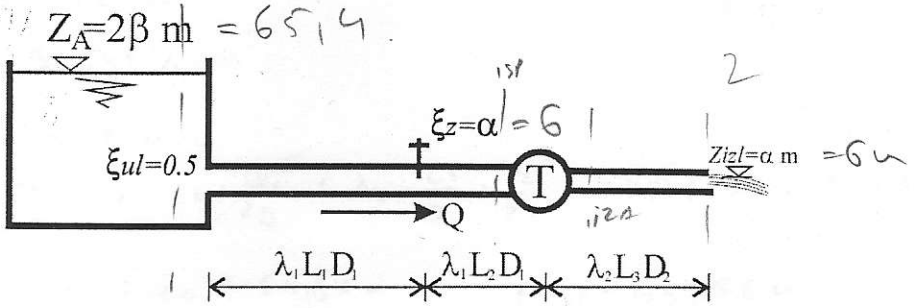
ZADACI ZA OVERU PRISUSTVA NA VEŽBAMA

ZADATAK 6.1

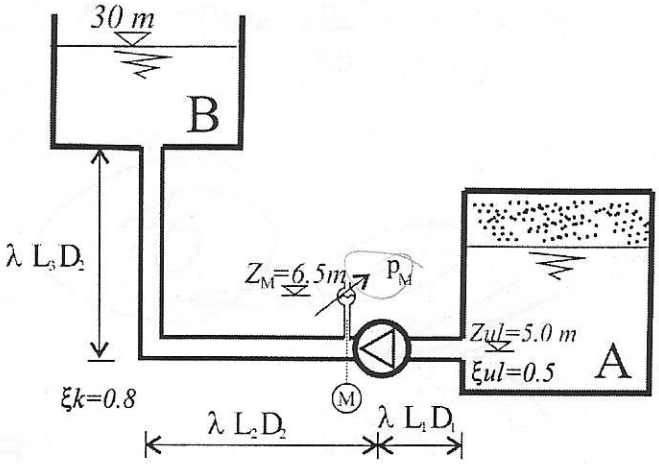
(Napomena: slike kotirati u metrima, a ne u opštim brojevima)

Na cevovodu kao na slici ($L_1=3\alpha$ m, $L_2=L_3=0.5L_1$ m, $D_1=(130+\alpha)$ mm, $D_2=0.85D_1$, $\lambda_1=0.015$, $\lambda_2=0.025$) nalazi se turbina ($\eta_T=0.75$). Kroz cevovod protiče $Q=(5+\beta)$ L/s. Postaviti en.jednačinu između rezervoara i preseka na izlazu i odrediti pad turbine (H_T) i snagu (S_T) pumpe. **Skicirati E i Π liniju.**



ZADATAK 6.2

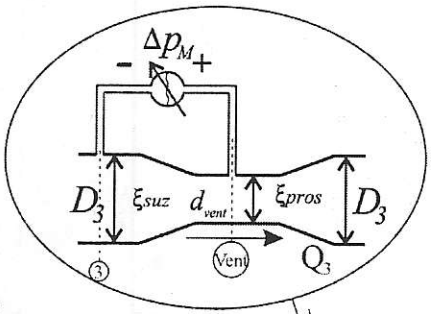
Na cevovodu ($L_1=\beta/5$ m, $L_2=2\beta$ m, $L_3=20$ m, $D_1=(100+\alpha)$ mm, $D_2=1.15D_1$, $\lambda=0.025$) je postavljena pumpa ($\eta_P=0.65$) i manometar koji očitava pritisak $p_M=\left(2.5+\alpha/50\right)$ bara. Postavljanjem energetske jednačine između preseka M i rezervoara B odrediti protok kroz cevovod Q. Ukoliko se zna da je instalirana pumpa snage $N_P=\left(5+\beta/10\right)$ KW odrediti visinu dizanja pumpe. Postavljanjem energetske jednačine između preseka M i rezervoara A odrediti pijezometarsku kotu Π_A. **Skicirati E i Π liniju.**

