

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

Equações gerais:

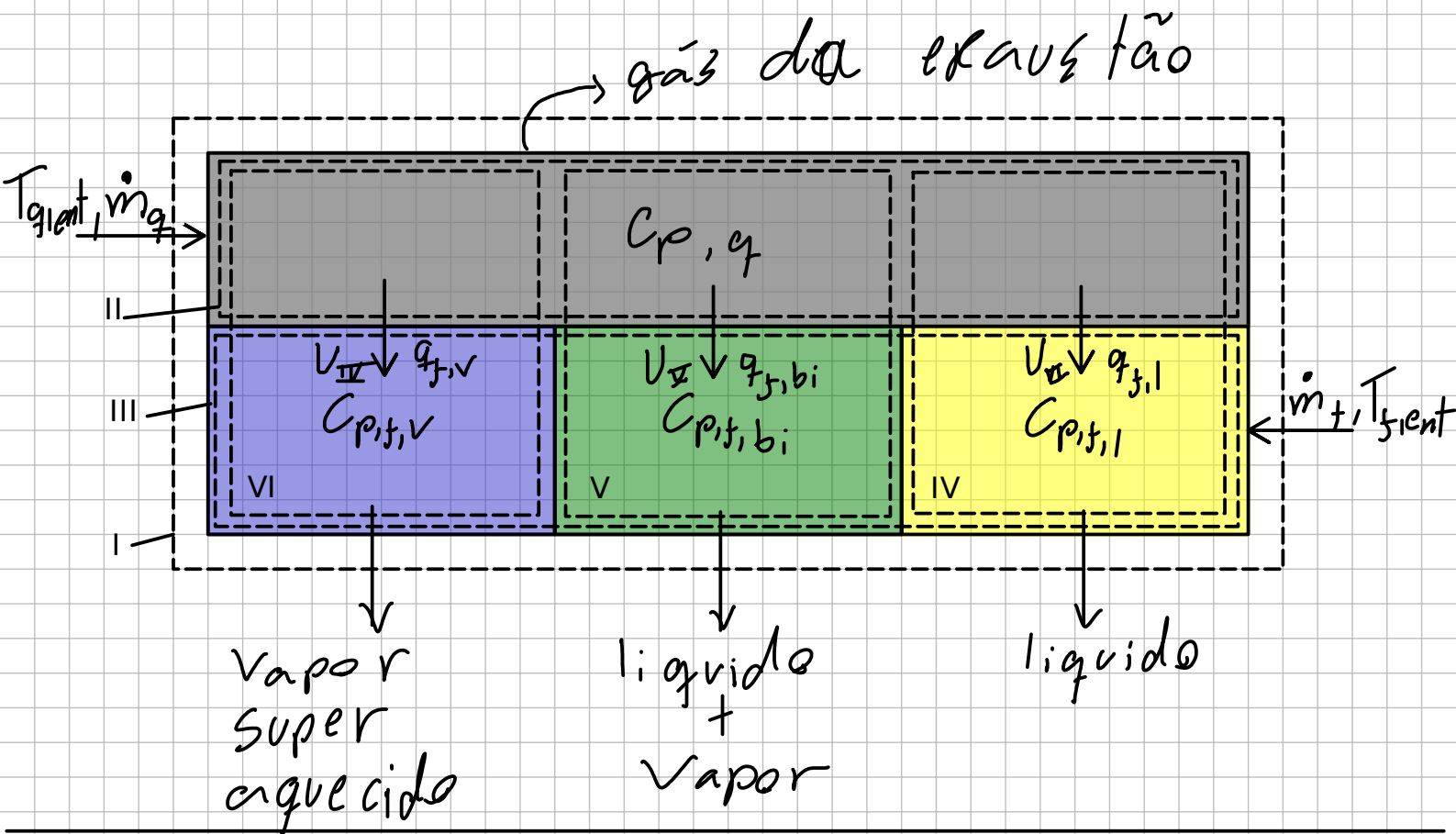
$$q = \dot{m}_q c_{p,q} (T_{q,ent} - T_{q,sai})$$

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

$$E = 1 - \exp(-NUT) \rightarrow \text{água}$$

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

\rightarrow exaustão do motor



Análise:

→ Volume de cont. Fluido Frio III

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

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

→ 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 IV, V, VI:

P/ todos temas que

Nuove \Rightarrow método de Kern

$$\hookrightarrow \underline{h_e} = C/e$$

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

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

Será necessário o uso de uma relação de $E(NVT)$ p/ cada zona, portanto temos que:

\rightarrow Volume de controle IV:

\hookrightarrow Método da efetividade

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

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

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

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

$$NUT_{IV} = \frac{U_w A}{C_p q}$$

$$D_h = \frac{A_{tr}}{P} \rightarrow \text{Área de sec. trans.}$$

$$P \rightarrow \text{Perímetro molhado.}$$

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

Para grandes variações de temp.
Método de Sieder e Tate

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

$$0,7 \leq Pr \leq 16700$$

$$Re_D \gtrsim 10000$$

$$L/D \gtrsim 10 \rightarrow \text{Plenamente desenvolvido}$$

→ Volume de controle V :

→ Método da efetividade

$$C_g = \text{ring } C_{pig} = C_{\min}$$

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

$$E = \frac{q}{q_{\max}} = \frac{\cancel{q_g}}{q_{\max}} = \frac{\cancel{q_f}}{q_{\max}}$$

Método da efetividade

$$C_q = \dot{m} q \quad C_{piq} = C_{min}$$

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

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

NUT interno: $C_r \rightarrow 0$

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

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

NUT externo: \sim p/ caso com 1 passe

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

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

Volumes de controle IV, V, VI:

P/ todos temas que

Nuoi \Rightarrow método de Kern

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

$$N/UT = \frac{U_i A_i}{C_{min}} = \frac{U_i D_i \tilde{n} L}{C_{min}} \therefore$$

$$L = \frac{N/UT \cdot C_{min}}{U_i D_i \tilde{n}}$$

$$q_G = \dot{m}_i (T_{sai} - T_{ent})$$

$$\frac{q_G}{\dot{m}_i} = T_{sai} - T_{ent} \therefore T_{sai} = \frac{q_G}{\dot{m}_i} + T_{ent}$$