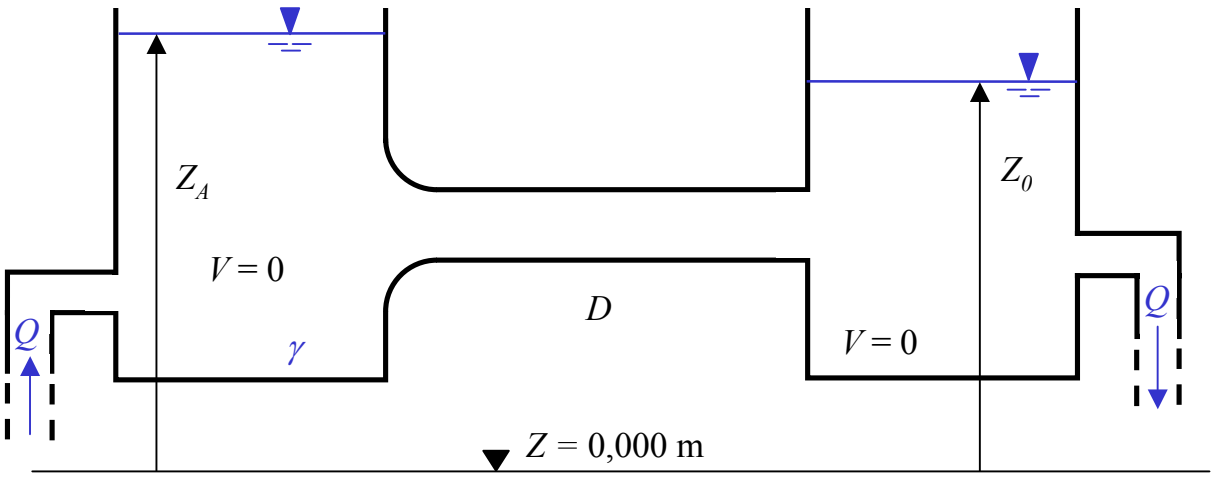
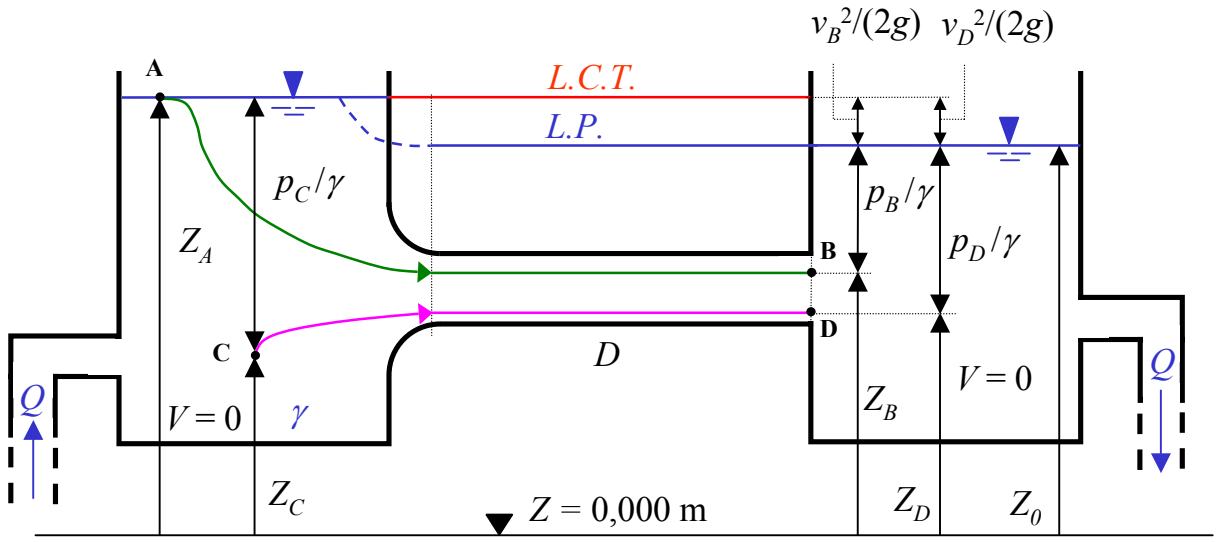
Esercizio 33

Noti: Z_A = 18,000 m, Z_0 = 16,000 m, D = 0,300 m, γ = 8825 N/m^3, g = 9,806 m/s^2, *fluido ideale*. **Determinare** la portata circolante Q. **Tracciare** la *linea dei carichi totali* (*L.C.T.*) e la *linea piezometrica* (*L.P.*).

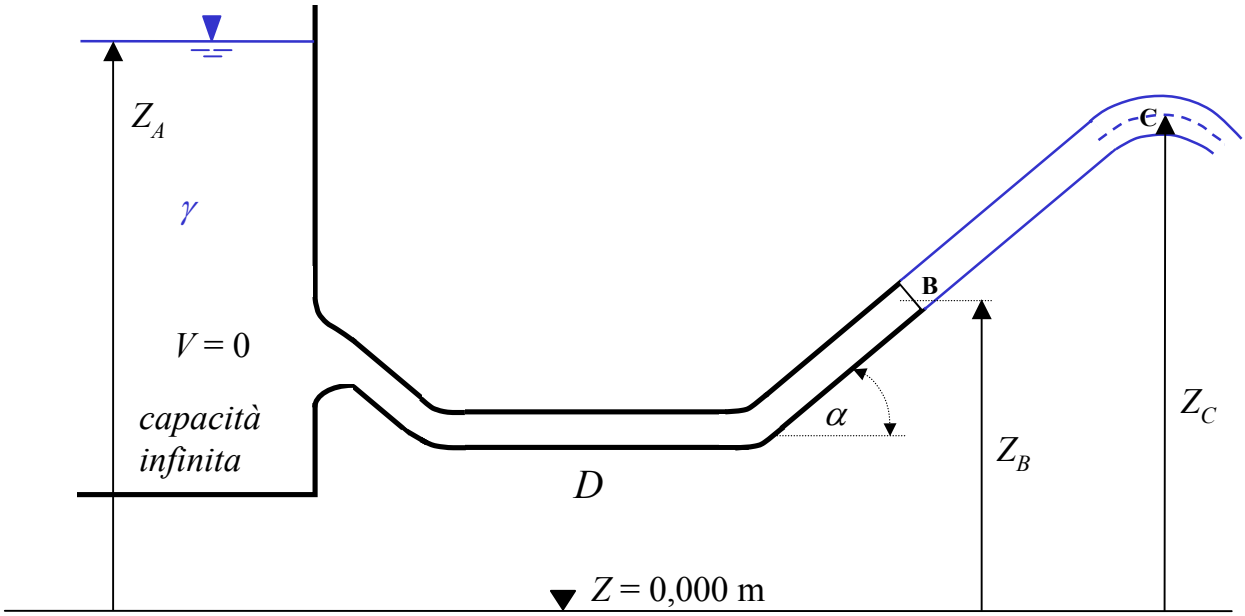


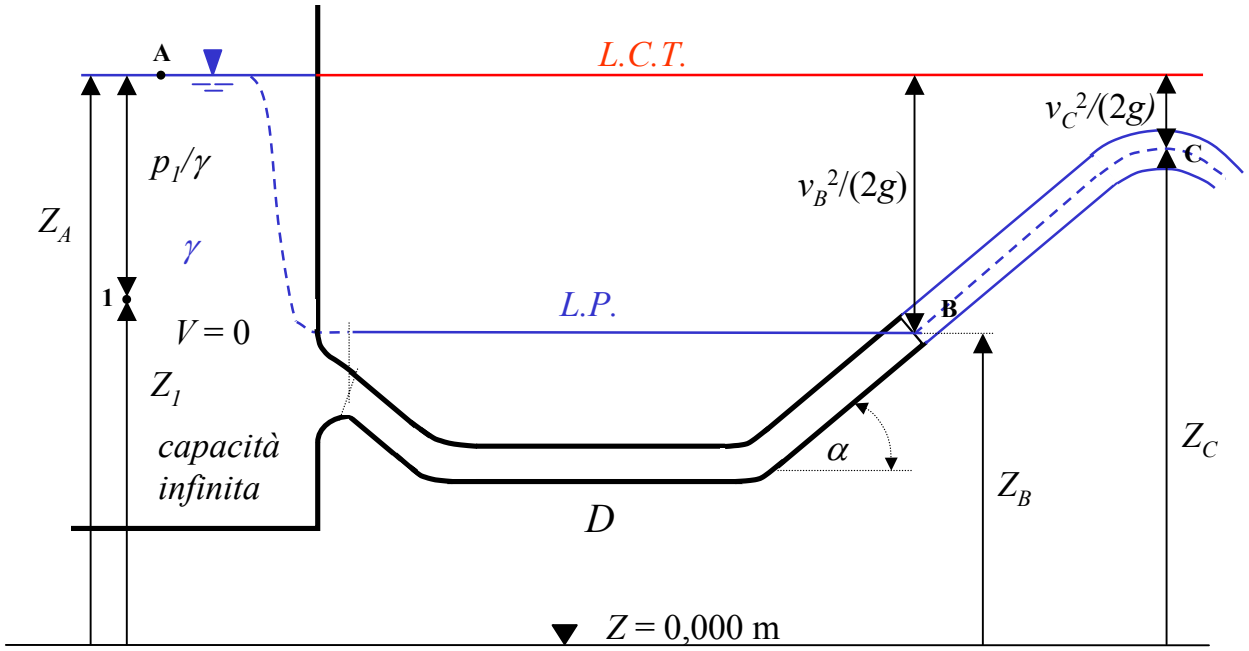


($Q = \pi D^2/4\ [2\ g\ (Z_A - Z_0)]^{1/2} = 0{,}443$ m^3/s)

Esercizio 34

Noti: $Z_A = 50{,}000$ m, $Z_B = 45{,}000$ m, $D = 0{,}600$ m, $\gamma = 7752$ N/m^3, $\alpha = 45°$, $g = 9{,}806$ m/s^2, *fluido ideale*. **Determinare** la portata Q transitante, la quota Z_C raggiungibile dal getto in atmosfera e la massima quota Z_C al variare dell'angolo α. **Tracciare** la *linea dei carichi totali* (*L.C.T.*) e la *linea piezometrica* (*L.P.*).





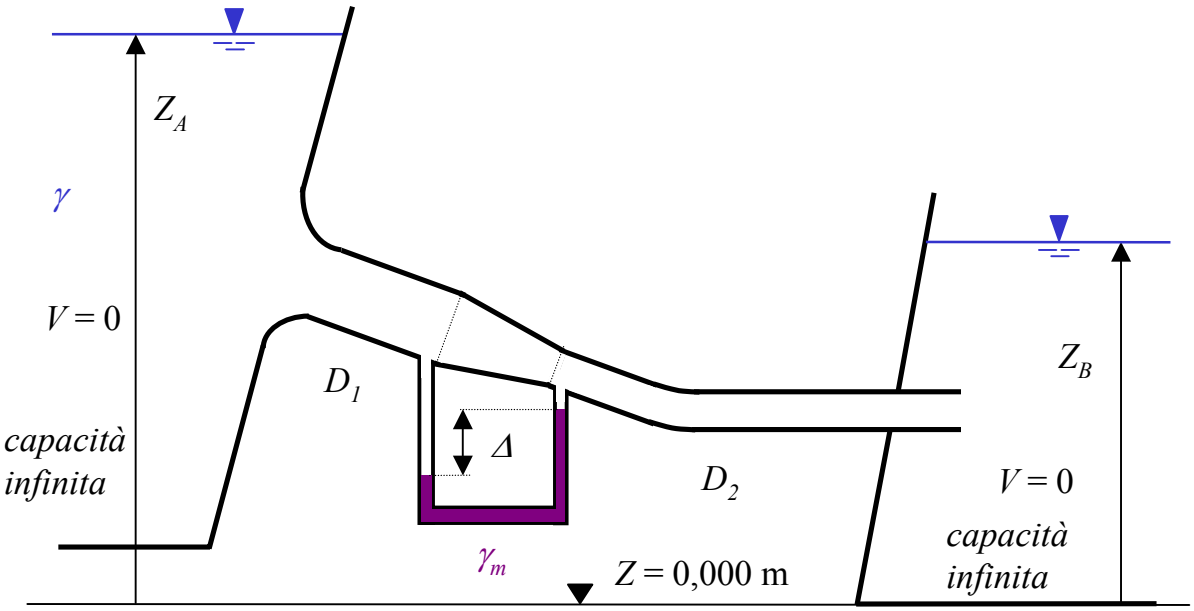
$Q = \pi D^2/4\,[2\,g\,(Z_A - Z_B)]^{1/2} = 2{,}800$ m^3/s $\qquad Z_C(\alpha) = Z_A - [v_B^2/(2\,g)]\cdot[\cos\alpha]^2 = 47{,}500$ m

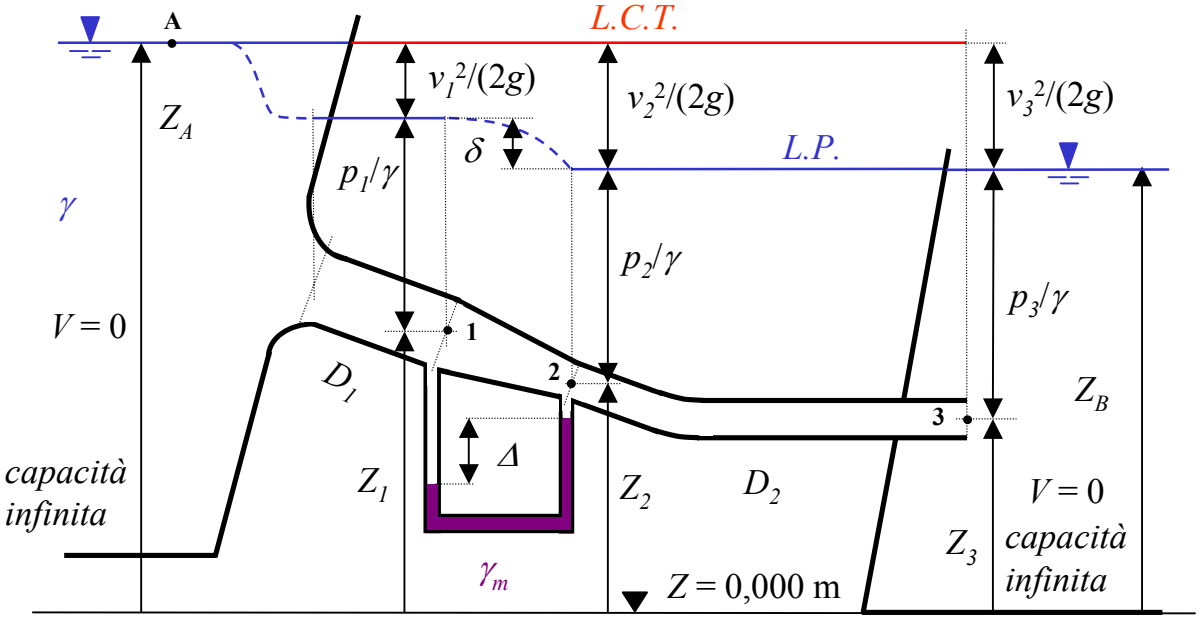
$Z_C(\alpha = 90°) = Z_{C\,MAX} = Z_A = 50{,}000$ m

Esercizio 35

Noti: $Z_A = 12{,}000$ m, $D_1 = 0{,}200$ m, $D_2 = 0{,}100$ m, $\Delta = 0{,}150$ m, $\gamma = 9806$ N/m^3, $\gamma_m = 133362$ N/m^3, $g = 9{,}806$ m/s^2, *fluido ideale*.

Determinare la portata Q transitante ed il livello Z_B del serbatoio di valle. **Tracciare** la *linea dei carichi totali* (*L.C.T.*) e la *linea piezometrica* (*L.P.*).





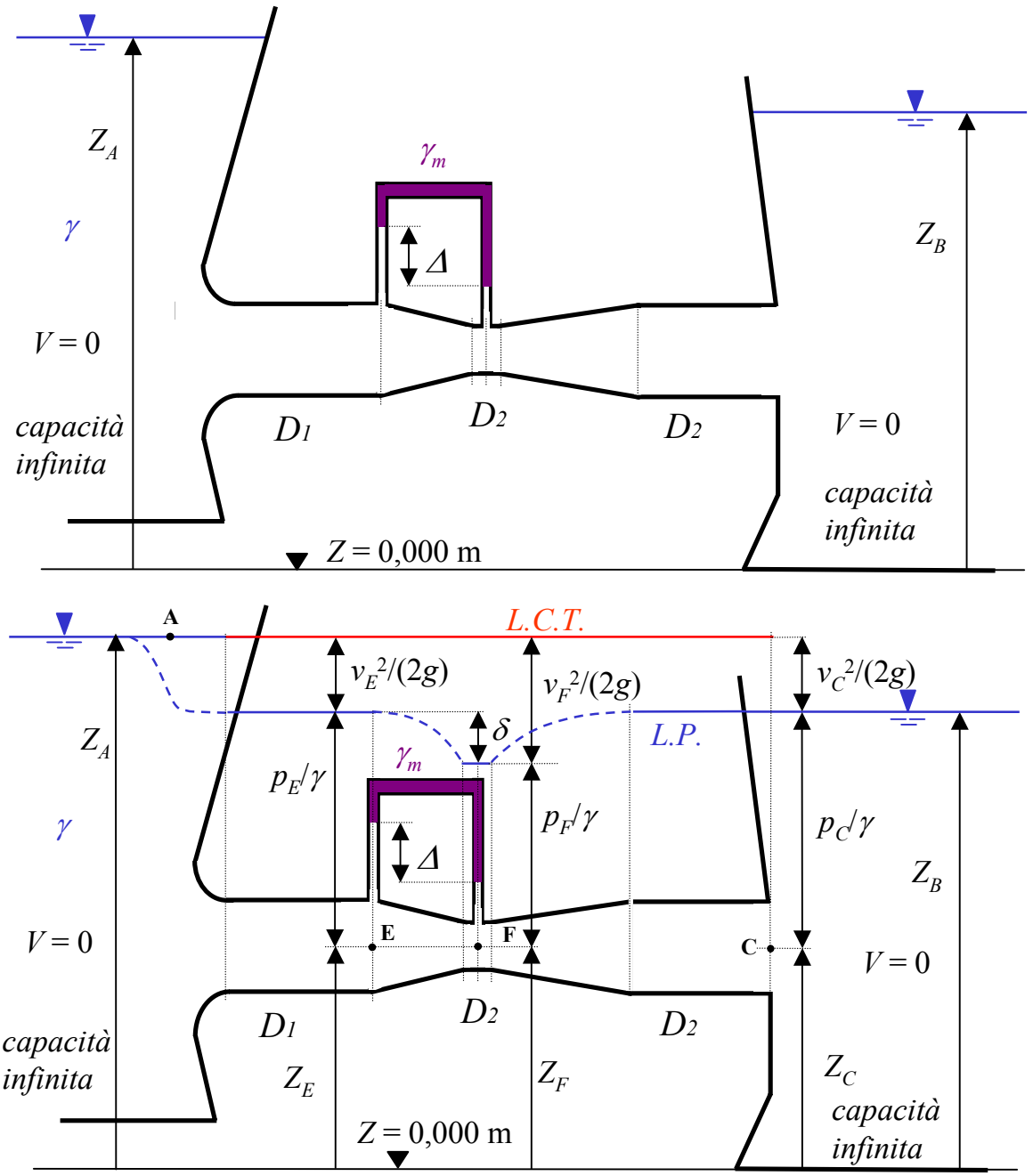
$Q = [A_1 A_2]/[A_1^2 - A_2^2]^{½} [2 g \Delta (\gamma_m - \gamma)/\gamma]^{1/2} = 0{,}049$ m^3/s

$Z_B = Z_A - Q^2/(2 g A_2^2) = 9{,}984$ m

Esercizio 36

Noti: $Z_A = 16{,}000$ m, $Z_B = 15{,}000$ m, $D_1 = 0{,}500$ m, $D_2 = 0{,}400$ m, $\gamma = 15000$ N/m^3, $\gamma_m = 600$ N/m^3, $g = 9{,}806$ m/s^2, *fluido ideale*.

