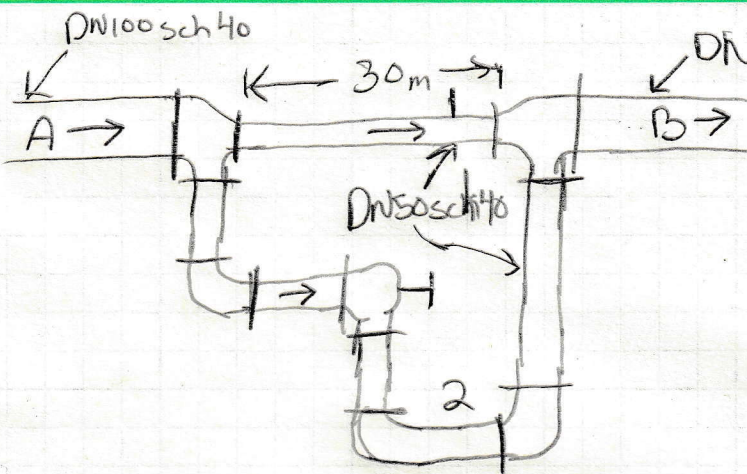


Ch. 12

3.



$$T = 10^{\circ}\text{C}$$

$$Q_B = Q_A = 850 \text{ L/min} = 0.0141 \text{ m}^3/\text{s}$$

$$Q_1 + Q_2 = Q_A = Q_B$$

$$\text{DN50 } P_a = 0.0525 \text{ m}$$

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

$$\frac{P_A - P_B}{\gamma} = h_L \rightarrow 1. h_{L1} = f \frac{L_1}{D_1} \frac{V_1^2}{2g}$$

$$2. h_{L2} = f \frac{L_1}{D_1} \frac{V_1^2}{2g} + 3K_{elb} \frac{V_1^2}{2g} + K_{valve} \frac{V_1^2}{2g}$$

$$h_{L1} = f \frac{L_1}{D_1} \frac{V_1^2}{2g}$$

$$V = \frac{4Q}{\pi D^2}$$

$$= f \frac{L_1}{D_1} \cdot \frac{16Q^2}{2g\pi^2 D_1^4}$$

$$= f \frac{L_1}{D_1} \cdot \frac{8}{g\pi^2 D_1^4} \cdot Q^2$$

$$h_{L2} = f_2 \cdot \frac{L_2}{D_2} \cdot \frac{8}{g\pi^2 D_2^4} \cdot Q_2^2 + 3K_{elb} \left(\frac{8}{g\pi^2 D_2^4} \right) \cdot Q_2^2 + K_{valve} \left(\frac{8}{g\pi^2 D_2^4} \right) \cdot Q_2^2$$

$$= \left[f_2 \cdot \frac{L_2}{D_2} + (3K_{elbow} + K_{valve}) \right] \frac{8}{g\pi^2 D_2^4} \cdot Q_2^2$$

$$h_{L1} = h_{L2}$$

$$f_1 \cdot \frac{L_1}{D_1} \cdot \frac{8}{g\pi^2 D_1^4} \cdot Q_1^2 = \left[f_2 \cdot \frac{L_2}{D_2} + (3K_{elbow} + K_{valve}) \right] \frac{8}{g\pi^2 D_2^4} \cdot Q_2^2$$

$$Q_1^2 = \frac{\left[f_2 \cdot \frac{L_2}{D_2} + (3K_{elb}^{1.71} + K_v^{2.85}) \right] Q_2^2}{f_1 \cdot \frac{L_1}{D_1}}$$

$$Q_1^2 = \frac{\left[f_2 \cdot 1142.857 + 4.56 \right] Q_2^2}{f_1 \cdot 571.429}$$

Completed in Excel

$$Q_1 = 0.00861 \text{ m}^3/\text{s} \text{ or } \boxed{516.6 \text{ L/min}}$$

$$Q_2 = 0.00549 \text{ m}^3/\text{s} \text{ or } \boxed{329.4 \text{ L/min}}$$

$$Q_2 = 0.00549 \text{ m}^3/\text{s}$$

$$Q_1 = 0.00861 \text{ m}^3/\text{s}$$

$$\frac{P_A - P_B}{\gamma} = h_{L1}$$

$$P_A - P_B = \gamma h_{L1}$$

$$= \gamma f_1 \cdot \frac{L}{D} \cdot \frac{8Q_1^2}{\pi g D^4}$$

$$= 9.81 \text{ kN/m}^3 \cdot \frac{30 \text{ m}}{0.0525 \text{ m}} \cdot \frac{8 (.00861)^2 \text{ m}^3/\text{s}^2}{\pi (9.81 \text{ m/s}^2) (0.0525 \text{ m})^4} = 94.966$$

