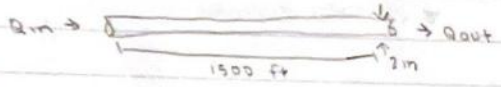
TEST 3 FLUIDS - KAYLA DANIES

(2) a) DETERMINE CORRESPONDING PRESSURE DROP

$L = 1500$ ft $D = 0.1558$ (appendix) $Q = 65$ gpm $= 0.145$ ft^3/s $A = 1.907E\text{-}2$



$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_L \quad \therefore \quad \frac{P_1 - P_2}{\gamma} = h_L$$

$$V = \frac{Q}{A} = \frac{0.145}{1.907E\text{-}2} = 7.604 \text{ ft/s}$$

relative roughness: $\frac{D}{\varepsilon} = \frac{0.1558}{1.5E\text{-}4} = 1038.66$ (from tables)

$$N_R = \frac{VD}{\nu} = \frac{7.604 \times 0.1558}{1.89E\text{-}5} = 62682.7 \text{ or } 6.2 \times 10^4$$

Friction factor, $f = \dfrac{0.25}{\left[\log\left(\frac{1}{3.7(DIE)} + \frac{5.74}{Re^{0.9}}\right)\right]^2} = 0.023$

$$H_L = f\left(\frac{L}{D}\right)\frac{V^2}{2g} = (0.023)\left(\frac{1500}{0.1558}\right) \times \frac{7.604^2}{2 \times 32.2} = 198.82 \text{ ft}$$

$$\frac{P_1 - P_2}{\gamma} = H_L \quad \therefore \quad \Delta P = \gamma H_L$$

$$= 62.43 \text{ lbf/ft}^3 \times 198.82 \text{ ft}$$

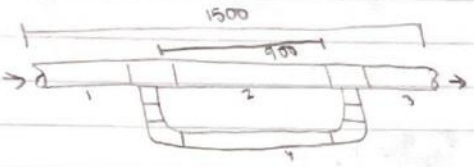
$$\boxed{\Delta P = 12412.3 \text{ lb/ft}^2}$$

TEST 3-KO

B) find expected increase in flow rate & consider minor losses

$L_1 = 1500$ ft $L_2 = 900$ ft $D_1 = 0.1150$ ft $D_2 = 0.1142$ ft assume $f = 0.01$

* variables on excel



$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + h_L \quad \therefore \quad \frac{P_1 - P_2}{\gamma} = h_L$$

h_L @ branch 2

$$\frac{\Delta P}{\gamma} = f_2\left(\frac{L}{D}\right)\left(\frac{V_2^2}{2g}\right) + 2(20 f_T)\left(\frac{V_2^2}{2g}\right) \quad \therefore \quad h_{L\,pipe\,2} + 2(h_{L\,Tee})$$

$$= \left[f_2\left(\frac{L}{D}\right) + 2(20 f_T)\right] \times \frac{1}{2g} \times \frac{1}{A_2^2} \times Q_2^2$$

$$\frac{\Delta P}{\gamma} = \left[f_2(9627.7) + 0.76\right] \times \frac{1}{0.0235} Q_2^2$$

$$Q_2^2 = \left(\frac{0.0235 \times 12412.3}{62.43}\right)\left(\frac{1}{0.01 \times 9627.7 + 0.76}\right)$$

$$Q_2 = \sqrt{0.048} = \boxed{0.219 \text{ ft}^3/\text{s}} \quad \leftarrow \text{iterate in excel}$$

$$Nr_2 = \frac{7.74 \times 0.1564}{1.67e-5} = 72209.1$$

h_L @ branch 3

$$\frac{\Delta P}{\gamma} = h_{L\,Pipe} + 2h_{L\,Tee} + h_{L\,reduction} + 2h_{L\,elbow} + h_{L\,enlargement}$$

$$= \frac{V_3^2}{2g}\left[f_3\left(\frac{L}{D}\right) + 2(60 f_T)\frac{V_3^2}{2g}\right] + 0.045\left(\frac{V_3^2}{2g}\right) + 2(30 f_T)\frac{V_3^2}{2g} + 0.36\left(\frac{V_3^2}{2g}\right)$$

$$= \left[f_3(7480.91) + 4.365\right] \frac{1}{2g} \times \frac{1}{A_3^2} \times Q_3^2$$

$$Q_3^2 = \left(\frac{0.00607 \times 12412.3}{62.43}\right)\left(\frac{1}{0.01 \times 7480.9 + 4.365}\right)$$

$$Q_3^2 = \sqrt{0.16} = \boxed{0.126 \text{ ft}^3/\text{s}} \quad \leftarrow \text{iterate in excel}$$

$$Nr_3 = \frac{8.354 \times 0.1142}{1.67e-4} = 52127.4$$

$$D/\epsilon = 761.33$$

$Q_1 = Q_2 + Q_3$

couldnt finish iterations