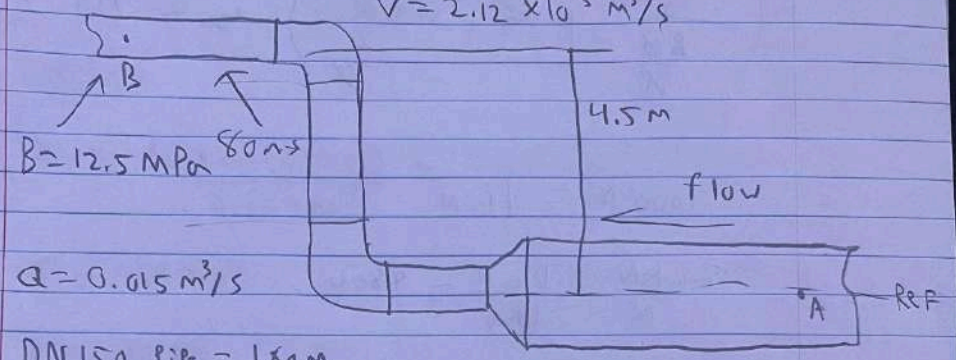
11.5)

$\gamma = 8.80\ kN/m^3$

$V = 2.12 \times 10^{-5}\ m^3/s$



DN 150 Pipe = 180 m

DN 50 Pipe = 80 m

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

$Q = VA \rightarrow Q = V_A A_A$

$$V_A = \frac{Q}{A_A} = \frac{0.015\ \frac{m^3}{s}}{1.082 \times 10^{-2}\ m^2} = 0.82\ m/s$$

Table F.2

$$V_B = \frac{Q}{A_B} = \frac{0.015\ \frac{m^3}{s}}{1.905 \times 10^{-3}\ m^2} = 7.87\ m/s$$

$h_L = h_{DN150} + 2h_{elbow} + h_{DN50}$

$h_{DN150} = f\left(\frac{L}{D}\right)\left(\frac{V_A^2}{2g}\right) = 0.037\left(\frac{180}{0.1463}\right)\left(\frac{0.82^2}{19.62}\right) = 1.56$

$h_{elbow} = f_T\,(L_e/D)\,(V_B^2/2g) = (0.019)(20)\left(\frac{7.87^2}{19.62}\right) = 1.19$

$h_{DN50} = f\,(L/D)\,(V_B^2/2g) = (0.028)\left(\frac{80}{0.0493}\right)\left(\frac{7.87^2}{19.62}\right) = 143$

DN 50

$$Re = \frac{VD}{\nu} = \frac{(7.87)(0.0493)}{2.12 \times 10^{-5}\ m^3/s} = 1.83 \times 10^4$$

DN 150

$$Re = \frac{(0.82)(0.1463)}{2.12 \times 10^{-5}} = 5.65 \times 10^3$$

$$\varepsilon = 4.6 \times 10^{-5}$$

$$f_{DN50} = \frac{0.25}{\left[\log\left(\frac{1}{3.7(1071.7)} + \frac{5.74}{(1.83 \times 10^{4})^{0.9}}\right)\right]^2} = 0.028$$

$$F_{DN150} = 0.037$$

$$h_L = 1.56 + (2 \times 1.19) + (3 \times 143) = 146.94$$

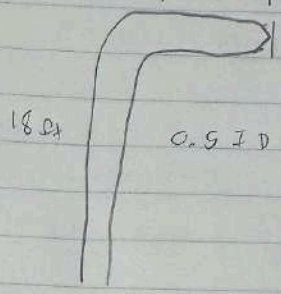
$$P_A = \left(\left(\frac{P_B}{\gamma} + z_B + \frac{V_B^2}{2g}\right) + h_L - \frac{V_A^2}{2g}\right)\gamma$$

Convert to $8.80 \frac{kN}{m^3}$

$$P_A = \left(\left(\frac{1.25 \times 10^{7}\ Pa}{8.80\ \frac{kN}{m^3}} + 4.5 + \frac{7.87^2}{19.62}\right) + 146.94 - \frac{0.82^2}{19.62}\right) 8.80\ \frac{kN}{m^3}$$

