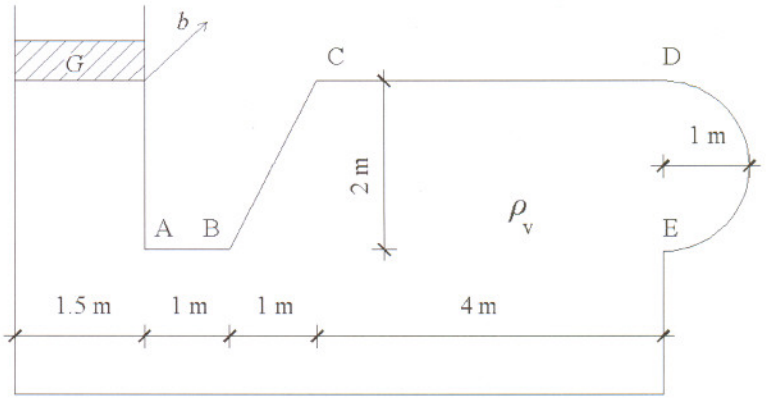
HIDROMEHANIKA 10.3.2011.

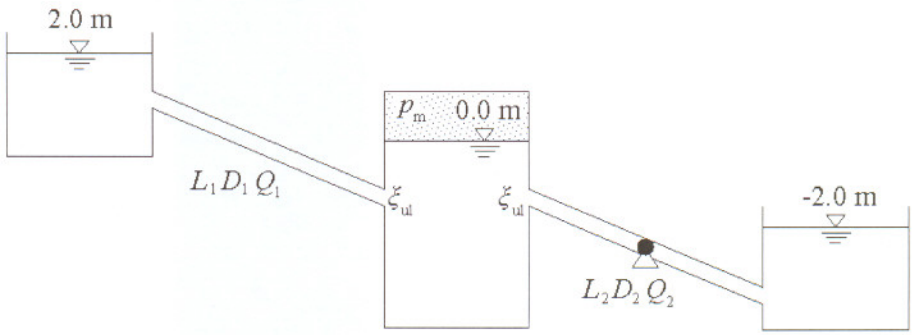
1. Potrebno je izračunati vrijednosti vertikalnih i horizontalnih komponenti sile tlaka na konture posude *AB*, *BC*, *CD*, *DE* i izračunati rezultantnu silu F_{AE} od točke *A* do točke *E*. Nacrtati horizontalne i vertikalne komponente dijagrama tlaka za konturu posude od A do E. (20 bodova)



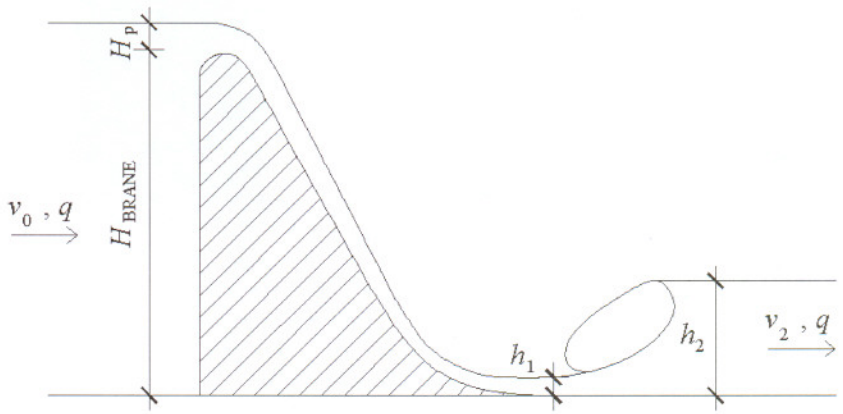
Zadano je: $\rho_V = 1000$ kg/m^3 ;
težina utega $G = 14.715$ kN;
širina posude $b = 1$m

2. Na komoru pod tlakom priključene su dvije grane cjevovoda iste apsolutne hrapavosti, ali različitih promjera D_1 i D_2 te različitih duljina L_1 i L_2. Odredite potrebnu visinu dizanja pumpe H_{pumpe} koja će omogućiti da se kroz «desnu» granu cjevovoda ostvaruje dva puta manji protok realne tekućine nego kroz «lijevu» granu cjevovoda. Nacrtati energetsku i piezometarsku liniju. Pretpostavlja se potpuno turbulentno tečenje u cijevima. (25 bodova)

