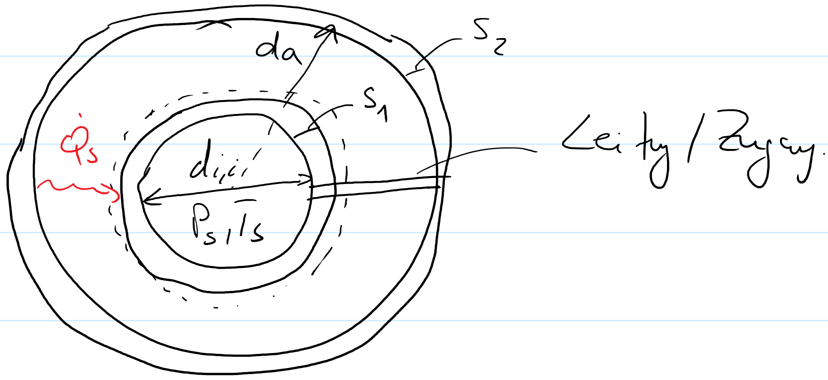
A21

Mittwoch, 3. März 2021 11:18

$d_{i,i} = 0{,}4\,m$

$d_{i,a} = 0{,}406\,m$

$d_a = 0{,}45$



a) Dauer, bis Helium nach außen verdampft.

$$m_{He} = \rho \cdot V = \rho \cdot \frac{\pi}{6} d_{i,i}^3 = 4{,}185\,kg$$

1. HS für Heliumtank

$$\frac{\partial U}{\partial t} = \sum \dot{Q} + \sum \dot{W} + \dot{m}_{ein} h_{ein} - \dot{m}_{aus} h_{aus}$$

($\frac{\partial U}{\partial t} = 0$, $\sum \dot{W} = 0$, $\dot{m}_{ein} = 0$)

$$0 = \dot{Q}_s - \dot{m}_{aus} \cdot h_{aus}$$

$$\dot{Q}_s = \dot{m}_{aus} \cdot h_{aus} = \frac{m_{He}}{t} \cdot r_{He} \rightarrow t = \frac{m_{He} \cdot r_{He}}{\dot{Q}_s}$$

Verdampfungsenthalpie! (r_{He})

Nettowärme:

$$\dot{Q}_s = \sigma \cdot A_{ia} (T_a^4 - T_s^4)$$

$$\text{mit } \frac{1}{A_{ia}} = \frac{1}{A_i \varepsilon} + \frac{1}{A_a \varepsilon} - \frac{1}{A_a}$$

$$A_{ia} = \left(\frac{1}{\pi d_{i,a}^2} + \frac{1}{\pi d_a^2 \cdot \varepsilon} - \frac{1}{\pi d_a^2} \right)^{-1} = 0{,}03\,m^2$$

$$\Rightarrow \dot{Q}_s = 13{,}78\,W$$

$$\Rightarrow t = 6165\,s \approx 1{,}71\,h$$

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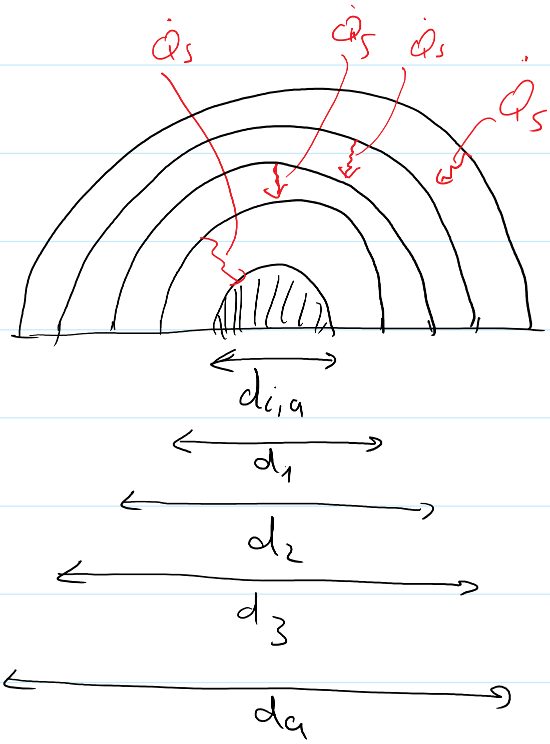
b)

$d_{i,a} = 0{,}406\,m$

$d_a = 0{,}45\,m$

$\Delta d = 0{,}044\,m$

$\frac{\Delta d}{4} = 0{,}011\,m$



$d_1 = d_{i,a} + 0{,}011\,m$

$= 0{,}417\,m$

$d_2 = 0{,}428\,m$

$d_3 = 0{,}439\,m$

Wärmestrom durch einzelne Schichten gleich groß:

$$\dot{Q}_s = \sigma \cdot A_{3a} \cdot (T_a^4 - T_3^4) \leftarrow \frac{\dot{Q}_s}{\sigma \cdot A_{3a}}$$

$$\dot{Q}_s = \sigma \cdot A_{23} (T_3^4 - T_2^4) \quad \frac{\dot{Q}_s}{\sigma \cdot A_{23}}$$

$$\dot{Q}_s = \sigma \cdot A_{12} (T_2^4 - T_1^4) \quad \vdots$$

$$\dot{Q}_s = \sigma \cdot A_{i1} (T_1^4 - T_i^4) \quad T_i = T_S\,!$$

$$\frac{\dot{Q}_s}{\sigma}\left(\frac{1}{A_{3a}} + \frac{1}{A_{23}} + \frac{1}{A_{12}} + \frac{1}{A_{i1}}\right) = \left(T_a^4 - T_3^4 + T_3^4 - T_2^2 + T_2^2 - T_1^4 + T_1^4 - T_i^4\right)$$

$$\frac{\dot{Q}_s}{\sigma} \cdot \frac{1}{A_{ia}} = T_a^4 - T_i^4$$

$$\frac{\dot{Q}_s}{\sigma \cdot A_{3a}} + \frac{\dot{Q}_s}{\sigma A_{23}} \dots = \frac{\dot{Q}}{\sigma}\left(\frac{1}{A_{3a}} + \dots\right.$$