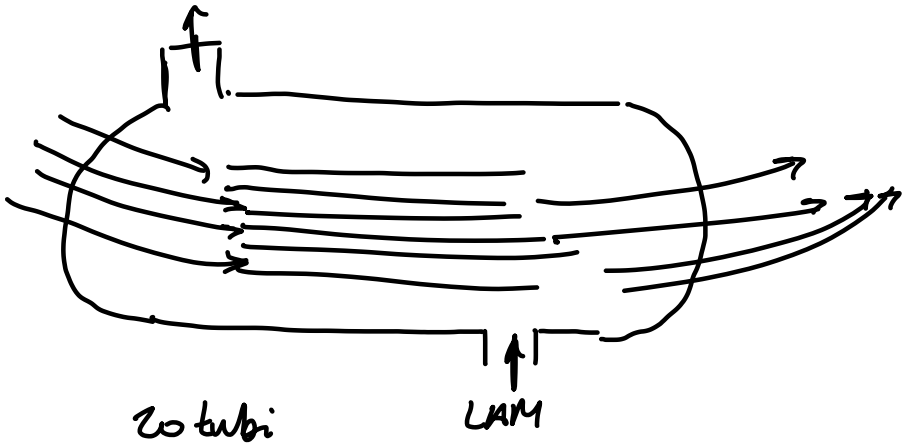
Esercitazione 14

Esercizio 3 Feb 2023



20 tubi

$K = \lambda = 52 \frac{W}{mK}$

$D_i = 10\,mm$

$s = 1\,mm$

$D_e = 12\,mm$

$Nu = 3{,}66$

$Nu_D = 0{,}023 Re^{0,8} Pr^{0,3}$

$\dot{M}_1 = 10\,kg/s$

ρ_1, c_{p1} λ_1 μ_1

$T_{1in} = 120°C$

c_{H_2O} $\dot{M}_a = 3\,kg/s$

$T_{ain} = 5°C$ $T_{aout} = 60°C$

$h_e = 5000 \frac{W}{m^2 K}$? T_{1OUT}

? h_1 ? V_i → Area Interna

? lunghezza tubi

? ΔS

$$Re = \frac{\rho_1 w L_c}{\mu_1} = \frac{\rho_1 w D}{\mu_1} =$$

$$Pr = \frac{c_p \mu_1}{k}$$

$$\dot{Q}_{H_2O}^{\leftarrow} = \dot{m}_2 c_a \left(T_{a\,OUT} - T_{a\,IN}\right)$$

$$\dot{Q}_1^{\rightarrow} = \dot{Q}_a^{\leftarrow} \qquad T_{1\,OUT} = T_{1\,IN} - \frac{\dot{Q}_a^{\leftarrow}}{\dot{m}_1 c_1}$$

$84°C$

$$\dot{Q} = U A \Delta T_{m,ln}$$

$$W_a = \frac{\dot{m}}{\rho A_{n\,TUBI}}$$

$$\hookrightarrow \frac{\pi D_i^2}{4}$$

$$Re_D = \frac{\rho_1 v_1 D_i}{\mu}$$

$$= 127\,332$$

$Re > 2300$

Re_{cr}

$\Rightarrow$ flusso turbolento

usiamo $Nu_D = 0{,}023\, Re^{0,8} Pr^{0,3}$

$$Pr = \frac{\mu_1 c_{p1}}{\lambda_1} = 8{,}35$$

$$Nu_D = 527 = \frac{h D}{\lambda} \Rightarrow h_i$$

$$\dot{Q}_{1\,TUBO} = \left[U_i A_{if}\right] \Delta T_{m,lg} = \frac{\Delta T_{m,ln}}{R_{TOT}}$$

$$R_{TOT} = \frac{1}{h_i A_i} + \frac{\ln D_e/D_i}{2\pi k L} + \frac{1}{h_e A_e}$$

$$\dot{Q} = N_{TUBI} \cdot \dot{Q}_{1\,TUBO}$$

$$\frac{\Delta T_{m,lg}}{R_{TOT}} = N_{TUBI} \cdot \frac{\Delta T_{m,lg}}{R_{TOT\ 1\,TUBO}}$$

$$R_{TOT} = \frac{R_{TOT\ 1\,TUBO}}{N_{TUBI}} \rightarrow R_{TOT} = \frac{1}{h_i A_i N_{TUBI}} + \frac{\ln D_e/D_i}{2\pi L k N_{TUBI}} + \frac{1}{h_e A_e N_{TUBI}}$$

