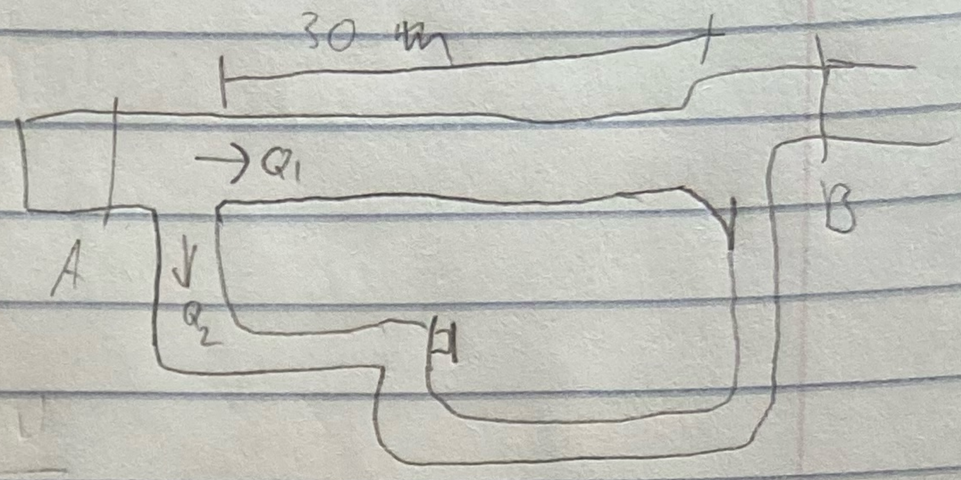
MET 330 Homework 3.1 and 3.2

12.3 $Q = 850\ L/min = 0.014167\ m^3/s$ $T = 10°C$

$Q = Q_1 + Q_2$ $h_{L1} = h_{L2}$ $L = 30m$

$Re = 4.15 \cdot 10^7$ $E = 4.6 \cdot 10^{-5}$



$h_{L1} = f_1 \left(\frac{L}{D_1}\right) \cdot \left(\frac{V_1^2}{2g}\right)$

$f_1 \left(\frac{30}{0.0508}\right) \cdot \left(\frac{V_1^2}{2g}\right)$

$h_{L1} = 590\ f_1 \cdot \left(\frac{V_1^2}{2g}\right)$

$R_\varepsilon = \frac{D}{\varepsilon} = \frac{0.0508}{4.6 \cdot 10^{-5}}$

$R_\varepsilon = 1104.4$

From Moody's → $F_1 = 0.02$

$F_2 = 0.02$

$h_{L2} = h_f + h_{valve} + 3 \cdot h_{elb}$

$= f_2 \left(\frac{L}{D}\right)\left(\frac{V_2^2}{2g}\right) + f_{DE}\left(\frac{Le}{D}\right)\left(\frac{V_2^2}{2g}\right) + 3 f_{bE}\left(\frac{Le}{D}\right)\left(\frac{V_2^2}{2g}\right)$

$f_2 \left(\frac{60}{0.0508}\right)\left(\frac{V_2^2}{2g}\right) + 0.019 \cdot 150 \cdot \left(\frac{V_2^2}{2g}\right) + 3 \cdot 0.019 \cdot 30 \cdot \left(\frac{V_2^2}{2g}\right)$

$h_{L2} = \frac{V_2^2}{2g}(1181 f_2 + 4.56)$

$h_{L1} = h_{L2}$

$590 f_1 \cdot \left(\frac{V_1^2}{2g}\right) = \frac{V_2^2}{2g}(1181 f_2 + 4.56)$

$V_1 = 1.55 V_2$

$Q_T = Q + Q_2 = A_1 V_1 + A_2 V_2$

$A_1 = A_2 = 2.168 \cdot 10^{-3} m^2$

$Q_T = 2.168 \cdot 10^{-3}(1.55 V_2 + V_2)$

$0.01416 = 2.168 \cdot 10^{-3}(1.55 V_2 + V_2)$

$V_2 = \underline{2.55 m/s}$

$V_1 = 1.55(2.55)$

$V_1 = \underline{3.97 m/s}$

$(R_\ell)_1 = \frac{V_1 D_1}{\nu} = \frac{2.5.0.0508}{1.3 \cdot 10^{-6}}$

$= 99.64 \cdot 10^3$

$Q_1 = A_1 V_1 = 2.168 \cdot 3.98 \cdot 10^{-3}$

$= 0.00863\ m^3/s = \underline{517.68 L/min}$

$Q_2 = A_2 V_2 = 2.168 \cdot 10^{-3} \cdot 2.55$

$= 0.00552 m^3/s = \underline{331.704 L/min}$

$h_L = (h_L)_1 = 590 f_1 \left(\frac{V_1^2}{2g}\right)$

$= 590 \cdot 0.0215 \left(\frac{3.98^2}{2 \cdot 9.81}\right)$

$h_L = \underline{10.24 m}$

$P_A - P_B = g \cdot h_L = 9.81 \cdot 10.24$

$P_A - P_B = \underline{100.42 kPA}$

12.5 $L = 30m$ $D_1 = 100mm = .1m$ $D_2 = 50mm = .05m$

$h_{L_1} = h_{L_2}$ $f = 0.017$

$$\frac{fLV_1^2}{2gD_1} + k\frac{V_1^2}{2g} = f \cdot \frac{LV_2^2}{2gD}$$

$$V_1 = \frac{\frac{500 \cdot 10^{-3}}{60}}{\frac{\pi}{4}\cdot(0.1)^2} = 1.06 m/s$$

$$V_2 = \frac{\frac{500 \cdot 10^{-3}}{60}}{\frac{\pi}{4}\cdot(0.05)^2} = 4.24 m/s$$

$$\frac{0.017 \cdot 30 \cdot (1.001)^2}{2 \cdot 9.81 \cdot 0.1} + k \cdot \frac{(1.061)^2}{2 \cdot 9.81} = \frac{.017 \cdot 30 \cdot 4.24^2}{2 \cdot 9.81 \cdot 0.05}$$

$$0.05238k = 9.0535$$

$$\boxed{k = 158.00}$$

12.6 $k_1 = 0.9$ $P = 20 PSIG$

$$(h_L)_a = 2k_1\left(\frac{V_a^2}{2g}\right) + k_2\left(\frac{V_a^2}{2g}\right)$$

$$= 2 \cdot 0.9 \cdot \frac{V_a^2}{2g} + 5 \cdot \frac{V_a^2}{2g}$$

$$= 6.4 \cdot \frac{V_a^2}{2g}$$

$$46.15 = 6.4 \cdot \frac{V_a^2}{2.322}$$

$$v_a = 20.9 ft/s$$

$$Q_A = A_a V_A = 0.0218 \cdot 20.9$$

$$\underline{Q_a = 0.456 ft^3/s}$$

$$(h_L)_b = 2k_1\left(\frac{V_b^2}{2g}\right) + k_3\left(\frac{V_b^2}{2g}\right)$$

$$= 2 \cdot 0.9 \cdot \frac{V_b^2}{2g} + 10 \cdot \frac{V_b^2}{2g}$$

$$= 11.8 \cdot \frac{V_a^2}{2g}$$

$$A_a = \frac{\pi}{4} \cdot D^2 = \frac{\pi}{4} \cdot \left(\frac{2}{12}\right)^2 = 0.0218 ft^2$$

$$Q_B = A_b V_b = 0.0873 \cdot 15.9$$

$$\underline{Q_B = 1.385 ft^3/s}$$

$$Q = Q_a + Q_B = 0.456 + 1.385$$

$$\underline{Q = 1.841}$$