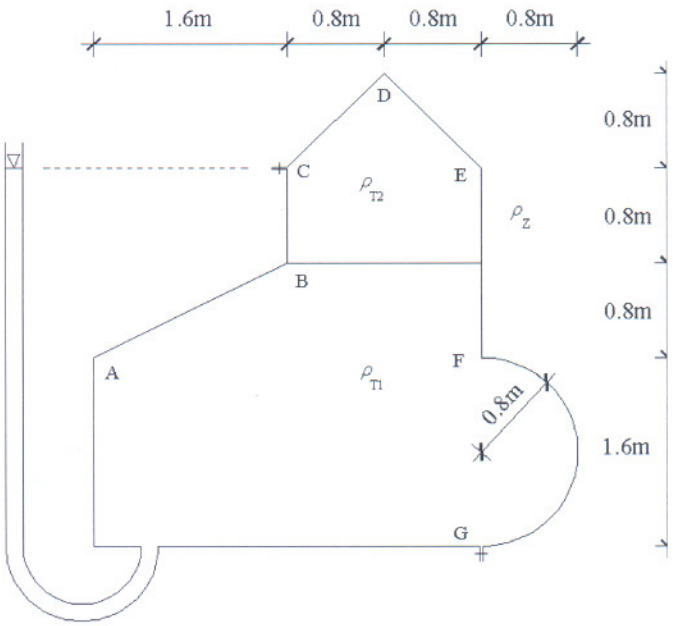
MEHANIKA TEKUĆINA 8. rujna 2011.

1) Rezervoar je potpuno napunjen dvjema tekućinama T1 i T2 kao što je prikazano na slici. Potrebno je izračunati tlakove u točkama A, B, C, D, E, F i G. Nacrtati horizontalni i vertikalni dijagram hidrostatskog tlaka na dio konture rezervoara A-B-C-D-E-F-G te izračunati vrijednost ukupne sile kojom tekućine djeluju na dio konture C-D-E-F-G. Zadatak je ravninski (računati na 1m širine rezervoara).

Zadano je: $\rho_{T1} = 1600$ kg/m^3; $\rho_{T2} = 800$ kg/m^3

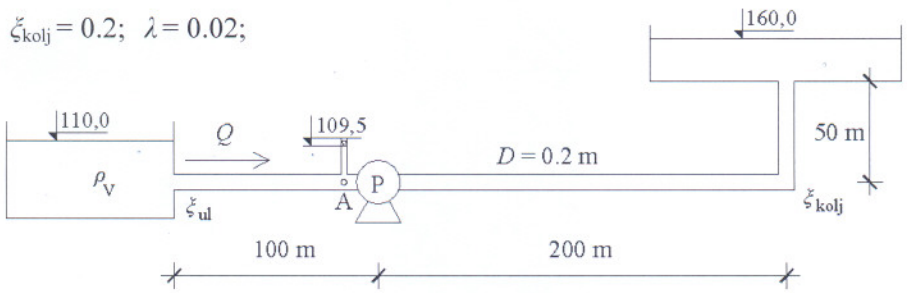
(25 bodova)



2) Za sustav na prikazan na slici izračunajte potrebnu snagu pumpe uz koeficijent iskoristivosti η=0.7. Nacrtati piezometarsku i energetsku liniju za sustav na slici.

Zadano je: $\xi_{ul} = 0.5$; $\xi_{kolj} = 0.2$; $\lambda = 0.02$;

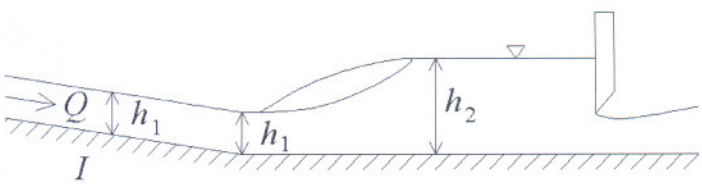
(25 bodova)



3) Potrebno je odrediti pad dna I pravokutnog kanala širine B=5m, tako da se formira normalni vodni skok kako je prikazano na slici.

