PME2360

2 de dezembro de 2011

1 Exercício

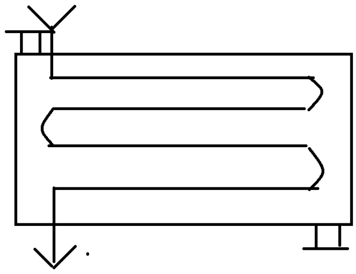

Figura 1: 1

$$\dot{m}_{oleo} = 2Kg/s$$
$$T_{h,i} = 120^oC$$
$$T_{h,o} = 40^oC$$
$$c_{p,oleo} = 2118.0J/kg$$

$$U = 3000W/m^2K$$
$$T_{c,i} = 15^oC$$
$$T_{c,o} = 45^oC$$
$$c_{p,agua} = 4178J/kg$$

1.1 a

vazão mássica de água

$$\dot{m}_{oleo} \times c_{p,oleo}(T_{h,i} - T_{h,o}) = \dot{m} \times c_{p,agua}(T_{c,o} - T_{c,i})$$

$$2 \times 2118 \times (120 - 40) = \dot{m} * 4178 * (45 - 15) = \dot{q} = 33880 J/kg$$

$$\dot{m}_{agua} = 2.70\ kg/s$$

1.2 b

Trocador de casco-tubo
    1 passe na carcaça
    6 passes nos tubos

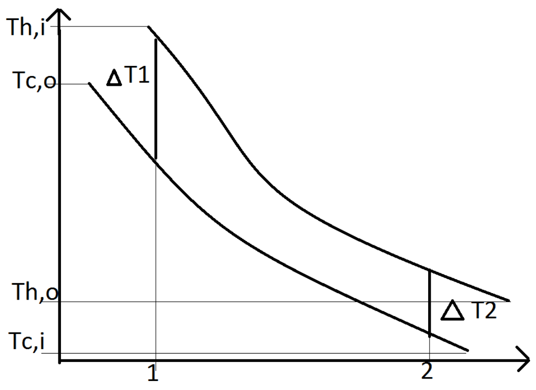

Figura 2: Trocador em contra-corrente

Método MLDT Método Logarítmo para trocador de calor em corrente contrária

$$\Delta T_{lm,cc} = \frac{\Delta T_1 - \Delta T_2}{\ln(\Delta T_1 / \Delta T_2)}$$

Em que lm é a média logarítmica e o cc é a corrente contrária

$$\Delta T_1 = T_{h,i} - T_{c,o} = 120 - 45 = 75$$

$$\Delta T_2 = T_{h,o} - T_{c,i} = 40 - 15 = 25$$

$$\Delta T_{lm,cc} = \frac{75-25}{\ln(75/25)} = 45.5^oC$$

$$q = UA\Delta T_{lm,cc}F$$

Pela figura 11.10, (pag 459, 5a ed.)

$$R = \frac{T_e - T_s}{t_s - t_e} = \frac{120-45}{45-15} = 2.66$$
$$P = \frac{t_s - t_e}{T_e - t_e} = \frac{45-15}{120-15} = 0.285$$

$$F = 0.85$$

$$338880 = 300 \times A \times 45,5 \times 0.85$$
$$A = 29.2m^2$$

1.3 c

Do trocador:

$$A = N\pi DL$$

$$L = \frac{29.20}{25 \times 6 \times \pi \times 0.02} = 3.09m$$

2 Ex 11.35 da 6a Ed

Trocador de calor casco tubo

1 passe carcaça

2 passes no tubo

130 tubos de latão

$$\phi_i = 13.4mm$$

$$\phi_e = 15.9mm$$

$$2m/passe$$

- Escoamento Interno nos tubos

$$\bar{T}_m = \frac{20+40}{2} = 30^oC$$

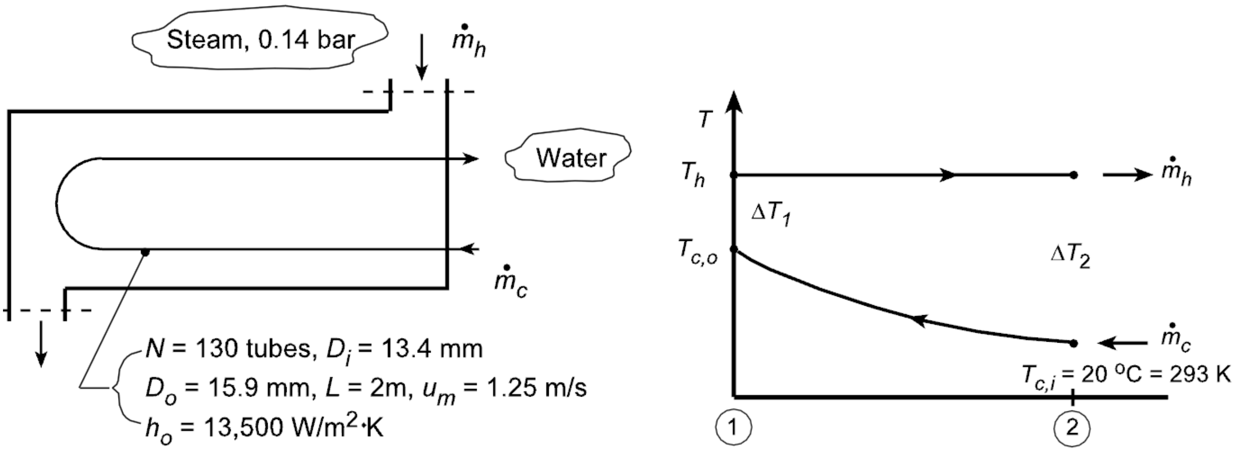

Figura 3: 3

$$\rho = 997 kg/m^3$$
$$\mu = 855 \times 10^{-6}$$
$$c_p = 4179 J/kgK$$
$$Pr = 5.83$$
$$K = 613 \times 10^{-3}$$

