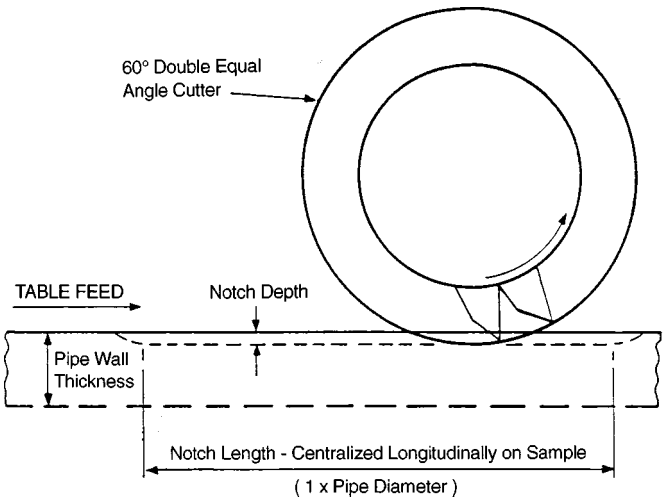

FIG. 2 Notching Method

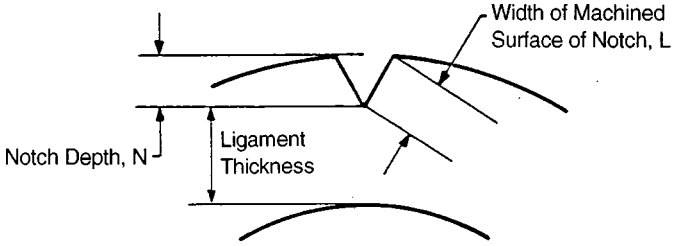

FIG. 3 Measurement to Calculate Notch Depth

NOTE 4—Limit cutter to 4000 in of notching unless it requires replacement earlier.

6.2 *Hydrostatic Pressure Test*:

6.2.1 *Specimen Preparation*—The pipe specimen shall be end capped as described in ISO 1167 or Test Method D 1598.

6.2.2 *Conditioning*—The pipe specimen shall be filled with water and immersed in the 176°F (80°C) water tank and allowed to condition for a period of 24 h for pipe of wall thickness up to 1 in. (25 mm) and 48 h for greater wall thicknesses.

6.2.3 *Test Procedure*:

6.2.3.1 The specimen shall then be pressurized with water to the desired test pressure within 30 to 40 s at a uniform rate.

6.2.3.2 The test time (to the nearest 1 h) shall be recorded. The minimum results shall be taken. In the case of failures, the location of failures shall be recorded for each specimen.

6.3 *Notch Depth Measurement*:

6.3.1 At the completion of the pressure test, a section of pipe shall be cut out from around the position of each notch.

6.3.2 The notch shall be opened up to give clear access to one of the machined surfaces of the notch. The width of the machined surface of the notch shall be measured to an accuracy of ±0.004 in. (0.1 mm) with a microscope or other suitable means, as in Fig. 3. If required by the pipe specification, the depth of the crack penetration should be measured.

6.3.3 The notch depth shall be calculated from the formula, as follows:

$$N = 0.5\,[D - \sqrt{(D^2 - L^2)}] + 0.866L$$

where
N = notch depth, in. (mm),
L = width of machined surface of notch, in. (mm), and
D = measured mean pipe outside diameter, in. (mm).

6.3.4 The ligament thickness shall be calculated from the notch depth and the individual average wall thickness at each notch position.

7. Test Report

7.1 Report the following information:

7.1.1 Complete identification of the pipe (manufacturer, type of pipe, production date),

7.1.2 Date of the test,

7.1.3 Cutter size and number of teeth,

7.1.4 Cutter speed (r/min) and traverse speed, in./min (mm/min),

7.1.5 Mean pipe diameter,

7.1.6 Minimum pipe wall thickness,

7.1.7 Ligament thickness,

7.1.8 Notch depth and percentage notch depth for each notch and identification of failed notch, and

7.1.9 Test pressure and failure time.

8. Precision and Bias

8.1 *Precision*[7]—Based on a nine-laboratory round robin conducted on polyethylene pipe, the precision (one standard deviation) of this test method is as follows:

Within laboratory ±25 %
Between laboratory ±40 %

8.2 *Bias*—Since there is no accepted reference material, bias has not been determined.

[7] Supporting data are available from ASTM Headquarters. Request RR:F17-1042.