

4.2 HW Nicholas Alband ch 6: 79, 80, 91 ch 7: 11, 16, 22, 30, 35, 42, 44

6.79:

$$h = 28 \text{ in} \quad D_A = 4 \text{ in} \quad \bullet \frac{P_1}{\gamma} + \frac{V^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V^2}{2g} + z_2$$

$$\text{Oil } sg = .9 \quad D_B = 2 \text{ in}$$

$$\text{merc } sg = 13.54 \quad \gamma_{\text{wat}} = 9.81 \frac{\text{kN}}{\text{m}^3} \quad \bullet Q = V \cdot A \rightarrow V = \frac{Q}{A}$$

$$\bullet \Delta P = \gamma \cdot h$$

Find Volume flow rate (Q):

$$A_A = \frac{\pi}{4} D_A^2 = .0873 \text{ ft}^2$$

$$A_B = \frac{\pi}{4} D_B^2 = .0218 \text{ ft}^2$$

$$\hookrightarrow \frac{Q^2}{2g} \left(\frac{1}{A_A^2} - \frac{1}{A_B^2} \right) = \frac{P_B - P_A}{\gamma} + (z_1 - z_2)$$

Solve for Q

$$Q = \sqrt{\frac{2g \left(\frac{P_B - P_A}{\gamma} + (z_1 - z_2) \right)}{\frac{1}{A_A^2} - \frac{1}{A_B^2}}}$$

$$\bullet P_A + \gamma_{\text{oil}} (z_A - z_B) + \gamma h - \gamma_{\text{merc}} h - \gamma_{\text{oil}} h = P_B$$

$$\frac{P_B - P_A}{\gamma_{\text{merc}}} = (z_A - z_B) + \left(1 - \frac{sg_{\text{merc}}}{sg_{\text{oil}}} \right) h$$

Into Q

$$Q = \sqrt{\frac{2 \cdot 32.2 \frac{\text{ft}}{\text{s}^2} \left(1 - \frac{13.54}{.9} \right) \cdot 28 \text{ in} \cdot \frac{1 \text{ ft}}{12 \text{ in}}}{\frac{1}{.0873^2} - \frac{1}{.0218^2}}} = 1.07 \frac{\text{ft}^3}{\text{s}}$$

6.82:

Data

$$SG_{oil} = 55 \text{ lb/ft}^3$$

$$\gamma_{water} = 62.4 \text{ lb/ft}^3$$

Find Q of oil:

Ch 40 pipe \rightarrow

$$D_B = 2 \text{ in} \rightarrow A = 3.14 \text{ in}^2$$

$$D_A = 4 \text{ in} \rightarrow A = 12.57 \text{ in}^2$$

$$P_A + \gamma_{oil} \cdot h - \gamma_{water} \cdot h - \gamma_{oil} \cdot h = P_B$$

$$P_B - P_A = \gamma_{oil} \cdot 1.16 \text{ ft} - \gamma_{water} \cdot .66 \text{ ft} - \gamma_{oil} \cdot 2$$

$$P_B - P_A = 63.8 - 41.18 - 110$$

$$P_B - P_A = -87.38 \text{ lb/ft}^2$$

$$-Q = V \cdot A \rightarrow V = \frac{Q}{A}$$

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

$$Q = \sqrt{\frac{2g(P_B - P_A) + (\gamma(z_1 - z_2))}{\frac{1}{A_A^2} - \frac{1}{A_B^2}}} \rightarrow Q = \sqrt{\frac{2 \cdot 32.2 \left(\frac{-87.38}{55} \right) + (1.16 - 3.16)}{\frac{1}{3.14^2} - \frac{1}{12.57^2}}}$$

$$Q = 32.47 \text{ ft}^3/\text{s}$$

6.91

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

Solve for z_2 : Arm press $z_2 = \frac{P_1 - P_2}{\gamma} + \frac{V_1^2 - V_2^2}{2g} + z_1 \rightarrow z_2 = z_1 \rightarrow z_2 = 2.6 \text{ m}$ 0 since at rest

$$z_2 = 2.6 \text{ m}$$

7.16:

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

power of pump: $P = \gamma Q h_A$

$$SG_{oil} = 0.85$$

$$H_{L_{total}} = 4.2 \text{ m}$$

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

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

$$h_A = \frac{P_2 - P_1}{\gamma} + \frac{V_2^2 - V_1^2}{2g} + z_2 - z_1 + h_{L12}$$

$$\hookrightarrow h_A = \frac{825 \text{ kPa}}{0.85 \cdot 9810 \frac{\text{N}}{\text{m}^3}} + 12.5 \text{ m} + 4.2 \text{ m} = 117.64 \text{ m}$$

$$P = \gamma \cdot Q \cdot h_A = (0.85 \cdot 9810 \frac{\text{N}}{\text{m}^3}) \cdot 0.014 \frac{\text{m}^3}{\text{s}} \cdot 117.64 = \boxed{13.73 \text{ kW}}$$

$$\frac{P_3}{\gamma} = -\frac{V_3^2}{2g} - z_3 - h_{L13}$$

$$V_3 = \frac{Q}{A_3} \rightarrow \frac{0.014}{3.09 \text{E-}3} = 4.531 \text{ m/s}$$

A from book: $3.09 \text{E-}3$

$$\boxed{P_3 = -45.41 \text{ kPa}}$$

7.42:

$$P = 30 \text{ PSI}$$

$$h_L = 15.5 \text{ lb-ft/lb}$$

$$Q = 40 \text{ gal/min} = 0.089 \text{ ft}^3/\text{s}$$

$$h_A + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_{L12}$$

$$\hookrightarrow h_A = \frac{P_2 - P_1}{\gamma} + \frac{V_2^2 - V_1^2}{2g} + z_2 - z_1 + h_{L12}$$

$$\hookrightarrow h_A = \frac{P_2}{\gamma} + z_2 + h_{L12} \Rightarrow \frac{30 \cdot \frac{\text{ft}}{\text{l}}}{62.4} + 220 + 15$$

$$h_A = 304.73 \text{ ft}$$

$$P_A = \gamma \cdot Q \cdot h_A \rightarrow 62.4 \cdot 0.089 \cdot 304.73 = \boxed{1692.35 \text{ lb-ft/s or } 3.077 \text{ HP}}$$

Survey 1: 640972Albano

Survey 2: 654321Albano