Case study

Hydraulic calculations & irrigation schedule

Pump selection

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❶ - IRRIGATION SCHEDULE

SHIFT	CONTROLLERS CONTROL-1					CON. FLOW	CONTROLLERS CONTROL-2					CON. FLOW	TOTAL GPM	RUN TIME	TOTAL GPD	
1	B1	B2	B3	B4			B19	B20	B21				238.00	15.00	3,570.00	
	25.00	32.00	32.00	39.00		128.00	39.00	39.00	32.00			110.00				
2	B5	B6	B7				B22	B24	B25				231.00	15.00	3,465.00	
	35.00	39.00	50.00			124.00	39.00	36.00	32.00			107.00				
3	B8	B9	B10	B11	B12		B26	B27	B28	B29	B30		239.00	15.00	3,585.00	
	39.00	15.00	14.00	25.00	28.00	121.00	18.00	21.00	8.00	39.00	32.00	118.00				
4	B13	B14	B15	B16			B31	B32					244.00	15.00	3,660.00	
	35.00	57.00	35.00	53.00		180.00	32.00	32.00				64.00				
5	B17	B18	B23	B35	B36		B33	B34					196.00	15.00	2,940.00	
	35.00	39.00	18.00	18.00	18.00	128.00	32.00	36.00				68.00				
8	D1	D2	D3	D4	D5		D19	D20	D21	D22			246.50	30.00	7,395.00	
	20.50	25.70	25.70	30.80	25.70	128.40	30.80	30.80	25.70	30.80		118.10				
9	D6	D7	D8	D9	D10		D24	D25	D26	D27	D28		231.10	30.00	6,933.00	
	30.80	41.10	30.80	15.40	10.30	128.40	30.80	25.70	15.40	20.50	10.30	102.70				
10	D11	D12	D13	D14	D15		D29	D30	D31				228.80	30.00	6,864.00	
	20.50	20.50	25.70	46.20	25.70	138.60	38.80	25.70	25.70			90.20				
11	D16	D17	D18	D23	D35		D32	D33	D34				218.20	30.00	6,546.00	
	41.10	25.70	30.80	15.40	15.40	128.40	25.70	36.00	28.10			89.80				
													MINUTES	195.00	44,958.00	GPD
													HAUR	03:15	170.17	M3/D

NOTES:

1.Total irrigation time per cycle is 3:15 hours.

2.Total consumption of water per irrigation cycle is 171 cubic meters.

3. Run time indicated for plants at maturity.At every stage of plant needs adjustment.

- The head loss calculations based on shift no. 11 as it is the widest shift and contain 2 of furthest valves (**D34** & **D33**)

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❷ - friction loss calculations

- The equations used in calculations as follow:-

- ***darcy-weisbach equation (pipes)*** **Hf=**$\text{ƒ}\left(\frac{L}{D}\right)\frac{v^2}{2g}$ where:-

  - -Hf= friction head (loss) in pipe
  - - L= pipe length
  - - D= pipe inner diameter
  - - v= flow velocity
  - - g= gravitational acceleration = 9.81 m/s2
  - - ƒ= friction factor, calculated from ***swamee-jain equation***

    -**swamee-jain equation** $\text{ƒ}=\frac{0.25}{\left[\log 10\left(\frac{\varepsilon}{3.7D}+\frac{5.74}{Re^{0.9}}\right)\right]^2}$ where:-

    -Ɛ = pipe surface Roughness

-Re = ***renold number*** = $Re = \frac{v*D}{kinematic\ viscosity}$

-**flow velocity** = $\boldsymbol{V = \frac{Q}{A}}$ where:-

-Q= flow rate

-A= pipe inner cross sectional area

- ***darcy-weisbach equation (fittings)*** **Hf=**$\boldsymbol{K\ \frac{v^2}{2g}}$ where:-

- **K** = friction factor for each fitting given from Cameron hydraulic handbook or any reference, and illustrated below in the calculation sheets.

