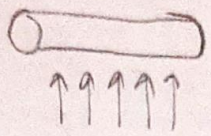
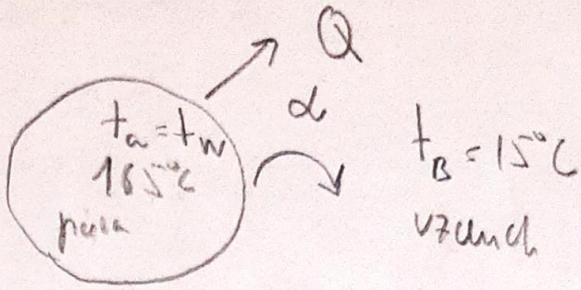
8-4 III Volná konvekce

$d_o = 51$ mm

$L = 50$ m





t_a pára sytá, 0,7 MPa $\Rightarrow$ 165 °C (tabulky)

$t_b = 15$ °C vzduch, 98 kPa

Pouze přestup na straně vzduchu, zanedbat vedení a přestup uvnitř trubky

$$Nu = C\,(Gr\,Pr)^{m}$$

$$Pr = \frac{\eta\, c_p}{\lambda} = \frac{21{,}28\cdot 10^{-6}\cdot 1007}{0{,}0311} = 0{,}689$$

$\langle t \rangle = 15 + 165 = 90\,°C = 363\,K$

vzduch 90 °C

$\eta = 21{,}28\cdot 10^{-6}$ Pa·s

$c_p = 1007$ J/kg·K

$\lambda = 0{,}0311$ W/m·K

$$\varrho = \frac{pM}{RT} = \frac{98\cdot 10^{3}\cdot 28{,}84\cdot 10^{-3}}{8{,}314\cdot 363} = 0{,}9365\ kg/m^3$$

$$\nu = \frac{\eta}{\varrho} = \frac{21{,}28\cdot 10^{-6}}{0{,}9365} = 2{,}272\cdot 10^{-5}\ m^2/s$$

$$Gr = \frac{g\,l^3\,\beta\,\Delta T}{\nu^2} \qquad \beta = \frac{1}{T} = \frac{1}{363} = 0{,}002755\ K^{-1}$$

$\Delta T = 165 - 15 = 150\,°C\,(K)$

$$Gr = \frac{9{,}81\cdot (0{,}051)^3\cdot 0{,}002755\cdot 150}{(2{,}272\cdot 10^{-5})^2} = 1{,}0418\cdot 10^{6}$$

$Gr\,Pr = 0{,}689\cdot 1{,}0418\cdot 10^{6} = 717\,800$ → $C = 0{,}53$, $m = 1/4$ (viz Tab 8-2)

$Nu = 0{,}53\,(717\,800)^{1/4} = 15{,}43$

$$Nu = \frac{\alpha \cdot l}{\lambda}$$

$$\alpha = \frac{Nu\,\lambda}{l} = \frac{15{,}43 \cdot 0{,}0311}{0{,}051} = 9{,}409 \text{ W/m}^2\text{K}$$

$$\underline{A} = \pi d_o L = \pi \cdot 0{,}051 \cdot 50 = \underline{8{,}011 \text{ m}^2} \quad (\text{plášť válce})$$

$$\dot{Q} = \alpha \cdot \Delta T \cdot A = 9{,}409 \cdot (165 - 15) \cdot 8{,}011$$

$$\underline{\dot{Q} = 11{,}3 \text{ kW}}$$