HW 2.1 - Ch6 - 79, 82, 91 Ch7 - 11, 16, 22, 30, 35, 42

79) $Sg_{oil} = 0.9$ $\Delta P = 28 in$ $Q = ?$

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

$$= \frac{V_1^2}{2g} - \frac{V_2^2}{2g} = \underbrace{\left[\frac{P_1}{\rho g} + z_1\right] - \left[\frac{P_2}{\rho g} + z_2\right]}_{\Delta P}$$

$Q_1 = Q_2$

$A_1 V_1 = A_2 V_2$

$\frac{\pi}{4} D_1^2 V_1 = \frac{\pi}{4} D_2^2 V_2 \Rightarrow V_1 = \frac{2^2}{4^2} V_2$

$V_1 = 0.25 V_2$

$$\frac{V_2^2}{2g} - \frac{(0.25 V_2)^2}{2g} = \Delta P$$

$V_2 = \sqrt{20.928 \Delta P}$

$Q = \frac{\pi}{4}(2)^2 \left(\sqrt{20.928 \Delta H}\right)$

$\Delta H = h\left(\frac{\gamma_{Hg}}{\rho_{oil}} - 1\right)$

$(28)\left(\frac{13.54}{0.9} - 1\right)$

$= 393.24$

$Q = 14.372\sqrt{393.24} = 285 \frac{in^3}{s}$

82) $\gamma_{oil} = 55 \frac{lb}{ft^3}$ $Q = ?$ $D_A = 4 in$ $D_B = 2 in$

$D_A = 0.33 ft$

$D_B = 0.167 ft$

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

$\frac{V_1^2}{2g} = \frac{V_2^2}{2g}$ $Q = A_1 V_1 = A_2 V_2$

$V_2 = \frac{A_1 V_1}{A_2}$ $A_A = \frac{\pi}{4}(0.33 ft)^2 = 0.0855 ft^2$

$A_B = \frac{\pi}{4}(0.167 ft)^2 = 0.0219 ft^2$

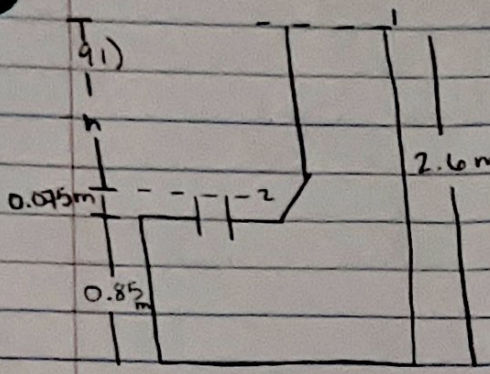
$h = x + \left[-1 + \frac{\gamma_w}{\gamma_{oil}}\right]$

$h = \frac{8}{12} + \left[\frac{62.45}{55} - 1\right] = 0.8 ft$

$$Q = \frac{C_d A_1^2 A_2^2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$Q = \frac{(1)(0.0855 ft^2)^2 (0.0219 ft^2)^2 \sqrt{2(32.2)(0.8)}}{\sqrt{(0.0855)^2 - (0.0219 ft^2)^2}} = \frac{2.51166\ E-5}{0.082647}$$

$Q = 3.045\ E-4 \frac{ft^3}{s}$



$$\frac{P}{\gamma_w} + \frac{V^2}{2g} + z_1 = \frac{P}{\gamma_w} + \frac{V^2}{2g} + z_2$$

$$2.6m = \frac{V_2^2}{2g} + [0.85 + 0.075]$$

$$2.6m = \frac{V_2^2}{2g} + 0.925$$

$$h = \frac{V_2^2}{2g}$$

$$h = 1.675m$$

11) $Q = 745 \frac{gal}{h}$ pipe = 1in sch 40 $h_L = 10.5 \frac{lbft}{lb}$

$P_A = h_a \gamma Q$

$$\frac{P_1}{\gamma_w} + \frac{V_1^2}{2g} + z_1 + h_a + h_r - h_L = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

$$h_A = \frac{P_2}{\gamma} + (z_2 - z_1) + \frac{V_2^2}{2g} + h_L$$

$$V_2 = \frac{Q}{A} \Rightarrow \frac{745 \frac{gal}{hr} \cdot \frac{449ft}{1gal} \frac{1hr}{60s}}{0.006ft^2} = 4.61 \frac{ft}{s}$$

$$h_A = \frac{5700 - 36}{62.4} + 120 + \frac{(461)^2}{2(32.18)} + 10.5 = 223.13ft$$

$$P_A = (223.13ft)(62.4)\left(\frac{745}{449 - 66}\right) = 385.04 \frac{lb \cdot ft}{s}$$