- **Valve flow coefficient** $Kv = Q(m3/h)\sqrt{\frac{SG}{\Delta p(bar)}}$ where SG=water specific gravity = 1

- **total dynamic head** = **TDH**= friction head (Hf)+ static head (Hs)

❸ - auxiliary data taken in calculation

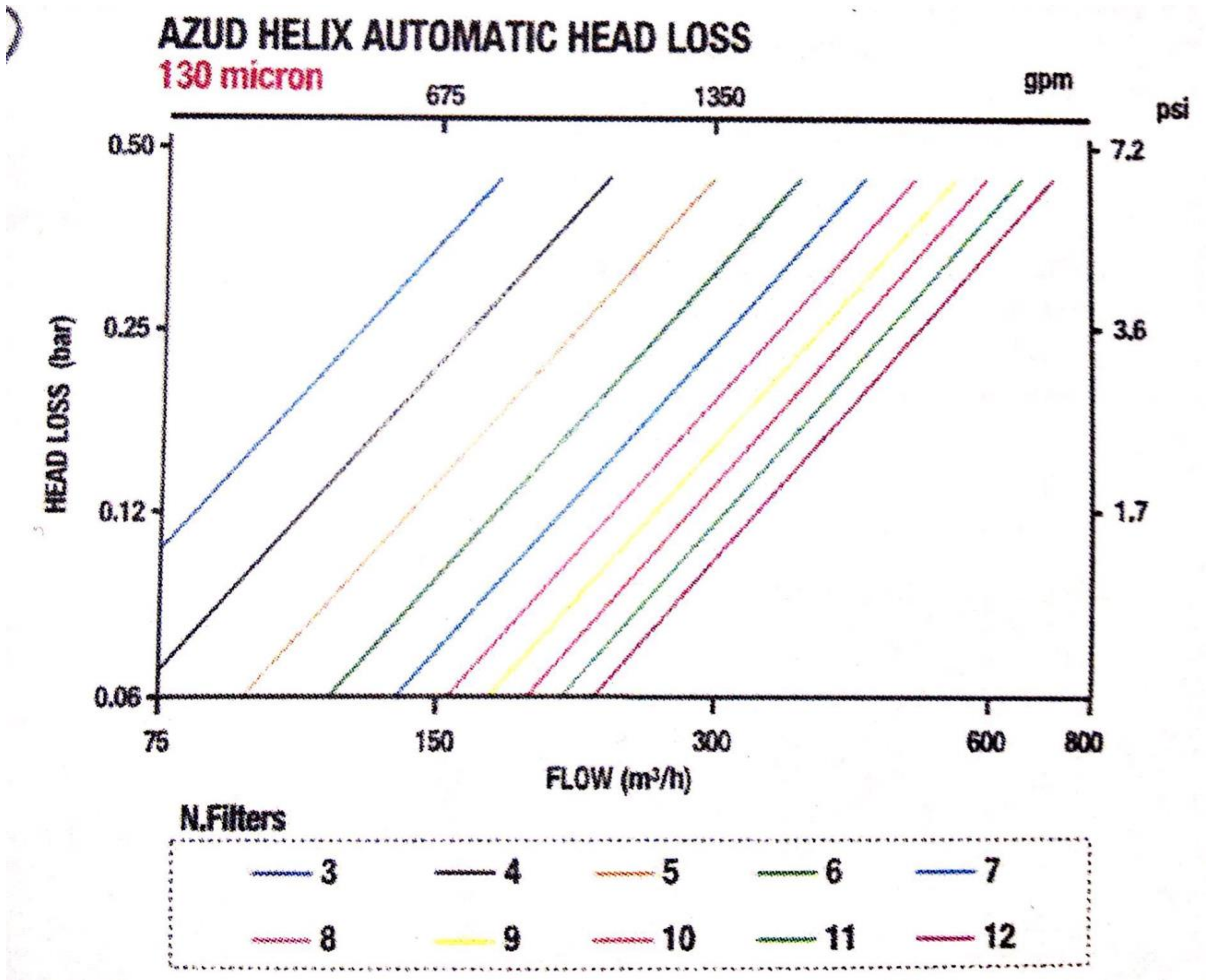
According the studied network the below date is required in calculation as follow:-

