

given

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(a)

$$T_i = 200^\circ\text{C} \quad T_\infty = 25^\circ\text{C}$$

$$h = 10 \text{ W/m}\cdot^\circ\text{C} \quad k = 1.28 \text{ W/m}\cdot^\circ\text{C}$$

$$\rho = 1458 \text{ kg/m}^3$$

$$c = 880 \text{ J/kg}\cdot^\circ\text{C}$$

$$t = 10 \text{ min} \rightarrow 600 \text{ sec}$$

$$L_c = \frac{A}{P} = \frac{W^2}{4W} = \frac{W}{4} = \frac{0.02 \text{ m}}{4} = 0.005 \text{ m}$$

$$Bi = \frac{hL_c}{k} = \frac{(10)(0.005)}{1.28} = 0.0391$$

$Bi < 0.1$ neg

$$b = \frac{hA}{\rho V c} = \frac{h}{\rho c L_c} = \frac{10}{(1458)(880)(0.005)} = 0.0015587 \text{ s}^{-1}$$

$$T(t) - T_\infty = e^{-bt}$$

$$T_i - T_\infty = (0.0015587 \cdot 600)$$

$$\frac{T(600) - 25}{200 - 25} = e^{-0.0015587 \cdot 600} \quad (200 - 25)$$

$$T(600) - 25 = e^{-0.0015587 \cdot 600} \cdot 175$$

$$T = 94.6^\circ\text{C}$$

(b)

$$2L = 0.05 \rightarrow 0.025 \text{ m}$$

$$Bi = \frac{hL}{k} = \frac{(10)(0.025)}{1.28} = 0.1953 \quad Bi > 0.1$$

$$b_{wall} = \frac{h}{\rho c L} = \frac{10}{(1458)(880)(0.025)} = 0.0003117 \text{ s}^{-1}$$

$$T(600) - 25 = e^{(-0.0003117 \cdot 600)} \cdot 175$$

$$T = 35.2^\circ\text{C}$$

Thermal diffusivity

$$\alpha = \frac{k}{\rho c} = \frac{1.28}{(1458)(880)} = 1.00 \times 10^{-6} \text{ m}^2/\text{s}$$

$$\tau = \frac{\alpha t}{L^2} = \frac{(1 \times 10^{-6})(600)}{(0.025)^2} = 0.96$$