Problem-Hazen William

- Problem 1: Calculate the diameter of pipe 1Km laid to discharge a flow of 1000m^3/day under a head loss of 10m(C=100)

- Problem 2: A 6-km-long, new cast-iron pipeline carries 320 l /s of water .The pipe diameter is 30 cm. Find the head loss .

(1) Data:

$d = ?$

$L = 1000m$

$Q = 11.57 \times 10^{-3} m^3/s$

$H_L = 10m$

$C = 100$

Sol: $d = 0.1337m$

(2) Data:

$L = 6000m$

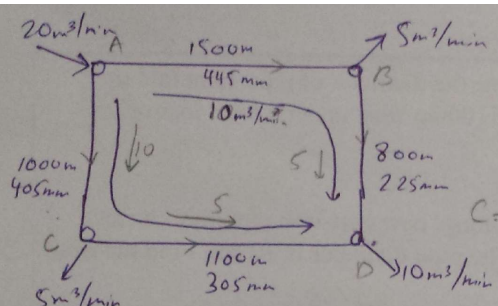
$C = 130$

$Q = 0.320 m^3/s$

$d = 0.3m$

$H_L = ?$

Sol: $h_L = 335.5m$



Flow CW = +ve
CCW = -ve

C = 100

Line	Q		D	L	h_L	H_L/Q	Correction Q	H_L	H_L/Q
	m³/min	m³/s	m	m	m	s/m²	m³/s	m	
AB	10	0.1667	0.445	1500	5.98	35.87	0.1473	4.75	32.24
BD	5	0.0833	0.225	800	24.46	293.63	0.0639	14.98	234.42
AC	-10	-0.1667	0.405	1000	-6.3	37.79	-0.1361	-7.73	41.53
CD	-5	-0.0833	0.305	1100	-7.64	91.71	-0.1027	-11.26	109.63
				Sum	16.5	459		0.74	417.82

Lowest flow = 0.0833
10% of lowest flow = 0.00833

$$\Delta = -\frac{\Sigma H_L}{1.85\left(\frac{1}{2}\frac{H_L}{2}\right)} = \frac{16.5}{1.85 \times 459}$$

$$= -0.0194$$

Δ > 10% of lowest flow
Apply correction

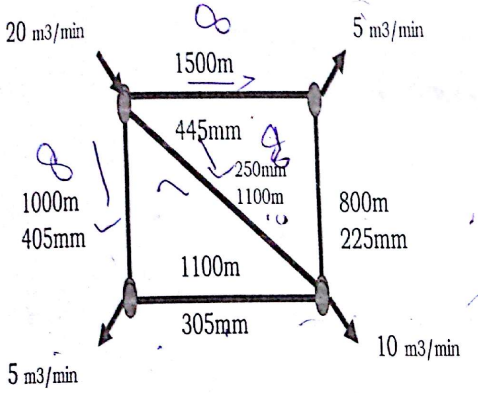
Lowest flow = 0.0639
10% " = 0.00639

$\Delta = 0.00096$

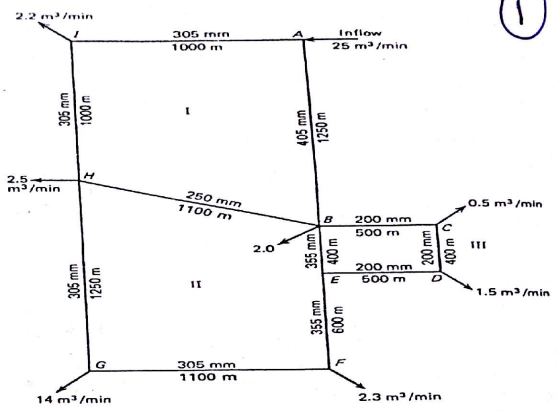
Δ < 10% of lowest flow
Hence ok.

Hardy
Proced
1. D
2. A
3. C
4. C
5.
6.

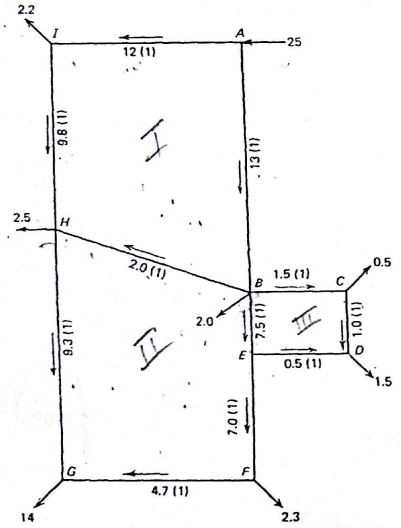
Problem 2-Hardy's Cross Method



Problem 3-Hardy's Cross Method



Solution



$h_L = 10.65 \times \left(\frac{Q}{C}\right)^{1.85} \times \frac{L}{D^{4.87}}$

First Correction A I H B

Loop I

Line	Flow, m^3/min	Dia, m	Length, m	s	h_L, m	h/Q, $m/m^3/min$
AB	13	0.40	1250	0.0110	13.75	1.058
BII	2	0.25	1100	0.0033	3.63	1.815
IH	−9.8	0.30	1000	−0.0260	−26.00	2.653
AI	−12	0.30	1000	−0.0380	−37.80	3.150
					−46.42	8.676

