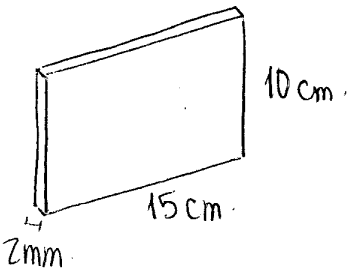
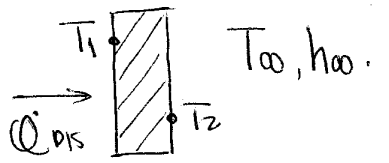
EJERCICIO REPASO. ALETAS.

TABLERO DE CIRCUITOS.



$\dot{Q}_{DISIPAR} = 15\,W$.

$K_{TABLERO} = 12\,W/mK$.



CASO 1. AIRE ESTÁTICO. $T_\infty = 37°C$; $h_\infty = 6\,W/m^2K$.

DETERMINAR LAS TEMPS. DE LA PLACA.

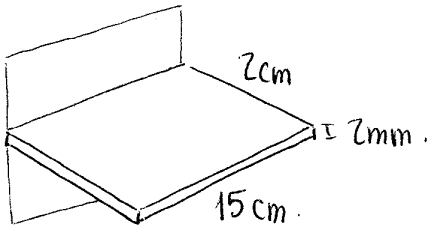
NO DEBE SUPERAR LOS 65°C LA BASE (T_1) ¿SE FUNDE?

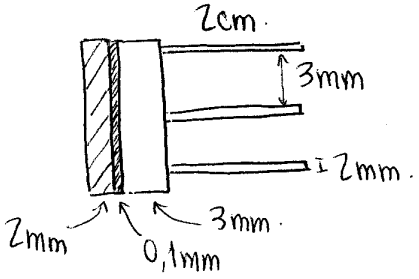
CASO 2. SE AÑADE AL TABLERO UN SISTEMA DE ALETAS.

SE USA UNA PELÍCULA DE EPÓXIDO ($K_{ep} = 1{,}8\,W/mK$) DE 0,1 mm.

EL ARREGLO ES DE ALETAS RECTANGULARES. SON 20 ALETAS, SEPARADAS 3mm ENTRE SÍ, SOBRE UNA PLACA DE ALUMINIO DE 3mm DE ESPESOR.

$K_{Al} = 237\,W/mK$.





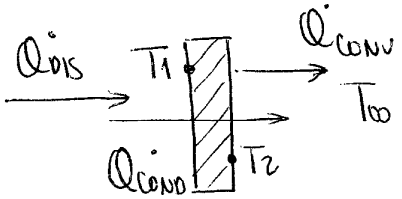
RESOLVER PARA a) $T_\infty = 37°C$; $h_\infty = 6\,W/m^2K$.

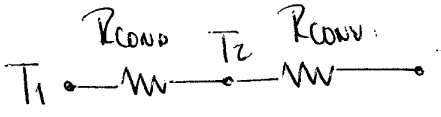
b) $T_\infty = 37°C$; $h_\infty = 45\,W/m^2K$.

DETERMINAR LA TEMP. DE LA BASE (T_1) PARA TODOS LOS CASOS.

¿CUÁL CONFIGURACIÓN COMPLACE $T_1 < 65°C$?

SOLUCIÓN CASO 1.





$$\dot{Q}_{DIS} = \dot{Q}_{COND} = \dot{Q}_{CONV} = \dot{Q}_{SALE}$$

DONDE $R_{COND} = \frac{\ell}{kA}$; $R_{CONV} = \frac{1}{h_\infty A}$; $A = 0{,}1\,m \times 0{,}15\,m$. $A = 0{,}015\,m^2$.

$$\dot{Q}_{SALE} = \frac{T_1 - T_\infty}{R_{COND} + R_{CONV}} \Longrightarrow T_1 = T_\infty + \dot{Q}_{SALE}(R_{COND} + R_{CONV})$$

$$T_1 = 37°C + 15\,W\left(\frac{0{,}002\,m}{12\,W/mk \cdot 0{,}015\,m^2} + \frac{1}{60\,W/m^2k \cdot 0{,}015\,m^2}\right)$$

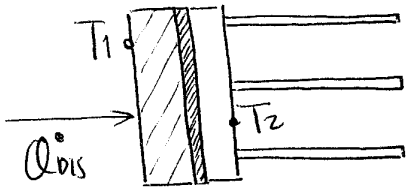
$$\boxed{T_1 = 203{,}8\,°C} > 65°C. \text{ SE FUNDE.}$$

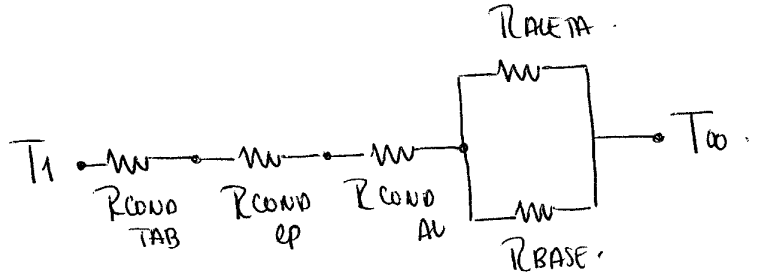
$$\dot{Q}_{SALE} = \frac{T_2 - T_\infty}{R_{CONV}} \Longrightarrow T_2 = T_\infty + \dot{Q}_{SALE} R_{CONV}$$

$$= 37°C + 15\,W \cdot \frac{1}{60\,W/m^2k \cdot 0{,}015\,m^2}.$$

$$\boxed{T_2 = 203{,}67\,°C}$$

CASO 2.



