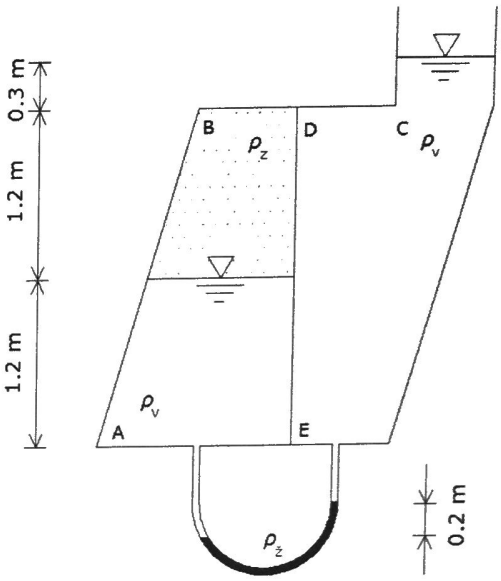
MEHANIKA TEKUĆINA 28.6.2012.

1) Potrebno je odrediti tlakove u točkama A, B i C. Dio rezervoara lijevo od pregrade je zatvoren te napunjen vodom i stlačenim zrakom. Desni dio rezervoara je napunjen vodom i u kontaktu je s atmosferom. Dva dijela rezervoara su spojena diferencijalnim tlakomjerom koji sadržava živu u položaju kao na slici. Potrebno je nacrtati dijagrame komponenti hidrostatskog tlaka za dio konture A-B-C. Također je potrebno odrediti hidrostatsku silu na pregradu D-E. Pretpostavite jediničnu širinu rezervoara.

Zadano je: $\rho_V = 1000$ kg/m^3; $\rho_Z = 0$ kg/m^3; $\rho_Ž = 13600$ kg/m^3;

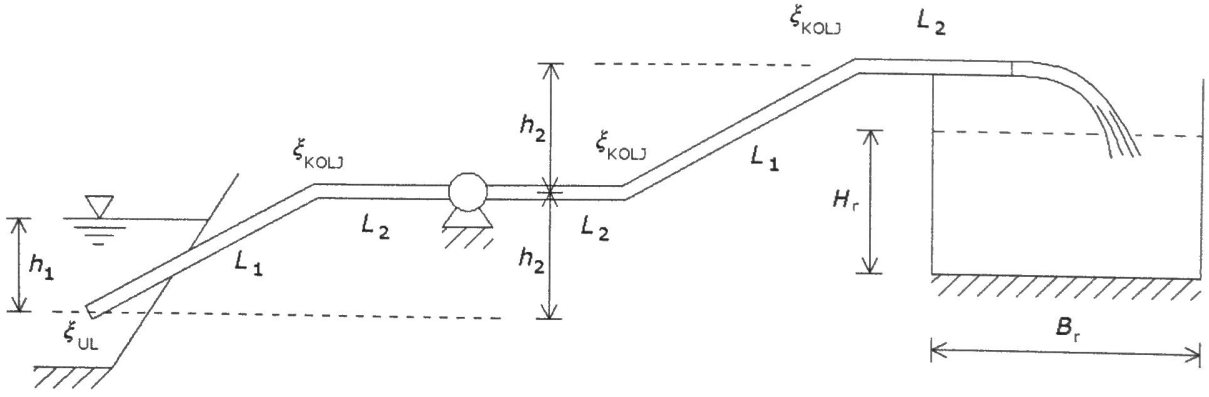
(20 bodova)



2) Odredite potrebnu snagu pumpe da bi se rezervoar kvadratičnog tlocrta duljine stranice B_r napunio do visine H_r za 30 minuta. Pumpa crpi vodu sustavom cijevi promjera D iz vodotoka kojemu se pri tom ne mijenja vodostaj. Nacrtati piezometarsku i energetsku liniju.

