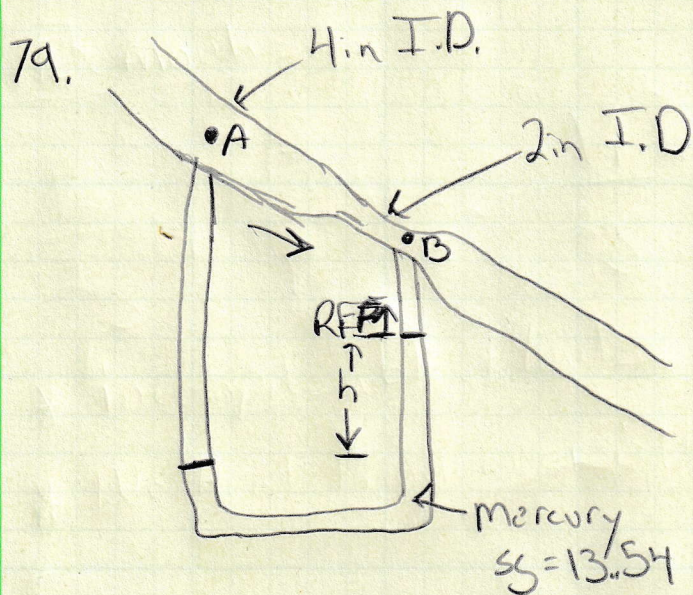




$$A_A = \pi \left(2 \text{ in} \cdot \frac{1 \text{ ft}}{12 \text{ in}} \right)^2$$

$$A_A = .0873 \text{ ft}^2$$

$$A_B = \pi \left(1 \text{ in} \cdot \frac{1 \text{ ft}}{12 \text{ in}} \right)^2$$

$$A_B = .02182 \text{ ft}^2$$

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + Z_B$$

↓

$$\frac{V_B^2 - V_A^2}{2g} = \left(\frac{P_A - P_B}{\gamma} + (Z_A - Z_B) \right)$$

$$\frac{Q^2 \left(\frac{1}{A_B^2} - \frac{1}{A_A^2} \right)}{2g} = \left(\frac{P_A - P_B}{\gamma} + (Z_A - Z_B) \right)$$

$$Q = \sqrt{\frac{2g \left[\frac{P_A - P_B}{\gamma} + (Z_A - Z_B) \right]}{\left(\frac{1}{A_B^2} - \frac{1}{A_A^2} \right)}}$$

$$P_A + \gamma_{oil} Z_A + \gamma_{oil} h - \gamma_{mercury} h - \gamma_{oil} Z_B = P_B$$

$$\frac{P_A - P_B}{\gamma_{oil}} = -Z_A - h + \frac{\gamma_{mercury}}{\gamma_{oil}} h + Z_B$$

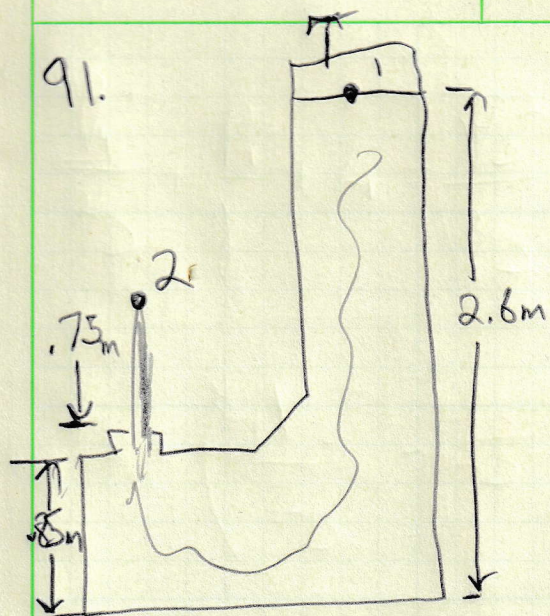
$$\frac{P_A - P_B}{\gamma_{oil}} = (Z_B - Z_A) + \frac{\gamma_{merc}}{\gamma_{oil}} h - h$$

$$\frac{P_A - P_B}{\gamma_{oil}} + (Z_A - Z_B) = \left(\frac{\gamma_{merc}}{\gamma_{oil}} - 1 \right) h$$

$$Q = \sqrt{\frac{(2.32.2 \text{ ft/s}^2) \left(\frac{13.54}{1.9} - 1 \right) (28 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right)}{\frac{1}{(.0218 \text{ ft}^2)^2} - \frac{1}{(.0873 \text{ ft}^2)^2}}}$$

$$Q = 1.0717 \text{ ft}^3/\text{s}$$

91.

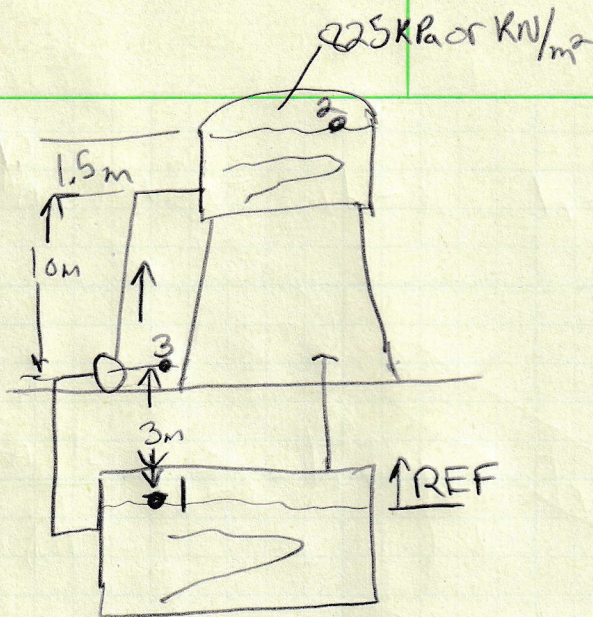


$$\frac{V_1}{\rho g} + \frac{P_1}{\rho} + Z_1 = \frac{V_2}{\rho g} + \frac{P_2}{\rho} + Z_2$$

$$Z_2 = Z_1$$

Ch. 7

16.