↳ Con più tubi è più possibile il trasferimento di calore

$$\frac{1}{U} = R_{TOT} A_{rif}$$

↳ $A_{rif\,tubi}$

$$\frac{1}{U_1} = R_{TOT} A_{ciab,tubi} = \frac{1}{h_{in}} + \frac{\ln D_e/D_i \cdot r_i}{\lambda} + \frac{r_i}{h_{est} r_e}$$

$$U_1 = \left(\frac{1}{U_1}\right)^{-1} = 2864{,}7 \ \frac{W}{m^2 K}$$

$$\Delta T_1 = 84° - 5°C$$

$$\Delta T_2 = 120 - 60 = 60°$$

$$\Delta T_{m,lg} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}} = 69{,}05\ K$$

$\dot{Q} = U A_i \Delta T_{m,ln} \rightarrow$ Area Interna

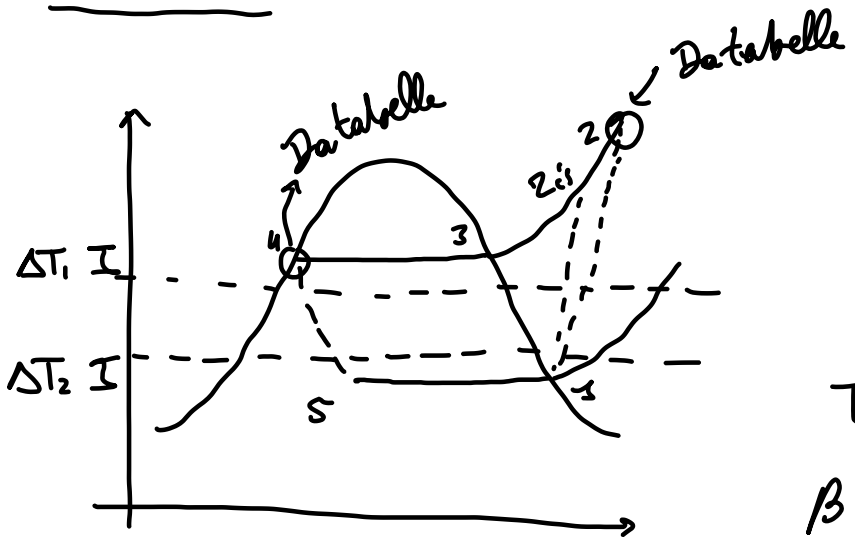
$= \pi D_i L$

$$\Delta S_{CALDO} = \dot{m}_1 \ln \frac{T_{1OUT}}{T_{1IN}}$$

$$\Delta S_{FREDDO} = \dot{m}_2 \ln \frac{T_{2OUT}}{T_{2IN}}$$

$$\Delta S_{SCAMBIO} = \Delta S_{CALDO} - \Delta S_{FREDDO} = 421,99 \frac{W}{K}$$

Esercizio 2



$\dot{L}_c = 200$ KW

$P_1 = 1,2$ bar

$T_2 = 60°C$

$\beta = 10 = \frac{P_2 \rightarrow 12 \text{ bar}}{P_1}$

$\Delta T_1 = \Delta T_2 = 10°C$

? $\dot{m}$? $\dot{S}_{irr}$

? $\eta_{is,c}$? x_5 ? η_{II}

$T_1 = -22,32°C$ $\quad v_1 = v_{vs} = 0,162 \frac{m^3}{kg}$

$h_1 = h_{vs} = 236,97$ KJ/kg

$s_1 = 0{,}94775 \frac{kJ}{kg\,k}$ $\quad T_{SORGENTE\ FREDDA} = -10{,}32°C$

② VAP SAT Tabelle T_2 e P_2

$h_2 = 289{,}64 \frac{kJ}{kg} \quad s_2 = 0{,}9614 \frac{kJ}{kg\,k}$

$\dot{L}_c^{\leftarrow} = \dot{m}(h_2 - h_1)$

$h_{2IS} = 285{,}18 \frac{kJ}{kg}$ ← Da tabelle P_2 e $s_{2IS} = s_1$

$\dot{L}_{CIS}^{\leftarrow} = \dot{m}(h_{2IS} - h_1) \qquad \eta_{IS_C} = \frac{\dot{L}_{CID}^{\leftarrow}}{\dot{L}_c^{\leftarrow}} = 0{,}915$

PUNTO 4 → LIQ SAT @ P_2

$T_4 = 46{,}29°C \quad v_4 = 0{,}0008934 \frac{m^3}{kg}$ $\quad T_{CALDO} = 36{,}29°C$

