Designation: C338 – 93 (Reapproved 2019)

Standard Test Method for Softening Point of Glass[1]

This standard is issued under the fixed designation C338; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers the determination of the softening point of a glass by determining the temperature at which a round fiber of the glass, nominally 0.65 mm in diameter and 235 mm long with specified tolerances, elongates under its own weight at a rate of 1 mm/min when the upper 100 mm of its length is heated in a specified furnace at the rate of 5 ± 1 °C/min.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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. Significance and Use

2.1 This test method is useful to determine approximately the temperature below which the glass behaves as a rigid solid in glass-forming operations and for a control test to indicate changes in composition. It has been found useful for specification acceptance and for providing information in research and development work with glass.

3. Apparatus

3.1 The apparatus for determining the softening point of glass shall consist essentially of an electrically heated resistance furnace, a furnace stand, a device for controlling the heating rate of the furnace, equipment for measuring the temperature of the furnace, and equipment for measuring the elongation rate of a fiber of glass suspended in the furnace.

3.1.1 *Furnace*—The furnace shall conform in all essential respects to the requirements shown in Fig. 1.

3.1.2 *Furnace Stand*—A means shall be provided for supporting the furnace so that the fiber hangs below it. This stand must be provided with a leveling device such as three screws. The stand shown in Fig. 1 is convenient when used with either a cathetometer or a telescope and scale.

3.1.3 *Heating Rate Controller*—Suitable controls shall be provided for maintaining the furnace heating rate at 5 ± 1 °C/min.

NOTE 1—A continually adjustable transformer has proved effective for controlling the heating rate.

3.1.4 *Temperature-Measuring Equipment*— The furnace temperature shall be measured with a calibrated Type R or S thermocouple and a calibrated potentiometer capable of measuring the true temperature of the furnace within ±0.2 °C. The cold junction shall be maintained at 0 °C by means of an ice bath. An alternative acceptable means of temperature measurement is the use of a potentiometer to oppose the thermocouple electromotive force. This potentiometer shall be set at a standard setting for the type of glass being measured, and galvanometer deflection shall serve as a means of obtaining relative temperatures, the deflection of the galvanometer having been calibrated. Also acceptable for temperature measurement is a solid-state digital thermometer that is capable of the accuracy specified.

3.1.5 *Fiber-Elongation Measurement Equipment*—The fiber elongation shall be measured by a device capable of measuring the position of the end of the fiber within 0.02 mm throughout the entire elongation period.

NOTE 2—Suitable devices that have proved effective for measuring the elongation are cathetometers, projection magnifiers, and telescope and scale combinations.

3.1.6 *Timer*—A timing device with a least count and accuracy of 1 s shall be used.

4. Preparation of Test Specimens

4.1 The fiber specimen used for the test shall meet the following requirements:

[1] This test method is under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.04 on Physical and Mechanical Properties.

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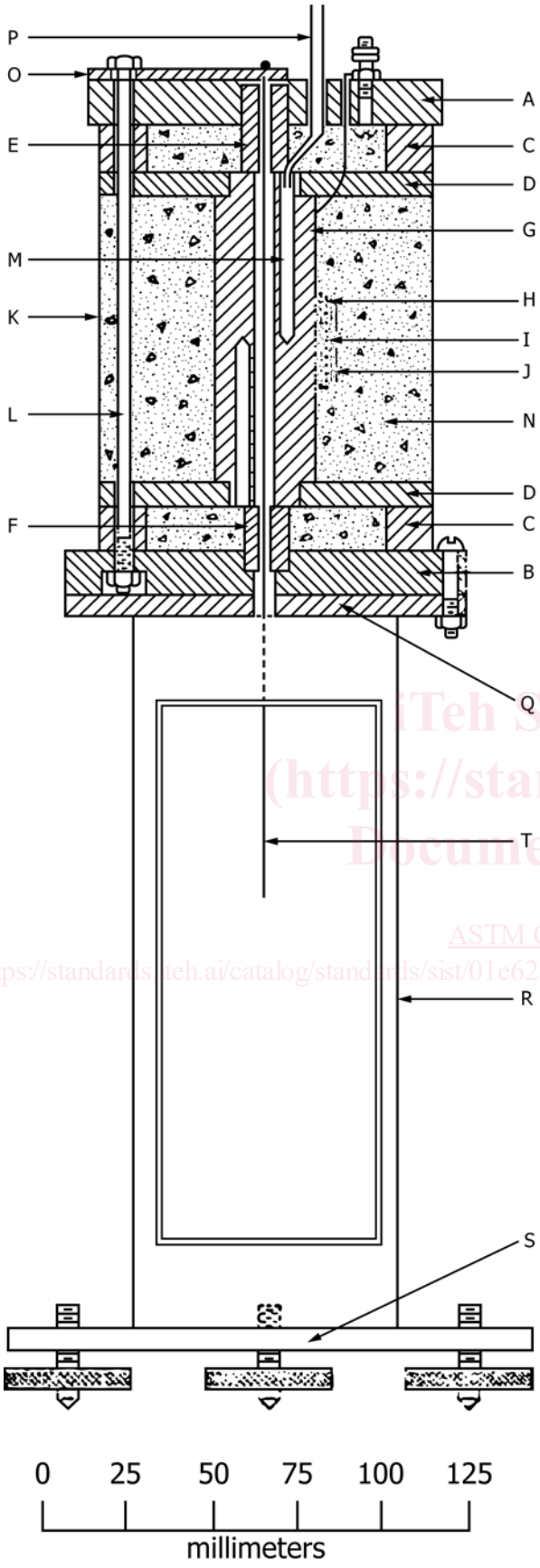

A—Furnace top, 12.70 mm (½ in.) thick by 101.60 mm (4 in.) in diameter, drilled 12.70 mm (½ in.) diameter at center, with three 5.56 mm (7/32 in.) diameter holes for tie rods spaced 120 deg apart on an 82.55-mm (3¼-in.) circle; also, two small holes suitably placed for thermocouple wires and two binding posts with nearby small holes for passage of heater wires. Material to be Transite II or Marenite or equivalent. One required.

