FT I – Teste 3

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Conteúdo

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Grupo I

Camisas são equipamentos de troca de calor que se encontram no exterior do reator, sua area de contato é a area externa do reator, possúi maior area de contato que espiras externas e menor que as espiras internas, apesar de ter maior area de contato o fluido é capás de passar por um percurso menor do que uma espira externa que força um percurso por todas as voltas. Por ser externa é possivel a troca da camisa sem ter de abrir o reator facilitando manutenção.

Grupo II

Questão 1

- Contra-corrente
- $n_{tubos} = 6$
- $D_e = 25\,\text{mm}$
- $D_i = 22\,\text{mm}$
- Condutividade da parede: $0.45\,\text{W}\,\text{m}^{-1}\,\text{K}^{-1}$
- Coeficiente de Filme do ben: $1.80\,\text{kW}\,\text{m}^{-2}\,\text{K}^{-1}$
- Benzeno
  - $G_{ben} = 156\,\text{kg}\,\text{min}^{-1}$
  - $C_{m,ben} = 1.9\,\text{kJ}\,\text{kg}^{-1}\,\text{K}^{-1}$
  - $T_{ben,0} = 330\,\text{K}$
  - $T_{ben,1} = 350\,\text{K}$
- Fluido:
  - $T_{flu,0} = 280\,\text{K}$
  - $C_{m,flu} = 4.181\,\text{kJ}\,\text{kg}^{-1}\,\text{K}^{-1}$
  - $\rho_{flu} = 1040\,\text{kg}\,\text{m}^{-3}$
  - $\mu_{flu} = 0.0012\,\text{kg}\,\text{m}^{-1}\,\text{s}^{-1}$
  - Condutividade do fluido: $0.643\,\text{W}\,\text{m}^{-1}\,\text{K}^{-1}$

$$\left(\frac{\boldsymbol{h_i\,D_i}}{\boldsymbol{K}}\right) = \mathbf{0.023}\,\left(\frac{\boldsymbol{\rho\,D_i\,V}}{\boldsymbol{\mu}}\right)^{\mathbf{0.8}}\,\left(\frac{\boldsymbol{C_p\,\mu}}{\boldsymbol{K}}\right)^{\boldsymbol{n}}$$

$$\boldsymbol{n} = \begin{cases} \mathbf{0.4} & - \quad \textbf{Aquecimento do fluido} \\ \mathbf{0.3} & - \quad \textbf{Arrefecimento do fluido} \end{cases}$$

Q1 a.

Qual o caldal mássico de fluido de arrefecimento necessário sabendo q a temp do fluido n pode ultrapassar 325 K

$$\min G_{m,flu} = \frac{Q_{flu}}{C_{m,flu}\ \max \Delta T_{flu}} = \frac{(-Q_{ben})}{C_{m,flu}\,(T_{flu,0} - \max T_{flu})} =$$
$$= \frac{(-G_{m,ben}\ \Delta T_{ben}\, C_{m,ben})}{C_{m,flu}\,(T_{flu,0} - \max T_{flu})} = -\frac{(156/60) * (350 - 330) * (1.9 * 10^3)}{(4.181 * 10^3) * (280 - 325)} \cong 525.13\,\mathrm{E}{-3}$$

Q1 b.

Qual deve ser o comprimento de cada tubo?

$$L = \frac{A_e}{\pi\, D_e} = \frac{A_i}{\pi\, D_i}; \qquad (\bar{h}_i\, A_i) = \frac{\Delta(\Delta T)_{\ln}}{Q_{flu}} = \frac{\left(\frac{\Delta T_1 - \Delta T_0}{\ln(\Delta T_1/\,\Delta T_0)}\right)}{G_{m,flu}\, C_{m,flu}\; \Delta T_{flu}} =$$

$$= \frac{(\Delta T_1 - \Delta T_0)}{G_{m,flu}\, C_{m,flu}\; \Delta T_{flu}\, \ln\left(\Delta T_1/\,\Delta T_0\right)} =$$

$$= (h_i\, A_i)^{-1} + (h_e\, A_e)^{-1} + \frac{x_w}{k_w\, A_w} =$$

$$= \begin{pmatrix} (h_i\, \pi\, D_i\, L)^{-1} & + \\ + \left(\left(\frac{k_{flu}\, 0.023}{D_e}\left(\frac{\rho\, D_e\, u}{\mu_{flu}}\right)^{0.8}\left(\frac{C_{p,flu}\,\mu_{flu}}{k}\right)^{0.4}\right)(\pi\, D_e\, L)\right)^{-1} & + \\ + \frac{(D_e - D_i)/2}{k_w}\left(\frac{A_e - A_i}{\ln\left(A_e/A_i\right)}\right)^{-1} & \end{pmatrix} =$$