$$Re = \frac{U\phi_i}{\nu} = \frac{U\phi_i\rho}{\mu}$$

$$Re = \frac{1.25 \times 0.0134 \times 997}{855 \times 10^{-6}} = 19531$$

Turbulento
L/D > 10

$$\bar{Nu}_D = 0.023 Re_D^{4/5} Pr^{0.4} = 126$$

$$\bar{h} = \frac{126 \times 613 \times 10^{-3}}{0.0134} = 5767 W/m^2K$$

Coeficiente Global

$$\frac{1 A_{ext}}{U_{ext} A_{ext}} = \frac{A_{ext}}{h_i A_i} + \frac{A_{ext}\ln(D_e/D_i)}{2\pi K L} + \frac{A_{ext}}{h_{ext} A_{ext}}$$

$$\frac{1}{U_{ext}} = \frac{A_{ext}}{h_i A_i} + \frac{A_e \ln(D_e/D_i)}{2\pi \times k_{latao} \times (130 \times 2 \times 2)} + \frac{1}{h_{ext}}$$

Substituindo $U_{ext} = 3422\ W/m^2K$

Método da Efetividade

$$NUT = \frac{UA}{C_{min}} = \frac{3422 \times \pi \times D_e \times 130 \times 2 \times 2}{4179 \times (\rho Veloc\pi\frac{Di^2}{4}) \times 130} = 0.934$$

Em que

$$\dot{m}_{agua} = 22.75 = (\rho Veloc\pi\frac{Di^2}{4}) \times 130$$

$$q_{max} = c_{min}(T_{h,e} - T_{c,e}) = 4179 \times 22.75 \times (325 - 293) = 3035kW$$

Para $C_r = 0$, para todo o trocador de calor:

$$\varepsilon = 1 - \exp(-NUT) = 1 - \exp(-0.934)$$

$$\varepsilon = 0.607$$

$$q = \varepsilon \times q_{max} = 0.607 \times 3035 = 1842kW$$

$$\dot{q} = \dot{m}_v h_{lv}$$

$$\dot{m}_v = \frac{1842 \times 10^3}{2378 \times 10^3}$$

3 11.70

$$T_{l,g} = 1400K$$

$$cp_g = 11205J/kgK$$

$$\dot{m}_g = 10kg/s$$

$$\dot{m}_{agua} = 3kg/s$$

Entra x = 0(T=450K)

Sai x = 1 (T=450K)

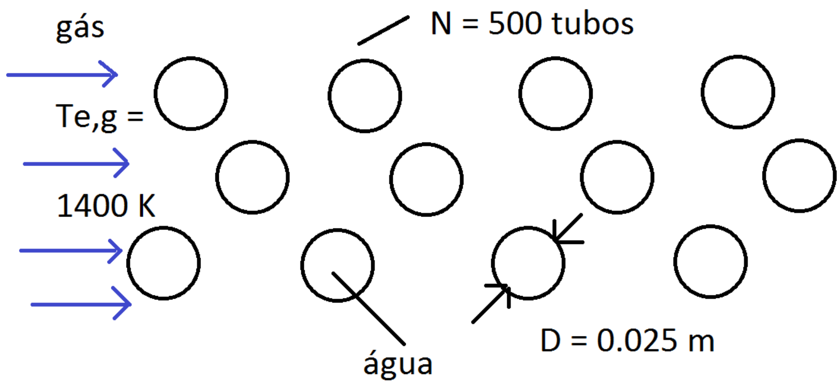

Figura 4: 4

$$U = 50W/m^2K$$

Lembrando:

$$\frac{1}{UA} = \frac{1}{U_f A_f} = \frac{1}{U_q A_q} = \frac{1}{(\eta_0 hA)_f} + \frac{R''_{i,f}}{(\eta_0 A)_f} + R_p + \frac{K''_{i,q}}{(\eta_0 A)_q} + \frac{1}{(\eta_0 hA)_q}$$

$$-NUT = \frac{UA}{c_{min}}$$

c_{min}, lado dos gases:

$$c_{min} = c_{p,g} \times \dot{m}_g = 1120 \times 10 = 11200W/K$$

Mudança de fase, $c_{vapor} \to \infty$, $c_r \to 0$
Area de troca?

$$A = 500 \times \pi \times 0.025 \times L = 39.27\ L$$

$$q_{max} = c_{min} \times (T_{h,e} - T_{c,e}) = 1200 \times (1400 - 450)$$

$$q_{max} = 10.64\ MW$$

$$q_{trocador} = \dot{m}_{agua} \times h_{lv}$$

Em que $h_{lv} = 2024 \times 10^3\ J/kg$

$$\varepsilon = \frac{6.07}{10.64} = 0.571$$

Trocador de calor com mudança de fase:

$$NUT = -\ln(1-\varepsilon)$$
$$NUT = -\ln(1-0.845)$$
$$NUT = \frac{UA}{c_{min}} = \frac{50 \times 39.27L}{11200}$$
$$L = 4.82m$$