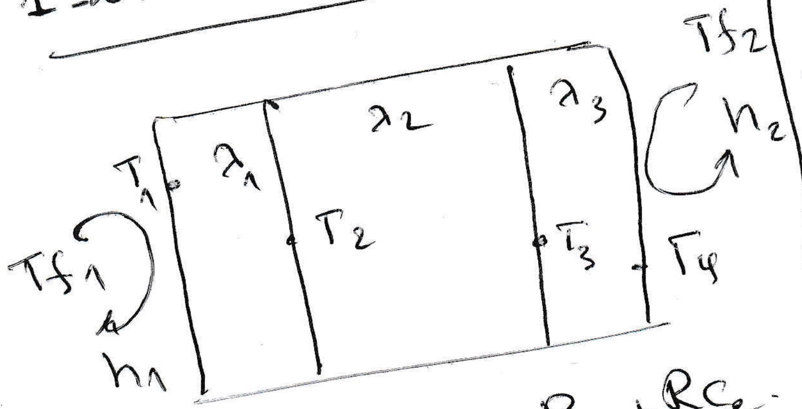
Transfert de chaleur
L3 (Matériaux)

2019_2020

Correction du Contrôle N°=01

Exercice N°=01:

1- La résistance totale



$$R_{tot} = Rc_1 + R_1 + R_2 + R_3 + Rc_2$$

$$Rc_1 = \frac{1}{h_1 . S} = \frac{1}{10.(0,8).(1,5)}$$

$$\boxed{Rc_1 = 0,083\ K/W}$$

$$R_1 = R_3 = \frac{e_1}{\lambda_1 . S} = \frac{4.10^{-3}}{0,026.(0,8)(1,5)}$$

$$\boxed{R_1 = R_3 = 4,273 . 10^{-3}\ K/W}$$

$$R_2 = \frac{e_2}{\lambda_2 . S} = \frac{10.10^{-3}}{0,026.(0,8)(1,5)}$$

$$\boxed{R_2 = 0,320\ K/W}$$

$$Rc_2 = \frac{1}{h_2 . S} = \frac{1}{40.(0,8)(1,5)}$$

$$\boxed{Rc_2 = 0,02\ K/W}$$

$$R_{tot} = 0,083 + 2 \times 4,273 . 10^{-3} + 0,320 + 0,020$$

$$\boxed{R_{tot} = 0,431\ K/W}$$

2- Le coefficient d'échange

$$K = \frac{1}{R_{tot}} = \frac{1}{0,431}$$

$$\boxed{K = 2,32\ W/K}$$

3- Le flux de chaleur

$$\varphi = \frac{Tf_1 - Tf_2}{R_{tot}} = \frac{20-(-10)}{0,431}$$

$$\boxed{\varphi = 69,60\ W}$$

4- Les températures

$$\varphi = h_1 S (Tf_1 - T_1)$$

$$\Rightarrow \boxed{T_1 = Tf_1 - \frac{\varphi}{h_1 S}}$$

$$T_1 = 20 - \frac{69,60}{10(0,8)(1,5)}$$

$$\boxed{T_1 = 14,2°C}$$

$$\varphi = \frac{\lambda_1 . S}{e_1} . (T_1 - T_2)$$

$$\boxed{T_2 = T_1 - \frac{\varphi . e_1}{\lambda_1 S}}$$

$$T_2 = 14,2 - \frac{69,60 . 4.10^{-3}}{0,78.0,8.1,5}$$

$$\boxed{T_2 = 13,90°C}$$

$$\varphi = \frac{\lambda_2 . S}{e_2} (T_2 - T_3)$$

$$\boxed{T_3 = T_2 - \frac{\varphi . e_2}{\lambda_2 . S}}$$

$$T_3 = 13,90 - \frac{69,60 . 10.10^{-3}}{0,026(0,8)(1,5)}$$

$$\boxed{T_3 = -8,4°C}$$

$$\varphi = \frac{\lambda_3 . S}{e_3} (T_3 - T_4)$$

$$T_4 = T_3 - \frac{\varphi . e_3}{\lambda_3 . S}$$

$$T_4 = -8,4 - \frac{69,6 . 4.10^{-3}}{0,78.0,8.1,5}$$

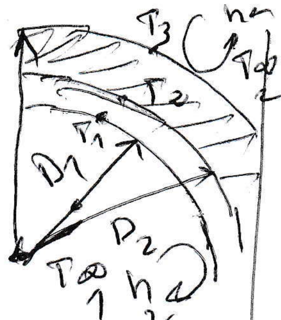
$$\boxed{T_4 = -8,69}$$

Exercice n° 02

$D_1 = 5,0$ cm.

