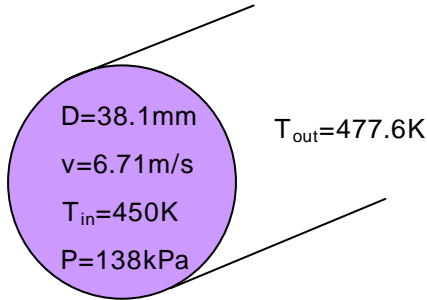


4.5-1. (W/m²/K) .



a) N_{Re} . , 267 (4.5-4) ,
 , 268 (4.5-8) . 945 .

$$\rho_{air}(450\text{K}) = 0.785 \frac{\text{kg}}{\text{m}^3}, \quad \mu_{air}(450\text{K}) = 2.50 \times 10^{-5} \frac{\text{kg}}{\text{m} \cdot \text{s}}, \quad \mu_{air}(477.6\text{K}) = 2.60 \times 10^{-5} \frac{\text{kg}}{\text{m} \cdot \text{s}}, \quad k(450\text{K}) = 0.03721 \frac{\text{W}}{\text{m} \cdot \text{K}}$$

$$N_{Re} = \frac{Dv\rho}{\mu} = \frac{0.0381\text{m} \cdot 6.71 \frac{\text{m}}{\text{s}} \cdot 0.785 \frac{\text{kg}}{\text{m}^3}}{2.5 \times 10^{-5} \frac{\text{kg}}{\text{m} \cdot \text{s}}} = 8027.4$$

, (4.5-8)

h

$$N_{Nu} = \frac{hD}{k} = 0.027 N_{Re}^{0.8} \cdot N_{Pr}^{0.333} \cdot \left(\frac{\mu_b}{\mu_w} \right)^{0.14}$$

b) N_{Nu} (k), , Prandtl ($N_{Pr} = \frac{c_p \mu}{k} = 0.687$) 945

$$N_{Nu} = \frac{hD}{k} = 0.027 \cdot (8027.4)^{0.8} \cdot (0.687)^{0.333} \cdot \left(\frac{2.5}{2.6} \right)^{0.14} = 31.5$$

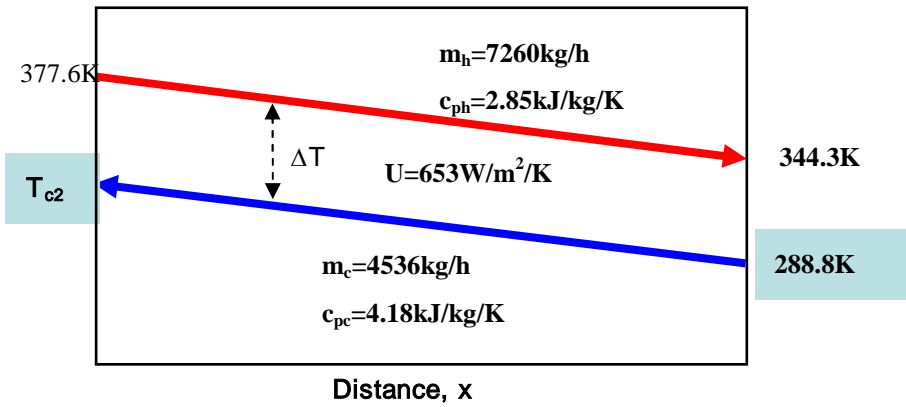
h

$$h = \frac{N_{Nu} \cdot k}{D} = \frac{31.5 \cdot 0.03721 \frac{\text{W}}{\text{mK}}}{0.0381\text{m}} = 30.77 \frac{\text{W}}{\text{m}^2\text{K}}$$

c)

$$\frac{q}{A} = h\Delta T = 30.77 \frac{\text{W}}{\text{m}^2\text{K}} \cdot (477.6 - 450)\text{K} = 849.16 \frac{\text{W}}{\text{m}^2}$$

4.5-3 /



935 , 4.18kJ/kg/K .