$$P_A = 13.9\ MPa$$

Fluids HW Prob 11.13 Ben Smithson



Diameter = 0.5 in water = 100°F

loss = K = 0.15 bend = 6 in radius

a = 20 psig

b = 80 psig

$Q = V_1 A$

$A = \frac{\pi}{4}\left(\frac{0.5}{12}\right)^2 = 0.00136\ ft^2$

$\frac{D}{\epsilon} = \frac{0.5}{12 \cdot 1.5 \cdot 10^{-4}} = 277.77$

$$LHS = \left[\frac{P_A}{\gamma} \frac{P_B}{\gamma}\right] + \left[\frac{v_A^2}{2g} - \frac{v_B^2}{2g}\right] + z_A - z_B$$

$$LHS = \left[\frac{2880 - 0}{62.4}\right] + (0 - 18) = 28.19\ ft$$

LHS ↑

$$RHS = f \frac{8LQ^2}{g\pi^2} \frac{1}{D^5} + (K_{elbow}) \frac{8Q^2}{g\pi^2} \frac{1}{D^4} + K_{nozz} \frac{8Q^2}{g\pi^2} \frac{1}{D^4}$$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.5(D/\epsilon)} + \frac{5.74}{Re^{0.9}}\right)\right]^2}$$

$f = 0.028009$ (excel)

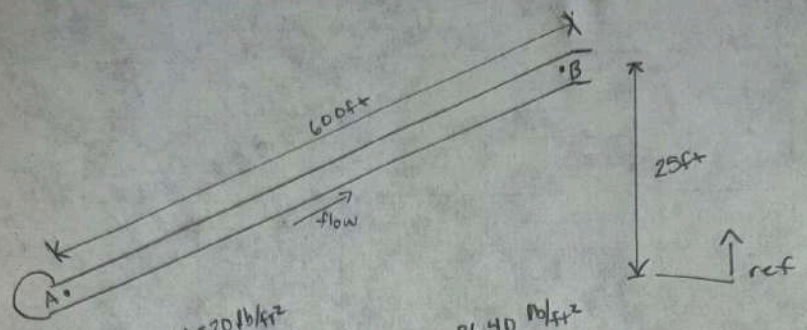
$Re = 10356255 1.8$

$$RHS = 0.028009 \frac{8 \cdot 18 \cdot 4^2}{32.2 \cdot \pi^2} \cdot \frac{1}{0.5^5} + 0.840262 \cdot \frac{8 \cdot 4^2}{32.2 \cdot \pi^2} \cdot \frac{1}{0.5^4}$$

$$+ 0.15 \cdot \frac{8 \cdot 4^2}{32.2 \cdot \pi^2} \cdot \frac{1}{0.25^4} = Q = 4 \text{ w LHS}$$

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

$$V = \frac{4}{0.00136} = 2941.17$$



$P_{main} = 80 psig = 11520 lb/ft^2$ $P_B = 60 psig = 8640 lb/ft^2$ • Schedule 40 steel

$Q = 0.5 ft^3/s$ $T = 60°F$ $\gamma = 62.4 lb/ft^3$

$\nu = 1.21 \times 10^{-5} ft^3/s$ $\varepsilon = 1.5 \times 10^{-4} ft$

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g}^{0} + z_A^{0} = \frac{P_B}{\gamma} + \frac{V_B^2}{2g}^{0} + z_B + h_L$$

$$h_L = \frac{P_A - P_B}{\gamma} - z_B \qquad h_L = f\frac{L}{D}\frac{V^2}{2g}$$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(D/\varepsilon)} + \frac{5.74}{Re^{0.9}}\right)\right]^2}$$

$$f\frac{L}{D}\frac{V^2}{2g} = \frac{P_A - P_B}{\gamma} - z_B \qquad V = \frac{4Q}{\pi D^2}$$

$$D = \sqrt[5]{\frac{f\frac{8LQ^2}{g\pi}}{\frac{P_A - P_B}{\gamma} - z_A}}$$

* Calculations done through excel

• Guessed f

$f = 0.01913$

$$D = \sqrt{\frac{(0.01913)\frac{8(600)(0.5)^2}{32.2\pi}}{\frac{11520-8640}{62.4} - 25}}$$

$D = 0.3211 ft$

$$v = \frac{4(0.5)}{\pi(0.3211)^2}$$

$v = 6.1742 ft/s$

$$Re = \frac{vD}{\nu} = \frac{6.1742(0.3211)}{(1.21\times10^{-5})}$$

$Re = 163891.578$

$$D/\varepsilon = \frac{0.3211}{(1.5\times10^{-4})} = 2141.2486$$

New f

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(2141.2486)} + \frac{5.74}{(163891.678)^{0.9}}\right)\right]^2}$$

