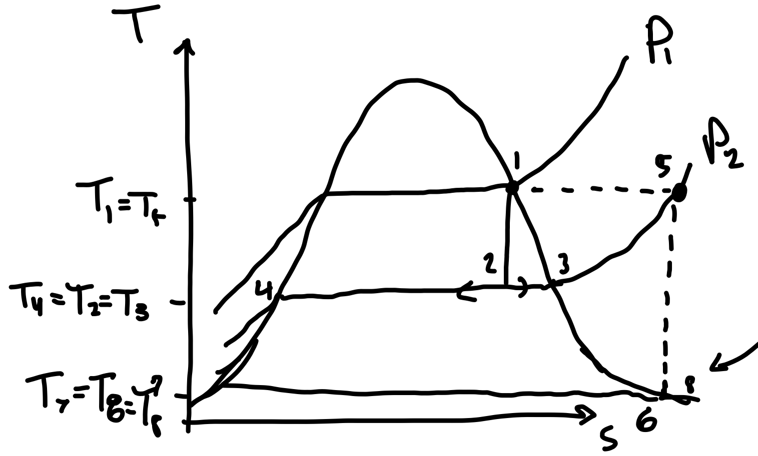
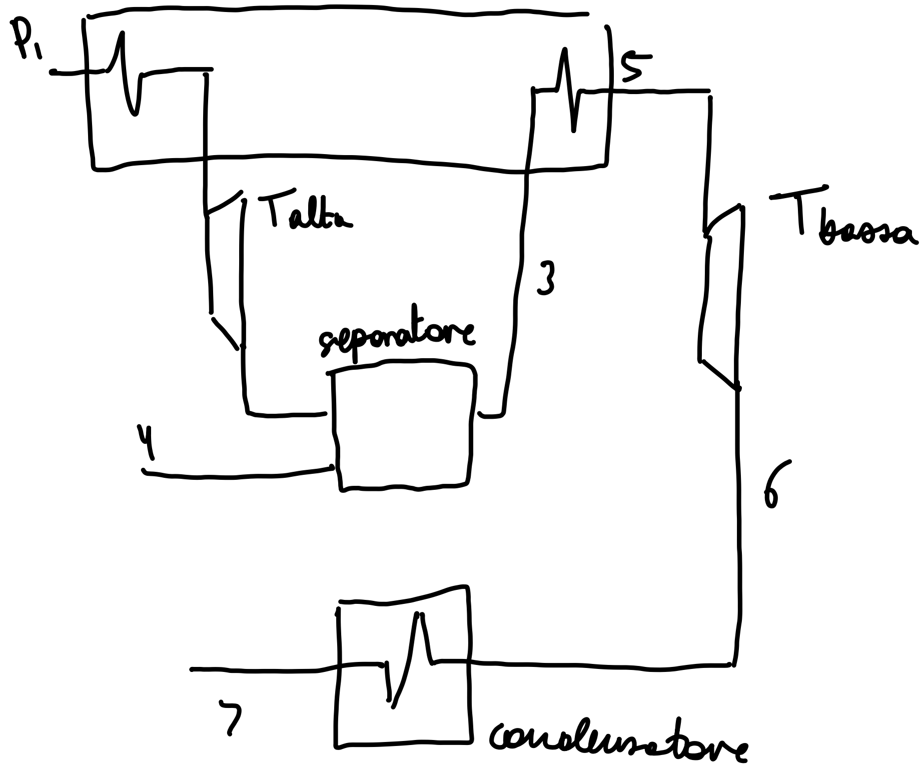
Esercitazione 13

Esercizio 1 - Ciclo Rankine

$\dot{m} = 40\,t/h$ vapore saturo secco



8 solo per non usare



$\dot{m} = 40\,t/h = 11{,}\bar{1}\ kg/s$

$P_1 = 35 \cdot 10^5\,Pa \quad P_2 = 10^6\,Pa \quad T_5 = T_1 \qquad P_6 = 5\,kPa$

