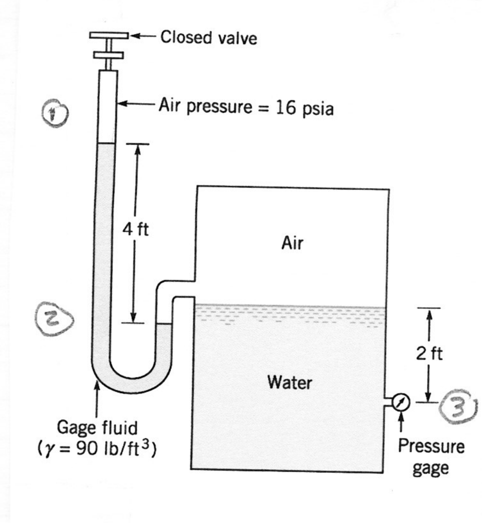
Consider the tank and manometer configuration given.

Determine the gage pressure at the bottom of the tank at the location indicated



This problem involves static incompressible fluids where

$$\Delta P = \gamma h$$

With the 3 pts as shown, we have

$$P_1 + \gamma_{gf}(4ft) + \gamma_w(2ft) = P_3$$

where we have assumed that the pressure throughout the air volume is constant.

$$\therefore P_{3_{abs}} = 16 \text{ psia} + \left(90 \frac{lbf}{ft^3}\right)(4 ft)\left(\frac{1 ft^2}{144 in^2}\right) + \frac{(62.4)(2)}{144}$$

$$= (16 + 2.50 + 0.867) \text{ psia}$$

$$= 19.367 \text{ psia} = \boxed{19.4 \text{ psia}}$$

But, gage pressure was requested

$$\therefore P_{3_{gage}} = 19.4 - 14.7 = \boxed{4.7 \text{ psig}}$$

ans

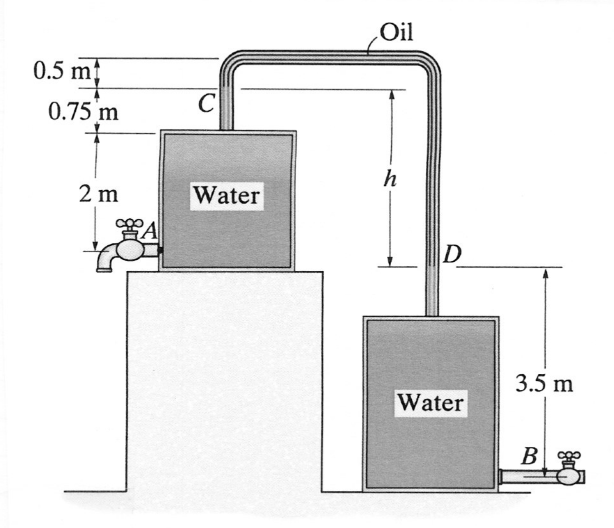
Hibbeler
2-49

Fluid Statics

Class Ex. #2

The pressure in the tank at the closed valve A is 300 kPa. If the differential elevation in the oil level is h = 2.5 m, determine the pressure in the pipe at closed valve B.

Use $\rho_o = 900\, kg/m^3$



This problem also involves incompressible fluids, where

$$\Delta P = \gamma h$$

Starting at pt. A, we have

$$P_A - \gamma_w (2.75\,m) + \gamma_o \underbrace{(2.5\,m)}_{h \text{ in diagram}} + \gamma_w (3.5\,m) = P_B$$