$D_2 = 5,75$ cm.

$D_3 = 5,75$ cm $+ 6$ cm $= 11,75$ cm



1)- La resistance totale

$R_{tot} = R_{c1} + R_1 + R_2 + R_{c2}$

$R_{c1} = \frac{1}{h_1 S} = \frac{1}{h_1 \cdot \pi D_1 \cdot L}$

$R_{c1} = \frac{1}{60 \cdot 3,14 \cdot 5 \cdot 10^{-2} \cdot (1)}$

$\boxed{R_{c1} = 0,106 \ °C/W}$

$R_1 = \frac{Ln(D_2/D_1)}{\lambda_1 \, 2\pi \cdot L}$

$R_2 = \frac{Ln(5,5/5)}{80 \cdot 2 \cdot 3,14 \cdot (1)}$

$\boxed{R_1 = 1,9 \cdot 10^{-4} \ °C/W}$

$R_2 = \frac{Ln(D_3/D_2)}{\lambda_2 \cdot 2\pi \cdot L}$

$R_2 = \frac{Ln\left(\frac{11,75}{5,75}\right)}{0,05 \cdot 2 \cdot 3,14}$

$\boxed{R_2 = 2,35 \ °C/W}$

$R_{c2} = \frac{1}{h_2 \cdot \pi \cdot D_3 \cdot L}$

$R_{c2} = \frac{1}{18 \cdot 3,14 \cdot 11,75 \cdot 10^{-2}}$

$\boxed{R_{c2} = 0,15 \ °C/W}$

$R_{tot} = R_{c1} + R_1 + R_2 + R_{c2}$

$\boxed{R_{tot} = 2,61 \ °C/W}$

2- Le flux de chaleur

$\varphi = \frac{T_{\infty 1} - T_{\infty 2}}{R_{tot}}$

$\varphi = \frac{320 - 5}{2,61}$

$\boxed{\varphi = 121 \ °C/W}$

3- La diminution de la temperature

$\Delta T_{ube} = T_1 - T_2 = \varphi \cdot R_1$

$\Delta T_{tube} = 121 \times 1,9 \cdot 10^{-4}$

$\boxed{\Delta T_{tube} = 0,02 \ °C}$

$\Delta T_{iso} = T_2 - T_3 = \varphi \cdot R_2$

$\Delta T_{iso} = 121 \times 2,35$

$\boxed{\Delta T_{iso} = 284 \ °C}$

Exercice n°03 :

Le flux de chaleur échangé par convection =diminution de l'énergie interne de la bille.

Fluide : $\varphi_c = h.S.(T - T_1)$; $T_1 = 92°C$

La bille : $Q = -m.c.\frac{dT}{dt} = \rho.V.c.\frac{dT}{dt}$

$$h.S.(T - T_0) = -\rho.V.c.\frac{dT}{dt} \Rightarrow \int \frac{dT}{T - T_1} = -\frac{h.S}{\rho.V.c}.\int dt \Leftrightarrow \ln(T - T_1) = -\frac{h.S}{\rho.V.c}.t + \ln C_1$$

$\Rightarrow T - T_0 = C_1.e^{\frac{h.S}{\rho.V.c}.t}$

A t=0 : T= T_i=288°C. (de la bille) : $T_i - T_0 = C_1.e^0 \Rightarrow C_1 = T_i - T_0$.

$$\frac{T - T_0}{T_i - T_0} = e^{\frac{-h.S}{\rho.V.c}.t} = e^{-\alpha.t}, \alpha = \frac{h.S}{\rho.V.c}, \qquad S = 4.\pi.r^2, V = \frac{4}{3}.\pi.r^3$$

$$\alpha = \frac{h.4\pi.r^2}{\rho.(4/3)\pi.r^3.c} = \frac{3h}{\rho.r.c} = \frac{3.10}{7850.\ 0{,}04\ .460} = 2{,}077.10^{-4}\ s^{-1}$$

$$\frac{T - T_0}{T_i - T_0} = e^{-2{,}077.10^{-4}.t}, \qquad \text{à } T = 144°C\ ;\ t = ?$$

$$e^{-2{,}077.10^{-4}.t} = \frac{144 - 92}{288 - 92} = 0{,}265 \Leftrightarrow -2{,}077.10^{-4}.t = \ln(0{,}265) \Rightarrow t = \frac{\ln(0{,}265)}{-2{,}077.10^{-4}}$$

$t = 6394s \approx 106{,}567min \approx$ **$1\ h\ 46{,}567min$**