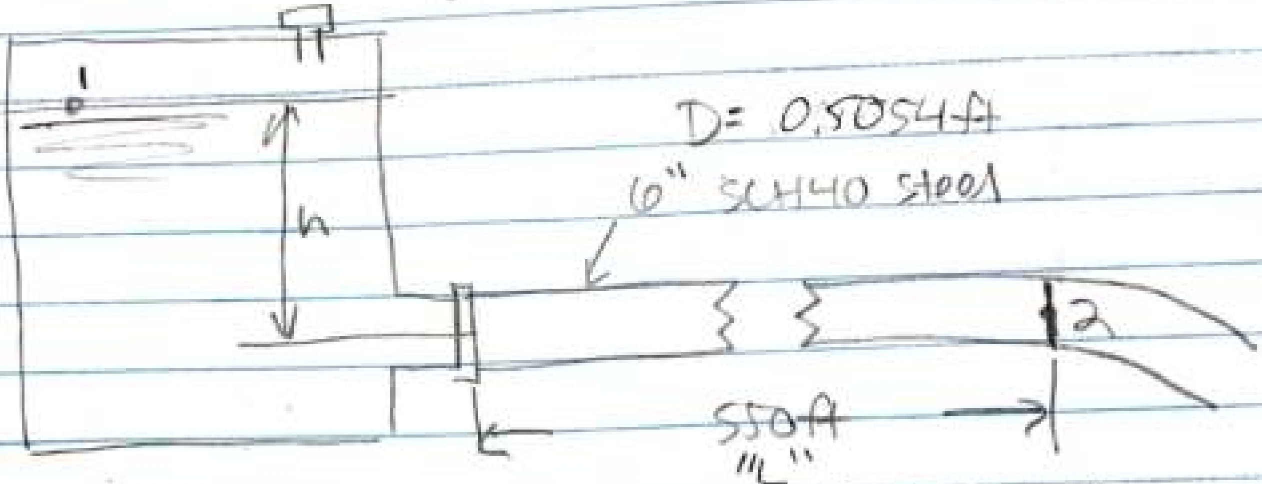
Dylan Arnold University ID: 01166349
MET 330 Professor Ayala June 18th, 2023

8.33



Water 80°F $Q = 2.50\ ft^3/s$ Roughness $= 1.5\times10^{-4}$ ft

$\gamma = 62.2\ lb/ft^3$ $\rho = 1.93\ \frac{slugs}{ft^3}$ $\nu = 9.15\times10^{-6}\ ft^2/s$

$\mu = 1.77\times10^{-5}\ lb\cdot s/ft^2$

$$\frac{\cancel{P_1}^{0}}{\gamma} + \frac{\cancel{V_1^2}^{0}}{2g} + z_1 = \frac{\cancel{P_2}^{0}}{\gamma} + \frac{V_2^2}{2g} + \cancel{z_2}^{0} + h_{L12}$$

$$h_L = f\frac{L}{D}\cdot\frac{V^2}{2g}$$ Relative Roughness $= \frac{D}{E}$

$$R_e = \frac{\rho V D}{\mu} = \frac{VD}{\nu}$$

$$\overset{"h"}{z_1} = \frac{V_2^2}{2g} + h_{L12} \rightarrow \overset{"h"}{z_1} = \frac{V_2^2}{2g}\cdot f\frac{L}{D}\cdot\frac{V_2^2}{2g}$$

$$h = \frac{V_2^2}{2g}\left(1 + f\frac{L}{D}\right)$$

$$V_2 = \frac{Q}{A} = \frac{2.50\ ft^3/s}{\frac{\pi}{4}\cdot 0.5054^2\ ft^2} = 12.46\ \frac{ft}{s}$$