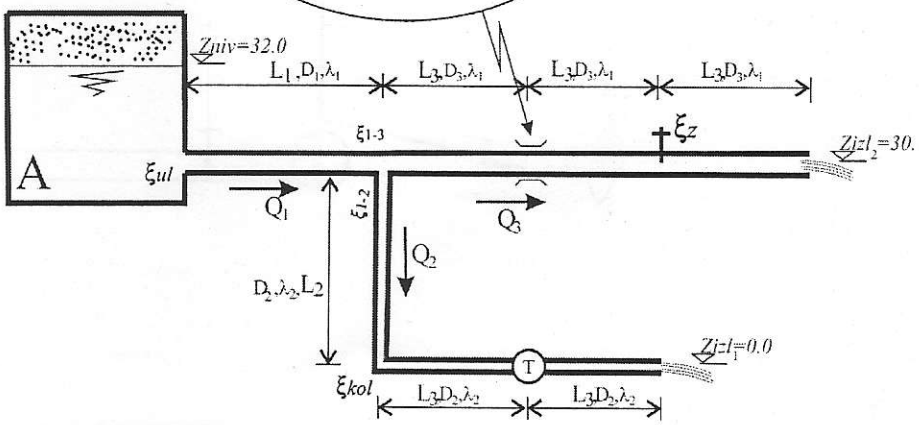


ZADATAK 6.3 ZA DOMAĆI RAD

U sistemu prikazanom na slici nalazi se instalirana turbina koeficijenta korisnog dejstva $\eta_T=0.85$. Karakteristike cevovoda su:

- $L_1=60$ m, $L_2=30$ m, $L_3=50$ m,
- $\xi_{1-2}=1.2$, $\xi_{1-3}=0.5$, $\xi_{kol}=0.8$, $\xi_z=20$, $\xi_{ul}=0.5$
- $\lambda_1=0.022$, $\lambda_2=0.025$
- $D_1=(120+\beta)$ mm, $D_2=0.9D_1$, $D_3=0.8D_1$





Uraditi sledeće:

1. Odrediti protok Q_3 koristeći čitanje na diferencijalnom manometru $\Delta p_M=-0.1$ bara postavljenom na Venturijevom suženju(en.jna 3-Vent) $d_{vent}=0.7D_3$, $\xi_{suz}=0.25$, $\xi_{pros}=1.25$
2. Ako je odnos protoka $Q_2/Q_3=\left(2+\alpha/20\right)$ odrediti protoke Q_2 i Q_1.
3. Odrediti Π kotu u rezervoaru A (en.jednačina A-Z_{izl2}) i pritisak u vazduhu iznad nivoa vode,
4. Odrediti pad turbine H_T (en.jednačina A-Z_{izl1}) i njenu snagu S_T
5. **Nacrtati u pogodnoj razmeri E i Π linije** (B - Z_{izl1} i B - Z_{izl2})

11 $L_1 = 18m$ $D_2 = 115,6mm = 0,1156m$

$L_2 = L_3 = 9m$ $\lambda_1 = 0,015$ $\eta_T = 0,75$

$D_1 = 136mm = 0,136m$ $\lambda_2 = 0,025$ $Q = 37,2\ L/s = 0,0372\ m^3/s$

$v_1 = 2,561\ m/s$

$E_1 = E_{isp} + \Delta E_{1-isp}$

$$H_1 = \xi_{VL} \cdot \frac{v_1^2}{2g} + \frac{\lambda_1}{D_1} \frac{v_1^2}{2g} \cdot L_1 + \xi_2 \cdot \frac{v_1^2}{2g} + \lambda_1 \frac{L_2}{D_1} \cdot \frac{v_1^2}{2g} + H_{isp} + \frac{v_1^2}{2g}$$