Determinare la portata Q transitante ed il dislivello manometrico Δ. **Tracciare** la *linea dei carichi totali* (*L.C.T.*) e la *linea piezometrica* (*L.P.*).



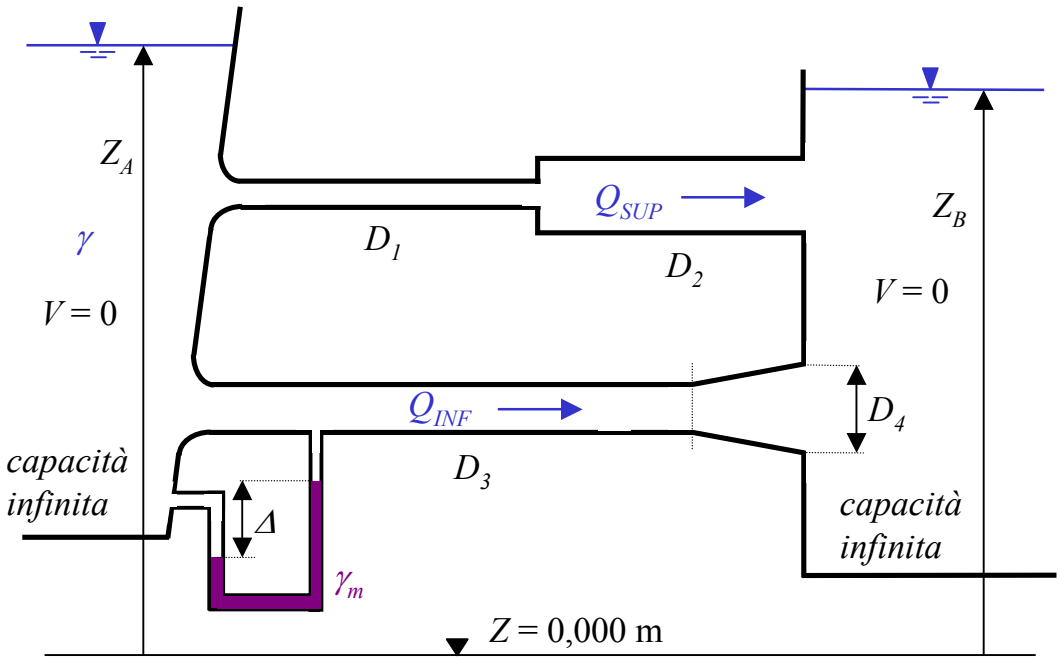
$$Q = \pi D_1^2/4 \, [2 g (Z_A - Z_B)]^{1/2} = 0{,}870 \text{ m}^3/\text{s}$$

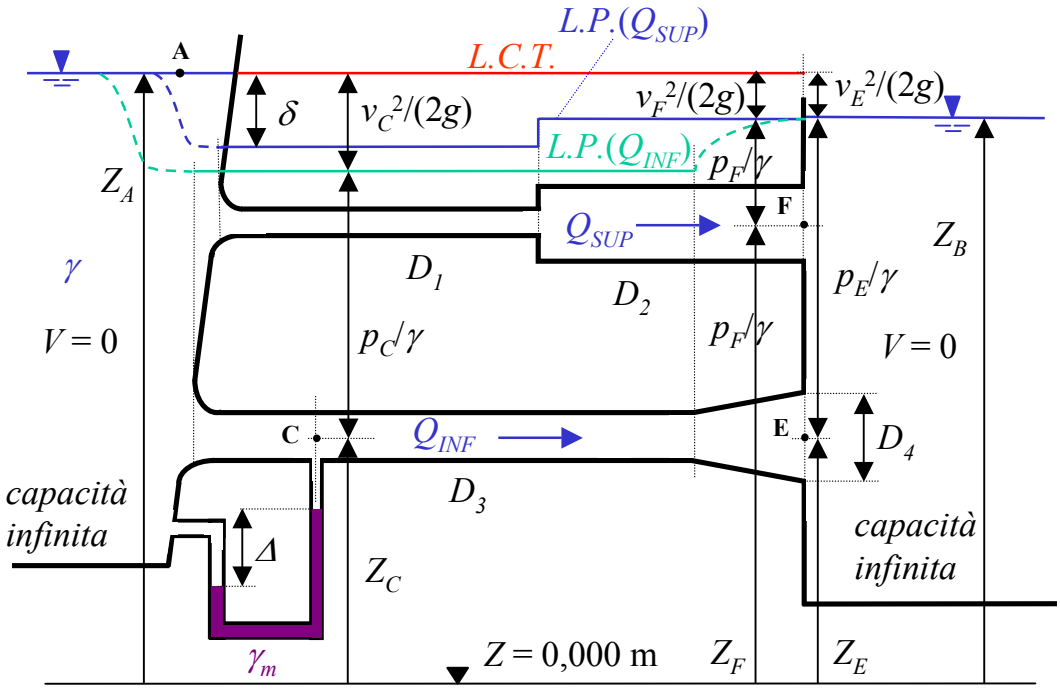
$$\Delta = \gamma/(\gamma - \gamma_m) \, Q^2/(2 g) \, [A_1^2 - A_2^2]/[A_1^2 A_2^2] = 1{,}501 \text{ m}$$

Esercizio 37

Noti: $Z_A = 21{,}000$ m, $\Delta = 0{,}050$ m, $D_2 = 0{,}250$ m, $D_3 = 0{,}200$ m, $D_4 = 0{,}300$ m, $\gamma = 7800$ N/m^3, $\gamma_m = 133362$ N/m^3, $g = 9{,}806$ m/s^2, *fluido ideale*.

Determinare le portate transitanti, Q_{INF} e Q_{SUP}, ed il livello Z_B del serbatoio di valle. **Tracciare** la *linea dei carichi totali* (*L.C.T.*) e la *linea piezometrica* (*L.P.*).





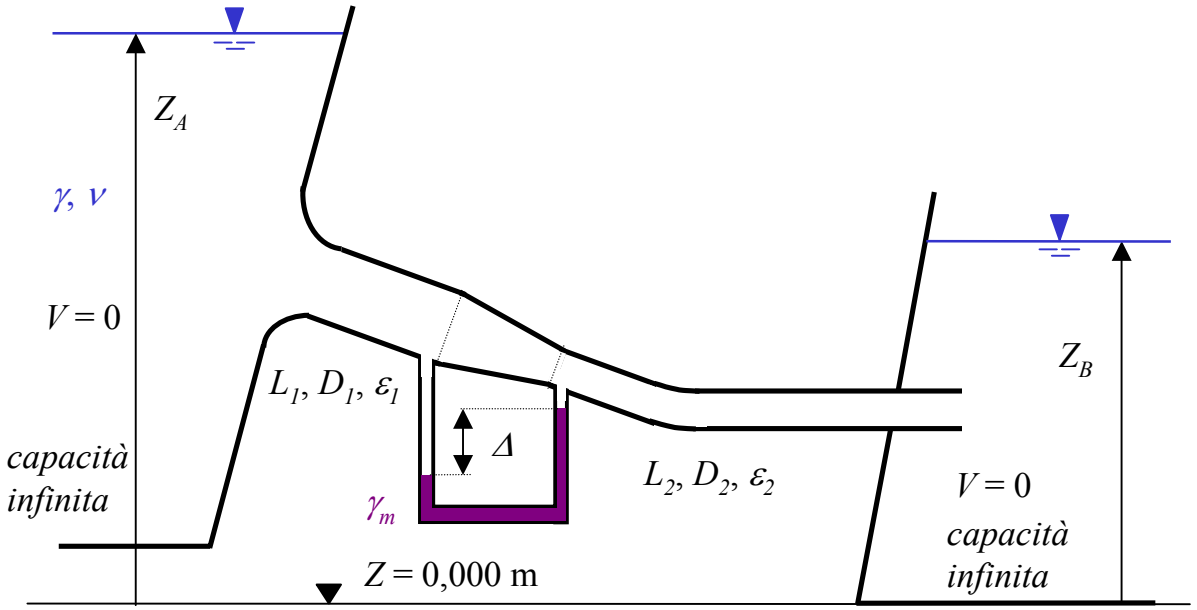
$Q_{INF} = A_3 [2\, g\, \Delta\, (\gamma_m - \gamma)/\gamma]^{1/2} = 0{,}125$ m^3/s $\quad Z_B = Z_A - Q_{INF}^2/(2\, g\, A_4^2) = 20{,}841$ m

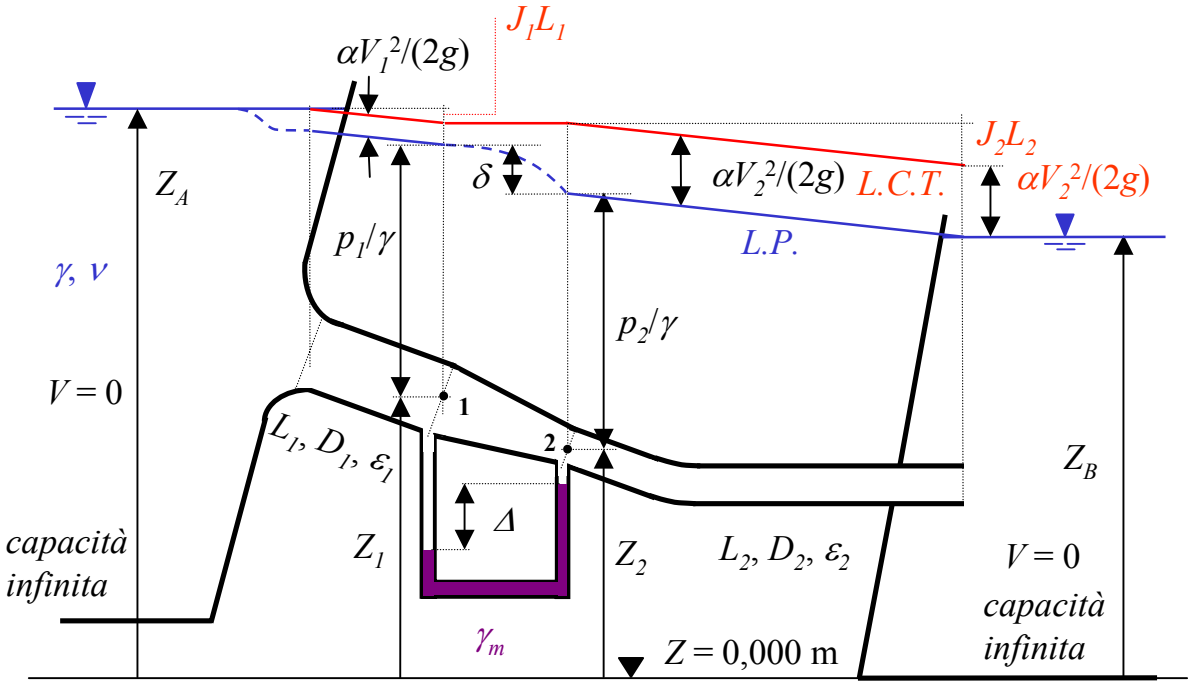
$Q_{SUP} = A_2 [2\, g\, (Z_A - Z_B)]^{1/2} = 0{,}087$ m^3/s

Esercizio 38

Noti: $Z_A = 12{,}000$ m, $D_1 = 0{,}200$ m, $D_2 = 0{,}100$ m, $\Delta = 0{,}150$ m, $\gamma = 9806$ N/m^3, $\gamma_m = 133362$ N/m^3, $g = 9{,}806$ m/s^2, $\nu = 2,\ 3 \cdot 10^{-6}$ m^2/s, $L_1 = 6{,}000$ m, $L_2 = 8{,}000$ m, $\varepsilon_1 = 0{,}0005$ m, $\varepsilon_2 = 0{,}000$ m (liscio), $\alpha = 1$.

Determinare la portata Q transitante ed il livello Z_B del serbatoio di valle. **Tracciare** la *L.C.T.* e la *L.P.*.





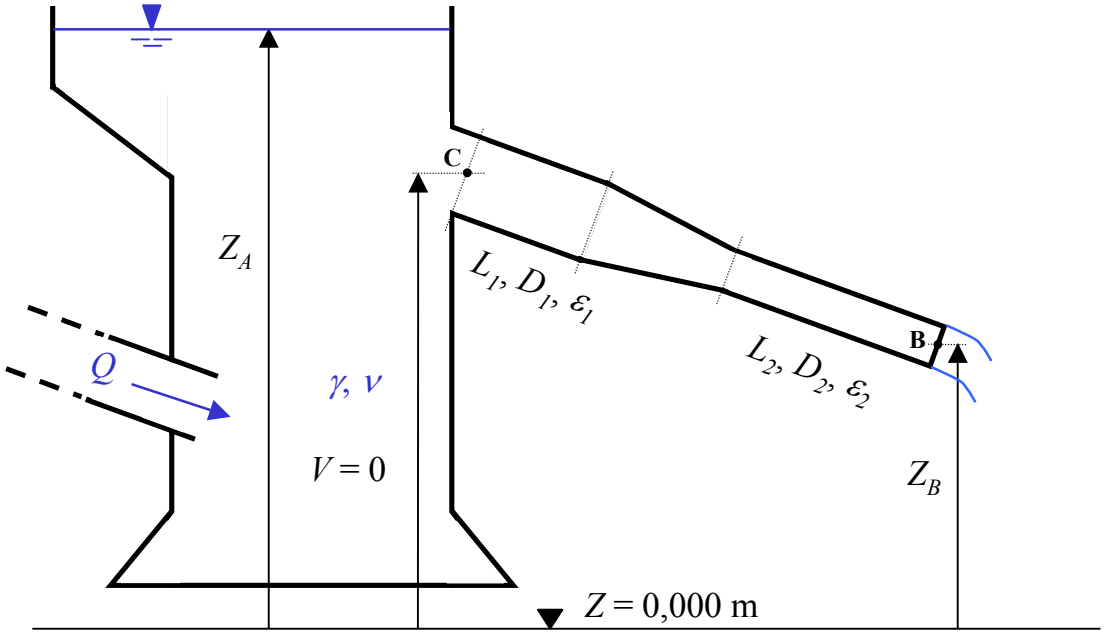
$$Q = [A_1\, A_2]/[A_1^2 - A_2^2]^{1/2}\, [2\, g\, \Delta\, (\gamma_m - \gamma)/\gamma]^{1/2} = 0{,}049 \text{ m}^3/\text{s}$$

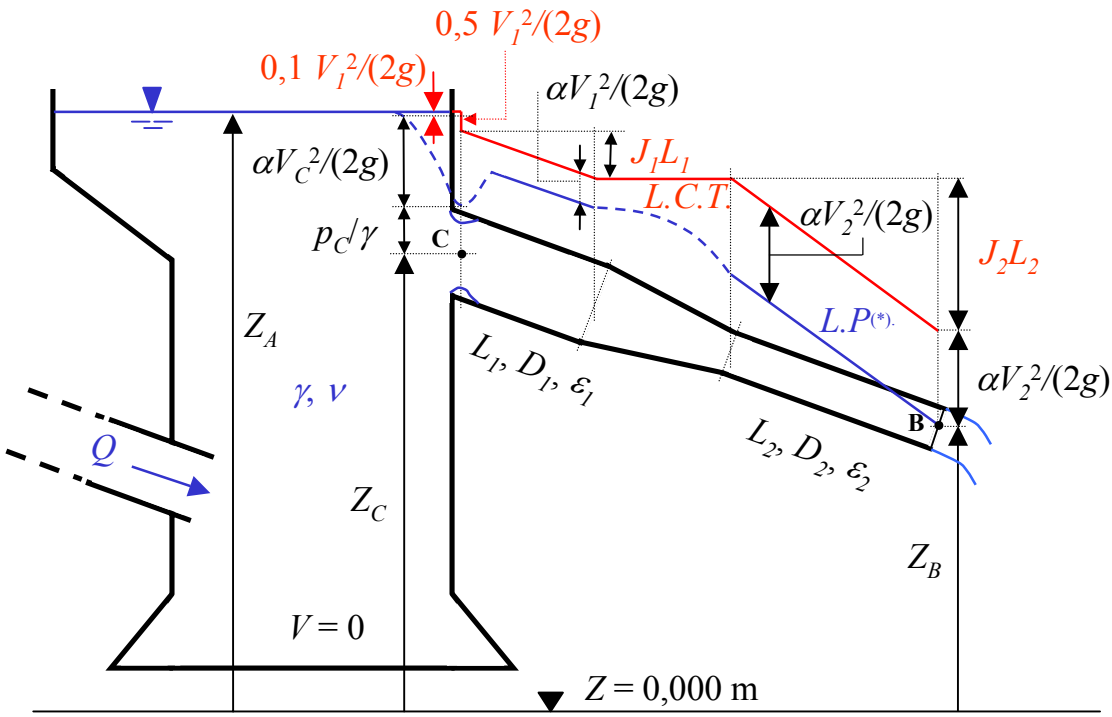
$$Z_B = Z_A - \lambda_1/D_1\, Q^2/(2\, g\, A_1^2)\, L_1 - \lambda_2/D_2\, Q^2/(2\, g\, A_2^2)\, L_2 - \alpha Q^2/(2\, g\, A_2^2) = 7{,}852 \text{ m}$$

Esercizio 39

Noti: $Z_C = 11{,}000$ m, $Z_B = 9{,}000$ m, $L_1 = 10{,}000$ m, $L_2 = 3{,}000$ m, $D_1 = 0{,}200$ m, $D_2 = 0{,}150$ m, $\gamma = 7845$ N/m^3, $\nu = 2{,}3\ 10^{-6}$ m^2/s, $Q = 0{,}100$ m^3/s, $C_C = 0{,}61$, $\varepsilon_1 = \varepsilon_2 = 0{,}000$ m (primo caso); $\varepsilon_1 = 8{,}0 \cdot 10^{-4}$ m, $\varepsilon_2{}^{(*)} = 7{,}0 \cdot 10^{-4}$ m (secondo caso), $g = 9{,}806$ m/s^2, $\alpha = 1$.

Determinare il livello Z_A del serbatoio di monte. **Tracciare** la *L.C.T.* e la *L.P.*. **Verificare** il valore della pressione all'imbocco.





