Designation: ~~F2136 – 08 (Reapproved 2015)~~ F2136 – 18

Standard Test Method for Notched, Constant Ligament-Stress (NCLS) Test to Determine Slow-Crack-Growth Resistance of HDPE Resins or HDPE Corrugated Pipe[1]

This standard is issued under the fixed designation F2136; 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~~ Scope*

1.1 This test method is used to determine the susceptibility of high-density polyethylene (HDPE) resins or corrugated pipe to slow-crack-growth under a constant ligament-stress in an accelerating environment. This test method is intended to apply only to HDPE of a limited melt index (~~<~~0.4 to 0.15) and density range ~~as defined in AASHTO~~(>0.947 to 0.955 g/cm^3~~ Standard Specification M 294.~~). This test method may be applicable for other materials, but data are not available for other materials at this time.

1.2 This test method measures the failure time associated with a given test specimen at a constant, specified, ligament-stress level.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 Definitions are in accordance with Terminology F412~~AASHTO Standard Specification M 294,~~ , and abbreviations are in accordance with Terminology D1600, unless otherwise specified.

1.5 *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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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]

D1600 Terminology for Abbreviated Terms Relating to Plastics
D1822 Test Method for Tensile-Impact Energy to Break Plastics and Electrical Insulating Materials
D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
D5397 Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
E4 Practices for Force Verification of Testing Machines
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
F412 Terminology Relating to Plastic Piping Systems

~~2.2 *Other Document:*~~
~~AASHTO Standard Specification M 294~~[3]

3. Summary of Test Method

3.1 This test method subjects a dumbbell-shaped, notched test-specimen (Fig. 1) to a constant ligament-stress in the presence of a surface-active agent at an elevated temperature. It differs from Test Method D5397 in that a constant ligament stress is used instead of a constant tensile load.

[1] This test method is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.40 on Test Methods.
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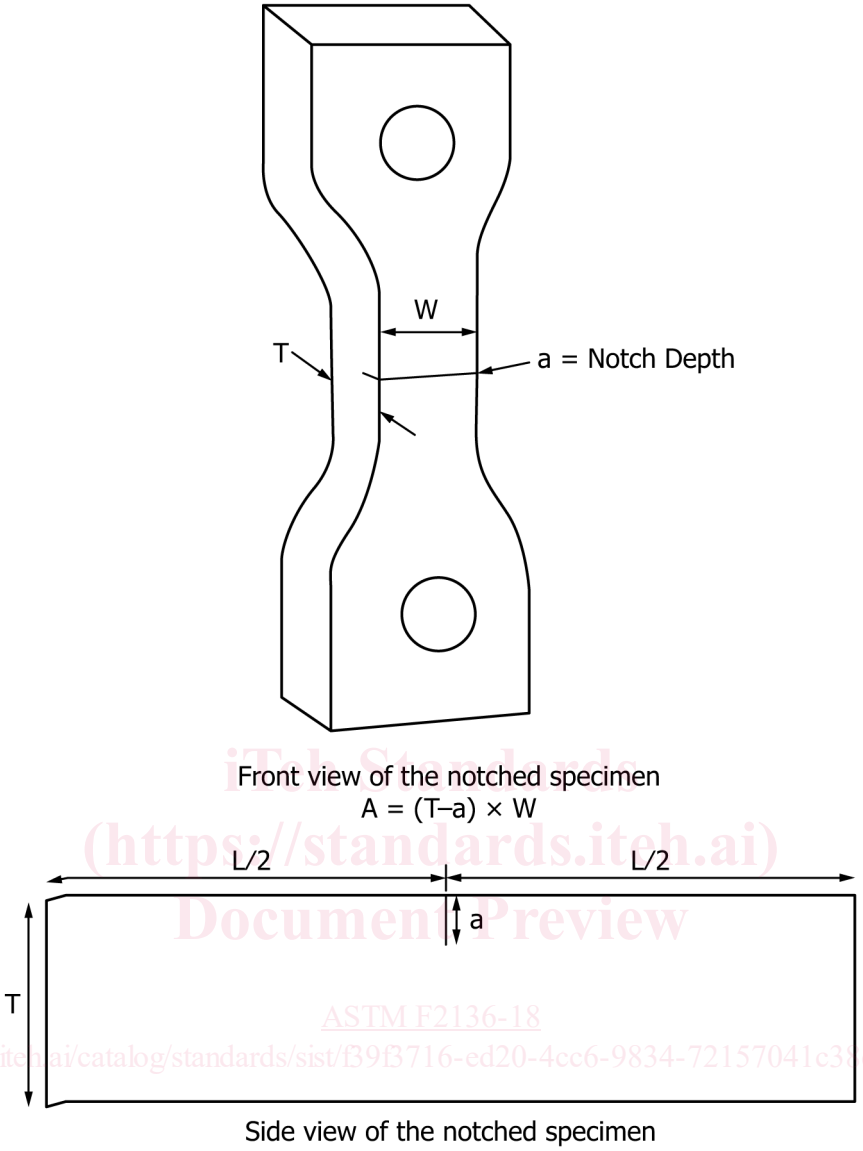
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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



T = thickness.
W = specimen width.