$? \dot{L}^{\rightarrow}_{T1}$ $\quad ? \dot{m}_{v5} = \dot{m}_3$ $\quad ? \dot{L}^{\rightarrow}_{T2}$ $\quad ? \dot{Q}_{OUT}$

Hp: - T_1 e T_2 ideali
- No dispersioni termiche
- $\Delta E_c = 0$

Da tabelle
$T_1 = T_5 = 242{,}6°C$

Bilancio Turbina alta pressione

$$\frac{dM}{dt} = \dot{M}_1 - \dot{M}_2 \overset{s.s}{=} 0 \Rightarrow \dot{m} = 11{,}7 \text{ kg/s}$$

adiabatico

$$\frac{dE}{dt} = \dot{m}_1 h_1 - \dot{m}_2 h_2 - \cancel{\dot{Q}_{12}}^{0} - \dot{L}^{\rightarrow}_{12} \overset{s.s}{=} 0$$

$$\frac{dS}{dt} = \dot{m}_1 s_1 - \dot{m}_2 s_2 + \cancel{\dot{S}_{12}}^{0} + \cancel{S_{IRR}}^{0} \overset{s.s}{=} 0 \Rightarrow s_1 = s_2$$

$$\dot{L}^{\rightarrow}_{12} = \dot{m}(h_1 - h_2)$$

Da tabelle: $h_1 = 2803{,}4$ kg/kg
$s_1 = 6{,}1253 \frac{kJ}{kg\,K} = s_2$

2 → Tabella bifase con $P = 10^6 Pa$

s_v $\quad h_v$

s_e $\quad h_e$

Regola della leva

$$X_2 = \frac{s_2 - s_e}{s_v - s_e} = 0,896$$

$$h_2 = h_L + X_2 (h_v - h_L) = 2569,1 \frac{kJ}{kg}$$

$$\dot{L}^{\rightarrow}_{Talta} = \dot{m}(h_1 - h_2) = 2603 \ kW$$

$$\dot{m}_3 = \dot{m}_{2v} = X_2 \cdot \dot{m}_2 = 9,956 \ kg/s$$

5 → 6

$$\frac{dM}{dt} = \dot{M}_5 - \dot{M}_6 \overset{s.s}{=} 0 \Rightarrow \dot{m} = 11,7 \ kg/s$$

adiabatico

$$\frac{dE}{dt} = \dot{m}_5 h_5 - \dot{m}_6 h_6 - \cancel{\dot{Q}_{56}}^{0} - \dot{L}^{\rightarrow}_{56} \overset{s.s}{=} 0$$

$$\frac{dS}{dt} = \dot{m}_5 s_5 - \dot{m}_6 s_6 + \cancel{\dot{S}^{\leftarrow}_{56}}^{0} + \cancel{S_{IRR}}^{0} \overset{s.s}{=} 0 \rightarrow s_5 = s_6$$

