1.) $\overline{T_\alpha} = \dfrac{37{,}92°C + 24{,}51°C}{2} = \underline{31{,}22\ °C}$

2.) $\dot{V}_\alpha = \dot{V}_{\alpha,N} \cdot \dfrac{T_\alpha}{T_{\alpha,N}} = 25{,}5\ \dfrac{Nm^3}{h} \cdot \dfrac{(273+31{,}22)\,K}{273\,K}$

$= \underline{28{,}4\ \dfrac{m^3}{h}}$

3.) $\dot{m}_\alpha = \dfrac{\dot{V}_\alpha \cdot p}{R_{sp} \cdot T} = \dfrac{28{,}42\ \frac{m^3}{h} \cdot 101325\ \cancel{Pa}}{0{,}29\ \frac{kJ}{kg \cdot K} \cdot (31{,}22+273)\ \cancel{K}}$

$= \underline{9{,}07 \cdot 10^{-3}\ \dfrac{kg}{s}}$

4.) $\dot{Q} = \dot{m}_\alpha \cdot c_{p,\alpha} \cdot \Delta T_\alpha$

$= 9{,}07 \cdot 10^{-3}\ \frac{kg}{s} \cdot 1005\ \frac{J}{kg \cdot k} \cdot (37{,}92-24{,}51)\,K$

$= \underline{122{,}2\ W}$

5.) $\rho_{1,H_2O}(T_{H_2O}) = 1005{,}7 - 0{,}375 \cdot T\,[°C]$

$\rho_{1,H_2O}(30{,}7°C) = 1005{,}7 - 0{,}375 \cdot 30{,}7$

$= \underline{995{,}1\ \dfrac{kg}{m^3}}$

6.) $\dot{m}_{H_2O} = \rho_{H_2O} \cdot \dot{V}_{H_2O}$

$= 986{,}1\ \frac{kg}{m^3} \cdot 0{,}385\ \frac{m^3}{h}$

$= \underline{0{,}11\ \dfrac{kg}{s}}$

7.) $\Delta T_{H_2O} = \dfrac{\dot{Q}}{\dot{m}_{H_2O} \cdot c_{p_{H_2O}}} = \dfrac{122{,}2\,W}{0{,}11\,\frac{kg}{s} \cdot 4185\,\frac{J}{kg \cdot k}} = \underline{0{,}27\,K}$

8.) $T_{\alpha_{H_2O}} = T_{\omega_{H_2O}} + \Delta T_{H_2O} = 54{,}5k + 0{,}27k$

$\qquad\qquad = \underline{54{,}77\,K}$

$\hookrightarrow \overline{T}_{H_2O} = \dfrac{T_{\alpha_{H_2O}} + T_{\omega_{H_2O}}}{2} = \dfrac{54{,}5k + 54{,}77k}{2} = \underline{54{,}64\,K}$

9.) $\angle NTD = \dfrac{\Delta T_A - \Delta T_B}{\ln\left(\frac{\Delta T_A}{\Delta T_B}\right)} = \dfrac{\left(54{,}5°C - 24{,}51°C\right) - \left(54{,}77°C - 37{,}92°C\right)}{\ln\left(\dfrac{54{,}5°C - 24{,}51°C}{54{,}77°C - 37{,}92°C}\right)}$

$\qquad\qquad = \underline{22{,}79\,K}$

10.) $U_a = \dfrac{\dot{Q}}{\angle NTD \cdot A} = \dfrac{122{,}2\,W}{22{,}79k \cdot 0{,}8m \cdot \pi \cdot 0{,}0213m}$

$\qquad\qquad = \underline{100{,}123\ \frac{W}{m^2 \cdot k}}$

Wasserseite

11.) $d_H = D_i - d_a = 0,0297m - 0,0213m$

$ = \underline{0,0084\,m}$

12.) $A_{H_2O}(Ringfläche) = \frac{\pi}{4} \cdot \left(D_i^2 - d_a^2\right) = \frac{\pi}{4}\left(0,0297m^2 - 0,0213m^2\right)$

$\phantom{A_{H_2O}(Ringfläche) = \frac{\pi}{4}} = \underline{3,36 \cdot 10^{-4}\,m^2}$

13.) $W_{H_2O} = \dfrac{\overset{o}{V}_{H_2O}}{A_{H_2O}} = \dfrac{0,385\frac{m^3}{h}}{3,36 \cdot 10^{-4}\,m^2} = \underline{0,32\,\frac{m}{s}}$

14.) $v_{H_2O}(T) = exp\left(-13,2883 - 0,02806 \cdot T + 1,123 \cdot 10^{-4} \cdot T^2\right)$

$v_{H_2O}(54,64°C) = \underline{5,11 \cdot 10^{-7}\,\frac{m^2}{s}}$

15.) $Re_{H_2} = \dfrac{d_H \cdot W_{H_2O}}{v_{H_2O}} = \dfrac{0,0084\,m \cdot 0,32\,\frac{m}{s}}{5,11 \cdot 10^{-7}\,\frac{m^2}{s}} = \underline{5,22 \cdot 10^3}$