E_{isp}

$H_{isp} = 63,225m$

$v_2 = \frac{Q}{A_2} = 3,549\ m/s$

$E_{i2A} = E_2 + \Delta E_{i2A-2}$

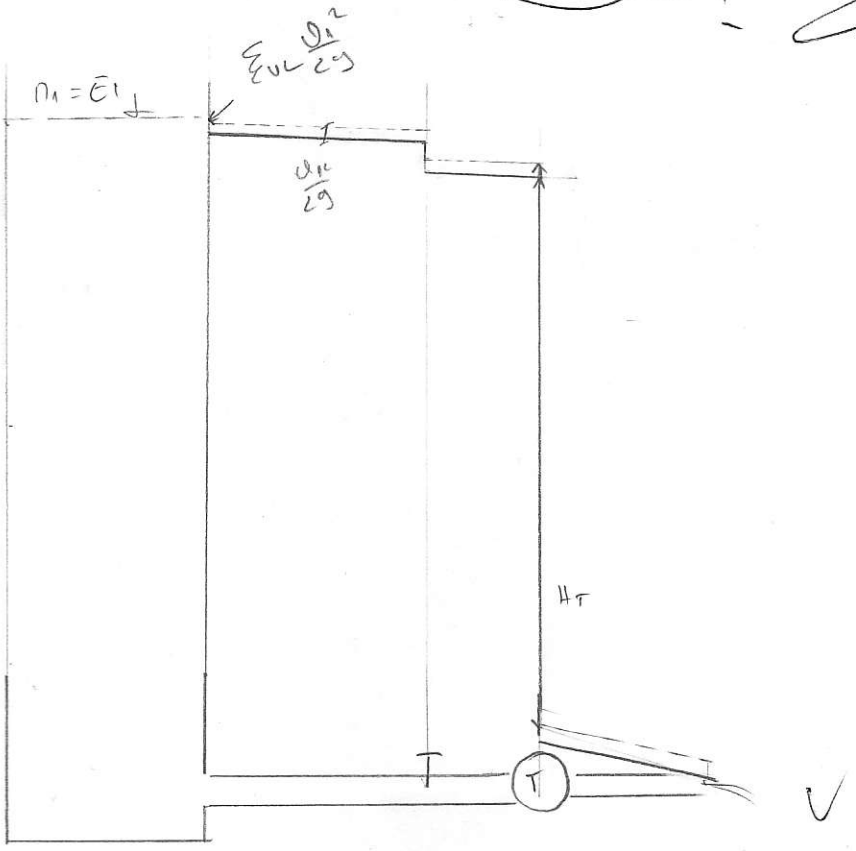
$$H_{i2A} + \frac{v_1^2}{2g} = z_{i2-2} + \frac{v_2^2}{2g} + \lambda_2 \cdot \frac{L_3}{D_2} \cdot \frac{v_2^2}{2g} \Rightarrow H_{i2A} = 7,246m$$

$H_T = E_{isp} - E_{i2A} = 55,64m$ $E_{isp} = 63,56m$

$S_T = \eta_T \cdot \rho \cdot g \cdot Q \cdot H_T$ $E_{i2A} = H_{i2A} + \frac{v_2^2}{2g} = 7,386m$

$S_T = 15,236,82\ kW$

10



6.2

$L_1 = 6,54\ m$ $\quad D_1 = 106\ mm = 0,106\ m$ $\quad \eta_p = 0,65$

$L_2 = 65,4\ m$ $\quad D_2 = 0,1219\ m$ $\quad p_m = 2,62\ bar$

$L_3 = 20\ m$ $\quad \lambda = 0,025$ $\quad N_p = 8270\ W$

$n_s = 30\ m$ $\quad n_m = z_m + \frac{p_m}{\rho g}$

$E_m = E_s + \Delta E_{m-s}$

$$n_m + \frac{Q^2}{A_2^2 2g} = n_s + \lambda \frac{L_2}{D_2} \frac{Q^2}{A_2^2 2g} + \xi_k \cdot \frac{Q^2}{A_2^2 2g} + \lambda \frac{L_3}{D_2} \frac{Q^2}{A_2^2 2g} + 1 \cdot \frac{Q^2}{A_2^2 2g}$$

$$n_m - n_s = \frac{Q^2}{A_2^2 2g} \left(\lambda \frac{L_2}{D_2} + \xi_k + \frac{\lambda \cdot L_3}{D_2} + 1 \right)$$

$Q = 19,951\ l/s$ $\quad v_2 = 1,699\ m/s$ $\quad v_1 = 2,246\ m/s$

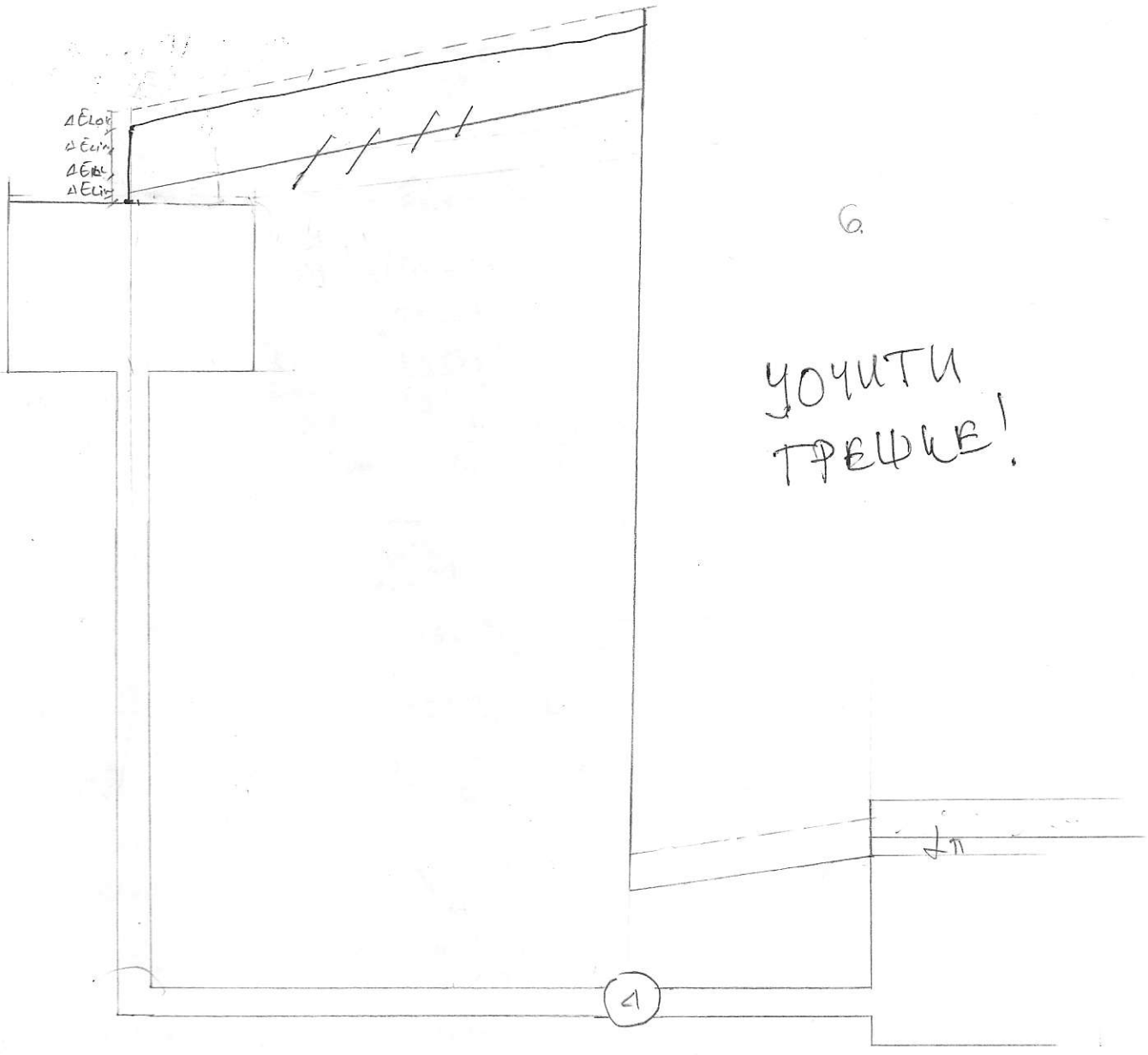
$$N_p = \frac{1}{\eta_p} \rho g Q H_p \Rightarrow H_p = 29,77\ m$$

$$E_{pre} = E_m - H_p \Rightarrow n_{pre} = n_m + \frac{v_2^2}{2g} + \frac{v_1^2}{2g} - H_p$$

$n_{pre} = 3,162\ m$

$E_A = E_{pre} + \Delta E_{A-pre}$

$$n_A = n_{pre} + \frac{v_1^2}{2g} + \xi_{VL} \cdot \frac{v_1^2}{2g} + \lambda \cdot \frac{L_1}{D_1} \frac{v_1^2}{2g} \Rightarrow n_A = 9,076\ m$$



6.

УОЧИТИ ТРЕШКЕ!

6.3

$L_1 = 60\,m$ $\quad \xi_2 = 20$ $\quad \eta_T = 0{,}85$

$L_2 = 30\,m$ $\quad \xi_{UL} = 0{,}5$

$L_3 = 50\,m$ $\quad \lambda_1 = 0{,}022$

$\xi_{1-2} = 1{,}2$ $\quad \lambda_2 = 0{,}025$

$\xi_{1-3} = 0{,}5$ $\quad D_1 = 152{,}7\,mm = 0{,}1527\,m$

$\xi_{KOL} = 0{,}18$ $\quad D_2 = 0{,}1374\,m$ $\quad D_3 = 0{,}1222\,m$

1) $\Delta p_M = -10000\,Pa$

$d_{VENT} = 0{,}7 \cdot 0{,}1222 \Rightarrow d_{VENT} = 0{,}08554$

$\xi_{SUŽ} = 0{,}25$ $\quad \xi_{PROS} = 1{,}25$

$E_3 = E_{VENT} + \Delta E_{3-VENT}$

$$H_3 + \frac{v_3^2}{2g} = H_{VENT} + \frac{v_{VENT}^2}{2g} + \xi_{SUŽ} \cdot \frac{v_{VENT}^2}{2g}$$

$Q = v \cdot A \Rightarrow v = \frac{Q}{A} = \frac{Q \cdot 4}{D^2 \pi}$

$v^2 = \frac{16 Q^2}{D^4 \pi^2}$

$\Delta p_M = \rho g (H_{VENT} - z_M) - \rho g (H_3 - z_M)$

$$H_3 - H_{VENT} = \frac{-\Delta p}{\rho g} = 1{,}01937\,m$$

$$H_3 - H_{VENT} = \frac{Q_3^2 \cdot 16}{2g\pi^2 \cdot d_{VENT}^4} - \frac{16 Q_3^2}{2g\pi^2 D_3^4} + \xi_{SUŽ} \frac{Q_3^2 \cdot 16}{2g\pi^2 d_{VENT}^4}$$

$$H_3 - H_{VENT} = \frac{Q_3^2 \cdot 8}{g\pi^2} \left(\frac{1}{d_{VENT}^4} - \frac{1}{D_3^4} + \frac{\xi_{SUŽ}}{d_{VENT}^4} \right) \Rightarrow$$

$$Q_3^2 = \frac{g\pi^2 \cdot 1{,}01937}{8\left(\frac{1}{d_{VENT}^4} - \frac{1}{D_3^4} + \frac{\xi_{SUŽ}}{d_{VENT}^4} \right)} \Rightarrow Q_3 = 24{,}155\,l/s$$

2) $\frac{Q_2}{Q_3} = 2{,}3$ $\quad Q_2 = 62{,}456\,l/s$ $\quad Q_1 = Q_2 + Q_3 \Rightarrow Q_1 = 89{,}6115\,l/s$