also since $\rho_o = 900\, kg/m^3$, Then

$$sg_{oil} = \frac{900}{1000} = 0.9$$

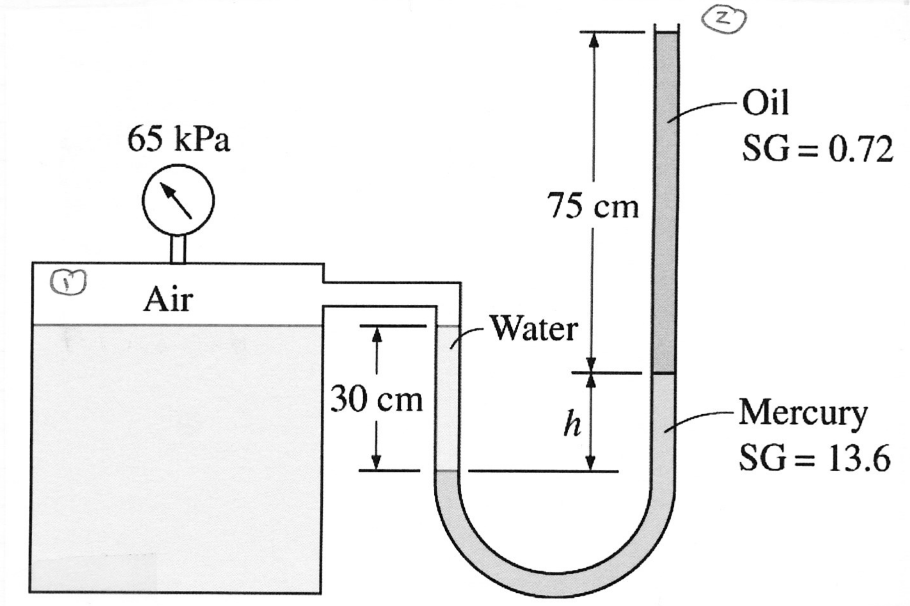
thus,

$$P_B = 300\,kPa + (-2.75 + 0.9(2.5) + 3.5)(m)\left(\overbrace{9.81\,\frac{kN}{m^3}}^{\gamma_w}\right)$$

$$= 300 + 3(9.81) = \boxed{329.4\,kPa}$$

or $\boxed{P_B = 329\,kPa}$ ans

For the system shown in the sketch, determine the height, h, of the mercury column.



Starting at Pt 1, we have

$$P_1 + \gamma_w (0.3\,m) - 13.6\,\gamma_w\, h - 0.72\,\gamma_w\,(0.75\,m) = P_2$$

but $P_1 = 65\,kPa$ gage and $P_2 = 0$ gage (open to atm)

Thus solving for h gives

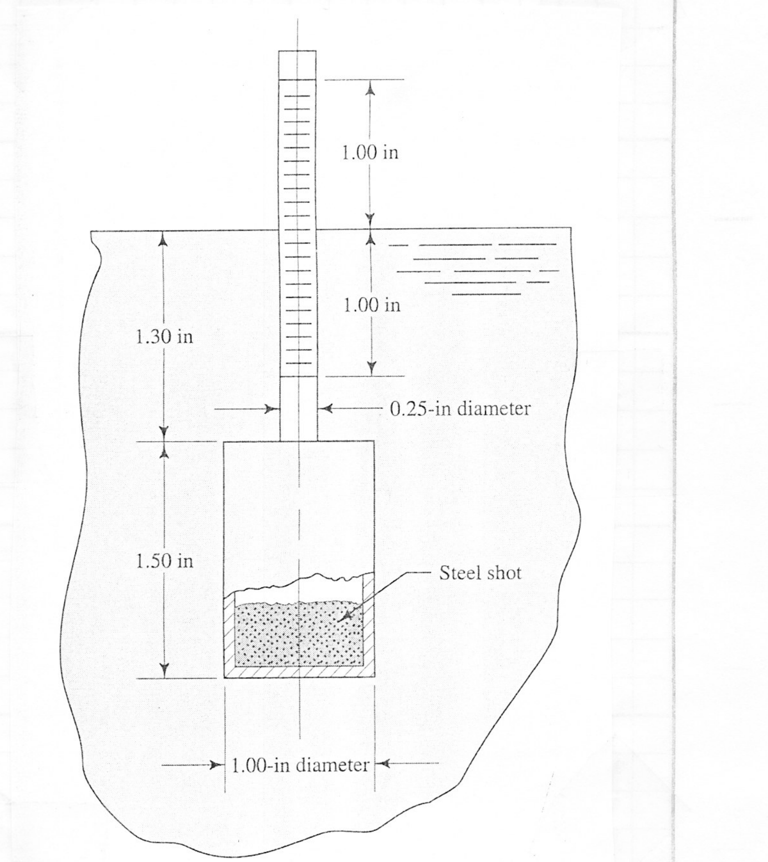
$$h = \frac{P_1 + [0.3 - 0.72(0.75)]\,\gamma_w}{13.6\,\gamma_w}$$

$$= \frac{65\,kPa - 0.24\,m\,(9.81\,kN/m^3)}{13.6\,(9.81\,kN/m^3)}$$

$$= 0.4696\,m$$

$$\boxed{h \approx 47.0\,cm}$$

5.13-15 A hydrometer is a device for measuring the specific gravity of liquids. For the specific design shown, the bottom hollow cylinder has a 1 in diameter and the top tube has a 0.25 in diameter. The empty hydrometer weighs 0.02 lbf.



