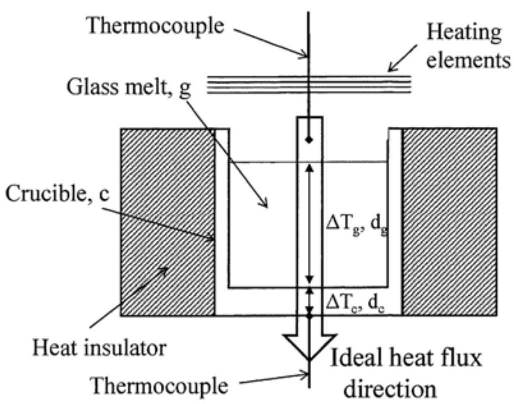
A-16

Evaluation of Effective Thermal Conductivity of Glass Melts by Steady-State Method with Numerical Simulation

Y. Kii, M. Nakamura, N. Yoshida, K. Aiuchi, M. Kawaguchi
Evaluation Technology Department, Nippon Electric Glass Co., Ltd., Otsu, Japan
Email ykii@neg.co.jp

Effective thermal conductivity K_{eff} of glass melts at high temperature is an essential property to simulate glass flows and temperature distributions in glass melting tanks. Previously, several K_{eff}values have been reported for a commercial soda-lime silicate glass composition, but there is about twice the differenceamong them around 1400°C[1-3].It is theoretically possible to evaluate K_{eff} from heat flux in the melt estimated by Fourier's law under one-dimensional heat conduction assumptionas shown in Fig. 1. However, it is hard to establish an experimental condition which fulfills the one-dimensional assumption due to heat losses in various directions. Temperature distribution obtained under such an experimental condition might lead to an erroneous K_{eff}. We evaluated K_{eff} of soda-lime silicate glass melts in the temperature range 1100-1400°C. The temperature profiles in the melts show S-shaped curvesas shown in Fig. 2. These results can be interpreted by taking into considerationofheat radiation and conduction. We propose an evaluation method to derive more accurate K_{eff} of glass melts by a use of numerical simulation to estimate the practical heat flux and temperature distributions in the experimental apparatus.



$$K_{eff,g} = K_c \frac{\Delta T_c d_g}{\Delta T_g d_c} \quad \text{(Fourier's law)}$$

Fig. 1.Evaluation method of effective thermal conductivity K_{eff}.

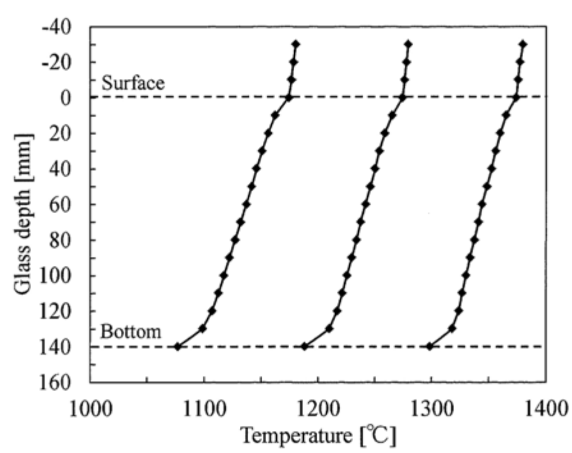


Fig.2.Temperature distributions measured in the depth direction for soda-lime silicate melt.

1) J. Endrys et al., Glastech. Ber. 66 [6-7] 151-157 (1993).
2) M. Taguchi et al., NEW GLASS 17 [1] 11-14 (2002).
3) L. Pilon et al., J. Am. Ceram. Soc., 97[2] 442-450 (2014).