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MET 440

HW 3.1

15) $d = 1\,cm$ $T_\infty = 10^\circ C$ $\rho = 1100\ kg/m^3$ $h = 20\ W/m^2 \cdot ^\circ C$

$T = 20^\circ C$ $K = 0.6\ W/(m \cdot ^\circ C)$ $c = 4200\ J/(kg \cdot ^\circ C)$

$$L_c = \frac{D}{6} = \frac{(1\,cm)\left(\frac{1\,m}{100\,cm}\right)}{6} = 0.00166\,m$$

$$Bi = \frac{h L_c}{K} = \frac{20(0.00166)}{0.6} = 0.055$$

$$t = \frac{\rho V c}{h A} = \frac{(1100)\left(\frac{\pi}{6} D^3\right)(4200)}{(20)(\pi D^2)}$$

$$= \frac{(1\,cm)\left(\frac{1\,m}{100\,cm}\right)}{6}\,(231000\ s/m)$$

$$= 385\ s$$

$$t = (385)\ln\left(\frac{20 - 5}{10 - 5}\right) = 422.96\,s$$

$$= 422.96\,s\left(\frac{1\,min}{60\,s}\right)$$

$$= \boxed{7.041\ min}$$

26] CROSS SECTION = 2cm x 2cm

$T_i = 200°C$ $T_\infty = 25°C$ $h = 10\ W/(m^2 \cdot °C)$ $K = 1.28\ W/(m \cdot °C)$

$\rho = 1458\ Kg/m^3$ $c = 880\ J/(Kg \cdot °C)$

$$e^{\left(\frac{hA}{\rho V c}\right) \times t} = \frac{T_i - T_\infty}{T - T_\infty}$$

TIME = 10 min = $10 \times 60_{1min}$ = 600s

$$e^{\left(\frac{hA}{\rho V c}\right) \times t} = \frac{T_i - T_\infty}{T - T_\infty}$$

$$e^{\left(\frac{10 \times 8^2 \times 8^2}{1458 \times 8 \times 8 \times 8 \times 880} \times 100 \times 600\right)} \quad \frac{200 - 25}{T - 25}$$

$$\frac{200 - 25}{T - 25} = 2.55$$

$$T - 25 = \frac{175}{2.55} \qquad T = 93.68°C$$

$$\frac{200 - 25}{T - 25} = e^{\frac{10 \times 2 \times 2 \times 2 \times 100}{1458 \times 2 \times 2 \times 2 \times 880} \times 600}$$

$$\frac{175}{T - 25} = 1.905 \qquad T = 170.144°C$$

10] $\alpha = 0.82 \times 10^{-7}\ m^2/s$ $K = 0.15\ W/(m \cdot °C)$ $T_f = 400°C$

$T_i = 20°C$ $T_\infty = 500°C$ $h = 45\ W/(m^2 \cdot °C)$

$$\frac{0.15}{0.82 \times 10^{-7}} = 1.829 \times 10^6$$

$$\frac{T - T_\infty}{T_i - T_\infty} = e^{-\frac{hA}{\rho V c} \times t}$$

$$\frac{400 - 500}{20 - 500} = e^{\frac{45 \times 0.82 \times 10^{-7}}{1.829 \times 10^6} \times t}$$

$t = 697.6\ s$

14] $\alpha = 1.3 \times 10^{-6}\ m^2/s$ $\quad K = 380\ W/(m.^\circ C)$

$t = 3cm$ $\quad T_i = 130^\circ C$ $\quad T_\infty = 30^\circ C$ $\quad t = 2min$

$$L_c = \frac{V}{A_s} = \frac{x}{6} = \frac{0.03m}{6} = 0.005m$$

$$\alpha = \frac{K}{\rho C_p} = 1.3 \times 10^{-6} = \frac{380}{\rho C_p} \qquad \rho C_p = 292.307 \times 10^6\ N/m^2.^\circ C$$

$$\frac{T - T_\infty}{T_i - T_\infty} = e^{\left(\frac{-hA\theta}{\rho V C_p}\right)}$$

$$\frac{T - 30}{130 - 30} = e^{\left(\frac{-100 \times 120}{292.307 \times 10^6 \times 0.005}\right)}$$

$$\frac{T - 30}{100} = 0.9918$$

$$T = 129.18^\circ C$$