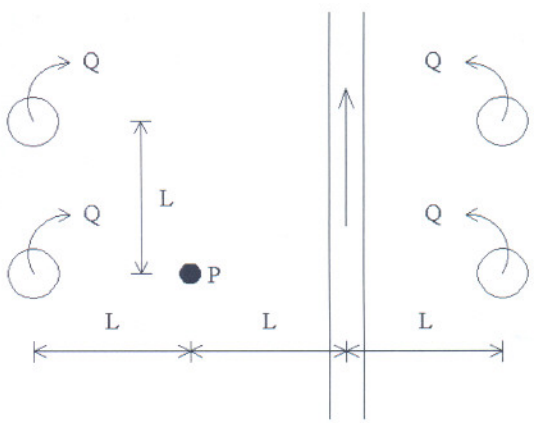
Zadano je: h_2=2m; Q=40m^3/s; C=60m$^{1/2}$/s (Chezyev koef. hrapavosti)

(20 bodova)



4) U vodonosnik sa slobodnim vodnim licem (k=0.002m/s) postavljena su četiri zdenca, po dva sa svake strane vodotoka. Potencijal vodonosnog sloja prije početka crpljenja iznosi H_0 = 15m, a međusobne udaljenosti zdenaca definirane su na slici. Iz zdenaca se crpe količine Q=0.08m^3/s. Potrebno je odrediti sniženje u piezometru P, ako je radijus utjecaja zdenaca R = 600m, a L = 50m.

(15 bodova)



Teorija: (15 bodova)

1. Riječima i grafički objasni Arhimedov zakon.
2. Kada se uspostavlja vodni skok i koje vrste vodnog skoka postoje?
3. Koje vrste sličnosti poznajete i objasnite za svaku navedenu u kojim se slučajevima modeliranja koristi.
4. Napiši Hagen-Poiuseilleov zakon i objasni članove.

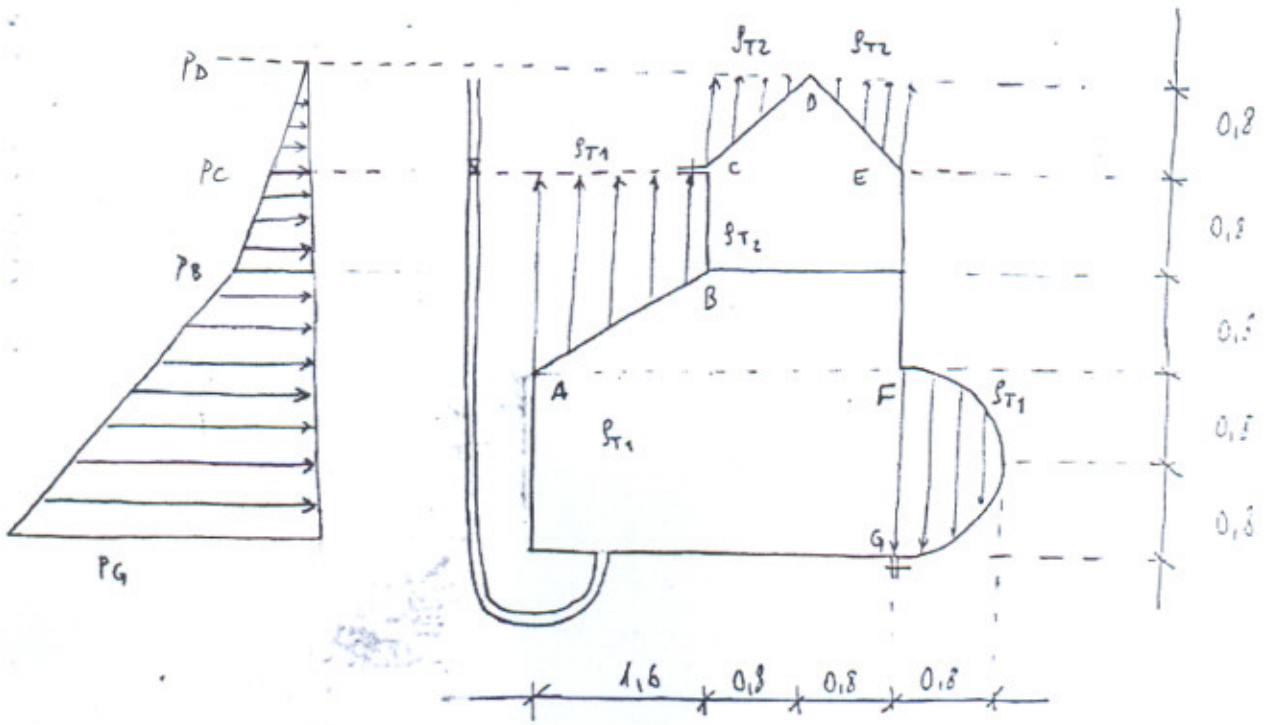
Uvjeti za usmeni dio ispita: minimalno 50 bodova i točno riješeni 1. i 2. zadatak!

