Mech Ferguson Consent Code
57476 Ferguson
674505 Ferguson

Ch 6 79, 82, 91

6.79

Design

Incompressible
isothermal
steady state
no energy loss

h=28in
sg_{oil} = .90
sg_{Hg} = 13.54
γ_{water} = 9.81 kN/m³

$A_A = \frac{\pi}{4} D_A^2 = 0.087 ft^2$

$A_B = \frac{\pi}{4} D_B^2 = 0.022 ft^2$

$Q = VA$

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

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

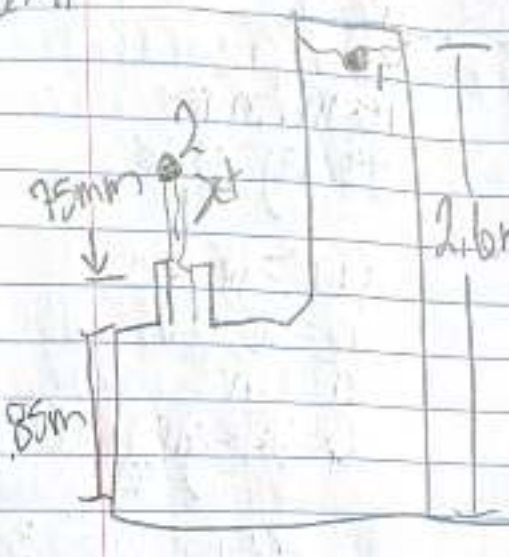
$$P_B = P_A + \gamma_{oil}(Z_A + Z_B)(h + h) - \gamma_{Hg} h - \gamma_{water} h$$

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

$$Q = \sqrt{\frac{2g\left(1 - \frac{sg_{Hg}}{sg_{oil}}\right)h}{\quad}} = \sqrt{\frac{2(32.2)\left(1 - \frac{13.54}{.9}\right)\left(\frac{28}{12}\right)}{\frac{1}{(0.087)^2} - \frac{1}{(0.022)^2}}}$$

$Q = 1.03 ft^3/s$

6.91



design
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steady state
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$\rho = 0.0$
$\gamma_{water} \approx 9.81 \text{ kN/m}^3$

Vat 1 = 0
Vat 2 = 0

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

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

$$z_2 = \frac{P_1 - P_2}{\gamma} + z_1$$

pat 1 & 2 = atm

$z_2 = z_1 \approx 2.6\text{m}$

Ch 7 11, 16, 22, 30, 35, 42, 44

11

design
incompressible
isothermal
steady state

$\rho_{air} = 46 psia$
$h_L = 10.5 \frac{lbf\,ft}{lbf}$
$d = 1 in$
$Q = 745 gal/h = .028 ft^3/s$

$$h_A = \frac{p_2 - p_1}{\gamma} + \frac{V_2^2 - V_1^2}{2g} + z_2 + z_1 + h_L$$

$$h_A = \frac{p_2}{\gamma} + z_2 + h_L = \frac{4(144)}{62.4} + 120 + 16.5 = 139.7 ft$$

$$P = \gamma Q h_A = 62.4(.028)(139.7) = 244.0.8 \frac{lbf\,ft}{s}$$

$$\frac{244.0.8}{550 \frac{lbf\,ft}{s}} \left| \frac{1 hp}{} \right. = 4.44 HP$$

$$Cm = \frac{P_A}{P_1} = \frac{4.44 Hp}{1 Hp} = 4.44 Hp$$

7.16

design
incompressible
isothermal
steady state

$sys_{1,1} = 0.85$

$Q = 8464 \text{ rpm} = 0.014 m^3/s$

$h_{L\ sys} = 4.2m$

$h_{L\ suction} = 1.4m$

$A_3 = 3.69 \times 10^{-3} m^2$

$$h_A = \frac{p_2 - p_1}{\gamma} + \frac{v_2^2 - v_1^2}{2g} + z_2 + z_1 + h_{L12}$$

$$h_A = \frac{p_2}{\gamma} + z_2 + h_{L12} = \frac{825kPa}{.85(9810 N/m^3)} + 14.5m + 4.2m$$

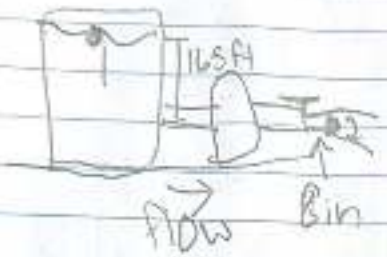
$$h_A = 117.64m$$

$$P = (.85(9810))(.014)(117.64) = 13.733 kW$$

$$Q = VA \rightarrow V_3 = \frac{Q}{A_3} = \frac{.014}{3.69 \times 10^{-3}} = 4.531 m/s$$

$$P_3 = (.85(9810))\left(\frac{-4.531}{2(9.81)} - 3 - 1.4\right) = -45.41 kPa$$

30



design
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steady state

data
$Q = 1000 \frac{gal}{min}$
60°F

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

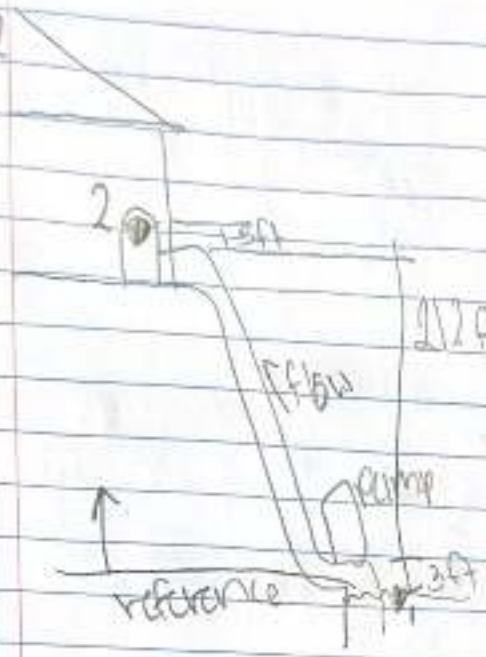
$$z_1 - h_L = z_2 + \frac{V_2^2}{2g}$$

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

$$V_2 = \frac{Q}{A} = \frac{1000}{\frac{\pi}{4}(8)^2} = 19.89 \text{ ft/s}$$

$$\frac{V_2^2}{2g} = \frac{19.89^2}{2(32.2)} = 6.16 \text{ ft}$$

$$h_L = (z_1 - z_2) - \frac{V_2^2}{2g} = 16.5 \text{ ft} - 6.16 = 158.9 \text{ ft}$$



design
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steady state

data
$Q = 460 gal/min = .089 ft^3/s$
$h_L = 15.5 ft$
$p = 35 psig$
efficiency pump = 0.72

$$h_A + \frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_{L12}$$

$$h_A = \frac{p_2 - p_1^{\,0}}{\gamma} + \frac{V_2^{\,0} - V_1^2}{2g} + z_2 - z_1^{\,0} + h_{L12}$$

$$h_A = \frac{p_2}{\gamma} + z_2 + h_{L12} = \frac{35(144)}{62.4} + 226 + 15.5$$

$$= 304.73 ft$$

$$P_A = \gamma Q h_A = 62.4 (.089)(304.73) = 1692.35 \frac{lb\,ft}{s}$$

$$\frac{1692.35}{550} \left| \frac{1 hp}{lb\,ft/s} \right. = 3.077 HP$$

$$P_m = \frac{3.077}{0.72} = 4.27 Hp$$