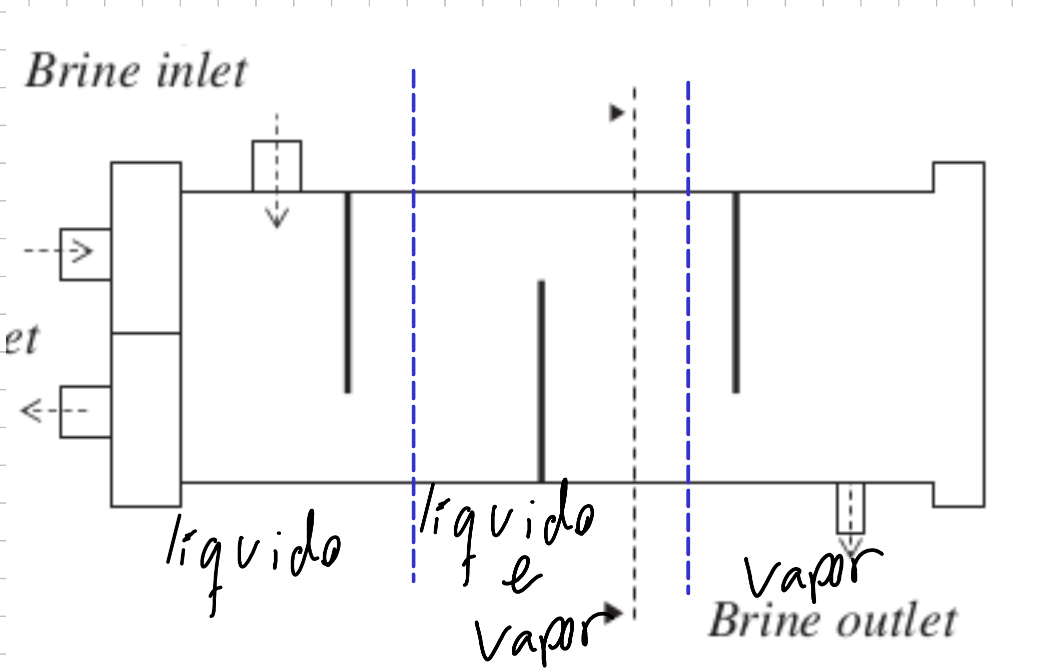
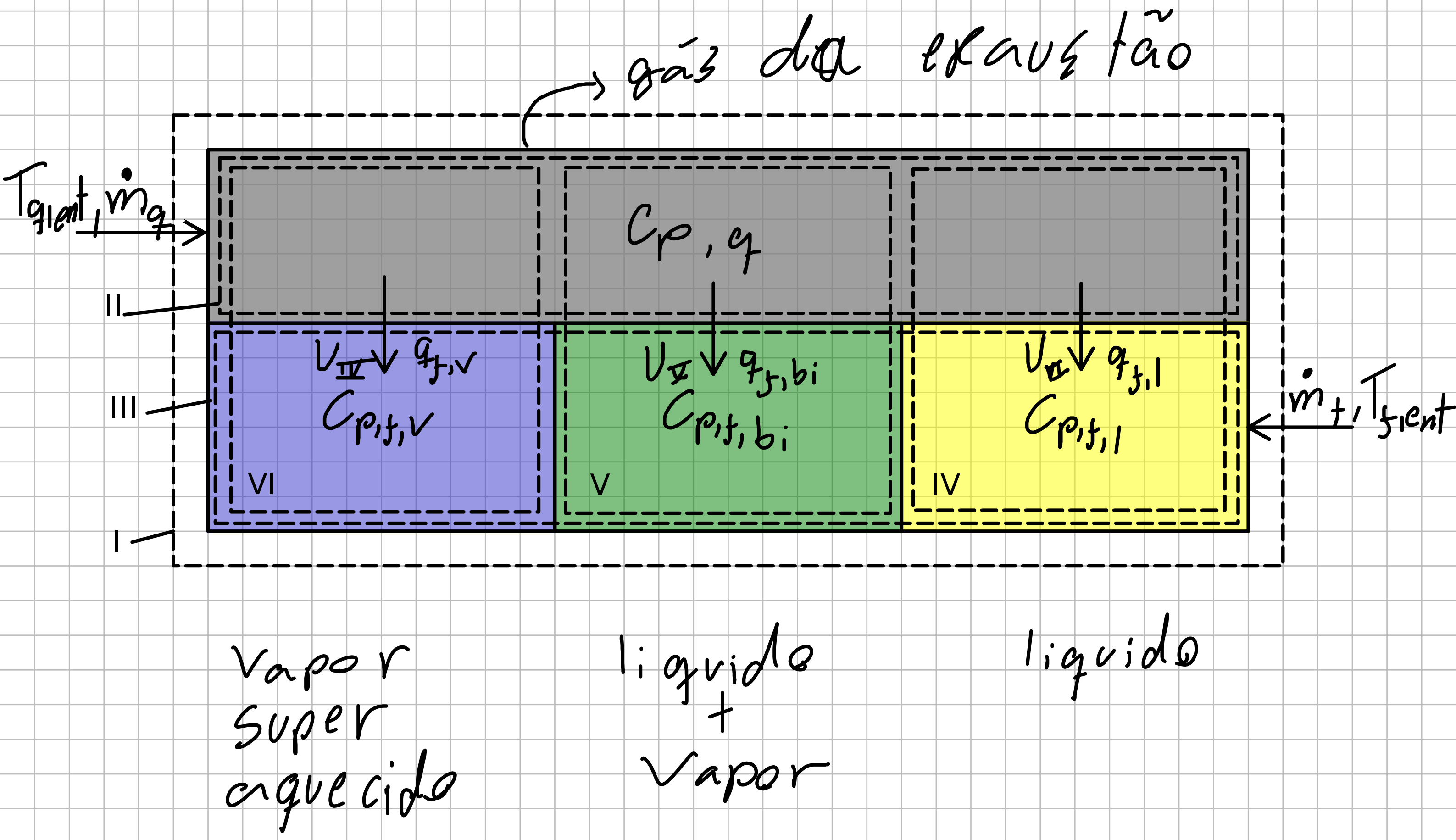