Zadano je: $D_1 = 0.2$m ; $D_2 = 0.1$m ; $\rho = 1000$ kg/m^3 ; $p_m = 49.05$kPa ; $\varepsilon = 0.2$mm; $\xi_{UL} = 0.5$; $L_1 = 100$m ; $L_2 = 500$m

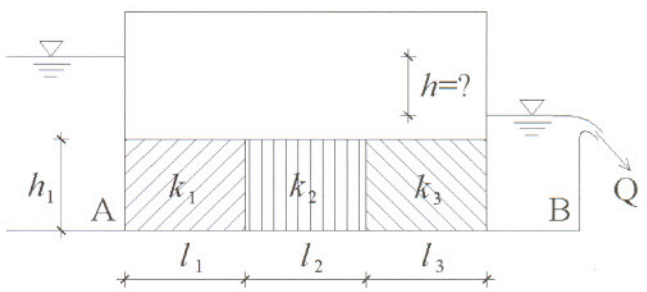


3. Potrebno je odrediti Froude-ov broj u presjeku 2 (nakon normalnog vodnog skoka) u pravokutnom kanalu ako je H_{BRANE} = 10m, jedinični protok $q = 2.21$ m^3/s/m^1, a koeficijent prelijevanja $C_P = 0.5$. (20 bodova)



4. Za stacionarni slučaj strujanja kroz poroznu sredinu širine $B = 3$m sa koeficijentima propusnosti k_1=10^{-3} m/s, k_2=10^{-2} m/s, k_3=5·10^{-3} m/s izmjeren je protok $Q = 0.005$ m^3/s. Potrebno je odrediti razliku razina h u posudi *A* i *B* koja omogućuje protjecanje zadanog Q te nacrtati piezometarsku liniju.

Zadano je: $h_1 = 4.5$m ; $l_1 = l_2 = l_3 = 5$m (20 bodova)

