Arbeitsgruppe 3.32 „Flüssigkeitseigenschaften“

– Data sheet –

Calibration glasses for high temperature viscosity measurement

Data for the soda lime glass G1:

Temperature °C	dynamic viscosity dPa·s	decadic logarithm of the dyn. viscosity	Temperature coefficient of viscosity in 10^{-2} K^{-1}
525	$2,3293 \cdot 10^{13}$	13,3672	10,07
600	$3,1685 \cdot 10^{10}$	10,5008	7,43
700	$8,5417 \cdot 10^{7}$	7,9315	4,65
800	1897700	6,2782	3,11
900	135970	5,1334	2,23
1000	19403	4,2878	1,69
1100	4294,5	3,6329	1,34
1200	1282,9	3,1081	1,08
1300	475,8	2,6773	0,90
1400	207,6	2,3171	0,76

528,9; u_T=1,2	$1,585 \cdot 10^{13}$	13,2	Upper cooling point
717,0; u_T=1,0	$3,981 \cdot 10^{7}$	7,6	Littleton Point
1041,0; u_T=1,2	$1,000 \cdot 10^{4}$	4,0	Processing point

The above values were calculated from a Vogel equation with three constants and a five-term correction polynomial according to Meerlender. The combined equation with the corresponding constants is:

$$lg\,\eta = A + \frac{B}{\vartheta - C} - \frac{B}{(\vartheta - C)^2}\sum_{i=1}^{5}\left\{b_i\left(\frac{1000}{\vartheta + 273{,}15}\right)^{i-1}\right\} \qquad \vartheta \text{ in } {}^\circ C \text{ and } \eta \text{ in dPa} \cdot s$$

with A = -1,485703,
B = 4472,106
C = 225,1503

b_1 = 604,2458
b_2 = -2807,975
b_3 = 4780,683
b_4 = -3537,12
b_5 = 960,6668.

The measurement uncertainty of the viscosity-temperature function, expressed as uncertainty of the temperature specification u_r is

in the temperature range from 525 °C to < 1100 °C: 1,5 K

in the temperature range from 1100 °C to < 1200 °C: 2,7 K

in the temperature range from 1200 °C to 1400 °C: 4,9 K.

Data for the lead glass G2:

Temperature °C	dyn. viscosity dPa·s	decadic logarithm of the dyn. viscosity	Temperature coefficient of viscosity in $10^{-2}K^{-1}$
900	35840	4,5543	1,72
1000	7700,8	3,8865	1,37
1100	2226,7	3,3476	1,12
1200	800,2	2,9031	0,93
1300	338,8	2,5299	0,79
1400	162,9	2,2119	0,67
981,3; u_T=1,5	10000	4,0	Processing point

The above values were calculated using an equation according to Sturm with three constants. The equation with the corresponding constants is:

$$lg\,\eta = A - B \cdot lg\left(1 - \frac{C}{T}\right) \qquad T \text{ in } K \text{ and } \eta \text{ in dPa} \cdot s$$

mit A = -1,831803

B = 24,27971

C = 532,931.

The measurement uncertainty of the viscosity-temperature function, expressed as the uncertainty of the temperature specification, is as follows

in the temperature range from 900 °C to < 1100 °C: 1,8 K

in the temperature range from 1100 °C to 1400 °C: 3,6 K

Data for the Suprax tempered glass G3:

Temperature °C	dyn. viscosity dPa·s	decadic logarithm of the dyn. viscosity	Temperature coefficient of viscosity in $10^{-2}K^{-1}$
1000	284380	5,4539	1,85
1100	54195	4,7339	1,47
1200	14239	4,1535	1,20
1300	4728,1	3,6746	1,00
1400	1872,8	3,2725	0,85
1230,1; u_T=2,4	10000	4,0	Processing point

The above values were calculated using an equation according to Sturm with three constants. The equation with the corresponding constants is:

$$lg\,\eta = A - B \cdot lg\left(1 - \frac{C}{T}\right) \qquad T \text{ in } K \text{ and } \eta \text{ in } \mathrm{dPa} \cdot s$$

mit A = -1,479891
B = 21,538
C = 666,4888.

The measurement uncertainty of the viscosity-temperature function, expressed as the uncertainty of the temperature specification, is as follows

in the temperature range from 1000 °C to < 1100 °C: 1,5 K
in the temperature range from 1100 °C to 1400 °C: 2,8 K

Notice: In the temperature range between 800 °C and below 1000 °C, the viscosity of Suprax hard glass G3 increases with time if it is kept in this range for many hours or longer. No viscosity change was observed over a period of up to 5 hours in this temperature range. Devitrification has been shown to be the cause of this behavior. This process can be reversed by heating the melt to 1300 °C or higher.

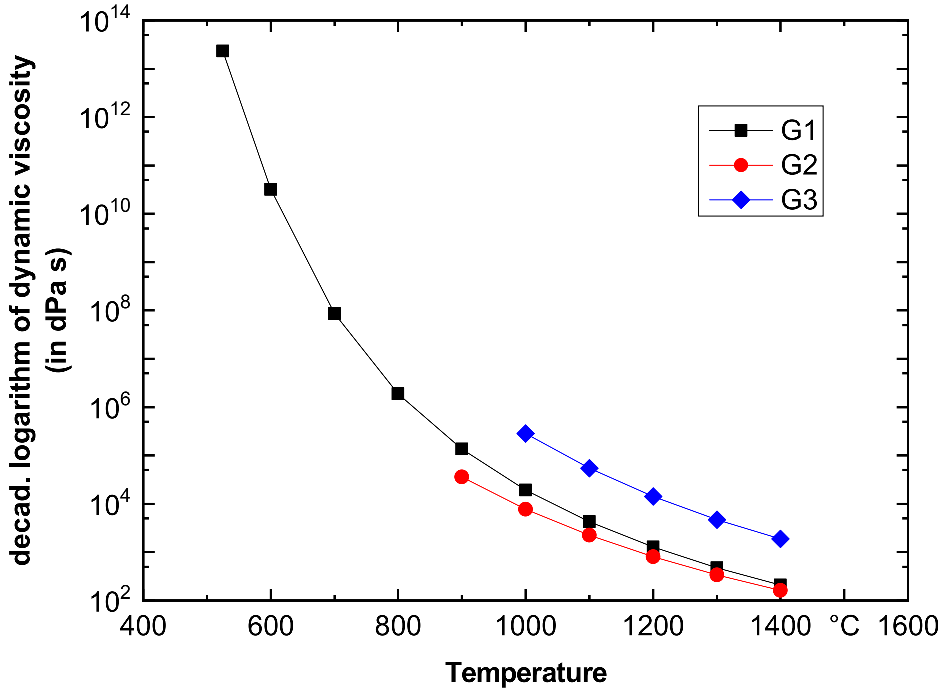

Fig. 1: Temperature dependence of the dynamic viscosity of the three calibration materials G1, G2 and G3.

Further information can be found in:

Norbert Böse, Günther Klingenberg, Gustav Meerlender, *Viscosity measurements of glass melts – Certification of reference material,* Glastech. Ber. Glass Sci. Technol. 74 **(2001)** 115–126