National Institute of Standards & Technology

Certificate

Standard Reference Material® 717a

Borosilicate Glass

This Standard Reference Material (SRM) is primarily intended to check test methods and to calibrate equipment for the determination of the viscosity of glass in accordance with ASTM Procedure C 965 [1]. A unit of SRM 717a consists of a borosilicate glass block with nominal dimensions: 40 mm x 40 mm x 150 mm, and a nominal mass of 570 g.

The certified viscosity was obtained from the results of seven cooperating laboratories, used to calculate a consensus fit of the Fulcher equation as follows:

$$\log_{10} [\text{viscosity (Pa·s)}] = -2.5602 + 4852.2/(t - 192.462)$$

where t is the temperature expressed in °C.

From that consensus fit, the certified viscosity values versus temperature were calculated. Noncertified viscosity values for the temperature range of 834 °C to 540 °C and borosilicate glass fixpoint temperatures are given for information only in Tables 2 and 3.

Table 1. Certified Viscosity

Log_{10} [Viscosity (Pa·s[a])]	Temperature (°C)
1.00 ± 0.06	1555
1.25 ± 0.06	1466
1.50 ± 0.07	1388
1.75 ± 0.08	1318
2.00 ± 0.10	1256
2.25 ± 0.11	1201
2.50 ± 0.12	1151
2.75 ± 0.13	1106
3.00 ± 0.14	1065
3.25 ± 0.14	1028
3.50 ± 0.15	993
3.75 ± 0.15	961
4.00 ± 0.16	932
4.25 ± 0.16	905
4.50 ± 0.17	880

[a]The SI unit for viscosity is Pa·s [2]. To convert from poise to Pa·s divide by 10. The viscosity in Table 1 is expressed in the customary manner as $\log_{10}$ viscosity. If $\log_{10}$ [viscosity (Pa·s)] = 1.0 ± 0.06 then $\log_{10}$ [viscosity (poise)] = 2.0 ± 0.06.

The uncertainties stated above are the 95 % simultaneous confidence intervals for the Fulcher equation.

The support aspects involved in the certification and issuance of this SRM were coordinated through the Standard Reference Materials Program by J.S. Kane and R.J. Gettings.

Gaithersburg, MD 20899
August 7, 1995

Thomas E. Gills, Chief
Standard Reference Materials Program

The glass for this SRM was obtained from Corning Inc., Corning, NY. The interlaboratory measurements leading to certification were performed under the auspices of ASTM Subcommittees C14.04 on Physical and Mechanical Properties of Glass and C14.91 on Glass Reference Materials.

Technical coordination of the certification of this SRM was performed by M.J. Cellarosi of the NIST Ceramics Division with the support of A.E. Siefert, ASTM C14.91 Research Associate.

Statistical evaluation was performed by L.M. Gill of the NIST Statistical Engineering Division.

The following data provided by one of the round robin participants is given for information purposes and is not certified. Fulcher fit of beam bending [3] and parallel plate viscometry [4] data using a 5 °C/min heating rate for the range 1×10^{11} Pa·s through 1×10^{5} Pa·s was:

$$\log_{10} [(\text{viscosity (Pa·s)}] = -3.012 + 5495.3/(t-148.1)$$

From that consensus fit, the following viscosity values were calculated:

Table 2. Noncertified Viscosity

Log_{10} [Viscosity (Pa·s)]	Temperature (°C)
5	834
6	758
7	697
8	647
9	606
10	570
11	540

The fixpoint temperatures as measured by ASTM Test Methods C 336 [5], C 338 [6], and C 598 [7] are:

Table 3. Fixpoint

Fixpoint	Temperature (°C)
Softening Point	719 ± 5
Annealing Point	513 ± 6
Strain Point	470 ± 9

The uncertainties given for the fixpoint temperatures are the 95 % confidence intervals of the interlaboratory mean temperatures.

Cooperating Laboratories:

Corning Inc., Corning, NY
Ferro Corp., Independence, OH
Monarch Analytical Laboratories Inc., Toledo, OH
Osram/Sylvania Inc., Danvers, MA
Owens Corning Fiberglass, Granville, OH
PPG Industries Inc., Pittsburgh, PA
Schuller Corp., Littleton, CO

REFERENCES

[1] ASTM Standard C 965-81, "Standard Practice for Measurement of Viscosity of Glass Above the Softening Point", Annual Book of ASTM Standards, Vol. 15.02, ASTM, Philadelphia, PA, (1990).

[2] Taylor, B.N., Guide for the Use of the International System of Units (SI), NIST Special Publication 811, 1995 Ed., (April 1995).

[3] Hagy, H.E., "Experimental Evaluation of Beam-Bending Method of Determining Glass Viscosities in the Range 10^8 to 10^{15} Poise", J. Am. Ceram. Soc., **46 (2)**, 93, (1963).

[4] Fontana, E.H., "A Versatile Parallel-Plate Viscometer for Glass Viscosity Measurements to 1000 °C", Bull. Am. Ceram. Soc., **49 (6)**, 594, (1970).

[5] ASTM Standard C 336-71, "Standard Test Method for Annealing Point and Strain Point of Glass by Fiber Elongation", Annual Book of ASTM Standards, Vol. 15.02, (1991).

[6] ASTM Standard C 338-93, "Standard Test Method for Softening Point of Glass", Annual Book of ASTM Standards, Vol. 15.02, (1993).

[7] ASTM Standard C 598-93, "Test Method for Annealing Point and Strain Point of Glass by Beam Bending", Annual Book of ASTM Standards, Vol. 15.02, (1993).