Zadano je: $B_r = 8$ m; $H_r = 2$ m; $D = 20$ cm; $L_1 = 30$ m; $L_2 = 14$ m; $h_1 = 1.7$ m; $h_2 = 2.1$ m;
$\rho_V = 1000$ kg/m^3; ν (kin. koef. visk.) $= 10^{-6}$ m^2/s; $\varepsilon = 0.2$ mm; $\xi_{UL} = 0.7$; $\xi_{KOLJ} = 0.25$; $\eta = 0.85$

(25 bodova)



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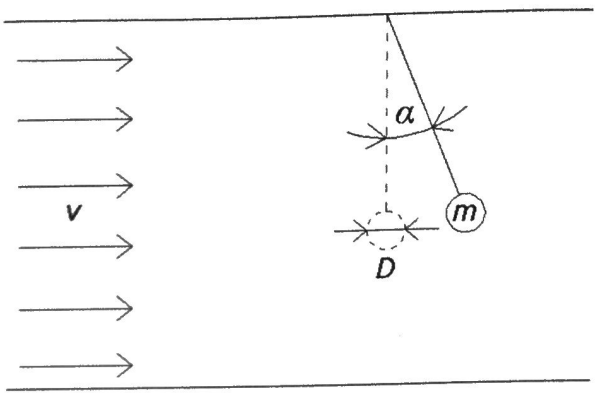
3) U zračni tunel postavljena je kugla mase m = 1300 g i promjera D = 28 cm na tanku nit. Profil brzina strujanja zraka u zračnom tunelu je jednolik i iznosi v = 15 m/s. Odredite koeficijent otpora oblika za obješenu kuglu ako je otklon napete niti α = 15°. Gustoća zraka iznosi ρ_Z = 1.2 kg/m^3.

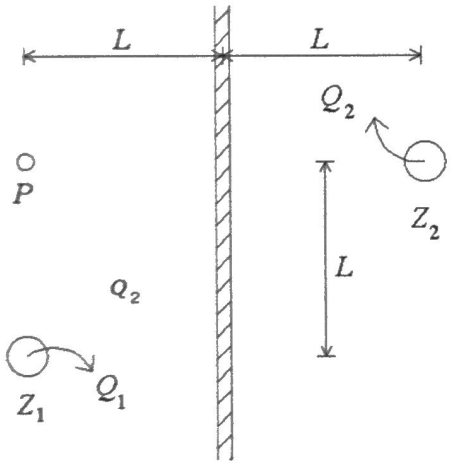
(20 bodova)



4) Zdenci Z_1 i Z_2 te piezometar P postavljeni su u vodonosnik sa slobodnim vodnim licem. Između zdenaca nalazi se napropusna granica. Potrebno je odrediti sniženja u piezometru P i zdencu Z_2.

Zadano je: k = 0.001 m/s; H = 20 m (početni potencijal vodonosnog sloja); R = 250 m (radijus utjecaja zdenaca); L = 80 m; r_0 = 0.3 m; Q_1 = 0.2 m^3/s; Q_2 = 0.1 m^3/s

(20 bodova)

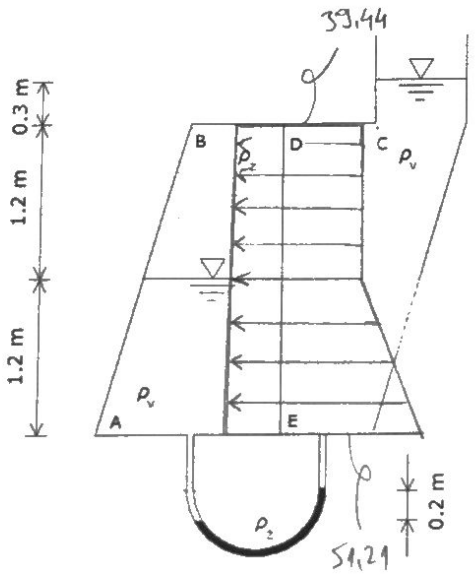


TEORIJA (15 bodova) :

1. Što je to strujna linija?
2. Riječima i grafički opišite Arhimedov zakon.
3. Napišite i objasnite zakon održanja količine gibanja.
4. Napišite Darcyjev zakon i objasnite članove.