$h_4 = 117{,}77 \frac{kJ}{kg} \quad s_4 = 0{,}42441 \frac{kJ}{kg\,k}$

PUNTO 5

$h_5 = h_4 \qquad P_5 = P_1$

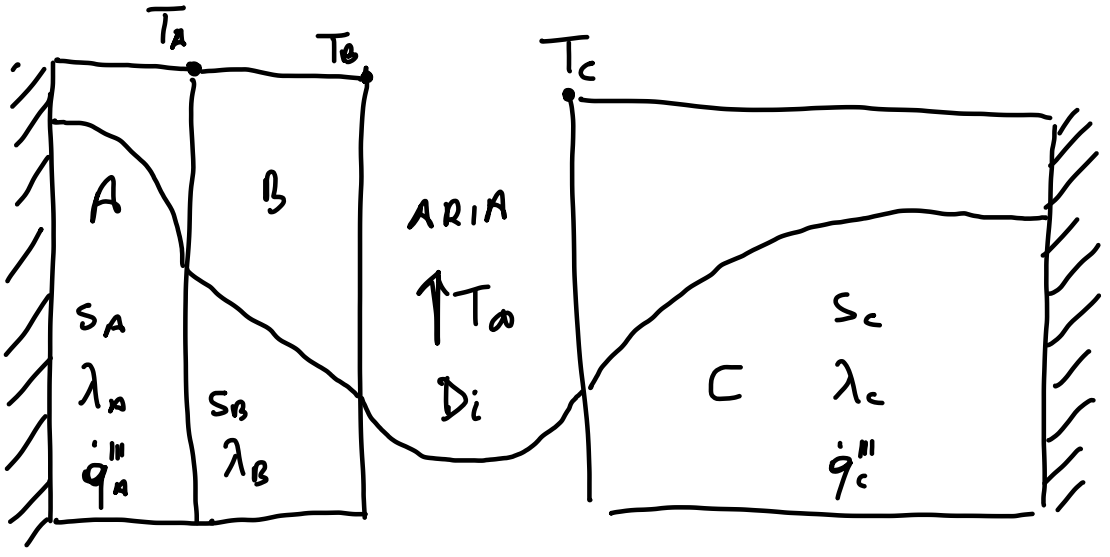
$\chi_5 = \frac{h_5 - h_{LS}}{h_{VS} - h_{LS}} = 0{,}44$

$\varepsilon_I = \frac{\dot{Q}}{\dot{L}_{CR}} = \frac{\dot{m}(h_1 - h_5)}{\dot{L}_c^{\leftarrow}} = 2{,}263$

$$\varepsilon_{CARNOT} = \frac{T_{FREDDO}}{T_{CALDA} - T_{FREDDA}} = 5{,}37 \qquad \eta_{II} = \frac{\varepsilon_{\Sigma}}{\varepsilon_{CARNOT}} = 0{,}422$$

$$\Delta S_{cyc} = \dot{S}_{IRR} = \frac{\dot{Q}_C}{T_{CALDO}} - \frac{\dot{Q}_F}{T_{FREDDO}} = 0{,}373 \ \frac{kW}{K}$$

Esercizio 3



In regime No irraggiamento

? T_B ? $T_{MAX\ in\ A}$

? T_A ? $T_{MAX\ in\ B}$

? T_C

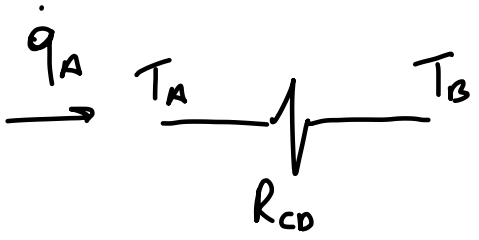
$$\dot{q}_{TOT} = \dot{q}_A + \dot{q}_C$$

$$\dot{q}_A = \dot{q}''_A \cdot s_A = 750 \ \frac{W}{m^2}$$

$$\dot{q}_C = \dot{q}''_C \cdot s_C = 2000 \ \frac{W}{m^2}$$

$$\dot{q}_h = h(T_B - T_\infty) \rightarrow T_B = 45{,}71\,^\circ C$$

$$\dot{q}_c = h(T_C - T_\infty) \rightarrow T_C = 63{,}57\,^\circ C$$



$$\dot{q}_A = \frac{T_A - T_B}{\frac{S_B}{K}}$$

$$T_A = 53{,}21\,^\circ C$$

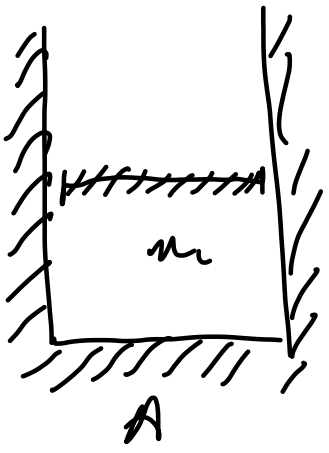
$$T_{MAX} = \frac{\dot{q}_c'''}{2\lambda_c} \cdot S_c^2 + T_c$$

