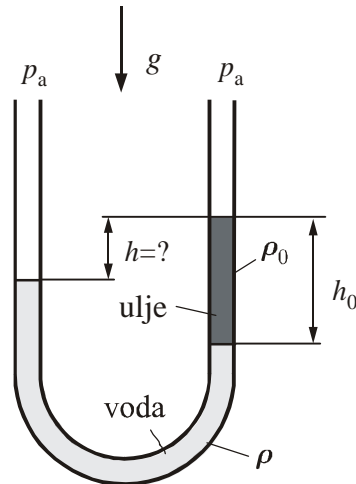
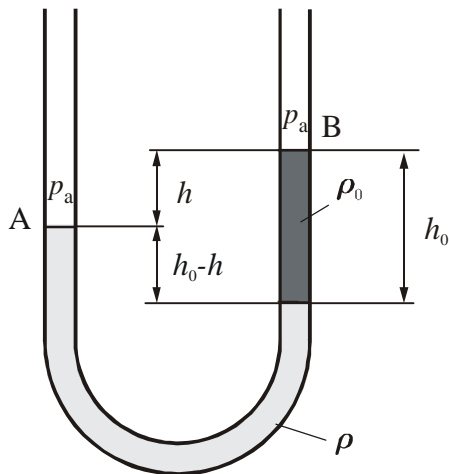


1. U jedan krak U-cijevi u kojoj se nalazi voda gustoće $\rho=999,1 \text{ kg/m}^3$ nadoliveno je ulje gustoće $\rho_0=820 \text{ kg/m}^3$, prema slici. Ako je visina stupca ulja $h_0=150 \text{ mm}$, odredite razliku visina h razina ulja i vode.



Rješenje:

Jednadžba manometra od A do B:



$$p_a + \rho g (h_0 - h) - \rho_0 g h_0 = p_a \quad (1)$$

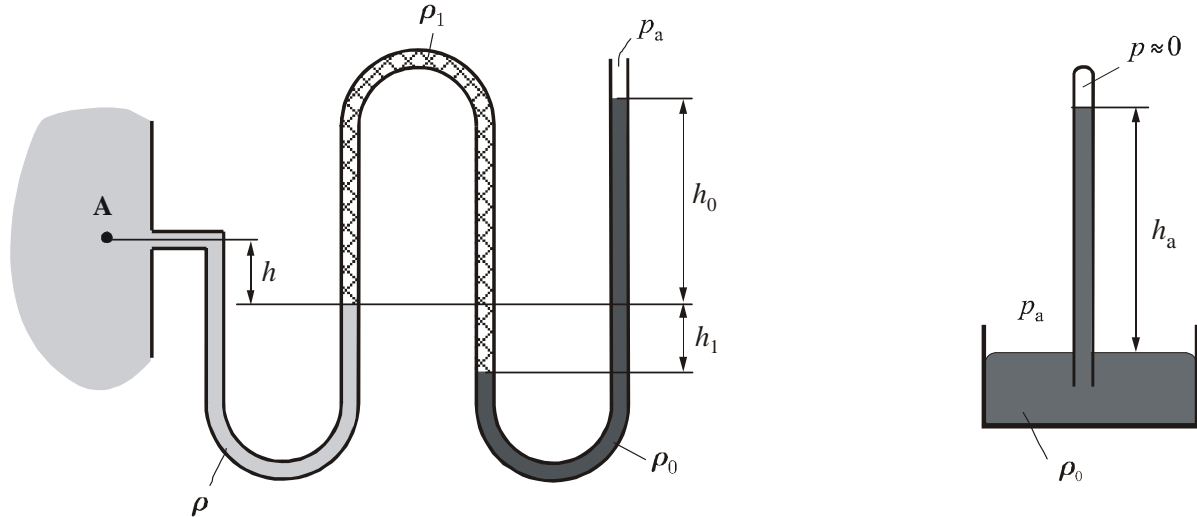
$$\rho h_0 - \rho h - \rho_0 h_0 = 0$$

$$h = h_0 \left(1 - \frac{\rho_0}{\rho} \right)$$

$$h = 0,150 \left(1 - \frac{820}{999,1} \right)$$

$$h = 0,0269 \text{ m} = 26,9 \text{ mm}$$

2. Odredite apsolutni i manometarski tlak u točki A spremnika, za otklone manometra i barometra prema slici. Zadano je: $\rho = 999 \text{ kg/m}^3$, $\rho_1 = 771 \text{ kg/m}^3$, $\rho_0 = 13560 \text{ kg/m}^3$, $h = 5 \text{ cm}$, $h_0 = 17,5 \text{ cm}$, $h_1 = 12,5 \text{ cm}$, $h_a = 752 \text{ mm}$.



Rješenje:

Barometar: $p_a = \rho_0 g h_a = 99999,6 \text{ Pa} = 1000 \text{ mbar} = 1000 \text{ hPa}$

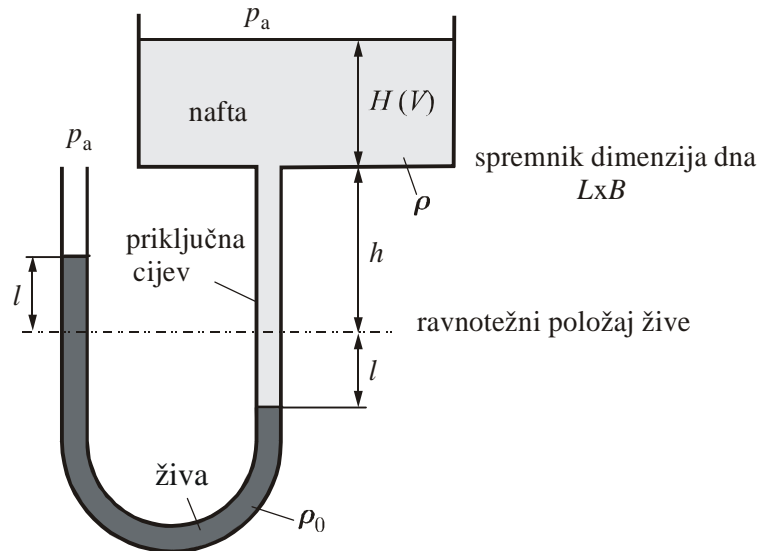
$$0,001 \text{ bar} = 1 \text{ mbar} = 1 \text{ hPa}$$

Manometar: $p_A = p_a + \rho_0 g (h_0 + h_1) - \rho_1 g h_1 - \rho g h$

Apsolutni tlak u točki A: $p_A = 138458 \text{ Pa} = 1385 \text{ mbar}$

Manometarski tlak u točki A: $p_{MA} = p_A - p_a = 38458 \text{ Pa} = 385 \text{ mbar}$

3. Hidrostatski manometar može se iskoristiti za mjerenje količine fluida u spremniku oblika paralelopipeda. Odredite zavisnost visine l žive gustoće ρ_0 u lijevom kraku manometra o volumenu V nafte gustoće ρ u spremniku dimenzija dna $L \times B$. Visina h se mjeri od ravnotežnog položaja žive prije punjenja spremnika i priključne cijevi naftom.



Rješenje:

$$V = L \cdot B \cdot H \Rightarrow H = \frac{V}{L \cdot B} \quad (1)$$

$$p_a + \rho g (H + h + l) - 2\rho_0 g l = p_a \quad (2)$$

(1) u (2)

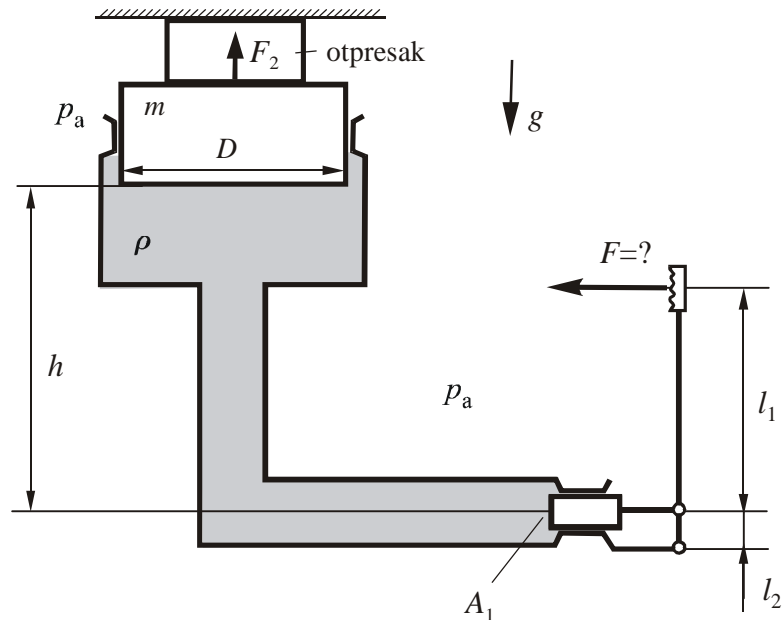
$$\rho \left(\frac{V}{L \cdot B} + h \right) = l (2\rho_0 - \rho)$$

$$l = \frac{\rho}{2\rho_0 - \rho} \left(\frac{V}{L \cdot B} + h \right)$$

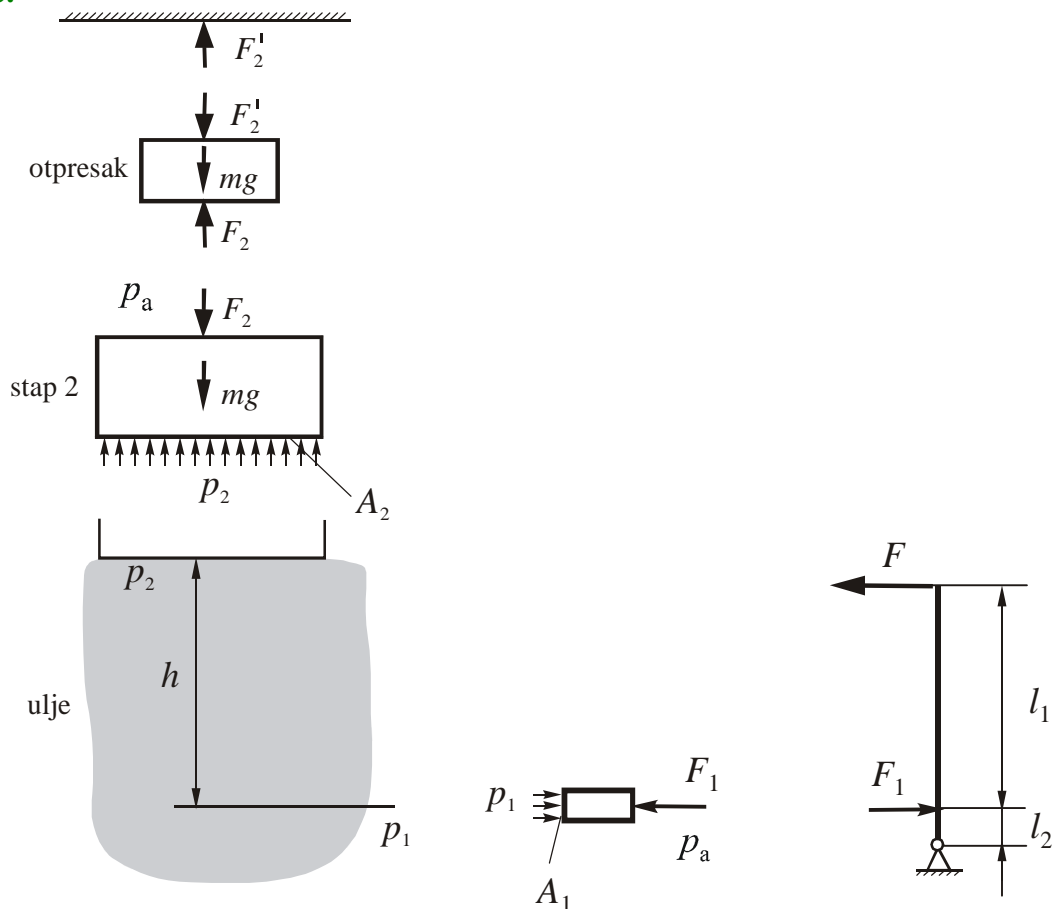
Slučaj $V=0$, priključna cijev puna, $l = l_0$

$$l_0 = \frac{\rho \cdot h}{2\rho_0 - \rho}$$

4. Na slici je shematski prikazan princip rada hidrauličke preše. Odredite kojom silom F treba gurati ručicu da se ostvari sila prešanja $F_2=4800$ N. Zadano je: $m=25$ kg, $D=200$ mm, $h=1,3$ m, $l_1=52$ cm, $l_2=12$ cm, $A_1=19,6$ cm², $\rho=820$ kg/m³.



