INTERNATIONAL

Designation: D8540 − 23

Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position Using a Dry Bath[1]

This standard is issued under the fixed designation D8540; 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 the temperature at which an arbitrary deformation occurs when specimens are subjected to an arbitrary set of testing conditions.

1.2 This test method applies to molded and sheet materials available in thicknesses of 3 mm (⅛ in.) or greater and which are rigid or semirigid at normal temperature.

NOTE 1—Sheet stock less than 3 mm (0.125 in.) but more than 1 mm (0.040 in.) in thickness may be tested by use of a composite sample having a minimum thickness of 3 mm. The laminae must be of uniform stress distribution. One type of composite specimen has been prepared by cementing the ends of the laminae together and then smoothing the edges with sandpaper. The direction of loading shall be perpendicular to the edges of the individual laminae.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.4 This standard and ASTM D648 address the same subject matter and are essentially the same test. However, due to known differences in results caused by the differences in heat transfer media, the results from this standard and ASTM D648 must not be compared or considered equivalent.

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

NOTE 2—The text of this standard references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

NOTE 3—This standard and ISO 75-1 and ISO 75-2 address the same subject matter, but differ in technical content, and results shall not be compared between the two test methods.

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]

D618 Practice for Conditioning Plastics for Testing
D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
D883 Terminology Relating to Plastics
D4000 Classification System for Specifying Plastic Materials
D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens
E1 Specification for ASTM Liquid-in-Glass Thermometers
E77 Test Method for Inspection and Verification of Thermometers
E608/E608M Specification for Mineral-Insulated, Metal-Sheathed Base Metal Thermocouples
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E1137/E1137M Specification for Industrial Platinum Resistance Thermometers
E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

2.2 *ISO Standards:*[3]

ISO 75-1 Plastics—Determination of Temperature of Deflection Under Load—Part 1: General Test Method
ISO 75-2 Plastics—Determination of Temperature of Deflection Under Load—Part 2: Plastics and Ebonite
IEC 60751 Industrial Platinum Resistance thermometers and platinum temperature sensors.
IEC 60584-1 Thermocouples—Part 1 EMF specifications and tolerances

[1] This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.30 on Thermal Properties.

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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.

2.3 *NIST Document:*[4]
NBS Special Publication 250-22

3. Terminology

3.1 *General*—The definitions of plastics used in this test method are in accordance with Terminology D883 unless otherwise indicated.

4. Summary of Test Method

4.1 A bar of rectangular cross section is tested in the edgewise position as a simple beam with the load applied at its center to give maximum fiber stresses of 0.455 MPa (66 psi), 1.82 MPa (264 psi) or 8.0 MPa (1160 psi). The specimen is immersed under load in a heat-transfer medium provided with a means of raising the temperature at 2 ± 0.2°C ⁄min. The temperature of the medium is measured when the test bar has deflected 0.25 mm (0.010 in.). This temperature is recorded as the deflection temperature under flexural load of the test specimen.

5. Significance and Use

5.1 This test is particularly suited to control and development work. Data obtained by this test method shall not be used to predict the behavior of plastic materials at elevated temperatures except in applications in which the factors of time, temperature, method of loading, and fiber stress are similar to those specified in this test method. The data are not intended for use in design or predicting endurance at elevated temperatures.

5.2 For many materials, it is possible there will be 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. Refer to Table 1 in Classification D4000, which lists the ASTM material standards that currently exist.

6. Interferences

6.1 The results of the test are dependent on the rate of heat transfer between the heat transfer medium and the specimen and the thermal conductivity of the heat transfer media.

6.2 The results of this test are dependent on the measured width and depth of the specimen and the final deflection at which the deflection temperature is determined.

6.3 The type of mold and the molding process used to produce test specimens affects the results obtained in this test. Molding conditions shall be in accordance with the standard for that material or shall be agreed upon by the cooperating laboratories.

6.4 Results of testing are affected by the design of the test equipment. The test span (100 mm) will influence the resultant measurement. Instrumentation equipped with metal clips or other types of auxiliary supports designed to maintain specimens perpendicular to the applied load will affect the test results if the pressure is sufficient to restrict the downward motion of the specimen at its center.

