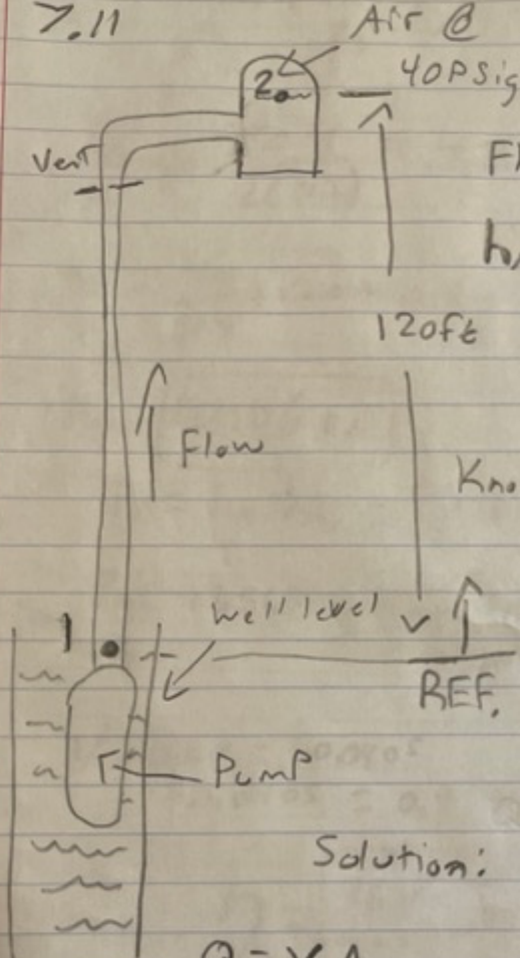
7.11 8.46 10.20 10.48

7.11 TYLER GRAY



Flow → bernoulli's equation

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

Known:

$Q = 745\ gal/min$

1 in Pipe

Schedule 40 Pipe

1 elbow

energy loss of 10.5 lb-ft

Solution:

$Q = VA$

$$\left(\frac{1\,gal}{7.48 ft^3}\right) 1224.2\ gal/min = V_1 \frac{\pi (1)^2}{4} \left(\frac{1\ ft}{12 in}\right)$$

$V_1 = 5.074\ ft/s$

$745\ gal/min = 1.659\ ft^3/s$

7.11

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

$$h_A + \cancel{\frac{P_1}{\gamma}} + \frac{5.074}{2(32.2)} = \frac{40}{\gamma} + 120 + 10.5 \text{ lb-ft}$$

$$h_A = \frac{40}{62.4} + 120 + 10.5 - \frac{5.074}{2(32.2)}$$

$$h_A = \boxed{131.06 \text{ ft}}$$

$$P_A = h_A \gamma Q = 131.06\text{ft}\left(\frac{62.4 \text{ lb}}{\text{ft}}\right)\left(\frac{1.659 \text{ ft}^3}{s}\right)$$

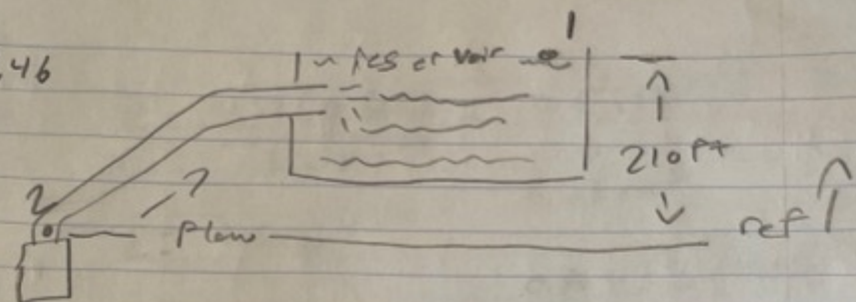
$$P_A = 13568 \frac{\text{lb-ft}}{s}\left(\frac{1 \text{ hp}}{550 \frac{\text{lb-ft}}{s}}\right) = 24.67 \text{ hp}$$

