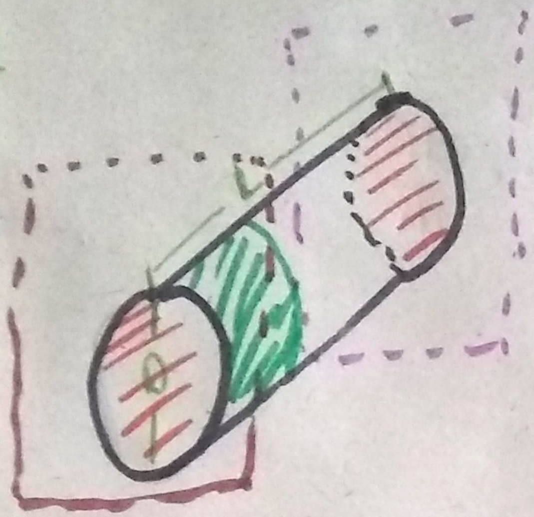
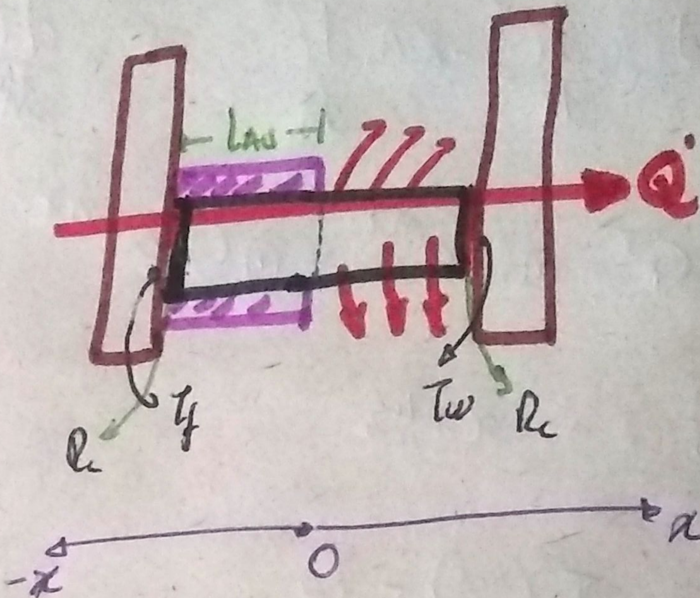
# Fenomenos Transporte

Conductividad $K$

1




a)

Ecuación General de Calor

Sistema I Aislado

B.C.1 $\Rightarrow$ $x = -L_c/2$

$$\dot{Q} = \frac{T_f - T^{I}(-L_c/2)}{R_c}$$

$$\dot{Q} = -K A_s \frac{dT}{dx} \rightarrow$$

$$-K A_s C_1^{I} = \frac{T_f - T^{I}(-L_c/2)}{R_c}$$

$$-K A_s C_1^{I} = \frac{T_f - C_1^{I} x + C_2^{I}}{R_c}$$

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} + \frac{\dot{e}_{gen}}{K} = \alpha \frac{dT}{dt}$$

$$\frac{dT^{I}}{dx} = C_1^{I}$$

$$T^{I}(x) = C_1^{I} x + C_2^{I}$$

B.C2 $\Rightarrow$ $x = 0$ $\rightarrow$ ??

$$T^{I}(x) = T^{II}(x)$$

$$C_1^{I} x + C_2^{I} = C_1^{II} e^{mx} + C_2^{II} e^{-mx}$$

$$C_2^{I} = C_1^{II} + C_2^{II}$$

Sistema II

B.C.1 $\rightarrow$ $x=0$

$\dot{Q}_{in} = Q_{out}$

$$\cancel{-KA_s}\frac{dT^{I}}{dx} = \cancel{-KA_s}\frac{dT^{II}}{dx} \rightarrow \frac{dT^{I}}{dx} = \frac{dT^{II}}{dx}$$

$$C_1^{I} = mC_1^{II}e^{mx} - mC_2^{II}e^{-mx}$$

B.C2 $\rightarrow$ $x = L/2$

$$\dot{Q} = \frac{T^{II}(L/2) - T_\omega}{R_c}$$

$$-KA_s\frac{dT^{II}}{dx} = \frac{T^{II}(L/2) - T_\omega}{R_c}$$

$$-KA_s\left(mC_1^{II}e^{mx} - mC_2^{II}e^{-mx}\right) = \frac{C_1^{II}e^{mx} + C_2^{II}e^{-mx} - T_\omega}{R_c}$$