(a) what weight of steel shot is needed to make the hydrometer float in the position shown in fresh water (i.e. indicate a sg = 1.0)?

FBD $\uparrow F_b$, $\downarrow W_e + W_s$

in equil

$$F_b = W_e + W_s$$

or $\boxed{W_s = F_b - W_e}$

wt of steel shot; buoyant force; empty wt.

$\boxed{W_e = 0.02 \text{ lbf}}$ (given)

F_b = weight of fluid displaced

$$= (SG)\,\gamma_W\,(V_{bot} + V_{top})$$

$$= (1.0)(62.4)(6.818\times10^{-4} + 3.693\times10^{-5})$$

$$\boxed{F_b = 4.485\times10^{-2}\text{ lbf}}$$

$$V_{bot} = \frac{\pi D^2}{4}H = \frac{\pi}{4}\left(\frac{1}{12}\right)^2\left(\frac{1.5}{12}\right)$$

$$\boxed{V_{bot} = 6.818\times10^{-4}\ ft^3}$$

$$V_{top} = \frac{\pi D^2}{4}H = \frac{\pi}{4}\left(\frac{0.25}{12}\right)^2\left(\frac{1.3}{12}\right)$$

$$\boxed{V_{top} = 3.693\times10^{-5}\ ft^3}$$

in position shown

only the portion below the fluid surface

$$\boxed{\gamma_w = 62.4\ \frac{lbf}{ft^3}}$$

$$\therefore W_s = F_b - W_e$$

$$= 0.0449 - 0.02$$

$\boxed{W_s = 0.0249 \text{ lbf}}$ ans

about 0.025 lbf

(b) The hydrometer from Part a is placed in a fluid and it floats at the Top indicator mark. What is the specific gravity of the fluid?

The only thing that changes from the above analysis is the volume of the Top cylinder that is under water.

new value

$$\therefore V_{Top} = \frac{\pi D^2}{4} H = \left(\frac{\pi}{4}\right)\left(\frac{0.25}{12}\right)^2\left(\frac{2.3}{12}\right)$$

$$= 6.534 \times 10^{-5}\ ft^3$$

We also write the force balance to highlight solution of the specific gravity (SG) term, as follows:

$$F_b = W_e + W_s$$

$$(SG)\gamma_w (V_{bot} + V_{Top}) = W_e + W_s$$

$$\therefore \boxed{SG = \frac{W_e + W_s}{\gamma_w (V_{bot} + V_{Top})}}$$

for present case

$$SG = \frac{(.02 + 0.0249)\,lbf}{(62.4)(6.818\times10^{-4} + 6.534\times10^{-5})\,lbf} = \frac{0.0449}{(62.4)(7.471\times10^{-4})}$$

or $\boxed{SG = 0.963}$ ans $\quad SG_f < 1.0 \therefore$ hydrometer is lower in the fluid (reads at Top mark)

(c) What is the specific gravity of the fluid at the hydrometer floats at the bottom mark?

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following the same procedure

only difference

$$V_{Top} = \frac{\pi}{4} D^2 H = \left(\frac{\pi}{4}\right)\left(\frac{0.25}{12}\right)^2\left(\frac{0.3}{12}\right)$$

$$= 8.522 \times 10^{-6}\ ft^3$$

$$\therefore SG = \frac{W_e + W_s}{\gamma_w (V_{bot} + V_{Top})}$$

$$= \frac{0.0449}{(62.4)(6.818\times10^{-4} + 8.522\times10^{-6})}$$

$\boxed{SG = 1.042}$ ans $\quad SG_f > 1.0 \therefore$ hydrometer is higher in the fluid (reads at bottom mark)