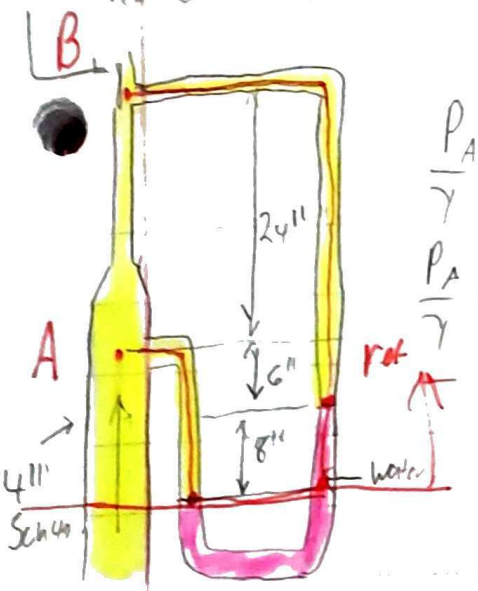
2" Sch 40 82 $\gamma = 55.0\ lb/ft^3$ $Q = ?$

$Q = VA$



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

$$\frac{P_A}{\gamma} + \frac{Q^2}{A_A^2 \cdot 2g} + z_A = \frac{P_B}{\gamma} + \frac{Q^2}{A_B^2 \cdot 2g} + z_B$$

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

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

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

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

$$P_B - P_A = \gamma_{oil} \cdot (8" + 6") - \gamma_{water} \cdot 8" - \gamma_{oil}(24" + 6")$$

$$P_B - P_A = \gamma_{oil} \cdot 8" - \gamma_{water} \cdot 8" - \gamma_{oil} \cdot 24"$$

$$P_B - P_A = 55\frac{lb}{ft^3} \cdot 8in \cdot \frac{1ft}{12in} - 62.4\frac{lb}{ft^3} \cdot 8in \cdot \frac{1ft}{12in} - 55\frac{lb}{ft^3} \cdot 2ft$$

$$P_B - P_A = -114.93\ \frac{lb}{ft^2}$$

$$A_a = \frac{\pi}{4} \cdot (0.3355 ft)^2$$

$$A_a = 0.0884\ ft^2$$

$$A_b = \frac{\pi}{4} \cdot (0.1723 ft)^2$$

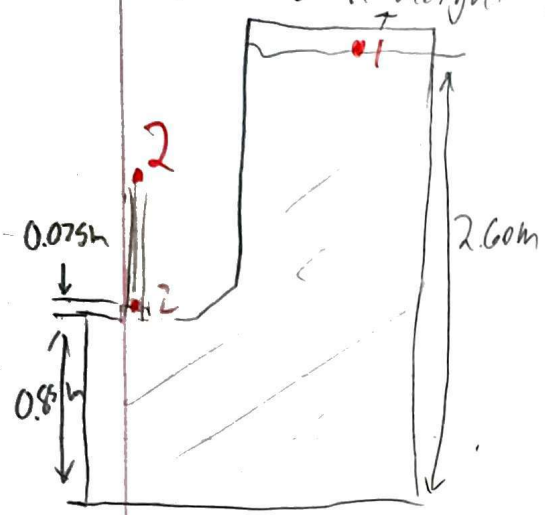
$$A_b = 0.0233 ft^2$$

$$Q = \sqrt{2 \cdot 32.2 \frac{ft}{s^2}\left[\frac{\left(\frac{-114.93 \frac{lb}{ft^2}}{55\ lb/ft^3} + 2ft\right)}{\frac{1}{0.0884 ft^2} - \frac{1}{0.0233 ft^2}}\right]}$$

~~$Q = 0.281\ ft^3/s$~~

$Q = 0.281\ ft^3/s$

q1. Jet height?