$I_1$ a Matrix System:

1) $-KA_sR_cC_1^I = T_f - C_1^I(-L_c/2) + C_2^I$

$C_1^I(-KA_sR_c - L_c/2) - C_2^I = T_f$

2) $C_1^I - C_1^{II} - C_2^{II} = 0$

$\alpha[1]$ $\alpha[2]$ $\alpha[3]$

3) $C_1^I - me^{mx}C_1^{II} + me^{-mx}C_2^{II} = 0$

$\alpha[0]$ $\alpha[2]$ $\alpha[3]$

4)

$R_c(-KA_sme^{ma}C_1^{II} + R_cKA_sme^{-ma}C_2^{II} = e^{ma}C_1^{II} + e^{-mx}C_2^{II} - T_w$

$C_1^{II}(-KR_cA_sme^{mx} - e^{ma}) + C_2^{II}(R_cKA_sme^{-mx} - e^{-mx}) = -T_w$

Recall:

$m = \sqrt{\dfrac{hp}{KA_c}}$

$p \rightarrow$ perimeter

$h \rightarrow$ convection

$K \rightarrow$ conduction

$A_c \rightarrow$ cross Area.

20 cm sin recubrimiento

$D = 2.2$ cm

$p = 2\pi r L_{c1/2}$

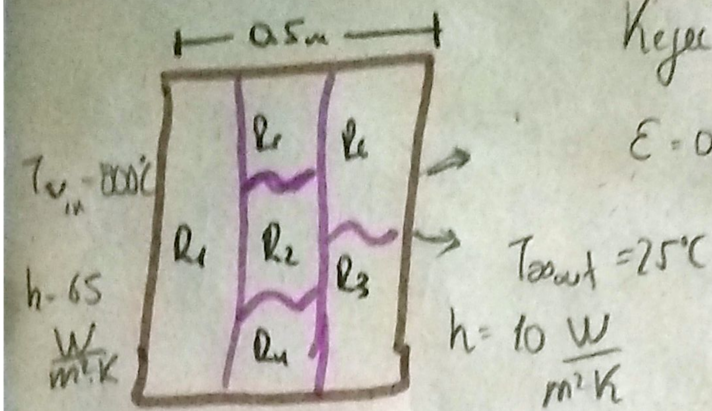
$p = \pi D L_{c1/2}$

$A_c = \dfrac{\pi D^2}{4}$

$$m = \sqrt{\frac{\pi D L_{c1/2} \cdot h}{K \cdot \frac{\pi D^2}{4}}}$$

$$m = \sqrt{\frac{4 \cdot L_{c1/2} \cdot h}{K D}}$$

2$^{DO}$ PUNTO.




$K_{yeso} = 0.2 \frac{W}{m \cdot K}$

$\varepsilon = 0.8$

a) Resistencia Termica equivalente.

Sabemos por sistema de Resistencias Termicas

$$\dot{Q} = \frac{T_{\infty, in} - T_{\infty out}}{R_{eq} + R_{conv,1} + R_{conv,2}}$$

Donde

$R_{eq_{serie}} = R_1 + R_2 + R_3 + \dots + R_n$ Si estan en serie.

$R_{eq_{paralelo}} = \frac{R_1 \cdot R_2 \cdot R_3 \cdots R_n}{R_1 + R_2 + R_3 + R_n}$ si estan en Paralelo.

