Q. R Cadet – 39556 (1)

Q2b> $Q = 2hA(960-340)$

$h = \frac{Nu \times k}{L}$

$Nu = 0.13(Gr.Pr)^{0.33}$ → $Pr = \frac{\mu C_p}{K} = 10.035$

$Gr = \frac{g\beta\Delta TL^3}{\nu^2} = \frac{9.81 \times \frac{1}{923} \times 620 \times 2.2^3 \times (10^4)^2}{\left(\frac{8.64}{10^4}\right)^2}$

$Gr = 8.75 \times 10^{15}$

$Nu = 50696.59$

$h = 300 \times 10^3 \ w/m^2k$

$Q = 1.1458 \times 10^9 W = 1145.88 W$ — Ans

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Q3b> $m = \sqrt{\frac{hP}{KA}}$ ($P \to \pi D$, $A \to \frac{\pi}{4}D^2$) $= \sqrt{\frac{4h}{KD}} = \sqrt{\frac{4 \times 20}{380 \times 0.005}} \Rightarrow m = 6.49$

(i) $Q = KA\,m\,\theta_0 \tanh(mL) = KA_{cs}\,m\,(t_0 - t_1)(\tanh(mL))$

$= 380 \times \left[\frac{\pi}{4} \times (0.005)^2\right] \times 6.49 \times (150-20) \tanh(6.49 \times 0.6)$

$Q = 6.29 W = 6.29 \times 3600 = 22.64 \ KJ/h$

$Q = 22.64 \ KJ/h$ — Ans.

(ii)

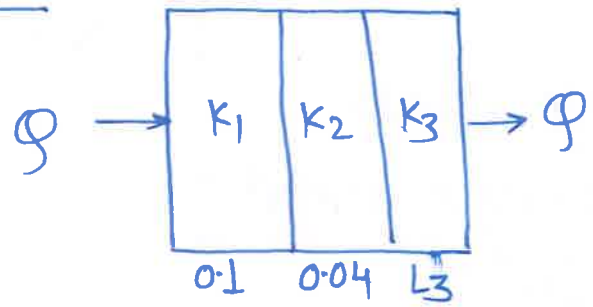
$\eta_{fin} = \frac{\tanh(mL)}{mL} =$

$= \frac{\tanh(6.49 \times 0.69)}{6.49 \times 0.6}$

$\eta_{fin} = 25.66\%$ — Ans

Q4a)

02




$$R_1 = \frac{L_1}{K_1 A} = \frac{0.1}{0.75} = 0.133 \text{ °c/w}$$

$$R_2 = \frac{L_2}{K_2 A} = \frac{0.04}{0.5} = 0.08 \text{ °C/W}$$

$$R_3 = \frac{L_3}{K_3 A}$$

$$R_1 + R_2 = 0.293 \text{ °c/w}$$

$$\frac{R_1 + R_L}{R_1 + R_2 + R_3} = 0.25$$

$$R_1 + R_2 + R_3 = 0.772$$

$$R_3 = 0.579 = L_3$$

$$L_3 = 0.45 \times 0.08$$

$$\boxed{L_3 = 0.037 \text{ m}}$$

Q4b) $Q = hA(t_s - t_\infty)$

$$Nu = \frac{hL}{K} = 0.55 (Gr \times Pr)^{0.25} \quad \frac{1}{273 + \frac{400}{2}}$$

$$Gr = \frac{L^3 \times g \times \beta (t_s - t_\infty)}{\nu^2}$$

$$Pr = \frac{\mu C_p}{K} = 0.699$$

$$= \frac{0.3^3 \times 9.81 \times 0.002114 \times (380 - 20)}{(34.57 \times 10^{-6})^2} = 168.67 \times 10^6$$

$$h = \frac{K}{L} \times 0.55 \times (168.67 \times 10^6 \times 0.699) = 7472.32$$

$$Q = 3.486 \times 10^6 \text{ W}$$

Q5b) $N = \frac{A_{total}}{A}$ (03)

$Q = \dot{m} C_p (T_{C_2} - T_{C_1}) = U_o A_{total} \times LMTD$

$= \dot{m} \times 4170 (45-22)$

$Q = 9.591 \times 10^5 \text{ W}$

$U_o A_o = \frac{1}{\varepsilon R_{th}}$

$U_o A_o = \frac{1}{\frac{1}{h_o A_o} + \frac{1}{h_i A_i}}$

$U_o = 671.58 \text{ W/m}^2\text{K}$

$LMTD = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\frac{\Delta T_1}{\Delta T_2}\right)} = \frac{78-55}{\ln\left(\frac{78}{55}\right)}$

$LMTD = 65.832^\circ C$

$A_{total} = \frac{9.541 \times 10^5}{U_o \times LMTD} = \frac{9.591 \times 10^5}{671.58 \times 65.83}$

$A_{total} = 21.693 \text{ m}^2$

$A = \pi d_o L = 0.377 \text{ m}^2$

$N = \frac{21.69}{0.377} = 51.53$

$N \approx 52$ tubes — Ans.

04

**b)** A ceramic block is of 0.3 m × 0.2 m section and is 0.3 m in height. Surface temperature of the block is 380 $^0$C.if it is exposed to air at 20 $^0$C, **(10)**

**Determine** the rate of convective heat loss.

Properties of air $\nu = 34.57 \times 10^{-6}$ m$^2$/s, **k** = 37.81 x $10^{-3}$ W/mK, **Pr.** =0.699.

The following empirical relation can be used

$$\mathbf{Nu_L = 0.55(Gr \times Pr)^{0.25}}$$

**Q.5 a)** Define Shape factor and discuss its properties. Derive an expression for shape factor for **(10)**
(i) Hemispherical shape of radius R (ii) Two concentric cylinders.

**b)** In a shell and tube heat exchanger, tubes are 4 m long, 3.1 cm OD, 2.7 cm ID. Water is heated from 22 $^0$C to 45 $^0$C by considering steam at 100 $^0$C on the outside of tubes. Water flow rate through the tubes is 10 kg/s. Heat transfer coefficient on steam side is 5500 W/m$^2$K and waterside, 850 W/m$^2$K. Neglecting all other resistances, find the number of tubes. **(10)**

**Q.6 a)** For transit conduction, with negligible internal resistance, with usual notations, show that: $\frac{\theta}{\theta} = \exp\left(-B_i . F_o\right)$ Also state the significations of '$B_i$' and '$F_o$'. **(10)**

**b)** Write short note on any **two** of the following **(10)**

**i)** Heisler Charts.

**ii)** Boiling curves and various regimes of boiling.

**iii)** Heat Pipe.