New $f = 0.1912$

% diff $= 0.0058$

∴

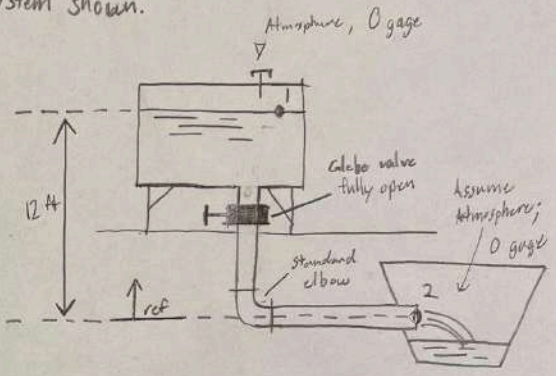
$D = 0.3211 ft$

Homework 3.1

John Barresi Pg1
MET 330
Homework 3.1

11.22)

The tank shown in figure P11.22 is to be drained to a sewer. Determine the size of the new Schedule 40 steel pipe that will carry at least 400 gal/min of water at through the system shown. The total length of pipe is 75 ft.



flow rate

$$Q = 400 \frac{gal}{min}\left(\frac{1\ ft^3}{7.4805\ gal}\right)\left(\frac{1\ min}{60\ s}\right)$$

$$Q = 0.89\ ft^3/s$$

$L = 75$ ft

$P_1 = 0$ psig

$P_2 = 0$ psig

$\Delta z = +12$ ft

specific weight

$\gamma_{water\ @\ 40°F} = 62.4\ lb/ft^3$

use 40°F

$\rho_{water} = 1.94\ slugs/ft^3 = 1.94\ \frac{lb\text{-}s^2}{ft^4}$

kinematic viscosity

$\nu_{water} = 1.67E\text{-}5\ ft^2/s$

$K_{valve} = 340\ f_T$ $\quad K_{entrance} = 0.5\ f_T$

$K_{elbow} = 30\ f_T$

Energy losses from: pipe
globe valve 340 f_T
90° elbow

wall roughness

$\varepsilon = 1.5E\text{-}4$ ft (Table 8.2)

Find R_e

Find f & f_T

Find D - guessing D in excel

anywhere under 1% difference

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_{L_{12}}$$

$$z_1 = \frac{V_2^2}{2g} + h_L$$

11.22 Continued)

$$Z_1 = \frac{V_2^2}{2g} + h_L \qquad R_e = \frac{VD}{\nu} \qquad \text{relative roughness} = \frac{D}{\varepsilon}$$

$$h_L = f \frac{L}{D} \frac{V^2}{2g} \qquad V = \frac{4Q}{\pi D^2} \qquad V^2 = \frac{16Q^2}{\pi^2 D^4}$$

$$\% \text{ diff} = \frac{\text{LHS} - \text{RHS}}{\text{LHS}} (100)$$

$$z_1 - \frac{V_2^2}{2g} = h_{L_{1\to 2}}$$

$$Z_1 - \frac{V_2^2}{2g} = f \frac{L}{D} \frac{V^2}{2g} + K_{valve} \frac{V^2}{2g} + K_{elbow} \frac{V^2}{2g} + K_{entrance} \frac{V^2}{2g}$$

$$Z_1 - \frac{1}{2g} \frac{16Q^2}{\pi^2 D^4} = f \frac{L}{D} \frac{16Q^2}{\pi^2 D^4} \frac{1}{2g} + K_{valve} \frac{16Q^2}{\pi^2 D^4} \frac{1}{2g} + K_{elbow} \frac{16Q^2}{\pi^2 D^4} \frac{1}{2g} + K_{entrance} \frac{16Q^2}{\pi^2 D^4} \frac{1}{2g}$$

$$Z_1 - \frac{8Q^2}{g\pi^2} \frac{1}{D^4} = f \frac{8LQ^2}{g\pi^2} \frac{1}{D^5} + K_{valve} \frac{8Q^2}{g\pi^2} \frac{1}{D^4} + K_{elbow} \frac{8Q^2}{g\pi^2} \frac{1}{D^4} + K_{entrance} \frac{8Q^2}{g\pi^2} \frac{1}{D^4}$$

$$\underbrace{Z_1}_{\text{LHS}} = \underbrace{f \frac{8Q^2}{g\pi^2} \frac{L}{D^5} + \left(\frac{8Q^2}{g\pi^2} \cdot \frac{1}{D^4} \right) \left(K_{valve} + K_{elbow} + K_{entrance} + 1 \right)}_{\text{RHS}}$$