conductivo

Donde $R_i = \frac{L_i}{K_i A_s}$

$R_{eq_{TOTAL}} = R_{eq_{serie}} + R_{eq_{paralelo}}$

$$Q = \frac{T_{\infty in} - T_{\infty out}}{R_{eq_{TOT}}}$$

$R_{eq_{TOT}} = \frac{L_T}{K_{yeso} \cdot A_s}$

$$\bullet\ \dot{Q} = \frac{T_{surr,in} - T_{surr,out}}{R_{conv,1} + R_{eq} + R_{comb,2}}$$

$$\frac{dT}{dx} = C_1$$

$$T(x) = C_1^{II} x + C_2^{II}$$

25°C

1 mmirge

$$(\Delta T) \Big/ \frac{1}{h_{conv,1}} + \frac{0.5}{0.2} + \frac{R_{conv_2} R_{rad}}{R_{conv_2} + R_{rad}}$$

$$\frac{1}{10} \cdot \frac{1}{\varepsilon\sigma(T_{surf,out} + T_{surr,out})(T_{surf,out}^2 + T_{surr,out}^2)}$$

$$\frac{\frac{1}{10} \cdot \frac{1}{\varepsilon\sigma(C_1(0.5) + C_2 + 298.15)((C_1(0.5) + C_2)^2 + 298.15)^2)}}{\frac{1}{10} + \frac{1}{\text{"} \quad \text{"} \quad \text{"} \quad \text{"} \quad \text{"}}}$$

Constraints given by boundary condition

B.C 1 → $x = 0$

$$\dot{Q}^I = \dot{Q}^{II} \Rightarrow h_{conv,1}(T_{surr_{in}} - T_{surf_{in}}) = -K C_1^{II}$$

$$h_{conv_1}(1073.15 - C_1^{II}(0) + C_2^{II}) = -K C_1^{II}$$

$$h_{conv_1}(1073.15 - C_2^{II}) + K C_1^{II} = 0$$

B.C.2 → $x = L$

$$\dot{Q}^I = \frac{T_{\infty,in} - T_{surf,out}}{R_{conv,1} + R_{eq}} \overset{II}{=} \Rightarrow h_{conv,1}(T_{surr_{in}}^I - T_{surf_{in}}^{II})\left(\frac{1}{h_{conv_1}} + \frac{0.5}{0.2}\right)$$

$$\Rightarrow (1073.15 - C_2^{II}) + h_{conv,1}\frac{0.5}{0.2}(1073.15 - C_2^{II})$$

$$= (1073.15 - 0.5C_1^{II} - C_2^{II})$$

BC 3 $\Rightarrow$ $x = L$ ?? $\rightarrow$ over fixed

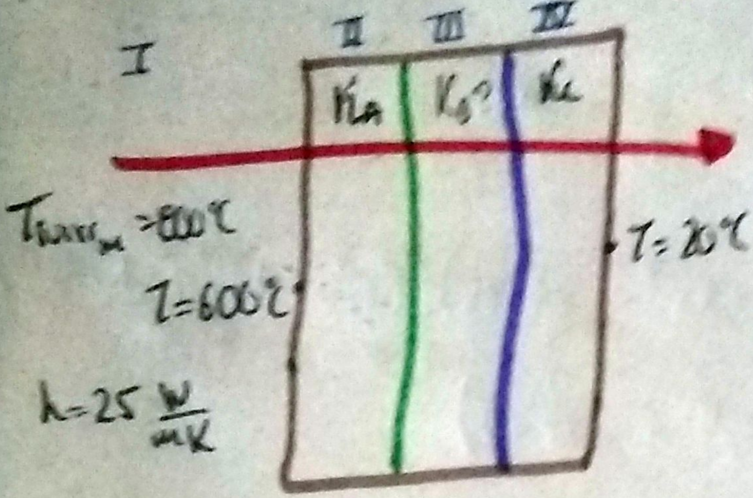
$$Q^{II} = Q^{III}$$

$$-k\frac{dT}{dx}^{II} = h_{comb}\left(T_{surf\text{-}out}^{II} - T_{surr}^{III}\right)$$

$$-kC_1^{II} = h_{conv_2} + \varepsilon\sigma\left(C_1^{II}0.5 + C_2^{II} + 298.15\right)\left(\left(C_1^{II}0.5 + C_2^{II}\right)^2 + 298.15^2\right)$$

$$\left(C_1^{II}0.5 + C_2^{II} - 298.15\right)$$

4to Punto




$K_A = 20 \frac{W}{m \cdot K}$

$K_C = 50 \frac{W}{m \cdot K}$

$L_A = 0.30$ m

$L_C = 0.15$ m

$L_B = 0.15$

$K_B = ??$

- Steady State
- Perfect contact
- Constant Area

I

$$Q = \frac{T_{surr_{in}} - T_{surf_{A\,in}}}{R_{conv_1}}$$

I

$$Q = \frac{1073.15 - 873.15}{\frac{1}{25}} \rightarrow \dot{Q} = 5000 \text{ [W]}$$