- 1) ; $q = \dot{m} \cdot c_p \cdot (T_2 - T_1)$.
- 2) ; $q_{cool} = q_{hot}$.
- 3) ; $q = UA\Delta T_{lm}$.

a) ?

a-1. 가

$$q_h = \dot{m} \cdot c_{ph} \cdot (T_{h2} - T_{h1}) = 7260 \frac{kg}{h} \cdot 2.85 \frac{kJ}{kgK} \cdot (377.6 - 344.3)K = 689010 \frac{kJ}{hr}$$

a-2.

$$q_c = \dot{m} \cdot c_{pc} \cdot (T_{c2} - T_{c1})$$

$$T_{c2} = T_{c1} + \frac{q_c}{\dot{m} \cdot c_{pc}}$$

$$= 288.8K + \frac{689010 \frac{kJ}{hr}}{4536 \frac{kg}{h} \cdot 4.18 \frac{kJ}{kgK}} = 325.14K$$

a-3. 가

$$q = UA\Delta T_{lm}$$

$$A = \frac{q}{U \cdot \Delta T_{lm}}$$

$$\Delta T_1 = (344.3 - 288.8)K = 55.5K ,$$

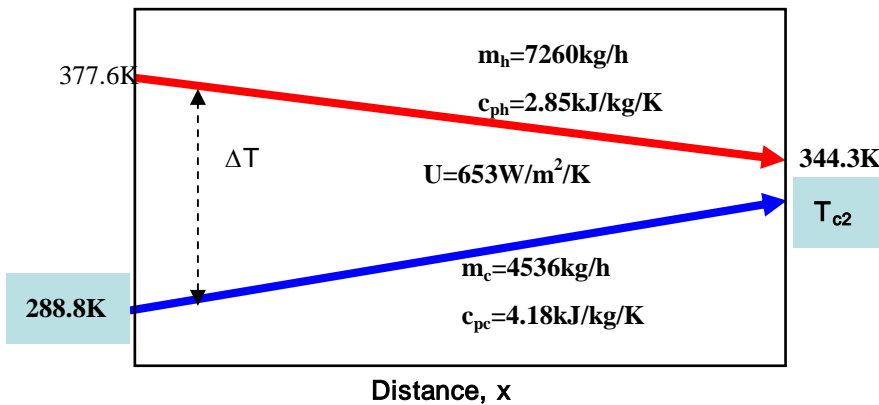
$$\Delta T_2 = (377.6 - 325.1)K = 52.5K .$$

$$A = \frac{q}{U \cdot \Delta T_{lm}} = \frac{689010 \frac{kJ}{hr}}{653 \frac{J}{s \cdot m^2 \cdot K} \cdot \frac{(55.5 - 52.5)K}{\ln \frac{55.5K}{52.5K}}} = \frac{689010 \frac{kJ}{hr}}{35.253 \frac{kJ}{s \cdot m^2} \cdot \frac{3600s}{hr}} = 5.43m^2$$

b)

?

가



가

$$q_h = 689010 \frac{kJ}{hr}, T_{c2} = 325.14K .$$

$$\Delta T_1 = (377.6 - 288.8)K = 88.8K ,$$

$$\Delta T_2 = (344.3 - 325.1)K = 19.2K .$$

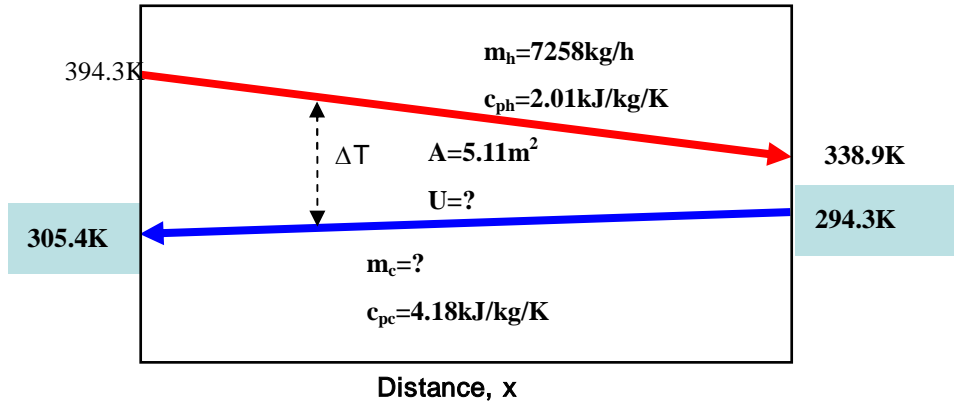
$$A = \frac{q}{U \cdot \Delta T_{lm}} = \frac{689010 \frac{kJ}{hr}}{653 \frac{J}{s \cdot m^2 \cdot K} \cdot \frac{(88.8 - 19.2)K}{\ln \frac{88.8K}{19.2K}}} = \frac{689010 \frac{kJ}{hr}}{29.676 \frac{kJ}{s \cdot m^2} \cdot \frac{3600s}{hr}} = 6.45m^2$$

(co-current flow)

(counter-current flow)

4.5-5

4.5-3



- 1) , , 가 .
- 2) , , , .
- 3) , , .