B—Furnace bottom, 12.70 mm (½ in.) thick by 14.30 mm (4½ in.) in diameter. Drill at center 12.70 mm (½ in.) diameter, 6.35 mm (¼ in.) deep from top; finish through at 5.56 mm (7/32 in.) diameter. Drill three holes for tie rods 120 deg apart on 82.55-mm (3¼-in.) circle, 12.70 mm (½ in.) diameter, 6.35 mm (¼ in.) deep from bottom, finish through at 5.56 mm (7/32 in.) diameter. Drill three 5.56-mm (7/32 in.) holes on 104.77-mm (4⅛ in.) circle. Material to be asbestos cement (Transite or equivalent). One required.

C—Spacer rings,12.70 mm (½ in.) thick by 93.66 mm (3 11/16 in.) OD by 69.85 mm (2¾ in.) ID, drilled 5.56 mm (7/32 in.) diameter for tie rods. Material to be asbestos cement (Transite or equivalent). Two required.

D—Webs, 6.35 mm (¼ in.) thick by 93.66 mm (3 11/16 in.) diameter drilled 19.05 mm (¾ in.) at center and six 19.05-mm (¾-in.) holes 60 deg apart on 50.8-mm (2-in.) circle; also drilled 5.56 mm (7/32 in.) diameter for tie rods. Material to be asbestos cement (Transite or equivalent). Two required.

E—Cylinder, 25.4 mm (1 in.) high by 12.7 mm (½ in.) OD by 3.17 mm (⅛ in.) ID, relieved at bottom for thermocouple wires as shown. Material to be asbestos cement (Transite or equivalent). One required.

F—Cylinder, 19.05 mm (¾ in.) high by 12.7 mm (½ in.) OD by 3.17 mm (⅛ in.) ID with tapered hole at top as shown in Fig. 1. Material to be asbestos cement (Transite or equivalent). One required.

G—Furnace core, 95.25 mm (3¾ in.) high by 28.58 mm (1⅛ in.) diameter, with 6.35 mm (¼ in.) at each end turned to 19.05 mm (¾ in.) diameter. Entire length drilled at center 5.56 mm (7/32 in.) diameter and symmetrically drilled 3.17 to 5.56 mm (⅛ to 7/32 in.) diameter from each end to depth of 47.62 mm (1⅞ in.) as near to center hole as possible. Material to be stainless steel (such as Inconel, Resisto, or equivalent). One required.

H—Core wrapping, of mica, double thickness.

I—Winding, of No. 20 Nichrome V wire, 55 turns, about 12 Ω, wound the whole length of 82.55 mm (3¼ in.) of furnace core.

J—Alundum cement coating.

K—Furnace shell , 95.25 mm (3¾ in.) ID by 122.24 mm (4 13/16 in.) long, welded. Material to be galvanized sheet steel or preferably stainless sheet steel. One required.

L—Tie rods, 3.97 mm (5/32 in.) by 152.4 mm (6 in.) threaded at both ends. Material to be steel. Three required.

M—Double-bore ceramic tubing, 3.17 to 4.76 mm (⅛ to 3/16 in.) diameter. (First insert 3.17 mm (⅛ in.) length to isolate thermocouple from core G.) Material to be porcelain. One required.

N—Insulation, consisting of diatomaceous earth (Sil-O-Cel or equivalent).

O—Fiber support, 57.15 mm (2¼ in.) by 12.7 mm (½ in.) by 3.17 mm (⅛ in.) with 0.79-mm (1/32-in.) hole on center line 6.35 mm (¼ in.) from one end and 6.35-mm (¼-in.) hole at other end, the holes to be 41.27 mm (1⅝ in.) apart on centers. Material to be brass. One required.

P—Thermocouple leads.

Q—Plate, 6.35 mm (¼ in.) by 114.3 mm (4½ in.) diameter, securely fastened (for example, welded) to lower chamber, with three holes to match edge holes of furnace bottom. Drilled at center 5.56 mm (7/32 in.) diameter. Material to be steel. One required.

R—Lower chamber consisting of cylinder 203.20 mm (8 in.) long and 76.20 mm (3 in.) diameter, carrying a flat glass window 63.5 mm (2½ in.) by 152.4 mm (6 in.). Material to be galvanized sheet steel or preferably stainless sheet steel. One required.

S—Bottom plate, 6.35 mm (¼ in.) by 152.4 mm (6 in.) diameter securely fastened (for example, welded) to lower chamber and carrying three levelling screws on 133.35-mm (5¼-in.) circle. Material to be steel. One required.

T—Glass samples, 235 ± 1.0 mm in length, exclusive of bead at top end, and 0.65 ± .10 mm in diameter, uniform to ± 0.01 mm.

NOTE—Equivalent materials may be employed, where available.

FIG. 1 Details of Softening Point Furnace