U. S. Department of Commerce
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Certificate

STANDARD REFERENCE MATERIAL 717

Borosilicate Glass

A. Napolitano and E. G. Hawkins

Table 1. *Comparison of $\log_{10}$ viscosity vs temperature data from each participating laboratory.*

$\log_{10}$ Viscosity Poise*	Temperatures°C Laboratories A	B	C	D	E	Value from combined equation
2.00	---	---	---	---	---	1545.1
2.10	---	---	---	1519.9	---	1508.2
2.25	1458.4	1476.5	---	1461.1	---	1456.4
2.50	1380.7	1388.5	1378.2	1375.7	1384.0	1378.7
2.75	1312.0	1312.8	1309.4	1303.1	1314.7	1310.0
3.00	1250.9	1247.0	1248.2	1240.4	1252.9	1248.8
3.50	1146.7	1138.3	1143.9	1138.0	1147.9	1144.7
4.00	1061.3	1052.0	1058.4	1057.8	1061.9	1059.4
4.50	989.9	981.9	986.9	---	990.1	988.2
5.00	929.4	923.9	926.4	---	929.4	927.9
5.50	877.5	875.0	874.4	---	877.3	876.1
6.00	832.5	---	829.4	---	---	831.2
6.50	793.0	---	789.9	---	---	791.8
7.00	758.1	---	755.0	---	---	757.1
7.50	727.1	---	723.9	---	---	726.2
8.00	699.4	---	696.1	---	---	698.6
8.50	674.4	---	671.1	---	---	673.7
9.00	651.7	---	648.5	---	---	651.1
9.50	631.1	---	627.9	---	---	630.7
10.00	612.3	---	609.0	---	---	611.9
10.50	595.1	---	591.8	---	---	594.8
11.00	579.2	---	575.9	---	---	579.0
11.50	564.5	---	561.2	---	---	564.4
12.00	550.9	---	547.6	---	---	550.9

*One poise is 0.1 kg/m s which is equal to 1 g/cm s

Viscosity of the Glass

The data received from each participating laboratory† were analyzed by the method of least squares combined with the Gauss-Newton iterative method for the Fulcher equation [1]. Only data between $\log_{10}2$ and $\log_{10}12$ viscosity and at equilibrium temperatures were used to solve for the best equation for each laboratory. Using these equations, a comparison of the temperatures obtained by each participating laboratory at nominal values of $\log_{10}$ viscosity are shown in Table 1. The last column in Table 1 gives the temperatures from the equation derived from all the data from the participating laboratories. The equation for the combined data is

$$\text{Log}_{10}\eta = -1.546 + \frac{4775.14}{T\,^{\circ}\text{C} - 198.3}$$

Standard error of $\text{Log}_{10}\eta = 0.029$

Washington, D. C. 20234
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J. Paul Cali, Acting Chief
Office of Standard Reference Materials

†List of Participating Laboratories

Corning Glass Works, Corning, N. Y. (Mr. Eugene H. Fontana)
Emhart Manufacturing Co., Hartford, Conn. (Mr. Leo E. Stadler)
National Bureau of Standards, Washington, D. C. (Mr. A. Napolitano)
Owens-Illinois, Toledo, Ohio (Mr. R. W. Beiswenger)
Thatcher Glass Manufacturing Co., Inc., Elmira, N.Y. (Mr. Thomas M. Mike)

Softening, Annealing and Strain Points of the Glass

These points, as defined in the ASTM STANDARDS, were determined by the five participating laboratories and are shown below in Table 2.

Table 2. *Softening, annealing and strain point of standard glass No. 717 by participating laboratories.*

	Temperature °C					
	Laboratories					
	A	B	C	D	E	Average
Softening Points[a]	723	722	717	721	716	720
Annealing Points[b]	517	516	516	515	515	516
Strain Points[b]	469	472	475	466	473	471

[a] ASTM Designation C 338-57
[b] ASTM Designation C 336-69

Type of Glass

The sample is a borosilicate glass having an index of refraction, after fine annealing, of $N_D = 1.48744 \pm .00016$, and a dispersion of $\upsilon = 65.6 \pm 0.6$.

Composition of the Glass

The nominal composition* of this glass is as follows:

SiO_2	–	70%
B_2O_3	–	17
K_2O	–	8
Na_2O	–	1
Al_2O_3	–	3
Li_2O	–	1

*This glass is not intended as a standard for chemical analysis. The above composition is offered only for information purposes.

Methods of measuring viscosity of glass used by the participating laboratories were:

Rotating concentric cylinder [2,3,4,5,6,7,8]
Fiber elongation [2,4,7,8,9]
Beam-Bending [10] and Parallel-Plate Method [11]

List of References

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