16.) $_2\varrho_{H_2O}(54,64°C) = \underline{986,1\,\frac{g}{m^3}}$

17.) $\lambda_{H_2O}(T) = 2,0107 + 0,00761 \cdot T + 3,347 \cdot 10^{-5} \cdot T^2$

$\lambda_{H_2O}(54,64°C) = \underline{0,65\,\frac{W}{m \cdot K}}$

18.) $\Pr_{\sigma\,H_2O} = \dfrac{c_{p\,H_2O} \cdot \nu_{H_2O} \cdot \rho_{H_2O}}{\lambda_{H_2O}}$

$$= \dfrac{4\,185\,\frac{J}{kg \cdot K} \cdot 5{,}11 \cdot 10^{-7}\,\frac{m^2}{s} \cdot 986{,}1\,\frac{kg}{m^3}}{0{,}65\,\frac{W}{m \cdot K}}$$

$$= \underline{\underline{3{,}27}}$$

19.) $Nu_{H_2O} = 0{,}023 \cdot \left(Re^2 \cdot Pr \right)^{0{,}4}$

$$= 0{,}023 \left([5{,}22 \cdot 10^3]^2 \cdot 3{,}27 \right)^{0{,}4}$$

$$= \underline{35}$$

20.) $\alpha_{H_2O,a} = \dfrac{Nu_{H_2O}}{d_H \cdot \lambda_{H_2O}} = \dfrac{35}{0{,}0084\,m} \cdot 0{,}65\,\frac{W}{m \cdot K}$

$$= \underline{\underline{2677\,\frac{W}{m^2 \cdot K}}}$$

Luftseite

21.) $A_L \text{ (Kreisinnenfläche)} = \frac{\pi}{4} \cdot d_i^2 = \frac{\pi}{4} \cdot (0{,}0173\,m)^2$

$$= \underline{\underline{2{,}35 \cdot 10^{-4}\,m^2}}$$

22.) $W_L = \dfrac{\dot{V}_L}{A_L} = \dfrac{28{,}42\,\frac{m^3}{h}}{2{,}35 \cdot 10^{-4}\,m^2} = \underline{\underline{33{,}58\,\frac{m}{s}}}$

23.)

$\nu_L (T) = 13\,323 \cdot 10^{-5} + 8{,}71 \cdot 10^{-8} \cdot T + 1{,}02 \cdot 10^{-10} \cdot T^2$

$\nu_L (31{,}22°C) = \underline{\underline{1{,}614 \cdot 10^{-5}\,\frac{m^2}{s}}}$

Seite 9

24.) $Re_L = \dfrac{d_i \cdot v_L}{v_L^2} = \dfrac{0,0173m \cdot 33,58\frac{m}{s}}{1,614 \cdot 10^{-5}\frac{m^2}{s}} = \underline{3,60 \cdot 10^4}$

25.) $\rho_L(T) = \dfrac{p}{R_{sp} \cdot T} = \dfrac{101325\,Pa}{0,23\frac{J}{g \cdot k} \cdot (31,22 + 273)k} = \underline{1,149\,\frac{g}{m^3}}$

26.) $\lambda_L(T) = 0,0876 + 2,46 \cdot 10^{-4} \cdot T + 1,12 \cdot 10^{-7} \cdot T^2$

$\lambda_L(31,22°C) = \underline{0,0265\,\frac{W}{m \cdot k}}$

27.) $Pr_L = \dfrac{c_{p,L} \cdot v_L \cdot \rho_L}{\lambda_L} = \dfrac{1005\frac{J}{g \cdot k} \cdot 1,614 \cdot 10^{-5}\frac{m^2}{s} \cdot 1,149\frac{g}{m^3}}{0,0265\frac{W}{m \cdot k}}$

$= \underline{0,70}$

28.) $\alpha_{d_i} = \left[\left(\dfrac{1}{U_a} - \dfrac{d_a}{2 \cdot \lambda_{st}} \cdot \ln\left[\dfrac{d_a}{d_i}\right] - \dfrac{1}{\alpha_{a,H_2O}}\right) \cdot \dfrac{d_i}{d_a}\right]^{-1}$

$= \left[\left(\dfrac{1}{100\frac{W}{m^2 \cdot k}} - \dfrac{0,0213m}{2 \cdot 15,6\frac{W}{m \cdot k}} \cdot \ln\left[\dfrac{0,0213m}{0,0173m}\right] - \dfrac{1}{2677\frac{W}{m^2 \cdot k}}\right) \cdot \dfrac{0,0173m}{0,0213m}\right]^{-1}$

$= \underline{130\,\frac{W}{m^2 \cdot k}}$

29.) $Nu_L = \dfrac{\alpha_{d_i} \cdot d_i}{\lambda_L} = \dfrac{130\frac{W}{m^2 \cdot k} \cdot 0,0173m}{0,0265\frac{W}{m \cdot k}} = \underline{\underline{85}}$

Seite 10

30.) $\ln\left(Re_x^2 \cdot Pr_x\right) = \ln\left(\left[3{,}6 \cdot 10^4\right]^2 \cdot 0{,}7\right) = \underline{20{,}63}$

$\ln\left(Nu_x\right) = \ln\left(85\right) \qquad = \underline{4{,}44}$