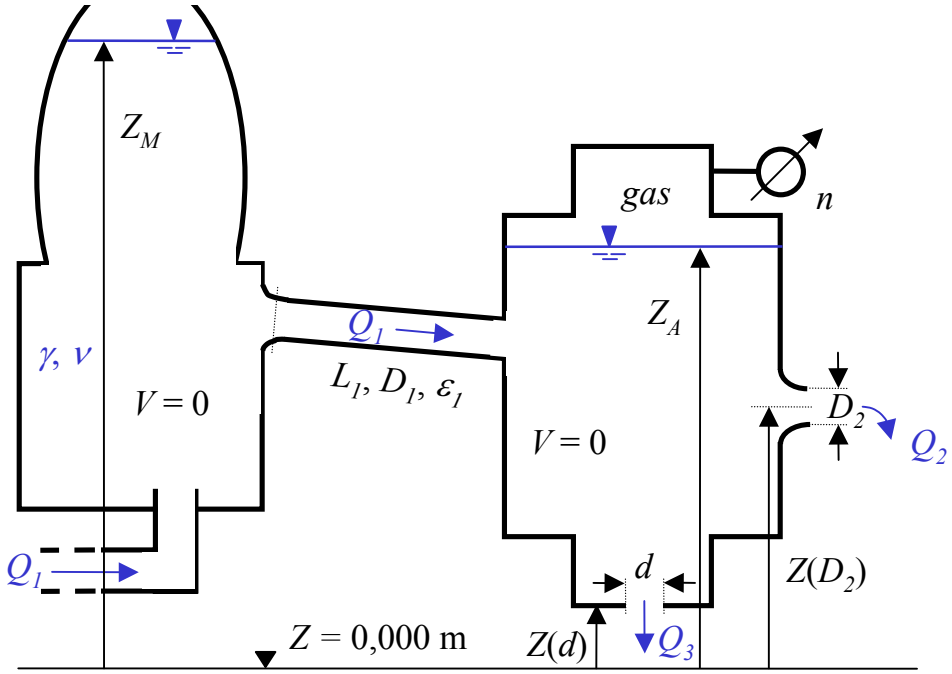
$Z_A = Z_B + \alpha V_2^2/(2\,g) + 0{,}5\ V_1^2/(2\,g) + J_1\,L_1 + J_2\,L_2 = 11{,}725$ m $\quad p_C/\gamma = -0{,}715$ m (tubi lisci)

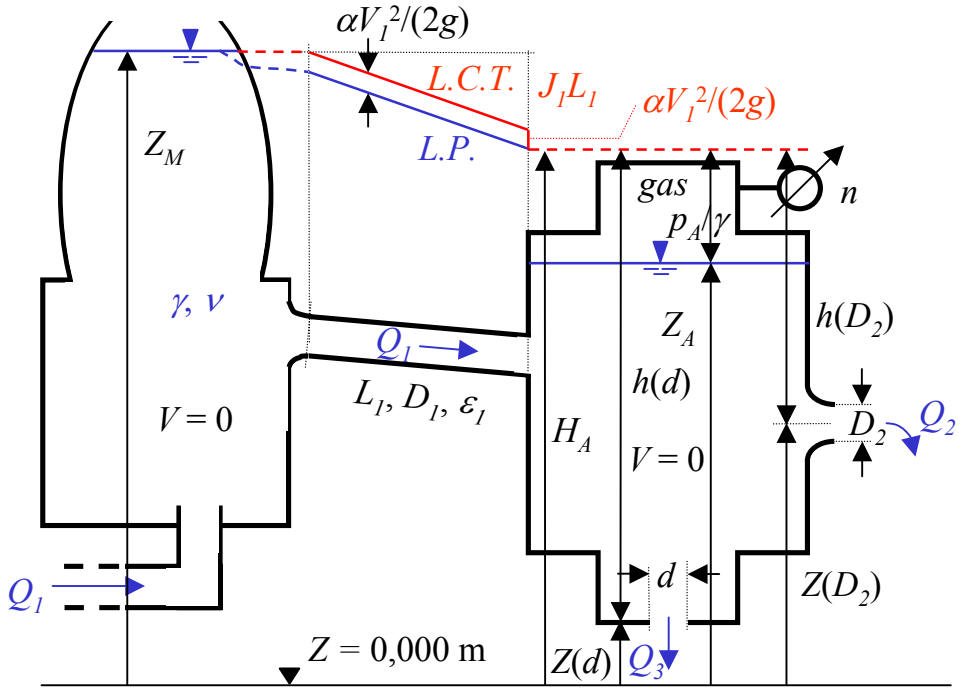
$Z_A = Z_B + \alpha V_2^2/(2\,g) + 0{,}5\ V_1^2/(2\,g) + J_1\,L_1 + J_2\,L_2 = 12{,}614$ m $\quad p_C/\gamma = 0{,}174$ m (tubi scabri)

Esercizio 40

Noti: n = 0,25 bar, Z_A = 10,000 m, $Z(d)$ = 3,000 m, $Z(D_2)$ = 5,000 m, L_1 = 100,000 m, D_1 = 0,600 m, ε_1 = 0,002 m, D_2 = 0,200 m, d = 0,150 m, γ = 6668 N/m^3, ν = 4,4·10^{-7} m^2/s, g = 9,806 m/s^2, $\mu(D_2)$ = 0,98, $\mu(d)$ = 0,6, α = 1.

Determinare le portate effluenti, Q_2 e Q_3, e quella circolante Q_1; **determinare** il livello Z_M del serbatoio di monte. **Tracciare** la *L.C.T.* e la *L.P.*.





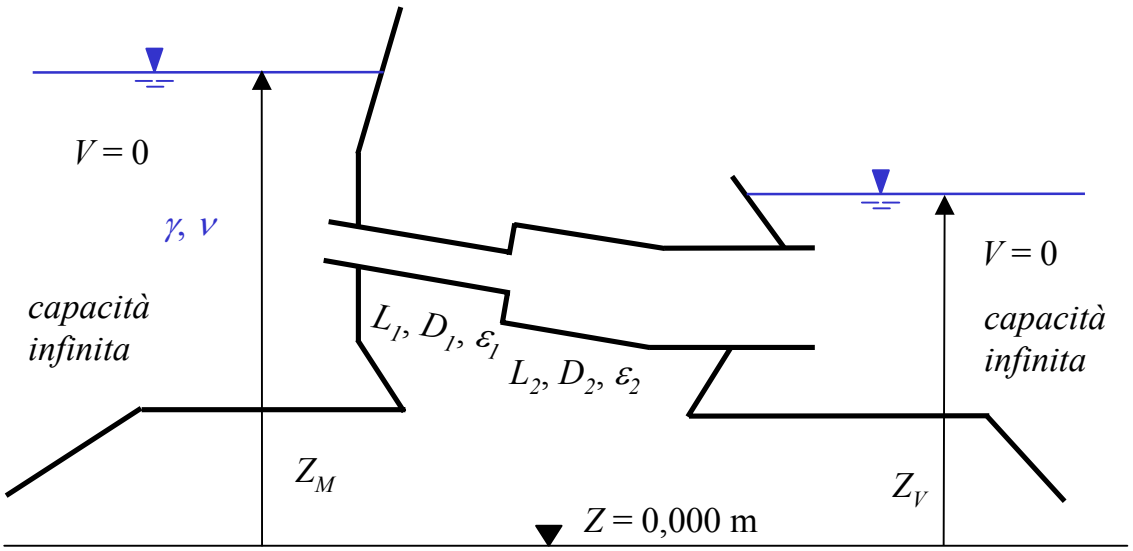
$Q_2 = \mu(D_2)\, A(D_2)\, [2\, g\, h(D_2)]^{1/2} = 0{,}403$ m^3/s $Q_3 = \mu(d)\, A(d)\, [2\, g\, h(d)]^{1/2} = 0{,}154$ m^3/s

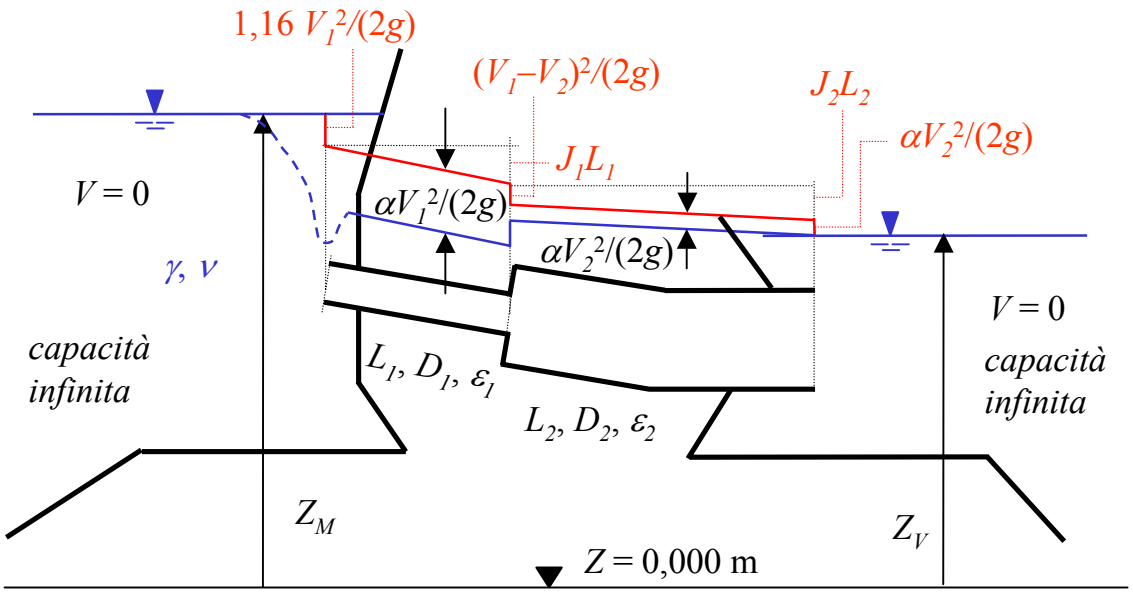
$Q_1 = Q_2 + Q_3 = 0{,}557$ m^3/s $Z_M = \alpha V_1^2/(2\, g) + J_1\, L_1 + H_A = 14{,}838$ m

Esercizio 41

Noti: $Z_V = 30{,}000$ m, $L_1 = 10{,}000$ m, $L_2 = 16{,}000$ m, $D_1 = 0{,}300$ m, $D_2 = 0{,}400$ m, $\gamma = 12366$ N/m^3, $\alpha = 1$, $\nu = 6{,}35 \cdot 10^{-5}$ m^2/s, $Q = 0{,}300$ m^3/s, $g = 9{,}806$ m/s^2, $\varepsilon_{1.1} = 0{,}000$ m (primo caso), $\varepsilon_{1.2} = 0{,}005$ m (secondo caso), $\varepsilon_2 = 0{,}005$ m.

Determinare il livello Z_M del serbatoio di monte. **Tracciare** la *L.C.T.* e la *L.P.*.





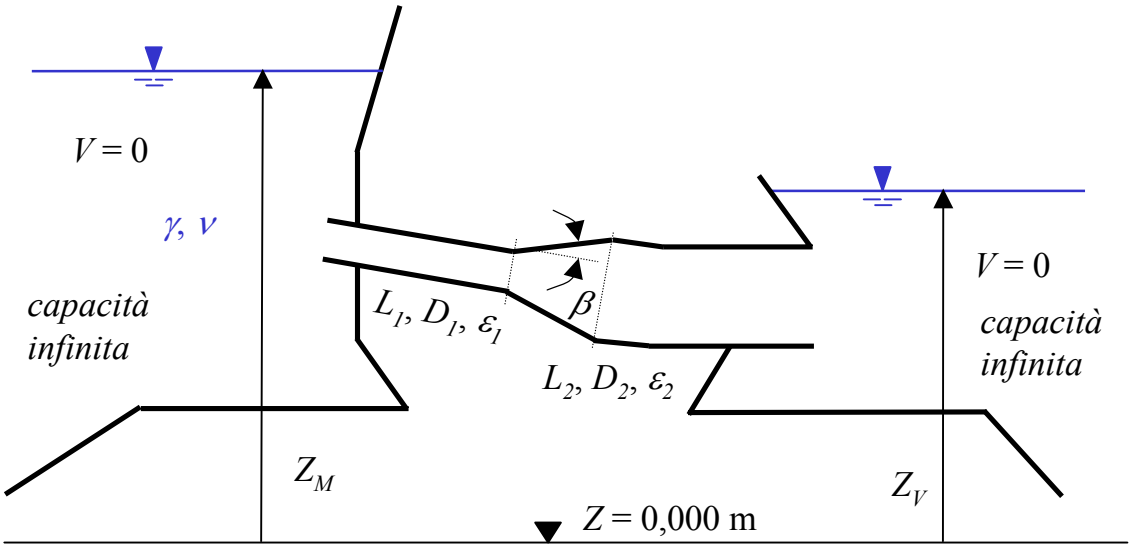
$$Z_M = 1{,}16\, V_1^2/(2\,g) + J_{1.1}\, L_1 + (V_1\text{-}V_2)^2 + J_2\, L_2 + \alpha V_2^2/(2\,g) + Z_V = 32{,}837 \text{ m}$$

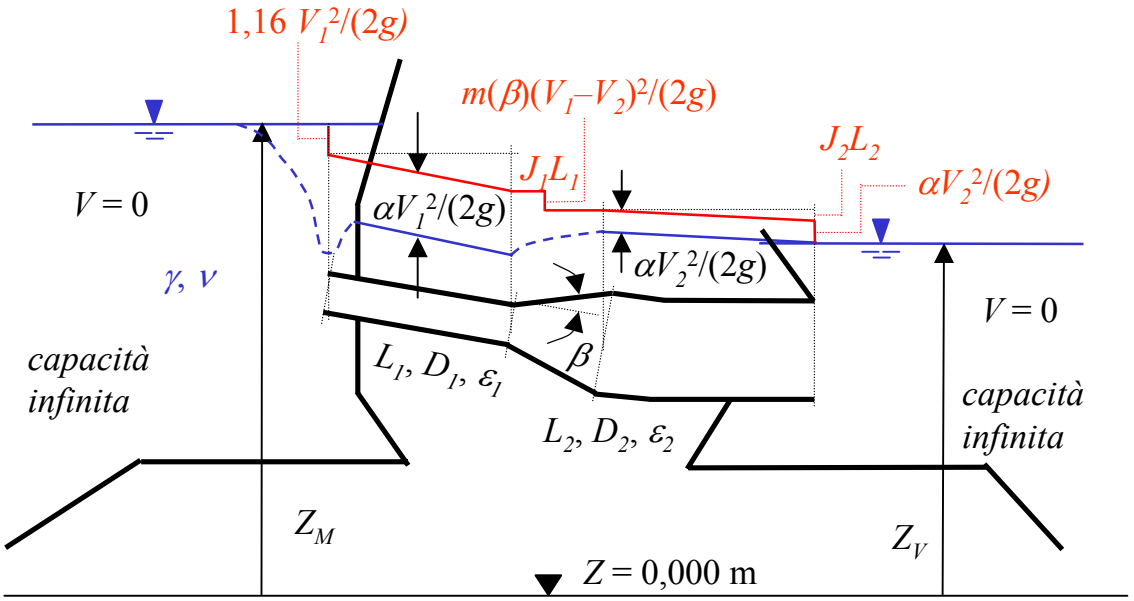
$$Z_M = 1{,}16\, V_1^2/(2\,g) + J_{1.2}\, L_1 + (V_1\text{-}V_2)^2 + J_2\, L_2 + \alpha V_2^2/(2\,g) + Z_V = 33{,}498 \text{ m}$$

Esercizio 42

Noti: $Z_V = 30{,}000$ m, $L_1 = 10{,}000$ m, $L_2 = 16{,}000$ m, $D_1 = 0{,}300$ m, $D_2 = 0{,}400$ m, $\gamma = 12366$ N/m^3, $\alpha = 1$, $\nu = 6{,}35 \cdot 10^{-5}$ m^2/s, $Q = 0{,}300$ m^3/s, $m(\beta) = 0{,}3$, $\varepsilon_{1.1} = 0{,}000$ m (primo caso), $\varepsilon_{1.2} = 0{,}005$ m (secondo caso), $\varepsilon_2 = 0{,}005$ m, $g = 9{,}806$ m/s^2.

Determinare il livello Z_M del serbatoio di monte. **Tracciare** la *L.C.T.* e la *L.P.*.





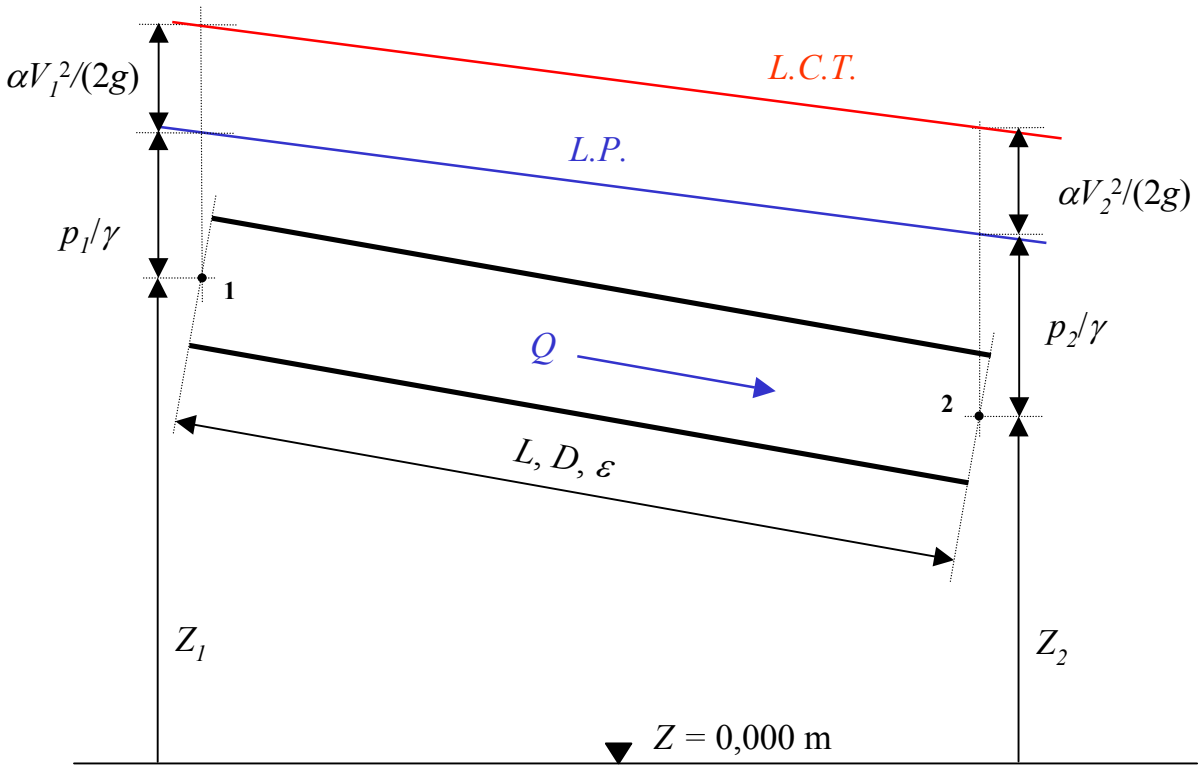
$$Z_M = 1{,}16\ V_1^2/(2\,g) + J_{1.1}\,L_1 + m(\beta)\,(V_1\text{-}V_2)^2 + J_2\,L_2 + \alpha V_2^2/(2\,g) + Z_V = 32{,}713 \text{ m}$$

$$Z_M = 1{,}16\ V_1^2/(2\,g) + J_{1.2}\,L_1 + m(\beta)\,(V_1\text{-}V_2)^2 + J_2\,L_2 + \alpha V_2^2/(2\,g) + Z_V = 33{,}375 \text{ m}$$

Esercizio 43

Noti: $Z_1 = 45{,}000$ m, $Z_2 = 15{,}000$ m, $\gamma = 7845$ N/m^3, $\nu = 2{,}3 \cdot 10^{-6}$ m^2/s, $p_1 = 300000$ Pa, $p_2 = 500000$ Pa, $D = 0{,}250$ m, $L = 150{,}000$ m, $\varepsilon = 0{,}00025$ m, $\alpha = 1$, $g = 9{,}806$ m/s^2.