II

$$Q^{I} = Q^{II} \rightarrow Q^{I} = \frac{T_{surf_{in\,A}} - T_{surf_{out\,A}}}{R^{I}_{cond}}$$

$$Q^{I} = 5000 = \frac{873.15 - ??}{\frac{0.30}{20}}$$

$$\Rightarrow T_{surf_{out_A}} = 798.15 \text{ [K]}$$

IV

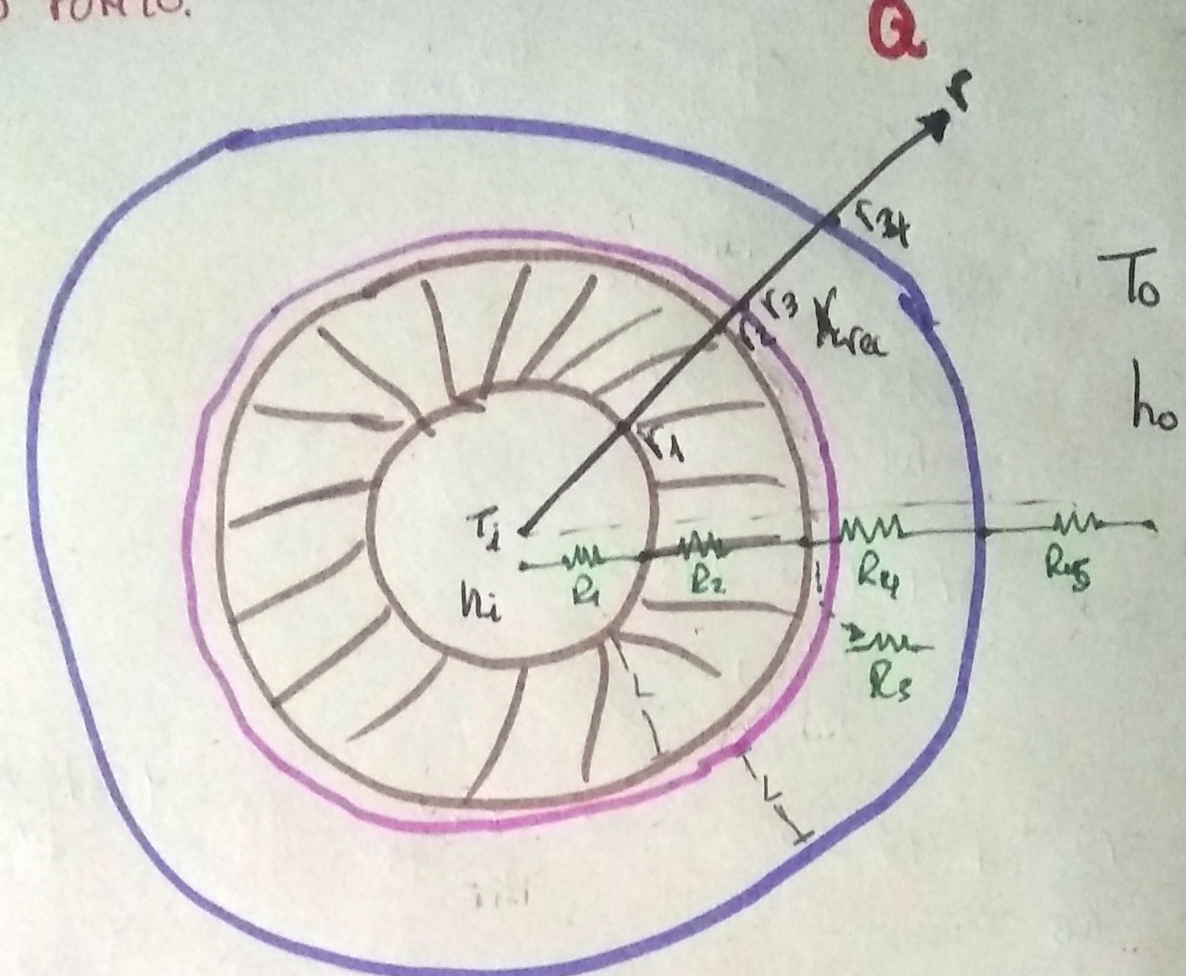
$$Q^{III} = Q^{II} \qquad T_{surf_{out\,A}} = T_{surf_{in\,B}}$$

