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

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Effective thermal conductivity $K_{\text{eff}}$ of glass melts at high temperature is an essential property to simulate glass flows and temperature distributions in glass melting tanks. Previously, several $K_{\text{eff}}$ values have been reported for a commercial soda-lime silicate glass composition, but there is about twice the difference among them around 1400°C\(^1\)\(^3\). It is theoretically possible to evaluate $K_{\text{eff}}$ from heat flux in the melt estimated by Fourier’s law under one-dimensional heat conduction assumptions 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 $K_{\text{eff}}$. We evaluated $K_{\text{eff}}$ of soda-lime silicate glass melts in the temperature range 1100-1400°C. The temperature profiles in the melts show S-shaped curves as shown in Fig. 2. These results can be interpreted by taking into consideration of heat radiation and conduction. We propose an evaluation method to derive more accurate $K_{\text{eff}}$ of glass melts by a use of numerical simulation to estimate the practical heat flux and temperature distributions in the experimental apparatus.

![Thermocouple](Image)

$$K_{\text{eff}, g} = K_e \frac{\Delta T_e d_e}{\Delta T_g d_g} \quad \text{(Fourier's law)}$$

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

![Temperature distributions](Image)

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