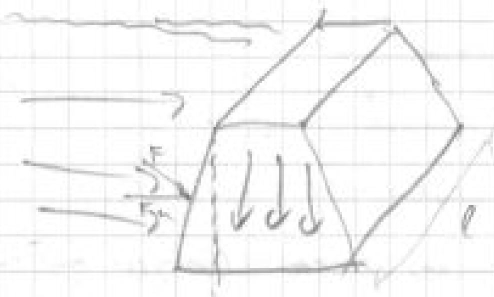
① Tri klisure



Duljina 2309 m

Visina 185 m

Dubina vode 175 m

$F_H = \rho g H_T \cdot A = 1000\,kg/m^3 \cdot 9.80665\,m/s^2 \cdot \frac{175}{2}\,m \cdot 2309\,m \cdot 175\,m =$

$= 3.47 \cdot 10^{11}\,N$

samo horizontalna (ne ukupna)

② [illegible]

1 kg vode, snaga 500 W $= \dot{Q}$

→ temp. okoline, počela ključati

→ 1 bar

$\eta_{EV} = 1$

$h_{isp.} = 2257.5313\,kJ/kg$

$dq = dh - v\,dp = dh$ ($dp = 0$)

$dH = h\,dm = (h'' - h')\,dm \;/dt$

$\frac{dH}{dt} = (h'' - h') \cdot \frac{dm}{dt}$

$\Rightarrow \frac{dm}{dt} = \frac{\dot{H}\,(=\dot{Q})}{h'' - h'} = \frac{500\,W}{2258\,kJ/kg} = 0.22\,g/s$

$0.22\,g : 1\,s = 1000\,g : x\,s$

$x = \frac{1000}{0.22} = 4545.45\,s = 1.26\,h$

(3) Izentropa = povratljiva adijabata (nema gubitaka u okolicu)

↓ $pV^{\varkappa} = konst$

$\varkappa = \frac{c_p}{c_v}$ Idealni plin ($K = 1.41$, $R = 287\ J/(kg\,K)$)

p_a: 1 bar, 20°C → kraj: 48 bar

$p_p V_p^{\varkappa} = p_k V_k^{\varkappa} \Rightarrow \frac{V_k}{V_p} = \left(\frac{p_p}{p_k}\right)^{\frac{1}{\varkappa}}$

$\frac{p_p V_p}{T_p} = \frac{p_k V_k}{T_k} \Rightarrow T_k = \frac{p_k V_k T_p}{p_p V_p}$

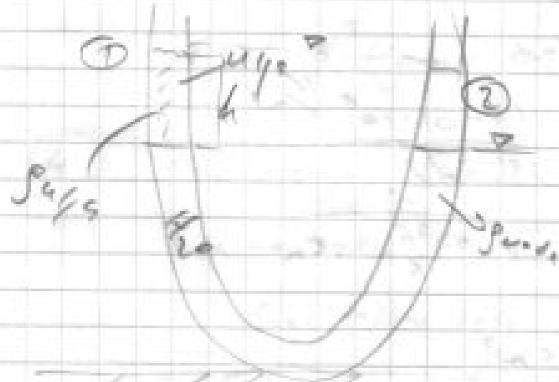
$T_k = 903.57\,K$ 0.0642

5n2 $\frac{p}{\rho^{\varkappa}} = konst \Rightarrow \frac{p_p}{\rho_p^{\varkappa}} = \frac{p_k}{\rho_k^{\varkappa}}$

$\rho_k = \left(\frac{p_k}{p_p}\right)^{\frac{1}{\varkappa}} \cdot \rho_p \Rightarrow \rho_p = \frac{p_p}{R_a T_p} = \frac{100\,k\frac{N}{m^2}}{0.287\,\frac{kNm}{kgK} \cdot 293.15\,K} = 1.19\,kg/m^3$

$\rho_k = \left(\frac{48\,bar}{1\,bar}\right)^{\frac{1}{1.41}} \cdot 1.19\,kg/m^3 = 18.53\,kg/m^3$

$T_k = \frac{p_k}{\rho_k \cdot R} = \frac{4800\,k\frac{N}{m^2}}{18.53\,kg/m^3 \cdot 0.287\,k\frac{Nm}{kgK}} = 902.5\,K$ (629.35°C)



$p_1 = \rho_{ulje} \cdot g \cdot h$

$p_2 = \rho_{vode} \cdot g \cdot h$

$p_1 = p_2$

$\rho_{ulje} \neq \rho_{vode} \Rightarrow h_{ulje}\ h_v \neq h_u$

Manometar

$$p_{at} + \rho_k \cdot g \cdot H_k - \rho_m \cdot g \cdot H_m = p_{at}$$

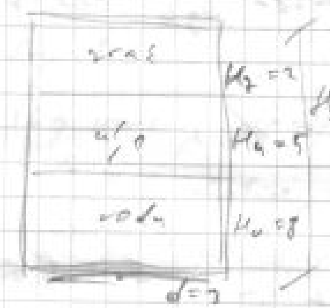
$$\Rightarrow H_k = H_m \cdot \frac{\rho_m}{\rho_k}$$

SPIT → 2-3 teoretska zadatka

→ zadaci ko u DZ (jednostavno)

1.07.-2008

1. Cilindrični valjak H_s, d
(zatvoren)



Manometar → pretlak

Ukupni tlak = Manometar + dolica

V_{uz} = konst, zanemarujemo

Ubacujemo zrak do manometar 1,0 MPa

$$K = -\frac{dp}{dV} \cdot V \rightarrow \text{volumni modul elast.}$$

$$d = \Delta + \Delta$$

ulja $\quad 2050\ N/m^2 = \dfrac{(1-0)\cdot 10^6\ N/m^2}{\dfrac{dV_{ulja}}{\frac{3^2\pi}{4} m^2 \cdot 5m}}$

$$\Rightarrow dV_{ulja} = -12.25\ m^3$$

voda $\quad 2025\ N/m^2 = \dfrac{(1-0)\cdot 10^6\ N/m^2}{\dfrac{dV_{H_2O}}{\frac{3^2\pi}{4} m^2 \cdot 8m}}$

$$dV_{H_2O} = -27.25\ m^3$$

$$dV_{uz} = dV_{H_2O} + dV_{ulja} = 44.49\ m^3$$

$44.49\,m^3 = \frac{3^2\pi}{4}\,m^2 \cdot x\,m \Rightarrow x = 6.29\,m$

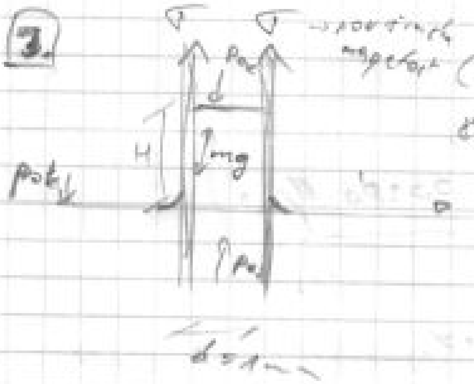
2. Voda pod nadtlakom 306 bara, čelični spremnik 1 m³. Raspored ... spremnika koliko će biti volumen vode.

$$\beta_p = \frac{1}{K} \Rightarrow K = \frac{1}{0.000476\ m^2/MN} = 2101\ \frac{MN}{m^2}$$

koef. vol. stlačivosti

$$K = -\frac{dp}{\frac{dV}{V}} = -\frac{0-360\cdot 10^5\ N/m^2}{\frac{(V_2 - 1\,m^3)}{1\,m^3}} \Rightarrow V_2 = 1.017\,m^3$$

3.



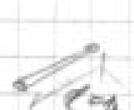
$\rho g V = \rho g d^2 \cdot H$

$$2\sigma d - d^2 H \rho g = 0\ (N) \Rightarrow H = 14.9\,mm$$

4. Max promjer igle?!?

igla na vodi $\rightarrow \sigma = 0.0236\ N/m$

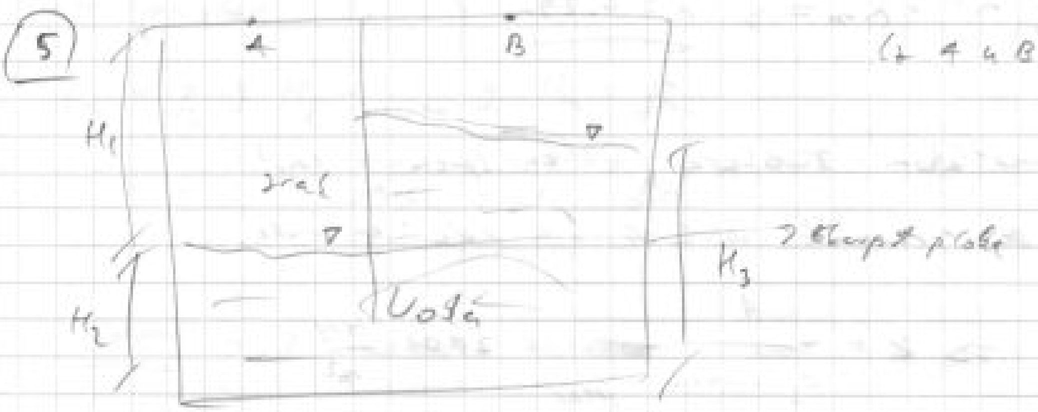
Spec težina igle $72{,}840\ N/m^3 \rightarrow \gamma_{čelik}$



$$2\sigma l \geq G_{igle} = \frac{d^2\pi}{4} \cdot l \cdot \gamma_{čelik}$$

$$d_{max} = \sqrt{\frac{8\sigma}{\gamma_{č}\,\pi}} = 1.55\,mm$$

(5)



(I)

$$p_A + \rho_z \cdot g \cdot H_1 - \rho_v \cdot g\,(H_3 - H_2) - \rho_z \cdot g\,(H_1 + H_2 - H_3) = p_B$$

$p_B = 70.404\ N/m^2$

(II) Bez težine zraka

$$p_A - \rho_v\, g\,(H_3 - H_2) = p_B$$

$90000\ N/m^2 - 1000\ kg/m^3 \cdot 9.81\ m/s^2 \cdot 2\ m = 70380\ N/m^2$

$$\text{Pogreška} = \frac{70404 - 70380}{70404} \cdot 100\% = 0.0341\%$$

(6) Manometar na vert. cijevi

$p_A - p_B = ?$ $\quad \rho_v = 1000\ kg/m^3$ $\quad \rho_{Hg} = 13600\ kg/m^3$

$g = 9.81\ m/s^2$

$H = 0.6\ m$ $\quad H_1 = 0.3\ m$ $\quad H_2 = 1.5\ m$

Iz A u B gore (minus), dole (plus)

$$p_A - \rho_v \cdot g\,(H_2 + H_1) - \rho_z \cdot g \cdot H + \rho_v \cdot g\,(H + H_1) = p_B$$

$p_A - p_B = 88\,878.6\ N/m^2$