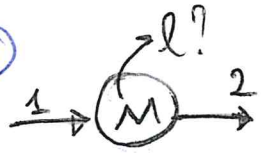
TEMA ESAME 25/11/2016 ✱

1



$P_1 = 15$ bar Fluido incomprimibile $\rho = 800\ kg/m^3$

$P_2 = 2$ bar $V_1 = 3\ m/s$ $\frac{S_1}{S_2} = 3$

CONSERVAZIONE MASSA → REGIME STAZIONARIO

$\dot{m}_1 = \dot{m}_2$

$\rho S_1 V_1 = \rho S_2 V_2 \Longrightarrow V_2 = V_1 \frac{S_1}{S_2} = 9\ m/s$

Pr. CONSERVAZIONE ENERGIA FLUIDO INCOMPRIMIBILE

$$\frac{P_1}{\rho} + \frac{V_1^2}{2} + g z_1 + l = \frac{P_2}{\rho} + \frac{V_2^2}{2} + g z_2 + Y \qquad g z_1 = g z_2$$

$$\Downarrow$$

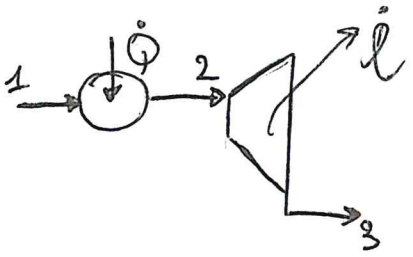
$$\frac{P_1}{\rho} + \frac{V_1^2}{2} + l = \frac{P_2}{\rho} + \frac{V_2^2}{2} + Y \longrightarrow Y = c_v \Delta T = 2000 \frac{J}{kgK} \cdot 0{,}2\ K = 400\ J/kg$$

$$l = \left(\frac{P_2}{\rho} - \frac{P_1}{\rho}\right) + \left(\frac{V_2^2}{2} - \frac{V_1^2}{2}\right) + Y = \qquad \text{(uscente macchina } l < 0\text{)}$$

$$\eta_{ISOT} = \frac{l}{\left(\frac{P_2}{\rho} - \frac{P_1}{\rho}\right) + \left(\frac{V_2^2}{2} - \frac{V_1^2}{2}\right)} = 0{,}748$$

RENDIMENTO ISOTERMO

(2)

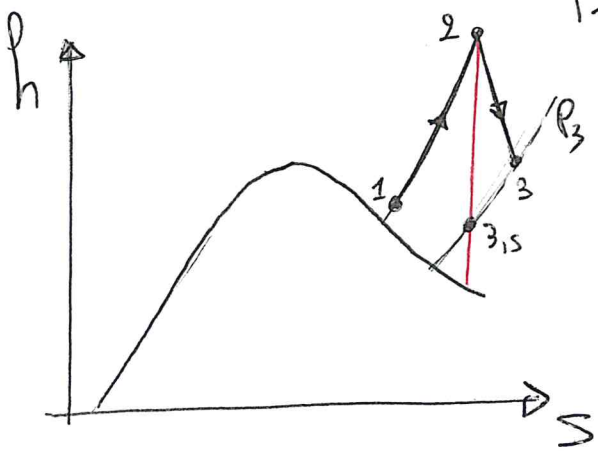


$\dot{Q} = 1100\ kW$

$P_1 = P_2$ (TRASFORMAZIONE 1→2 ISOBARA) $= 2\ bar$

$\eta_{IS} = 0{,}8 \quad P_3 = 0{,}1\ bar$

$T_1 = 440\ K$



$h_1(P_1, T_1) \simeq 2800\ kJ/kg$

TRASFORMAZIONE 1→2 $\quad \dot{L} = 0$

$\dot{m}_1 h_1 + \dot{Q}_{1\to2} = \dot{m}_2 h_2 \qquad \dot{m}_1 = \dot{m}_2$

$\Downarrow$

$h_2 = h_1 + \frac{\dot{Q}_{1\to2}}{\dot{m}} \simeq 3350\ kJ/kg$

- IL PUNTO 2 È IDENTIFICATO DALL'INTERSEZIONE TRA L'ISOBARA $P = P_2$ E L'ISOENTROPICA

$h_2 = 3350\ kJ/kg$ (LINEA ORIZZONTALE)