1) 가

$$q_h = \dot{m} \cdot c_{ph} \cdot (T_{h2} - T_{h1}) = 7258 \frac{\text{kg}}{\text{h}} \cdot 2.01 \frac{\text{kJ}}{\text{kgK}} \cdot (394.3 - 338.9)\text{K} = 808207 \frac{\text{kJ}}{\text{hr}}$$

2)

$$q_c = \dot{m} \cdot c_{pc} \cdot (T_{c2} - T_{c1})$$

$$\dot{m} = \frac{q_c}{c_{pc} \cdot (T_{c2} - T_{c1})} = \frac{808207 \frac{\text{kJ}}{\text{hr}}}{4.18 \frac{\text{kJ}}{\text{kgK}} \cdot (305.4 - 294.3)\text{K}} = 17419 \frac{\text{kg}}{\text{hr}}$$

3) 가

$$q = UA\Delta T_{lm}$$

$$U = \frac{q}{A \cdot \Delta T_{lm}}$$

$$\Delta T_1 = (338.9 - 294.3)\text{K} = 44.6\text{K} ,$$

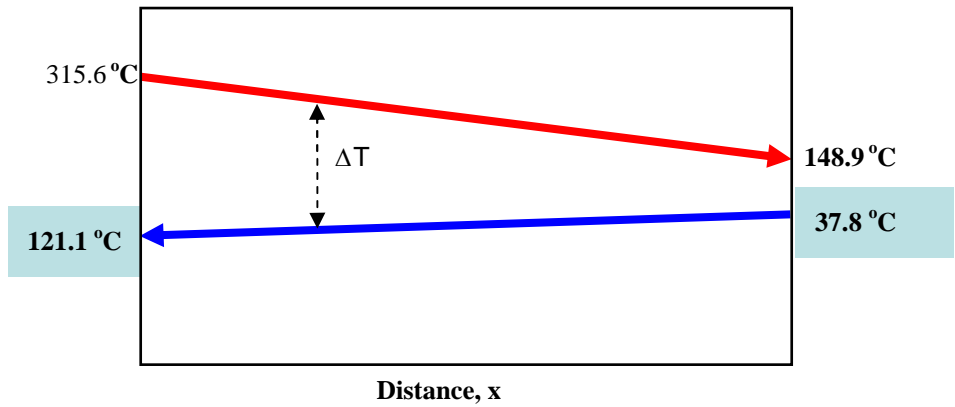
$$\Delta T_2 = (394.3 - 305.4)\text{K} = 88.9\text{K} .$$

$$U = \frac{q}{A \cdot \Delta T_{lm}} = \frac{808207 \frac{\text{kJ}}{\text{hr}}}{5.11\text{m}^2 \cdot \frac{(88.9 - 44.6)\text{K}}{\ln \frac{88.9\text{K}}{44.6\text{K}}}} = \frac{808207 \frac{\text{kJ}}{\text{hr}} \cdot \frac{\text{hr}}{3600\text{s}}}{328.18\text{m}^2\text{K}} = 0.68408 \frac{\text{kW}}{\text{m}^2\text{K}} = 684.08 \frac{\text{W}}{\text{m}^2\text{K}}$$

4.9-1. 1-2

(ΔT_{lm})

$(\Delta T_m) :$ 303-304



$$\Delta T_1 = (148.9 - 37.8)K = 111.1K ,$$

$$\Delta T_2 = (315.6 - 121.1)K = 194.5K .$$

$$\Delta T_{lm} = \frac{\Delta T_2 - \Delta T_1}{\ln \frac{\Delta T_2}{\Delta T_1}} = \frac{(194.5 - 111.1)K}{\ln \frac{194.5}{111.1}} = 148.9K$$

$$\Delta T_m = F_T \Delta T_{lm}$$

, F_T 1-2

4.9-4 (304) F_T

$$Z = \frac{T_{hi} - T_{ho}}{T_{co} - T_{ci}} = \frac{315.6 - 148.9}{121.1 - 37.8} = 2$$

$$Y = \frac{T_{co} - T_{ci}}{T_{hi} - T_{ci}} = \frac{121.1 - 37.8}{315.6 - 37.8} = 0.3$$

4.9-4 F_T 0.87 ,

$$\Delta T_m = 0.87 \cdot 148.9K = 129.5K$$

, (ΔT_m) (ΔT_{lm}) (q_{real})

(q_{theory})

$$q_{theory} = UA \Delta T_{lm}$$

$$q_{real} = UA \Delta T_m$$

$$q_{theory} \geq q_{real}$$