HW 4

6/7/22
Logan Kooy

6.82

$\gamma_{oil} = 55.0\ lb/ft^3$

$\gamma_w = 62.4\ lb/ft^3$

Find Q

$Q = AV$

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

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

$P_A + \gamma_{oil}\ 1.667ft + \gamma_w .666ft - \gamma_{oil}\ 2.5ft = P_B$

$P_A - P_B = 55\frac{lb}{ft^3} \times 1.667ft - 62.4\frac{lb}{ft^3} \times .666ft - 55\frac{lb}{ft^3} \times 2.5ft$

$P_A - P_B = -114.93\frac{lb}{ft^2} \times \frac{ft^2}{144in^2}$ $\quad P_A - P_B = -.8psi$

$A = \frac{\pi}{4}D^2$ $\quad A_A = \frac{\pi}{4}(\frac{1}{3})^2$ $\quad A_A = .087ft^2$

$A_B = \frac{\pi}{4}(\frac{1}{6})^2$ $\quad A_B = .022ft^2$

$$Q = \sqrt{\frac{2 \cdot 32.2\frac{ft}{sec^2}\left(\frac{-114.93lb \cdot ft^3}{ft^2 \cdot 55lb}\right) + (2ft - 0ft)}{\frac{1}{(.087ft^2)^2} - \frac{1}{(.022ft^2)^2}}}$$

$\boxed{Q = .055ft^3/s}$

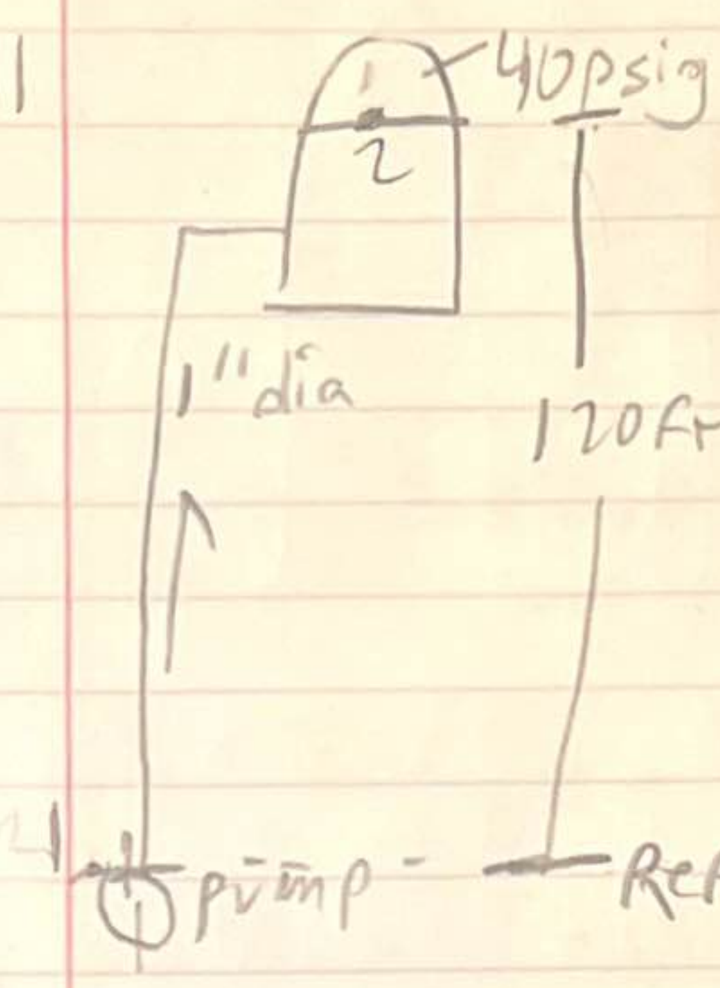
6.91 $h = 2.6m$

$h_{nozzle} = .075m + .85m = .925m$

$2.6m - .925m$

$h_{Jet} = 1.675m$

7.11



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

$$Q = 745\frac{gal}{hr} = .01277\frac{ft^3}{sec} \qquad V = \frac{Q}{A}$$

$$A = \frac{\pi}{4}(1in)^2 \quad A = .0055ft^2$$

$$V = .01277\frac{ft^3}{sec}$$

$$V = 5.04\frac{ft}{sec}$$

$$h_A = \frac{40lb}{in^2} \times \frac{144in^2}{ft^2} + \frac{\left(5.04\frac{ft}{sec}\right)^2}{2(32.2\frac{ft}{sec^2})} + 120ft + 10ft$$

