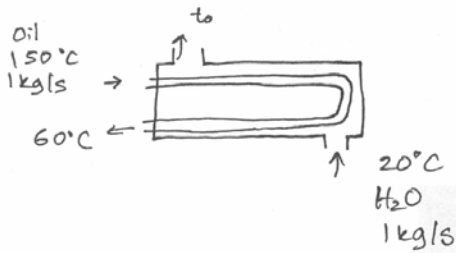


Recitation 11/9/04



$$h_o = h_w = 1000 \text{ W/m}^2\text{K}$$

$$h_i = h_{oil} = 300 \text{ W/m}^2\text{K}$$

a) Energy Balance

$$\dot{q} = (\dot{m} c_p)_{oil} \Delta T = 1 \text{ kg/s} (2120) (150 - 60) = 1.908 \times 10^5 \text{ W}$$

$$= (\dot{m} c_p)_{H_2O} \Delta T = 1 (4190) (t_o - 20)$$

$$t_o = 65.5^\circ\text{C}$$

$$\frac{1}{U_o A_o} = \frac{1}{h_i A_i} + \frac{1}{h_o A_o} + \frac{t}{k A_{avg}}$$

$$A_i = \pi D_i L$$

$$A_o = \pi D_o L$$

$$\frac{1}{U_o} = \frac{D_o}{h_i D_i} + \frac{1}{h_o} + \frac{t \cdot D_o}{k (D_i + D_o)/2}$$

$$= \frac{0.015}{(300)(13)} + \frac{1}{1000} + \frac{(0.001)(15)}{(15)(15+13)/2}$$

$$= 4.92 \times 10^{-3}$$

$$U_o = 203.4 \text{ W/m}^2\text{K}$$

$$\Delta T_{lm} = \frac{(150 - 65.5) - (60 - 20)}{\ln \frac{150 - 65.5}{60 - 20}} = 59.5$$

$$R = \frac{T_i - T_o}{t_o - t_i} = 0.506$$

$$P = \frac{t_o - t_i}{T_i - t_i} = 0.692$$

Fig. 11.10  $F = 0.74$

$$q = U_o A_o F \Delta T_{em}$$

$$1.908 \times 10^5 = (203.4) A_o (0.74)(59.5)$$

$$A_o = 21.3 \text{ m}^2$$

$$b) \quad q = \dot{m} c_p \Delta T = 1(2120)(150-80) = 1.484 \times 10^5$$

$$EB \Rightarrow t_o = 554^\circ\text{C}$$

$$LMTD = \Delta T_{em} = 76^\circ\text{C}$$

$$\left. \begin{array}{l} P = 0.58 \\ R = 0.538 \end{array} \right\} F = 0.92$$

$$q = U_o A_o F \Delta T_{em}$$

$$1.484 \times 10^5 = U_o (21.3)(0.92)(76)$$

$$U_o = 99.6 \text{ W/(m}^2\text{K)}$$

$$\frac{1}{U_o A_o} = \frac{1}{h_o A_o} + \frac{1}{h_i A_i} + \frac{\ln D_i/D_i'}{2\pi k_a L}$$

$$\frac{1}{U_o} = \frac{1}{h_o} + \frac{D_o}{h_i D_i} + \frac{D_o \ln D_i/D_i'}{2 k_{gao}}$$

$$\ln \frac{D_i}{D_i'} = 0.0962$$

$$\frac{D_i}{D_i'} = 1.101$$

$$D_i' = \frac{13}{1.101} = 11.81 \text{ mm}$$

$$\text{thickness} = \frac{13 - 11.81}{2} = \boxed{0.596 \text{ mm}}$$

plausible

c) Infinitely large -

$$F = 0$$

$$t_0 = 150^\circ\text{C}$$

$$\text{from 11-10 } R = 0.66 = \frac{T - T_0}{t_0 - T} = \frac{20 - t_0}{60 - 150}$$

$$t_0 = 79.4^\circ\text{C}$$

$$\dot{q}_T = 1.908 \times 10^5 = \dot{m} (4190) (79.4 - 20)$$

$$\dot{m} = 0.766 \text{ kg/s}$$