

(1)

LECTURE 11

LG ADVANCED THERMO. ~ ϵ -NTU PROBLEM.

(a) $A = 12 \text{ m}^2$ $NTU = \frac{U \cdot A}{C_{\min}}$
 $U = 250 \text{ W/m}^2\text{K}$
 $C_{\min} = 5 \text{ kW/K}$ $\therefore NTU = \frac{250 \times 12}{5 \times 10^3} = 0.6$
 $C_{\max} = 10 \text{ kW/K}$

For parallel flow HX;
 $\epsilon = \frac{1 - e^{\frac{-NTU(1+Cr)}{1+Cr}}}{1 + Cr}$ where, $Cr = \frac{C_{\min}}{C_{\max}}$
 $\therefore Cr = \frac{5}{10} = 0.5$

Now, $\epsilon = \frac{1 - e^{\frac{-0.6(1+0.5)}{1+0.5}}}{1 + 0.5}$
 $\therefore \epsilon = 0.396$ (0.4) Graph value is approx. 0.38.

(b) Inner tube $\phi = 0.025 \text{ m}$ and, $l = 4 \text{ m}$
 $\therefore A = \pi d l = \pi(0.025) \times 4 = 0.1\pi \text{ m}^2$

$U = 100 \text{ W/m}^2\text{K}$ $\therefore NTU = \frac{U \cdot A}{C_{\min}} = \frac{100 \times 0.1\pi}{70}$
 $C_{\min} = 70 \text{ W/K}$

$C_{\max} = 100 \text{ W/K}$ $\therefore NTU = 0.449$ (0.45)

Parallel flow HX;

Now, $Cr = \frac{C_{\min}}{C_{\max}} = \frac{70}{100} = 0.7$

$\therefore \epsilon = \frac{1 - e^{\frac{-0.45(1+0.7)}{1+0.7}}}{1 + 0.7}$ Graph value is approx. 0.35.
 $\therefore \epsilon = 0.314$ (0.3)

①

LG ADVANCED THERMO ~ E-NTU PROBLEM

$$L = 10 \text{ m}; \quad \phi_{\text{INTERFACE}} = 0.1 \text{ m}$$

$$\dot{V}_H = 300 \text{ l/min} = \frac{300}{60,000} = 0.005 \text{ m}^3/\text{s} @ 60^\circ\text{C}.$$

$$\rho_H = 983.38 \text{ kg/m}^3$$

$$\therefore \dot{m}_H = 0.005 \times 983.38 = 4.9169 \text{ kg/s}.$$

$$\dot{V}_C = \frac{720}{60,000} = 0.012 \text{ m}^3/\text{s}, \text{ and } \rho_C = 1.2041 \text{ kg/m}^3$$

$$\therefore \dot{m}_C = 0.0145 \text{ kg/s}.$$

$$h_H = 2619 \text{ W/m}^2\text{K} \text{ and } h_C = 7.96 \text{ W/m}^2\text{K}.$$

(a) Area of hot-cold interface;

$$A = \pi d L = \pi \times 0.1 \times 10 = \underline{\pi \text{ m}^2}$$

(b) Find U ; $U = \frac{1}{R.A}$

$$\text{where, } R = \frac{1}{h_H.A} + \frac{1}{h_C.A} = \frac{1}{2619\pi} + \frac{1}{7.96\pi}$$

$$\therefore U = \frac{1}{\frac{1}{2619} + \frac{1}{7.96}} = \underline{7.936 \text{ W/m}^2\text{K}}$$

(c) Heat Capacity rates and ratio;

$$C_H = \dot{m}_H \cdot c_{pH} = 4.9169 \times 4190 = \underline{20,601.8 \text{ W/K}}$$

$$\text{and, } C_C = \dot{m}_C \cdot c_{pC} = 0.0145 \times 1005 = \underline{14.573 \text{ W/K}}$$

$$\therefore C_r = \frac{C_{\text{MIN}}}{C_{\text{MAX}}} = \frac{14.573}{20,601.8} = \underline{0.707 \times 10^{-3}}$$

②

LECTURE 10.

LG ADVANCED THERMO. ~ E-NTU PROBLEM.

(d) Find NTU (counter-flow HX).

$$NTU = \frac{U.A}{C_{min}} = \frac{7.936 \times \pi}{14.573} = \underline{1.711}$$

(e) Find effectiveness.

$$\begin{aligned} \epsilon &= \frac{1 - e^{[-NTU(1-C_r)]}}{1 - C_r e^{[-NTU(1-C_r)]}} \quad 0.180904 \\ &= \frac{1 - e^{[-1.711(1-0.7074 \times 10^{-3})]}}{1 - (0.7074 \times 10^{-3}) e^{[-1.711(1-0.7074 \times 10^{-3})]}} \quad 0.999872 \end{aligned}$$

$$\therefore \epsilon = \underline{0.8192}$$

(f) $\dot{Q}$ from hot to cold stream; i.e. find $\dot{Q}_{ACT}$.

$$\dot{Q}_{ACT} = \epsilon \cdot \dot{Q}_{MAX} \quad \text{where, } \dot{Q}_{MAX} = C_{min} (T_{H,in} - T_{C,in})$$

$$\therefore \dot{Q}_{ACT} = 0.8192 \times 14.573 (60 - 20)$$

$$\text{i.e. } \dot{Q}_{ACT} = \underline{477.53 \text{ W}}$$

(g) Outlet temperatures of both streams;
Using conservation of energy for both streams;

$$\dot{Q}_{ACT} = C_H (T_{H,in} - T_{H,out}) \Rightarrow T_{H,out} = T_{H,in} - \frac{\dot{Q}_{ACT}}{C_H}$$

$$\therefore T_{H,out} = 60 - \frac{477.53}{20,601.8} = \underline{59.98^\circ \text{C}}$$

$$\text{and, } T_{C,out} = T_{C,in} + \frac{\dot{Q}_{ACT}}{C_c} = 20 + \frac{477.53}{14.573}$$

$$\therefore T_{C,out} = \underline{52.77^\circ \text{C}}$$