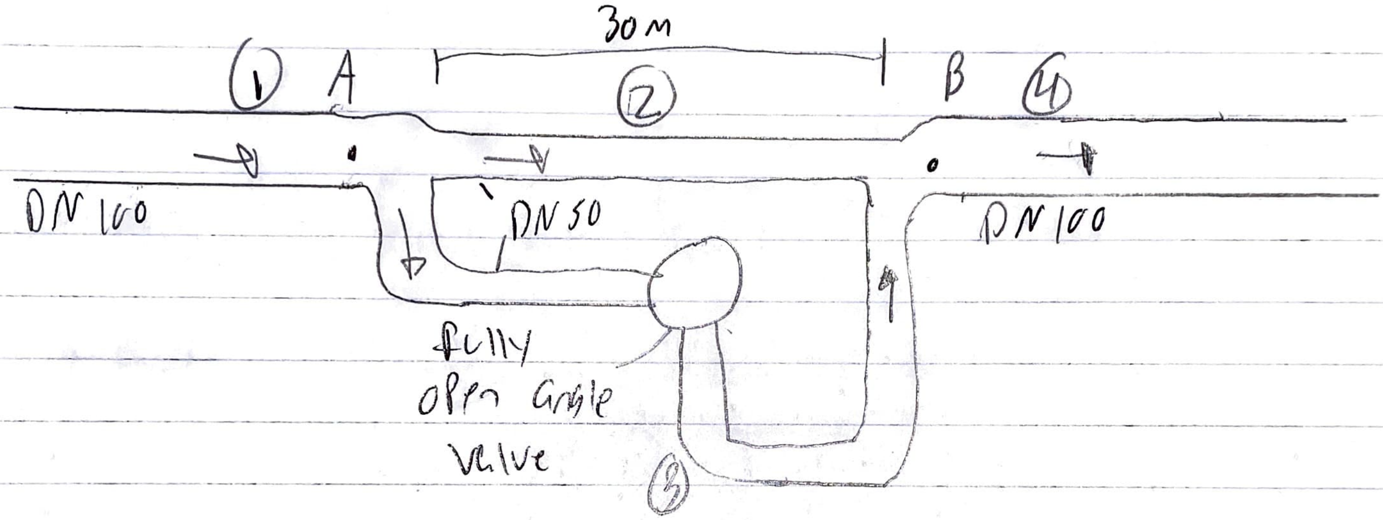
Hw 3.1 & 3.2

1) From the Series Pipeline example problem's reviewed in class I was reminded how to set up a problem using Bernoulli's equation. When solving problems for a value (A) and the equation has a tearm (B) that is dependent on (A), (B) should be guessed and (A) can be solved for. Once (A) is found the correct value of (B) can be found and the guessed value can be checked. If the value of (B) is close to correct (Ayala's Law) then it is complete, if it is not close enough another closer value of (B) can be used to solve for (A)

From the Parallel Pipeline example problems from class questions that use Bernoulli's equation more than once. If there are more unknowns in a problem than the number of Bernoulli's equations another equation will have to be found. The left hand right hand method of solving problems by iteration is a great way to solve complex problems and I will be using it when I can.

2) 11.24: For the system showed in the diagram specify the size of Schedule 40 Steel pipe required to return the fluid to the machines. machine 1 needs 20 gal/min and machine 2 needs 10 gal/min. Fluid leaves the pipe at 0 psig.

12-3 Using system below total flow rate of 850 L/min of 10°C water. DN 100 Schedule 40 pipe at A & B. Flow splits into two DN 50 scheduel 40 pipes as shown. Calculate flow rate in each branch and the ΔP from A to B



Length of bottom pipes is 60 m

$$\frac{P_A}{\gamma_w} + \cancel{\frac{V_A^2}{2g}} + \cancel{z_A} = \frac{P_B}{\gamma_w} + \cancel{\frac{V_B^2}{2g}} + \cancel{z_B} + h_{L\,A-B}$$

$$\frac{\Delta P}{\gamma_w} = h_{L\,A-B_1} \qquad \frac{\Delta P}{\gamma_w} = h_{L\,A-B_2}$$

$$h_{L\,A-B_2} = 20 f_{T,1} \cdot \frac{V_1^2}{2g} + K_{red}\frac{V_2^2}{2g} + f_1 \frac{L_1}{D_1}\frac{V_2^2}{2g} + K_{enlg}\frac{V_2^2}{2g}$$

$$h_{L\,A-B_3} = 60 f_{T,1}\frac{V_1^2}{2g} + K_{red}\frac{V_3^2}{2g} + K_{enlg}\frac{V_3^2}{2g} + 150 f_{T,3}\frac{V_3^2}{2g} + 3\left(30 f_{T,3}\frac{V_3^2}{2g}\right) + f_3 \frac{L_3}{D_3}\frac{V_3^2}{2g}$$