7. Apparatus

7.1 The apparatus shall be constructed essentially as shown in Fig. 1 and shall consist of the following:

7.1.1 *Specimen Supports,* metal supports, allowing the load to be applied on top of the specimen vertically and midway between the supports, which shall be separated by a distance, defined in 7.1.1.1. The contact edges of the supports and of the piece by which load is applied shall be rounded to a radius of 3 ± 0.2 mm (0.118 ± 0.008 in.).

7.1.1.1 *Span*—100.0 ± 0.5 mm (3.937 ± 0.020 in.).

7.1.2 *Immersion Bath*—An immersion bath containing the heat-transfer medium shall be equipped with an agitation system, temperature-measuring device, and heater. The heater shall have automatic control of the selected bath temperature rise rate. The bath shall be constructed to allow the specimens to be submerged at least 35 mm below the surface of the heat-transfer medium.

7.1.3 *Heat-Transfer Medium*—Shall be a fluidized powder in which the specimen shall be immersed, which will not affect the specimen. It shall be well-agitated during the test and shall be provided with a means of raising the temperature at a uniform rate of 2 ± 0.2°C ⁄min. This heating rate shall be considered to be met if, over every 5-min interval during the test, the temperature of the bath shall rise 10 ± 1°C at each specimen location.

NOTE 4—Aluminum Oxide has been found satisfactory and safe for short-term heat cycles up to 500°C.

7.1.4 *Deflection Measurement Device,* suitable for measuring specimen deflection of at least 0.25 mm (0.010 in.). It shall be readable to 0.01 mm (0.0005 in.) or better. Electronic displacement sensing devices shall be used.

7.1.5 *Weights*—A set of weights of suitable sizes so that the specimen are loaded to a fiber stress of 0.455 MPa (66 psi) ± 2.5 % ,1.82 MPa (264 psi) ± 2.5 % or 8.00 MPa (1160 psi) ± 2.5%. The mass of the rod that applies the testing force shall be determined and included as part of the total load. Calculate the testing force and the mass that must be added to achieve the desired stress as follows:

$$F = 2Sbd^2/3L \quad (1)$$

$$F^1 = F/9.80665$$

$$M_w = F/9.80665 - m_r$$

where:

F = load, N,
F^1 = load, kgf,
S = fiber stress in the specimen (0.455 MPa, 1.82 MPa or 8.0 MPa),
b = width of specimen, mm,
d = depth of specimen, mm,
L = distance between supports, 100 mm), see 7.1.1.1,
m_w = added mass, kg, and
m_r = mass of the rod that applies the testing force to the specimen, kg.

7.1.6 *Temperature Measurement System:*

[4] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov.

