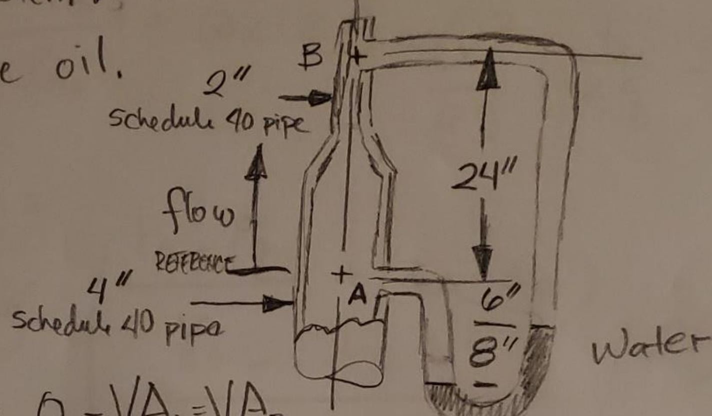
Hw3

HW 1.3

(6.82) PROBLEM: Oil with a specific weight of 55.0 $\frac{lb}{ft^3}$ flows from A to B through the system. Calculate the Volume flow Rate of the oil.



Solution: $Q = V_A A_A = V_B A_B$

$$\gamma_{OIL} = sg\,\gamma_w = \left(55.0\left[\frac{lb}{ft^3}\right]\right)\left(62.4\left[\frac{lb}{ft^3}\right]\right) = 3432\left[\frac{lb}{ft^3}\right]$$

$$\gamma_{water} = sg\,\gamma_w = 62.4\left[\frac{lb}{ft^3}\right](1) = 62.4\left[\frac{lb}{ft^3}\right]$$

$$\cancel{h_A} + \frac{P_A}{\gamma_{OIL}} + z_A + \frac{v_A^2}{2g} = \frac{P_B}{\gamma_{OIL}} + z_B + \frac{v_B^2}{2g} + \cancel{h_L} + \cancel{h_R}$$

$Q = V_A A_A = V_B A_B$ so, $V_A = \frac{Q}{A_A}$ $\quad V_B = \frac{Q}{A_B}$

$$\frac{P_A - P_B}{\gamma_{OIL}} + z_A - z_B = \frac{V_B^2 - V_A^2}{2g}$$

$$\frac{P_A - P_B}{\gamma_{OIL}} + (z_A - z_B) = \frac{\frac{Q^2}{A_B^2} - \frac{Q^2}{A_A^2}}{2g}$$

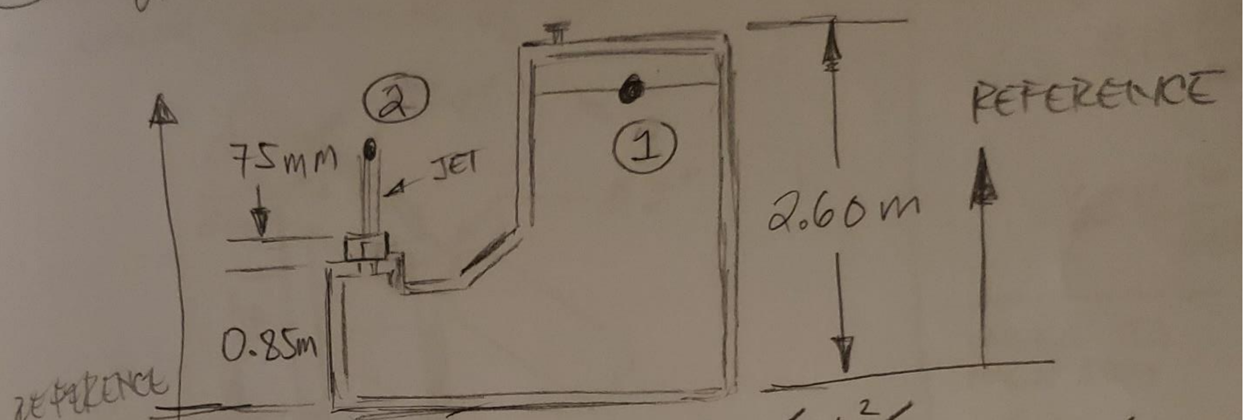
$$Q = \sqrt{\frac{2\left(32.17\left[\frac{ft}{s^2}\right]\right)\left(1-\frac{13.54}{0.90}\right)\times\left(28''\left(\frac{1\,ft}{12''}\right)\right)}{\frac{1}{8.727\times10^{-2}[ft^2]} - \frac{1}{2.182\times10^{-2}[ft]^2}}}$$

$$= \sqrt{\frac{\left(64.34\left[\frac{ft}{s^2}\right]\times(-14.4)\times 2.3[ft]\right)}{-1969\left[\frac{1}{ft^4}\right]}}$$

$$\boxed{Q = 1.034\left[\frac{ft^3}{s}\right]}$$

HW1.3

6.91 PROBLEM: TO WHAT HEIGHT WILL THE JET OF THE FLUID RISE FOR THE CONDITION



Solution: $\cancel{h_1} + \cancel{\frac{P_1}{\gamma}} + \cancel{\frac{V_1^2}{2g}} + Z_1 = \cancel{\frac{P_2}{\gamma}} + \cancel{\frac{V_2^2}{2g}} + Z_2 + \cancel{h_L} + \cancel{h_R}$

$$Z_1 = Z_2$$

$$\boxed{Z_2 = 2.60\,m}$$

W 1.3

3.79 Problem: Oil with a specific gravity of 0.90 is flowing downward through the venturi meter. If the manometer deflection h is 28 in, Calculate the volume flow rate of oil