Determinare la portata Q transitante. **Tracciare** la *L.C.T.* e la *L.P.*.

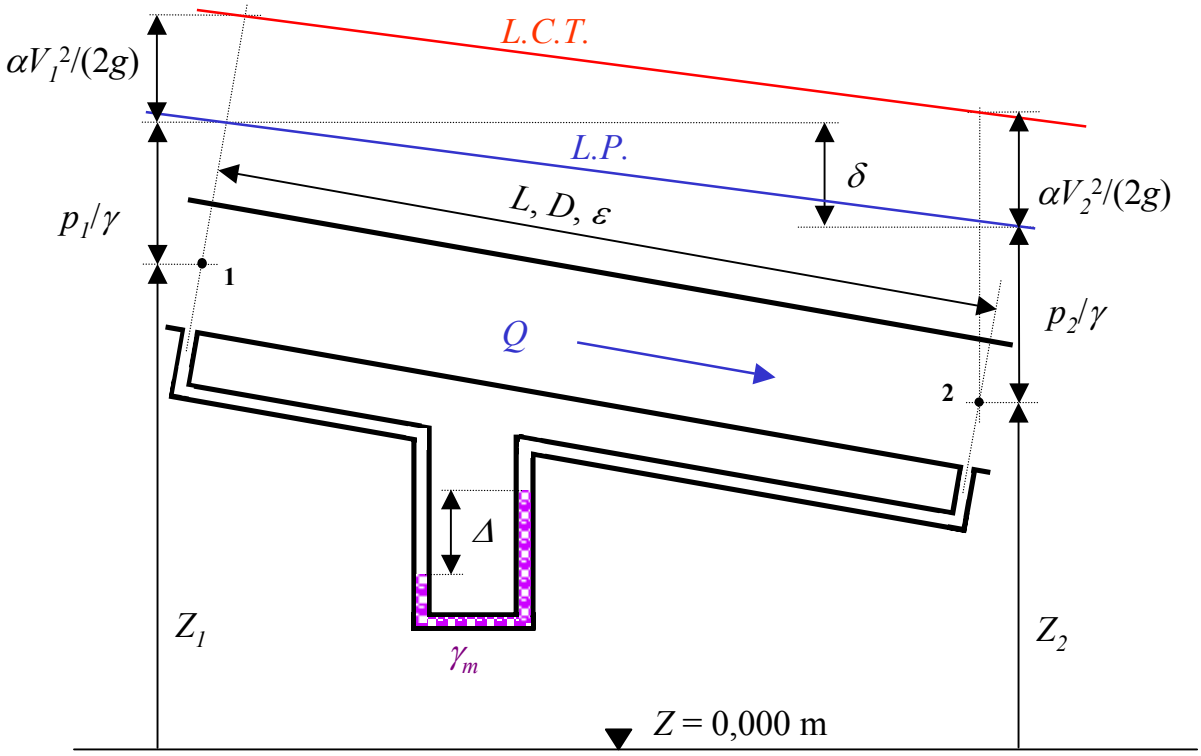


($Q = \pi D^2/4 \, [2 \, g \, D \, J/\lambda]^{1/2} = 0{,}131$ m^3/s)

Esercizio 44

Noti: $\Delta = 0{,}282$ m, $\gamma = 7845$ N/m^3, $\nu = 2{,}3 \cdot 10^{-6}$ m^2/s, $\gamma_m = 133362$ N/m^3, $D = 0{,}250$ m, $L = 150{,}000$ m, $\varepsilon = 0{,}00025$ m, $\alpha = 1$, $g = 9{,}806$ m/s^2.

Determinare la portata Q transitante. **Tracciare** la *L.C.T.* e la *L.P.*.

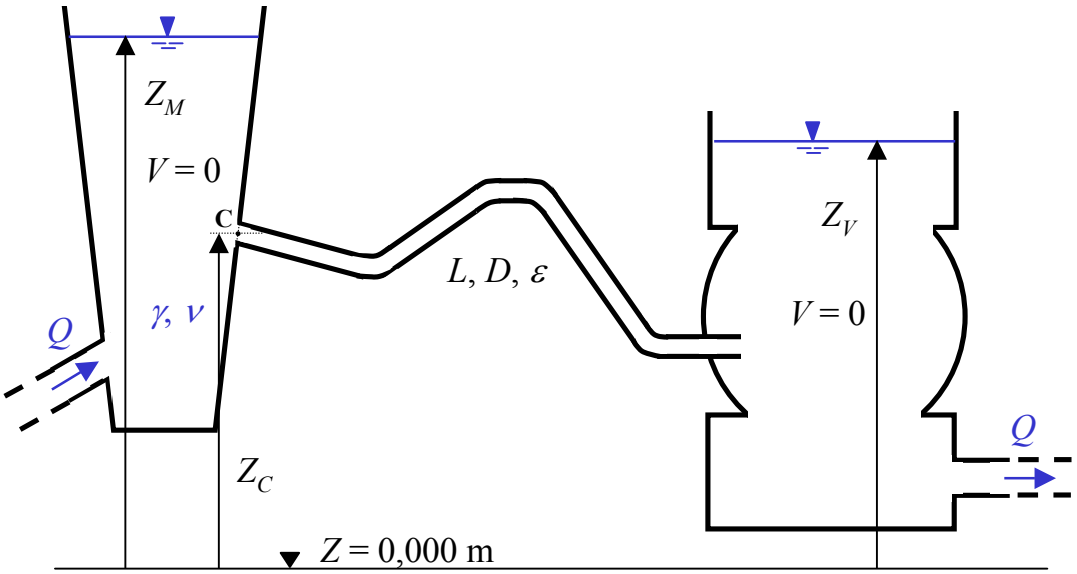


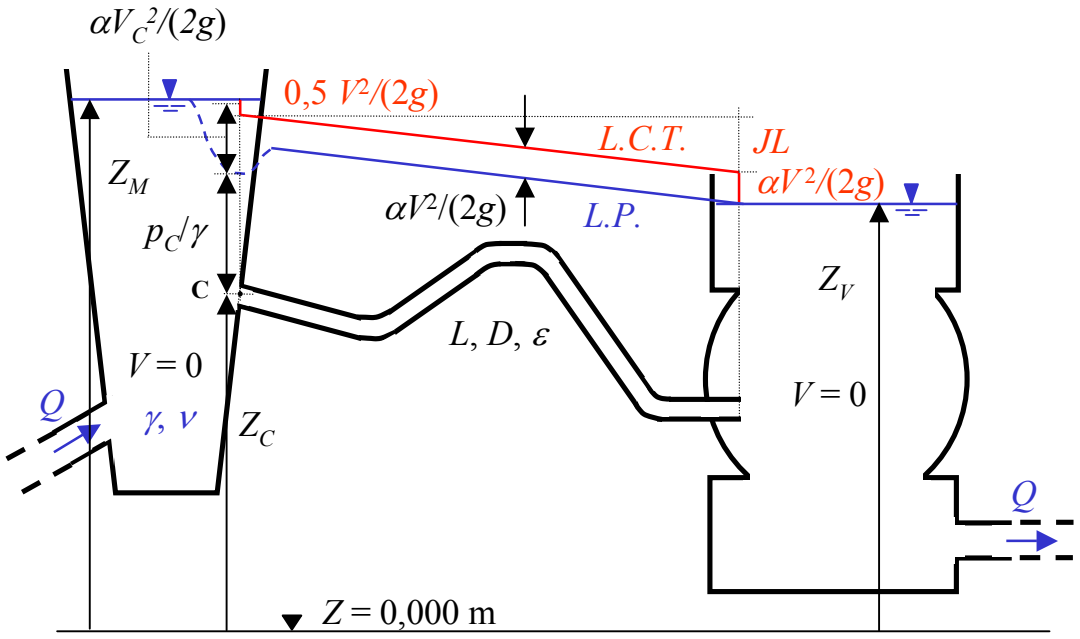
($Q = \pi D^2/4 \ [2 g D J/\lambda]^{1/2} = 0{,}131$ m^3/s)

Esercizio 45

Noti: $Z_M = 50{,}000$ m, $Z_V = 20{,}000$ m, $Z_C = 35{,}000$ m, $L = 100{,}000$ m, $D = 0{,}100$ m, $\varepsilon = 1{,}0 \cdot 10^{-4}$ m, $\gamma = 9806$ N/m^3, $\nu = 1{,}0 \cdot 10^{-6}$ m^2/s, $\alpha = 1$, $g = 9{,}806$ m/s^2.

Determinare la portata circolante Q e verificare la pressione all'imbocco **Tracciare** la *L.C.T.* e la *L.P.*.





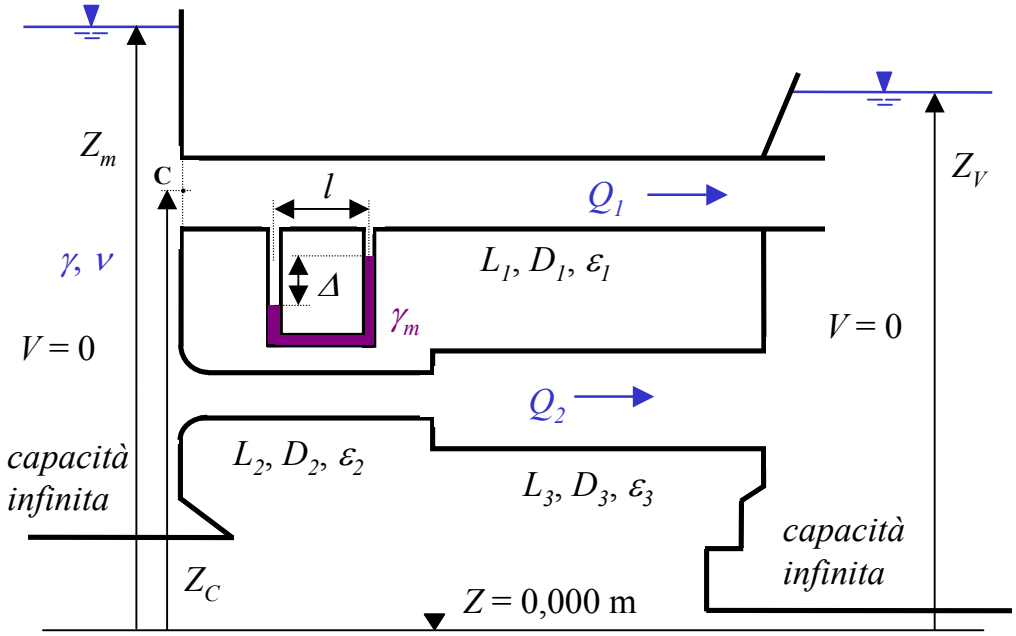
$$Q^{(IV)} = A \left\{[2\, g\, (Z_M - Z_V)]/[0{,}5 + \lambda^{(III)}\, L/D + 1]\right\}^{1/2} = 0{,}0409 \text{ m}^3/\text{s}$$

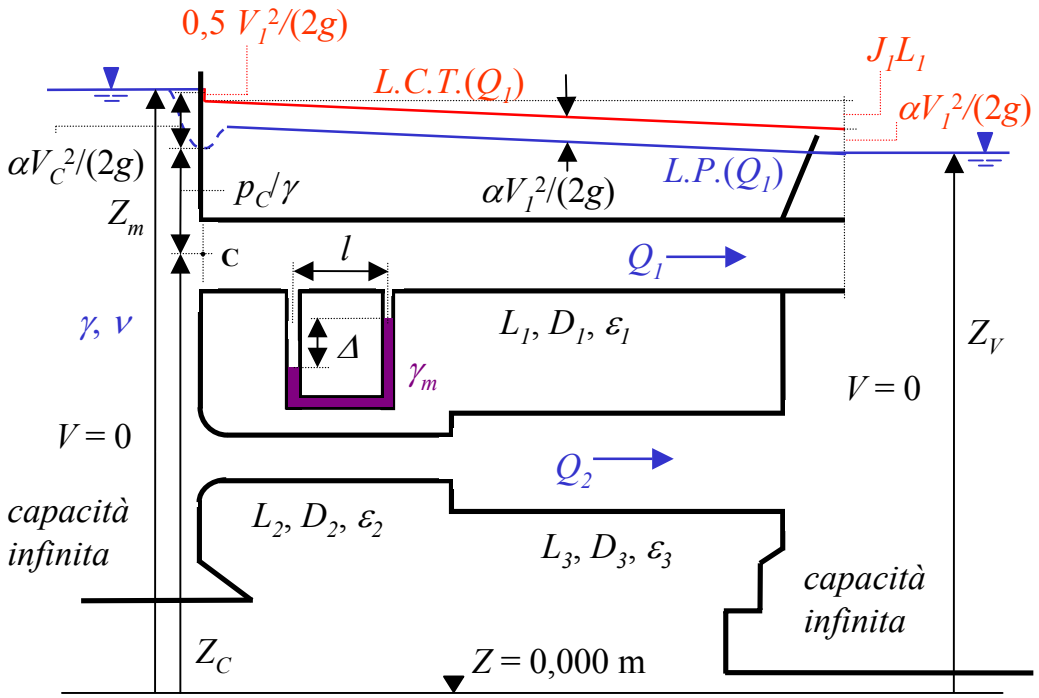
$$p_C = \gamma \{Z_M - [Z_C + \alpha V_C^2/(2\, g) + 0{,}1\, V^2/(2\, g)]\} = 108811 \text{ Pa}$$

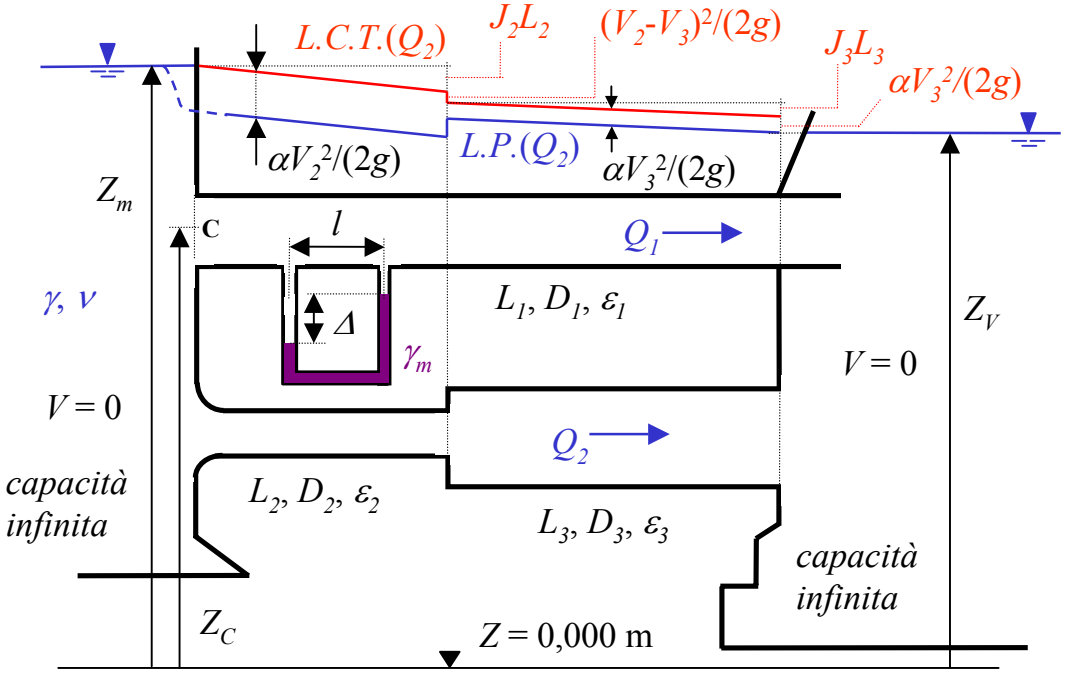
Esercizio 46

Noti: $Z_m = 50{,}000$ m, $Z_C = 40{,}000$ m, $L_1 = 300{,}000$ m, $L_2 = 150{,}000$ m, $L_3 = 150{,}000$ m, $D_1 = 0{,}500$ m, $D_2 = 0{,}300$ m, $D_3 = 0{,}600$ m, $\varepsilon_1 = 0{,}005$ m, $\varepsilon_2 = 0{,}009$ m, $\varepsilon_3 = 0{,}009$ m, $\gamma = 9806$ N/m^3, $\nu = 1{,}0 \cdot 10^{-6}$ m^2/s, $\gamma_m = 133362$ N/m^3, $\Delta = 0{,}300$ m, $l = 30{,}000$ m, $C_C = 0{,}61$, $g = 9{,}806$ m/s^2, $\alpha = 1$.

Determinare le portate circolanti Q_1 e Q_2 ed il livello Z_V del serbatoio di valle. **Verificare** il valore della pressione all'imbocco. **Tracciare** le *L.C.T.* e le *L.P.*.