$$\dot{L}^{\rightarrow}_{56} = \dot{m}(h_5 - h_6)$$

$$h_5 = 2925,6 \ \frac{kJ}{kg} \rightarrow \text{tabelle vapore}$$

$$s_5 = 6,8906 \ \frac{kJ}{kg} = s_6$$

$P_{SAT} @ P_6$ → Trova

0,47

s_e h_e

s_v h_v

$8,9951 \frac{kJ}{kg}$

|

↳ $s_\ell \le s_6 \le s_v$ ✓ 6 è a bifase

$$X_6 = \frac{s_6 - s_\ell}{s_v - s_\ell} = 0{,}881$$

$$h_6 = h_\ell + X_6 (h_v - h_\ell) = 2101 \ \frac{kJ}{kg}$$

$$\dot{L}_{T\,bassa} = 8210 \ kW$$

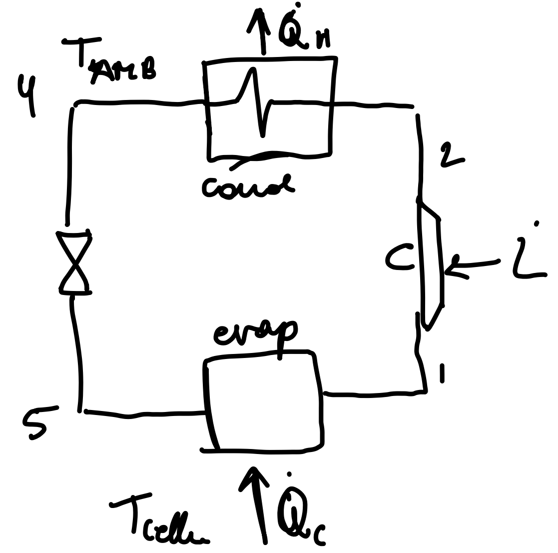
$$\dot{Q}_{OUT} = \dot{m}_6 (h_6 - h_7) = \dot{m}_3 (h_6 - h_\ell) = 19546 \ kW$$

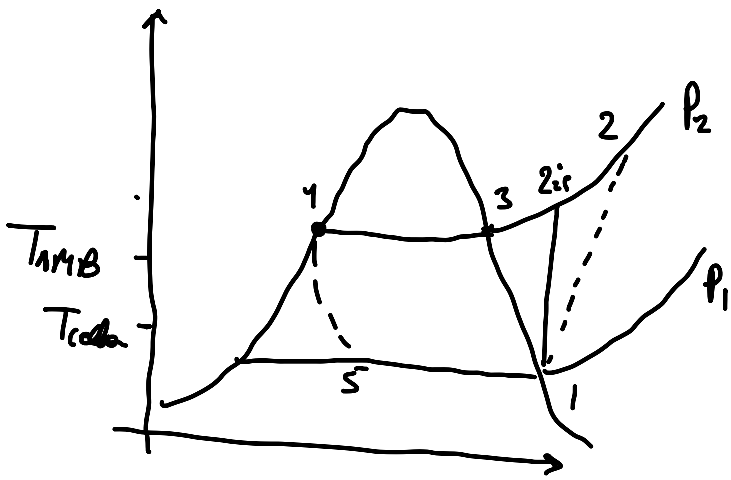
Note: Turbina è isoentropica e compressori

Joule-Brayton → gas perfetto
Rankine → tabelle bifase e monofase

Temi d'Esame che ha condiviso

Esercizio 2 (anche in temi d'esame) → 21/6/18





EVAPORATORE

$P_1 = 1 bar = 10^5 Pa$

CONDENSATORE $\Rightarrow$ $P_2 = 14 bar$

$\eta_c = 0,9$

$T_{AMB} = 20°C$

$T_{cella} = -10°C$

$\dot{m} = 0,8\ kg/s$ R134a

$P_1 \rightarrow$ Tabella $\rightarrow T_1 \rightarrow T_{SAT} @ P_1$

$h_1 \quad s_1$

$P_{2is} \rightarrow$ Tabelle vap. sur $\quad P_2$

$s_{2is} = s_1 \rightarrow h_{2is}$

$$\eta_c = \frac{h_{2is} - h_1}{h_2 - h_1} \rightarrow h_2 \rightarrow \text{Tabelle} \rightarrow s_2$$