Za pristupanje usmenom dijelu ispita potrebno je ostvariti minimalno 50 bodova i točno riješiti 1. i 2. zadatak!

1



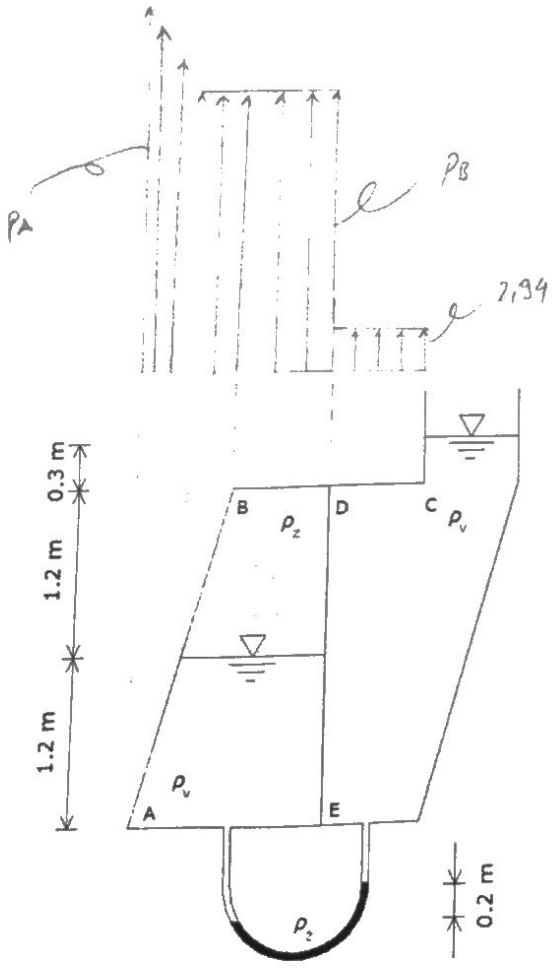
$p_C = \rho_v \cdot g \cdot 0,3 = 2,94 \text{ kPa}$

$p_E^D = \rho_v \cdot g \cdot 2,7 = 26,49 \text{ kPa}$

$p_A + \rho_v \cdot g \cdot 0,2 = p_E + \rho_{\bar{t}} \cdot g \cdot 0,2$

$p_A = 26,49 + 26,68 - 1,96 = 51,21 \text{ kPa}$

$p_B = p_A - \rho_v \cdot g \cdot 1,2 = 39,44 \text{ kPa}$



$F_{DE} = F_{DE}^L - F_{DE}^D$

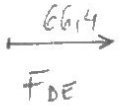
$F_{DE}^L = p_B \cdot 1,2 + \frac{p_B + p_A}{2} \cdot 1,2$