$$\dot{Q} = \frac{T_{surf_{out\,A}} - T_{surf_{out\,C}}}{\frac{0.15}{k_B} + \frac{0.15}{50}}$$

$$5000 = \frac{798.15 - 293.15}{\frac{0.15}{k_B} + \frac{0.15}{50}}$$

$$\Rightarrow \frac{750}{k_B} + 15 = 505 \quad \Rightarrow \quad \frac{750}{505-15} = k_B = 1.531 \left[\frac{W}{m.K}\right]$$

3 PUNTO.




disipa el flujo de calor uniforme $q''_h$ $\left[\frac{W}{m^3}\right]$

$$R_1 = \frac{1}{h_i A_s} = \frac{1}{h_i 2\pi r_1} \quad ; \quad R_2 = \frac{\ln(r_2/r_1)}{2\pi(r_2-r_1)K_{TUBO}}$$

$$R_3 = \frac{\ln(r_3/r_2)}{2\pi(r_3-r_2)K_{PLACA}} \quad ; \quad R_4 = \frac{\ln(r_4/r_3)}{2\pi(r_4-r_3)K_{aislante}}$$

$$R_5 = \frac{1}{h_o A_s} = \frac{1}{h_o 2\pi r_4}$$

$$\dot{Q} = \frac{T_{\infty,in} - T_{\infty out}}{R_{tot}}$$ · Se desprecia radiación

$$R_{tot} = R_1 + R_2 + R_3 + R_4 + R_5$$

· Suposición → Si la resistencia disipa $q''_h \left[\frac{W}{m^3}\right]$ por tanto el flujo $\dot{Q}$

$\dot{Q} = q''_h$ * Volumen de lamina $\Rightarrow$ $\dot{Q} = q''_h \cdot 2\pi(r_3 - r_2) \cdot L$ → longitud tubería

$$\frac{dT}{dr} = \frac{C_1^{III}}{r} \quad ; \quad T(r)^{III} = C_1^{III} \ln r + C_2^{III}$$

B.C.1 → $r = r_2$

$$\dot{Q}^{II} = Q^{III} \rightarrow -k A_s \frac{dT}{dx}^{II} = -k A_s \frac{dT}{dx}^{III}$$

$$Q^{II} = Q^{I} = Q^{III} = -k A_s \frac{dT}{dx}^{III}$$

$$q''_h \cdot 2\pi(r_3 - r_2) \cdot L = -k A_s \frac{C_1}{r}^{III} \Rightarrow q''_h L = -k \frac{C_1}{r_2}^{III}$$

B.C2 → $r = r_2$

$$q''_h 2\pi(r_3 - r_2) \cdot L = \frac{T^{I}_{surr_{\infty,in}} - T^{III}_{surr_{in}}}{R_1 + R_2} \Rightarrow Q = \frac{T^{I}_{surr_{\infty,in}} - C_1^{III} \ln r_2 + C_2}{\frac{1}{h_i 2\pi r_1} + \frac{\ln(r_2/r_1)}{2\pi(r_2 - r_1)k_{\infty}}}$$

en Recubrimiento


$P = 20$ bar $\rightarrow$ vapor saturado

$h_i = 30 \frac{W}{m^2 K}$

$T_{amb} = 25$ °C

$h_o = 5 \frac{W}{m^2 K}$

$\varepsilon = 0.5$

$P = 2000$ KPa

D = 5cm ⇒ 0.05

Espesor = 15 mm ⇒ 0.015

$K_{max} \Rightarrow 15.6 \frac{W}{m K}$

Temperaturas para el Vapor Saturado.

| | | |
|---|---|---|
| T | 200 °C | 1553.8 KPa |
| | 220 °C | 2318 |

$T \Rightarrow y = mx + b \rightarrow$

$y - y_1 = m(x - x_1)$

$y = mx - mx_1 + y_1$

Ecuacion General de Calor.