$T_2 \simeq 710\ K$ → (letto indicativamente dalle isoterme)

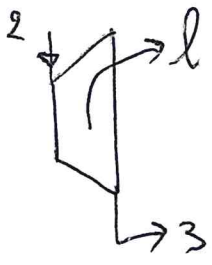
→ TRASFORMAZIONE 2→3 ESPANSIONE CON $\eta_{IS} = 0{,}8$ $\quad P_3 = 0{,}1\ bar$

① CONSIDERO ESPANSIONE ISOENTROPICA 2→3is (TRASFORMAZIONE VERTICALE)

$h_{3,IS} \simeq 2650\ kJ/kg \qquad \Delta h_{IS} = h_2 - h_{3,IS}$

② ESPANSIONE REALE $\eta_{IS} = 0{,}8$

$$\eta_{IS} = \frac{\Delta h_{REALE}}{\Delta h_{IS}} = \frac{h_2 - h_3}{h_2 - h_{3,IS}} \Longrightarrow h_3 = -\eta_{IS}\,\Delta h_{IS} + h_2 = 2787$$

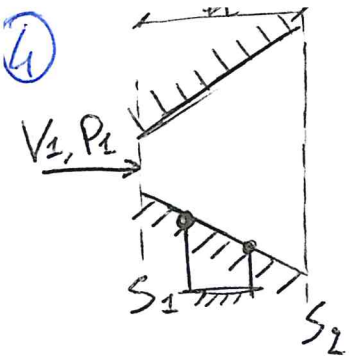


$m_2 h_2 + l = m_3 h_3 \qquad m_2 = m_3$

$\Downarrow$

$\dot{l} = \dot{m}(h_3 - h_2) = -1132{,}3\ kW$

4



$P_1 = 1\ bar$
$V_1 = 10\ m/s$
$D_1 = 0{,}02\ m$
$D_2 = 0{,}045\ m$
$h = 0{,}25\ m$
$\rho_{H_2O} = 1000\ kg/m^3$

→ CONS. MASSA × REGIME STAZIONARIO

$\dot{m} = \dot{m}_1 = \dot{m}_2$ ~~$\rho S_1 V_1 = \rho S_2 V_2 = \dot{m}$~~

$\dot{m} = \rho S_1 V_1 = \rho \frac{\pi D_1^2}{4} V_1 = 3{,}15\ kg/s$

$\dot{m} = \rho S_2 V_2 \Rightarrow V_2 = \frac{\dot{m}}{\rho S_2} = \frac{\dot{m}}{\rho \frac{\pi D_2^2}{4}} = 1{,}975\ m/s$

→ × CALCOLARE LA PRESSIONE 2 APPLICO IL PRINC. CONS. ENERGIA × FLUIDI INCOMPRIMIBILI

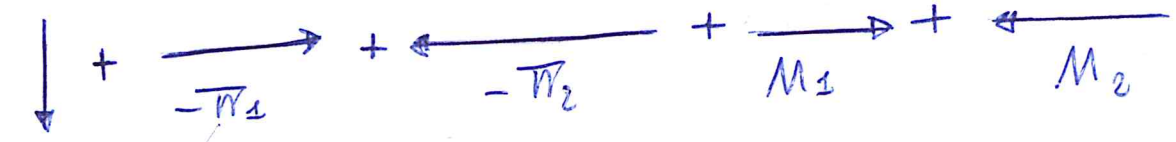
$\frac{P_1}{\rho} + \frac{V_1^2}{2} + g z_1 = \frac{P_2}{\rho} + \frac{V_2^2}{2} + g z_2$ ($\nu = 0$, $z_1 = z_2$ (DIVERGENTE ORIZZONTALE), $\ell = 0$

$$P_2 = \left(\frac{P_1}{\rho} + \frac{V_1^2}{2} - \frac{V_2^2}{2} \right) \rho = 1{,}48\ bar$$

PRINCIPIO CONSERVAZIONE Q. DI MOTO

$\vec{G} - \vec{\Pi}_1 - \vec{\Pi}_2 + \vec{M}_1 - \vec{M}_2 + \vec{R}_3 = 0$

$\vec{G}$ → $\rho V g$; $\vec{\Pi}_1$ → $P_1 \vec{n}_1 S_1$; $\vec{\Pi}_2$ → $P_2 \vec{n}_2 S_2$; $\vec{M}_1$ → $\dot{m} \vec{V}_1$; $\vec{M}_2$ → $\dot{m} \vec{V}_2$