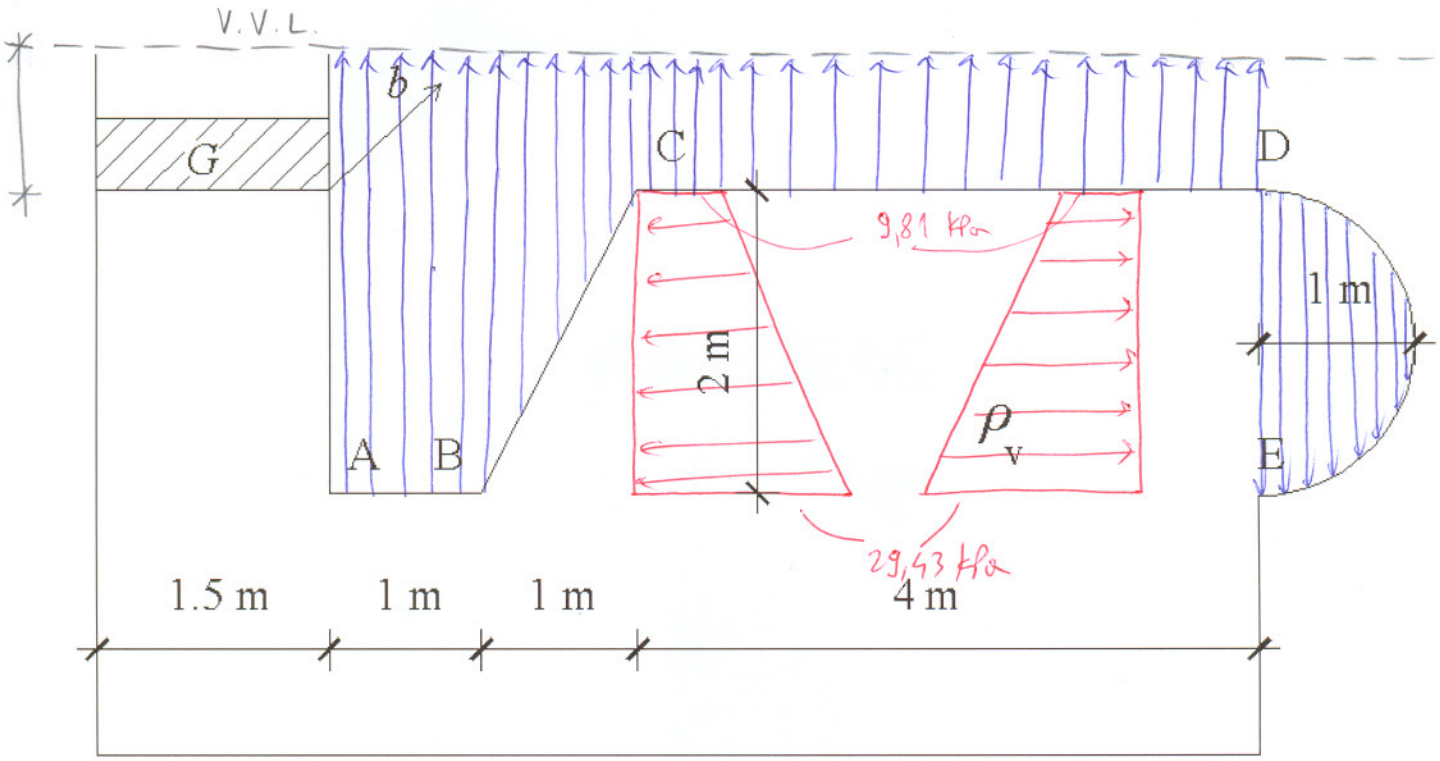


TEORIJA: (15 bodova)

1. Objasni što je to homogeno a što nehomogeno polje.
2. Koje sve vrste energije sadrži Bernoullijeva jednadžba ?
3. Što je to bučnica i kolika treba biti njena duljina?
4. Što je to Pitot cijev a što Prandtl-Pitot cijev

Obavezno ispravno riješiti prvi i drugi zadatak!

1



$$p_A = \frac{G}{1,5 \cdot 1} + \rho_V \cdot g \cdot 2 = 9,81 + 19,62 = 29,43 \text{ kPa}$$

$$p_B = p_A$$

$$p_C = \frac{G}{1,5 \cdot 1} = 9,81 \text{ kPa}$$

$$p_D = p_C$$

$$p_E = p_B = p_A$$

$$F_V^{(AB)} = p_A \cdot 1 = 29,43 \text{ kN}$$

$$F_V^{(BC)} = \frac{p_B + p_C}{2} \cdot 1 = \frac{29,43 + 9,81}{2} \cdot 1 = 19,62 \text{ kN}$$

$$F_V^{(CD)} = p_C \cdot 4 = 9,81 \cdot 4 = 39,24 \text{ kN}$$

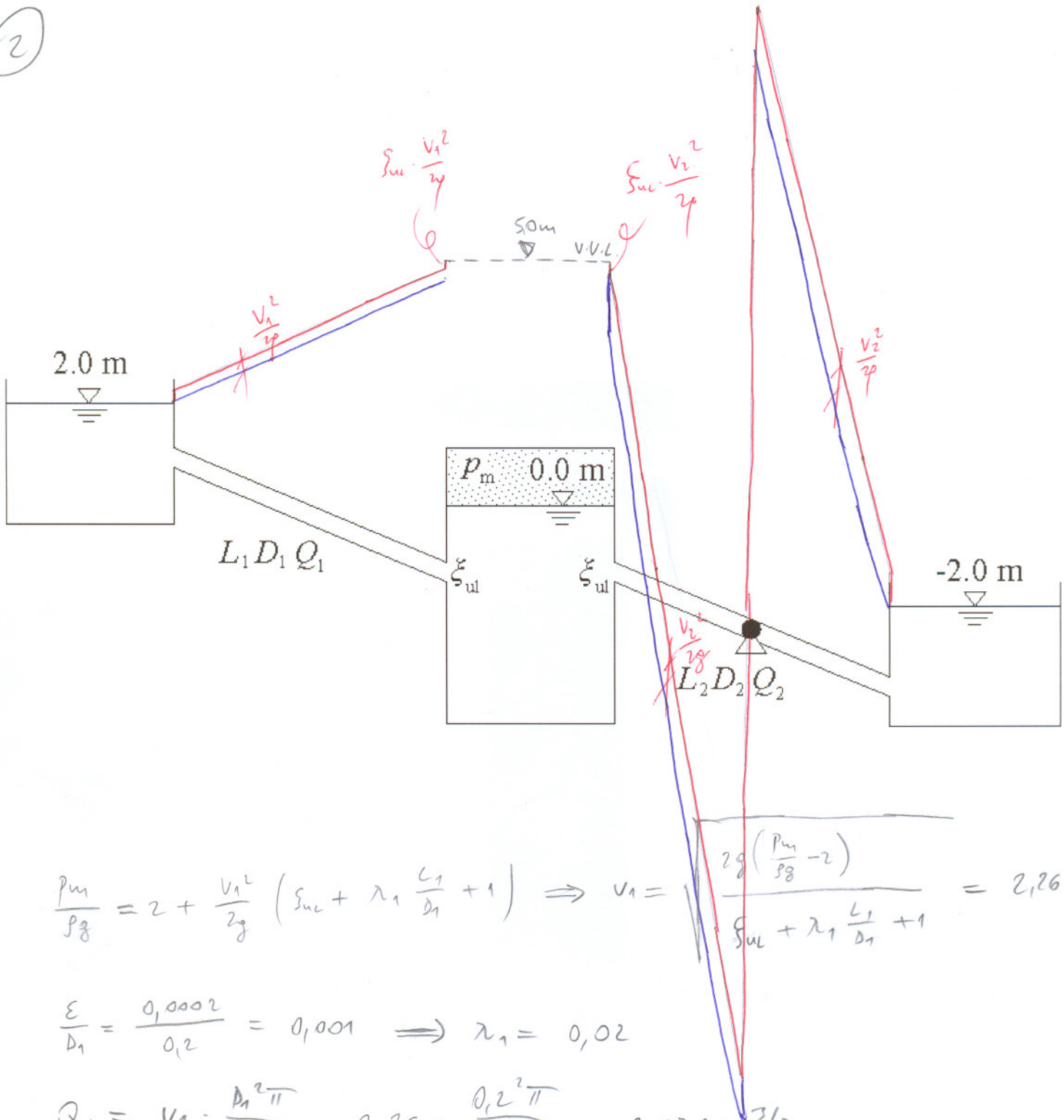
$$F_V^{(DE)} = -\rho \cdot g \cdot \frac{1^2 \pi}{2} = -15,41 \text{ kN}$$

