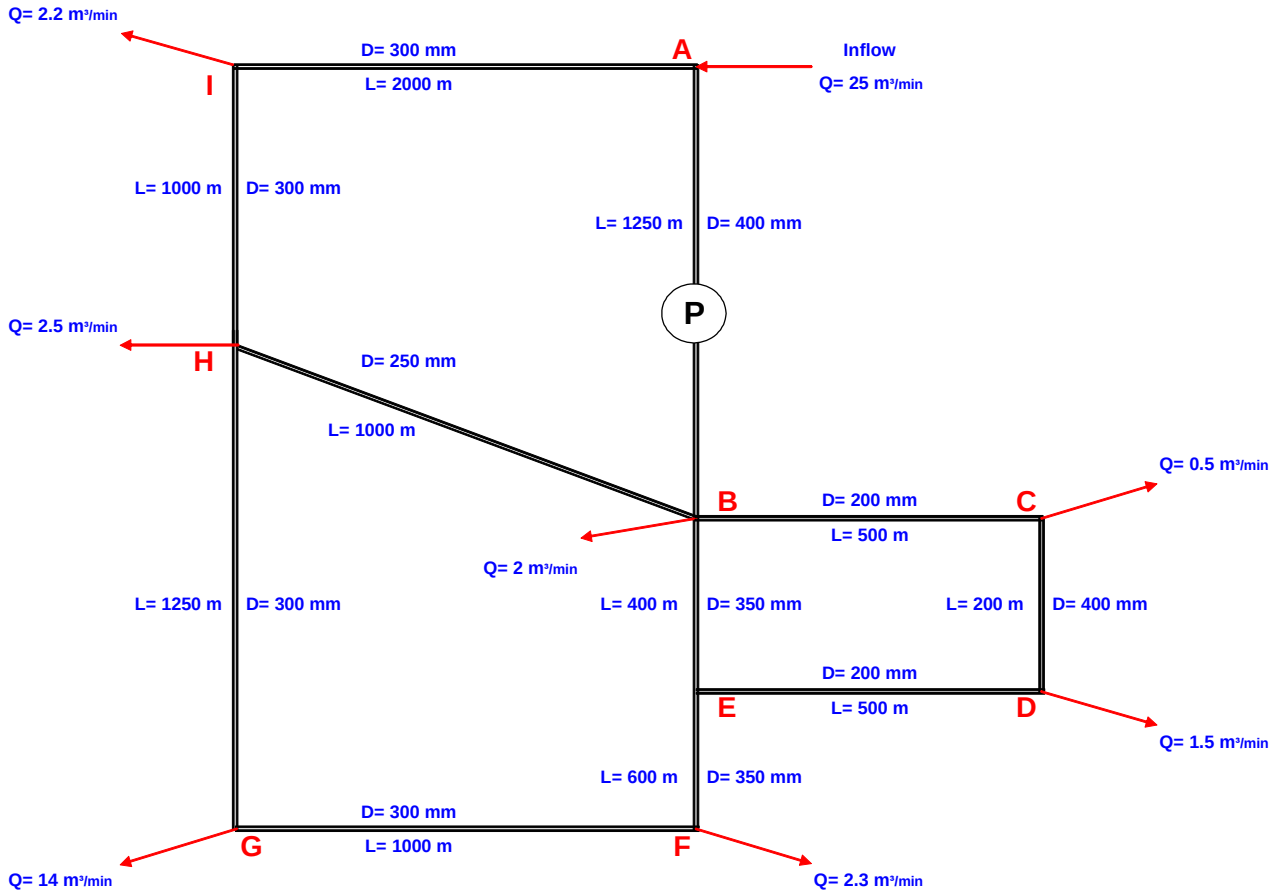
Third Example (Loop System with Pump)

Design the network of pipes? A pump is installed in line AB boosting the flow towards B and delivers a head of 10 m. C = 100.



Third Example Solution

The head loss in line AB will be :

