INTERNATIONAL

Designation: D3763 – 23

Standard Test Method for High Speed Puncture Properties of Plastics Using Load and Displacement Sensors[1]

This standard is issued under the fixed designation D3763; 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 puncture properties of rigid plastics over a range of test velocities.

1.2 Test data obtained by this test method are relevant and appropriate for use in engineering design.

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

NOTE 1—This standard and ISO 6603-2 address the same subject matter, but differ in technical content. The technical content and results shall not be compared between the two test methods.

1.5 *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]

D618 Practice for Conditioning Plastics for Testing

D883 Terminology Relating to Plastics

D4000 Classification System for Specifying Plastic Materials

E456 Terminology Relating to Quality and Statistics

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

E2935 Practice for Evaluating Equivalence of Two Testing Processes

2.2 *ISO Standard:*[3]

ISO 6603-2 Plastics—Determination of Multi-axial Impact Behavior of Rigid Plastics Part 2: Instrumented Puncture Test

3. Terminology

3.1 *Definitions*—Terms used in this standard are defined in accordance with Terminology D883, unless otherwise specified. For terms relating to precision and bias and associated issues, the terms used in this standard are defined in accordance with Terminology E456.

4. Significance and Use

4.1 This test method is designed to provide load versus deformation response of plastics under essentially multi-axial deformation conditions at impact velocities. This test method further provides a measure of the rate sensitivity of the material to impact.

4.2 Multi-axial impact response, while partly dependent on thickness, does not necessarily have a linear correlation with specimen thickness. Therefore, results must be compared only for specimens of essentially the same thickness, unless specific responses versus thickness formulae have been established for the material.

4.3 For many materials, there are cases where a specification that requires the use of this test method, but with some procedural modifications that take precedence when adhering to the specification. Therefore, it is advisable to refer to that material specification before using this test method. Table 1 of Classification System D4000 lists the ASTM materials standards that currently exist.

5. Interferences

5.1 *Inertial Effects*—A loading function encountered when performing an instrumented impact test that will, in some

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties.

Current edition approved Nov. 1, 2023. Published November 2023. Originally approved in 1979. Last previous edition approved in 2018 as D3763 – 18. DOI: 10.1520/D3763-23.

[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.

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

cases, confuse the interpretation of the test data. For further definition and examples of inertial effects, refer to Appendix X1.

6. Apparatus

6.1 The testing machine shall consist of two assemblies, one fixed and the other driven by a suitable method to achieve the required impact velocity (that is, hydraulic, pneumatic, mechanical, or gravity):

6.1.1 *Clamp Assembly,* consisting of two parallel rigid plates with a 76.0 ± 3.0 mm diameter hole in the center of each. The hole edges shall be rounded to a radius of 0.8 ± 0.4 mm. Sufficient force must be applied (mechanically, pneumatically, or hydraulically) to prevent slippage of the specimen in the clamp during impact.

6.1.2 *Plunger Assembly,* consisting of a 12.70 ± 0.13 mm diameter steel rod with a hemispherical end of the same diameter positioned perpendicular to, and centered on, the clamp hole.

6.1.3 *Other Geometries*—The dimensions given in 6.1.1 and 6.1.2 shall be the standard geometry. If other plunger or hole sizes are used they shall be highlighted in the report. Correlations between various geometries have not been established.

6.1.4 *Load Sensing System*—A load cell of sufficiently high natural resonance frequency, as described in A1.1, used together with a calibrating network for adjusting load sensitivity.

6.1.5 *Plunger Displacement Measurement System*—A means of monitoring the displacement of the moving assembly during the loading and complete penetration of the specimen. Acceptable methods and devices for measuring displacement include a suitable transducer or potentiometer attached directly to the system, photographic or optical systems.

6.1.5.1 Alternatively, it is possible to calculate displacements as a function of velocity and total available energy at initial impact, along with increments of load versus time, using a microprocessor.

6.1.5.2 Some machines use an accelerometer, whose output is used to calculate both load and displacement.

6.1.6 *Display and Recording Instrumentation*—Use any suitable means to display and record the data developed from the load and displacement-sensing systems, provided its response characteristics are capable of presenting the data sensed, with minimal distortion. The recording apparatus shall record load and displacement simultaneously. For further information, see A1.2.

6.1.6.1 The most rudimentary apparatus is a cathode-ray oscilloscope with a camera. This approach also requires a planimeter or other suitable device, capable of measuring the area under the recorded load-versus-displacement trace of the event with an accuracy of ±5 %.

6.1.6.2 More sophisticated systems are commercially available. Most of them include computerized data reduction and automatic printouts of results.

7. Test Specimen

7.1 Specimens must be large enough to be adequately gripped in the clamp. In general, the minimum lateral dimension shall be at least 13 mm greater than the diameter of the hole in the clamp (see 6.1.1 and 10.9).

7.2 Specimens shall be cut from injection-molded, extruded, or compression molded sheet; or be cast or molded to size.

8. Conditioning

8.1 *Conditioning*—Condition the test specimens in accordance with Procedure A in Practice D618 unless otherwise specified by contract or the relevant ASTM material specification. Temperature and humidity tolerances shall be in accordance with Section 7 of Practice D618, unless otherwise specified by contract or relevant ASTM material specification.

8.2 *Test Conditions*—Conduct tests at the same temperature and humidity used for conditioning with tolerances in accordance with Section 7 of Practice D618, unless otherwise specified by contract or relevant ASTM material specification.

8.2.1 It is possible to determine the temperature at which transition from ductile to brittle failure occurs in most plastics by changing the conditioning and test temperature in a controlled manner for a given test velocity.

NOTE 2—To facilitate high throughput during automated testing at temperatures other than ambient, it is often necessary to stack the specimens in a column with no airflow in between. To assure compliance with Section 10 of Practice D618, the time to equilibrium must be determined for a given material. A thermocouple may be placed at the center of a specimen stack in which its height is equal to its minimum width. Determine the time to reach equilibrium at the desired test temperature. Experiments with materials having low thermal conductivity values have shown that more than 7.5 h of soak time was required before the stack center temperature fell within the tolerances specified in D618 at a setpoint of –40°C. Two and a half additional hours were needed to reach equilibrium. The opposite extreme was seen in a material of higher thermal conductivity that only required 2 h to reach equilibrium at –40°C.

NOTE 3—The impact behavior of some materials (for example, polypropylene, polyethylene), at sub-ambient temperatures, can be affected by the delay or "transit" time[4] after the specimen is removed from a remote environmental conditioning/freezer chamber. The transit time is defined as the total time from the removal of the specimen from the conditioning environment until the specimen is impacted.

9. Speed of Testing

9.1 For recommended testing speeds see 10.4.

10. Procedure

10.1 Test a minimum of five specimens at each specified speed.

10.2 Measure and record the thickness of each specimen to the nearest 0.025 mm at the center of the specimen. In the case of injection molded specimens, it is sufficient to measure and record thickness for one specimen when it has been previously demonstrated that the thickness does not vary by more than 5 %.

10.3 Clamp the specimen between the plates of the specimen holder, taking care to center the specimen for uniform gripping. Tighten the clamping plate in such a way as to provide uniform clamping pressure to prevent slippage during testing.

10.4 Set the test speed to the desired value. The testing speed (movable-member velocity at the instant before contact with the specimen) shall be as follows:

[4] Transit Time: Reference from ISO document 6603-1-clause 7.1.2 and 7.1.3.