$$F_H^{(BC)} = -F_H^{(DE)} = \frac{p_B + p_C}{2} \cdot 2 = 39,24 \text{ kN}$$

$$F_H^{(AE)} = 0$$

$$F_V^{(AE)} = 29,43 + 19,62 + 39,24 - 15,41 = 72,88 \text{ kN} = F_{UKUPNO}^{(AE)}$$

(2)



$$\frac{p_m}{\rho g} = 2 + \frac{V_1^2}{2g}\left(\xi_{ul} + \lambda_1 \frac{L_1}{D_1} + 1\right) \Rightarrow V_1 = \sqrt{\frac{2g\left(\frac{p_m}{\rho g} - 2\right)}{\xi_{ul} + \lambda_1 \frac{L_1}{D_1} + 1}} = 2{,}26 \text{ m/s}$$

$$\frac{\varepsilon}{D_1} = \frac{0{,}0002}{0{,}2} = 0{,}001 \Rightarrow \lambda_1 = 0{,}02$$

$$Q_1 = V_1 \cdot \frac{D_1^2 \pi}{4} = 2{,}26 \cdot \frac{0{,}2^2 \pi}{4} = 0{,}071 \text{ m}^3/\text{s}$$

$$Q_2 = 0{,}5\, Q_1 = 0{,}0355 \text{ m}^3/\text{s}$$

$$V_2 = \frac{4 Q_2}{D_2^2 \pi} = \frac{4 \cdot 0{,}0355}{0{,}1^2 \pi} = 4{,}52 \text{ m/s} \Rightarrow \frac{V_2^2}{2g} = 1{,}04$$

$$\frac{p_m}{\rho g} + H_p = -2 + \frac{V_2^2}{2g}\left(\xi_{ul} + \lambda_2 \frac{L_2}{D_2} + 1\right)$$

$$\frac{\varepsilon}{D_2} = \frac{0{,}0002}{0{,}1} = 0{,}002 \Rightarrow \lambda_2 = 0{,}024$$

$$H_p = -5 - 2 + 1{,}04\left(0{,}5 + 0{,}024 \cdot \frac{500}{0{,}1} + 1\right) = 119{,}36 \text{ m}$$