$Q_1 = A_1 [2\,g\,D_1\,J_1/\lambda_1]^{1/2} = 1{,}121$ m^3/s

$Z_V = Z_M - [0{,}5\,Q_1^2/(2\,g\,A_1^2) + J_1\,L_1 + Q_1^2/(2\,g\,A_1^2)] = 9{,}706$ m

$p_C/\gamma = Z_M - [Z_C + \alpha V_C^2/(2\,g) + 0{,}1\,V_1^2/(2\,g)] = 5{,}365$ m

$Q_2 = \{(Z_M - Z_V)/[(\lambda_2\,L_2)/(2\,g\,D_2\,A_2^2) + 1/(2\,g)\,(1/A_2 - 1/A_3)^2 + (\lambda_3\,L_3)/(2\,g\,D_3\,A_3^2) + 1/(2\,g\,A_3^2)]\}^{1/2} =$

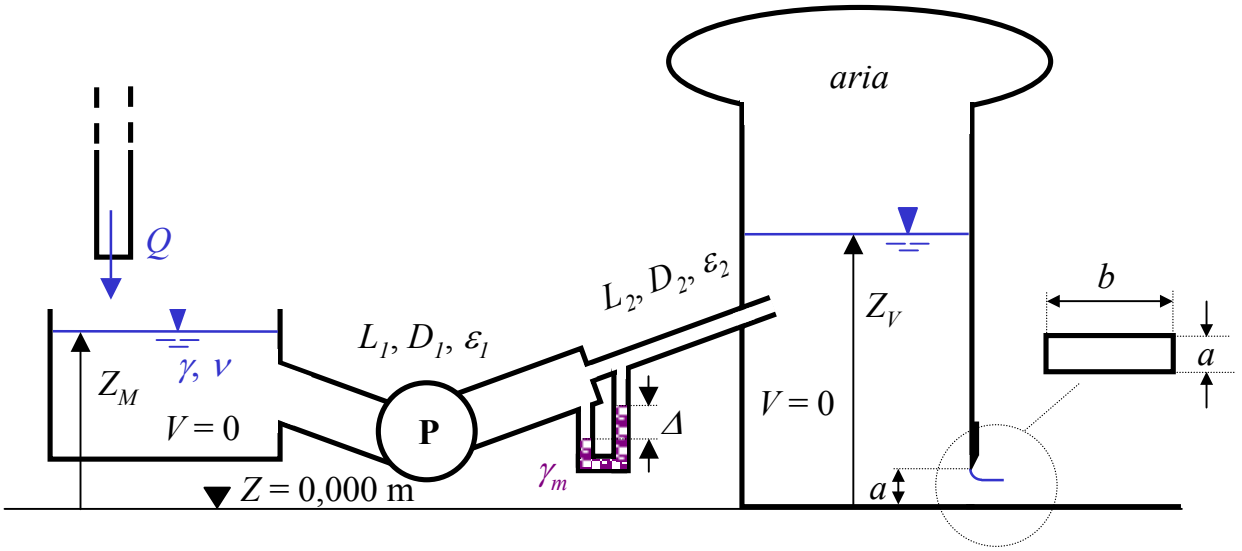
$= 0{,}364$ m^3/s

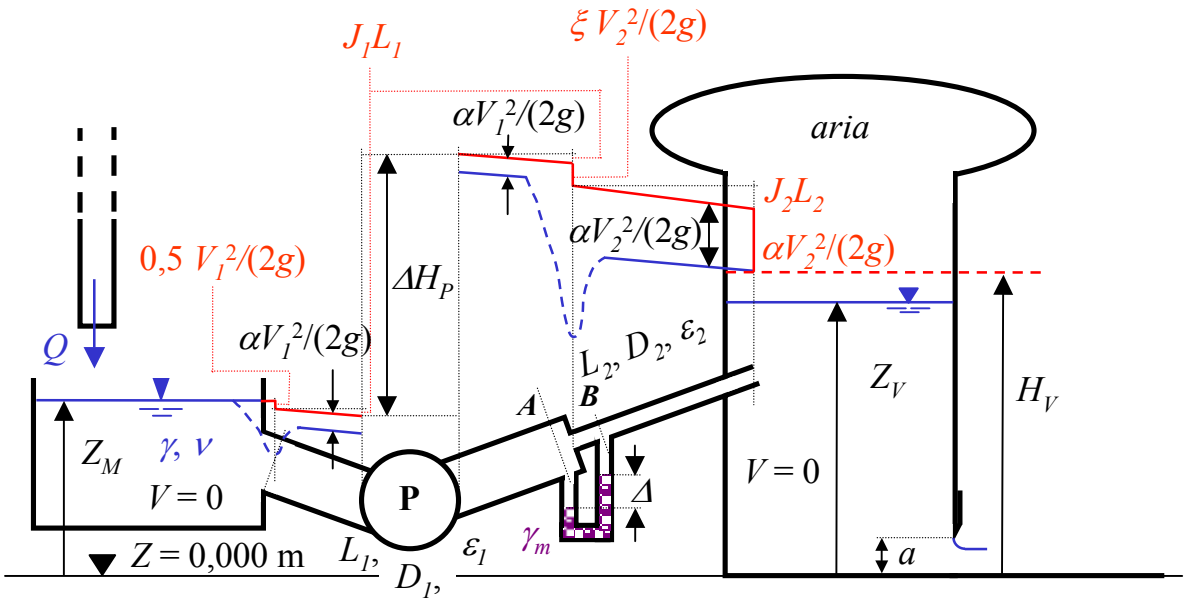
Esercizio 47

Noti: $Z_M = 3{,}000$ m, $Z_V = 6{,}500$ m, $L_1 = 55{,}000$ m, $L_2 = 40{,}000$ m, $a = 0{,}040$ m, $b = 0{,}750$ m, $\alpha = 1$, $D_1 = 0{,}300$ m, $D_2 = 0{,}200$ m, $\xi_{brusco\ restr.} = 0{,}32$, $\eta_P = 0{,}75$, $C_C = 0{,}61$, $\mu = 0{,}6$, $\varepsilon_1 = \varepsilon_2 = 6{,}0 \cdot 10^{-4}$ m, $\Delta = 0{,}300$ m, $\gamma = 7845$ N/m^3, $\nu = 2{,}3 \cdot 10^{-6}$ m^2/s, $\gamma_m = 133362$ N/m^3, $g = 9,806$ m/s^2 .

Determinare la portata circolante Q, il carico H_V del serbatoio di valle, la pressione dell'aria e la potenza W_P assorbita dalla pompa.

Tracciare la *L.C.T.* e la *L.P.*.





$Q = \{[2\,g\,\Delta\,(\gamma_m - \gamma)/\gamma]/[(1 + \xi)/A_2^2 - 1/A_1^2]\}^{1/2} = 0{,}288$ m^3/s $\quad H_V = C_C\,a + Q^2/[(\mu\,a\,b)^2\,2\,g] = 13{,}050$ m

$\Delta H_P = H_V + 0{,}5\,Q^2/(2\,g\,A_1^2) + (\lambda_1/D_1)\,Q^2/(2\,g\,A_1^2)\,L_1 + (\lambda_2/D_2)\,Q^2/(2\,g\,A_2^2)\,L_2 + \xi\,Q^2/(2\,g\,A_2^2) +$

$W_P = \gamma\,Q\,\Delta H_P/\eta_P = 127293$ W $\quad + \alpha Q^2/(2\,g\,A_2^2) - Z_M = 42{,}299$ m

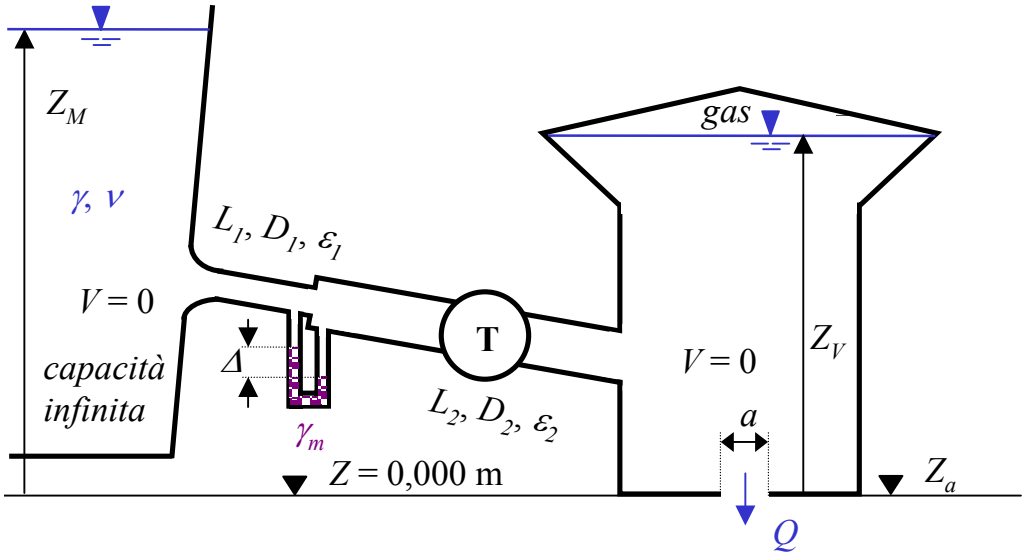
$p_{aria} = \gamma\,[H_V - Z_V] = 51388$ Pa

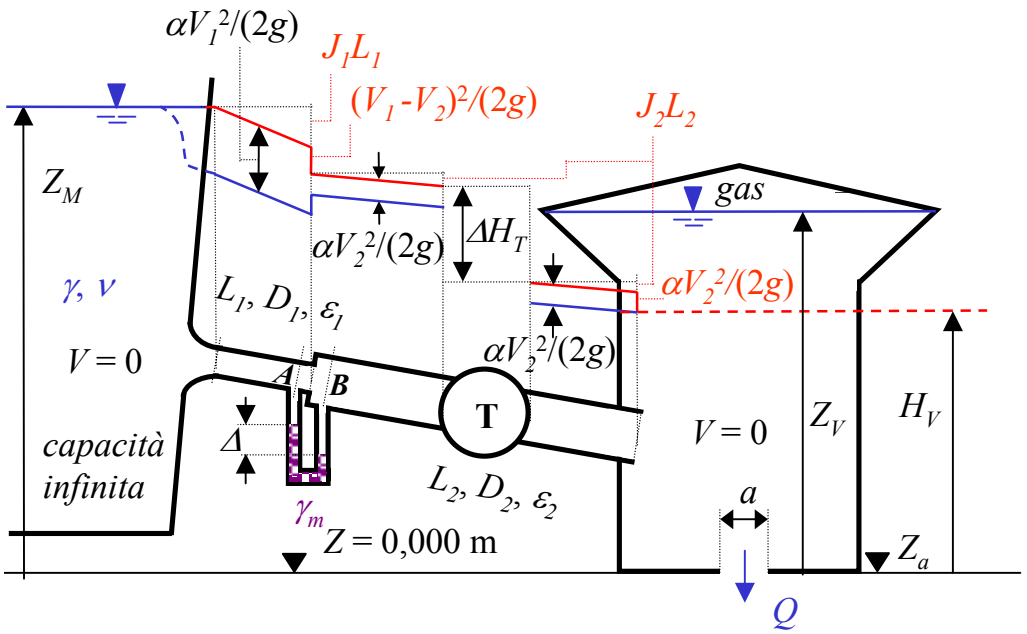
Esercizio 48

Noti: $Z_M = 25{,}000$ m, $Z_V = 9{,}000$ m, $Z_a = 0{,}000$ m, $L_1 = 30{,}000$ m, $L_2 = 60{,}000$ m, $a = 0{,}150$ m (luce circolare), $D_1 = 0{,}200$ m, $D_2 = 0{,}400$ m, $\eta_T = 0{,}8$, $\mu = 0{,}6$, $\varepsilon_1 = \varepsilon_2 = 2{,}0 \cdot 10^{-4}$ m, $\alpha = 1$, $\Delta = 0{,}030$ m, $\gamma = 6668$ N/m^3, $\nu = 4{,}4 \cdot 10^{-7}$ m^2/s, $\gamma_m = 133362$ N/m^3, $g = 9{,}806$ m/s^2.

Determinare la portata circolante Q, il carico H_V del serbatoio di valle, la pressione del gas e la potenza W_T ritraibile dalla turbina.

Tracciare la *L.C.T.* e la *L.P.*.





$Q = \{[2\,g\,\Delta\,(\gamma_m - \gamma)/\gamma]/[1/A_1^2 - 1/A_2^2 - (1/A_1 - 1/A_2)^2]\}^{1/2} = 0{,}120$ m^3/s

$H_V = Q^2/[\mu^2\,(\pi\,a^2/4)^2\,2\,g] = 6{,}551$ m

$\Delta H_T = Z_M - (\lambda_1/D_1)\,Q^2/(2\,g\,A_1^2)\,L_1 - Q^2/(2\,g)\,(1/A_1 - 1/A_2)^2 - (\lambda_2/D_2)\,Q^2/(2\,g\,A_2^2)\,L_2 -$
$- \alpha Q^2/(2\,g\,A_2^2) - H_V = 6{,}551$ m

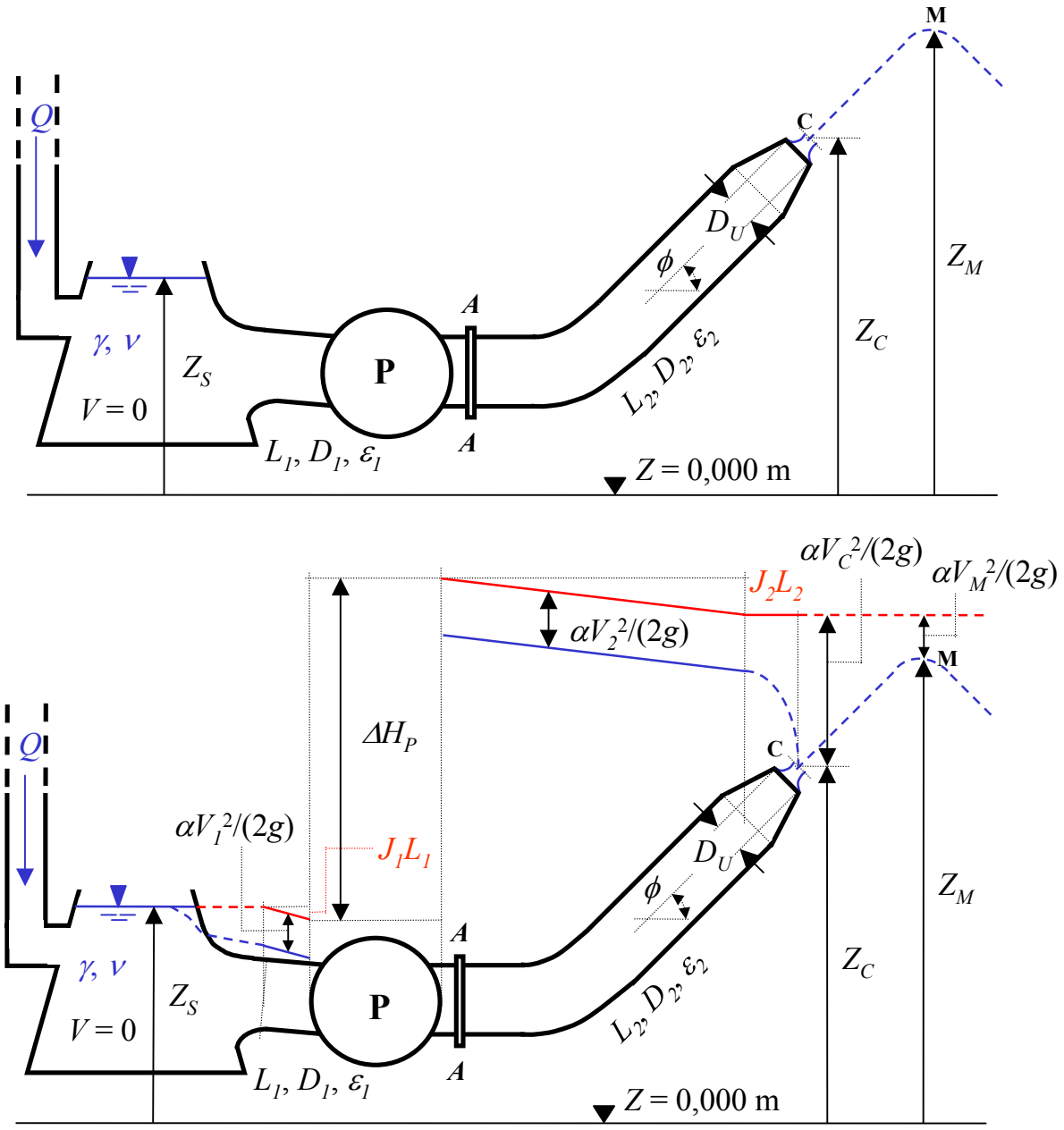
$W_T = \eta_T\,\gamma\,Q\,\Delta H_T = 4200$ W

$p_{gas} = \gamma\,[H_V - Z_V] = -16330$ Pa

Esercizio 49

Noti: $Z_S = 9{,}000$ m, $Z_C = 11{,}500$ m, $Z_M = 13{,}000$ m, $\alpha = 1$, $L_1 = 11{,}000$ m, $D_1 = 0{,}250$ m, $\varepsilon_1 = 1{,}0 \cdot 10^{-3}$ m, $L_2 = 20{,}000$ m, $D_2 = 0{,}200$ m, $\varepsilon_2 = 5{,}0 \cdot 10^{-4}$ m, $D_U = 0{,}150$ m, $C_C = 0{,}8$, $\gamma = 7845$ N/m^3, $\nu = 2{,}3 \cdot 10^{-6}$ m^2/s, $\eta_P = 0{,}78$, $\phi = 0{,}78$, $g = 9{,}806$ m/s^2 – si consideri trascurabile la distanza tra la pompa e la flangia di traccia AA ed ideale il comportamento del liquido nell'atmosfera.

Determinare la portata Q transitante, la potenza W_P assorbita dalla pompa. **Tracciare** la *L.C.T.* e la *L.P.*.



$Q = C_C A_U [2\, g\, (Z_M - Z_C)/(sen\phi)^2]^{1/2} = 0{,}108$ m^3/s

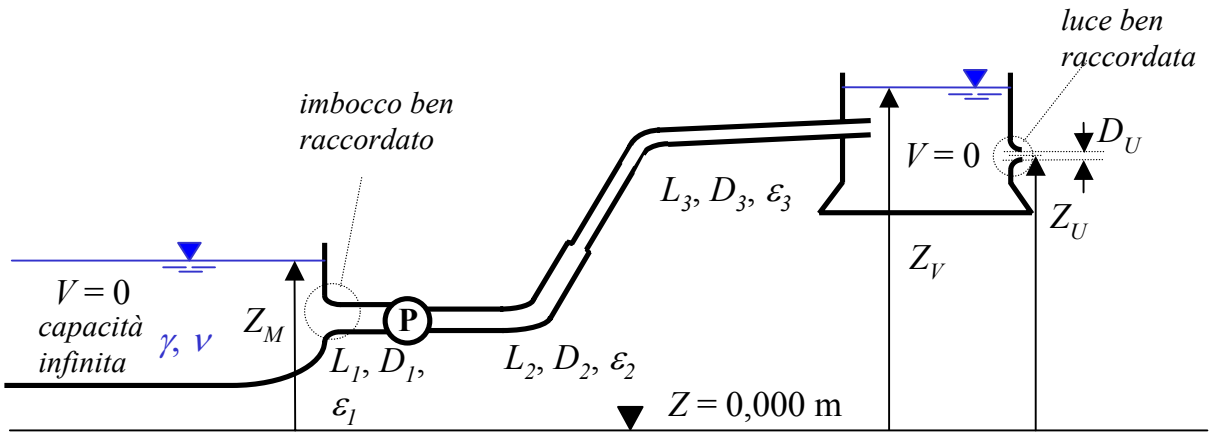
$\Delta H_P = Z_C + \alpha V_C^2/(2\, g) + J_2\, L_2 - Z_S + J_1\, L_1 = 7{,}358$ m

$W_P = \gamma\, Q\, \Delta H_P / \eta_P = 8024$ W

Esercizio 50 (Tema d'esame del 15 Luglio 2002)

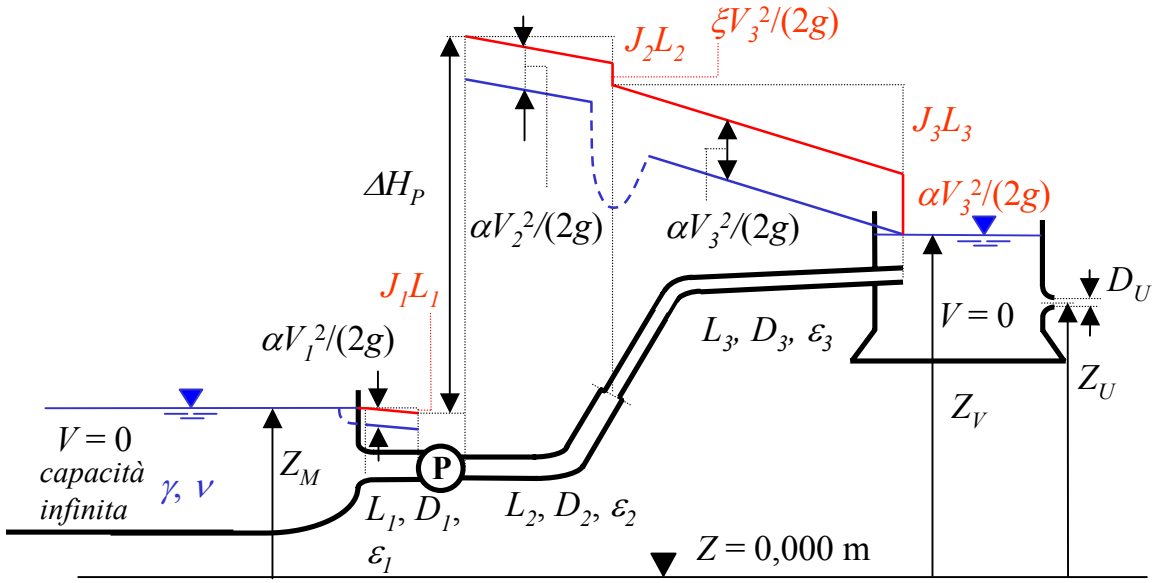
Noti: $Z_V = 35{,}000$ m, $Z_U = 31{,}000$ m, $W_P = (75000+C\cdot100)$ W, $D_1 = 0{,}400$ m, $D_2 = 0{,}350$ m, $D_3 = 0{,}300$ m, $L_1 = 8{,}000$ m, $L_2 = (6{,}000+N/20)$ m, $L_3 = 9{,}000$ m, $\varepsilon_1 = \varepsilon_2 = \varepsilon_3 = 9\cdot10^{-4}$ m, $D_U = 0{,}200$ m, $Cv = 0{,}98$, $\alpha = 1$, $\eta_P = 0{,}75$, $\gamma = 9806$ N/m^3, $\nu = 1\cdot10^{-6}$ m^2/s, $\xi_{brusco\ restr.} = 0{,}3$, $g = 9,806$ m/s^2.