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

$$h_A = 223.2ft$$

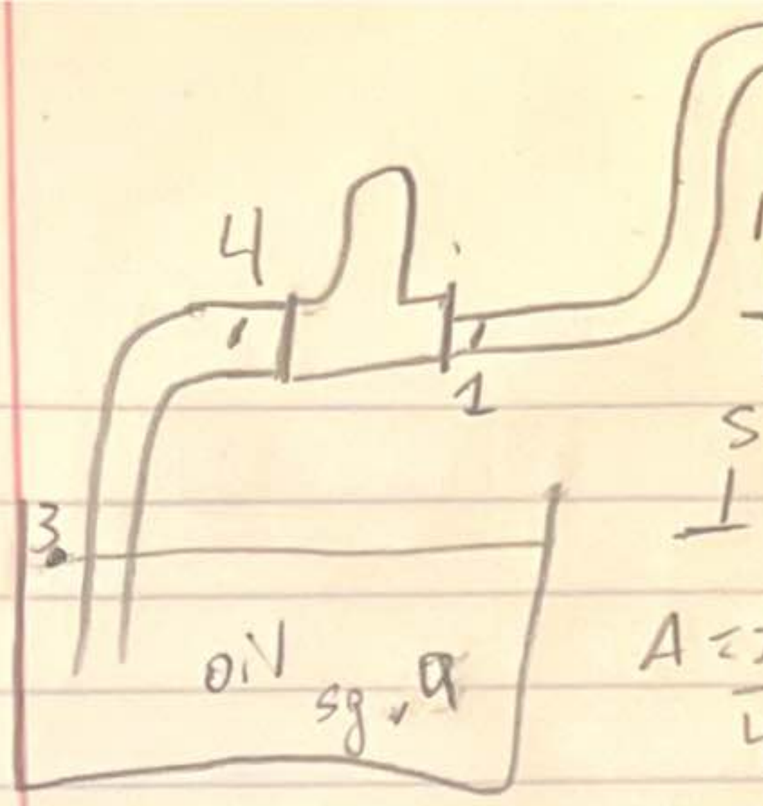
$$Power = \gamma Q h_A = .01277\frac{ft^3}{sec} \times 223.2ft \times 62.4\frac{lb}{ft^3}$$

$$Power = 385.8\frac{ft \cdot lb}{sec} \times \frac{1HP}{550\frac{ft \cdot lb}{sec}}$$

Power = .7HP

$$\eta = \frac{Power}{\uparrow} \qquad \eta = \frac{.7HP}{1}$$

$\eta = 70\%$



$F = 11{,}000\,lb$

$Q = A \cdot V \qquad Q = \frac{A \cdot L}{t} \qquad a$

$Q = 7{,}136\,ft^2 \cdot \frac{12\,in}{1\,ft} \cdot \frac{1\,ft}{15\,sec}$

$A = \frac{\pi}{4}\left(\frac{5\,in}{12\,in/ft}\right)^2 \quad A = .136\,ft^2$

$\boxed{Q = .015\,\frac{ft^3}{sec}}$

b) $P = \frac{F}{A} \qquad P = \frac{11{,}000\,lb}{.136\,ft^3}$

$\boxed{P = 80{,}882.41\,\frac{lb}{ft^2} \text{ or } 561.7\,psi}$

c) $\frac{P_1}{\gamma_{oil}} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma_{oil}} + \frac{V_2^2}{2g} + z_2$

$z_2 = 15ft \quad z_1 = 5ft$

$V_1 = .015\,\frac{ft^3}{sec} / .000976\,ft^2$

$P_1 = \gamma_{oil}\left(\frac{P_2}{\gamma_{oil}} + \frac{V_2^2 - V_1^2}{2g} + z_2 - z_1 + h_L\right) \quad V_1 = 15.37\,\frac{ft}{sec}$

$P_1 = 56.16\,\frac{lb}{ft^3}\left(\frac{80{,}882.41\,\frac{lb}{ft^2}}{56.16\,\frac{lb}{ft^3}} + \frac{(.1111\,ft/sec)^2 - (15.37\,ft)^2}{2 \times 32.2\,\frac{ft}{sec^2}} + (15ft - 5ft) + 35\right)$

$\boxed{P_1 = 83{,}203.61\,\frac{lb}{ft^2}}$

$V_4 = V_1$

d) $\frac{P_3}{\gamma_{oil}} + \frac{V_3^2}{2g} + z_3 = \frac{P_4}{\gamma_{oil}} + \frac{V_4^2}{2g} + z_4 + h_L$

$P_4 = \gamma_{oil}\left(\frac{-V_4^2}{2g} - z_4 - h_L\right) \qquad P_4 = \frac{56.16\,lb}{ft^3}\left(-\frac{(15.37\,ft/s)^2}{2{,}32.2\,\frac{ft}{sec^2}} - 5ft - 11.5ft\right)$

$\boxed{P_4 = -1132.65\,\frac{lb}{ft^2} \text{ or } -7.87\,psi}$

e) $P = \gamma h_A Q \qquad \frac{P_3}{\gamma_{oil}} + \frac{V_3^2}{2g} + z_3 + h_A = \frac{P_2}{\gamma_i} + \frac{V_2^2}{2g} + z_2 + h_{L\,total}$

$h_A = \frac{80{,}882.41\,lb/ft^2}{56.16\,\frac{lb}{ft^3}} + \frac{(.111\,ft/sec)^2}{2 \times 32.2\,\frac{ft}{sec^2}} + 15ft + 46.5ft$

$h_A = 1511.7\,ft$

$P = 56.16\,\frac{lb}{ft^3} \times 1511.7\,ft \times .015\,\frac{ft^3}{sec} \times \frac{1\,HP}{550\,\frac{ft \cdot lb}{sec}}$

$\boxed{P = 2.32\,HP}$