$$P_A - P_B = 94.966 \text{ kN/m}^2 \text{ or kPa}$$

Calculations for Problem 12.3

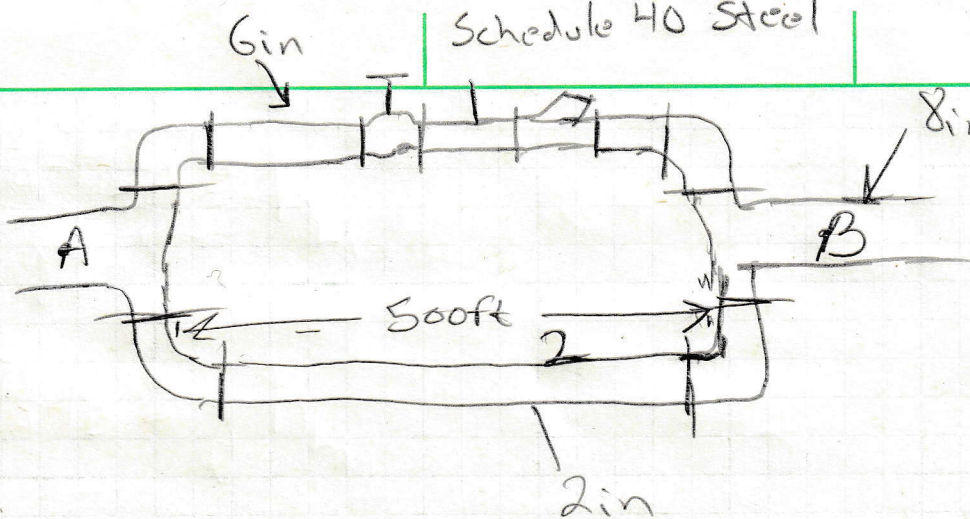
Data		
D1=	0.0525 m	A1= 0.002165 m ²
D2=	0.0525 m	A2= 0.002165 m ²
L1=	30 m	
L2=	60 m	
Qtotal=	0.0141 m ³ /s	
Roughness=	0.000046 m	
Rr=	1141.3043	
Ft=	0.019	
Kelb=	0.57	
Kvalve=	2.85	
Kvisc.=	0.0000013 m ² /s	
gamma=	9.81 KN/m ³	

Trial	F1	F2	X:Q1=XQ2	Q2	Q1	Re1	New F1	Re2	New F2	F1 % Err	F2 % Err
1	0.02	0.02	1.548871 Q2	0.005532	0.008568	159843.1	0.021019	103199.8	0.021834	-0.05095	-0.09170
2	0.02102	0.02183	1.56755 Q2	0.005492	0.008608	160593.9	0.021012	102449	0.02185	0.00035	-0.00072
3	0.02101	0.02185	1.568306 Q2	0.00549	0.00861	160624.1	0.021011	102418.8	0.02185	0.00001	-0.00003
4	0.02101	0.02185	1.568337 Q2	0.00549	0.00861	160625.3	0.021011	102417.6	0.02185	0.00000	0.00000
5	0.02101	0.02185	1.568338 Q2	0.00549	0.00861	160625.3	0.021011	102417.6	0.02185	0.00000	0.00000

Q1= 0.0086101 m³/s
Q2= 0.0054899 m³/s

Delta P= 94.968392 Kpa

4.

Find: $Q_1 + Q_2$

$$Q_T = 1350 \text{ gal/min}$$

$$\downarrow$$

$$3.0078 \text{ ft}^3/\text{s}$$

Benzine @ 140°F
 $S_g = 0.87$

$$Q_T = Q_1 + Q_2$$

$$* V = \frac{4Q}{\pi D^2}$$

$$h_{L1} = h_{L2}$$

$$D_2 = .1723 \text{ ft}$$

$$A_2 = .02333 \text{ ft}^2$$

$$Q = .5054 \text{ ft}^3/\text{s}$$

$$A_1 = .2066 \text{ ft}^2$$

$$h_{L2} = f_2 \cdot \frac{L_2}{D_2} \cdot \frac{V_2^2}{2g} + 2 \left(K_{elb} \cdot f_{T2} \right) \frac{V_2^2}{2g}$$

