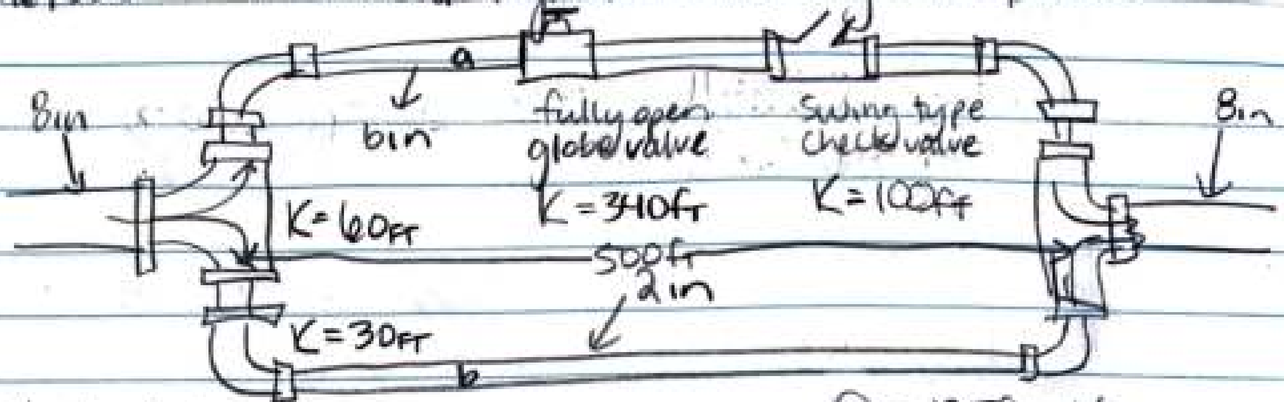
Dylan Arnold Week 07 University ID: 01166349
MET330 Professor Ayala July 2nd, 2023

Q.4



All steel pipe

$Q_T = 1350\ gal/min$

$Q_a = A_a v_a$ and $Q_b = A_b v_b$

$Q_1 = 3.01\ ft^3/s$

$A_A = 0.2006\ ft^2$

$A_B = 0.02333\ ft^2$

f_T 2" SCH40 = 0.019

f_T 6" SCH40 = 0.015

K_1 = Tee QTY 2 = $(0.015)(60) = 0.9$ $(0.015)(30) = 0$

K_2 = Elbow QTY 4 (2 6" + 2 2") = $(0.019)(30) = 0.57$ or 5 2"

K_3 = Globe valve QTY 1 = $(340)(0.015) = 5.1$

K_4 = Check valve QTY 1 = $(100)(0.015) = 1.5$

K_5 = friction loss branch b = $f_b(500/0.1723) = 2901.92f$

$$h_a = (0.9)\left(\frac{v_a^2}{2g}\right) + 2(0.45)\left(\frac{v_a^2}{2g}\right) + 5.1\left(\frac{v_a^2}{2g}\right) + 1.5\left(\frac{v_a^2}{2g}\right)$$

$$h_b = (0.9)\left(\frac{v_b^2}{2g}\right) + 2(0.57)\left(\frac{v_b^2}{2g}\right) + 2901.92 f_b \left(\frac{v_b^2}{2g}\right)$$

D/ε for $f_b = (0.1723)/(1.5\times10^{-4}) = 1149$

Continued on PG 2

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Problem 12.4 continued

$$N_R = \frac{\left(\frac{3.01\,ft^3/s}{0.02333\,ft^2}\right)(0.1723)}{v = 7.41\times10^{-6}\,ft^2/s} = 2999983$$
$$3.0\times10^{6}$$

$$f_b = \frac{0.25}{\left(\log\frac{1}{3.7(1149} + \frac{5.74}{(3.0\times10^6)^{0.9}}\right)^2} \quad f_b = 0.019$$

$$h_a = 8.4\left(\frac{v_a^2}{2g}\right) = h_b = 57.2\left(\frac{v_b^2}{2g}\right)$$

$$8.4\left(\frac{v_a^2}{2g}\right) = 57.2\left(\frac{v_b^2}{2g}\right) \quad g = 32.17405\,ft/s^2$$
$$2g = 64.3481$$

$$\frac{8.4}{64.3481} = \frac{57.2}{64.3481} = \sqrt{0.1305\,v_a^2} = \sqrt{0.8889\,v_b^2}$$

$$v_a = 2.61\,v_b$$

$$Q_1 = A_a v_a + A_b v_b$$
$$Q_1 = A_a(2.61 v_b) + A_b v_b = v_b(2.61 A_a + A_b)$$

$$v_b = \frac{3.01\,ft^3/s}{(2.61\cdot(0.2006))(0.02333)} \quad v_b = 5.5\,ft/s$$
$$v_a = 2.61(5.5) = 14.36\,ft/s$$