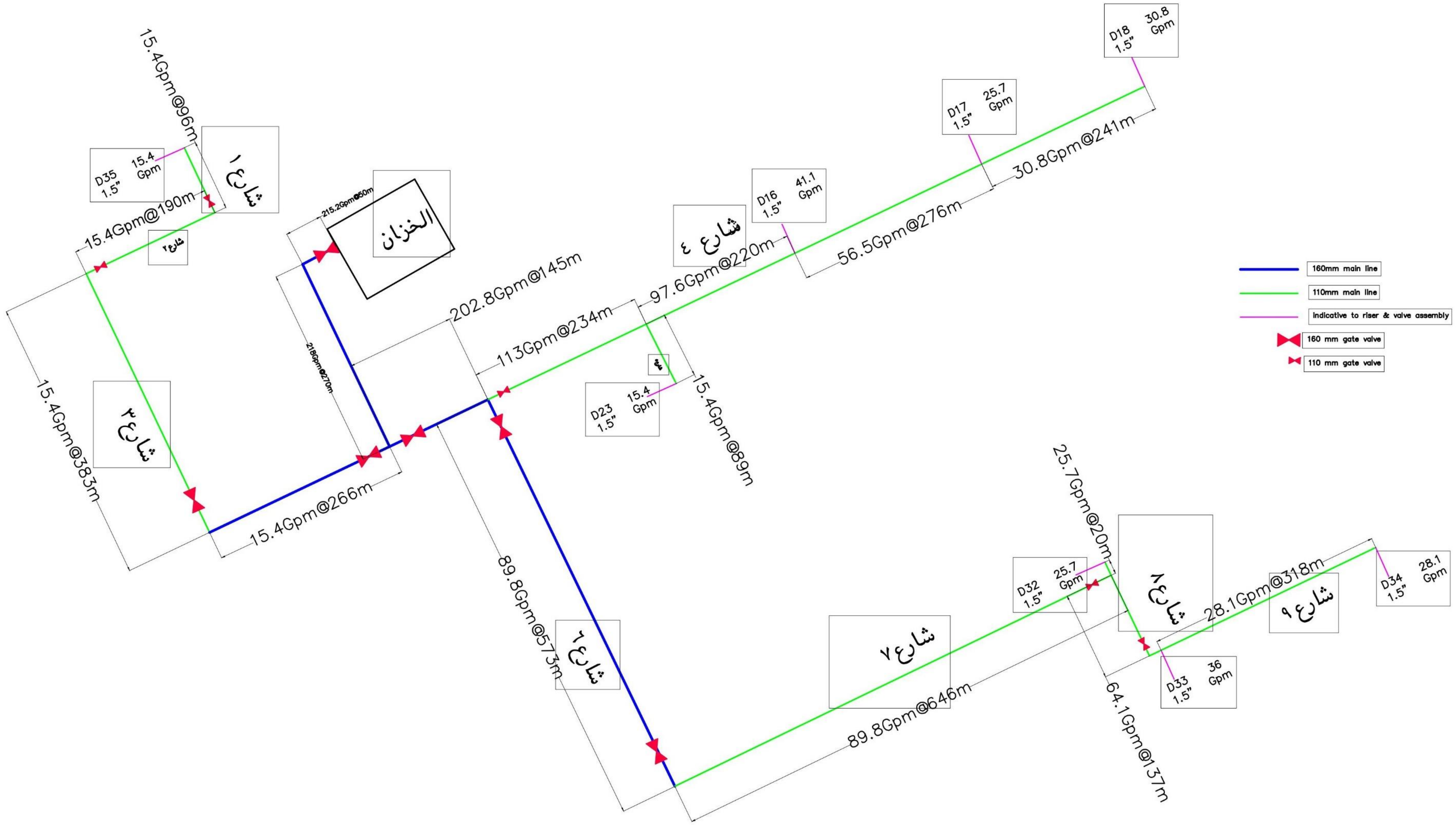
- Pvc pipe 160mm class5 inner diameter=**D**=136.2 mm
- Pvc pipe160mm class5 inner cross sectional area = **A**=0.014569482 m2
- Pvc pipe 110mm class5 inner diameter=**D** =93.6 mm
- Pvc pipe110 class5 inner cross sectional area=**A** = 0.006880842 m2
- Pvc pipe 63mm class5 inner diameter=**D**=53.6 mm
- Pvc pipe 63 class5 inner cross sectional area = **A**= 0.002256418 m2
- Pvc pipe 50mm class5 inner diameter=**D**= 42.6 mm
- Pvc pipe 50mm class5 inner cross sectional area = **A**= 0.001425309 m2
- Pvc pipe 32mm class5 inner diameter=**D**= 27.2mm

- Pvc pipe 32mm class5 inner cross sectional area = **A**= 0.000581069 m2
- Pvc pipe 20mm class5 inner diameter=**D**= 17mm
- Pvc pipe 20mm class5 inner cross sectional area = **A**= 0.00022698 m2
- Pvc pipes surface roughness = **ε**= 0.0015 mm
- Steel pipe 6 inch inner diameter= **D**= 154.08 mm
- Steel pipe 6 inch inner cross sectional area = **A**= 0.01864586 m2
- Steel pipes surface roughness = **ε**= 0.046 mm
- Ductile pipe 6 inch inner diameter= D= 159.258 mm
- Ductile pipe 6 inch cross sectional area= A=0.01992014 m2
- Ductile pipe surface roughness = **ε**=0.5mm
- Water kinematic viscosity = 1Cst = 1 mm2/s = 10^{-6} m2/s
- **K** factors for each fitting illustrated in the calculation sheet
- Static head = the difference in level between tank water level and highest valve =**HS** =7m

❹ - the studied network geometry and dimensions

- The below drawing illustrate the studied network(irrigation network only without pump room)
- Pump room components calculations illustrated directly in calculations sheets considering its actual geometry and dimensions
- Friction loss across the Disc filter in the pump room taken from the below curve (given from supplier or manufacturer)





main lines network dimensions

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❺ - main lines friction loss calculations

- Calculation based on the above mentioned network geometry and dimensions
- The above illustrated drawing dimensions may slightly differ while construction
- The pump room geometry and dimensions was not illustrated in the above drawing but taken directly within the calculations sheets
- The main line friction loss calculations made after lateral line calculations, and take the values of lateral lines total dynamic head while main calculations
- The later line calculations are illustrated by the end of this calculation note in section ⓱
- These calculation based on assumed static head **Hs = 7m (**the difference in level between water level and valve level**)**
- The calculations made for each valve in shift no.11 individually
- The calculations based on a range of flow rates including the intended flow rate of the intended valve to construct system curve keeping the same ratios of flow rates range while calculate each valve
- Pumps characteristic curves were picked up from **KSB** data sheets

❻ - valve D34 calculations

	Range of flow rates								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
D35	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D23	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D16	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
D17	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D18	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
D32	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D33	9	13.5	18	27	36	45	49.5	54	63
D34	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175

flow velocity

$$V = \frac{Q}{A}$$

Renold number

$$Re = \frac{v * D}{kinematic\ viscosity}$$

swamee-jain equation

$$f = \frac{0.25}{[log10(\frac{\varepsilon}{3.7D} + \frac{5.74}{Re^{0.9}})]^2}$$

darcy-weisbach equation (pipes)

$$Hf = f(\frac{L}{D})\frac{v^2}{2g}$$

darcy-weisbach equation (fittings)

$$Hf = K\frac{v^2}{2g}$$

D34 path elements	Q(Gpm)								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1- ductile pipe (L=1.7m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
1'-pipe entry (k=0.78)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
2- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
3- elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
4- Y strainer (k=1)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
5-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
7-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
8- steel pipe (L=1.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
9-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
10- disc filter	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
11- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
12- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
13- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
14- check valve 6" (k=1.85)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- steel pipe (L=5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- ductile pipe (L=1.3m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
17-gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
18- pvc pipe (L=50m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
19-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
20- pvc pipe (L=270m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
21- branch tee 6" (k=0.9)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
22- gate valve 6" (k=0.12)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
23- pvc pipe (L=145m & D=160mm)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
24- branch tee 6" (k=0.9)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
25- gate valve 6" (k=0.12)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
26- pvc pipe (L=573m & D=160mm)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
27- gate valve 6" (k=0.12)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
28-elbow 6" (k=0.45)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
30- pvc pipe (L=646m & D=110mm)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
31- gate valve 4" (k=0.14)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
32- branch tee 4" (k=1.02)	16.025	24.0375	32.05	48.075	64.1	80.125	88.1375	96.15	112.175
33- pvc pipe (L=137m & D=110mm)	16.025	24.0375	32.05	48.075	64.1	80.125	88.1375	96.15	112.175
34- gate valve 4" (k=0.14)	16.025	24.0375	32.05	48.075	64.1	80.125	88.1375	96.15	112.175
35-elbow 4" (k=0.51)	16.025	24.0375	32.05	48.075	64.1	80.125	88.1375	96.15	112.175
36- pvc pipe (L=318m & D=110mm)	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175
37-saddle (110mm-63mm) (k=1.7)	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175
38- pvc riser pipe(L=1.5 m & D=63mm)	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175
39- elbow 63mm (k=0.54)	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175
40- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175
41-gate valve 1.5" (k=0.15)	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175
40- solenoid valve 1.5" (k=7.1)	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175