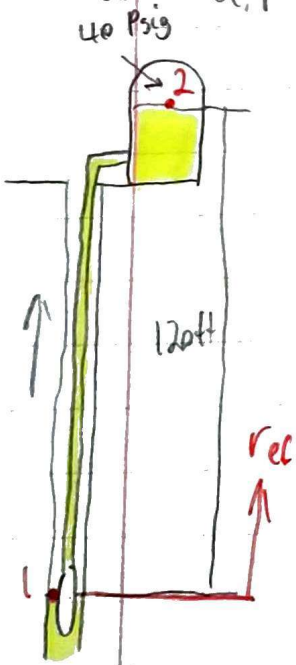
$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

$$z_1 = z_2$$

$$z_1 = z_2 = 2.60\,m$$

Ch7 11. $Q = 745 \frac{gal}{hr}$ $D = 1\,in$ sch 40 $h_L = 10.5 \frac{lb\text{-}ft}{lb}$

a. & a. P = ? b. If pump draws 1HP, calc efficiency



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

$$h_A = \frac{P_2}{\gamma} + z_2 + h_{L12}$$

$$h_A = \frac{40 \frac{lb}{in^2} \cdot \frac{144 in^2}{ft^2}}{62.4 \frac{lb}{ft^3}} + 120ft + 10.5 \frac{lb\text{-}ft}{lb}$$

$$h_A = 222.81\,ft$$

$$\eta_A = \frac{P_A}{P_{in}} = \frac{0.649}{1HP}$$

$$\eta_A = 70.1\%$$

$$P = \gamma \cdot Q \cdot h_A \qquad \frac{lb}{ft^3} \cdot \frac{ft^3}{s} \cdot ft$$

$$P = 62.4 \frac{lb}{ft^3} \cdot 745 \frac{gal}{hr} \cdot \frac{231 in^3}{gal} \cdot \frac{1 ft^3}{1728 in^3} \cdot \frac{1 hr}{3600 s} \cdot 222.81\,ft$$

$$P = 384.6 \frac{ft \cdot lb}{s} \cdot \frac{1HP}{550 \frac{ft \cdot lb}{s}} = P_A = 0.699\,HP$$

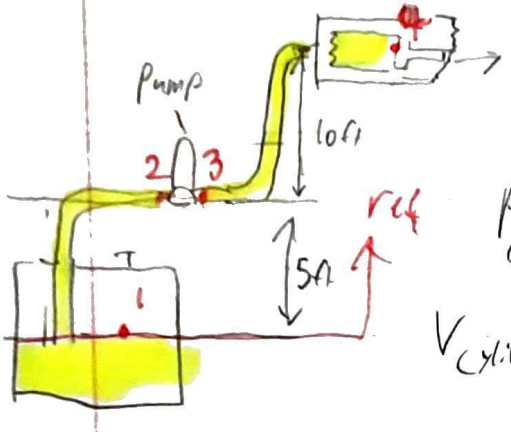
22. $SG = 0.90$ $ID = 5.0\,in$ Piston must travel 20 in in 15s while exerting force of 11000 lb

$h_{L_{12}} = 11.5 \frac{lb \cdot ft}{lb}$ Suction

$h_{L_{34}} = 35 \frac{lb \cdot ft}{lb}$ discharge

Pipe = 3/4 Sch80

A $Q = ?$ b $P_{cylinder}$ C P_{outlet} d P_{inlet} e $P_a = ?$



$F = P \cdot A$ $P = \frac{F}{A}$

$P_{cylinder} = \frac{11000\,lb}{\frac{\pi}{4} \cdot 5in^2} = 560\,psi$ b.

$560 \frac{lb}{in^2} \cdot \frac{144 in^2}{1 ft^2} = P_{cylinder} = 80640 \frac{lb}{ft^2}$

$V_{cylinder} = \frac{20in}{15\,sec} \cdot \frac{1ft}{12in} = 0.11\,ft/s$

$Q = VA = 0.11 \frac{ft}{s} \cdot \frac{\pi}{4} \cdot 5in^2 \cdot \frac{1ft^2}{144in^2}$ $Q = 0.015 \frac{ft^3}{s}$ a.