NOTE 1—The test specimen is intended to have the same geometry used for Test Method D5397 specimens. The length of the specimen can be changed to suit the design of the test apparatus. However, there should be a constant neck section with length at least 0.5 in. (13 mm) long.

NOTE 2—It is preferable to modify the specimen die so that the attachment holes are punched out at the same time as the specimen rather than punching or machining them into the specimen at a later time. If the attachment holes are introduced at a later time, it is extremely important that they be carefully aligned so as to avoid adding a twisting component to the stress being placed on the specimen.

FIG. 1 Notching Position

4. Significance and Use

4.1 This test method does not purport to interpret the data generated.

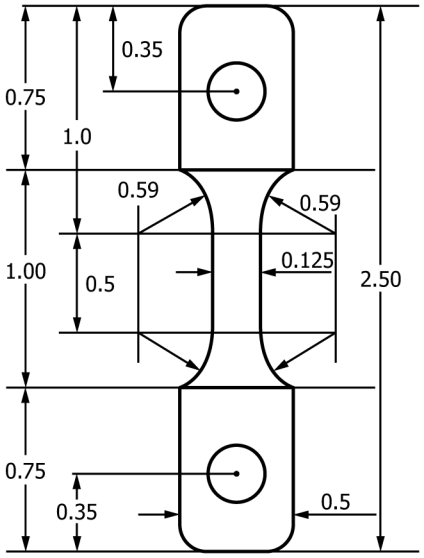
4.2 This test method is intended to compare slow-crack-growth (SCG) resistance for a limited set of HDPE resins.

4.3 This test method may be used on virgin HDPE resin compression-molded into a plaque or on extruded HDPE corrugated pipe that is chopped and compression-molded into a plaque (see 7.1.1 for details).

5. Apparatus

5.1 *Blanking Die*—A die suitable for cutting test specimens. Acceptable dies are: the type L die per Test Method D1822, with holes drilled or punched in the tab areas after die cutting; a die with the dimensions and tolerances specified in Fig. 2.

5.2 *Stress-Crack Testing Apparatus*—A lever loading machine, with a lever arm ratio of 2:1 to 5:1 similar to that described in Test Method D5397. Alternatively, the tensile load may be applied directly using dead weights or any other method for producing



NOTE 1—Dimensions are in inches with tolerance of ±0.005 in., except specimen width, which has a tolerance of ±0.001 in.

FIG. 2 Specimen Geometry—Test Specimen Dimensions

a constant ligament stress. Determine the zero-load offset and lever-arm ratio for each test station, using a force standard that complies with Practices E4. The load on the specimen shall be accurate to 0.5 % of the calculated or applied load. The bath solution temperature shall be set at 122 ± 2°F (50 ± 1°C).

5.3 *Notching Device*—Notch depth is an important variable that must be controlled. Paragraph 7.2.1 describes the notching procedure and type of apparatus used. The approximate thickness of the blade should be 0.2 to 0.3 mm.

NOTE 1—A round robin was conducted to determine the effect of types of blades on the notch depth. In this study, several types of steel blades (single-edge, double-edge, and so forth) from various manufacturers were used by the round-robin participants. The round robin consisted of seven laboratories using two types of resins molded into plaques. The standard deviation of the test results within laboratories is less than ±10 %.

5.4 *Micrometer,* capable of measuring to ±0.001 in. (±0.025 mm).

5.5 *Microscope,* equipped with micrometer or an equivalent device capable of accurately measuring the notch depth.

5.6 *Compression-Molding Press and Suitable Chase for Compression-Molding the Specimens,* in accordance with Practice D4703.

5.7 *Metal Shot,* for weight tubes.

5.8 *Electronic Scale,* for measuring shot weight tubes capable of measuring to ±0.1 g.

5.9 *Timing Device,* capable of recording failure time to the nearest 0.1 h.

6. Reagents

6.1 The stress-cracking reagent shall consist of 10 % nonylphenoxy poly (ethyleneoxy) ethanol by volume in 90 % deionized water. The solution level is to be checked daily and deionized water used to keep the bath at a constant level.

7. Procedure

7.1 *Specimen Preparation:*

7.1.1 Compression-mold pellet specimens (virgin resin) or chopped pipe into 0.075-in. (1.9-mm) sheet in accordance with Procedure C of Practice D4703, except that the pellets do not have to be roll-milled prior to being compression-molded. The rate of cooling shall be 27 +/- 3.6°F (15 ± 2°C) per minute. If desired, the sheet may be trimmed by 0.6 in. (15 mm) on each side in order to avoid any edge effects. Since pipes have extrusion-induced orientation that can significantly affect the test results, it is necessary to remove the orientation effect by molding into a plaque. Chop and mold a pipe specimen in accordance with the following procedure. Cut 1-in. (25-mm) wide sections from the pipe along its longitudinal axis. To randomize the orientation, cut these sections into smaller pieces until there is about 1 lb (0.5 kg) of material. These sections represent a complete cross-sectional sample from the inside to the outside of the pipe specimen. Compression mold a plaque as previously stated. If different materials are used for the inner and outer wall of dual wall pipe, each wall must be tested separately.

7.1.2 Die cut test specimens from the sheet, and make holes in the specimen as shown in Fig. 1.

7.1.3 Specimen tolerances are as follows: