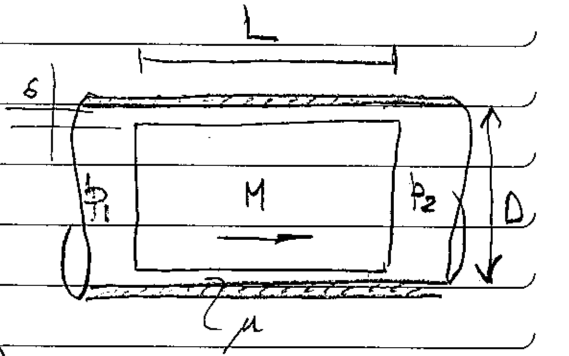
SOLUÇÃO P1 15 de abril 2010

Prob1:

a) balanço de forçc no bloco de hidrato:



$$M\frac{dV}{dt} = (p_1 - p_2)A - \tau \pi D L$$

onde $\tau = \mu \frac{du}{dr} = \mu \frac{V}{\delta}$

então $$M\frac{dV}{dt} = (p_1 - p_2)\frac{\pi D^2}{4} - \frac{\mu V}{\delta}\pi D L$$

b) Integrando,

3 $$\frac{dV}{dt} = \underbrace{\frac{\Delta p\, \pi D^2}{4M}}_{\alpha} - \underbrace{\frac{\mu \pi D L}{M\delta}}_{\beta} V$$

$$\frac{dV}{dt} = \alpha - \beta V \quad \therefore \quad \frac{dV}{\alpha - \beta V} = dt \rightarrow \int_0^V \frac{dV}{\alpha - \beta V} = \int_0^t dt$$

$$-\frac{1}{\beta}\ln(\alpha - \beta V)\Big|_0^V = t \quad \therefore \quad \ln\frac{\alpha - \beta V}{\alpha} = -\beta t$$

$$V(t) = \frac{\alpha}{\beta}\left(1 - e^{-\beta t}\right)$$

c) $D = 100\text{ mm} = 0{,}1\text{m}$

$\delta = 0{,}1\text{ mm} = 10^{-4}\text{m}$

$\mu = 10^{-2}\text{ Pa.s}$

$L = 30\text{ m}$

$M = 200\text{ kg}$

$$\alpha = \frac{\Delta p\, \pi D^2}{4M} = \frac{(1{,}96\times10^7)(\pi)(0{,}1)^2}{(4)(200)} = 769{,}69$$

$$\beta = \frac{\mu \pi D L}{M\delta} = \frac{(10^{-2})(\pi)(0{,}1)(30)}{(200)(10^{-4})} = 4{,}71$$

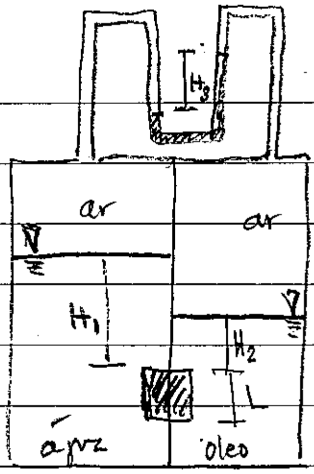
$$V(t) = \frac{769{,}69}{4{,}71}\left(1 - e^{-4{,}71 t}\right)$$

para $t = 1s$

$V = 161{,}86\ \frac{m}{s} = 582{,}7\ \frac{km}{h}$

$\Delta p = p_1 - p_2 = 2000\text{ m c.a.} = (2000)(999)(9{,}8) = 1{,}96\times10^7\text{ Pa}$

Prob2:



$H_1 = 4{,}3\ m$

$H_2 = 2{,}7\ m$

$H_3 = 150\ mm$

$L = 600\ mm$

$\rho_o = 800\ kg/m^3$

$\rho_a = 1000\ kg/m^3$

$\rho_{Hg} = 13600\ kg/m^3$

$g = 9{,}8\ m/s^2$

força horizontal devido à pressão agindo nas faces do cubo:

- Pressão do lado esquerdo:

$$p_1 = p_{ar_A} + \rho_a g \left(H_1 + \frac{L}{2}\right)$$

- Pressão do lado direito

$$p_2 = p_{ar_B} + \rho_{óleo} g \left(H_2 + \frac{L}{2}\right)$$

força horizontal resultante sobre o cubo:

$$F_H = (p_1 - p_2) A = L^2 \left[(p_{ar_A} - p_{ar_B}) + \rho_a g \left(H_1 + \frac{L}{2}\right) - \rho_{óleo} g \left(H_2 + \frac{L}{2}\right) \right]$$

mas $p_{ar_A} - p_{ar_B} = \rho_{Hg} g H_3$

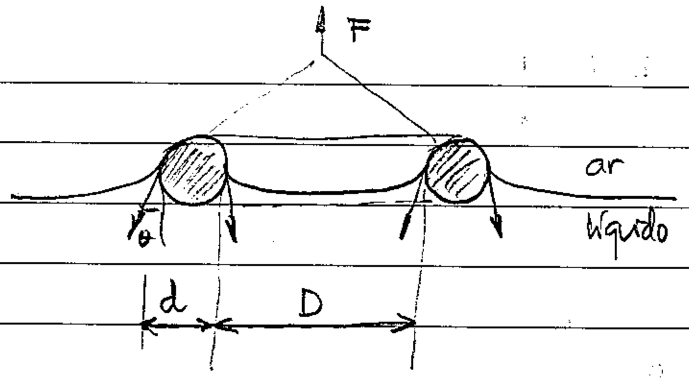
$$F_H = L^2 \left[\rho_{Hg} g H_3 + \rho_{água} g \left(H_1 + \frac{L}{2}\right) - \rho_{óleo} g \left(H_2 + \frac{L}{2}\right) \right]$$

b)

$$F_H = (0{,}6)^2 \left[(13600)(9{,}8)(0{,}150) + (1000)(9{,}8)\left(4{,}3 + \frac{0{,}6}{2}\right) - (800)(9{,}8)\left(2{,}7 + \frac{0{,}6}{2}\right) \right]$$

$F_H = 14958\ N$ (para a direita)

Prob 3 : tensiômetro



a) balanço de forças no anel, desprezando o empuxo, direção vertical

$$F = Mg + \pi D \sigma \cos\theta + \pi (D + 2d) \sigma \cos\theta$$

$$\therefore \quad \sigma = \frac{F - Mg}{2\pi \cos\theta \, (D+d)} = \frac{F - \overbrace{\frac{\pi d^2}{4} \cdot \pi (D+d)}^{V} g \rho_{fio}}{2\pi \cos\theta \, (D+d)}$$

$$\sigma = \frac{F - \frac{\pi^2 d^2 g \rho_{fio} (D+d)}{4}}{2\pi \cos\theta \, (D+d)}$$

$d = 0{,}1\,mm = 10^{-4}\,m$

$D = 20\,mm = 20 \times 10^{-3}\,m$

$\theta = 0^\circ$

$\sigma = 70 \times 10^{-3}\,N/m$

$\rho_f = 7000\,kg/m^3$

$g = 9{,}8\,m/s^2$

b)

$$F = 2\pi \sigma \cos\theta (D+d) + \frac{\pi^2 d^2 g}{4} (D+d) \rho_{fio}$$

$$F = (2)(\pi)(70 \times 10^{-3})(\cos 0^\circ)(20 \times 10^{-3} + 10^{-4}) + \frac{(\pi)^2 (10^{-4})^2 (9{,}8)}{4} (20 \times 10^{-3} + 10^{-4})(7000)$$

$$F = 8{,}87 \times 10^{-3}\,N \implies F = 9{,}06 \times 10^{-4}\,kgf \quad =$$