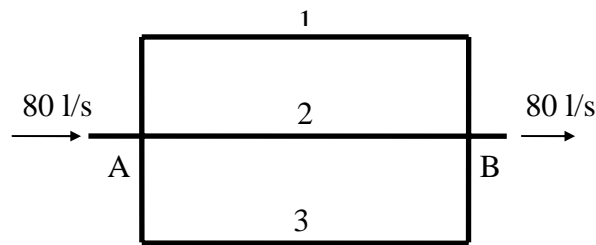


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/ 80

( )	( )		
100	1000		1
150	3000		2
200	4000		3



B A

Pipe	L (m)	d (mm)	e (mm) 5	e/d	f
1	1000	100	0.017	0.00017	0.0135
2	3000	150	0.25	0.00166	0.0225
3	4000	200	0.15	0.00075	0.0185

$$\therefore h_{f1} = h_{f2} = h_{f3}$$

$$\therefore f_1 \frac{L_1}{d_1} \frac{V_1^2}{2g} = f_2 \frac{L_2}{d_2} \frac{V_2^2}{2g} = f_3 \frac{L_3}{d_3} \frac{V_3^2}{2g}$$

$$\therefore 0.0135 \times \frac{1000}{0.100} \times \frac{Q_1^2}{\left[\frac{\pi}{4}(0.10)^2\right]^2 \times 2g} = 0.0225 \times \frac{3000}{0.150} \times \frac{Q_2^2}{\left[\frac{\pi}{4}(0.15)^2\right]^2 \times 2g} = 0.0185 \times \frac{4000}{0.200} \times \frac{Q_3^2}{\left[\frac{\pi}{4}(0.20)^2\right]^2 \times 2g}$$

$$1.35 \times 10^6 Q_1^2 = 8.888 \times 10^5 Q_2^2 = 2.3125 \times 10^5 Q_3^2$$

$$\therefore 1.35 Q_1^2 = 8.888 Q_2^2 = 2.3125 Q_3^2$$

.....

$$3.674 Q_1 = 2.981 Q_2 = 1.5207 Q_3$$

$$\therefore Q_3 = 2.416 Q_1 \quad , \quad Q_2 = 1.232 Q_1$$

$$\therefore Q_1 + Q_2 + Q_3 = 80 \text{ L/s} \quad \therefore Q_1 + 2.416 Q_1 + 1.232 Q_1 = 80$$

$$\therefore 4.648 Q_1 = 80 \quad \therefore Q_1 = 17.21 \text{ L/s}$$

$$Q_2 = 1.232 \times 17.21 = 21.2 \text{ L/s} \quad Q_3 = 2.416 \times 17.21 = 41.58 \text{ L/s}$$

$$\therefore V_1 = \frac{Q_1}{A_1} = \frac{0.01721}{\frac{\pi}{4}(0.10)^2} = 2.19 \text{ m/s}$$

$$h_{f1} = 0.0135 \times \frac{1000}{0.10} \times \frac{(2.19)^2}{2 \times 9.81} = 33.0 \text{ m}$$

$$\therefore V_2 = \frac{Q_2}{A_2} = \frac{0.0212}{\frac{\pi}{4}(0.15)^2} = 1.2 \text{ m/s}$$

$$h_{f2} = 0.0225 \times \frac{3000}{0.15} \times \frac{(1.2)^2}{2 \times 9.81} = 33.0 \text{ m}$$

$$\therefore V_3 = \frac{Q_3}{A_3} = \frac{0.04158}{\frac{\pi}{4}(0.20)^2} = 1.323 \text{ m/s}$$

$$h_{f3} = 0.0185 \times \frac{4000}{0.20} \times \frac{(1.323)^2}{2 \times 9.81} = 33.0 \text{ m}$$