D34 path elements	V(m/s)								
	V1	V2	V3	V4	V5	V6	V7	V8	V9
1- ductile pipe (L=1.7m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
1'-pipe entry (k=0.78)	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
2- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
3- elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
4- Y strainer (k=1)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
5-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
7-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
8- steel pipe (L=1.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
9-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
10- disc filter	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
11- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
12- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
13- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
14- check valve 6" (k=1.85)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- steel pipe (L=5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- ductile pipe (L=1.3m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
17-gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
18- pvc pipe (L=50m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
19-elbow 6" (k=0.45)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
20- pvc pipe (L=270m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
21- branch tee 6" (k=0.9)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
22- gate valve 6" (k=0.12)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
23- pvc pipe (L=145m & D=160mm)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
24- branch tee 6" (k=0.9)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
25- gate valve 6" (k=0.12)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
26- pvc pipe (L=573m & D=160mm)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
27- gate valve 6" (k=0.12)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
28-elbow 6" (k=0.45)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.205843	0.308764	0.411685	0.617528	0.82337	1.029213	1.132134	1.235056	1.440898
30- pvc pipe (L=646m & D=110mm)	0.205843	0.308764	0.411685	0.617528	0.82337	1.029213	1.132134	1.235056	1.440898
31- gate valve 4" (k=0.14)	0.205843	0.308764	0.411685	0.617528	0.82337	1.029213	1.132134	1.235056	1.440898
32- branch tee 4" (k=1.02)	0.146932	0.220398	0.293864	0.440797	0.587729	0.734661	0.808127	0.881593	1.028525
33- pvc pipe (L=137m & D=110mm)	0.146932	0.220398	0.293864	0.440797	0.587729	0.734661	0.808127	0.881593	1.028525
34- gate valve 4" (k=0.14)	0.146932	0.220398	0.293864	0.440797	0.587729	0.734661	0.808127	0.881593	1.028525
35-elbow 4" (k=0.51)	0.146932	0.220398	0.293864	0.440797	0.587729	0.734661	0.808127	0.881593	1.028525
36- pvc pipe (L=318m & D=110mm)	0.064412	0.096618	0.128824	0.193235	0.257647	0.322059	0.354265	0.386471	0.450882
37-saddle (110mm-63mm) (k=1.7)	0.196421	0.294631	0.392841	0.589262	0.785683	0.982104	1.080314	1.178524	1.374945
38- pvc riser pipe(L=1.5 m & D=63mm)	0.196421	0.294631	0.392841	0.589262	0.785683	0.982104	1.080314	1.178524	1.374945
39- elbow 63mm (k=0.54)	0.196421	0.294631	0.392841	0.589262	0.785683	0.982104	1.080314	1.178524	1.374945
40- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.488157	0.732235	0.976313	1.46447	1.952627	2.440784	2.684862	2.92894	3.417097
41-gate valve 1.5" (k=0.15)	0.488157	0.732235	0.976313	1.46447	1.952627	2.440784	2.684862	2.92894	3.417097
40- solenoid valve 1.5" (k=7.1)	0.488157	0.732235	0.976313	1.46447	1.952627	2.440784	2.684862	2.92894	3.417097

