Joey Cantrell

MET 330 Ch.3 Homework

3.6 The value for the absolute pressure will always be greater than that for the gage pressure.

Solution: **True** since $P_{abs} = P_{gage} + P_{atm}$

3.7 As long as you stay on the surface of Earth, the atmospheric pressure will be 14.7 psia.

Solution: **False** P_{atm} can change based on changes in temperature, elevation, etc.

3.8 The pressure in a certain tank is −55.8 Pa (abs)

Solution: **False** P_{abs} is always positive.

3.9 The pressure in a certain tank is −4.65 psi (gage).

Solution: **True** P_{gage} can be negative if below atmospheric pressure.

3.10 The pressure in a certain tank is −150 kPa (gage).

Solution: **False** P_{atm} near Earth's surface is $\approx 101\,kPa$ so this would cause $P_{abs} < 0$ $(-150 + 101 < 0)$.

3.11 If you were to ride in an open-cockpit airplane to an elevation of 4000 ft above sea level, what would the atmospheric pressure be if it conforms to the standard atmosphere?

Solution: We know $\Delta p = \gamma_{air} h$ $\quad h = 4000\,ft \quad \gamma_{air} = 0.0765\,lb/ft^3$

So $\Delta p = (0.0765\,lb/ft^3)(4000\,ft) = 306\,lb/ft^2$

$306\,lb/ft^2 \left(\frac{1\,ft^2}{(12\,in)^2}\right) = 2.125\,psia$

Then $P = P_{atm} - \Delta p = 14.7\,psia - 2.125\,psia = \boxed{12.575\,psia}$

3.13 Expressed as a gage pressure, what is the pressure at the surface of a glass of milk?

Solution: Since you are at the surface of the milk, $h = 0$

Then $P_{abs} = P_{atm} + \rho g h^{\,0} \rightarrow P_{abs} = P_{atm}$

Then $P_{gage} = P_{abs} - P_{atm} = P_{atm} - P_{atm} = \boxed{0}$

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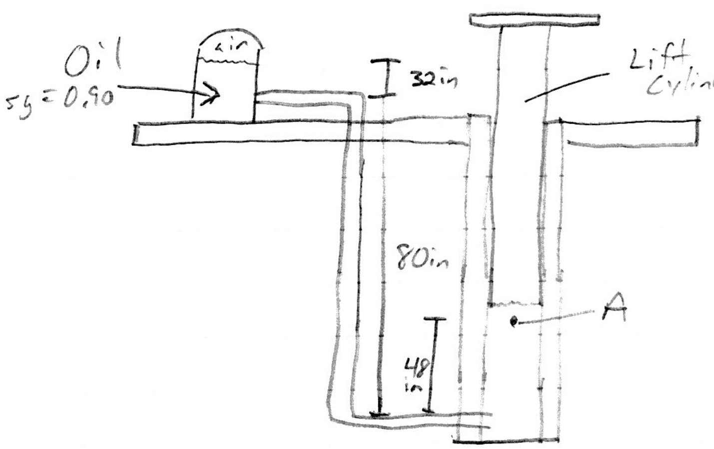
3.41 Figure shows a diagram of the hydraulic system for a vehicle lift. An air compressor maintains pressure above the oil in the reservoir. What must the air pressure be if the pressure at point A must be at least 180 psig?



Solution: We know $P_{air} = P_A - \Delta P$ $\quad \Delta P = \gamma_{oil} \cdot h$

$sg_{oil} = 0.90 = \frac{\gamma_{oil}}{\gamma_{H_2O @ 4°C}} \rightarrow \gamma_{oil} = (0.90)(62.4\ lb/ft^3) = 56.16\ lb/ft^3$