$1/24.67 = 0.0405$

$1 - 0.0405 = 0.959$

$$\eta = \boxed{96\%}$$

8.46



Given:

water @ 60°F

Distance of pipe and height

$Q = 4.0 \, ft^3/s$

Solution:

$$\cancel{h_A} + \cancel{\frac{P_1}{\gamma}} + \cancel{\frac{v_1^2}{2g}} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + \cancel{z_2} + \cancel{h_R} + h_L$$

$$210 \, ft = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + h_L$$

$Q = vA$

$$v = \frac{Q}{A} \quad \frac{4.00 \, ft^3/s}{0.3472 \, ft^2} \times$$

Kin vis

1.21×10^{-5}

$V_2 = 11.52 \, ft/s$

$D = 0.6651$

$\gamma = 62.4$

8.46

$$N_R = \frac{VD}{\nu} \quad \frac{11.52(0.6651)}{1.21\times10^{-5}} = 633219$$

$$\downarrow$$

$$6.33\times10^{5}$$

$$\varepsilon = 1.5\times10^{-4}$$

$$\frac{0.6651}{1.5\times10^{-4}} = 4434$$

$$\downarrow$$

Moody diagram

$$h_L = F\times\frac{L}{D}\times\frac{v^2}{2g}$$

$$h_L = 0.0145\times\frac{2500}{0.6651}\times\frac{11.52^2}{2(32.2)} \qquad F = 0.0145$$

$$h_L = 112.32\,ft$$

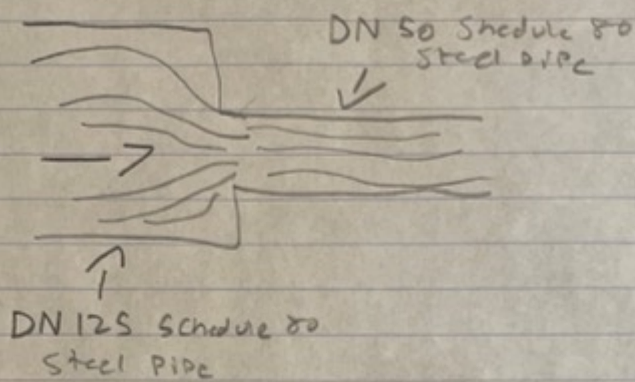
$$210\,ft = \frac{P_2}{62.4\,lb/ft^3} + \frac{11.52^2}{2(32.2)} + 112.32\,ft$$

$$P_2 = \frac{\left(210 - \frac{11.52^2}{32.22} - 112.32\right)}{62.4}$$

$$P_2 = \boxed{1.53\,ft\text{-}16}$$

10.20

Given:



Flow rate: 500 L/min

Solution:

$h_L = K(v_2^2/2g)$

$D_1 = 122.3\,mm$ from tables

$D_2 = 49.3\,mm$

$D_1/D_2 = 122.3/49.3 = 2.4807$

$v_2 = \frac{Q}{A_2} = \frac{500\,L/min}{0.0019089} \times \frac{1\,m^3/s}{60000\,L/min} = 4.3655\,m/s$

$A_2 = \frac{\pi(0.0493)^2}{4} = 0.0019089$

$\frac{v_2^2}{2g} = \frac{4.3655^2}{2(9.81)} = 0.9713\,m$

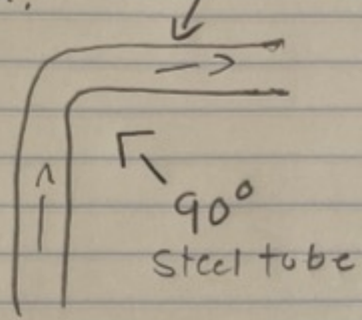
$K = 0.38$ from tables

$h_L = 0.38 \times 0.9713 = \boxed{0.369\,m}$

10.48

Given:

$1\frac{1}{4}$ OD, wall thickness of 0.083in



Hydraulic oil

$Q = 27.5 \text{ gal/min}$

Mean bend radius is 3.25in

$r = 3.25 \text{ in}$

Solution:

$1.25 - (0.083\text{in} \times 2) = D = 1.084\text{in}$

$r/D = 3.25 / 1.084 = 2.998$

equivalent length ratio $= 12$

$$V = \frac{Q}{A} = \frac{27.5 \text{ gal/min}}{\frac{\pi(0.09)^2}{4}} \times \frac{1 \text{ ft}^3}{7.48 \text{ gal}} \times \frac{1 \text{ min}}{60 \text{ s}}$$

$v = 9.56 \text{ ft/s}$

$D/\varepsilon = 0.09\text{ft} / 1.5\times10^{-4}\text{ft} = 602.2$

$f_r = 0.0235$ from table

$$K = f_r\left(\frac{L_e}{D}\right) = 0.0235(12) = 0.282$$

$$h_L = K\frac{v^2}{2g} = 0.282\left(\frac{9.56^2}{2(32.2)}\right) = \boxed{0.400 \ \frac{\text{ft-lb}}{\text{ft}}}$$