https://www.onda-it.com/eng/products/shell-and-tube-heat-exchangers

Equações gerais:

- $q = \dot{m}_g \, c_{p,g} (T_{g,ent} - T_{g,sai})$
- $q = \dot{m}_f (i_{f,sai} - i_{f,ent})$
- $\varepsilon = 1 - exp(-NUT)$ → água
- $\varepsilon = 2 \left\{ 1 + C_r + (1 + C_r^2)^{1/2} \times \dfrac{1 + exp[-NUT(1+C_r^2)^{1/2}]}{1 - exp[-NUT(1+C_r^2)^{1/2}]} \right\}^{-1}$

→ exaustão do motor



Análise:

→ Volume de cont. Fluido Frio III

$$q_f = \dot{m}_f (i_{f,sai} - i_{f,ent}) \therefore$$

$$q_f = q_{f,l} + q_{f,bi} + q_{f,v}$$ ⇒ Vol. Cont. das regiões

→ Vol. Cont. Fluido quente: II

$$q_q = \dot{m}_q c_{p,q} (T_{q,ent} - T_{q,sai})$$

→ Vol. Cont. geral - balanço de massas e Energia I

$$q_q = q_f \therefore$$

$$\dot{m}_q c_{p,q} (T_{q,ent} - T_{q,sai}) = \dot{m}_f (i_{f,sai} - i_{f,ent}) \therefore$$

Volumes de controle $\cancel{IV}$, V, VI:

P/ todos temos que

$Nu_{D,e} \Rightarrow$ método de Kern

$\hookrightarrow \underline{\underline{h_e}} = Cte$

$$T_{q,sai} = T_{q,ent} - \frac{\dot{m}_f (i_{f,sai} - i_{f,ent})}{\dot{m}_q c_{p,q}}$$

$$U_1 = \left[\frac{1}{h_i} + R_{d,i} + \frac{D_i \cancel{\pi} \ln(d_e/d_i)}{2\cancel{\pi} k_{aço}} + \left(\frac{d_i}{d_e}\right) R_{d,e} + \frac{d_i}{d_e h_e}\right]^{-1}$$

Será nescessário o uso de uma relação de $\varepsilon(NUT)$ p/ cada zona, portanto temos que:

→ Volume de controle $\cancel{IV}$:

↳ <u>Método da efetividade</u>

$$\left.\begin{aligned} C_q &= \dot{m}_q c_{p,q} \\ C_f &= \dot{m}_{f,liq.} c_{p,f,liq} \end{aligned}\right\} C_{min}$$

$$q_{max} = C_{min}(T_{q,ent} - T_{f,ent})$$

$$\varepsilon = \frac{q}{q_{max}}$$

$$\varepsilon = 2\left\{1 + C_r + (1 + C_r^2)^{1/2} \times \frac{1 + \exp\left[-NUT(1+C_r^2)^{1/2}\right]}{1 - \exp\left[-NUT(1+C_r^2)^{1/2}\right]}\right\}^{-1}$$

$$NUT_{IV} = \frac{U_{IV} A}{C_q}$$

$$D_h = \frac{A_{tr}}{P}$$ A_{tr} → Área de sec. trans.
P → Perímetro molhado.

$$Re_{iD} = \frac{\dot{m} D_h}{A \mu} = 11582$$ → turbulento

Para grandes variações de temp.
Método de Sieder e Tate

$$Nu_{i,D} = 0{,}027\, Re_{iD}^{4/5}\, Pr^{1/3} \left(\frac{\mu}{\mu_s}\right)^{0{,}14}$$

$$\begin{cases} 0{,}7 \leq Pr \leq 16\,700 \\ Re_D \gtrsim 10000 \\ L/D \gtrsim 10 \end{cases}$$ → Plenamente desenvolvido

Volume de controle $\forall$:

Método da efetividade

$$C_q = \dot{m}_q \, c_{p,q} = C_{min}$$

$$C_f \to \infty = C_{max}$$

$$\varepsilon = \frac{q}{q_{max}} = \frac{q_q}{q_{max}} = \frac{q_f}{q_{max}}$$

Método da efetividade

$$C_q = \dot{m}_q c_{p,q} = C_{min}$$

$$C_f \to \infty = C_{max}$$

$$\varepsilon = \frac{q}{q_{max}} = \frac{q_q}{q_{max}} = \frac{q_f}{q_{max}}$$

NUT interno: $C_r \to 0$

$$NUT_i = -\ln(1-\varepsilon)$$

$$NUT_i = \frac{U_i A_i}{C_q} = \frac{UA}{C_q}$$

NUT externo: → p/ casco com 1 passe

$$\varepsilon = 2\left\{1 + C_r + (1+C_r^2)^{1/2} \times \frac{1+\exp[-NUT(1+C_r^2)^{1/2}]}{1-\exp[-NUT(1+C_r^2)^{1/2}]}\right\}^{1}$$

$$NUT_e = \frac{U_e A_e}{C_q}$$

Volumes de controle IV, V, VI:

P/ todos temos que

$Nu_{D,i,e} \Rightarrow$ método de Kern

$$U = U_{IV} + U_{V} + U_{VI}$$

$$NUT = \frac{U_i A_i}{C_{min}} = \frac{U_i D_i \pi L}{C_{min}} \therefore$$

$$L = \frac{NUT \cdot C_{min}}{U_i D_i \pi}$$

$$q_6 = h_i (T_{sai} - T_{ent})$$

$$\frac{q_6}{h_i} = T_{sai} - T_{ent} \therefore T_{sai} = \frac{q_6}{h_i} + T_{ent}$$