$$S_{\text{soil}} = 0.85$$

$$h_{L \text{ system}} = 4.2 \text{ m}$$

$$L_{\text{ suction}} = 1.4 \text{ m}$$

$$Q = 840 \text{ L/min or } 0.014 \text{ m}^3/\text{s}$$

$$* P = \gamma Q h_A$$

$$* Q = V \cdot A$$

$$h_A + \frac{V_1^2}{2g} + \frac{P_1}{\gamma} + Z_1 = \frac{V_2^2}{2g} + \frac{P_2}{\gamma} + Z_2 + h_{L \text{ system}}$$

$$h_A = \frac{P_2}{\gamma} + Z_2 + h_{L \text{ sys}}$$

$$= \frac{825 \text{ kN/m}^2}{(0.85 \cdot 9.810 \text{ kN/m}^3)} + 14.5 \text{ m} + 4.2 \text{ m}$$

$$h_A = 117.638 \text{ m}$$

$$P = (0.85 \cdot 9.810 \text{ kN/m}^3) (0.014 \text{ m}^3/\text{s}) \cdot 117.638 \text{ m}$$

$$P = 13.733 \text{ kN} \cdot \text{m/s or kW}$$

$$\frac{V_1^2}{2g} + \frac{P_1}{\gamma} + Z_1 = \frac{V_3^2}{2g} + \frac{P_3}{\gamma} + Z_3 + h_{\text{suction}}$$

$$P_3 = \left(\frac{-V_3^2}{2g} - Z_3 - h_{\text{suction}} \right) \gamma$$

$$V_3 = \frac{Q}{A_3}$$

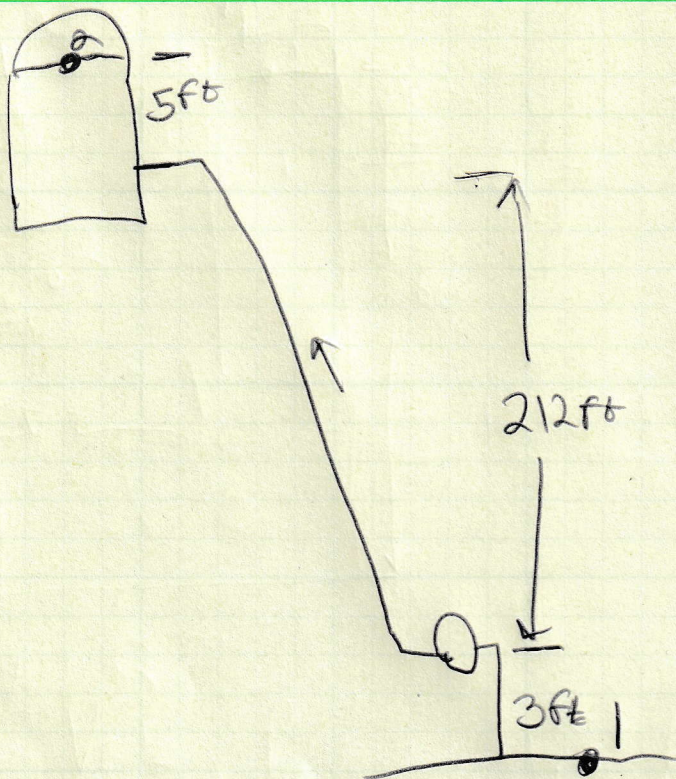
$$= \frac{0.014 \text{ m}^3/\text{s}}{3.09 \times 10^{-3} \text{ m}^2}$$

$$V_3 = 4.531 \text{ m/s}$$

$$P_3 = \left(\frac{(4.531 \text{ m/s})^2}{(2 \cdot 9.81 \text{ m/s}^2)} - 3 \text{ m} - 1.4 \text{ m} \right) (0.85 \cdot 9.810 \text{ kN/m}^3)$$

$$P_3 = -27.964 \text{ kN/m}^2 \text{ or kPa}$$

42.



$$P_2 = 30 \text{ psig} \cdot \frac{144 \text{ in}^2}{1 \text{ ft}^2} = 4320 \text{ lb/ft}^2$$

$$h_L = 15.5 \text{ ft} \cdot \frac{\text{ft}}{\text{ft}}$$

$$Q = 40 \text{ gpm or } 0.089 \text{ ft}^3/\text{s}$$

$$h_A + \frac{V_1^2}{2g} + \frac{P_1}{\gamma} + z_1 = \frac{V_2^2}{2g} + \frac{P_2}{\gamma} + z_2 + h_L$$

$$h_A = \frac{4320 \text{ lb/ft}^2}{62.4 \text{ lb/ft}^3} + 220 \text{ ft} + 15.5 \text{ ft}$$

$$h_A = 304.730 \text{ ft}$$

$$P_A = \gamma Q h_A$$

$$= (62.4 \frac{\text{lb}}{\text{ft}^3}) (0.089 \text{ ft}^3/\text{s}) (304.730 \text{ ft})$$

$$P_A = 1692.353 \text{ lb} \cdot \text{ft}/\text{s} \cdot 0.0018 = \boxed{3.046 \text{ HP}}$$