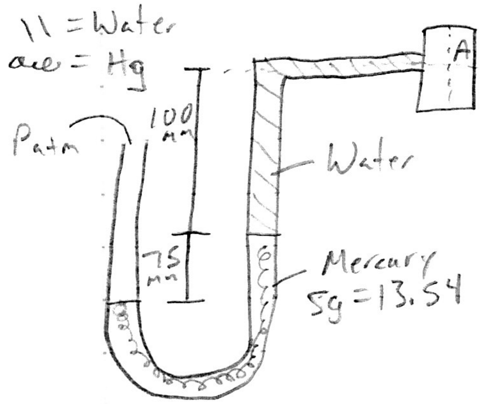
Then $\Delta P = (56.16\ lb/ft^3)\left(\frac{1 ft^3}{(12 in)^3}\right)(112 in - 48 in)$

$\Delta P = 2.08\ lb/in^2$

So $P_{air} = P_A - \Delta P \rightarrow P_{air} = 180\ psig - 2.08\ psig$

$\rightarrow$ $\boxed{P_{air} = 177.92\ psig}$

3.62 Water is in the pipe shown in figure. Calculate the pressure at point A in kPa (gage).



Solution: $P_A + \gamma_w \cdot h_w + \gamma_{Hg} h_{Hg} = P_{atm}$

$\rightarrow P_A - P_{atm} = -\gamma_w \cdot h_w - \gamma_{Hg} h_{Hg}$

$\rightarrow P_{A(gage)} = -\gamma_w \cdot h_w - \gamma_{Hg} h_{Hg}$

$\gamma_w = 9.807\ kN/m^3$

$sg_{Hg} = \frac{\gamma_{Hg}}{\gamma_{w @ 4°C}} \rightarrow \gamma_{Hg} = (13.54)(9.807\ kN/m^3) = 132.79\ kN/m^3$

Then $P_{A(gage)} = -(9.807\ kN/m^3)(0.1 m) - (132.79\ kN/m^3)(0.075 m)$

$\rightarrow P_{A(gage)} = -10.94\ kN/m^2 = \boxed{-10.94\ kPa}$

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3.83 A barometer indicates the atmospheric pressure to be 30.65 in of mercury. Calculate the atmospheric pressure in psia.

Solution: We know $sg_{Hg} = 13.54 = \frac{\gamma_{Hg}}{\gamma_{H_2O @ 4°C}}$

$\rightarrow \gamma_{Hg} = (13.54)(62.4\ lb/ft^3) = 844.90\ lb/ft^3$

Then $P_{atm} = (30.65\ in)(844.90\ lb/ft^3)\left(\frac{(1\ ft)^3}{(12\ in)^3}\right)$

$\rightarrow P_{atm} = 14.99\ lb/in^2 = \boxed{14.99\ psia}$

3.90 The pressure in a vacuum chamber is −68.2 kPa. Express this pressure in mm Hg.

Solution: We know $P_{atm} = \gamma_{Hg} h_{Hg} \rightarrow h_{Hg} = \frac{P_{atm}}{\gamma_{Hg}}$

Then $\gamma_{Hg} = (13.54)(9.807\ kN/m^3) = 132.79\ kN/m^3$

So $h_{Hg} = \frac{-68.2\ kPa}{132.79\ kN/m^3} = -0.5136\ m = \boxed{-513.6\ mm\ Hg}$

3.94 A passive solar water heater is to be installed on the roof of a multi-story building. The heater tank is open to atmospheric pressure and is mounted 16m above ground level. In the static (non-flowing) state, what gage pressure (kPa) must the plumbing line be designed to withstand if it is connected all the way down to ground level?

Solution: We know $\Delta P = \gamma_w h$

So $\Delta P = (9.807\ kN/m^3)(16\ m) = 156.9\ kN/m^2 = \boxed{156.9\ kPa}$

Reflection: From the problems solved in class, we learned the function of multiple manometers and the procedure for determining pressure from them. We applied the gamma-H equation in different ways to obtain pressure values. In multiple cases we were asked to solve for specific weight when given a value for specific gravity. The most important thing we need to remember with pressure calculations is to add when going down and to subtract when going up in the manometer. Although some of this was review from Thermodynamics, it applied a new twist to help retain the information.