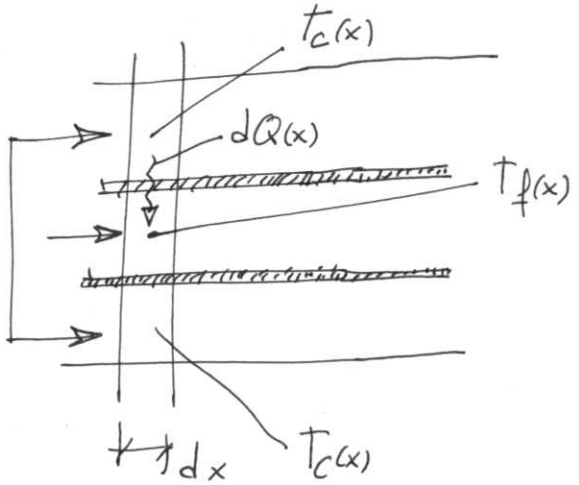
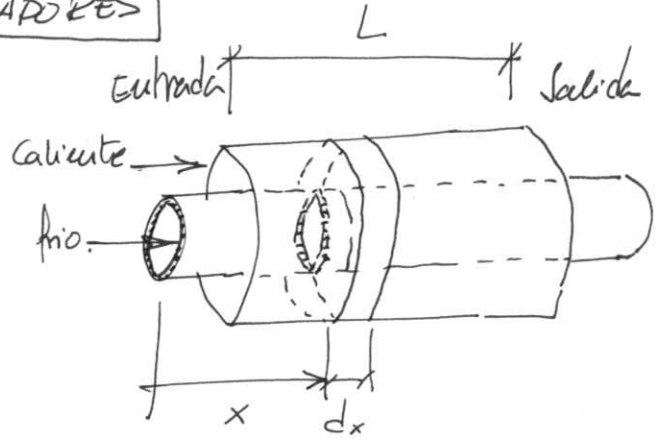
ECUACIÓN TC. INTERCAMBIADORES



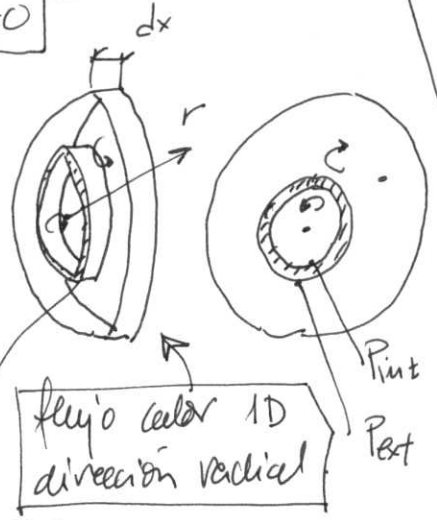


Balances Energía

$$dQ(x) = -(\dot{m} C_p)_c \, dT_c(x)$$

$$dQ(x) = (\dot{m} C_p)_f \, dT_f(x)$$

TROZO



$$dA_{int} = P_{int} \cdot dx$$

$h_{int} \neq h_{int}(x)$

$h_{ext} \neq h_{ext}(x)$

pq las capas límite están desarrolladas (*) (ver)

$$dQ(x) = \frac{T_c(x) - T_f(x)}{\frac{1}{h_{int} P_{int} dx} + \frac{\ln(r_{ext}/r_{int})}{2\pi k dx} + \frac{1}{h_{ext} P_{ext} dx}}$$

TRANSMISIÓN CALOR EN EL TROZO

$$dQ(x) = \frac{1}{\frac{1}{(\,)} + \frac{\ln}{(\,)} + \frac{1}{(\,)} \cdot P_{int} \cdot dx} \; P_{int} \, dx \; (T_c(x) - T_f(x))$$

U referido al área interior

$$dQ(x) = U \underbrace{dA_{int}(x)}_{P_{int} \cdot dx} \underbrace{(T_c(x) - T_f(x))}_{\Delta T(x)}$$

Transf. de calor.

$$d(\Delta T) = d(T_c(x) - T_f(x)) = dT_c(x) - dT_f(x)$$

$$= -dQ(x) \left(\frac{1}{(\dot{m} C_p)_c} + \frac{1}{(\dot{m} C_p)_f} \right) = -U \cdot P_{int} \cdot dx \; \Delta T(x) \left(\frac{1}{(\dot{m} C_p)_c} + \frac{1}{(\dot{m} C_p)_f} \right)$$

$$\frac{d(\Delta T)}{\Delta T(x)} = -\underbrace{U P_{int} \left(\frac{1}{(\dot{m} C_p)_c} + \frac{1}{(\dot{m} C_p)_f} \right)}_{= cte} \cdot dx \rightarrow \text{integramos} \int_{\text{entrada}}^{\text{salida}}$$

$$\ln\left(\frac{\Delta T_{salida}}{\Delta T_{entrada}} \right) = -U P_{int} L \left(\frac{1}{(\dot{m} C_p)_c} + \frac{1}{(\dot{m} C_p)_f} \right)$$

$$\ln\left(\frac{\Delta T_s}{\Delta T_e}\right) = \ln\left(\frac{T_{cs}-T_{fs}}{T_{ce}-T_{fe}}\right) = -U\underbrace{P_{int}L}_{A_{int}}\left(\frac{1}{(\dot{m}c_p)_c}+\frac{1}{(\dot{m}c_p)_f}\right)$$

$$= -U A_{int}\left(\frac{1}{(\dot{m}c_p)_c}+\frac{1}{(\dot{m}c_p)_f}\right)$$

$$\ln\left(\frac{T_{cs}-T_{fs}}{T_{ce}-T_{fe}}\right) = -U A_{int}\left[\frac{T_{ce}-T_{cs}}{Q}+\frac{T_{fs}-T_{fe}}{Q}\right]$$

$$Q_c = (\dot{m}c_p)_c (T_{ce}-T_{cs}) = Q$$
$$Q_f = (\dot{m}c_p)_f (T_{fs}-T_{fe}) = Q$$

$$\ln\left(\frac{T_{cs}-T_{fs}}{T_{ce}-T_{fe}}\right) = \frac{-UA_{int}}{Q}\left[(T_{ce}-T_{fe})-(T_{cs}-T_{fs})\right]$$

$$Q = UA_{int}\frac{\left[(T_{cs}-T_{fs})-(T_{ce}-T_{fe})\right]}{\ln\left(\frac{T_{cs}-T_{fs}}{T_{ce}-T_{fe}}\right)} = \underbrace{UA_{int}}\frac{\Delta T_s-\Delta T_e}{\ln\left(\frac{\Delta T_s}{\Delta T_e}\right)}$$

luego el UA_{int}, como no depende de x (posición en el intercambiador) se calcula utilizando las ecuaciones de flujo 1D radial estacionario.