

8-45

$$T_{mi} = 20^\circ\text{C} \quad \dot{m} = 5 \text{ kg/s}$$

$$D = 0.05 \text{ m} \quad L = 10 \text{ m}$$

$$T_s = 60^\circ\text{C}$$

$$T_b = \frac{20 + 38}{2} = 29^\circ\text{C}$$

$$C_p = 4179 \text{ J/kg}\cdot\text{K}$$

$$\mu = 0.789 \times 10^{-3}$$

$$k = 0.618 \text{ W/m}\cdot\text{K}$$

$$Pr = 5.44$$

$$Re_D = \frac{\dot{m}}{\pi D \mu} = \frac{4(5)}{\pi(0.05)(0.789 \times 10^{-3})} = 1.60 \times 10^5$$

turbulent flow

10,000

$$Nu_D = 0.023 Re_D^{0.8} Pr^{0.4} = (0.023)(1.6 \times 10^5)^{0.8} (5.44)^{0.4} = 658$$

$$h = \frac{Nu_D k}{D} = \frac{(658)(0.618)}{(0.05)} = 8.07 \times 10^3 \text{ W/m}^2\cdot\text{K}$$

$$\frac{T_s - T_{m,o}}{T_s - T_{m,i}} = \exp \left[\frac{-h \pi D L}{\dot{m} C_p} \right]$$

$$\frac{60 - T_{m,o}}{60 - 20} = \exp \left[\frac{(8068 \pi)(0.05)(10)}{(5)(4179)} \right]$$

$$= 38.2^\circ\text{C}$$