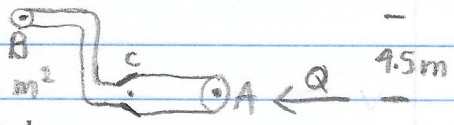
MET 330 Chapter 11 HW

5. $Q = 0.015 \frac{m^3}{s}$ $\gamma = 8.8 \frac{kN}{m^3}$ $\nu = 2.12 \cdot 10^{-5} \frac{m^2}{s}$ $L_B = 8 m$

$L_A = 180 m$ $P_B = 12.5 MPa$ $d_A = 146.3 mm$



$d_B = 493 mm$ $A_A = 0.01682 m^2$ $A_B = 0.00191 m^2$

$V_A = 0.892 \frac{m}{s}$ $V_B = 7.874 \frac{m}{s}$ $Re_A = \frac{V_A \cdot d_A}{\nu} = 6155$

$Re_B = \frac{V_B \cdot d_B}{\nu} = 18311$ $f_A = 0.25 / \left(\log\left(\frac{1}{3.7 \cdot D/\varepsilon} + \frac{5.74}{Re_A^{0.9}}\right)\right)^2 = 0.036$

$\varepsilon = 4.6 \cdot 10^{-5} m$ $f_B = 0.25 / \left(\log\left(\frac{1}{3.7 \cdot D/\varepsilon} + \frac{5.74}{Re_B^{0.9}}\right)\right)^2 = 0.028$

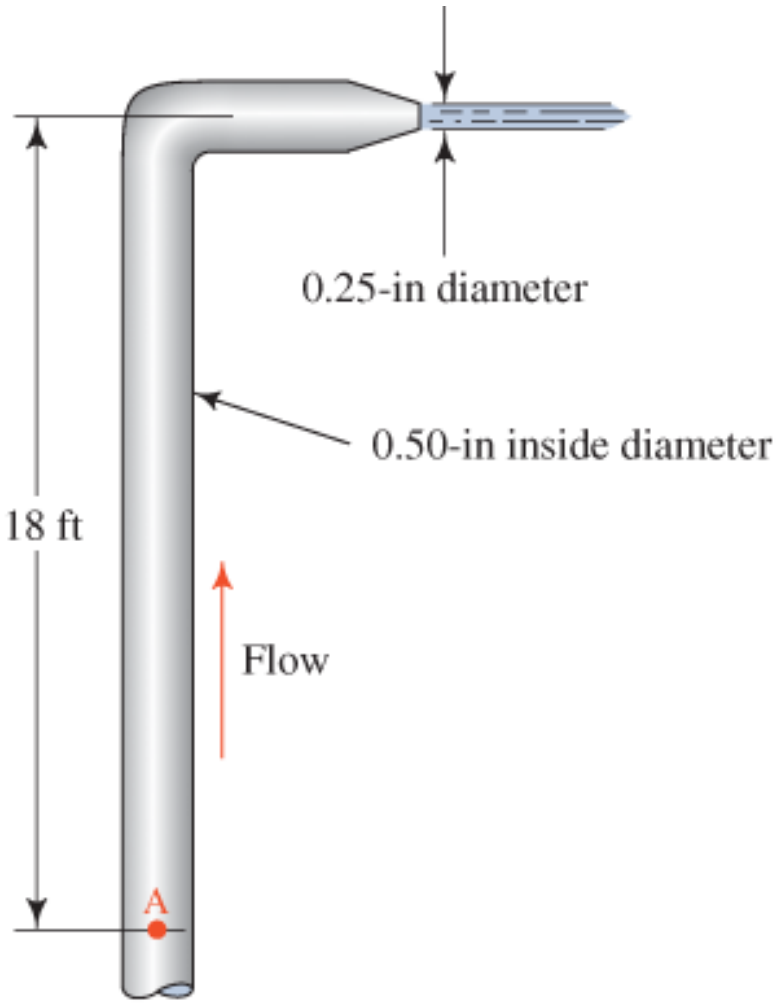
$h_{LA} = f_A \cdot \frac{L_A}{d_A} \cdot \frac{V_A^2}{2g} = 1.8 m$ $h_{LB} = f_B \cdot \frac{L_B}{d_B} \cdot \frac{V_B^2}{2g} = 14.36 m$ $h_{Le} = 2 \cdot K \cdot \frac{V_B^2}{2g}$

$K = \frac{L_e}{D} \cdot f_T$ $\frac{L_e}{D} = 20$ $f_T = 0.019$ from Moody diagram $h_{Le} = 2.4 m$

$h_{Lc} = K \cdot \frac{V_B^2}{2g}$ $K = 0.38$ from figure 10.8 $h_{Lc} = 1.2 m$

$h_L = h_{LA} + h_{LB} + h_{Lc} + h_{Le} = 19.76 m$ $\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + z_B + h_L$