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Problem 8.33 Continued

$$Re = \frac{VD}{\nu} = \frac{12.46\frac{ft}{s}\ 0.5054\,ft}{9.15\times10^{-6}\frac{ft^2}{s}} = 6.88\times10^{-5}$$

$$\frac{D}{\varepsilon} = \frac{0.5054\,ft}{1.5\times10^{-4}ft} = 3369$$

$$f \approx 0.016$$

$$h = \frac{V_2^2}{2g}\left(1+f\frac{L}{D}\right) = \left(\frac{(12.46\,ft/s)^2}{2\cdot 32.2\,ft/s^2}\right)\left(1+0.016\frac{550ft}{0.5054ft}\right)$$

$$\boxed{h = 45.7\,ft}$$

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8.62 Heavy fuel oil at 77°F in 6" SCH40 steel pipe at 12ft/s

$sg = 0.906$ $\rho = 906\ kg/m^3$ $\nu = 1.18 \times 10^{-4}\ m^2/s \rightarrow 1.27 \times 10^{-3}\ ft^2/s$
$\gamma = 8.89\ kN/m^3$ $\eta = 1.07 \times 10^{-1}\ Pa \cdot s$

6" steel SCH40 OD = 6.625" (168.3mm)
WT = 0.280" (7.11mm) ID = 6.065" (154.1mm) (0.5054ft)
Flow Area = $0.2006\ ft^2$ ($1.864 \times 10^{-2}\ m^2$)

$$N_R = \frac{vD}{\nu} = \frac{12\ ft/s \cdot 0.5054ft}{1.27 \times 10^{-3}\ ft^2/s} = 4775$$

$\varepsilon = 4.6 \times 10^{-5}\ m$ or $1.5 \times 10^{-4}\ ft$ $\frac{D}{\varepsilon} = \frac{0.5054ft}{1.5 \times 10^{-4}ft} = 3369$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(3369)} + \frac{5.74}{(4775)^{0.9}}\right)\right]^2} = \boxed{0.03875}$$

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10.20 Sudden Contraction

DN125 SCH 80 to DN50 SCH 80

$Q = 500\ L/min$

$h_L = K(v_2^2/2g)$ $D_1 = 122.3m$ $A_1 = 1.173 \times 10^{-2} m^2$ $D_2 = 73.7mm$ $A_2 = 4.264 \times 10^{-3} m^2$

$D_1/D_2 = 122.3/73.7 = 1.659$

$v_2 = \frac{Q}{A} = \frac{500\ L/min}{4.264 \times 10^{-3} m^2} \times \frac{1 m^3 s}{60000\ L/min} = 1.954 \frac{m}{s}$

$\frac{v_2^2}{2g} = \frac{(1.954 \frac{m}{s})^2}{2(9.81 \frac{m^2}{s})} = 0.1946\ m$

$K = 0.28$ $h_L = (0.28)(0.1946\ m) \boxed{= 0.054 m}$

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10.48 $90°$ bend $3.125''$ mean bend radius
$1.25''$ OD WT = $0.083''$ $1.034''$ ID
$Q = 27.5\ gal/min$ $\hookrightarrow 0.0903 ft$

$90°$ long radius elbow $L_e/D = 20$

$\varepsilon = 4.6 \times 10^{-5}\ m$ or $1.5 \times 10^{-4}\ ft$ $\frac{D}{\varepsilon} = \frac{0.0903 ft}{1.5 \times 10^{-4} ft}$

$\frac{D}{\varepsilon} = 602$ $N_R = \frac{vD}{\nu} = \frac{9.56\ ft/s \cdot 0.0903 ft}{7.29 \times 10^{-3}\ ft^2/s}$

assume $77°F$ or $25°C$
ν of castor oil $= 6.78 \times 10^{-4}\ m^2/s = 7.29 \times 10^{-3}\ ft^2/s$

$v = \frac{Q}{A} = \frac{27.5\ \frac{gal}{min}}{6.409 \times 10^{-3}\ ft^2} \cdot \frac{ft^3/s}{449\ \frac{gal}{min}} = 9.56\ ft/s$

$N_R = 118.4$ laminar $f = 64/118.4 = 0.5405$

$K = (0.5405)(20) = 10.81$

$h_L = (10.81)\left(\frac{(9.56\frac{ft}{s})^2}{2(32.2\frac{ft}{s^2})}\right) = \boxed{15.34\ ft}$