Determinare la portata Q circolante nell'impianto, la prevalenza ΔH_P superata dalla pompa, la quota Z_M del serbatoio di monte. **Tracciare** la *LCT* e la *LP*.



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

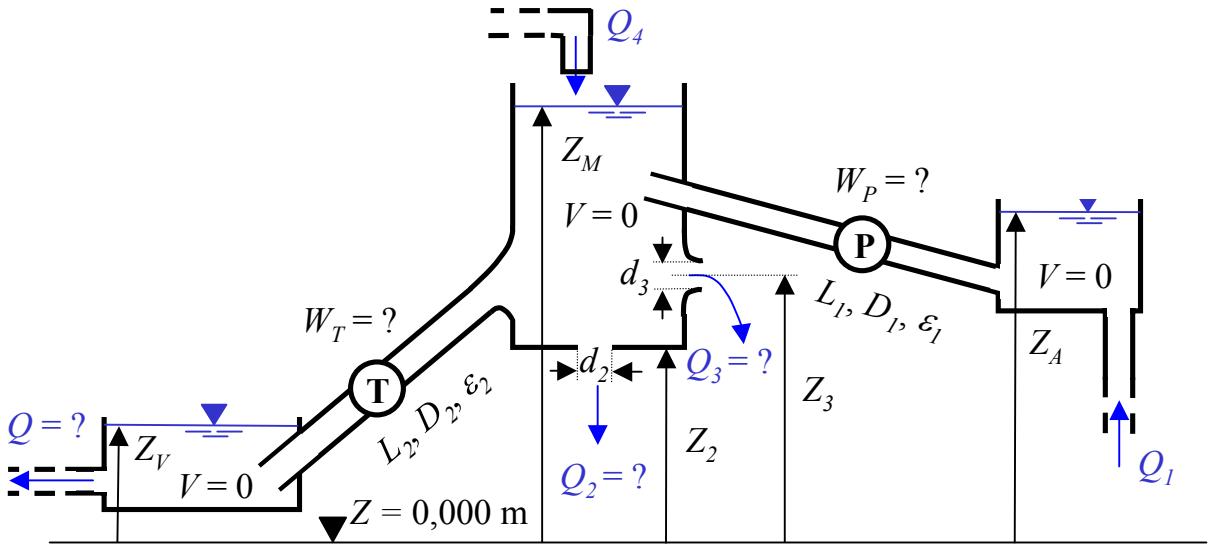
$N =$ prima lettera del nome = 26 $\quad$ $C =$ prima lettera del cognome = 26



$$Q = C_V A_U [2\,g\,(Z_V - Z_U]^{1/2} = 0{,}273 \text{ m}^3/\text{s} \qquad \Delta H_P = \eta_P W_P/(\gamma Q) = 21{,}765 \text{ m}$$

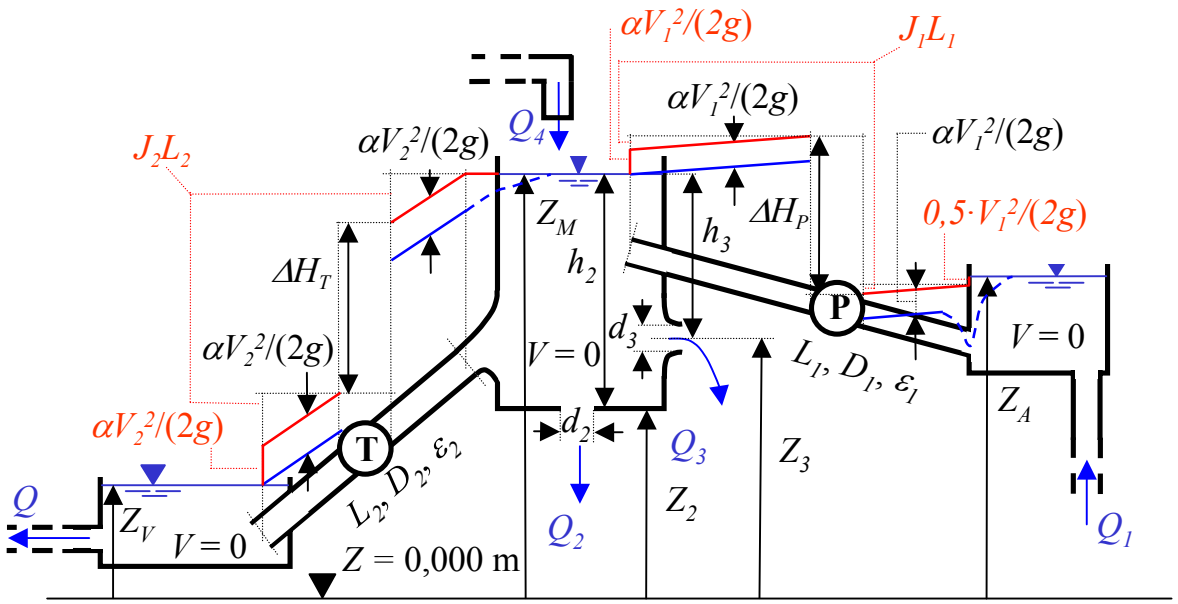
$$Z_M = (\lambda_1/D_1)\,Q^2/(2\,g\,A_1^2)\,L_1 - \Delta H_P + (\lambda_2/D_2)\,Q^2/(2\,g\,A_2^2)\,L_2 + \xi\,Q^2/(2\,g\,A_3^2) +$$
$$+ (\lambda_3/D_3)\,Q^2/(2\,g\,A_3^2)\,L_2 + \alpha Q^2/(2\,g\,A_3^2) + Z_V = 15{,}151 \text{ m}$$

Esercizio 51 (Tema d'esame del 13 Luglio 2004)
Noti: Z_A = 450,000 m, Z_M = 500,000 m, Z_V = 200,000 m, Z_2 = 490,000 m, Z_3 = 494,000 m, moto permanente, Q_1 = 0,500 m^3/s, Q_4 = 0,200 m^3/s, L_1 = (200,000 + N/10) m, L_2 = (500,000 + C/10) m, D_1 = 0,400 m, D_2 = 0,500 m, $d_2 = d_3$ = 0,100 m, ε_1 = 0,00 m, ε_2 = 2,0·10^{-3} m, α = 1, γ = 9806 N/m^3, ν = 1,0·10^{-6} m^2/s (viscosità cinematica), g = 9,806 m/s^2, C_v = 0,98, μ = 0,6, η_T = 0,8, η_P = 0,7.
Determinare la potenza W_P assorbita dalla pompa, le portate effluenti Q_2 *e* Q_3, quella circolante Q e la potenza W_T ottenibile dalla turbina. **Tracciare** *L.P.* e *L.C.T.*.
Si descrivano in modo esaustivo le grandezze in gioco ed i passaggi occorrenti alla soluzione.



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

N = prima lettera del nome = 1 C = prima lettera del cognome = 1

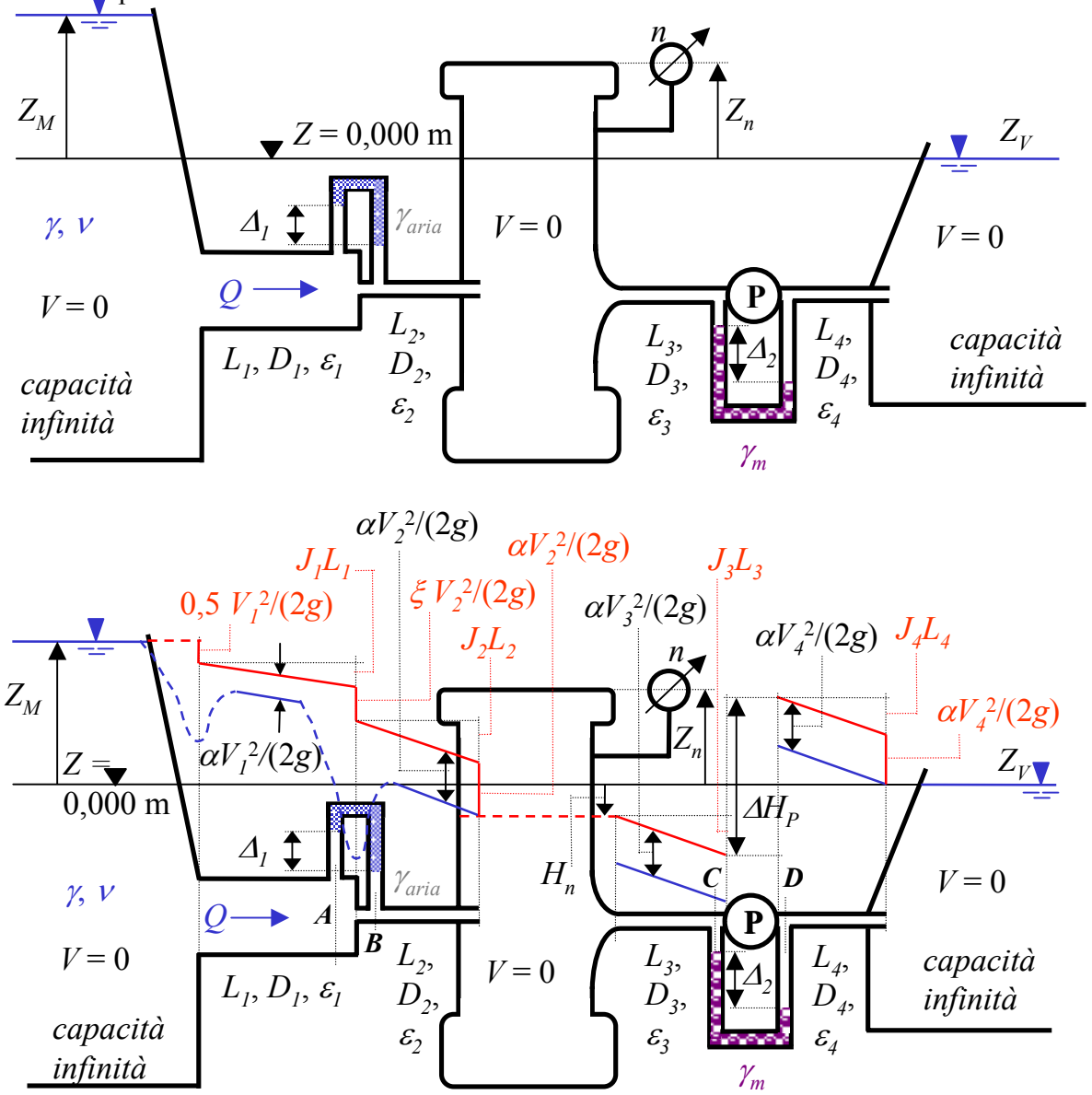


(W_P = 389153 W Q_2 = 0,066 m^3/s Q_2 = 0,083 m^3/s Q_2 = 0,551 m^3/s W_T = 1244567 W)

Esercizio 52

Noti: $Z_n = 6{,}000$ m, $Z_V = 0{,}000$ m, $\alpha = 1$, $L_1 = 15{,}000$ m, $L_2 = L_3 = 12{,}000$ m, $L_4 = 13{,}000$ m, $D_1 = 0{,}500$ m, $D_2 = D_3 = D_4 = 0{,}300$ m, $\varepsilon_1 = \varepsilon_2 = \varepsilon_3 = \varepsilon_4 = 1{,}0 \cdot 10^{-3}$ m, $\xi_{(brusco\ restr.)} = 0{,}3$, $\eta_P = 0{,}75$, $\gamma_m = 133362$ N/m^3, $\gamma = 7845$ N/m^3, $\nu = 2{,}3 \cdot 10^{-6}$ m^2/s, $\Delta_1 = 0{,}900$ m, $\Delta_2 = 0$, 200 m, $g = 9$, 806 m/s^2.

Determinare la portata circolante Q, la potenza W_P assorbita dalla pompa, il livello Z_M del serbatoio di monte e la pressione n rilevata dal manometro metallico. Fare attenzione, l'esercizio può essere risolto anche senza adoperare il manometro differenziale di valle. **Tracciare** la *L.C.T.* e la *L.P.*.



$Q = \{[2\,g\,\Delta_1/[(1 + \xi)/A_2^2 - 1/A_1^2]\}^{1/2} = 0{,}275$ m^3/s $\qquad \Delta H_P = \Delta_2\,(\gamma_m - \gamma)/\gamma = 3{,}200$ m

$W_P = \gamma\,Q\,\Delta H_P/\eta_P = 9188$ W

$H_n = (\lambda_3/D_3)\,Q^2/(2\,g\,A_3^2)\,L_3 - \Delta H_P + (\lambda_4/D_4)\,Q^2/(2\,g\,A_4^2)\,L_4 + \alpha Q^2/(2\,g\,A_4^2) + Z_V = -0{,}689$ m

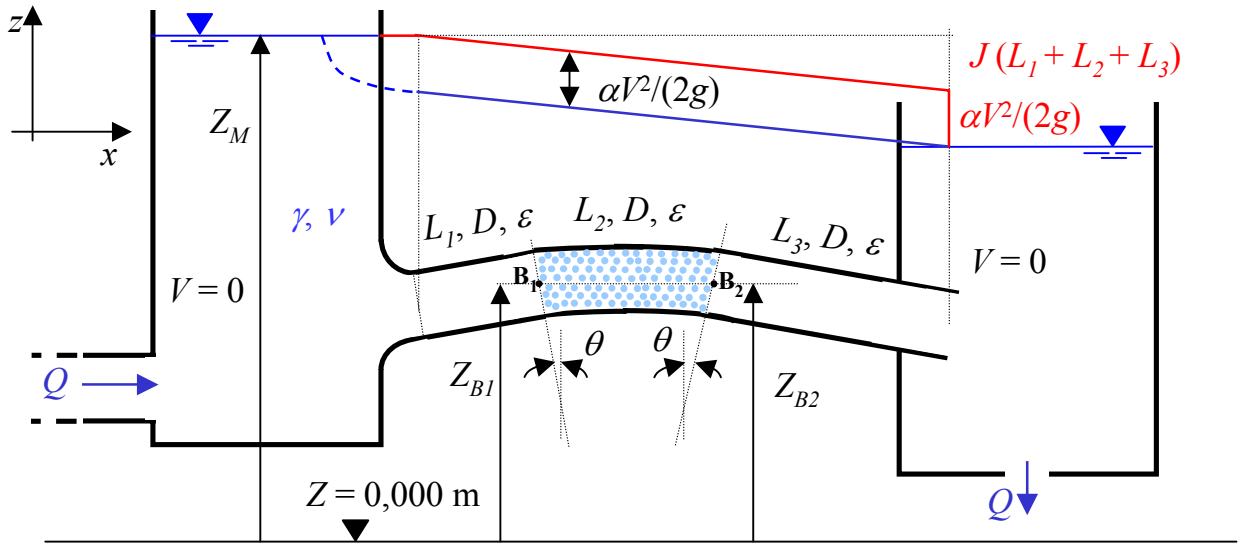
$n = \gamma\,[H_n - Z_n] = -52474$ Pa

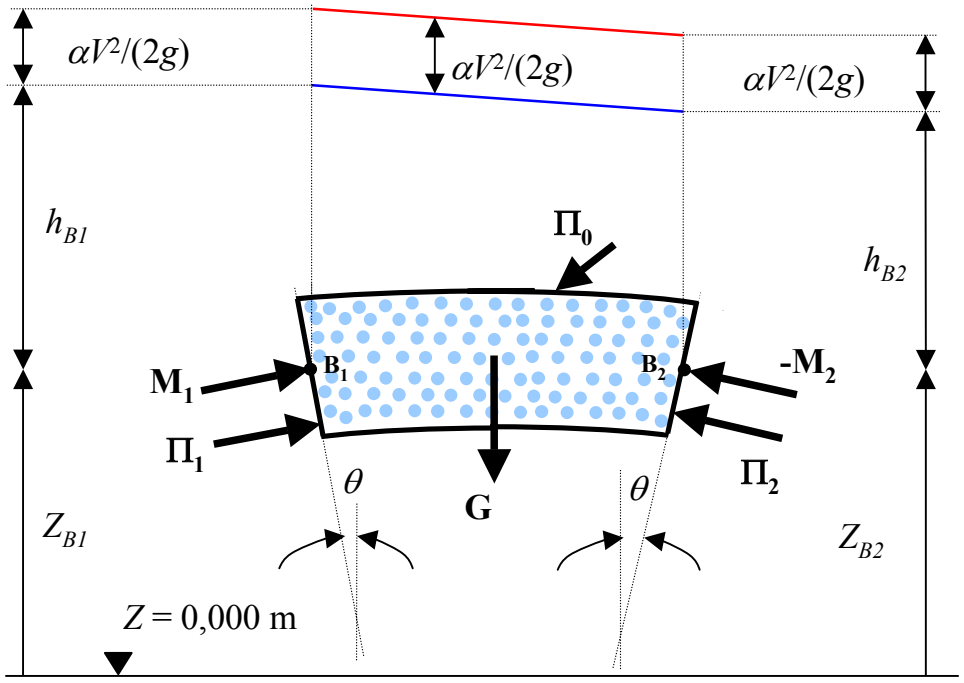
$Z_M = 0{,}5\,Q^2/(2\,g\,A_1^2) + (\lambda_1/D_1)\,Q^2/(2\,g\,A_1^2)\,L_1 + \xi\,Q^2/(2\,g\,A_2^2) + (\lambda_2/D_2)\,Q^2/(2\,g\,A_2^2)\,L_2 +$
$+ \alpha Q^2/(2\,g\,A_2^2) + H_n = 1{,}269$ m

Esercizio 53

Noti: $Z_M = 65{,}000$ m, $Z_{B1} = Z_{B2} = 20{,}000$ m, $Q = 0{,}250$ m^3/s, $L_1 = 10{,}000$ m, $L_2 = 12{,}000$ m, $L_3 = 15{,}000$ m, $D = 0{,}200$ m, $\varepsilon = 7{,}0 \cdot 10^{-4}$ m, $\gamma = 6668$ N/m^3, $g = 9{,}806$ m/s^2, $\nu = 4{,}4 \cdot 10^{-7}$ m^2/s, $\theta = 10°$, $\alpha = 1$, $\beta = 1$.

