/ /

GABARITO

1ª QUESTÃO

$C_{sf} = 0,0060$

$L = 30cm$

$d = 0,4 cm$

$V = 1\ l$

$T_i = 14°C$

$\Delta t = 32 min = 1920 s$

$\Delta V = V/2$

$$q = q'' \cdot A_s = \dot{m}_{evap} \cdot h_{lv} = \frac{\Delta m}{\Delta t} h_{lv} = \frac{\rho \Delta V h_{lv}}{\Delta t}$$

$$q = \frac{962 \cdot 0,5 \cdot 10^{-3} \cdot 2250 \cdot 10^{3}}{1920}$$

a) $$\underline{q = 563,67\ W}$$ 1,5

$$q'' = q / A_s = 563,67 / (\pi \cdot 0,001 \cdot 0,3)$$

$$q'' = \underline{149.518,6\ W/m^2}$$

$$q'' = \mu_l h_{lv} \left[\frac{g(\rho_l - \rho_v)}{\sigma}\right]^{1/2} \left(\frac{c_{p,l} \Delta T_e}{C_{s,f} h_{lv} Pr_l^n}\right)^3 ; \quad n = 1$$

$$q'' = 277 \times 10^{-6} \cdot 2250 \cdot 10^3 \left[\frac{9,81 (962 - 0,6)}{58,8 \times 10^{-3}}\right]^{1/2} \left(\frac{4211 \cdot \Delta T_e}{0,0060 \cdot 2250 \cdot 10^3 \cdot 1,75}\right)^3$$

$$q'' = 1413,5151\ \Delta T_e^3 \quad \therefore \quad \Delta T_e = \left(\frac{q''}{1413,5151}\right)^{1/3} = \left(\frac{149518,6}{1413,5151}\right)^{1/3}$$

$$\boxed{\Delta T_e = 4,73 K} \quad \therefore$$ Ebulição por convecção natural b)

1,5

c) $$q \Delta t = m \cdot c_p (T_{eb} - T_i)$$

$$\Delta t = \frac{m \cdot c_p (T_{eb} - T_i)}{q} = \frac{\rho \cdot V c (T_{eb} - T_i)}{q}$$

$$\Delta t = \frac{962 \cdot 0,001 \cdot 4211 (100 - 14)}{563,67}$$

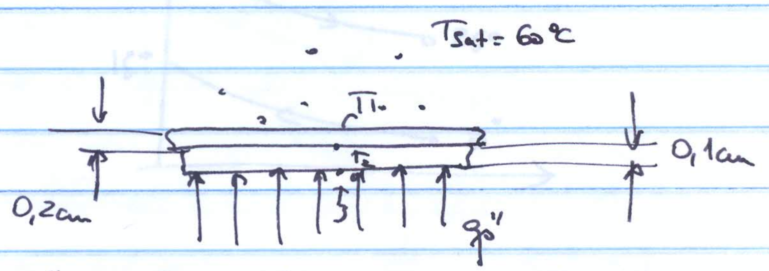
$$\underline{\Delta t = 618,06\ s = 10,30\ min}$$ 1,0

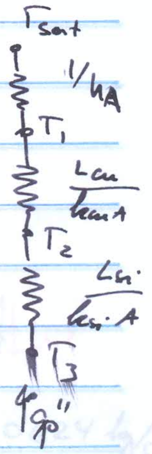
= 10min e 18s

GABARITO DA 4ª PROVA - TC 2 - 2005-S1

1ª QUESTÃO

3,5





$k_{cu} = 399\ W/mK$

$q_o'' = 5 \times 10^4\ W/m^2$

$C_{sf} = 0,0049$

$k_{si} = 125\ W/mK$

$$q_o'' = \frac{-T_{sat} + T_1}{1/h} = \frac{-T_1 + T_3}{\frac{L_{cu}}{k_{cu}} + \frac{L_{si}}{k_{si}}}$$ 0,5

$$q_s'' = \mu_l h_{fg} \left[\frac{g(\rho_l - \rho_s)}{\sigma}\right]^{1/2} \left(\frac{c_{p,l} \cdot \Delta T_e}{C_{s,f} h_{fg} Pr_l^n}\right)^3$$

$$5 \times 10^4 = 4,4 \times 10^{-4} \cdot 84 \cdot 10^3 \left[\frac{9,81(1620 - 13,4)}{0,081}\right]^{1/2} \left(\frac{1.100\ (T_s - 60)}{0,0049 \cdot 84 \times 10^3 \cdot 9'}\right)^3$$

$$(T_1 - 60)^3 = 113,13 \rightarrow T_1 - 60 = 4,893 \rightarrow \boxed{T_1 = 64,89°C}$$ 1,0

$$T_3 = T_1 + q_o''\left(\frac{L_{cu}}{k_{cu}} + \frac{L_{si}}{k_{si}}\right) = 64,89 + 50.000\left(\frac{0,001}{399} + \frac{0,002}{125}\right) = \boxed{65,82°C}$$ 1,0

$$q''_{máx} = \frac{\pi}{24} \rho_s h_{fg} \left[\frac{g\sigma(\rho_l - \rho_s)}{\rho_s^2}\right]^{1/4} \cdot \left(\frac{(\rho_l + \rho_s)}{\rho_l}\right)^{1/2}$$

$$q''_{máx} = \frac{\pi}{24} \cdot 13,4 \cdot 84 \cdot 10^3 \left[\frac{9,81 \cdot 0,081(1620 - 13,4)}{13,4^2}\right]^{1/4} \cdot \left(\frac{(1620 + 13,4)}{1620}\right)^{1/2}$$

$$q''_{máx} = 241,59\ kW/m^2$$ 1,0

2ª QUESTÃO:

$C_o = \dot{m}_o \cdot c_o = 0{,}3 \cdot 2300 = 690\,W/K = C_{min}$

$C_a = \dot{m}_a c_a = 2 \cdot 4180 = 8360\,W/K = C_{máx}$

$C_r = C_{min}/C_{max} = 0{,}0825$; $A = N\pi d \cdot L = 8 \cdot \pi \cdot 0{,}014 \cdot 5 = \underline{1{,}76\,m^2}$

$q_{max} = C_{min}(T_{e,o} - T_{e,a}) = 690(150-20) = \underline{89\,700\,W}$

$NUT = UA/C_{min} = 310 \cdot 1{,}76/690 = \underline{0{,}7904}$

$$\varepsilon = 2\left\{1 + C_r + \sqrt{1+C_r^2} \cdot \frac{1+\exp\left[-NUT\sqrt{1+C_r^2}\right]}{1-\exp\left[-NUT\sqrt{1+C_r^2}\right]}\right\}^{-1} = \underline{0{,}53417}$$

$q = \varepsilon \cdot q_{max} = 0{,}53417 \cdot 89700 = \underline{\underline{47{,}915\,kW}}$ a)

1,0

b) $q = \dot{m} c \Delta T \therefore$

$$\begin{cases} T_{s,o} = T_{e,o} - \dfrac{q}{\dot{m}_o c_{p,o}} = 150 - \dfrac{47915}{0{,}3 \cdot 2300} = \underline{\underline{80{,}56°C}} \\ T_{s,a} = T_{e,a} + \dfrac{q}{\dot{m}_a c_{p,a}} = 20 + \dfrac{47915}{2 \cdot 4180} = \underline{\underline{25{,}73°C}} \end{cases}$$

1,0

c) $Re = \dfrac{VD}{\nu} = \dfrac{4\dot{m}_a \cdot \cancel{D}}{\rho_a \pi D^{\cancel{2}} \cdot \nu} = \dfrac{4\dot{m}_a}{\rho_a \pi D \nu} = \dfrac{4 \cdot 2}{999 \cdot \pi \cdot 0{,}014 \cdot 0{,}861 \times 10^{-6}}$

$Re = 2{,}1126 \times 10^5$ (Turbulento)

$Nu_D = \dfrac{h_i D}{k} = \dfrac{h \cdot 0{,}014}{0{,}643} = 0{,}023 \cdot Re_D^{4/5} \cdot Pr^{0{,}4} = 695{,}83$

$\therefore \boxed{h_i = 31\,958{,}48\,W/m^2K}$ 1,5

d) $A_{sup} = L \times W = 5\,m^2$

$A_\ell = 2(L \times H + W \times H)$
$= 2(5 \cdot 1 + 1 \cdot 1)$
$= 12\,m^2$

Sup. Superior:

$L_c = A/P$; $L_c = L \cdot W / 2(L+W)$

$L_c = 5 \cdot 1/2(5+1) = 5/12\,m$
$= 0{,}41667\,m$

$T_{sup} = \dfrac{150 + 80{,}56}{2}$

$T_{sup} = 115{,}28°C = 388{,}43\,K$

$T_\beta = (115{,}28 + 20)/2 = 67{,}64°C$

$T_\beta = 340{,}79\,K$

$\alpha = \nu / Pr = 2{,}33286 \times 10^{-5}\,m^2/s$

$Ra_{L_c} = \dfrac{g\beta(T_s - T_\infty)L_c^3}{\alpha\nu}$

$= \dfrac{9{,}81 \cdot (115{,}28-20)(0{,}416667)^3}{340{,}79 \cdot 2{,}33286 \times 10^{-5} \cdot 16{,}4 \cdot 10^{-6}}$

$= 5{,}1858 \times 10^8$

$Nu_{L_c} = \dfrac{h L_c}{k} = \dfrac{h \cdot 0{,}416667}{0{,}02814} = 0{,}15\, Ra_L^{1/3} = 120{,}5$

$\underline{h = 8{,}139\,W/m^2K}$

$1/1$

$q = h\,A\,(T_s - T_\infty) = 8{,}139 \cdot 5\,(115{,}28 - 20)$

$\boxed{q = 3.877{,}42\ W}$ 0,5

Paredes laterais:

$L_c = H = 1m$

$$Ra_L = \frac{9{,}81\,(115{,}28-20) \cdot 1^3}{340{,}79 \cdot 2{,}33286\times10^{-5} \cdot 16{,}4 \cdot 10^{-6}}$$

$Ra_L = 7{,}1689 \times 10^9$

$$Nu_L = \left\{ 0{,}825 + \frac{0{,}387 \cdot Ra_L^{1/6}}{\left[1 + (0{,}492/Pr)^{9/16}\right]^{8/27}} \right\}^2 = 226{,}81$$

$$Nu_L = \frac{hL}{k} = \frac{h \cdot 1}{0{,}02814} = 226{,}81 \therefore \boxed{h = 6{,}382\ W/m^2K}$$

$q = h \cdot A\,(T_s - T_\infty) = 6{,}382 \cdot 12\,(115{,}28 - 20)$

$\boxed{q = 7.297{,}32\ W}$ 0,5

$\boxed{q_T = 11.174\ W}$ 0,5

e) Depende o que se procura:

i) Se o desejado é resfriar o óleo isto ajuda.

ii) Se procura-se aquecer a água o efeito será contrário.

1,0