D34 path elements	Re								
	Re1	Re2	Re3	Re4	Re5	Re6	Re7	Re8	Re9
1- ductile pipe (L=1.7m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
19-elbow 6" (k=0.45)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
20- pvc pipe (L=270m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	33827.55784	50741.34	67655.12	101482.7	135310.2	169137.8	186051.6	202965.3	236792.9
24- branch tee 6" (k=0.9)									
25- gate valve 6" (k=0.12)									
26- pvc pipe (L=573m & D=160mm)	14978.8693	22468.3	29957.74	44936.61	59915.48	74894.35	82383.78	89873.22	104852.1
27- gate valve 6" (k=0.12)									
28-elbow 6" (k=0.45)									
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
30- pvc pipe (L=646m & D=110mm)	19266.86862	28900.3	38533.74	57800.61	77067.47	96334.34	105967.8	115601.2	134868.1
31- gate valve 4" (k=0.14)									
32- branch tee 4" (k=1.02)									
33- pvc pipe (L=137m & D=110mm)	13752.85388	20629.28	27505.71	41258.56	55011.42	68764.27	75640.7	82517.12	96269.98
34- gate valve 4" (k=0.14)									
35-elbow 4" (k=0.51)									
36- pvc pipe (L=318m & D=110mm)	6028.942185	9043.413	12057.88	18086.83	24115.77	30144.71	33159.18	36173.65	42202.6
37-saddle (110mm-63mm) (k=1.7)									
38- pvc riser pipe(L=1.5 m & D=63mm)	10528.15064	15792.23	21056.3	31584.45	42112.6	52640.75	57904.83	63168.9	73697.05
39- elbow 63mm (k=0.54)									
40- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
41-gate valve 1.5" (k=0.15)									
40- solenoid valve 1.5" (k=7.1)									

D34 path elements	f								
	f1	f2	f3	f4	f5	f6	f7	f8	f9
1- ductile pipe (L=1.7m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
19-elbow 6" (k=0.45)									
20- pvc pipe (L=270m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	0.022753	0.020738	0.01947	0.017876	0.016866	0.016144	0.01585	0.01559	0.015146
24- branch tee 6" (k=0.9)									
25- gate valve 6" (k=0.12)									
26- pvc pipe (L=573m & D=160mm)	0.02782	0.025105	0.023415	0.021312	0.01999	0.01905	0.018669	0.018331	0.017757
27- gate valve 6" (k=0.12)									
28-elbow 6" (k=0.45)									
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
30- pvc pipe (L=646m & D=110mm)	0.026098	0.023632	0.022092	0.020171	0.018961	0.018099	0.01775	0.01744	0.016913
31- gate valve 4" (k=0.14)									
32- branch tee 4" (k=1.02)									
33- pvc pipe (L=137m & D=110mm)	0.028458	0.025655	0.023913	0.021749	0.020391	0.019426	0.019036	0.01869	0.018101
34- gate valve 4" (k=0.14)									
35-elbow 4" (k=0.51)									
36- pvc pipe (L=318m & D=110mm)	0.035803	0.031874	0.029468	0.026517	0.024687	0.023396	0.022876	0.022417	0.021637
37-saddle (110mm-63mm) (k=1.7)									
38- pvc riser pipe(L=1.5 m & D=63mm)	0.030589	0.027479	0.025556	0.023178	0.021692	0.020641	0.020216	0.01984	0.019202
39- elbow 63mm (k=0.54)									
40- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
41-gate valve 1.5" (k=0.15)									
40- solenoid valve 1.5" (k=7.1)									