Rješenje:



$$\text{Poluga: } F \cdot (l_1 + l_2) = F_1 \cdot l_2 \quad (1)$$

$$\text{Stap 1: } p_1 A_1 = p_a A_1 + F_1 \Rightarrow p_1 = p_a + \frac{F_1}{A_1} \quad (2)$$

$$\text{Jednadžba manometra } p_2 = p_1 - \rho g h \quad (3)$$

$$\text{Stap 2: } p_2 A_2 = p_a A_2 + F_2 + mg \Rightarrow p_2 = p_a + \frac{F_2 + mg}{\frac{D^2 \pi}{4}} \quad (4)$$

Nepoznanice: F, F_1, p_1, p_2

(2) i (4) u (3)

$$p_a + \frac{F_2 + mg}{\frac{D^2 \pi}{4}} = p_a + \frac{F_1}{A_1} - \rho g h$$

$$F_1 = A_1 \left[\rho g h + \frac{F_2 + mg}{\frac{D^2 \pi}{4}} \right]$$

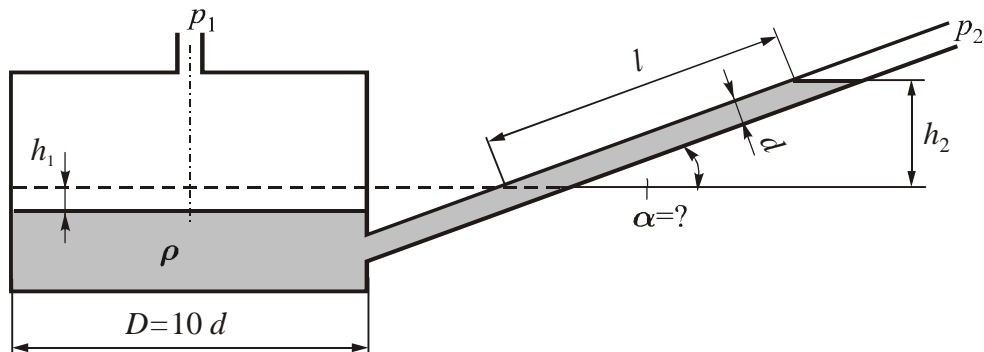
$$F_1 = 335 \text{ N}$$

$$F = F_1 \frac{l_2}{l_1 + l_2}$$

$$F = 62,9 \text{ N}$$

5. Osjetljivost hidrostatskog manometra (definirana odnosom otklon manometra / mjerena razlika tlakova) povećava se naginjanjem kraka manometra. Za mikromanometar na slici, duljina l u nagnutom kraku mjeri se od položaja meniskusa kod jednakih tlakova p_1 i p_2 .

Odredite kut nagiba kraka da bi osjetljivost manometra bila 1mm/Pa. Zadano je: $\rho=800 \text{ kg/m}^3$.



Rješenje:

$$h_2 = l \cdot \sin \alpha \quad (1)$$

$$\text{J.M. } p_2 + \rho g (h_1 + h_2) = p_1 \quad (2)$$

$$\frac{D^2 \pi}{4} h_1 = \frac{d^2 \pi}{4} l \quad (3)$$

$$\text{iz(3) } h_1 = l \left(\frac{d}{D} \right)^2 \quad (3a)$$

(1) i (3a) u (2)

$$\rho \cdot g \cdot l \left[\left(\frac{d}{D} \right)^2 + \sin \alpha \right] = p_1 - p_2 \quad (4)$$

$$\text{osjetljivost} = \frac{l}{p_1 - p_2} = \frac{1}{\rho g \left[\left(\frac{d}{D} \right)^2 + \sin \alpha \right]} = 10^{-3} \text{ m/Pa} \quad (5)$$

$$10^{-3} \rho g \left[\left(\frac{d}{D} \right)^2 + \sin \alpha \right] = 1 \Rightarrow \sin \alpha = \frac{10^3}{\rho g} - \left(\frac{d}{D} \right)^2 = 0,017$$

$$\sin \alpha = 0,117$$

$$\alpha = 6,72^\circ = 6^\circ 43' 8''$$