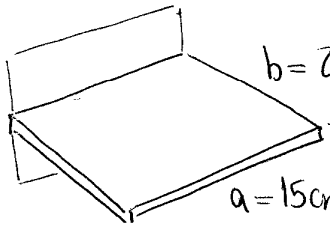


DONDE $R_{COND_{TAB}} = \frac{\ell}{k_{TAB} A} = \frac{0{,}002\,m}{12\,W/mk \cdot 0{,}015\,m^2} = 1{,}1 \times 10^{-2}\,k/w$.

$$R_{COND_{ep}} = \frac{\ell}{k_{ep} A} = \frac{0{,}1 \times 10^{-3}\,m}{1{,}8\,W/mk \cdot 0{,}015\,m^2} = 3{,}7 \times 10^{-3}\,k/w,$$

$$R_{COND_{AL}} = \frac{\ell}{k_{AL} A} = \frac{3 \times 10^{-3}\,m}{237\,W/mk \cdot 0{,}015\,m^2} = 8{,}4 \times 10^{-4}\,k/w.$$

$$R_{eq} = \left(\frac{1}{R_{ALETA}} + \frac{1}{R_{BASE}}\right)^{-1} = \left(h_\infty A_{ALETA} \cdot N_{AL} \eta_{AL} + h_\infty A_{BASE\ SIN\ ALETAS}\right)^{-1}.$$



$$A_{ALETA} = 2ab + 2tb + at$$
$$= 2 \cdot 0{,}15m \cdot 0{,}02m + 2 \cdot 0{,}002m \cdot 0{,}02m + 0{,}15 \cdot 0{,}002m$$
$$A_{ALETA} = 6{,}38 \times 10^{-3}\ m^2$$

SE DETERMINA LA EFICIENCIA η_{AL} DE LA FIG. 3,18, PÁG. 123, INCROPERA 4TA EDICIÓN.

ALETA RECTA
PERFIL RECTANGULAR.

$$L_c = L + t/2 = 0{,}02m + 0{,}001m = 2{,}1 \times 10^{-2} m.$$
$$A_p = Lt = 2{,}1 \times 10^{-2} m \cdot 2 \times 10^{-3} m = 4{,}2 \times 10^{-5} m^2.$$

$$L_c^{3/2}(h/kA_p)^{1/2} = (2{,}1 \times 10^{-2} m)^{3/2} \cdot \left(6\ W/m^2K \,/\, 237\ W/mK \cdot 4{,}2 \times 10^{-5} m^2\right) = 0{,}075$$

CON $L_c^{3/2}(h/kA_p)^{1/2} = 0{,}075$ SE LEE DEL GRÁFICO $\eta_{AL} = 98\%$.

$$A_{BASE\ SIN\ ALETAS} = 0{,}1m \cdot 0{,}15m - 20 \cdot 0{,}002m \cdot 0{,}15m = 0{,}009\ m^2.$$

$$R_{eq} = \left(6\ W/m^2K \cdot 6{,}38 \times 10^{-3} m^2 \cdot 20 \cdot 0{,}98 + 6\ W/m^2K \cdot 0{,}009\ m^2\right)^{-1} = 1{,}24\ K/W.$$

$$\dot{Q}_{SALE} = \frac{T_1 - T_\infty}{R_{COND\ TAB} + R_{COND\ EP} + R_{COND\ AL} + R_{eq}} \longrightarrow T_1 = T_\infty + \dot{Q}_{SALE} \Sigma R.$$

$$T_1 = 37°C + 15W \cdot 1{,}25554\ K/W.$$

$$\boxed{T_1 = 55{,}8°C} < 65°C.$$

b) PARA $h_\infty = 45\ W/m^2K$ SE RECALCULA LA EFICIENCIA η_{AL}.

$$L_c^{3/2}(h/kA_p)^{1/2} = 0{,}2 \longrightarrow \text{SE LEE } \eta_{AL} = 95\%.$$

RECALCULANDO $R_{eq} = 0{,}17$.

$$T_1 = T_\infty + \dot{Q}_{SALE} \Sigma R = 37°C + 15W \cdot 0{,}18554\ K/W.$$

$$\boxed{T_1 = 39{,}8°C} < 65°C.$$