$$hL = k * Q^{1.85} - hp$$

Where :
hp = total head delivered by pump

$$Q_{new} = Sign(Q_{old}) + \Delta$$

Loop 1

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	13.00	1.72	3.56	0.27		
1	BH	Yes	1	250	1000	100	1811.99	2.00	0.68	3.35	1.68		
1	HI	No	-1	300	1000	100	745.67	-9.80	2.31	-26.11	2.66		
1	IA	No	-1	300	2000	100	1491.33	-12.00	2.83	-75.94	6.33		
										-95.14	10.94	Δ1	4.699
2	BE	Yes	1	350	400	100	140.79	7.50	1.30	3.01	0.40		
2	EF	No	1	350	600	100	211.19	7.00	1.21	3.97	0.57		
2	FG	No	1	300	1000	100	745.67	4.70	1.11	6.70	1.43		
2	GH	No	-1	350	1250	100	439.97	-9.30	1.61	-13.98	1.50		
2	HB	Yes	-1	250	1000	100	1811.99	-2.00	0.68	-3.35	1.68		
										-3.66	5.57	Δ2	0.355
3	BC	No	1	200	500	100	2685.83	1.50	0.80	2.92	1.95		
3	CD	No	1	200	400	100	2148.66	1.00	0.53	1.10	1.10		
3	DE	No	-1	200	500	100	2685.83	-0.50	0.27	-0.38	0.76		
3	EB	Yes	-1	350	400	100	140.79	-7.50	1.30	-3.01	0.40		
										0.63	4.21	Δ3	-0.081

Loop 2

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	17.70	2.35	14.00	0.79		
1	BH	Yes	1	250	1000	100	1811.99	6.34	2.15	28.38	4.47		
1	HI	No	-1	300	1000	100	745.67	-5.10	1.20	-7.80	1.53		
1	IA	No	-1	300	2000	100	1491.33	-7.30	1.72	-30.28	4.15		
										4.30	10.94	Δ1	-0.212
2	BE	Yes	1	350	400	100	140.79	7.94	1.37	3.34	0.42		
2	EF	No	1	350	600	100	211.19	7.35	1.27	4.35	0.59		
2	FG	No	1	300	1000	100	745.67	5.05	1.19	7.67	1.52		
2	GH	No	-1	350	1250	100	439.97	-8.95	1.55	-13.01	1.45		
2	HB	Yes	-1	250	1000	100	1811.99	-6.34	2.15	-28.38	4.47		
										-26.04	8.46	Δ2	1.664
3	BC	No	1	200	500	100	2685.83	1.42	0.75	2.63	1.86		
3	CD	No	1	200	400	100	2148.66	0.92	0.49	0.94	1.03		
3	DE	No	-1	200	500	100	2685.83	-0.58	0.31	-0.51	0.87		
3	EB	Yes	-1	350	400	100	140.79	-7.94	1.37	-3.34	0.42		
										-0.27	4.17	Δ3	0.034

Loop 3

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	17.49	2.32	13.47	0.77		
1	BH	Yes	1	250	1000	100	1811.99	4.47	1.52	14.84	3.32		
1	HI	No	-1	300	1000	100	745.67	-5.31	1.25	-8.41	1.58		
1	IA	No	-1	300	2000	100	1491.33	-7.51	1.77	-31.93	4.25		
										-12.04	9.92	Δ1	0.656
2	BE	Yes	1	350	400	100	140.79	9.57	1.66	4.71	0.49		
2	EF	No	1	350	600	100	211.19	9.02	1.56	6.34	0.70		
2	FG	No	1	300	1000	100	745.67	6.72	1.58	12.99	1.93		
2	GH	No	-1	350	1250	100	439.97	-7.28	1.26	-8.89	1.22		
2	HB	Yes	-1	250	1000	100	1811.99	-4.47	1.52	-14.84	3.32		
										0.31	7.67	Δ2	-0.022
3	BC	No	1	200	500	100	2685.83	1.45	0.77	2.75	1.89		
3	CD	No	1	200	400	100	2148.66	0.95	0.51	1.01	1.06		
3	DE	No	-1	200	500	100	2685.83	-0.55	0.29	-0.45	0.83		
3	EB	Yes	-1	350	400	100	140.79	-9.57	1.66	-4.71	0.49		
										-1.40	4.27	Δ3	0.178

Loop 4

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	18.14	2.41	15.12	0.83		
1	BH	Yes	1	250	1000	100	1811.99	5.15	1.75	19.27	3.74		
1	HI	No	-1	300	1000	100	745.67	-4.66	1.10	-6.59	1.42		
1	IA	No	-1	300	2000	100	1491.33	-6.86	1.62	-26.97	3.93		
										0.83	9.93	Δ1	-0.045
2	BE	Yes	1	350	400	100	140.79	9.37	1.62	4.53	0.48		
2	EF	No	1	350	600	100	211.19	9.00	1.56	6.31	0.70		
2	FG	No	1	300	1000	100	745.67	6.70	1.58	12.91	1.93		
2	GH	No	-1	350	1250	100	439.97	-7.30	1.27	-8.94	1.22		
2	HB	Yes	-1	250	1000	100	1811.99	-5.15	1.75	-19.27	3.74		
										-4.45	8.08	Δ2	0.298
3	BC	No	1	200	500	100	2685.83	1.63	0.87	3.41	2.09		
3	CD	No	1	200	400	100	2148.66	1.13	0.60	1.38	1.22		
3	DE	No	-1	200	500	100	2685.83	-0.37	0.20	-0.22	0.59		
3	EB	Yes	-1	350	400	100	140.79	-9.37	1.62	-4.53	0.48		
										0.04	4.39	Δ3	-0.005