Pipe	(1)	(2)	(3)
L (m)	250	200	100
d (cm)	30	35	15
f	0.020	0,022	0.028

C B

25 45

Q

$$Q = Q_1 = Q_2 = Q_3$$

$$\therefore V_1 = \frac{Q}{A_1} = \frac{Q}{\frac{\pi}{4}(0.30)^2} = 14.15Q$$

$$\therefore \frac{V_1^2}{2g} = 10.2Q^2$$

$$\therefore V_2 = \frac{Q}{A_2} = \frac{Q}{\frac{\pi}{4}(0.25)^2} = 20.37Q$$

$$\therefore \frac{V_2^2}{2g} = 21.15Q^2$$

$$\therefore V_3 = \frac{Q}{A_3} = \frac{Q}{\frac{\pi}{4}(0.15)^2} = 56.59Q$$

$$\therefore \frac{V_3^2}{2g} = 163.21Q^2$$

$$h_{L1} = h_m = 0.5 \frac{V_1^2}{2g} = 0.5(10.2Q^2) = 5.1Q^2$$

$$h_{L2} = h_{f1} = f_1 \frac{L_1}{d_1} \frac{V_1^2}{2g} = 0.020 \times \frac{250}{0.30} \times (10.2Q^2) = 170Q^2$$

$$K = 0.15$$

$$h_{L3} = h_m = K \frac{V_1^2}{2g} = 0.15(10.2Q^2) = 1.03Q^2$$

$$(d/D)^2 = (25/30)^2 = 0.69$$

$$K = 0.20$$

$$h_{L4} = h_m = K \frac{V_2^2}{2g} = 0.20(21.15Q^2) = 4.23Q^2$$

$$h_{L5} = h_{f2} = f_2 \frac{L_2}{d_2} \frac{V_2^2}{2g} = 0.022 \times \frac{200}{0.25} \times (21.15 Q^2) = 372.24 Q^2$$

2

2

$$K = 0.15$$

$$h_{L6} = h_m = K \frac{V_2^2}{2g} = 0.15 (21.15 Q^2) = 3.17 Q^2$$

3

2

K

$$(d/D)^2 = (15/25)^2 = 0.36$$

$$K = 0.35$$

$$h_{L7} = h_m = K \frac{V_3^2}{2g} = 0.35 (163.21 Q^2) = 57.12 Q^2$$

3

$$h_{L8} = h_{f3} = f_3 \frac{L_3}{d_3} \frac{V_3^2}{2g} = 0.028 \times \frac{100}{0.15} \times (163.21 Q^2) = 3046.59 Q^2$$

3

$$K = 0.15$$

$$h_{L9} = h_m = K \frac{V_3^2}{2g} = 0.15 (163.21 Q^2) = 24.48 Q^2$$

C

3

$$h_{L10} = h_m = K \frac{V_3^2}{2g} = 1 (163.21 Q^2) = 163.21 Q^2$$

$$\sum h_L = h_{L1} + h_{L2} + h_{L3} + \dots + h_{L10}$$

$$\sum h_L = Q^2 (5.1 + 170 + 1.03 + \dots + 163.21)$$

$$\sum h_L = 3847.17 Q^2$$

$$Z_B - Z_C = \sum h_L$$

$$45 - 25 = 3847.17 Q^2$$

$$Q^2 = \frac{20}{3847.17} = 0.0052$$

$$Q = 0.0721 \text{ m}^3/\text{s}$$

$$h_{L1} = 5.1 Q^2 = 5.1 \times 0.0052 = 0.0265 \text{ m}$$

$$h_{L2} = 170 Q^2 = 170 \times 0.0052 = 0.884\text{m}$$

$$h_{L3} = 1.03 Q^2 = 1.03 \times 0.0052 = 0.0054\text{m}$$

$$h_{L4} = 4.23 Q^2 = 4.23 \times 0.0052 = 0.022\text{m}$$

$$h_{L5} = 372.24 Q^2 = 372.24 \times 0.0052 = 1.9356\text{m}$$

$$h_{L6} = 3.17 Q^2 = 3.17 \times 0.0052 = 0.0165\text{m}$$

$$h_{L7} = 57.12 Q^2 = 57.12 \times 0.0052 = 0.297\text{m}$$

$$h_{L8} = 3046.59 Q^2 = 3046.59 \times 0.0052 = 15.8423\text{m}$$

$$h_{L9} = 24.48 Q^2 = 24.48 \times 0.0052 = 0.1273\text{m}$$

$$h_{L10} = 163.21 Q^2 = 0.8487\text{m}$$

20m

45 60 75

60 75 120

:

0.015 0.020 0.025

.0.015

45

255

.0.017

45

$$\frac{f L}{d^5} = \left( \frac{f_1 L_1}{d_1^5} + \frac{f_2 L_2}{d_2^5} + \frac{f_3 L_3}{d_3^5} \right)$$

$$\frac{0.015 L}{0.045^5} = \left( \frac{0.025 \times 120}{0.075^5} + \frac{0.020 \times 75}{0.060^5} + \frac{0.015 \times 60}{0.045^5} \right)$$

$$\frac{0.015 L}{0.045^5} = (1264197.5 + 1929012.3 + 4877305.3) = 8070515$$

$$L = 99.3 \text{ m}$$

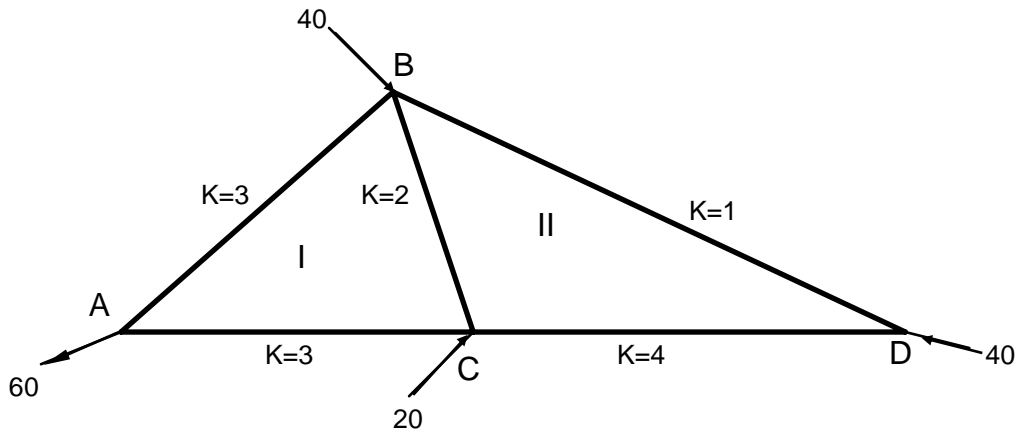
255

$$\frac{f L}{d^5} = 8070515$$

$$\frac{0.017 \times 255}{d^5} = 8070515$$

$$d = 0.056 \text{ m} = 56 \text{ mm}$$

K



Line	K	Q	$\pm KQ^2$	2KQ	Line	K	Q	$\pm KQ^2$	2KQ
CA	3	30	2700	180	BD	1	-30	-900	60
AB	3	-30	-2700	180	DC	4	10	400	80
BC	2	40	3200	160	CB	2	-40	-3200	160
$\Sigma =$			3200	520	$\Sigma =$			-3700	300

$$dQ = \frac{-\sum KQ^2}{2KQ} = \frac{-3200}{520} = -6.154 \approx -6$$

$$dQ = \frac{-\sum KQ^2}{2KQ} = \frac{-(-3700)}{300} = 12.33 \approx 12$$

Line	K	Q	$\pm KQ^2$	2KQ	Line	K	Q	$\pm KQ^2$	2KQ
CA	3	24	1728	144	BD	1	-18	-324	36
AB	3	-36	-3888	216	DC	4	22	1936	176
BC	2	22	968	88	CB	2	-22	-968	88
$\Sigma =$			-1192	448	$\Sigma =$			644	300

$$dQ = \frac{-(-1192)}{448} = 2.66 \approx 3$$

$$dQ = \frac{-644}{300} = -2.15 \approx -2$$

Line	K	Q	$\pm KQ^2$	2KQ	Line	K	Q	$\pm KQ^2$	2KQ
CA	3	27	2187	162	BD	1	-20	-400	40
AB	3	-33	-3267	198	DC	4	20	1600	160
BC	2	27	1458	108	CB	2	-27	-1458	108
$\Sigma =$			378	468	$\Sigma =$			-258	308

$$dQ = \frac{-378}{468} = -0.81$$

$$dQ = \frac{-(-258)}{308} = -0.84$$

Line	K	Q	$\pm KQ^2$	2KQ	Line	K	Q	$\pm KQ^2$	2KQ
CA	3	26.19	2058.1	157.15	BD	1	-19.16	-367.2	38.32
AB	3	-33.81	-3429	202.85	DC	4	20.84	1736.8	166.70
BC	2	25.35	1285.7	101.42	CB	2	-25.35	1285.7	101.42
$\Sigma =$			-85.05	461.42	$\Sigma =$			83.92	306.44

$$dQ = \frac{-(-85.05)}{461.42} = -0.18$$

$$dQ = \frac{-83.92}{306.44} = -0.28$$