$$N_R \text{ branch } b = \frac{(5.5)(0.1723)}{7.41\times10^{-6}} = 127888$$

Continued on Pg 3

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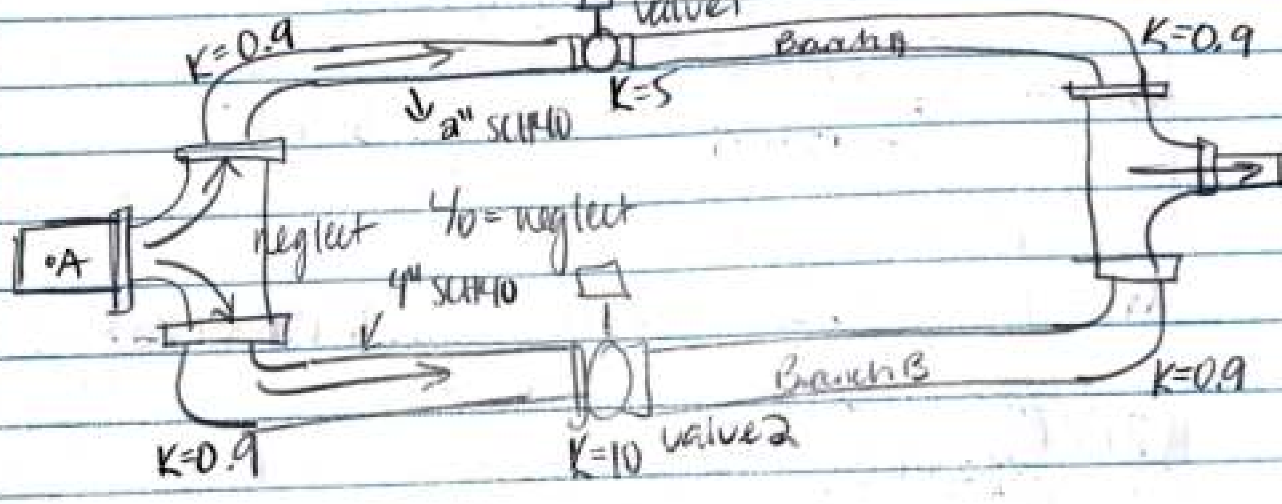
Problem 12.4 Continued

$$f_b = \frac{0.25}{\left(\log\frac{1}{3.7(1149)} + \frac{5.74}{127888^{0.9}}\right)^2} \quad f_b = 0.021$$

Within ± 0.005 variation ✓

$$Q_a = A_a v_a = (0.2006\,ft^2)(14.35\,ft/s) \;\boxed{= 2.88\,ft^3/s}$$
$$Q_b = A_b v_b = (0.02333\,ft^2)(5.5\,ft/s) \;\boxed{= 0.13\,ft^3/s}$$
$$= 3.01\,ft^3/s \checkmark$$

12.6



What is Q? Both valves open, valve 1 open, valve 2 open

$A_A = 0.0233\,ft^2$ $\quad f_A = 0.019$
$A_B = 0.08840\,ft^2$ $\quad f_B = 0.016$
$\varepsilon = 1.5\times10^{-4}$

$$H_{LA} = (0.9)\left(\frac{v_A^2}{2g}\right) + (5)\left(\frac{v_A^2}{2g}\right) + (0.9)\left(\frac{v_A^2}{2g}\right)$$

$$H_{LB} = (0.9)\left(\frac{v_B^2}{2g}\right) + (10)\left(\frac{v_B^2}{2g}\right) + (0.9)\left(\frac{v_A^2}{2g}\right)$$

Continued on Pg 4

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12.6 Cont'd $H_{LA} = (6.8)\left(\frac{V_A^2}{2g}\right) = H_{LB} = (11.8)\left(\frac{V_B^2}{2g}\right)$

$6.8 \frac{V_A^2}{2g} = 11.8 \frac{V_B^2}{2g}$ $\quad g = 32.17405 \frac{ft}{s^2}$

$2g = 64.3481$

$\frac{6.8}{64.3481} = \frac{11.8}{64.3481}$

$\sqrt{0.105675\, va^2} = \sqrt{0.183377\, vb^2}$

$va = \frac{\sqrt{0.183377\, vb^2}}{\sqrt{0.105675}} = va = 1.317 vb$

$Q_1 = A_A V_A + A_B V_B$

$Q_1 = A_A (1.317) V_B + A_B V_B = V_B (1.317 A_A + A_B)$

$\frac{20\ lb}{in^2} \cdot \frac{144\ in^2}{ft^2} \cdot \frac{1\ ft^3}{62.4\ lb} = 46.15 ft$

^ pressure head of H_A

$46.15 ft = 6.8 \left(\frac{V_A^2}{2g}\right) = 46.15 ft = 6.8 \frac{V_A^2}{64.3481}$

$\sqrt{\frac{46.15 ft \cdot 64.3481 ft/s^2}{6.8}} = V_A = 20.89\ ft/s$

$Q_A = A_A V_A = (0.0233 ft^2)(20.89\ ft/s) = 0.487\ ft^3/s$

$20.89 = 1.317 vb = 15.86\ ft/s = V_b$

Continued on PG 5

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D.6 Contd

$$Q_1 = A_A V_A + A_B V_B$$
$$= (0.0233)(20.89) + (0.08840)(15.86)$$

$$\boxed{Q_1 = 1.89 \ ft^3/s}$$ both values

$$Q_{v_1} = A_A V_A = (0.0233)(20.89)$$

$$\boxed{Q_{v_1} = 0.487 \ ft^3/s}$$ only valve 1 (branch A)

$$Q_{v_2} = A_B V_B = (0.08840)(15.86)$$

$$\boxed{Q_{v_2} = 1.40 \ ft^3/s}$$ only valve 2 (branch B)