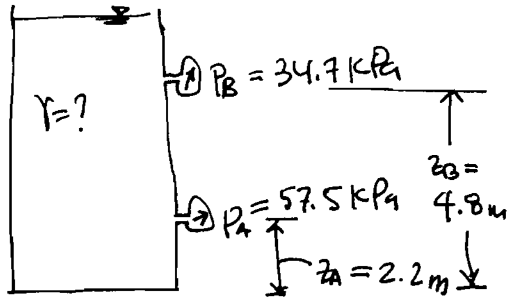
3.1. A pressure gage at elevation 4.8 m on the side of a storage tank containing oil reads 34.7 kPa. Another gage at elevation 2.2 m reads 57.5 kPa. Compute the specific weight, density, and specific gravity of the oil.




USING EQUATION OF HYDROSTATICS:

$$P_B - P_A = -\gamma(z_B - z_A)$$

$$(34.7\times10^3 - 57.5\times10^3)\,Pa = -\gamma(4.8^m - 2.2m)$$

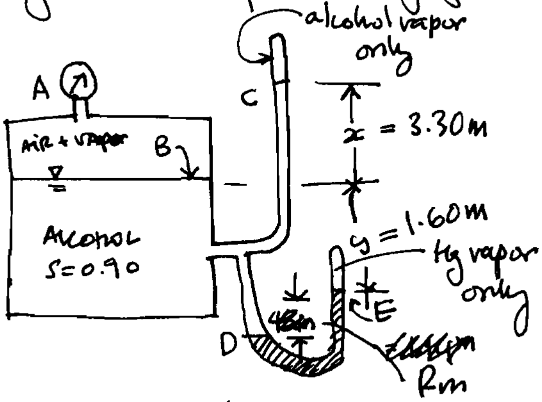
$$-22800 \cdot \frac{N}{m^2} = -\gamma \cdot (2.6^m)$$

$$\boxed{\gamma = \frac{22800}{2.6}\frac{N}{m^3} = 8769.23\ N/m^3}$$

$$\boxed{\rho = \frac{\gamma}{g} = \frac{8769.23\ N/m^3}{9.81\ m/s^2} = 893.91\ kg/m^3}$$

$$\boxed{S = \frac{\rho}{\rho_w} = \frac{893.91\ kg/m^3}{1000\ kg/m^3} = 0.894}$$

3.9. In Fig. X3.5.8 assume the following: atmospheric pressure = 930 mb abs; vapor pressure of alcohol = 110 mb abs; $x = 3.30$ m and $y = 1.60$ m. Compute the reading (a) on the pressure gage and (b) on the manometer.




NOTE: From Book's inside cover we have that
$1\,Pa = 10^{-5}\,bar = 10^{-5}\times10^3\,mbar = 0.01\,mbar$
$\Rightarrow 1\,mbar = 100\,Pa = 0.10\,kPa$

$P_{atm} = 930\,mb\ abs = 93000\ Pa\ abs$

$(P_{vapor})_{alc} = 110\,mb\ abs = 11000\ Pa\ abs = P_C$

~~NOTE: 45 in = 45/12 ft = 3.75 ft = 3.75/3.28 m = 1.14 m~~

manometer CB: $P_C + S_{alc}\cdot\gamma_w\cdot x = P_B \Rightarrow P_B = P_C + S_{alc}\cdot\gamma_w\cdot x = 11000 + 0.90\times9810\times3.30$

$P_B = 40135.7\ Pa$

In the air + vapor chamber above free surface, $P_A = P_B = 40135.7\ Pa\ abs$

The gage reading is $(P_A)_{gage} = (P_A)_{abs} - P_{atm} = 40135.7\,Pa - 93000\,Pa = -52864.3\,Pa$

$$\boxed{(P_A)_{gage} = -52.86\ kPa}$$

MANOMETER BDE: $P_B + S_{alc}\gamma_w(y + \cancel{1.14^m}\ Rm) - S_{Hg}\cdot\gamma_w\cdot \cancel{1.14}^m\ Rm = 0$ ($P_{vapor\,Hg} \approx 0$)

$$P_B + S_{alc}\gamma_w y + S_{alc}\gamma_w Rm - S_{Hg}\gamma_w Rm = 0$$

$$\gamma_w Rm(S_{Hg} - S_{alc}) = P_B + S_{alc}\gamma_w y$$

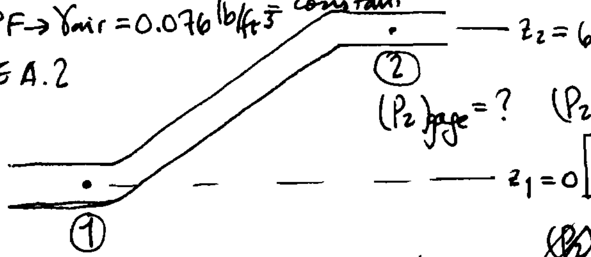
$$Rm = \frac{P_B + S_{alc}\cdot\gamma_w\cdot y}{\gamma_w(S_{Hg} - S_{alc})} = \frac{40135.7 + 0.90\times9810\times1.60}{9810\times(13.56-0.90)} = 4.37^m,\ \boxed{Rm = 4.37^m}$$

3.12. At a certain point the gage pressure in a pipeline containing gas ($\gamma = 0.05\ lb/ft^3$) is 5.6 in $H_2O$. The gas is not flowing, and all temperatures are 60°F. What is the gage pressure in in $H_2O$ at another point in the line whose elevation is 650 ft greater than the first point? Make and state all necessary assumptions.

ASSUME: $\gamma = 0.05\ lb/ft^3$ = constant

at 60°F → $\gamma_{air} = 0.076\ lb/ft^3$ = constant

TABLE A.2




$\Delta z = z_2 - z_1 = 650$ ft

$(P_2)_{gage} = ?$ $\quad (P_2)_{atm} = P_0 - \gamma_{air} \cdot (z_2 - z_1)$

$$\boxed{(P_2)_{abs} = (P_2)_{gage} + (P_2)_{atm}}$$

$$\boxed{(P_2)_{abs} = (P_2)_{gage} + P_0 - \gamma_{air} \cdot \Delta z}$$

$(P_1)_{gage} = 5.6\ in\ H_2O = 29.12\ \frac{lb}{ft^2}$

$(P_1)_{atm} = P_0 \quad P_0$

$$\boxed{(P_1)_{abs} = (P_1)_{atm} + (P_1)_{gage}}$$

Manometer eqn: FOR ABSOLUTE PRESSURES

$(P_2)_{abs} = (P_1)_{abs} - \gamma \cdot \Delta z$

NOTE: $1\ in\ H_2O = \left(62.4\ \frac{lb}{ft^3}\right)\left(\frac{1}{12}\ ft\right) = 5.2\ lb/ft^2$

$$(P_2)_{gage} + \cancel{P_0} - \gamma_{air} \cdot \Delta z = \cancel{P_0} + (P_1)_{gage} - \gamma \cdot \Delta z$$

$$(P_2)_{gage} = (P_1)_{gage} - \gamma \Delta z + \gamma_{air} \Delta z$$

$$= 29.12\ \frac{lb}{ft^2} - \left(0.05\ \frac{lb}{ft^3}\right)(650\ ft) + \left(0.076\ \frac{lb}{ft^3}\right)(650\ ft)$$

$$= 46.02\ lb/ft^2 = \frac{46.02}{144}\ \frac{lb}{in^2} = 0.32\ psi$$

also, $(h_2) = \frac{46.02\ lb/ft^2}{62.4\ lb/ft^3} = 0.7375\ ft = 8.85\ in$