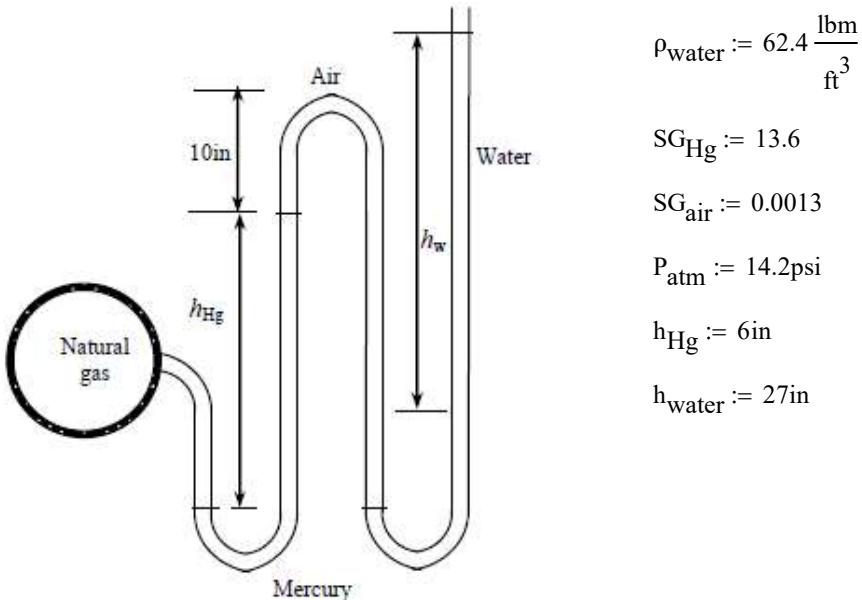


**Given and Required:**

Determine the absolute and gauge pressure of the natural gas.



**Solution:**

The first step in manometer problems is to start at the left and proceed to the right. So the pressure of the natural gas is set to the left hand side of the pressure balance.

$$P_{\text{ng}} = \blacksquare$$

Next, we add any column of fluids. If the column goes up, it is positive. If the column goes down, it is negative. Elbows of fluids are not included. The first column of fluid is the mercury and it goes up so the pressure balance becomes

$$P_{\text{ng}} = \rho_{\text{Hg}} \cdot h_{\text{Hg}} \cdot g + \blacksquare$$

The next column of fluid is the air and it goes down so the pressure balance becomes

$$P_{\text{ng}} = \rho_{\text{Hg}} \cdot h_{\text{Hg}} \cdot g - \rho_{\text{air}} \cdot h_{\text{air}} \cdot g + \blacksquare$$

The next column of fluid is the water and it goes up so the pressure balance becomes

$$P_{\text{ng}} = \rho_{\text{Hg}} \cdot h_{\text{Hg}} \cdot g - \rho_{\text{air}} \cdot h_{\text{air}} \cdot g + \rho_{\text{water}} \cdot h_{\text{water}} \cdot g + \blacksquare$$

Finally, the end pressure state is reached. So it is then added to the pressure balance as shown below.

$$P_{\text{ng}} = \rho_{\text{Hg}} \cdot h_{\text{Hg}} \cdot g - \rho_{\text{air}} \cdot h_{\text{air}} \cdot g + \rho_{\text{water}} \cdot h_{\text{water}} \cdot g + P_{\text{atm}}$$

Knowing the specific gravity (SG) of a fluid is simply the ratio of the density of the fluid to the density of water, the pressure balance becomes

$$P_{\text{ng}} = SG_{\text{Hg}} \cdot \rho_{\text{water}} \cdot h_{\text{Hg}} \cdot g - SG_{\text{air}} \cdot \rho_{\text{water}} \cdot h_{\text{air}} \cdot g + \rho_{\text{water}} \cdot h_{\text{water}} \cdot g + P_{\text{atm}}$$

$$P_{\text{ng}} = P_{\text{atm}} + \rho_{\text{water}} \cdot g \left( SG_{\text{Hg}} \cdot h_{\text{Hg}} - SG_{\text{air}} \cdot h_{\text{air}} + h_{\text{water}} \right)$$

**Solution (contd.):**

Inspecting the pressure balance, every variable is known except for  $P_{ng}$  and  $h_{air}$ . The variable  $P_{ng}$  is the quantity that the problem asks for so it is fine for this to be an unknown. However,  $h_{air}$  is needed to find  $P_{ng}$ . Looking at the specific gravity values of the fluids, it may be seen that the specific gravity of air is much much less than everything else. Thus, the air term in the pressure balance may be neglected resulting in

$$P_{ng} := P_{atm} + \rho_{water} \cdot g \cdot (SG_{Hg} \cdot h_{Hg} + h_{water}) = 18.122 \cdot \text{psi}$$

The gauge pressure is then simply

$$P_{ng} - P_{atm} = 3.922 \cdot \text{psi}$$