$$= \begin{pmatrix} (h_i\, D_i)^{-1}\,(\pi\, L)^{-1} & + \\ + \left(\frac{0.023\, k_{flu}^{0.6}\, \rho^{0.8}\, D_e^{0.8}\, u^{0.8}\, C_{p,flu}^{0.4}}{\mu_{flu}^{0.4}}\right)^{-1}(\pi\, L)^{-1} & + \\ + \frac{(D_e - D_i)/2}{k_w}\left(\frac{\ln\left(D_e/D_i\right)}{D_e - D_i}\right)(\pi\, L)^{-1} & \end{pmatrix} =$$

$$= \begin{pmatrix} (h_i\, D_i)^{-1} & + \\ + \frac{\mu_{flu}^{0.4}}{0.023\, k_{flu}^{0.6}\, \rho^{0.8}\, C_{p,flu}^{0.4}\, D_e^{0.8}}\left(\frac{G_{m,flu}}{n_{tubos}\, \rho_{flu}\, (\pi\, (D_e/2)^2)}\right)^{-0.8} & + \\ + \frac{\ln\left(D_e/D_i\right)}{2\, k_w} & \end{pmatrix}(\pi\, L)^{-1} =$$

$$= \begin{pmatrix} (h_i\, D_i)^{-1} & + \\ + \frac{\mu_{flu}^{0.4}\, n_{tubos}^{0.8}\, \pi^{0.8}\, D_e^{0.8}}{0.023\, k_{flu}^{0.6}\, C_{p,flu}^{0.4}\, G_{m,flu}^{0.8}\, 2^{1.6}} & + \\ + \frac{\ln\left(D_e/D_i\right)}{2\, k_w} & \end{pmatrix}(\pi\, L)^{-1} \implies$$

$$\implies L = \left(\begin{array}{l} (h_i\, D_i)^{-1} \\ + \dfrac{\mu_{flu}^{0.4}\, n_{tubos}^{0.8}\, \pi^{0.8}\, D_e^{0.8}}{0.023\, k_{flu}^{0.6}\, C_{p,flu}^{0.4}\, G_{m,flu}^{0.8}\, 2^{1.6}} \\ + \dfrac{\ln\left(D_e/D_i\right)}{2\, k_w} \end{array} \right) + + + *$$

$$* \frac{G_{m,flu}\, C_{m,flu}\, \Delta T_{flu}\, \ln\left(\Delta T_1/\, \Delta T_0\right)}{\pi\left(\Delta T_1 - \Delta T_0\right)} =$$

$$= \left(\begin{array}{l} \left((1.80 * 10^3) * 22 * 10^{-3}\right)^{-1} \\ + \dfrac{(0.0012)^{0.4} * 6^{0.8} * \pi^{0.8} * (25 * 10^{-3})^{0.8}}{0.023 * (0.643)^{0.6} * (4.181 * 10^3)^{0.4} * (525.13\,\mathrm{E}{-3})^{0.8} * 2^{1.6}} \\ + \dfrac{\ln\left(25/22\right)}{2 * 45} \end{array} \right) + + + *$$

$$* \frac{525.13\,\mathrm{E}{-3} * (4.181 * 10^3) * (325 - 280) * \ln\frac{355-325}{330-280}}{\pi * ((355 - 325) - (330 - 280))} \cong 4.31$$

Q1 c.

Caso seja cocorrente

$$L = \left(\begin{array}{l} (h_i\, D_i)^{-1} \\ +\dfrac{\mu_{flu}^{0.4}\, n_{tubos}^{0.8}\, \pi^{0.8}\, D_e^{0.8}}{0.023\, k_{flu}^{0.6}\, C_{p,flu}^{0.4}\, G_{m,flu}^{0.8}\, 2^{1.6}} \\ +\dfrac{\ln\left(D_e/D_i\right)}{2\, k_w} \end{array} \right) + \left(\begin{array}{l} \\ + \\ \end{array} \right) * \\ * \frac{G_{m,flu}\, C_{m,flu}\, \Delta T_{flu}\, \ln\left(\Delta T_1/\, \Delta T_0\right)}{\pi\left(\Delta T_1 - \Delta T_0\right)} = \\ = \left(\begin{array}{l} \left((1.80 * 10^3) * 22 * 10^{-3}\right)^{-1} \\ +\dfrac{(0.0012)^{0.4} * 6^{0.8} * \pi^{0.8} * (25 * 10^{-3})^{0.8}}{0.023 * (0.643)^{0.6} * (4.181 * 10^3)^{0.4} * (525.13\,\mathrm{E}{-3})^{0.8} * 2^{1.6}} \\ +\dfrac{\ln\left(25/22\right)}{2 * 45} \end{array} \right) + \left(\begin{array}{l} \\ + \\ \end{array} \right) * \\ * \frac{525.13\,\mathrm{E}{-3} * (4.181 * 10^3) * (325 - 280) * \ln\frac{355-280}{330-325}}{\pi * ((355 - 280) - (330 - 325))} \cong 82.85$$