↳ del compressore

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

4 → Tabella Bifase con P_2 → h_4

↳ liquido saturo

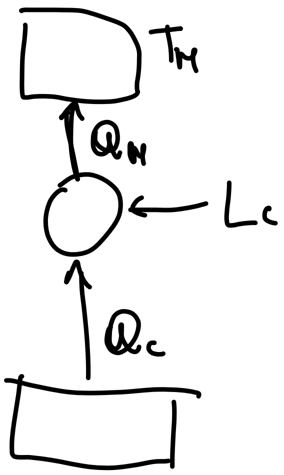
$$\dot{Q}_c = \dot{m}(h_5 - h_1)$$

↳ $h_5 = h_4$

↑

Valvola Isoentalpica

$$COP_F = \frac{\dot{Q}_c}{\dot{L}_c} = 1{,}734$$



$$L_c = Q_c - Q_H$$

IDEALE

$$\frac{Q_H}{T_H} - \frac{Q_c}{T_c} = 0 \rightarrow Q_c = Q_H \cdot \frac{T_c}{T_H}$$

$$L_c = Q_H - Q_H \frac{T_c}{T_H} = Q_H\left(1 - \frac{T_c}{T_H}\right)$$

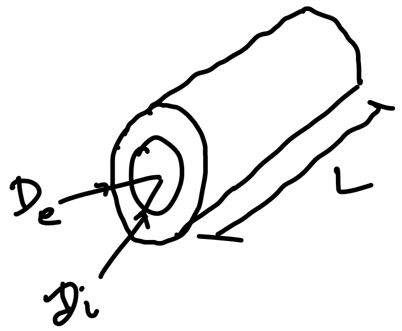
$$COP_{FID} = \frac{Q_c}{L_c} = \frac{T_c}{T_H - T_c}$$

CASO REALE

$$\frac{\dot{Q}_H}{T_H} - \frac{\dot{Q}_c}{T_c} = \dot{S}_{IRR}$$

Esercizio 3

nero $\rightarrow \varepsilon = 1$



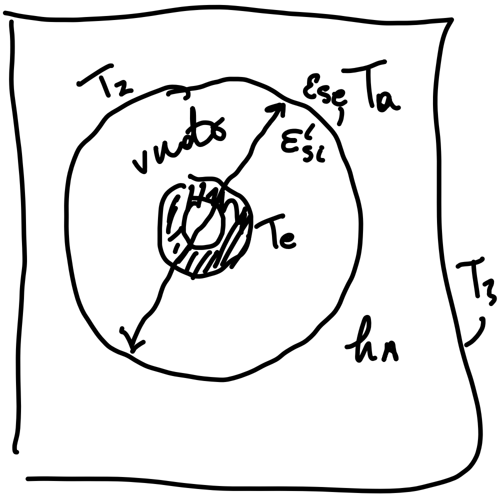
$D_i =$

$D_e =$

$k =$

$L =$

$D_s =$



$\varepsilon_{sin} = 0{,}01$

$\varepsilon_{se} = 0{,}1$

$T_3 =$

$T_a = 27$

$h_A =$

? T_{IN}

? T_{OUT}

? $\dot{Q}$

$$\dot{q}_{CV} = h(T_2 - T_a)$$

$$\dot{q}_{RAD} = \sigma\varepsilon(T_2^4 - T_3^4)$$

$$\dot{q}_{TOT} = \dot{q}_{CV} + \dot{q}_{RAD}$$

$$\dot{Q}_{TOT} = \dot{q}''_{TOT} \cdot \text{Areaschermo}$$

$$\dot{Q}_{T\to} = \dot{Q}_{TOT}^{\to} = \frac{\sigma(T_e^4 - T_2^4)}{\frac{1-\varepsilon}{A\varepsilon} + \frac{1}{A\underbrace{F_{12}}_{1}} + \frac{1-\varepsilon_2}{A_2\varepsilon_2}} \Rightarrow T_e$$

stessa perché in un sistema senza ΔT, q è sempre uguale

$$\dot{Q}_{CD} = \dot{Q}_{TOT}^{\to} = \frac{T_1 - T_2}{\frac{\ln D_1/D_2}{k 2\pi L}} \to T_i$$

Siamo andati dall'esterno all'interno perché era più facile trovare $\dot{Q}$ e poi usare la stessa equazione all'interno