$$\Delta_1 = -\frac{-46.42}{1.85(8.676)} = 2.9$$

Loop II

Line	Flow, m^3/min	Dia., m	Length, m	s	h_f, m	h/Q, $m/m^3/min$
BE	7.5	0.35	400	0.0075	3.00	0.400
EF	7.0	0.35	600	0.0066	3.96	0.566
FG	4.7	0.30	1000	0.0067	6.68	1.423
GH	−9.3	0.30	1250	−0.0236	−29.54	3.177
HB	−2.0	0.25	1100	−0.0033	−3.63	1.815
					−19.53	7.381

$$\Delta_{II} = -\frac{-19.53}{1.85(7.381)} = 1.4$$

Loop III

Line	Flow, m^3/min	Dia., m	Length, m	s	h_f, m	h/Q, $m/m^3/min$
BC	1.5	0.20	500	0.0058	2.91	1.937
CD	1.0	0.20	400	0.0028	1.10	1.110
DE	−0.5	0.20	500	−0.0008	−0.38	0.762
EB	−7.5	0.35	400	−0.0075	−3.00	0.400
					0.63	4.209

$$\Delta_{III} = -\frac{0.63}{1.85(4.209)} = -0.1$$

Second Correction

Loop I

Line	Flow, m^3/min	Dia., m	Length, m	s	h_f, m	h/Q, $m/m^3/min$
AB	15.9	0.40	1250	0.0157	19.65	1.236
BH	3.5	0.25	1100	0.0094	10.34	2.954
HI	−6.9	0.30	1000	−0.0136	−13.60	1.971
IA	−9.1	0.30	1000	−0.0227	−22.70	2.495
					−6.31	8.656

$$\Delta_I = 0.4$$

Loop II

Line	Flow, m^3/min	Dia., m	Length, m	s	h_f, m	h/Q, $m/m^3/min$
BE	9.0	0.35	400	0.0105	4.20	0.467
EF	8.4	0.35	600	0.0093	5.58	0.664
FG	6.1	0.30	1000	0.0108	10.80	1.770
GH	−7.9	0.30	1250	−0.0175	−21.88	2.769
HB	−3.5	0.25	1100	−0.0094	−10.34	2.954
					−11.64	8.624

$$\Delta_{II} = 0.7$$

Loop III

Line	Flow, m^3/min	Dia., m	Length, m	s	h_f, m	h/Q, $m/m^3/min$
BC	1.4	0.20	500	0.0051	2.55	1.821
CD	0.9	0.20	400	0.0023	0.92	1.022
DE	−0.6	0.20	500	−0.0011	−0.55	0.917
EB	−9.0	0.35	400	−0.0105	−4.20	0.467
					−1.28	4.227

$$\Delta_{III} = 0.2$$

Third Correction

Loop I

Line	Flow, m^3/min	Dia., m	Length, m	s	h_f, m	h/Q, $m/m^3/min$
AB	16.3	0.40	1250	0.0165	20.63	1.265
BH	3.2	0.25	1100	0.0080	8.80	2.750
HI	−6.5	0.30	1000	−0.0122	−12.20	1.877
IA	−8.7	0.30	1000	−0.0209	−20.90	2.402
					−3.67	8.294

$$\Delta_I = 0.2$$

Loop II

Line	Flow, m^3/min	Dia., m	Length, m	s	h_f, m	h/Q, $m/m^3/min$
BE	9.5	0.35	400	0.0116	4.64	0.488
EF	9.1	0.35	600	0.0107	6.42	0.705
FG	6.8	0.30	1000	0.0132	13.20	1.941
GH	−7.2	0.30	1250	−0.0147	−18.38	2.552
HB	−3.2	0.25	1100	−0.0080	−8.80	2.750
					−2.92	8.436

$$\Delta_{II} = 0.2$$

Loop III

Line	Flow, m^3/min	Dia, m	Length, m	s	h_f, m	h/Q, $m/m^3/min$
BC	1.6	0.20	500	0.0066	3.30	2.063
CD	1.1	0.20	400	0.0033	1.32	1.200
DE	−0.4	0.20	500	−0.0005	−0.25	0.625
EB	−9.5	0.35	400	−0.0116	−4.64	0.488
					−0.27	4.376

$\Delta_{III} = 0.03$