$\Sigma r = 0$

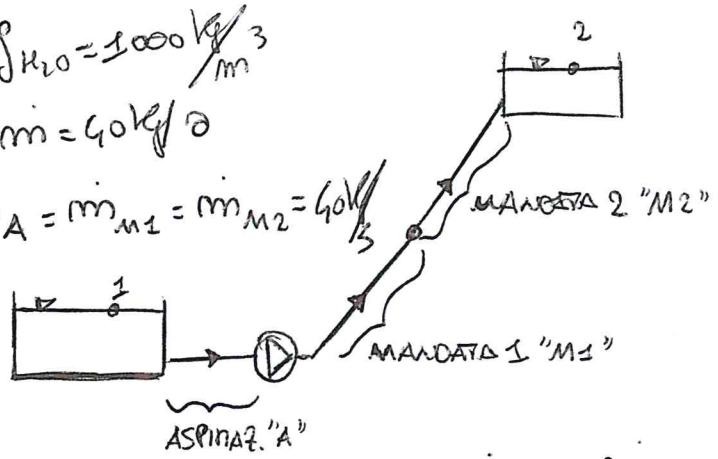
$-R_3 = S_3 \rightarrow S_z = \rho V g = -0{,}213\ N$

$S_x = \underbrace{P_1 S_1}_{21{,}6\ N} - \underbrace{P_2 S_2}_{235\ N} + \underbrace{\dot{m} V_1}_{31{,}4\ N} - \underbrace{\dot{m} V_2}_{6{,}2\ N} = -178\ N$

(3) $\rho_{H_2O} = 1000\ kg/m^3$

$\dot{m} = 40\ kg/s$

$\dot{m}_A = \dot{m}_{M1} = \dot{m}_{M2} = 40\ kg/s$



$$\dot{m} = \rho A_A V_A \Rightarrow V_A = \frac{\dot{m}}{\rho A_A} = \frac{\dot{m}}{\rho \frac{\pi D_A^2}{4}} = 1{,}27\ m/s$$

$$V_{M1} = \frac{\dot{m}}{\rho A_{M1}} = \frac{\dot{m}}{\rho \frac{\pi D_{M1}^2}{4}} = 1{,}27\ m/s$$

$$V_{M2} = \frac{\dot{m}}{\rho \frac{\pi D_{M2}^2}{4}} = 0{,}5659\ m/s$$

CALCOLO PERDITE

$$Y_A = \underbrace{f}_{0{,}02} \frac{L_A}{D_A} \frac{V_A^2}{2} + \underbrace{K_c}_{5} \frac{V_A^2}{2} = 6{,}48\ J/kg$$

$$Y_{M1} = f \frac{L_{M1}}{D_{M1}} \frac{V_{M1}^2}{2} + K_c \frac{V_{M1}^2}{2} = 6{,}48\ J/kg$$

$$Y_{M2} = f \frac{L_{M2}}{D_{M2}} \frac{V_{M2}^2}{2} + K_c \frac{V_{M2}^2}{2} = 1{,}86\ J/kg$$

$$Y_{impianto} = Y_A + Y_{M1} + Y_{M2} = 14{,}82\ J/kg$$

CARICO IDEALE PER PORTARE ACQUA DEL SERBATOIO 1 A 2 (CASO CON PERDITE $Y = 0$)

$$\frac{P_1}{\rho} + \frac{V_1^2}{2} + g z_1 + l = \frac{P_2}{\rho} + \frac{V_2^2}{2} + g z_2$$

$P_1 = P_2 = 0 \Rightarrow$ PRESSIONE ATMOSFERICA

$V_1 = V_2 = 0$

$$l = g(z_2 - z_1) = g\underbrace{(\Delta H)}_{100\ m} = 981\ J/kg$$

$$l_{EL} = \frac{l}{\eta_{ION}\,\eta_{ONG-EL}} = 1350\ kJ/kg$$

$\eta_{ION} = 0{,}8$ $\quad$ $\eta_{ONG-EL} = 0{,}99$

$P_{EL} = \dot{m}\, l_{EL} = 54\,kW$ POTENZA ELETTRICA CONSUMATA DALLA POMPA