Designation: D3420 – 14

Standard Test Method for Pendulum Impact Resistance of Plastic Film[1]

This standard is issued under the fixed designation D3420; 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 covers the determination of resistance of film to impact-puncture penetration. Knowledge of how the impact energy is absorbed by the specimen while it is deforming under the impact loading, and the behavior of the specimen after yielding, is not provided by this test. No provision is made for nonambient temperatures in this test method.

1.2 The values stated in SI units are to be regarded as the 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 and health practices and determine the applicability of regulatory limitations prior to use.* Specific hazards statements are given in Section 7.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D883 Terminology Relating to Plastics

D1709 Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method

D1922 Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method

D4272 Test Method for Total Energy Impact of Plastic Films By Dart Drop

D6988 Guide for Determination of Thickness of Plastic Film Test Specimens

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions*—Definitions of terms relating to plastics not otherwise described in this test method shall be in accordance with Terminology D883.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *failure completion energy*—the energy necessary to initiate failure plus the energy necessary to cause complete rupture to the test specimen.

3.2.2 *failure initiated energy*—the energy necessary to begin failure of the test specimen.

3.2.3 *pendulum impact resistance*—the resistance to failure of plastic film is measured by loss in mechanical work capacity due to the expenditure of kinetic energy by a pendulum.

4. Summary of Test Method

4.1 The energy necessary to burst and penetrate the center of a specimen, mounted between two plates with a circular aperture, is measured by the loss in mechanical work-capacity due to the expenditure of kinetic energy by a pendulum, the rounded probe of which passes through the test specimen. Corrections for "toss factor" or kinetic energy imparted to the puncture fragment of the test specimen are not made, as only tiny masses are involved. The pendulum head hits the specimen with a maximum velocity of about 74 m/min and a maximum energy of about 5 J (50 cm·kgf).

5. Significance and Use

5.1 Like other techniques to measure toughness, this test method provides a means to determine parameters of a material at strain rates closer to some end-use applications than provided by low-speed uniaxial tensile tests. Dynamic tensile behavior of a film is important, particularly when the film is used as a packaging material. The same uncertainties about correlations with thickness that apply to other impact tests also apply to this test (see section 3.4 of Test Methods D1709). Hence, no provision for rationalizing to unit thickness is provided. Also, no provision is made for testing at non-ambient temperatures.

5.2 This test method includes two procedures, similar except with regard to sample size: Procedure A for 60-mm diameter and Procedure B for 89-mm diameter (commonly called the "Spencer"). The data have not been shown relatable to each other.

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.19 on Film, Sheeting, and Molded Products.

Current edition approved Dec. 1, 2014. Published December 2014. Originally approved in 1975. Last previous edition approved in 2008 as D3420 – 08a. DOI: 10.1520/D3420-14.

[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**

5.3 Several impact test methods are used for film. It is sometimes desirable to know the relationships among test results derived by different methods. A study was conducted in which four films made from two resins (polypropylene and linear low-density polyethylene), with two film thicknesses for each resin, were impacted using Test Methods D1709 (Method A), Test Method D3420 (Procedures A and B), and Test Method D4272. The test results are shown in Appendix X2. Differences in results between Test Methods D1709 and D4272 are expected since Test Methods D1709 represents failure initiated energy while Test Method D4272 is initiation plus completion energy. Some films have shown consistency when the initiation energy was the same as the total energy. This statement and the test data also appear in the significance and appendixes sections of Test Methods of D1709 and D4272.

6. Apparatus

6.1 *Tester,*[3] having a heavy base plate (to be bolted down when the higher energy ranges are used), housing, and frame upon which is located a free-swinging pendulum with an impact head. The dimensions for the impact heads for Procedures A and B are as follows:

6.1.1 *Procedure A*—Hemispherical, having a smooth surface of 12.7-mm (0.5-in.) radius and 25.4-mm (1.0-in.) diameter, which when released from the starting position punctures the material. The specimen is clamped between two plates with a circular aperture of 60 ± 0.3-mm (2.362 ± 0.012-in.) diameter in the center.