$\frac{dT}{dr} = \frac{C_1}{r}$ ; $T(r) = C_1 \ln(r) + C_2$

B.C 1 $\rightarrow a = 0.025$ m

$\frac{dT^I}{dx} = \frac{dT^{II}}{dx}$

$h(T_{conv,in}^{I} - T_{sur,in}^{II}) = -K\frac{C_1}{r}$

$h(T_{conv,in}^{I} - C_1 \ln(r) - C_2) = -\frac{KC_1}{r}$

$Q = -KC_1/r$

B.C 2 $a = 0.025 + 0.015$

$Q = \frac{T_{in}^{I} - T_{sur}^{III}}{R_{conv,1} + R_{cond} + R_{comb}}$

$Q = \frac{T_{in}^{I} - T_{sur}^{III}}{\frac{1}{h_1 A_s} + \frac{\ln(r_2 - r_1)}{2\pi K_1} + \frac{1}{h_{comb} A_s}}$

$h_{comb} = h_{conv_2} + \varepsilon\sigma(T_{surf} + T_{surr_2})(T_{surf}^2 + T_{surr}^2)$

$$h_{comb} = h_{conv} + 0.5(\sigma)(C_1 \ln(r_{max}) + C_2 - T_{surr_2})$$
$$* [ (C_1 \ln(r_{max}) + C_2)^2 - T_{surr}^2 ]$$

Suppose the $T_{surface}^{II}$

$$T_{surf_{suppose}} - C_1 \ln(r) - C_2 = \Delta T \quad \text{minimize}$$

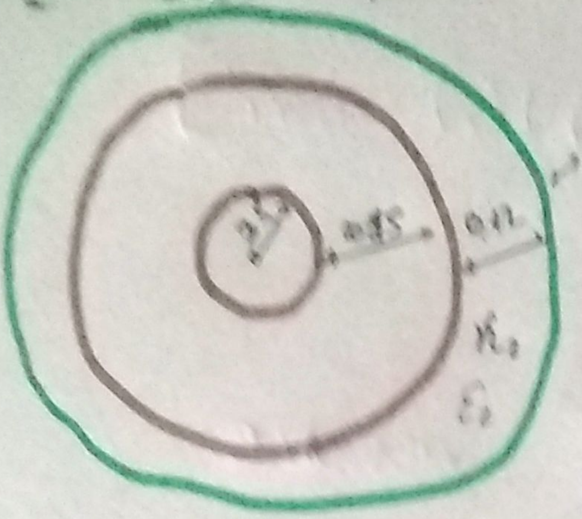
B.C 2 → x = 0.055 y B.C 1 en 1 solo.

$$-K \frac{C_1}{0.035} = \frac{T_{in}^{I} - T_{surr}^{III}}{\frac{1}{h_1 A_s} + \frac{\ln(0.05-0.035)}{2\pi K_1} + \frac{1}{A_s(h_{conv} + \varepsilon\sigma(}}$$

$A_s \to 2\pi r_{0.035}$

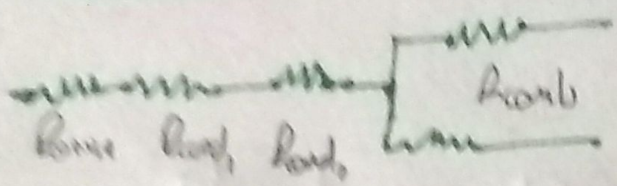
$A_s \to 2\pi(0.05)$

2do Caso.




$K_2 = 0.25 \ \frac{W}{m \cdot K}$

$\varepsilon = 0.8$




Suppose the surface $^{II}$

$$\underbrace{T_{surf\,suppose}}_{429.15\ K} - C_1 \ln(0.025+0.015+0.012) - C_2 = \Delta T$$

B.C2 y B.C1

$$-\frac{K C_1}{0.025} = \frac{T_{in}^{I} - T_{surr}^{IV}}{\frac{1}{h_i A_s} + \frac{\ln(\text{th}K)}{2\pi K_1} + \frac{\ln(\text{th}K_2)}{2\pi K_2} + \frac{1}{A_s(h_{conv} + \varepsilon\sigma \ldots}}$$

$A_s$: $2\pi r_{0.025}$

$A_s$: $2\pi(0.025+0.015+0.012)$