$= 101,72 \text{ kN}$

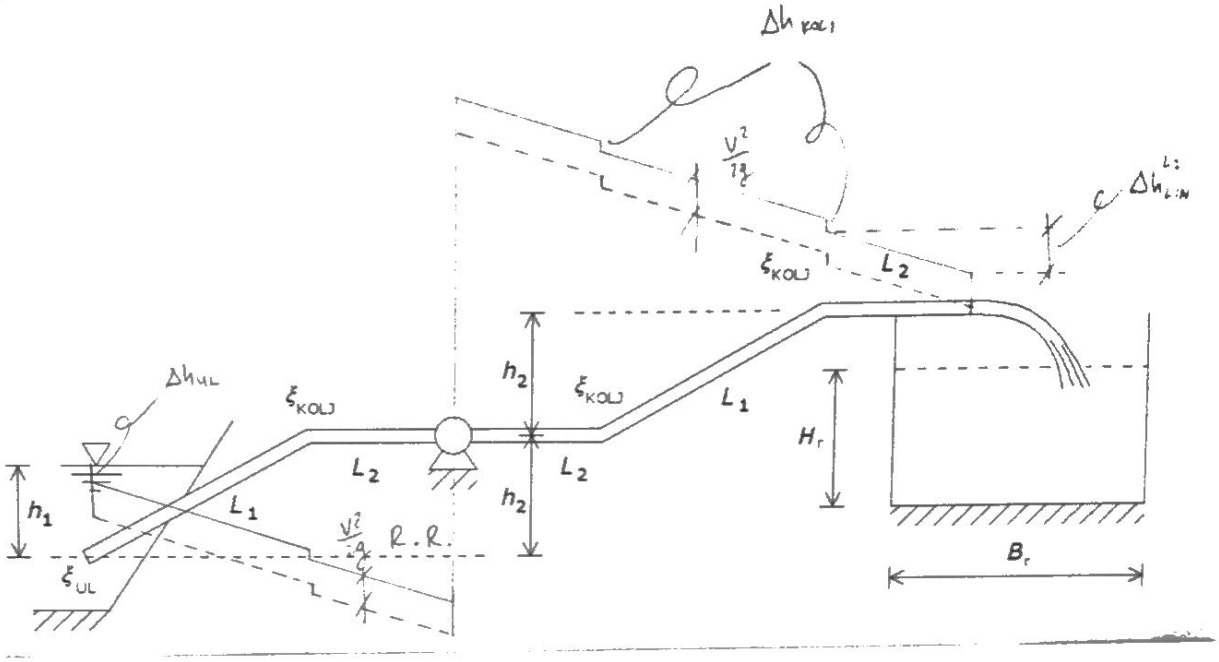
$F_{DE}^D = \frac{p_C + p_E^D}{2} \cdot 2,4$

$= 35,32 \text{ kN}$

$F_{DE} = 101,72 - 35,32 = 66,4 \text{ kN}$



(2)



$$Q = \frac{V}{t} = \frac{B_r^2 \cdot H_r}{t} = \frac{8^2 \cdot 2}{30 \cdot 60} = 0{,}0711 \ m^3/s$$

$$v = \frac{Q \cdot 4}{D^2 \pi} = \frac{0{,}0711 \cdot 4}{0{,}2^2 \pi} = 2{,}263 \ m/s$$

$$\frac{\varepsilon}{D} = \frac{0{,}2}{200} = 0{,}001 \ ; \qquad Re = \frac{v \cdot D}{\nu} = \frac{2{,}263 \cdot 0{,}2}{10^{-6}} = 4{,}5 \cdot 10^5 \Rightarrow \lambda = 0{,}0205$$

$$h_1 + H_D = 2h_2 + \frac{v^2}{2g}\left(\xi_{UL} + 3\xi_{KOL} + 2\lambda\frac{L_1}{D} + 3\lambda\frac{L_2}{D} + 1\right)$$

$$1{,}7 + H_p = 2 \cdot 2{,}1 + \frac{2{,}263^2}{2g}\left(0{,}7 + 3 \cdot 0{,}25 + 2 \cdot 0{,}0205\frac{30}{0{,}2} + 3 \cdot 0{,}0205\frac{14}{0{,}2} + 1\right)$$

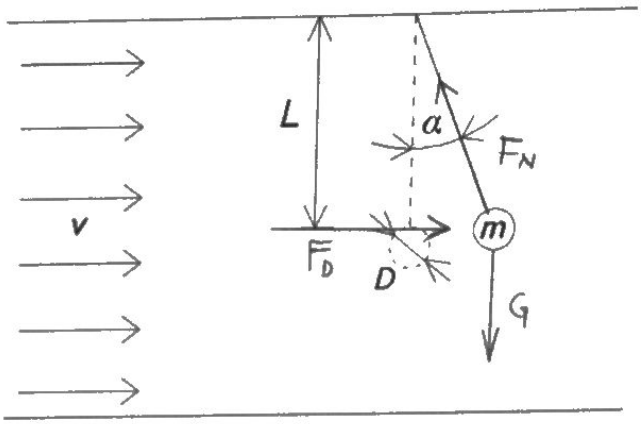
$$H_p = 4{,}2 - 1{,}7 + 0{,}261\left(0{,}7 + 3 \cdot 0{,}25 + 2 \cdot 3{,}02 + 3 \cdot 1{,}414 + 1\right)$$