6.1.2 *Procedure B*—Having a smooth surface of 12.7-mm (0.5-in.) radius, and 19.0-mm (0.75-in.) diameter, which when released from the starting position punctures the material. The specimen is clamped between two plates with a circular aperture of 89 ± 0.5 mm (3.50 ± 0.02 in.). Several types of clamps are available on the Spencer testers: a slip-ring type, manual-tightening type with O-ring, and air-operated type with O-ring. The O-ring type, either manual or air-operated, is recommended to minimize slippage of the test specimen. The air-operated O-ring clamp shall be the referee-type.

6.1.3 *Calibrated Dial or Digital Readout,* to record the energy necessary to burst and penetrate the specimen (a scale and pointer with indicating follower and attachable auxiliary weights to give suitable energy scales). Four energy scales have been found suitable, 0.5, 1.0, 2.5, and 5.0 J (5, 10, 25, and 50 cm·kgf), for Procedure A through the use of attachable auxiliary weights. For Procedure B, a modified Elmendorf tester having a capacity of 1600 gf (3200 gf with auxiliary weight) is normally used. Pendulums of 200, 400, and 800 gf are also available. Equivalent energy capacities for these force capacities are as follows:

gf	J (cm·kgf)
200	0.169 (1.7)
400	0.338 (3.4)
800	0.675 (6.8)
1600	1.35 (13.5)
3200	2.70 (27)

[3] A tester of the Procedure A type is available from Testing Machines Inc. (TMI), 2 Fleetwood Court, Ronkonkoma, NY 11779. A tester of the Procedure B type is available from Thwing-Albert Instrument Co., 14 W. Collings Ave., West Berlin, NJ 08091.

6.2 *Micrometer,* reading to ±0.00025 mm (±0.00001 in.) for measuring specimen thickness.

6.3 *Specimen Cutter.*

7. Hazards

7.1 In Procedure A do not release the pendulum manually when the temperature chamber is in position unless the unit is plugged in and energized; otherwise the chamber doors will not open and will be struck by the pendulum ball. In either procedure, be sure that the hands are kept out of the pendulum path when it is in the cocked position.

8. Test Specimens

8.1 Obtain samples that are of uniform thickness and consistency, flat, free of defects, and representative of the material to be tested.

NOTE 2—Although the scope of this test method is for films [sheeting ≤0.25 mm (≤10 mils)], samples up to 0.40 mm (15 mils) have been tested, representing the upper limit imposed by the design of the clamp, without damage to the pendulum.

8.2 From throughout the sample, cut at least five specimens, 100-mm (4-in.) diameter circular, or 100 by 100-mm (4 by 4-in.) square or larger if clamps require.

9. Preparation of Apparatus

9.1 *Procedure A:*

9.1.1 Level the instrument carefully, using the level located on the instrument (assuming the level has been properly mounted and calibrated).

9.1.2 Attach the largest weight (for example, "50 cm·kgf" or "5.0 J").

9.1.3 Adjust the auxiliary weights on the rear of the pendulum so the pendulum hangs vertically when free.

9.1.4 Set the pointer on Point *P* of the scale, and adjust the arm that moves the pointer so it just contacts the pointer in this position.

9.1.5 Release the pendulum from its latched position and allow to swing freely (with no sample). The pointer shall come to within one scale division of the zero point. If this is not the case, the bearing likely needs cleaning.

9.1.6 Whenever the range of test is changed, the instrument must be reset so the "pointer pusher" is against the pointer with the pointer at *P* and the pendulum hanging freely. This is done by repositioning the auxiliary weights.

9.1.7 Select the energy range and attach the correct weights to the pendulum. Do not use a higher range than is necessary to ensure rupture of the film under test.

9.2 *Procedure B:*

9.2.1 Locate the instrument on a level surface.

9.2.2 Zero the instrument in accordance with Test Method D1922 if the instrument has a pointer, or refer to the manufacturer's recommendations if it has a digital readout.

9.2.3 Select the weight so that the scale readings do not fall on the extreme ends of the range when testing specimens.

9.2.4 Slippage of the specimen in the clamp when it is struck by the impact head is a recognized cause for testing error. The condition of the clamp and its operation must be