(3)

$$H_p^{3/2} = \frac{Q}{C_p\sqrt{2g}} = \frac{2,21}{0,5\sqrt{2\cdot 9,81}} = 0,998$$

$$H_p = 0,998^{\frac{2}{3}} \approx 1\ m$$

$$H_{BRANE} + H_p + \frac{v_0^2}{2g} = h_1 + \frac{v_1^2}{2g}$$

$$10 + 1 + \frac{Q^2}{2g(H_{BRANE}+H_p)^2} = h_1 + \frac{Q^2}{2g h_1^2}$$

$$11 + \frac{2,21^2}{2g\cdot 11^2} \quad \text{ZANEMARIVO} = h_1 + \frac{2,21^2}{2g h_1^2}$$

$$h_1 = \sqrt{\frac{2,21^2}{2g(11-h_1)}}$$

ITERACIJA:

h_1^{PRETP} [m]	$h_1^{DOBIVENO}$ [m]
1	0,158
0,158	0,152
0,152	0,151

ODABRANO $h_1 = 0,151\ m$

$$v_1 = \frac{Q}{h_1} = \frac{2,21}{0,151} = 14,63\ m/s \longrightarrow Fr_1^2 = \frac{v_1^2}{g h_1} = 144,5$$

$$h_2 = \frac{h_1}{2}\left(-1 + \sqrt{1+8Fr_1^2}\right) = 2,49\ m$$

$$v_2 = \frac{Q}{h_2} = \frac{2,21}{2,49} = 0,89\ m/s \Rightarrow Fr_2 = \frac{v_2}{\sqrt{g h_2}} = \frac{0,89}{\sqrt{9\cdot 2,49}} = 0,18$$

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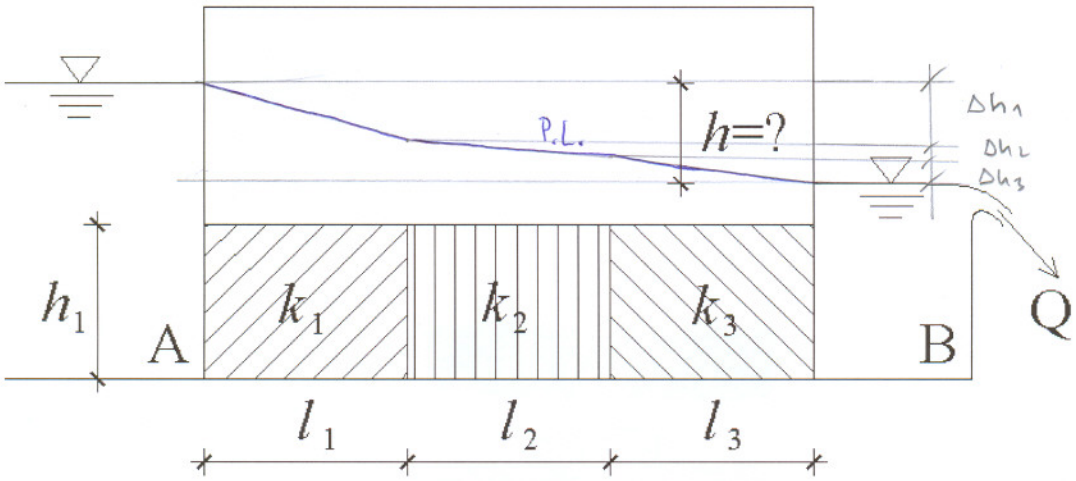

$$v_1 = v_2 = v_3 = \frac{Q}{B \cdot h_1} = \frac{0{,}005}{3 \cdot 4{,}5} = 0{,}00037 \text{ m/s}$$

$$v = k \cdot J = k \cdot \frac{\Delta h}{\Delta L} \rightarrow \Delta h = \frac{v \cdot \Delta L}{k}$$

$$\Delta h_1 = \frac{v_1 \cdot l_1}{k_1} = \frac{0{,}00037 \cdot 5}{10^{-3}} = 1{,}85 \text{ m}$$

$$\Delta h_2 = \frac{v_2 \cdot l_2}{k_2} = \frac{0{,}00037 \cdot 5}{10^{-2}} = 0{,}185 \text{ m}$$

$$\Delta h_3 = \frac{v_3 \cdot l_3}{k_3} = \frac{0{,}00037 \cdot 5}{5 \cdot 10^{-3}} = 0{,}37 \text{ m}$$

$$h = \Delta h_1 + \Delta h_2 + \Delta h_3 = 1{,}85 + 0{,}185 + 0{,}37 = 2{,}405 \text{ m}$$