$$\frac{d^2T}{dx^2} = \frac{-\dot{q}'''}{\lambda_c} \rightarrow \frac{dT}{dx} = -\frac{\dot{q}'''}{k}x + C_1 \rightarrow q(x) = -k\frac{dT}{dx}$$

$$\boxed{T(x) = \frac{-\dot{q}'''}{\lambda_c}\frac{x^2}{2} + C_1 x + C_2} \qquad T(S_c) = T_c + C_2 = T_c + \frac{\dot{q}_c''' S_c^2}{2}$$

$$T_{AMBIENTE}$$

Esercizio 4 → 2018

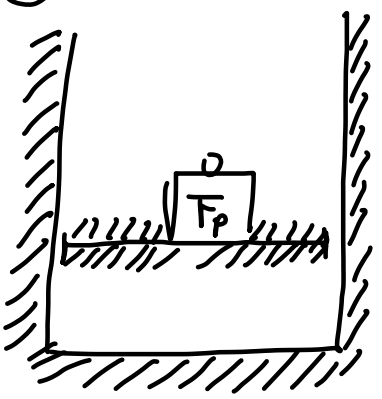
① 

$m = 10\,kg$

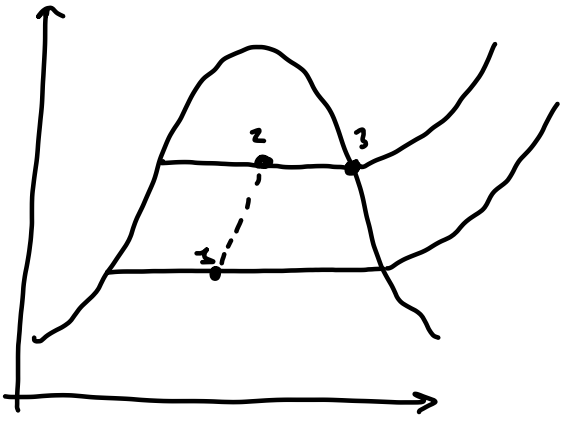
H_2O BIFASE

$P_1 = 4\,bar$

$V_1 = 50\,m^3$

② 

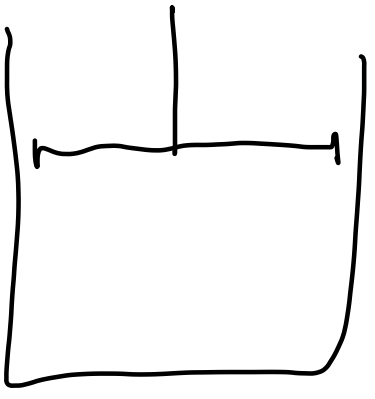
$F_p = 200000\,N$



? X_2

? ΔY

? $L^{\leftarrow}$



③ Pressione costante e non isolato

Vapore saturo

? $L^{\rightarrow}$

$$v_1 = \frac{V_1}{m_1} = \frac{5\,m^3}{kg} \rightarrow \text{Tab @ } P_1 \rightarrow v_{LS} \text{ e } v_{VS}$$

$$X_1 = \frac{v - v_{LS}}{v_{VS} - v_{LS}} = 0{,}59 \qquad u_1 = (1 - X)\,u_{LS} + X\,u_{VS} = 1643{,}72\,\frac{kJ}{kg}$$

$$\Delta U_{12} = \overleftarrow{Q_{12}} - \overrightarrow{L_{12}} = -MP(v_2 - v_1) = M(u_2 - u_1)$$

$$X_2 = \frac{u_1 - u_{LS2} - P_2(v_{LS2} - v_1)}{u_{VS2} - u_{LS2} + P_2(v_{VS} - v_{LS})} = 0,64$$

↑ Da questo

$$(1-X_2)\, u_{LS} + X_2 u_{VS2} - u_1 = -P_2\left[(1-X_2)\, v_{LS} + X_2 v_{VS2} - v_1\right]$$

$$v_2 = (1-x_2)\, v_{LS} + X_2 v_{VS} = \qquad V_2 = M v_2$$

$$\overrightarrow{L_{12}} = \Delta U_{12} = -M\ \Delta u_{12} = -18337 \cdot 10^3 kJ$$

$2 \to 3$

$$\Delta U_{23} = Q_{23} - L_{23} \quad \to \quad \Delta U_{23} = \Delta H_{23} - L_{23} \to L_{23} = \Delta H_{23} - \Delta U_{23}$$

$$\hookrightarrow Q_{23} = H_3 - H_2$$

↑ processo isobaro

$$= M(h_3 - h_2) - M(u_3 - u_2)$$

$$= 650,1\ kJ$$