$$= f_2 \cdot \frac{L_2}{D_2} \cdot \frac{8}{g \pi^2 D_2^4} \cdot Q_2^2 + 2 \left(K_{elb} \cdot f_{T2} \right) \frac{8}{g \pi^2 D_2^4} \cdot Q_2^2$$

$$f_{T2} = 0.019$$

$$f_{T1} = 0.015$$

$$K_{elb} = 30$$

$$K_{check} = 100$$

$$K_{globe} = 340$$

$$\xi = 1.5 \times 10^{-4} \text{ ft}$$

$$* = Q_2^2 \cdot \frac{8}{g \pi^2 D_2^4} \left[f_2 \cdot \frac{L_2}{D_2} + (2 K_{elb} \cdot f_{T2}) \right]$$

$$h_{L1} = f_1 \cdot \frac{L_1}{D_1} \cdot \frac{V_1^2}{2g} + 2 \left(K_{elb} \cdot f_{T1} \right) \frac{V_1^2}{2g} + \left(K_{check} \cdot f_{T1} \right) \frac{V_1^2}{2g}$$

$$+ \left(K_{globe} \cdot f_{T1} \right) \frac{V_1^2}{2g}$$

$$h_{L1} = Q_1^2 \cdot \frac{8}{g \pi^2 D_1^4} \left[2 K_{elb} \cdot f_{T1} + K_{check} \cdot f_{T1} + K_{globe} \cdot f_{T1} + \left(f_1 \cdot \frac{L_1}{D_1} \right) \right]$$

$$Q_1^2 \cdot \frac{8}{g\pi^2 D^5} \left[F_{T_1} (2K_{elb} + K_{check} + K_{globe}) + \left(F_1 \cdot \frac{L_1}{D} \right) \right]$$

$$Q_2 = Q_1 \sqrt{\frac{\frac{8}{g\pi^2 D^5} \left[F_{T_1} (2K_{elb} + K_{check} + K_{globe}) + \left(F_1 \cdot \frac{L_1}{D} \right) \right]}{\frac{8}{g\pi^2 D^5} \left[\left(F_2 \cdot \frac{L_2}{D} \right) + (2K_{elb} \cdot F_{T_2}) \right]}}$$

Solved in Excel

$$Q_1 = 2.8061 \text{ ft}^3/\text{s} = 1259.4652 \text{ gal/min}$$

$$Q_2 = 0.2017 \text{ ft}^3/\text{s} = 90.5292 \text{ gal/min}$$

Calculations for Problem 12.4

Data		
D1=	0.5054 ft	A1= 0.200614 f [^] 2
D2=	0.1723 ft	A2= 0.023316 f [^] 2
L1=	500 ft	
L2=	500 ft	
Qtotal=	3.0078 ft [^] 3/s	
Roughness=	0.00015 ft	
Rr1=	3369.3333	
Rr2=	1148.6667	
Ft1=	0.015	
Ft2=	0.019	
Kelb=	30	
Kcheck=	100	
Kglobe=	340	
Kvisc.=	4.93E-06 ft [^] 2/s	

Trial	F1	F2	X:Q2=XQ1	Q1	Q2	Re1	New F1	Re2	New F2	F1 % Err	F2 % Err
1	0.02	0.02	0.078921 Q1	2.787786	0.220014	1424582	0.015516	329783.2	0.020099	0.22418	-0.00496
2	0.01552	0.02010	0.072047 Q1	2.805662	0.202138	1433716	0.015513	302988.9	0.020181	0.00021	-0.00405
3	0.01551	0.02018	0.071899 Q1	2.806049	0.201751	1433914	0.015513	302408.9	0.020183	0.00000	-0.00009
4	0.01551	0.02018	0.071895 Q1	2.806058	0.201742	1433919	0.015513	302395.4	0.020183	0.00000	0.00000
5	0.01551	0.02018	0.071895 Q1	2.806058	0.201742	1433919	0.015513	302395.1	0.020183	0.00000	0.00000

Q1= 2.8060577 f[^]3/s
Q2= 0.2017423 f[^]3/s

Old Test Review

As I looked over the two tests, I feel the Fall 2016 test better represents the material / problems we have been covering. If the first problem hadn't been worded in the way that it was, I most likely would have had some reservations about neglecting the pipe frictional losses with the percentage being over 5%. However, I do think this was an interesting problem because of that added element. The second problem, in my opinion, was the more difficult of the two. The fact that the pressures were found by basically treating the two sides as separate systems, applying Bernoulli to each, I feel is the learning moment here. It is a good example of how to further use and manipulate the equation in a single problem. Overall, I would hope to see a test "similar" to this one. As I said at the beginning, it is a good representation of the material.