HW 9.1 Ch. 7 #36, 37 | Ch. 8 45 Ch. 9 22

7.36)

Given: $T_\infty = 27°C$ $V_\infty = 20 m/s$ $D = 2.5cm$ $T_w = 127°C$

Find: h_m? Q?

Solution: $T_f = (T_w + T_\infty)/2$

$= 127 + 27/2$

$= 77°C$ or $350K$

$K = .03003$ w/m·C $Pr = .697$ $v = 20.760 \times 10^{-6} m^2/s$

(1.266)

$$Re = \frac{V_\infty D}{v} = \frac{(20 m/s)(.025m)}{2.076 \times 10^{-5}}$$

$Re = 24084$

✓ Table 7.1

$$Nu_m = cRe^n = (.224)(24084)^{.82}$$

$= 216.21$

$$h_m = \frac{K}{D} Nu_m = \frac{.03003 \, w/m·C}{.025m}(216.21)$$

$$h_m = 31.57 \, (w/m^2·C)$$

$$Q = h_m(\pi DL)(T_w - T_\infty)$$

$= (31.57)(\pi \cdot .025 \cdot 1)(127°C - 27°C)$

$Q = 247.9 \, w$

7.37)

8.45) Given: water : $T_{in} = 20^\circ C$ $T_w = 60^\circ C$

$\dot{m} = 5 kg/s$ $L = 1m$ $D = 5cm$

Find: T_{out}

Solution: $h_m (\pi D L) \Delta T_m = (\dot{m} c_p)(T_{out} - T_{in})$

$Nu_m = \frac{h_m D}{k} = 3.66$ from fig 8.5

$k = .5978 \ W/m \cdot K$

$h_m = 3.66 \frac{.5978}{.005}$ $h = 43.75$

$(\dot{m} c_p)(T_{out} - T_{in}) = h_m (\pi D L) \Delta T_m$

$= (43.75)(\pi \cdot .05m \cdot 1m)(60^\circ C - 20^\circ C)$

$(\dot{m} c_p)(T_{out} - T_{in}) = 2748.9 \ W$

$T_{out} = 20^\circ C + \frac{2748.9}{(1.5)(4200)}$

$T_{out} = 20.43^\circ C$

9.22) Given: $T_w = 220°C$ $T_\infty = 50°C$

$L = 3m$ $D = 15cm$

Find: $Q = ?$

Solution:

$$T_m = \frac{T_w + T_\infty}{2} = \frac{220°C + 35°C}{2}$$

$$T_m = 125°C$$

air at 125°C: $k = .0332\ w/mK$ $\nu = 20.96 \times 10^{-6} m^2/s$

$\beta = 2.80 \times 10^{-3} 1/K$ $Pr = .707$

$$= \frac{L^3 g\beta(T_w - T_\infty)}{\nu^2} = \frac{(3)^3(9.81)(2.80\times10^{-3})(190°C)}{(20.96\times10^{-6}\ m^2/s)^2}$$

$$= 3.2 \times 10^{10}$$

$Pr = .707$

$$Nu = .12(Gr \cdot Pr)^{1/3}$$

$Nu = 731.77$

$$h = \frac{Nu\ k}{L} = \frac{(731.77)(.0332)}{3}$$

$$h = 8.0982\ w/m^2 K$$

$$Q = hA(T_w - T_\infty)$$

$$= 8.082(\pi \cdot .15 \cdot 3)(220 - 30)$$

$$Q = 271.52\ w$$