(1)

$\rho_{T1} = 1600\ kg/m^3$

$\rho_{T2} = 800\ kg/m^3$

REZULTANTNI DIJAGRAMI



$p_A = \rho_{T1} \cdot g \cdot h_A = 1,6 \cdot 9,81 \cdot 1,6 = 25,1\ kPa$

$p_B = \rho_{T1} \cdot g \cdot h_B = 1,6 \cdot 9,81 \cdot 0,8 = 12,56\ kPa$

$p_C = p_B - \rho_{T2} \cdot g \cdot 0,8 = 12,56 - 0,8 \cdot 9,81 \cdot 0,8 = 6,28\ kPa$

$p_D = p_C - \rho_{T2} \cdot g \cdot 0,8 = 0$

$p_E = p_C = 6,28\ kPa$

$p_F = p_A = 25,1\ kPa$

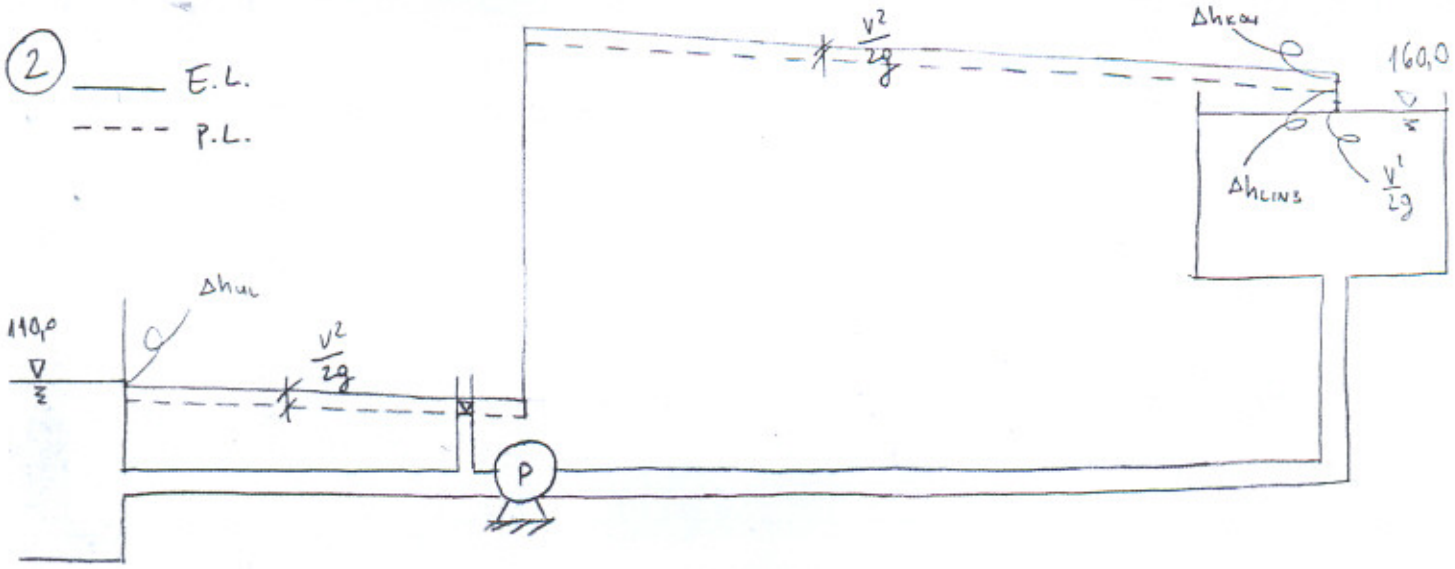
$p_G = p_F + \rho_{T1} \cdot g \cdot 1,6 = 25,1 + 1,6 \cdot g \cdot 1,6 = 50,2\ kPa$

$$F_y^{C-G} = \rho_{T2} \cdot g \cdot \frac{0,8 \cdot 0,8}{2} \cdot 2 - \rho_{T1} \cdot g \cdot \frac{1}{2} \cdot 0,8^2 \pi$$

$$= 5,02 - 15,78 = -10,76\ kN$$

$$F_x^{C-G} = \frac{p_C + p_B}{2} \cdot 0,8 + \frac{p_D + p_G}{2} \cdot 2,4 = 7,54 + 75,31 = 82,85\ kN$$

$$F_{uk}^{C-G} = \sqrt{\left(F_y^{C-G}\right)^2 + \left(F_x^{C-G}\right)^2} = 83,55\ kN$$