$$H_p = 2{,}5 + 0{,}183 + 3 \cdot 0{,}065 + 2 \cdot 0{,}804 + 3 \cdot 0{,}376 + 0{,}261$$

$$H_p = 5{,}87 \ m$$

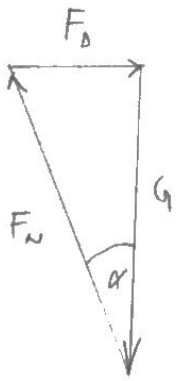
$$N_p = \frac{\rho g Q H_p}{\eta} = \frac{1 \cdot 9{,}81 \cdot 0{,}0711 \cdot 5{,}87}{0{,}85} = 4{,}82 \ kW$$

3



$G = m \cdot g = 1{,}3 \cdot 9{,}81$

$G = 12{,}75\ N$



$F_D = tg\alpha \cdot G$

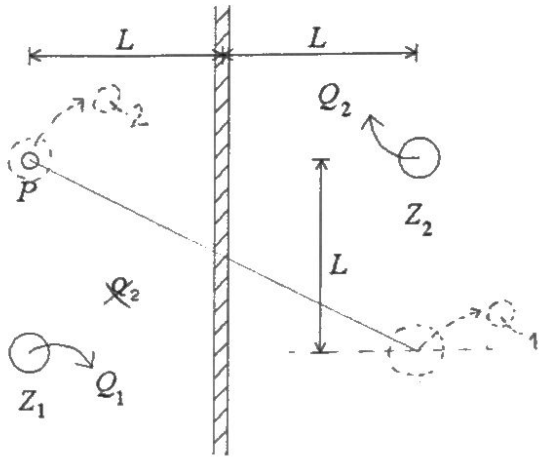
$= tg15° \cdot 12{,}75$

$= \underline{3{,}42\ N}$

$F_D = c_D \cdot \frac{D^2\pi}{4} \cdot \rho_z \cdot \frac{v^2}{2}$

$c_D = \frac{F_D \cdot 4 \cdot 2}{D^2\pi \cdot \rho_z \cdot v^2} = \frac{3{,}42 \cdot 4 \cdot 2}{0{,}28^2\pi \cdot 1{,}2 \cdot 15^2} = 0{,}41$

(4)



$$\Delta\phi_p = \frac{k}{2}\left(H^2 - h_p^2\right) = \frac{Q_1}{2\pi}\left(\ln\frac{R}{L} + \ln\frac{R}{\sqrt{5}L}\right)$$

$$\frac{0{,}001}{2}\left(20^2 - h_p^2\right) = \frac{0{,}2}{2\pi}\left(\ln\frac{750}{50} + \ln\frac{250}{\sqrt{5}\cdot 50}\right)$$

$$0{,}2 - 0{,}0005\,h_p^2 = 0{,}047$$

$$h_p = \sqrt{\frac{0{,}2 - 0{,}047}{0{,}0005}} = 17{,}49\ \text{m}$$

$$D_p = H - h_p = 2{,}51\ \text{m}$$

$$\Delta\phi_{z_2} = \frac{k}{2}\left(H^2 - h_{z_2}^2\right) = \frac{Q_2}{2\pi}\left(\ln\frac{R}{50} + \ln\frac{R}{2L}\right)$$

$$0{,}2 - 0{,}0005\,h_{z_2}^2 = 0{,}114$$

$$h_{z_2} = \sqrt{\frac{0{,}2 - 0{,}114}{0{,}0005}} = 13{,}11\ \text{m}$$

$$D_{z_2} = H - h_{z_2} = 6{,}89\ \text{m}$$