3) $v_1 = \frac{Q_1}{A_1} = \frac{4Q_1}{D_1^2 \pi} = 4{,}893\,m/s$ $\quad v_{VENT} = \frac{Q_3}{A_{VENT}} = \frac{4Q_3}{d_{VENT}^2 \pi} = 4{,}425\,m/s$

$v_3 = \frac{4Q_3}{D_3^2 \pi} = 2{,}315\,m/s$ $\quad v_2 = \frac{4Q_2}{D_2^2 \pi} = 4{,}212\,m/s$

$E_A = E_{IZL2} + \Delta E_{A-IZL2}$

$$H_A = z_{IZL2} + \frac{v_3^2}{2g} + \frac{v_1^2}{2g}\left(\xi_{UL} + \lambda_1 \frac{L_1}{D_1} \right) + \frac{v_3^2}{2g}\left(\xi_{1-3} + \lambda_1 \frac{L_3}{D_3} \right) + \xi_{SUŽ} \cdot \frac{v_{VENT}^2}{2g}$$

$$+ \left(\xi_{PROŠ} + \lambda_1 \frac{L_3}{D_3} + \xi_2 + \lambda_1 \frac{L_2}{D_3} \right) \cdot \frac{v_3^2}{2g}$$

$H_A = 51{,}435\,m$ $\quad p_A = (H_A - z_{NIV}) \cdot \rho g = 190657{,}3\,Pa$

4) $E_A = E_{IZL1} + \Delta E_{A-IZL1} + H_T$

$$H_A = \frac{v_2^2}{2g} + \frac{v_1^2}{2g}\left(\xi_{UL} + \lambda_1 \frac{L_1}{D_1} \right) + \frac{v_2^2}{2g}\left(\xi_{1-2} + \lambda_2 \cdot \frac{L_2}{D_2} + \xi_{KOL} + \lambda_2 \frac{L_3}{D_2} + \lambda_2 \frac{L_3}{D_2} \right) + H_T$$

$H_T = 22{,}247\,m$

$S_t = \rho g Q_2 \cdot H_T \cdot \eta_T = 11{,}586\,kW$

6.3 $L_1 = 60\,m$ $\xi_2 = 20$ $\eta_T = 0,85$

$L_2 = 30\,m$ $\xi_{UL} = 0,5$

$L_3 = 50\,m$ $\lambda_1 = 0,022$

$\xi_{1-2} = 1,2$ $\lambda_2 = 0,025$

$\xi_{1-3} = 0,5$ $D_1 = 152,7\,mm = 0,1527\,m$

$\xi_{KOL} = 0,18$ $D_2 = 0,1374\,m$ $D_3 = 0,1222\,m$

1) $\Delta p_M = 10000\,Pa$

$d_{VENT} = 0,7 \cdot 0,1222 \Rightarrow d_{VENT} = 0,08554$

$\xi_{SUŽ} = 0,25$ $\xi_{PROS} = 1,25$

$E_3 = E_{VENT} + \Delta E_{3-VENT}$

$H_3 + \frac{v_3^2}{2g} = H_{VENT} + \frac{v_{VENT}^2}{2g} + \xi_{SUŽ} \cdot \frac{v_{VENT}^2}{2g}$ $\quad Q = v \cdot A \Rightarrow v = \frac{Q}{A} = \frac{Q \cdot 4}{D^2 \pi}$

$\Delta p_M = \rho g (H_{VENT} - z_M) - \rho g (H_3 - z_M)$ $\quad v^2 = \frac{16 Q^2}{D^4 \pi^2}$

$H_3 - H_{VENT} = \frac{-\Delta p}{\rho g} = 1,01937\,m$

$H_3 - H_{VENT} = \frac{Q_3^2 \cdot 16}{2 g \pi^2 \cdot d_{VENT}^4} - \frac{16 Q_3^2}{2 g \pi^2 D_3^4} + \xi_{SUŽ} \frac{Q_3^2 \cdot 16}{2 g \pi^2 d_{VENT}^4}$

$H_3 - H_{VENT} = \frac{Q_3^2 \cdot 8}{g \pi^2} \left(\frac{1}{d_{VENT}^4} - \frac{1}{D_3^4} + \frac{\xi_{SUŽ}}{d_{VENT}^4} \right) \Rightarrow$

$Q_3^2 = \frac{g \pi^2 \cdot 1,01937}{8 \left(\frac{1}{d_{VENT}^4} - \frac{1}{D_3^4} + \frac{\xi_{SUŽ}}{d_{VENT}^4} \right)} \Rightarrow Q_3 = 24,155\,l/s$

2) $\frac{Q_2}{Q_3} = 2,3$ $\quad Q_2 = 62,456\,l/s$ $\quad Q_1 = Q_2 + Q_3 \Rightarrow Q_1 = 89,6115\,l/s$

3) $v_1 = \frac{Q_1}{A_1} = \frac{4 Q_1}{D_1^2 \pi} = 4,893\,m/s$ $\quad v_{VENT} = \frac{Q_3}{A_{VENT}} = \frac{4 Q_3}{d_{VENT}^2 \pi} = 4,425\,m/s$

$v_3 = \frac{4 Q_3}{D_3^2 \pi} = 2,315\,m/s$ $\quad v_2 = \frac{4 Q_2}{D_2^2 \pi} = 4,212\,m/s$

$E_A = E_{IZL2} + \Delta E_{A-IZL2}$

$H_A = z_{IZL2} + \frac{v_3^2}{2g} + \frac{v_1^2}{2g} \left(\xi_{UL} + \lambda_1 \frac{L_1}{D_1} \right) + \frac{v_3^2}{2g} \left(\xi_{1-3} + \lambda_1 \frac{L_3}{D_3} \right) + \xi_{SUŽ} \cdot \frac{v_{VENT}^2}{2g}$

$+ \left(\xi_{PROŠ} + \lambda_1 \frac{L_3}{D_3} + \xi_2 + \lambda_1 \frac{L_2}{D_3} \right) \cdot \frac{v_3^2}{2g}$

$H_A = 51,435\,m$ $\quad p_A = (H_A - z_{NIV}) \cdot \rho g = 190657,3\,Pa$

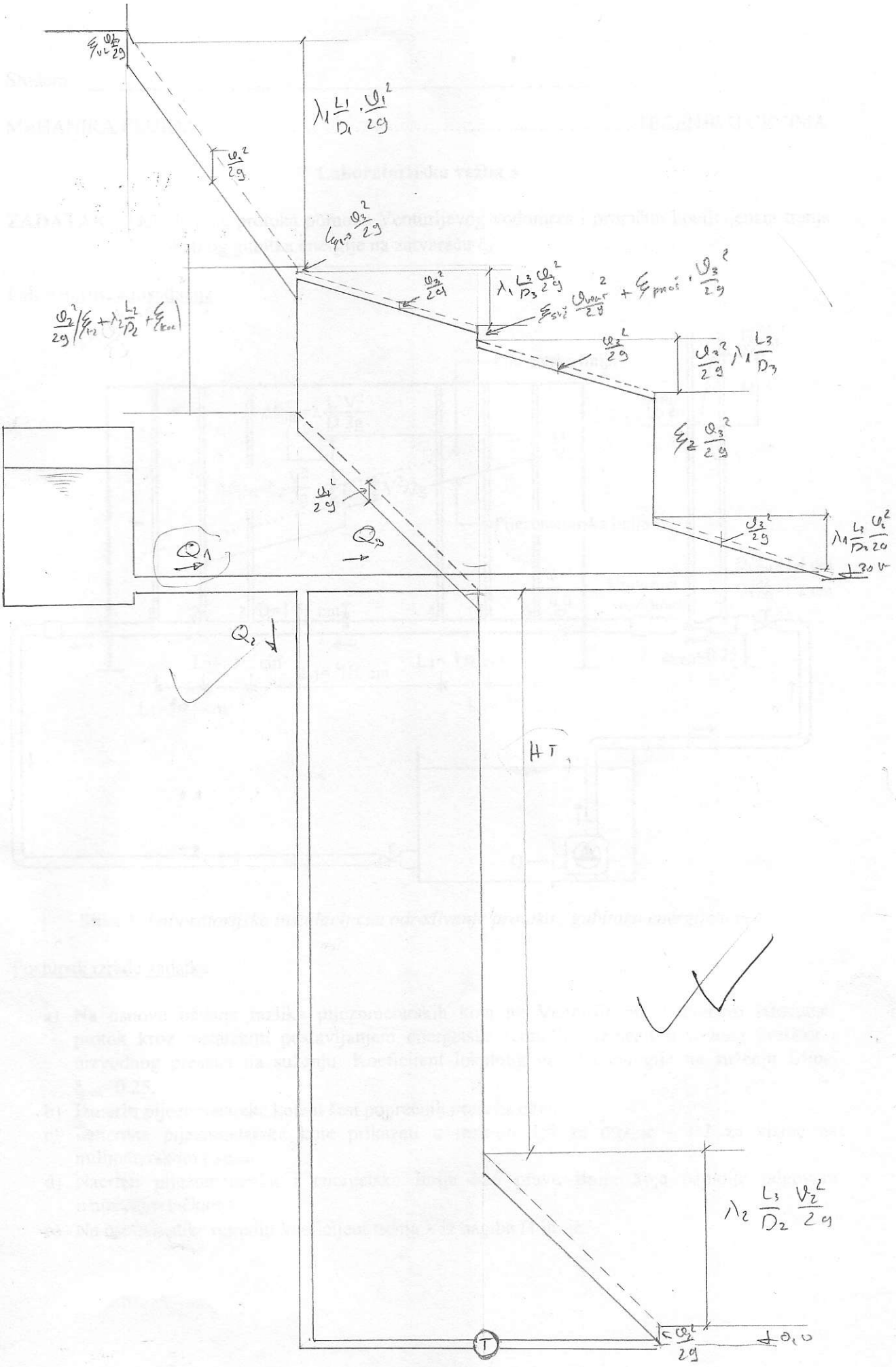
4) $E_A = E_{IZL1} + \Delta E_{A-IZL1} + H_T$

$H_A = \frac{v_2^2}{2g} + \frac{v_1^2}{2g} \left(\xi_{UL} + \lambda_1 \frac{L_1}{D_1} \right) + \frac{v_2^2}{2g} \left(\xi_{1-2} + \lambda_2 \cdot \frac{L_2}{D_2} + \xi_{KOL} + \lambda_2 \frac{L_3}{D_2} + \lambda_2 \frac{L_3}{D_2} \right) + H_T$

$H_T = 22,247\,m$

$S_t = \rho g Q_2 \cdot H_T \cdot \eta_T = 11,586\,kW$

6.3


$\zeta_{vt}\frac{v_1^2}{2g}$
$\lambda_1\frac{L_1}{D_1}\cdot\frac{v_1^2}{2g}$
$\frac{v_2^2}{2g}$
$\zeta_{ven}\frac{v_2^2}{2g}$
$\frac{v_2^2}{2g}\left(\zeta_{ki2}+\lambda_2\frac{L_2}{D_2}+\zeta_{kol}\right)$
$\frac{v_2^2}{2g}$
$\lambda_1\frac{L_3}{D_3}\frac{v_3^2}{2g}$
$\zeta_{sv2}\frac{v_{ven}^2}{2g}+\zeta_{proi}\cdot\frac{v_3^2}{2g}$
$\frac{v_3^2}{2g}$
$\frac{v_3^2}{2g}\lambda_1\frac{L_3}{D_3}$
$\zeta_2\frac{v_3^2}{2g}$
$\frac{v_2^2}{2g}$
Q_1
Q_2
$\frac{v_3^2}{2g}$
$\lambda_1\frac{L_3}{D_3}\frac{v_3^2}{2g}$
+30 m
Q_3
HT
$\lambda_2\frac{L_3}{D_2}\frac{v_2^2}{2g}$
$\frac{v_2^2}{2g}$
+0,0
T