$g = 32.17 \frac{ft}{s^2}$

$\gamma_W = 9.81 \frac{kN}{m^3}$

$= 62.4 \frac{lb}{ft^3}$

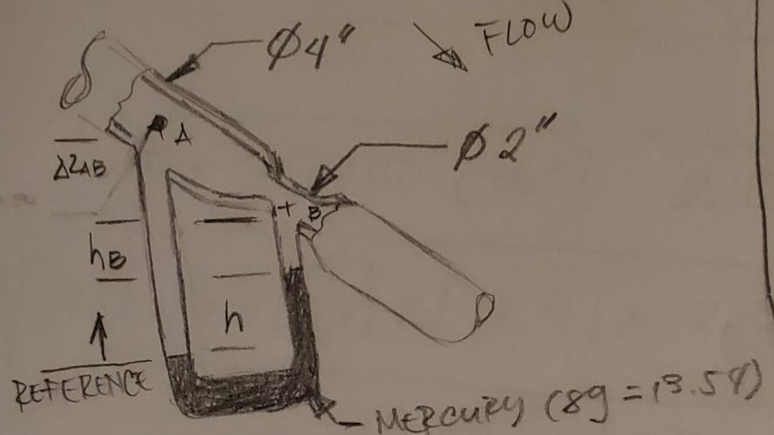


TABLE J.1
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$*\ \phi 4$

$A_A = 8.727 \times 10^{-2}\ ft^2$

$*\ \phi 2$

$A_B = 2182 \times 10^{-2}\ ft^2$

Solution:

$$\frac{P_A}{\gamma} + z_A + \frac{V_A^2}{2g} = \frac{P_B}{\gamma} + z_B + \frac{V_B^2}{2g}$$

$$\gamma_{OIL} = sg_{OIL} \cdot \gamma_w = (.9)(62.4 \frac{lb}{ft^3}) = 56.16 \frac{lb}{ft^3}$$

$$\gamma_{Hg} = sg_{Hg}\gamma_w = (13.54)(62.4 \frac{lb}{ft^3}) = 844.896 \frac{lb}{ft^3}$$

Volume Flow RATE: $Q = AV\ [ft^3/s]$

$$\frac{P_A - P_B}{\gamma} + (z_A - z_B) = \frac{V_B^2}{2g}$$

$z_A - z_B = \Delta z_{AB}$

$$\frac{P_A - P_B}{\gamma} + \Delta z_{AB} = \frac{V_B^2}{2g}$$

$$P_B = P_A + \gamma_{OIL}(z_A - z_B) + h^* + h) - \gamma_{Hg} h - \gamma_{OIL} h$$

$$\frac{P_B - P_A}{\gamma_{Hg}} = (z_A - z_B) + (1 - \frac{sg_{Hg}}{sg_{OIL}})h$$

$$Q = \frac{\sqrt{2g(1 - \frac{sg_{Hg}}{sg_{OIL}})h}}{(\frac{1}{A_A^2} - \frac{1}{A_B^2})}$$

$$\frac{P_A - P_B}{\gamma_{OIL}} + (z_A - z_B) = \frac{Q^2\left(\frac{1}{A_B^2} - \frac{1}{A_A^2}\right)}{\cancel{2g}} \left(\frac{1}{2g}\right)$$

$$\frac{P_A - P_B}{\gamma_{OIL}} + (z_A - z_B) = \frac{Q^2}{2g}\left(\frac{1}{A_B^2} - \frac{1}{A_A^2}\right)$$

$$\cancel{(2g)}\ \frac{Q^2}{\cancel{2g}} = \left(\frac{\frac{P_A - P_B}{\gamma_{OIL}} + (z_A - z_B)}{\left(\frac{1}{A_B^2} - \frac{1}{A_A^2}\right)}\right) 2g$$

$$Q = \sqrt{\frac{\left(1 - \frac{SW_{WATER}}{SW_{OIL}}\right) 2g}{\left(\frac{1}{A_B^2} - \frac{1}{A_A^2}\right)}}$$

$$Q = \sqrt{\frac{2\left(32.2\left[\frac{ft}{s^2}\right]\right)\left(1 - \frac{(1\ \frac{lb}{ft^3})(62.4\ \frac{lb}{ft^3})}{(55\ \frac{lb}{ft^3})(62.4\ \frac{lb}{ft^3})}\right)\left(\frac{24\,[in]}{1}\right)\left(\frac{1\,[ft]}{12\,in}\right)}{\left[\left(\frac{1}{8.727\times10^{-2}\,[ft^2]}\right)^2 - \left(\frac{1}{2.182\times10^{-2}\,[ft^2]}\right)^2\right]}}$$

$$Q = \sqrt{\frac{64.34\left[\frac{ft}{s^2}\right] \times .98 \times 2ft}{-1969\left[\frac{1}{ft^4}\right]}}$$

$$\boxed{= .25\ \left[\frac{ft^3}{s}\right]}$$