$P_A = 0.7 hp$

$$\eta = \frac{P_A}{P_d} = \frac{0.7}{1} = 70\%$$

16) $\gamma_{oil} = Sg \cdot \gamma_w = 0.85(9810 \frac{N}{m^3}) = 8338.5 \frac{N}{m^3}$

$Q = 840 \frac{L}{min}\left(\frac{1m^3}{1000L}\right)\left(\frac{1min}{60s}\right) = 0.014 \frac{m^3}{s}$

$Power = \gamma Q h_L$

$P = (8338.5 \frac{N}{m^3})(0.014 \frac{m^3}{s})(4.2 \frac{N \cdot m}{N}) = 490.30 W$

22) $V = Ad \Rightarrow \frac{\pi}{4} D^2 \cdot d$

$\frac{\pi}{4}(5^2) \cdot 20 = 392.7 \text{ in}^3 \frac{1 \text{ gal}}{231 \text{ in}^3} = 1.7 \text{ gal}$

$Q = \frac{V_g}{t} = \frac{1.7 \text{ gal}}{15 \text{ s}} = 0.113 \frac{\text{gal}}{\text{s}}$

$P = F v h_L \Rightarrow (1100016)(0.113(20)) + (11.5+35)$

$46.516 \frac{\text{lb-ft}}{\text{lb}}$

30) Water @ 60° rate = $1000 \frac{\text{gal}}{\text{min}}$ $h_p = 37 \text{ hp}$ h_m

$Q = 1000 \frac{\text{gal}}{\text{min}} \frac{1 \text{ ft}^3}{7.48052 \text{ gal}} \frac{1 \text{ min}}{60 \text{ s}} = 2.23 \frac{\text{ft}^3}{\text{s}}$

$P_p = 37 \text{hp} \frac{550 \text{ ft lb}}{1 \text{ hp}} = 20350 \frac{\text{ft-lb}}{\text{lb}}$

$P_f = \gamma_w Q h \Rightarrow (62.42 \frac{\text{lb}}{\text{ft}^3})(2.23 \frac{\text{ft}^3}{\text{s}}) h$

$h_L = \frac{P_f - P_p}{\gamma_w Q} \Rightarrow \frac{(62.42)(2.23)h - 20.350}{(62.4)(2.23)} = h - 146.24 \text{ ft}$

35) $Sg_{oil} = 0.93$ $Q = 175 \frac{\text{gal}}{\text{min}}$ $P_p = 28.4 \text{ hp}$ $\eta = 80\%$

$h_{L_{1-2}} = 2.8 \frac{\text{lb-ft}}{\text{lb}}$ $h_{3-4} = 28.5 \frac{\text{lb-ft}}{\text{lb}}$ $h_{5-6} = 3.5 \frac{\text{lb-ft}}{\text{lb}}$

$Q = 175 (2.2280 \times 10^{-3}) = 0.3899 \frac{\text{ft}^3}{\text{s}}$

$W_p = 28.4 \times 550 = 15{,}620 \frac{\text{lb-ft}}{\text{s}}$ $W_f = W_p \eta \Rightarrow (15{,}620)(0.8) = 12{,}496 \frac{\text{lb ft}}{\text{s}}$

$W_{press} = W_f - h_{L_{1-2}} - h_{3-4} - h_{6-6} = (12{,}496 \frac{\text{lb ft}}{\text{s}}) - (2.8 \cdot 0.3899) - (28.5 \cdot 0.3899)$

$- (3.5 \cdot 0.3899)$

$W_{press} = \frac{12482.43}{550} = 22.7 \text{ hp}$

42) $P = 30\ psig \quad h_L = 15.5\ \frac{lb\text{-}ft}{lb} \quad P_{del} = 40\ \frac{gal}{min}$

$Q = (40)(2.22801 \times 10^{-3}) = 0.0891\ \frac{ft^3}{s}$

$\Delta P = (30) + 14.7 = 44.7 \times 144 = 6436.8\ \frac{lb}{ft^2}$

$\dot{W}_p = Q(\Delta P + h_L) = 0.0891\ \frac{ft^3}{s}\left(6436.8\ \frac{lb}{ft^2} + 15.5\right)$

$\dot{W}_p = \frac{574.9}{550}\ \frac{lb\text{-}ft}{s} = 1.045\ hp$