Heat transfer from plane wall

Example 4.8 $\begin{cases} Bi = 0.0327 \\ \lambda_1 = 0.1776 \\ \theta_{wall}(0,t) = 0.77 \end{cases}$

Heat transfer: $\left(\frac{Q}{Q_{max}}\right)_{wall} = 1 - \theta_{0,wall}\frac{sin\,(\lambda_1)}{\lambda_1} = 1 - (0.77)\frac{sin\,(0.1776)}{0.1776} = 0.23$

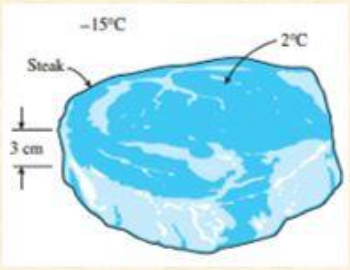
Heat transfer from cylinder

Example 4.8 $\begin{cases} \tau = 12.2 \\ Bi = 0.0273 \\ \lambda_1 = 0.229 \\ \theta_{cyl}(0,t) = 0.53 \end{cases}$ Table 4.3 $J_1(\lambda_1) = J_1(0.229) = 0.114$!

Heat transfer: $\left(\frac{Q}{Q_{max}}\right)_{cyl} = 1 - 2\theta_{0,cyl}\frac{J_1(\lambda_1)}{\lambda_1} = 1 - 2(0.53)\frac{0.114}{0.229} = 0.47$

Total heat transfer from the short cylinder: $\left(\frac{Q}{Q_{max}}\right)_{tot,short\ cyl} = 0.23 + 0.47(1 - 0.23) = 0.592$

$Q = 0.592 Q_{max} = (0.592)(290244) = 171824\,J = 171.824\,kJ$



$\theta_{wall}(L,t) = \frac{T(L,t) - T_\infty}{T_i - T_\infty} = \frac{2 - (-15)}{T_i - T_\infty}$

$\theta_{wall}(0,t) = \frac{T(0,t) - T_\infty}{T_i - T_\infty} = \frac{8 - (-15)}{T_i - T_\infty}$

Surface temp.

$\frac{\theta_{wall}(L,t)}{\theta_{wall}(0,t)} = \frac{T(L,t) - T_\infty}{T(0,t) - T_\infty} = \frac{(2) - (-15)}{(8) - (-15)} = 0.74$

Center temp.

$\theta_{wall}(L,t) = A_1 e^{-\lambda_1^2 \tau} cos\left(\frac{\lambda_1 x}{L}\right)$

$\theta_{wall}(0,t) = A_1 e^{-\lambda_1^2 \tau}$

$\frac{\theta_{wall}(L,t)}{\theta_{wall}(0,t)} = cos\left(\frac{\lambda_1 L}{L}\right) = 0.74$

$cos(\lambda_1) = 0.74$

$\lambda_1 = 0.737$ Table 4.2 Bi = 0.67

Heat transfer coef.: $\mathrm{Bi} = \frac{hL}{k} = \frac{h(0.015)}{0.45} = 0.67 \Rightarrow h = 20.1\,W/m^2K$

$\mathrm{Bi} < 0.1$ ***Lumped system analysis is not applicable.***