DN 100 inner dia $= 102.3\,mm = 0.102\,m$

$A_1 = 8.213 \times 10^{-3}\,m^2 = A_4$

DN 50 inner dia $= 52.5\,mm = 0.0525\,m$

$A_2 = 2.168 \times 10^{-3}\,m^2 = A_3$

$Q = VA \qquad V = Q/A \qquad V = 4Q/\pi D^2$

$Q_1 = 850\,L/min = 0.014\,m^3/s$

$V_1 = 0.014\,m^3/s \,/\, 8.213 \times 10^{-3}\,m^2 \qquad \epsilon = 4.6 \times 10^{-5}\,m$

$V_1 = 1.7\,m/s$

$$h_{L\,A-B}(2) = 20 f_{T,1}\frac{V_1^2}{2g} + \left(K_{red} + K_{enlg} + f_2\frac{L_2}{D_2} + 20 f_{T,2}\right)\frac{V_2^2}{2g}$$

$$h_{L\,A-B}(3) = 60 f_{T,1}\frac{V_1^2}{2g} + \left(K_{red} + K_{enlg} + f_3\frac{L_3}{D_3} + 150 f_{T,3} + 3(f_{T,3})\right)\frac{V_3^2}{2g}$$

$$f_{T,1} = \frac{0.25}{\left(\log\left(\frac{1}{3.7\,D/\epsilon}\right)\right)^2} = \frac{0.25}{\left(\log\left(\frac{1}{3.7\left(\frac{0.0525\,m}{4.6\times10^{-5}\,m}\right)}\right)\right)^2}$$

$f_{T,1} = 0.016$

$f_{T,2} = 0.019 = f_{T,3}$

$Re_1 = V_1 D_1/\nu$

$= 1.7\,m/s \cdot 0.102\,m / 1.02 \times 10^{-6}\,m^2/s$

$Re_1 = 170{,}000$

$$f_1 = \frac{0.25}{\left(\log\left(\frac{1}{3.7\left(\frac{D}{\epsilon}\right)}\right) + \left(\frac{5.74}{Re^{0.9}}\right)\right)^2}$$

f_2 assumed to be 0.023 and f_3

$K_{eng} = K_{red} = 0.3$

$$h_{L\,A-B\,(2)} = 0.047\,m + (14.12\,m)\frac{V_2^2}{19.62\,m^2/s}$$

$$h_{L\,A-B\,(3)} = 0.14\,m + (29.79\,m)\frac{V_3^2}{19.62\,m^2/s}$$

$$h_{L\,A-B\,(2)} = h_{L\,A-B\,(3)}$$

$$0.047\,m + (14.12\,m)\,V_2^2/19.62\,m^2/s = 0.14\,m + (29.79\,m)\frac{V_3^2}{19.62}$$

$$0.72\,\tfrac{s}{m}\,V_2^2 = 0.093\,m + 1.52\,m/s\;V_3^2$$

$$V_2 = 0.36\,m + 1.45\;V_3$$

$$Q_1 = A_2 V_2 + A_3 V_3 = 0.014\,m^3/s \qquad A_2 = A_3$$

$$Q_1 = A(V_2 + V_3) = A((0.36\,m + 1.45\,V_3) + V_3)$$

$$\frac{Q_1}{A} - 0.36\,m = 2.45\,V_3 \qquad V_3 = \frac{1}{2.45}\left(\frac{Q_1}{A} - 0.36\,m\right)$$

$$V_3 = \frac{1}{2.45}\left(\frac{0.014\,m^3/s}{2.168\times10^{-3}\,m^2} - 0.36\,m\right)$$

$$V_3 = 2.78\,m/s \qquad V_2 = \frac{Q_1}{A} - V_3 \qquad V_2 = 3.7\,m/s$$

$$Q_2 = 0.008\,m^3/s \qquad Q_3 = 0.006\,m^3/s$$

$\Delta P = \gamma_w\, h_L$ if no Δz or Δv for A and B

$$\Delta P = 9.79\,kN/m^3 \cdot 11.9\,m \qquad \Delta P = 116\,kPa$$