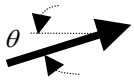
Determinare le componenti della spinta sulla superficie curva di lunghezza L_2 secondo l'assegnato sistema di riferimento.



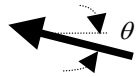


$$\mathbf{G} + \mathbf{\Pi_1} + \mathbf{\Pi_2} + \mathbf{\Pi_0} + \mathbf{M_1} - \mathbf{M_2} = 0 \qquad \mathbf{S} = -\mathbf{\Pi_0} = \mathbf{G} + \mathbf{\Pi_1} + \mathbf{\Pi_2} + \mathbf{M_1} - \mathbf{M_2}$$

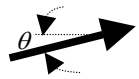
$G \cong \gamma A L_2$  applicato nel baricentro del volume di controllo

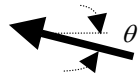
$\Pi_1 = \gamma h_{B1} A$  applicata nel centro di spinta della superficie di baricentro B_1, posto più in basso di quest'ultimo.

$h_{B1} = Z_M - J L_1 - \alpha V^2/(2\,g) - Z_{B1}$

$\Pi_2 = \gamma h_{B2} A$  applicata nel centro di spinta della superficie di baricentro B_2, posto più in basso di quest'ultimo.

$h_{B2} = Z_M - J (L_1 + L_2) - \alpha V^2/(2\,g) - Z_{B2}$

$M_1 = \beta \rho Q V$  applicato nel baricentro B_1

$M_2 = \beta \rho Q V$  applicato nel baricentro B_2

$S_x = (\Pi_1 + M_1 - \Pi_2 - M_2)\cos\theta = (\Pi_1 - \Pi_2)\cos\theta = \gamma A J L_2 \cos\theta =$ 290 N

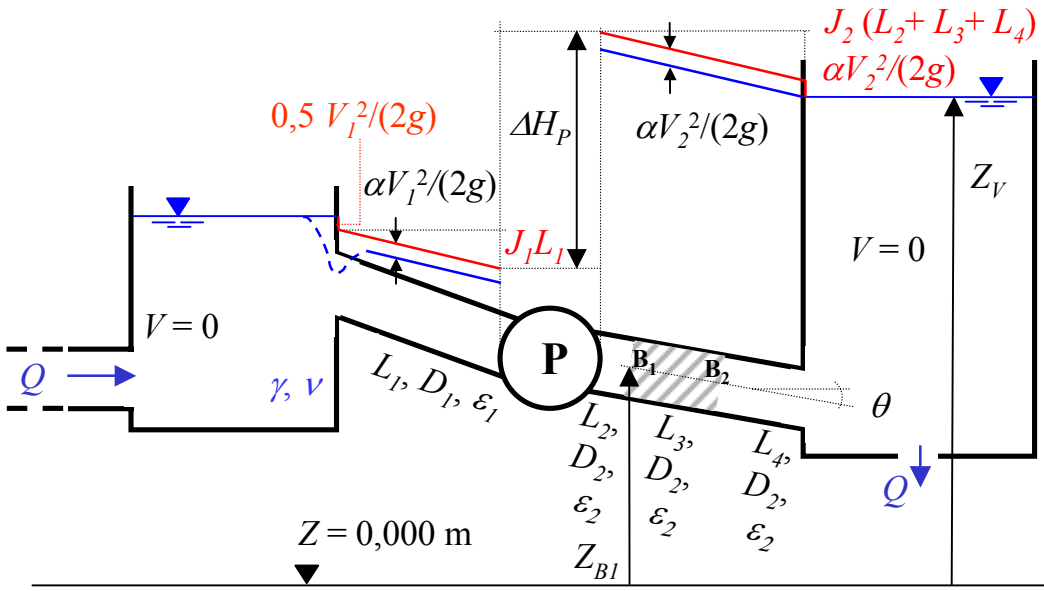
$S_z = (\Pi_1 + M_1 + \Pi_2 + M_2)\,sen\theta - G =$ 1678 N 

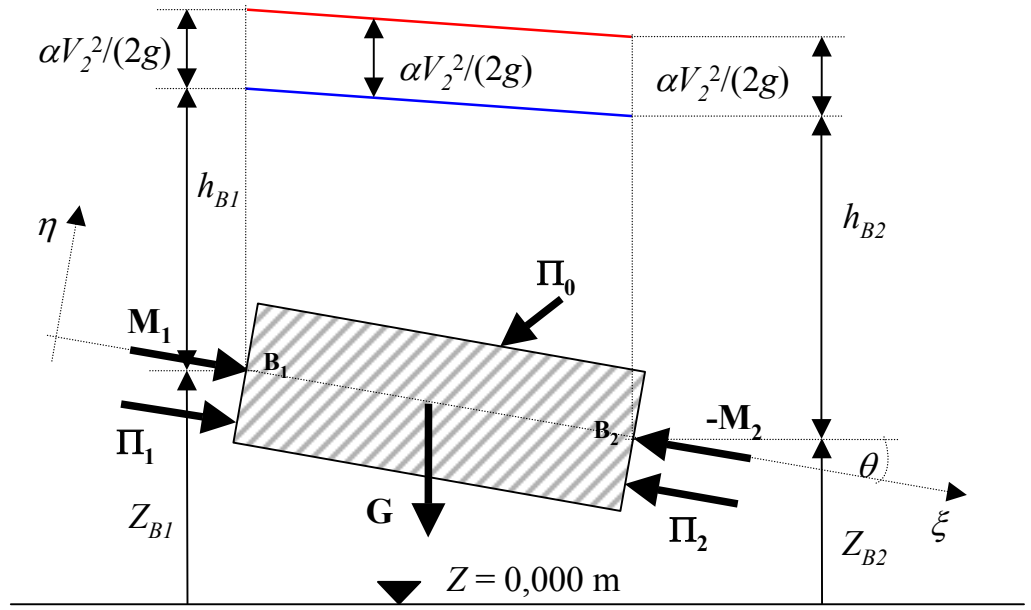
$S = [S_x^2 + S_z^2]^{1/2} =$ 1703 N

Esercizio 54

Noti: $Z_V = 45{,}000$ m, $Z_{B1} = 20{,}000$ m, $Q = 0{,}300$ m^3/s, $L_1 = 10{,}000$ m, $L_2 = 12{,}000$ m, $L_3 = 15{,}000$ m, $L_4 = 15{,}000$ m, $D_1 = 0{,}350$ m, $D_2 = 0{,}300$ m, $\varepsilon_1 = 1{,}0\cdot10^{-3}$ m, $\varepsilon_2 = 5{,}0\cdot10^{-4}$ m, $\gamma = 7845$ N/m^3, $\nu = 2{,}3\cdot10^{-6}$ m^2/s, $g = 9{,}806$ m/s^2, $\theta = 20°$, $\alpha = 1$, $\beta = 1$.

Determinare le componenti della spinta sulla superficie curva di lunghezza L_3 secondo un "conveniente" sistema di riferimento.





$$\mathbf{G} + \mathbf{\Pi_1} + \mathbf{\Pi_2} + \mathbf{\Pi_0} + \mathbf{M_1} - \mathbf{M_2} = 0 \qquad \mathbf{S} = -\mathbf{\Pi_0} = \mathbf{G} + \mathbf{\Pi_1} + \mathbf{\Pi_2} + \mathbf{M_1} - \mathbf{M_2}$$

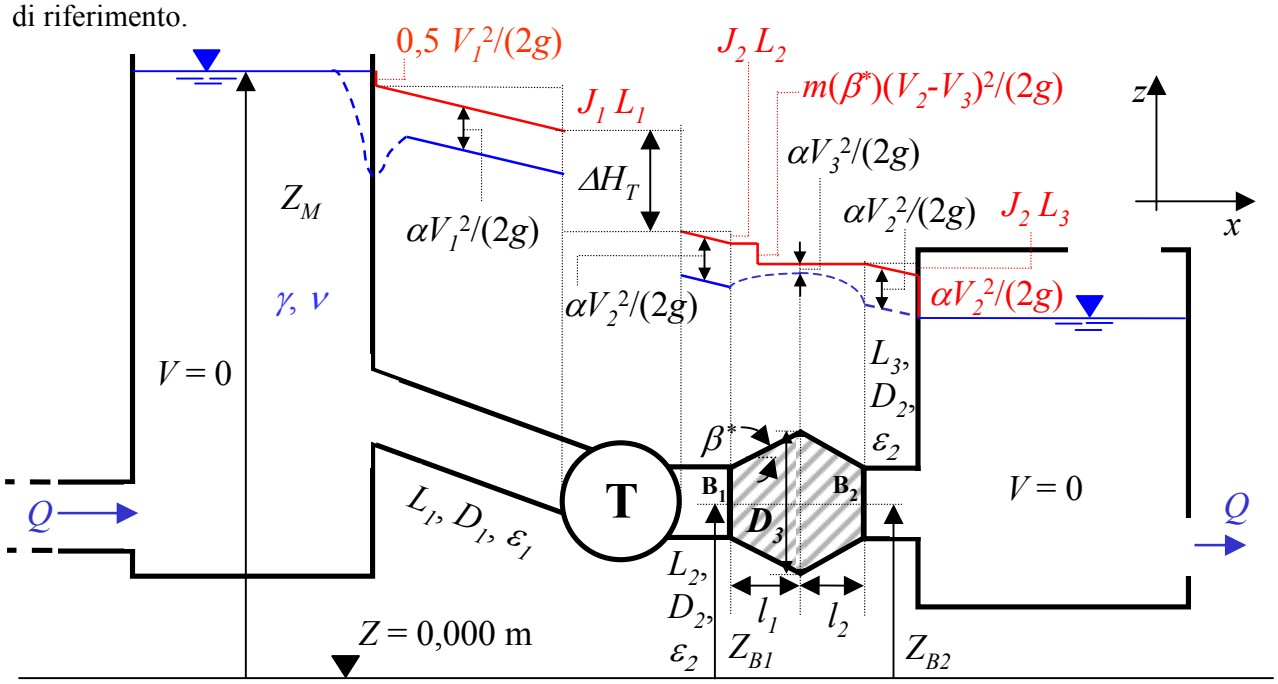
$$S_\xi = (\Pi_1 + M_1 - \Pi_2 - M_2) + G\,sen\theta = (\Pi_1 - \Pi_2) + G\,sen\theta = 270 \text{ N}$$

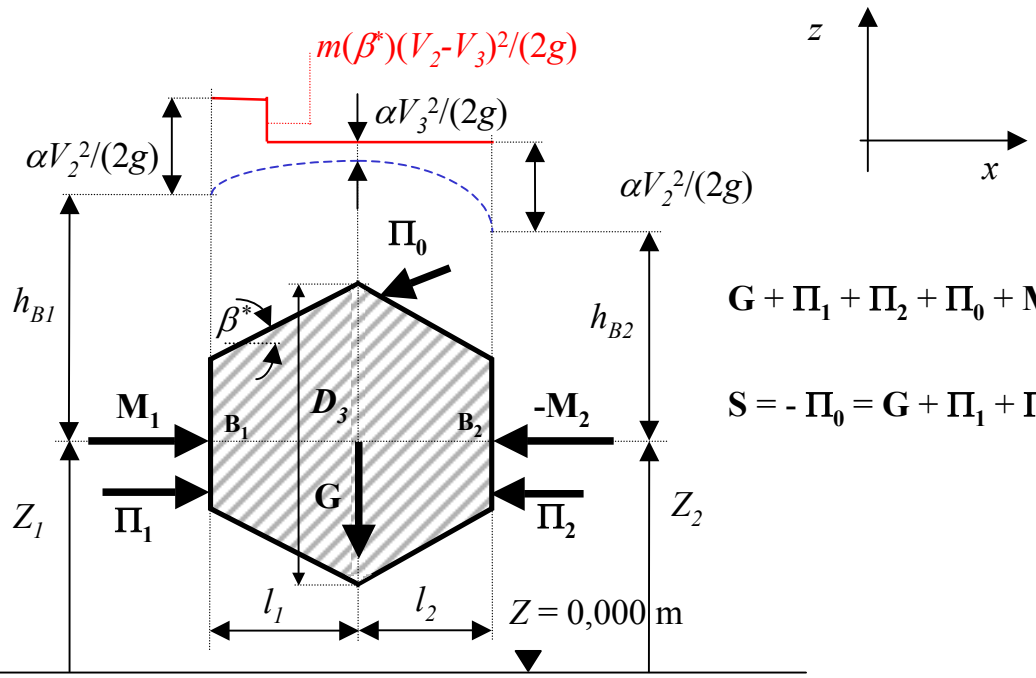
$$S_\eta = -\,G\,\cos\theta = -3648 \text{ N} \qquad S = [S_\xi^{\,2} + S_\eta^{\,2}]^{1/2} = 3658 \text{ N}$$

Esercizio 55

Noti: $Z_M = 100{,}000$ m, $Z_{B1} = Z_{B2} = 15{,}000$ m, $W_T = 100000$ W, $Q = 0{,}300$ m^3/s, $m(\beta^*) = 0{,}7$, $\alpha = 1$, $\beta = 1$, $L_1 = 100{,}000$ m, $D_1 = 0{,}300$ m, $\varepsilon_1 = 5{,}0\cdot10^{-4}$ m, $L_2 = 10{,}000$ m, $D_2 = 0{,}500$ m, $\varepsilon_2 = 9{,}0\cdot10^{-4}$ m, $D_3 = 0{,}700$ m, $l_1 = l_2 = 0{,}951$ m, $\gamma = 9806$ N/m^3, $\nu = 1{,}0\cdot10^{-6}$ m^2/s, $g = 9{,}806$ m/s^2, $\eta_T = 0{,}8$.

Determinare le componenti della spinta sul tronco divergente+convergente secondo l'assegnato sistema. di riferimento.





$$\mathbf{G} + \mathbf{\Pi_1} + \mathbf{\Pi_2} + \mathbf{\Pi_0} + \mathbf{M_1} - \mathbf{M_2} = \mathbf{0}$$

$$\mathbf{S} = -\mathbf{\Pi_0} = \mathbf{G} + \mathbf{\Pi_1} + \mathbf{\Pi_2} + \mathbf{M_1} - \mathbf{M_2}$$

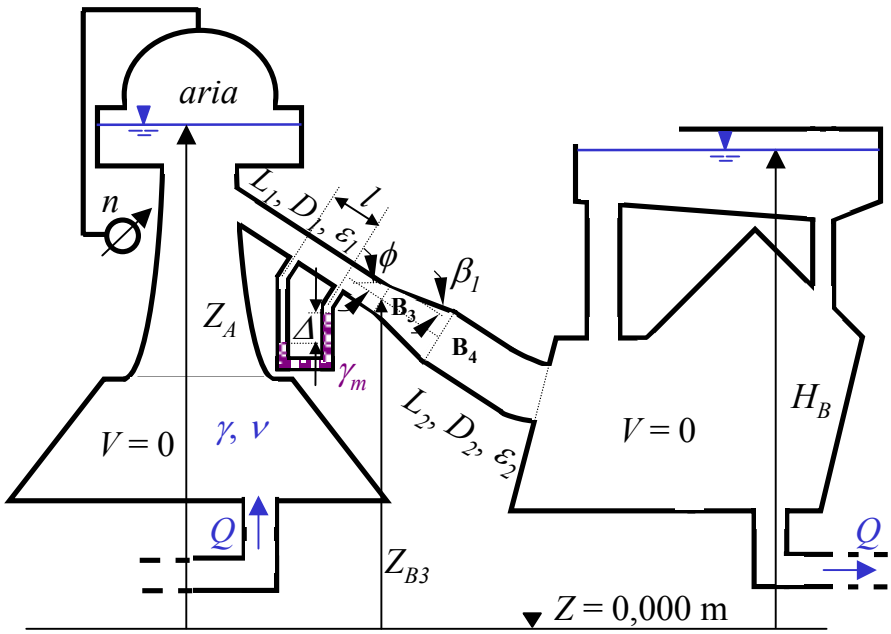
$S_x = (\Pi_1 + M_1 - \Pi_2 - M_2) = (\Pi_1 - \Pi_2) = \gamma A_2\, m(\beta^*)\,(V_2 - V_3)^2/(2\,g) = 38$ N →

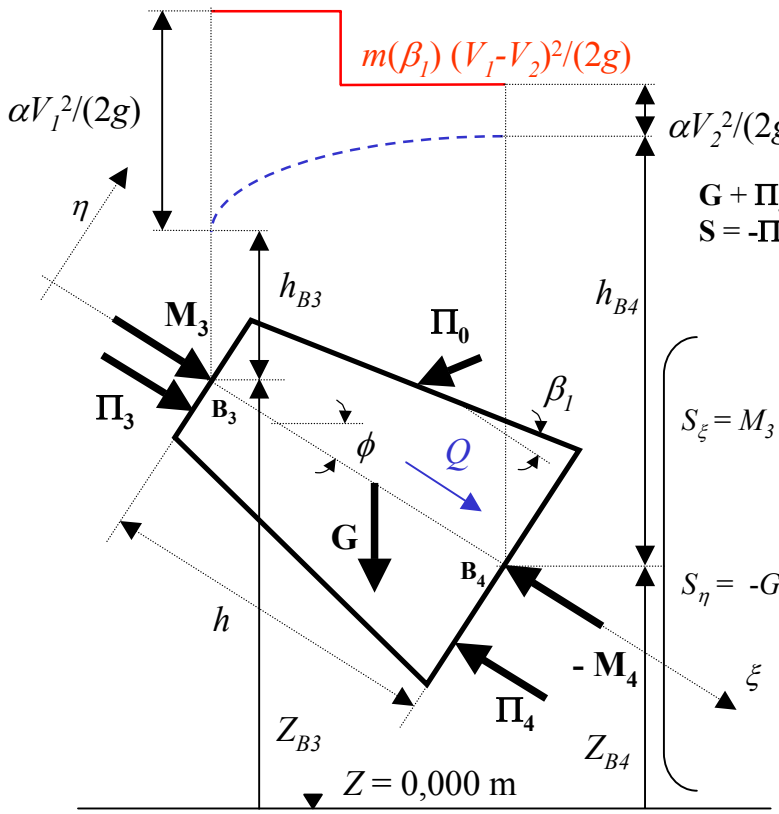
$S_z = -G = \gamma\, 1/3\, \pi\,(l_1 + l_2)[(D_2/2)^2 + (D_3/2)^2 + (D_2/2\, D_3/2)] = -5325$ N ↓

$S = [S_x^2 + S_z^2]^{1/2} = 5325$ N

Esercizio 56

Noti: Z_A = 25,000 m, Z_{B3}= 16,000 m, n = 0,6 bar, α = 1, L_1 = 12,000 m, L_2 = 9,000 m, l = 7,000 m, D_1 = 0,200 m, D_2 = 0,400 m, ε_1= 6,0·10^{-4} m, ε_2= 7,0·10^{-4} m, Δ = 0,150 m β_1 = 30°, ϕ = 33°, β = 1, $m(\beta_1)$ = 0,38, γ = 8139 N/m^3, ν = 1,2·10^{-5} m^2/s, ρ = 830 kg/m^3, γ_m= 133362 N/m^3, g = 9,806 m/s^2.
Determinare la portata circolante Q, il livello H_B del serbatoio di valle e la spinta **S** sul divergente troncoconico. **Tracciare** la *L.C.T.* e la *L.P.*.