D = 0.586 ft

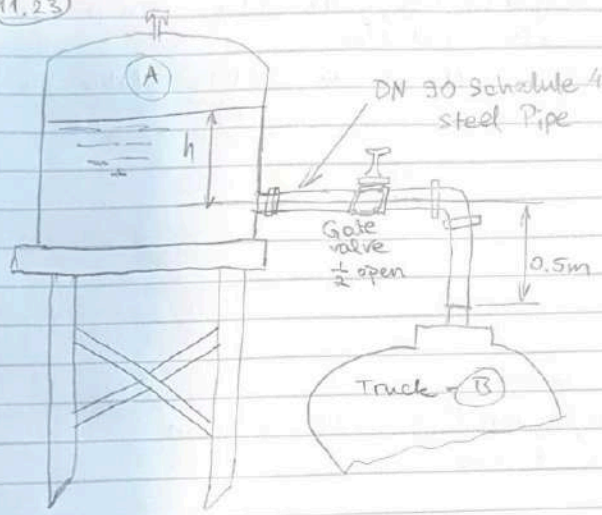
8 inch Schedule 40 steel pipe

- Calculations in Excel sheet

HW 3.1 – MET330

03/20/2024
Angela Sicaja

11.23



* P_A – pressure in tank A
* P_B – pressure in tank B
* V_A, V_B – velocities at suction and discharge line

specific gravity (gasoline) = 0.68

T = 25°C

h = ? Flow = 1500 L/min

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

$$A = \frac{\pi}{4} D^2 = \frac{\pi}{4} \cdot (0.090)^2 = 6.581 \cdot 10^{-3}\ m^2$$

$$V_B = \frac{1500}{6.581 \cdot 10^{-3}} = 3.92\ m/s$$

– friction loss in pipe

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

$P_A = P_B$

$V_A = 0$

$$\rightarrow h_L = \left(-\frac{V_B^2}{2g}\right) + (z_A - z_B)$$

$$z_A - z_B = h_L + \frac{V_B^2}{2g}$$

$$\rightarrow h_1 = \frac{k V_4^2}{2g} = 0.5 \cdot \frac{3.92^2}{2 \cdot 9.81} \Rightarrow h_1 = 0.392 m //$$

$$f_T = 0.018$$

$$\rightarrow h_2 = 160 \cdot ft \cdot \frac{V_B^2}{2g} = 160 \cdot 0.018 \cdot \frac{3.92^2}{2 \cdot 9.81}$$

$$h_2 = 2.25 m //$$

$$\rightarrow h_3 = 30 \cdot ft \cdot \frac{V_B^2}{2g} = 30 \cdot 0.018 \cdot \frac{3.92^2}{2 \cdot 9.81}$$

$$h_3 = 0.422 m //$$

$$h_L = h_1 + h_2 + h_3 = 0.392 m + 2.25 m + 0.422 m$$

$$h_L = 3.0668 m$$

$$z_A - z_B = h_L + \frac{V_B^2}{2g}$$

$$z_A - z_B = 3.0668 + \frac{3.92^2}{2 \cdot 9.81}$$

$$z_A - z_B = 3.3492 m$$

$$z_A - z_B = h + 0.5$$

$$h = 3.3492 - 0.5$$

$$\boxed{h = 3.35 m}$$

Reflection Paragraph

The main topic covered in class this week was series pipelines. In a series pipeline, the fluid flows through a single continuous path which means that there is no change in the volumetric flow rate "Q" or in other words, Q 1 = Q 2 = Q n = Q total.
There are five types of problems we encounter in series pipeline systems. Each class is defined by what needs to be solved whether it's energy losses, flow rate, pipe diameter, etc. One thing that was emphasized by our professor was to ignore a couple of the equations we find in the textbook. For classes two and three, (find flow rate and find pipe diameter) the textbook gives us equations to use however they are designed for a single really long pipe. This isn't something we see regularly so to avoid making the mistake of trying to apply those equations, we're instructed to ignore them entirely.

For finding energy losses, we use the Bernoulli's equation to find it along with the moody diagram to account for relative roughness and to find things such as a K value. For classes two and three, there is usually some guesswork being done to then be proven correct. The end goal of this part is to get both sides of the Bernoulli's equation equal to each other and if proven incorrect, repeat the steps to get to the correct answer. Ultimately this is another example of how helpful Microsoft Excel is in applications such as these. Rather than go all the way back through and re do the work, all you really have to do once everything is loaded into Excel is to change the values as you see fit and the software will do the rest for you.