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

$\frac{P_2}{\gamma} = -\frac{V_2^2}{2g} - z_2 - h_{L12}$

$P_2 = \gamma\left(-\frac{V_2^2}{2g} - z_2 - h_{L12}\right)$

$V_2 = \frac{Q}{A} = \frac{0.015 \frac{ft^3}{s}}{\frac{\pi}{4} \cdot 0.03325 ft^2} = 15.36 \frac{ft}{s}$

$P_2 = 0.90(62.4 \frac{lb}{ft^3})\left(\frac{-15.36 \frac{ft}{s}}{2.322 \frac{ft}{s^2}} - 5ft - 11.5 ft\right)$

$P_2 = -913 \frac{lb}{ft^2} \frac{1ft^2}{144in^2} = -6.34\,psi$ d

$P_{inlet} = -913 \frac{lb}{ft^2} = -6.34\,psi$

a. $Q = 0.015 \frac{ft^3}{s}$

b. $P_{cylinder} = 80640 \frac{lb}{ft^2}$ or $560\,psi$

C. $P_{outlet} = 82691 \frac{lb}{ft^2}$ or $576\,psi$

d. $P_{inlet} = -913 \frac{lb}{ft^2}$ or $-6.34\,psi$

e. Power $= 2.29\,HP$

22. $\frac{P_3}{\gamma} + \frac{V_3^2}{2g} + z_3 = \frac{P_4}{\gamma} + \frac{V_4^2}{2g} + z_4 + H_{L34}$

$\frac{P_3}{\gamma} = \frac{P_4}{\gamma} + \frac{V_4^2 - V_3^2}{2g} + z_4 - z_3 + H_{L34}$

$P_3 = \gamma\left(\frac{P_4}{\gamma} + \frac{V_4^2 - V_3^2}{2g} + z_4 - z_3 + H_{L34}\right)$

$P_3 = \left(0.90 \cdot 62.4 \frac{lb}{ft^3}\right)\left(\frac{80640 \frac{lb}{ft^2}}{0.90 \cdot 62.4 \frac{lb}{ft^3}} + \frac{(0.11 \frac{ft}{s})^2 - (5.36 \frac{ft}{s})^2}{2 \cdot 32.2 \frac{ft}{s^2}} + 10ft + \frac{35 lb \cdot ft}{lb}\right)$

$P_{outlet} = 82961 \frac{lb}{ft^2}$ C

$83159 \frac{lb}{ft^2} \cdot \frac{1 ft^2}{144 in^2} = 576 psi$

$h_A + \frac{P_1}{\gamma}^{0} + \frac{V_1^2}{2g}^{0} + z_1^{0} = \frac{P_3}{\gamma} + \frac{V_3^2}{2g} + z_3 + H_{L12}$

$h_A = \frac{P_3}{\gamma} + \frac{V_3^2}{2g} + z_3 + H_{L12}$

$h_A = \frac{82961 \frac{lb}{ft^2}}{0.90 \cdot 62.4 \frac{lb}{ft^3}} + \frac{(15.36 \frac{ft}{s})^2}{2 \cdot 32.2 \frac{ft}{s^2}} + 5ft + 11.5 \frac{lb \cdot ft}{lb}$

$1477 + 3.66 + 5 + 11.5$

$h_A = 1497 ft$

$P = \gamma \cdot Q \cdot h_A$

$Power = \left(0.90 \cdot 62.4 \frac{lb}{ft^3}\right)\left(0.015 \frac{ft^3}{s}\right)(1497 ft) = 1261 \frac{lb \cdot ft}{s}$

$1261 \frac{lb \cdot ft}{s} \cdot \frac{1 HP}{550 \frac{lb \cdot ft}{s}} = 2.29 HP$

e Power = 2.294HP