Loop 5

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	18.10	2.40	15.01	0.83		
1	BH	Yes	1	250	1000	100	1811.99	4.80	1.63	16.96	3.53		
1	HI	No	-1	300	1000	100	745.67	-4.70	1.11	-6.71	1.43		
1	IA	No	-1	300	2000	100	1491.33	-6.90	1.63	-27.30	3.95		
										-2.04	9.74	$\Delta 1$	0.113
2	BE	Yes	1	350	400	100	140.79	9.67	1.67	4.81	0.50		
2	EF	No	1	350	600	100	211.19	9.29	1.61	6.70	0.72		
2	FG	No	1	300	1000	100	745.67	6.99	1.65	13.99	2.00		
2	GH	No	-1	350	1250	100	439.97	-7.01	1.21	-8.28	1.18		
2	HB	Yes	-1	250	1000	100	1811.99	-4.80	1.63	-16.96	3.53		
										0.27	7.93	$\Delta 2$	-0.018
3	BC	No	1	200	500	100	2685.83	1.63	0.86	3.39	2.08		
3	CD	No	1	200	400	100	2148.66	1.13	0.60	1.37	1.22		
3	DE	No	-1	200	500	100	2685.83	-0.37	0.20	-0.22	0.60		
3	EB	Yes	-1	350	400	100	140.79	-9.67	1.67	-4.81	0.50		
										-0.27	4.40	$\Delta 3$	0.033

Loop 6

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	18.21	2.42	15.30	0.84		
1	BH	Yes	1	250	1000	100	1811.99	4.93	1.68	17.83	3.61		
1	HI	No	-1	300	1000	100	745.67	-4.59	1.08	-6.41	1.40		
1	IA	No	-1	300	2000	100	1491.33	-6.79	1.60	-26.47	3.90		
										0.24	9.75	$\Delta 1$	-0.013
2	BE	Yes	1	350	400	100	140.79	9.62	1.67	4.76	0.49		
2	EF	No	1	350	600	100	211.19	9.28	1.61	6.68	0.72		
2	FG	No	1	300	1000	100	745.67	6.98	1.64	13.92	2.00		
2	GH	No	-1	350	1250	100	439.97	-7.02	1.22	-8.32	1.18		
2	HB	Yes	-1	250	1000	100	1811.99	-4.93	1.68	-17.83	3.61		
										-0.78	8.01	$\Delta 2$	0.053
3	BC	No	1	200	500	100	2685.83	1.66	0.88	3.52	2.12		
3	CD	No	1	200	400	100	2148.66	1.16	0.61	1.45	1.25		
3	DE	No	-1	200	500	100	2685.83	-0.34	0.18	-0.19	0.55		
3	EB	Yes	-1	350	400	100	140.79	-9.62	1.67	-4.76	0.49		
										0.02	4.42	$\Delta 3$	-0.002

Loop 7

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	18.20	2.41	15.26	0.84		
1	BH	Yes	1	250	1000	100	1811.99	4.87	1.65	17.39	3.57		
1	HI	No	-1	300	1000	100	745.67	-4.60	1.09	-6.45	1.40		
1	IA	No	-1	300	2000	100	1491.33	-6.80	1.60	-26.57	3.91		
										-0.36	9.72	Δ1	0.020
2	BE	Yes	1	350	400	100	140.79	9.67	1.68	4.81	0.50		
2	EF	No	1	350	600	100	211.19	9.33	1.62	6.75	0.72		
2	FG	No	1	300	1000	100	745.67	7.03	1.66	14.12	2.01		
2	GH	No	-1	350	1250	100	439.97	-6.97	1.21	-8.20	1.18		
2	HB	Yes	-1	250	1000	100	1811.99	-4.87	1.65	-17.39	3.57		
										0.09	7.98	Δ2	-0.006
3	BC	No	1	200	500	100	2685.83	1.66	0.88	3.51	2.12		
3	CD	No	1	200	400	100	2148.66	1.16	0.61	1.44	1.25		
3	DE	No	-1	200	500	100	2685.83	-0.34	0.18	-0.19	0.56		
3	EB	Yes	-1	350	400	100	140.79	-9.67	1.68	-4.81	0.50		
										-0.05	4.42	Δ3	0.006