GUBITCI TLAKA OD ULAZA DO TOČKE A:

$$\Delta h_{UL-A} = \frac{V^2}{2g}\left(\xi_{UL} + \lambda\frac{100}{D} + 1\right) = 0{,}5$$

$$\frac{v^2}{2g}\left(0{,}5 + 0{,}02\cdot\frac{100}{0{,}2} + 1\right) = 0{,}5 \Rightarrow v = 0{,}92\ m/s$$

$$Q = v\cdot\frac{D^2\pi}{4} = 0{,}92\cdot\frac{0{,}2^2\pi}{4} = 0{,}029\ m^3/s$$

$$110 + H_p = 160 + \frac{v^2}{2g}\left(\xi_{UL} + \lambda\frac{100}{D} + \lambda\frac{200}{D} + \xi_{KOL} + \lambda\frac{50}{D}\right)$$

$$H_p = 50 + \frac{0{,}92^2}{2g}\left(0{,}5 + 0{,}02\cdot\frac{100}{0{,}2} + 0{,}02\cdot\frac{200}{0{,}2} + 0{,}2 + 0{,}02\cdot\frac{50}{0{,}2} + 1\right)$$

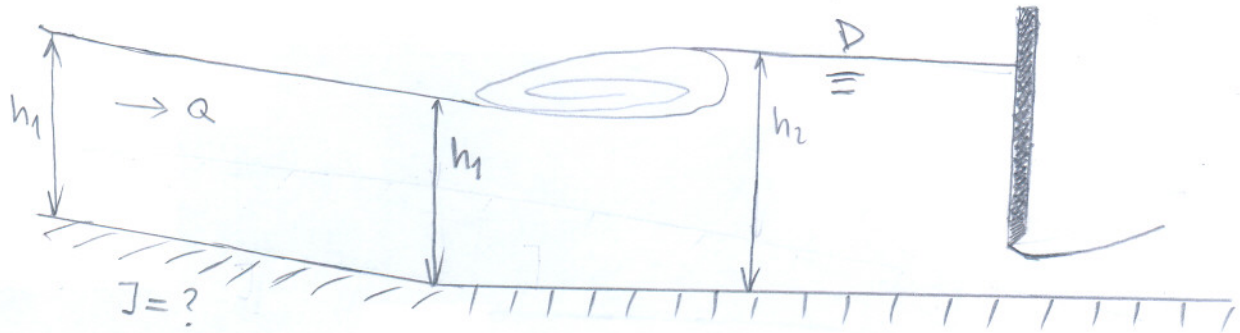
$$H_p = 50 + 0{,}043\left(0{,}5 + 10 + 20 + 0{,}2 + 5 + 1\right)$$

$$H_p = 50 + \underset{\Delta h_{UL}}{0{,}022} + \underset{\Delta h_{LIN1}}{0{,}43} + \underset{\Delta h_{LIN2}}{0{,}86} + \underset{\Delta h_{KOL}}{0{,}009} + \underset{\Delta h_{LIN3}}{0{,}215} + 0{,}043$$

$$H_p = 51{,}58\ m$$

$$N_p = \frac{\rho g Q H_p}{\eta} = \frac{1000\cdot 9{,}81\cdot 0{,}029\ 51{,}58}{0{,}7} = 20{,}96\ kW$$

(3)



$Q = 40\,m^3/s$

$B = 5$

$h_2 = 2\,m$

$C = 60\,m^{1/2}/s$

$J = ?$

$$h_2 = \frac{1}{2} h_1 \left(-1 + \sqrt{8 F_{r_1}^2 + 1} \right)$$

$$F_{r_1}^2 = \frac{v_1^2}{g h_1} = \frac{Q^2}{B^2 h_1^2 \cdot g \cdot h_1}$$

$$2 \cdot 2 = h_1 \left(-1 + \sqrt{8 \cdot \frac{40^2}{5^2 \cdot 9{,}81 \cdot h_1^3} + 1} \right)$$

$$4 = h_1 \left(-1 + \sqrt{\frac{52{,}19}{h_1^3} + 1} \right)$$

ITERACIJA:

$h_1 = 1$	$4 = 6{,}29$
$h_1 = 2$	$4 = 3{,}48$
$h_1 = 1{,}8$	$4 = 3{,}88$
$h_1 = 1{,}7$	$4 = 4{,}1$
$h_1 = 1{,}75$ //	$4 = 3{,}98$ ✓

$$Q = A \cdot C \sqrt{RJ} = B \cdot h_1 \cdot C \sqrt{\frac{B \cdot h_1}{B + 2h_1}} \cdot \sqrt{J}$$

$$40 = 5 \cdot 1{,}75 \cdot 60 \sqrt{\frac{5 \cdot 1{,}75}{5 + 2 \cdot 1{,}75}} \cdot \sqrt{J}$$

$$40 = 532{,}66 \cdot \sqrt{J} \Rightarrow J = \left(\frac{40}{532{,}66} \right)^2 = 0{,}0056 //$$

(3) DRUGA METODA:

$$h_1 = \frac{1}{2} h_2 \left(-1 + \sqrt{8 F_{r_2}^2 + 1}\right)$$

$$F_{r_2}^2 = \frac{V_2^2}{g h_2} = \frac{Q^2}{B^2 h_2^2 \cdot g \cdot h_2} = \frac{40^2}{5^2 \cdot 2^2 \cdot 9{,}81 \cdot 2} = 0{,}82$$

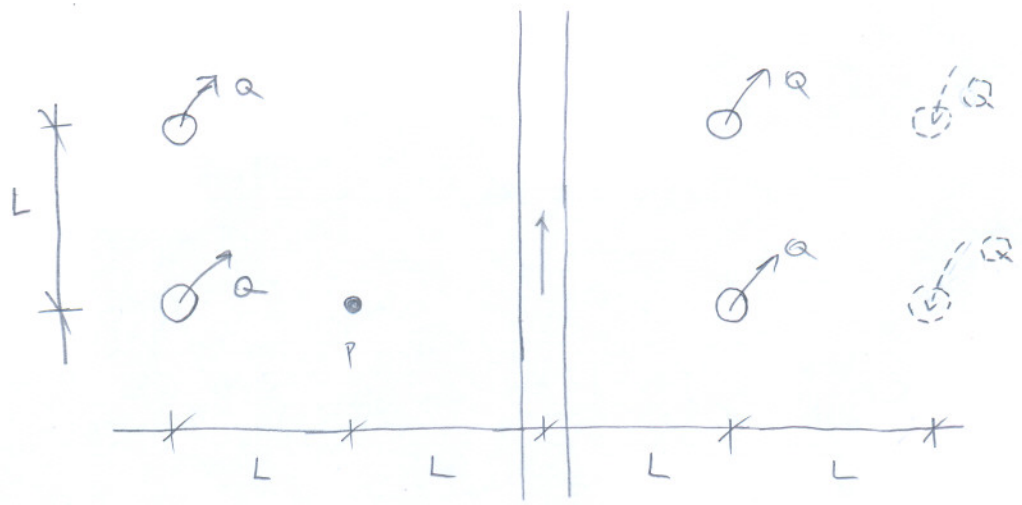
$$h_1 = \frac{1}{2} \cdot 2 \left(-1 + \sqrt{8 \cdot 0{,}82 + 1}\right)$$

$$h_1 = -1 + 2{,}75$$

$$h_1 = 1{,}75 \text{ m}$$

$$Q = A \cdot C \sqrt{RJ} \rightarrow J = \dots$$

(4)



$Q = 0{,}08\ m^3/s$

$H_0 = 15\ m$

$R = 600\ m$

$L = 50\ m$

$k = 0{,}002\ m/s$

$s_p = ?$

$$\Delta\phi_p = \frac{Q}{2\pi}\left(\ln\frac{R}{L} + \ln\frac{R}{L\sqrt{2}} - \ln\frac{R}{3L} - \frac{R}{L\sqrt{10}}\right)$$

$$= \frac{0{,}08}{2\pi}\left(2{,}48 + 2{,}14 - 1{,}38 - 1{,}33\right)$$

$$= 0{,}0127 \cdot 1{,}91$$

$$= 0{,}0243$$

$$\frac{k\left(H_0^2 - h_p^2\right)}{2} = \Delta\phi_p$$

$$\frac{0{,}002\left(15^2 - h_p^2\right)}{2} = 0{,}0243$$

$$15^2 - h_p^2 = 24{,}32$$

$$h_p^2 = 15^2 - 24{,}32 = 200{,}68 \Longrightarrow h_p = 14{,}17\ m$$

$$s_p = H_0 - h_p = 15 - 14{,}17$$

$$s_p = 0{,}83\ m$$