$P_A = \gamma\left(\frac{P_B}{\gamma} + \frac{V_B^2}{2g} + z_B + h_L - \frac{V_A^2}{2g} - z_A\right) = 12.74 MPa$


0.25-in diameter
0.50-in inside diameter
18 ft
Flow
A

13

Cross Section Area of Pipe

$$A = \frac{\pi \cdot D}{4}$$

$$A = \frac{\pi \left(\frac{0.5 in}{12}\right)^2}{4}$$

$$A = 0.00136 ft^2$$

D/ε ratio

$$\frac{0.5/12}{1.5 \cdot 10^{-4}}$$

$$= 277.77$$

head loss

$$h_L = \frac{P_A - P_B}{\gamma} + \frac{V_A^2 - V_B^2}{2g} + Z_A - Z_B$$

$$h_L = \frac{2880 psf}{62.4 lb/ft^3} - 18 ft$$

$$h_L = 28.15 ft$$

$$Q = -2.22 \cdot D^2 \sqrt{\frac{g \cdot D \cdot h}{L}} \log\left(\frac{1}{3.7 D/\varepsilon} + \frac{1.784 \cdot \nu}{D\sqrt{\frac{g \cdot D \cdot h}{L}}}\right)$$

$$Q = 0.0425 ft^3/s$$

Velocity

$$Q = A \cdot V$$

$$V = \frac{Q}{A}$$

$$V = 31.17 ft/s$$

Head loss

$$h_L = \left(\frac{P_A - P_B}{\gamma}\right) + \left(\frac{V_A^2}{2g} - \frac{V_B^2}{2g}\right) + Z_A - Z_B$$

$$h_L = \frac{11520}{62.4} + -18$$

$$h_L = 166.61 \text{ ft}$$

$$Q = -2.22 \times D^2 \sqrt{\frac{g \cdot D \cdot h_L}{L}} \log\left(\frac{1}{3.7D/\varepsilon} + \frac{1.784 \cdot \nu}{D\sqrt{g D h_L}}\right)$$

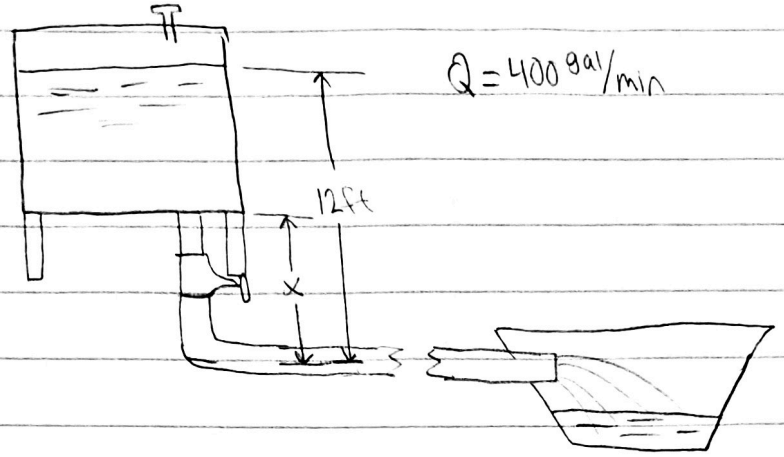
$$Q = 0.0887 \text{ ft}^3/\text{s}$$

Velocity

$$V = \frac{Q}{A}$$

$$V = 64.53 \text{ ft/s}$$

11.20



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

$\hookrightarrow h_1 + z_1 - h_L = h_2 + z_2 \rightarrow (12-x) + x - h_L = 0$

$\hookrightarrow h_L = 12\,ft$

$$D = 0.66\left(\varepsilon^{1.25}\left(\frac{LQ^2}{gh_L}\right)^{4.75} + \nu Q^{9.4}\left(\frac{L}{gh_L}\right)^{5.2}\right)^{0.04}$$

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

ν @ 80°F $= 9.15\times10^{-6}\,ft^2/s$

$$D = 0.66\left((1.5\times10^{-4}\,ft)^{1.25}\left(\frac{(75ft)(0.891\,ft^3/s)^2}{(32.2\,ft/s^2)(12ft)}\right)^{4.75} + (9.15\times10^{-6}\,ft^2/s)(0.891\,ft^3/s)^{9.4}\left(\frac{75ft}{(32.2\,ft/s^2)(12ft)}\right)^{5.2}\right)^{0.04}$$

$$D = 0.66\left((2.301\times10^{-9}) + (6.138\times10^{-10})\right)^{0.04}$$

$D = 0.66\,(0.456) = \boxed{0.301\,ft}$