Loop 8

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	18.22	2.42	15.31	0.84		
1	BH	Yes	1	250	1000	100	1811.99	4.89	1.66	17.56	3.59		
1	HI	No	-1	300	1000	100	745.67	-4.58	1.08	-6.40	1.40		
1	IA	No	-1	300	2000	100	1491.33	-6.78	1.60	-26.42	3.90		
										0.06	9.72	Δ1	-0.003
2	BE	Yes	1	350	400	100	140.79	9.66	1.67	4.80	0.50		
2	EF	No	1	350	600	100	211.19	9.32	1.62	6.74	0.72		
2	FG	No	1	300	1000	100	745.67	7.02	1.66	14.10	2.01		
2	GH	No	-1	350	1250	100	439.97	-6.98	1.21	-8.21	1.18		
2	HB	Yes	-1	250	1000	100	1811.99	-4.89	1.66	-17.56	3.59		
										-0.14	7.99	Δ2	0.009
3	BC	No	1	200	500	100	2685.83	1.66	0.88	3.53	2.12		
3	CD	No	1	200	400	100	2148.66	1.16	0.62	1.46	1.25		
3	DE	No	-1	200	500	100	2685.83	-0.34	0.18	-0.18	0.55		
3	EB	Yes	-1	350	400	100	140.79	-9.66	1.67	-4.80	0.50		
										0.01	4.42	Δ3	-0.001

Loop 9

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	18.22	2.42	15.31	0.84		
1	BH	Yes	1	250	1000	100	1811.99	4.88	1.66	17.48	3.58		
1	HI	No	-1	300	1000	100	745.67	-4.58	1.08	-6.40	1.40		
1	IA	No	-1	300	2000	100	1491.33	-6.78	1.60	-26.45	3.90		
										-0.07	9.71	$\Delta 1$	0.004
2	BE	Yes	1	350	400	100	140.79	9.67	1.68	4.81	0.50		
2	EF	No	1	350	600	100	211.19	9.33	1.62	6.75	0.72		
2	FG	No	1	300	1000	100	745.67	7.03	1.66	14.13	2.01		
2	GH	No	-1	350	1250	100	439.97	-6.97	1.21	-8.19	1.18		
2	HB	Yes	-1	250	1000	100	1811.99	-4.88	1.66	-17.48	3.58		
										0.02	7.99	$\Delta 2$	-0.002
3	BC	No	1	200	500	100	2685.83	1.66	0.88	3.53	2.12		
3	CD	No	1	200	400	100	2148.66	1.16	0.62	1.46	1.25		
3	DE	No	-1	200	500	100	2685.83	-0.34	0.18	-0.19	0.55		
3	EB	Yes	-1	350	400	100	140.79	-9.67	1.68	-4.81	0.50		
										-0.01	4.42	$\Delta 3$	0.001

Loop 10

Loop No.	Pipe Line	Combined Pipe	Sign	Diameter (mm)	Pipe Length (m)	C	k	Assumed Discharge (m^3/min)	Velcity (m/sec)	Total Head Loss (m)	hL / Q		
1	AB	No	1	400	1250	100	229.62	18.22	2.42	15.32	0.84		
1	BH	Yes	1	250	1000	100	1811.99	4.89	1.66	17.51	3.58		
1	HI	No	-1	300	1000	100	745.67	-4.58	1.08	-6.39	1.40		
1	IA	No	-1	300	2000	100	1491.33	-6.78	1.60	-26.42	3.90		
										0.01	9.72	$\Delta 1$	-0.001
2	BE	Yes	1	350	400	100	140.79	9.67	1.67	4.81	0.50		
2	EF	No	1	350	600	100	211.19	9.33	1.62	6.75	0.72		
2	FG	No	1	300	1000	100	745.67	7.03	1.66	14.12	2.01		
2	GH	No	-1	350	1250	100	439.97	-6.97	1.21	-8.20	1.18		
2	HB	Yes	-1	250	1000	100	1811.99	-4.89	1.66	-17.51	3.58		
										-0.03	7.99	$\Delta 2$	0.002
3	BC	No	1	200	500	100	2685.83	1.66	0.88	3.53	2.12		
3	CD	No	1	200	400	100	2148.66	1.16	0.62	1.46	1.25		
3	DE	No	-1	200	500	100	2685.83	-0.34	0.18	-0.18	0.55		
3	EB	Yes	-1	350	400	100	140.79	-9.67	1.67	-4.81	0.50		
										0.00	4.42	$\Delta 3$	0.000