(Kond-4) $\dot{m} = 4000$ kg/h $= 1.1111$ kg/s $\quad d_i = 16{,}5$ mm, $d_o = 19$ mm, $L = 2$ m, horisontellt

$T_{in,v} = 20°C \quad T_{kond} = 100°C$, (Förenkling: $T_f = 100°C$), $k = 45$ W/m·K

Flera temperaturberoenden $\Rightarrow$ Iterera!

Gissa $T_{ut,v} \rightarrow$ Bestäm $h_i \rightarrow$ Bestäm $T_w \rightarrow$ Bestäm $h_o \rightarrow$

$\rightarrow q = UA\Delta T_{lm} \overset{?}{=} \dot{m} c_p \Delta T$

1. Gissa $T_{ut,v} = 30°C \Rightarrow T_{m,v} = 25°C$

$$Re_{in} = \frac{\dot{m} 4}{\pi d_i \mu} = \left\{\mu(25°C) = 903\cdot10^{-6}\ \text{Pas}\right\} = \frac{1.1111 \cdot 4}{\pi \cdot 16{,}5\cdot10^{-3} \cdot 903\cdot10^{-6}} = 94\,950 \text{ - Turbulent}$$

$$(20\text{-}28) \Rightarrow h_i = \frac{k}{d_i} 0.023\, Re^{0.8} Pr^{0.4} = \left\{\begin{matrix} k = 0.606\,W/m\cdot K \\ Pr = 6.175 \end{matrix}\right\} = 16\,787\,W/m^2\cdot K$$

Delbalans ut till utsidan röret:

$$\left.\begin{matrix} T_{w,o} - T_{w,i} = q_r \dfrac{\ln r_o/r_i}{2\pi k L} \\ T_{w,i} - T_{m,v} = q_r \dfrac{1}{h_i \cdot \pi d_i L} \end{matrix}\right\} \Rightarrow T_{w,o} - T_{m,v} = \frac{q_r}{L}\left(\frac{\ln r_o/r_i}{2\pi k} + \frac{1}{h_i d_i \pi}\right)$$

$$\Rightarrow T_{w,o} = T_{m,v} + \frac{q_r}{L}\left(\frac{\ln r_o/r_i}{2\pi k} + \frac{1}{h_i d_i \pi}\right) = \left\{q_r = \dot{m} c_p \Delta T = 46422\ J/s\right\} =$$

$$= 25 + \frac{46422}{2}\left(\frac{\ln 19/16{,}5}{2\pi \cdot 45} + \frac{1}{16787 \cdot 16{,}5\cdot10^{-3}\cdot\pi}\right) = 63{,}26°C$$

Konvektion på utsidan:

$$(20\text{-}20)\quad h_o = 0.725\left(\frac{\rho_L g k^3 (\rho_L - \rho_v)\left(h_{fg} + \frac{3}{8} c_{p,L}(T_{sat} - T_w)\right)}{D\mu (T_{sat} - T_w)}\right)^{1/4} =$$

$$= \left\{\begin{matrix} \text{Data vid } T_f \approx 80°C: \\ \rho_L = 971{,}8\ kg/m^3 \quad k = 0.674\,W/m\cdot K \quad c_{pL} = 4193\,J/kg\cdot K \\ \mu = 357\cdot10^{-6}\ Pas \quad h_{fg}(T_{sat}) = 2257000\,J/kg \quad \rho_v(T_{sat}) = 0.5984\,kg/m^3 \end{matrix}\right\} =$$

$$= 9235\ W/m^2\cdot K$$

$$(15\text{-}18)\quad UA = \frac{1}{\frac{1}{A_i h_i} + \frac{\ln r_o/r_i}{2\pi k L} + \frac{1}{A_o h_o}} = 577{,}66\ W/K$$

$$q = UA\Delta T_{lm} \overset{?}{=} \dot{m} c_p (T_{in,v} - T_{ut,v})$$

$$\Rightarrow T_{ut,v} = T_{in,v} + \frac{UA\ \frac{(100-30)-(100-20)}{\ln\frac{100-30}{100-20}}}{\dot{m}\ c_p} = 29{,}32 \qquad \text{Ok!}$$

$$q = \dot{m}_{kond} h_{fg} \Rightarrow \dot{m}_{kond} = 0.019\ kg/s$$

Svar: ▸ $h_i = 94\,950\ W/m^2\cdot K$ ▸ $h_o = 9235\ W/m^2\cdot K$

▸ $T_{v,ut} = 29{,}3°C$ ▸ $\dot{m}_{kond} = 0.019\ kg/s$