$\mathbf{G} + \mathbf{\Pi_3} + \mathbf{\Pi_4} + \mathbf{\Pi_0} + \mathbf{M_3} + \mathbf{M_4} = \mathbf{0}$

$\mathbf{S} = \mathbf{-\Pi_0}$

$S_\xi = M_3 + \Pi_3 - \Pi_4 - M_4 + G\ sen\phi = -2901$ N

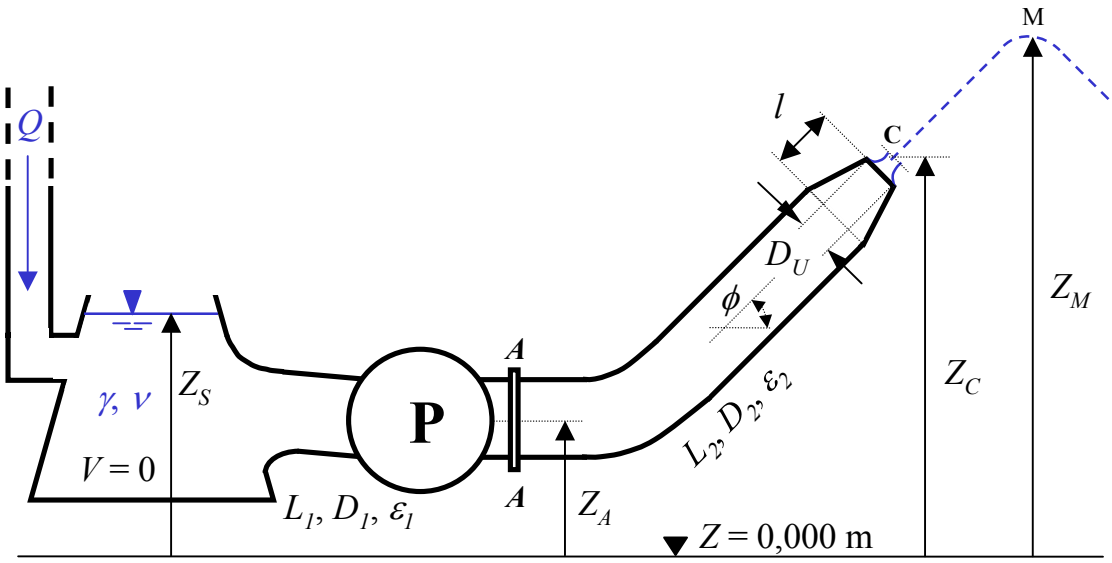
$S_\eta = -G\ cos\phi = -87$ N

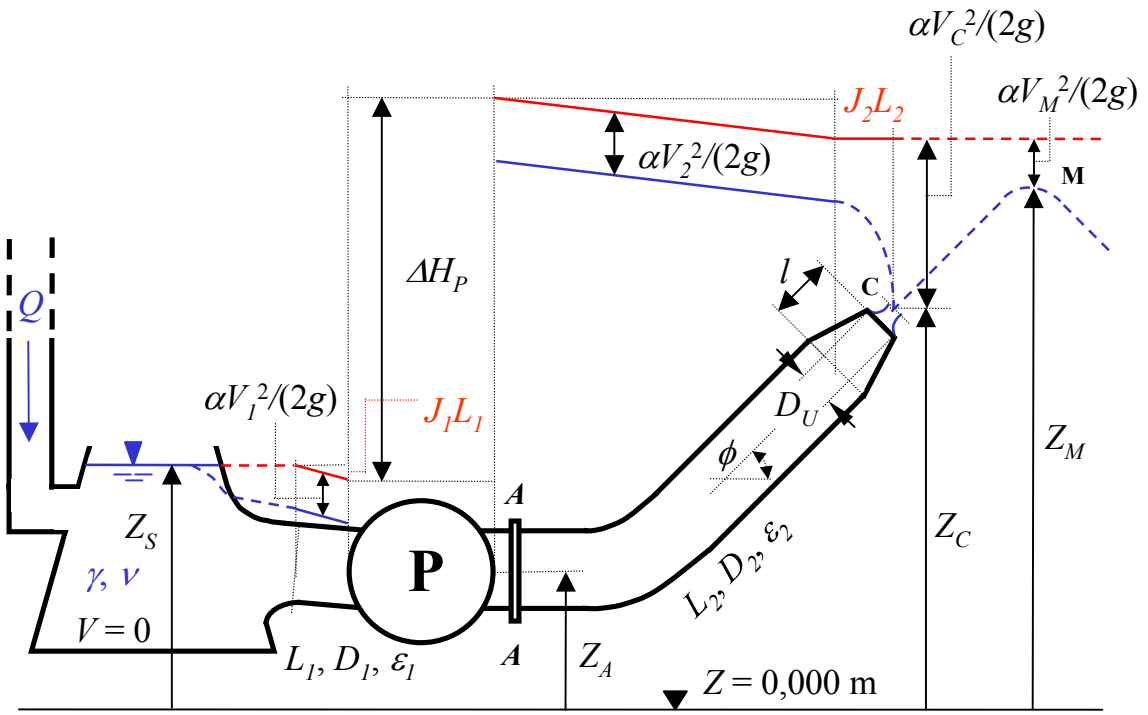
$S = 2902$ N

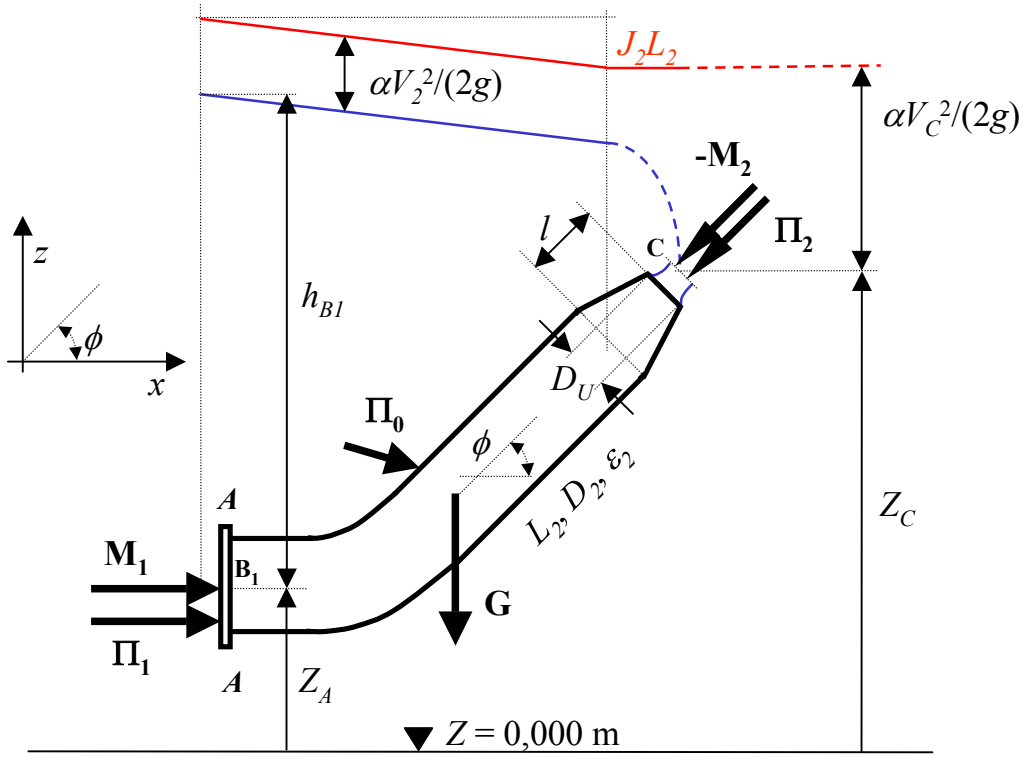
Esercizio 57

Noti: $Z_S = 9{,}000$ m, $Z_A = 4{,}000$ m, $Z_C = 11{,}500$ m, $Z_M = 13{,}000$ m, $\alpha = 1$, $L_1 = 11{,}000$ m, $D_1 = 0{,}250$ m, $\varepsilon_1 = 1{,}0 \cdot 10^{-3}$ m, $L_2 = 20{,}000$ m, $D_2 = 0{,}200$ m, $\varepsilon_2 = 5{,}0 \cdot 10^{-4}$ m, $l = 0{,}286$ m, $D_U = 0{,}150$ m, $C_C = 0{,}80$, $\gamma = 7845$ N/m^3, $\nu = 2{,}3 \cdot 10^{-6}$ m^2/s, g = 9,806 m/s^2, $\eta_P = 0{,}78$, $\phi = 0{,}78$, $\beta = 1$ – si consideri trascurabile la distanza tra la pompa e la flangia di traccia **AA** ed ideale il comportamento del liquido nell'atmosfera.

Determinare la portata Q transitante, la potenza W_P assorbita dalla pompa e le componenti della spinta sul tronco di tubazione compreso tra la flangia di traccia **AA** e l'ugello. **Tracciare** la *L.C.T.* e la *L.P.*.







$$\mathbf{G + \Pi_1 + \Pi_2 + \Pi_0 + M_1 - M_2 = 0} \qquad \mathbf{S = -\Pi_0}$$

$Q = C_C\, A_U\, [2\, g\, (Z_M - Z_C)/(sen\phi)^2]^{1/2} = 0{,}108$ m^3/s

$W_P = \gamma\, Q\, \Delta H_P / \eta_P = 8024$ W

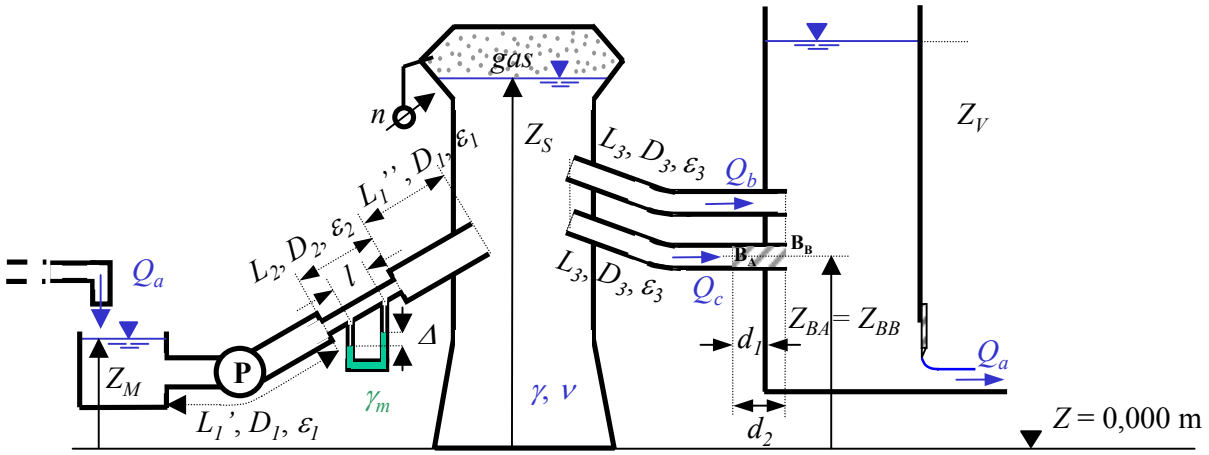
$S_x = 2647$ N $\longrightarrow$ $S_z = -5590$ N $\downarrow$

$S = [S_x^2 + S_z^2]^{1/2} = 6185$ N

Esercizio 58 (Tema d'esame del 15 Luglio 2002)

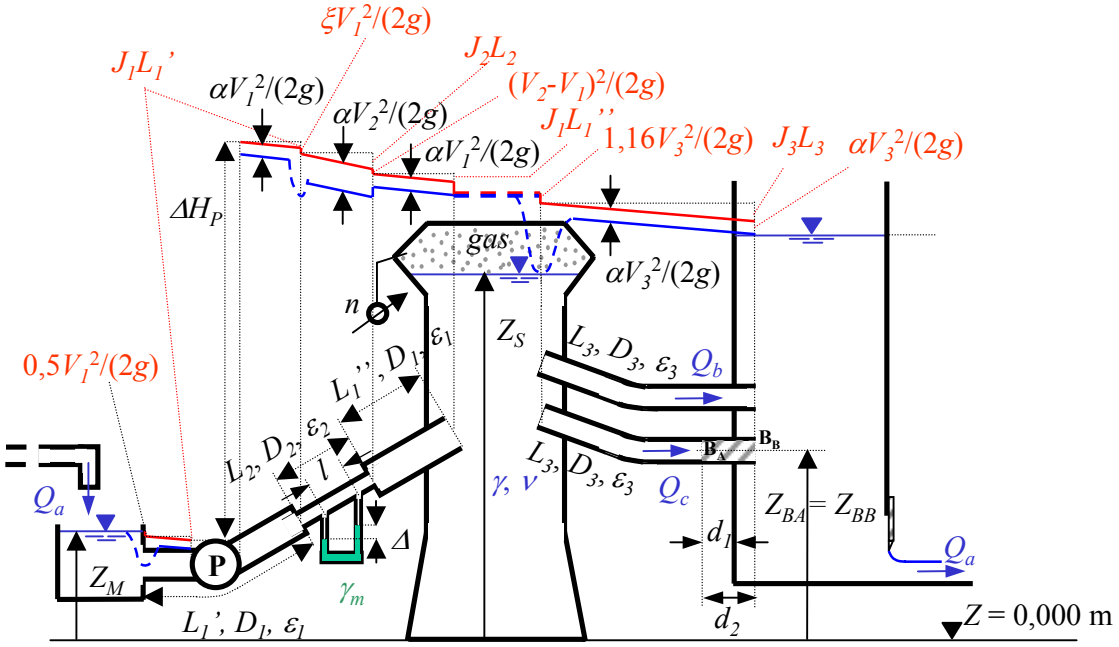
Noti: $Z_M = 15{,}000$ m, $Z_S = 55{,}000$ m, $Z_A = Z_B = 35{,}000$ m, $n = 0{,}500$ bar, $\Delta = 0{,}050$ m, $L_1' = 21{,}000$ m, $L_1'' = 13{,}000$ m, $L_2 = (10{,}000+C/10)$ m, $L_3 = 34{,}000$ m, $D_1 = 0{,}350$ m, $D_2 = 0{,}200$ m, $D_3 = 0{,}150$ m, $\varepsilon_1 = \varepsilon_2 = 7\cdot10^{-4}$ m, $\varepsilon_3 = 9\cdot10^{-4}$ m, $d_1 = 2{,}000$ m, $d_2 = 8{,}000$ m, $l = (7{,}000+0{,}05\,N)$ m, $\gamma = 9806$ N/m^3, $\gamma_m = 133362$ N/m^3, $\nu = 1\cdot10^{-6}$ m^2/s, $\eta_P = 0{,}78$, $g = 9{,}806$ m/s^2, $\xi_{brusco\ restringimento} = 0{,}4$, $\alpha = 1$, moto permanente.

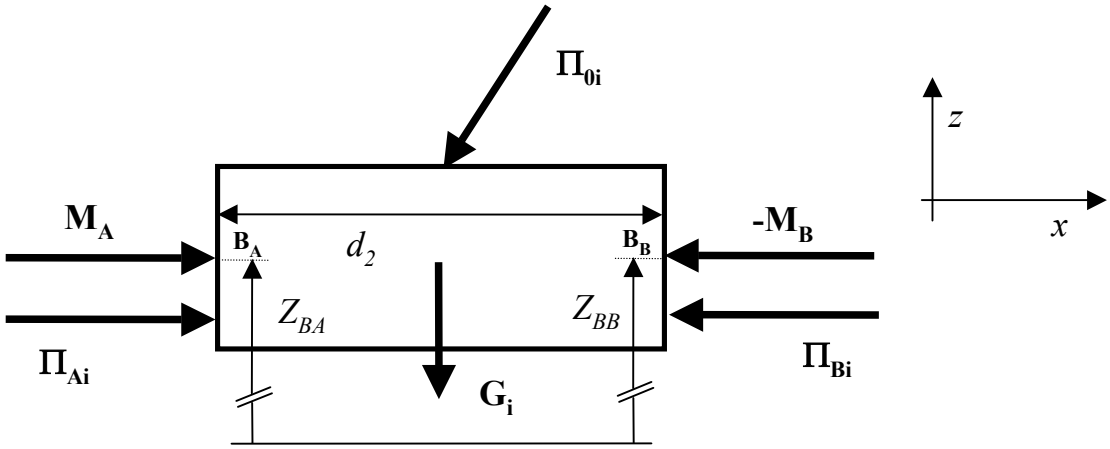
Determinare le portate Q_a, Q_b e Q_c circolanti nell'impianto, la potenza W_P assorbita dalla pompa, il livello Z_V nel serbatoio di valle e le componenti della spinta sul tratto di tubazione orizzontale evidenziato in figura. **Tracciare** *LCT* e *LP*.



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

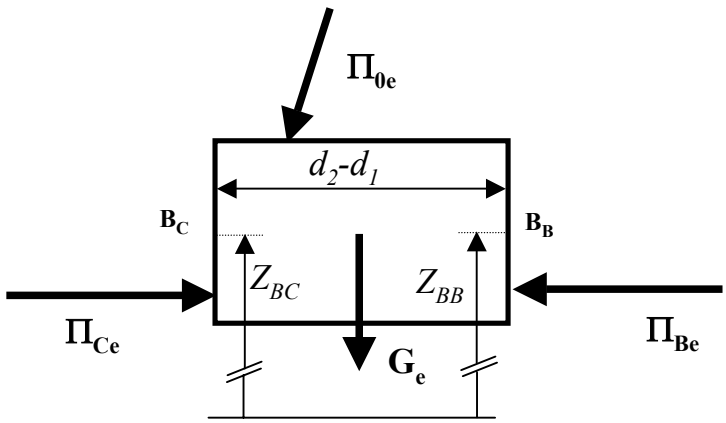
$N =$ prima lettera del nome = 1 $\quad$ $C =$ prima lettera del cognome = 1





Spinta dovuta al fluido interno al tubo (pedice "**i**")

$$\mathbf{G_i + \Pi_{Ai} + \Pi_{Bi} + \Pi_{0i} + M_A - M_B = 0} \qquad \mathbf{S_i = -\Pi_{02} = G_i + \Pi_{Ai} + \Pi_{Bi}}$$



Spinta dovuta al fluido esterno al tubo (pedice "**e**")

$$\mathbf{G_e + \Pi_{Ce} + \Pi_{Be} + \Pi_{0e} = 0} \qquad \mathbf{S_e = \Pi_{0e} = -G_e}$$

$Q_a = A_2\,[2\,g\,J_2\,D_2/\lambda_2]^{1/2} = 0{,}112$ m^3/s

$Q_b = Q_c = Q_a/2 = 0{,}056$ m^3/s

$S_x = \gamma J_3\, d_2\, A_3 = 153$ N ⟶

$S = 379$ N

$W_P = \gamma\, Q_a\, \Delta H_P/\eta_P = 66523$ W

$Z_V = H_S - 1{,}16\, V_3^2/(2\,g) - J_3\, L_3 - \alpha V_3^2/(2\,g) = 55{,}232$ m

$S_z = G_e - G_i = -347$ N ↓