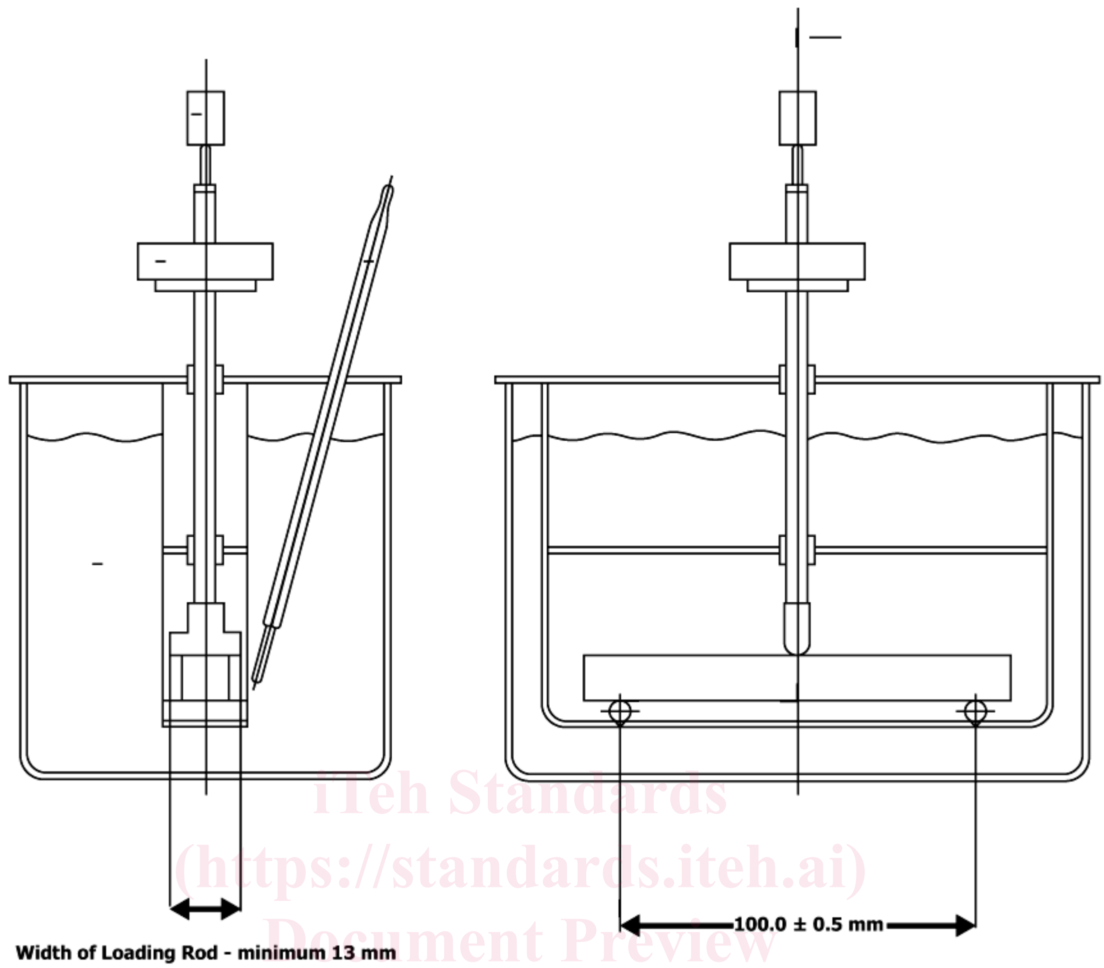

FIG. 1 Apparatus for Deflection Temperature Test

7.1.6.1 *Digital Indicating System*—Consisting of a thermocouple, resistance thermometer (RTD), and so forth, as the sensor, together with associated conditioning, conversion, and readout instrumentation adequate to cover the range being tested. The sensor and related electronics shall be accurate to at least ±0.5°C. Thermocouples shall comply with the requirements of Specification E608/E608M or IEC 60584-1. Resistance thermometers shall comply with the requirements of Specification E1137/E1137M or IEC 60751.

7.2 *Micrometers* shall meet the requirements of Test Methods D5947 and be calibrated in accordance with that test method.

8. Sampling

8.1 Sample in a statistically acceptable manner. When samples are taken from a production lot or process, the process shall be in a state of statistical control.

9. Test Specimen

9.1 At least two test specimens of the same nominal width shall be used to test each sample at each fiber stress. The length of the specimen shall at a minimum be the distance between supports +12.7 mm (0.500 in.). The depth of the specimen must be 12.7 mm ± 0.5 mm (0.500 ± 0.020 in.). The width of the specimen shall be any width from 3 mm to 13 mm (0.118 in. to 0.512 in.).

9.1.1 For tests performed at 8.0 MPa stresses, specimens shall be 6.35 mm or less in width due to the safety concerns of raising and lowering the weights required and the load limitations for common instruments.

NOTE 5—Tolerances on the depth and width dimensions should be of the order of ±0.13 mm (0.005 in.) along the length of the specimen to minimize variations.

NOTE 6—The test results obtained on specimens approaching 13 mm in width may be 2 to 4°C above those obtained from 4 mm or narrower test specimens because of poor heat transfer through the specimen.

9.2 The specimens shall have smooth flat surfaces free from saw cuts, excessive sink marks, or flash.

9.3 Molding conditions shall be in accordance with the specification for that material or shall be agreed upon by the cooperating laboratories. Discrepancies in test results due to variations in molding conditions are often minimized by annealing the test specimens before the test. Since different materials require different annealing conditions, annealing procedures shall be employed only if required by the material standard or if agreed upon by the cooperating laboratories.