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# Standard Test Method for Charpy Impact Test on Thin Specimens of Polyethylene Used in Pressurized Pipes[1]

This standard is issued under the fixed designation F2231; 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 describes the specimen preparation and the method of measuring the impact energy of polyethylene used in pressurized pipes.

1.2 The test specimens are taken from compression molded plaques of the resin from pellets or pipe.

1.3 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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:*[2]

D6110 Test Method for Determining the Charpy Impact Resistance of Notched Specimens of Plastics

F412 Terminology Relating to Plastic Piping Systems

2.2 *ISO Standard:*

ISO 13477 Small Scale Steady State S-4 Test[3]

## 3. Terminology

3.1 *General*—Definitions are in accordance with Terminology F412 unless otherwise indicated.

3.2 *Definitions of Terms Specific to this Standard:*

3.3 *ultimate critical temperature, (CT)*—for RCP in a pressurized pipe, the temperature above which RCP is not possible at any pressure based on ISO 13477.

## 4. Summary of Test Method

4.1 The Charpy specimen is 3 mm thick and taken from a compression-molded plaque of the resin. The specimen is notched precisely with a razor blade and tested between 19 °C and 27°C.

## 5. Significance and Use

5.1 Brown and Lu [4,5] show the Charpy impact energy is related to the ultimate critical temperature of the rapid crack propagation [RCP] behavior as measured by the ISO 13477, S-4 test.[6]

5.2 The test method may be used to determine the impact energy of polyethylene used in the manufacture of pipe . This test method involves the preparation of a small compression molded specimen of PE resin that is then notched in a specified manner. The specimen is then broken in a pendulum impact machine. The impact energy is recorded in joules. The value obtained is referred to as the Charpy impact energy.

## 6. Apparatus

6.1 *Impact Tester,* with input energy of 1 to 3 J and impact velocity of about 3.0 µs. The energy loss shall be measured with a precision of ±0.004 J.

6.2 *Notching Machine,* shall be capable of notching with a razor blade with a precision of ±0.01 mm and pressing the razor blade into the specimen.

6.3 Details concerning pendulum impact machines are in Test Method D6110 section on Apparatus.

## 7. Test Specimen

7.1 The specimen is machined from the compression molded plaque of the resin. The resin may come from pellets or from sections taken from a pipe.

7.2 The specimen geometry is shown in Fig. 1.

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[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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Brown, N. and Lu, X., "Dependence of Rapid Crack Propagation in PE Pipes on the Plane Stress Fracture Energy of the Resin," *Polymer Engineering and Science* Vol 41, 2001, p. 1140.

[5] Brown, N. and Lu, X., "A Simple Test to Prevent Rapid Crack Propagation," *Plastic Pipes XI*, Munich, 2001, p. 583.

[6] The critical temperature is also related to the dimensions of the pipe.

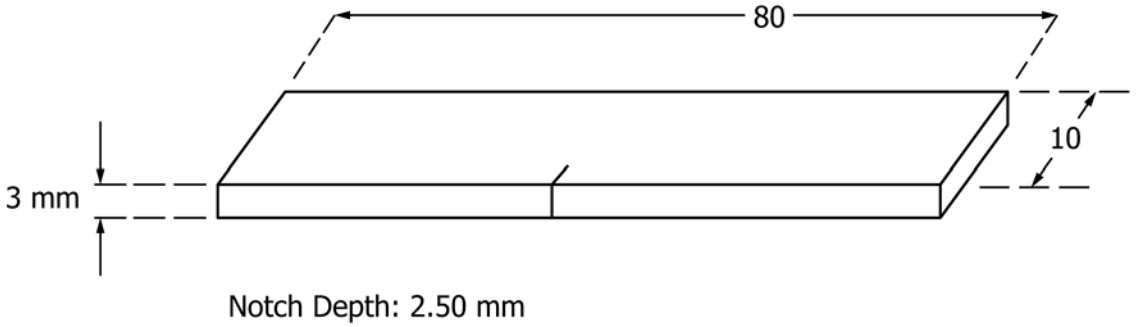


**FIG. 1 Geometry of Impact Specimen**

7.3 The dimension tolerances are as follows: thickness = 3 ± 0.2 mm; width = 10 ± 0.2 mm; length = 80 ± 1 mm; notch depth = 2.50 ± 0.02 mm. The notch is centered within a distance of 40 ± 0.5 mm from the end.

## 8. Preparation of the Compression Molded Plaque

8.1 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, a higher temperature for a lower melt index. The purpose of applying and removing he pressure is to eliminate voids. Turn off the heat and apply pressure. The time to cool between 130 and 190°C shall be greater than 80 min. Alternatively the time to cool from the molding temperature to room temperature shall be greater than 5 h. During cooling the pressure is allowed to decrease naturally.

## 9. Procedure

9.1 The span of the specimen on the impact machine shall be 40 ± 0.5 mm.

9.2 The fracture energy shall be less than 85 % of the input energy. Choose the minimum input energy that satisfies this requirement.

9.3 The pendulum impact machine shall be rigidly fixed in accordance with Test Method D6110.

9.4 The test temperature shall be between 19 and 27°C, but the impact testing of all specimens shall be conducted within a range of ±0.5°C.

9.5 The notch shall be in the center of the span.

9.6 Follow Test Method D6110 section 10.2 on Machine Preparation, and the sections 10.3.2 to 10.3.4 on Specimen Testing.

## 10. Test Results

10.1 Test five specimens. Calculate the average value and the standard deviation. Note intralaboratory repeatability is 5.0 % according to the precision statement in 12.1.

## 11. Report

11.1 Report the following information:
11.1.1 Identify the resin by manufacturer, type, and grade,
11.1.2 Thickness, width, and length of each specimen,
11.1.3 Depth of notch,
11.1.4 Impact energy of each specimen in joules,
11.1.5 Average value and standard deviation of the energies in joules, and
11.1.6 Temperature at the impact machine.

## 12. Precision and Bias[7]

12.1 *Precision*—A round robin was conducted by 6 laboratories on 3 gas pipe resins. The intralaboratory repeatability is 5.0 %. The interlaboratory reproducibility is 16.2 %.

12.2 *Bias*—No statement on bias can be made because there is no established reference value.

[7] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:F17-1048.