D34 path elements	Hf (m H₂o)								
	Hf1	Hf2	Hf3	Hf4	Hf5	Hf6	Hf7	Hf8	Hf9
1- ductile pipe (L=1.7m & D=6")	0.000501541	0.001084	0.001884	0.004134	0.007249	0.011228	0.013541	0.016069	0.021774
1'-pipe entry (k=0.78)	0.001186663	0.00267	0.004747	0.01068	0.018987	0.029667	0.035897	0.04272	0.058146
2- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
3- elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
4- Y strainer (k=1)	0.001736388	0.003907	0.006946	0.015627	0.027782	0.04341	0.052526	0.06251	0.085083
5-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
7-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
8- steel pipe (L=1.5m & D=6")	0.000414916	0.000859	0.001447	0.003039	0.005172	0.007836	0.009366	0.011025	0.014736
9-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
10- disc filter								0.05555	0.410125
11- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
12- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
13- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
14- check valve 6" (k=1.85)	0.003212317	0.007228	0.012849	0.028911	0.051397	0.080308	0.097173	0.115643	0.157404
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- steel pipe (L=5m & D=6")	0.001383054	0.002864	0.004824	0.010131	0.017241	0.026121	0.031218	0.036751	0.049119
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- ductile pipe (L=1.3m & D=6")	0.000383531	0.000829	0.001441	0.003161	0.005543	0.008586	0.010355	0.012288	0.016651
17-gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
18- pvc pipe (L=50m & D=160mm)	0.024036685	0.049265	0.082195	0.169715	0.28457	0.425487	0.505426	0.591559	0.782091
19-elbow 6" (k=0.45)	0.001279782	0.00288	0.005119	0.011518	0.020477	0.031995	0.038713	0.046072	0.062709
20- pvc pipe (L=270m & D=160mm)	0.1297981	0.266031	0.44385	0.916463	1.536678	2.297629	2.729299	3.194417	4.22329
21- branch tee 6" (k=0.9)	0.002211018	0.004975	0.008844	0.019899	0.035376	0.055275	0.066883	0.079597	0.10834
22- gate valve 6" (k=0.12)	0.000294802	0.000663	0.001179	0.002653	0.004717	0.00737	0.008918	0.010613	0.014445
23- pvc pipe (L=145m & D=160mm)	0.059508331	0.122036	0.203683	0.420778	0.705783	1.055557	1.25401	1.467862	1.940984
24- branch tee 6" (k=0.9)	0.00043352	0.000975	0.001734	0.003902	0.006936	0.010838	0.013114	0.015607	0.021242
25- gate valve 6" (k=0.12)	5.78027E-05	0.00013	0.000231	0.00052	0.000925	0.001445	0.001749	0.002081	0.002832
26- pvc pipe (L=573m & D=160mm)	0.056376566	0.114469	0.189802	0.388697	0.648157	0.965105	1.144428	1.337345	1.763191
27- gate valve 6" (k=0.12)	5.78027E-05	0.00013	0.000231	0.00052	0.000925	0.001445	0.001749	0.002081	0.002832
28-elbow 6" (k=0.45)	0.00021676	0.000488	0.000867	0.001951	0.003468	0.005419	0.006557	0.007803	0.010621
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.002548318	0.005734	0.010193	0.022935	0.040773	0.063708	0.077087	0.091739	0.124868
30- pvc pipe (L=646m & D=110mm)	0.388979914	0.79252	1.317113	2.70577	4.521677	6.744042	8.002863	9.358054	12.35239
31- gate valve 4" (k=0.14)	0.000302343	0.00068	0.001209	0.002721	0.004837	0.007559	0.009146	0.010884	0.014815
32- branch tee 4" (k=1.02)	0.001122368	0.002525	0.004489	0.010101	0.017958	0.028059	0.033952	0.040405	0.054996
33- pvc pipe (L=137m & D=110mm)	0.045834288	0.092969	0.154056	0.315253	0.525454	0.782177	0.927413	1.083652	1.428524
34- gate valve 4" (k=0.14)	0.00015405	0.000347	0.000616	0.001386	0.002465	0.003851	0.00466	0.005546	0.007548
35-elbow 4" (k=0.51)	0.000561184	0.001263	0.002245	0.005051	0.008979	0.01403	0.016976	0.020203	0.027498
36- pvc pipe (L=318m & D=110mm)	0.025721713	0.051523	0.084683	0.171454	0.283768	0.420211	0.497155	0.579775	0.761689
37-saddle (110mm-63mm) (k=1.7)	0.003342909	0.007522	0.013372	0.030086	0.053487	0.083573	0.101123	0.120345	0.163803
38- pvc riser pipe(L=1.5 m & D=63mm)	0.001683321	0.003402	0.005625	0.011479	0.0191	0.028396	0.033653	0.039305	0.051778
39- elbow 63mm (k=0.54)	0.001061865	0.002389	0.004247	0.009557	0.01699	0.026547	0.032121	0.038227	0.052031
40- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.022347933	0.050283	0.089392	0.201131	0.357567	0.558698	0.676025	0.804526	1.095049
41-gate valve 1.5" (k=0.15)	0.001821842	0.004099	0.007287	0.016397	0.029149	0.045546	0.055111	0.065586	0.08927
40- solenoid valve 1.5" (k=7.1)	0.086233873	0.194026	0.344935	0.776105	1.379742	2.155847	2.608575	3.104419	4.22546
total									
	0.870395458	1.803294	3.033555	6.341575	10.73179	16.16502	19.26375	22.66889	30.46551

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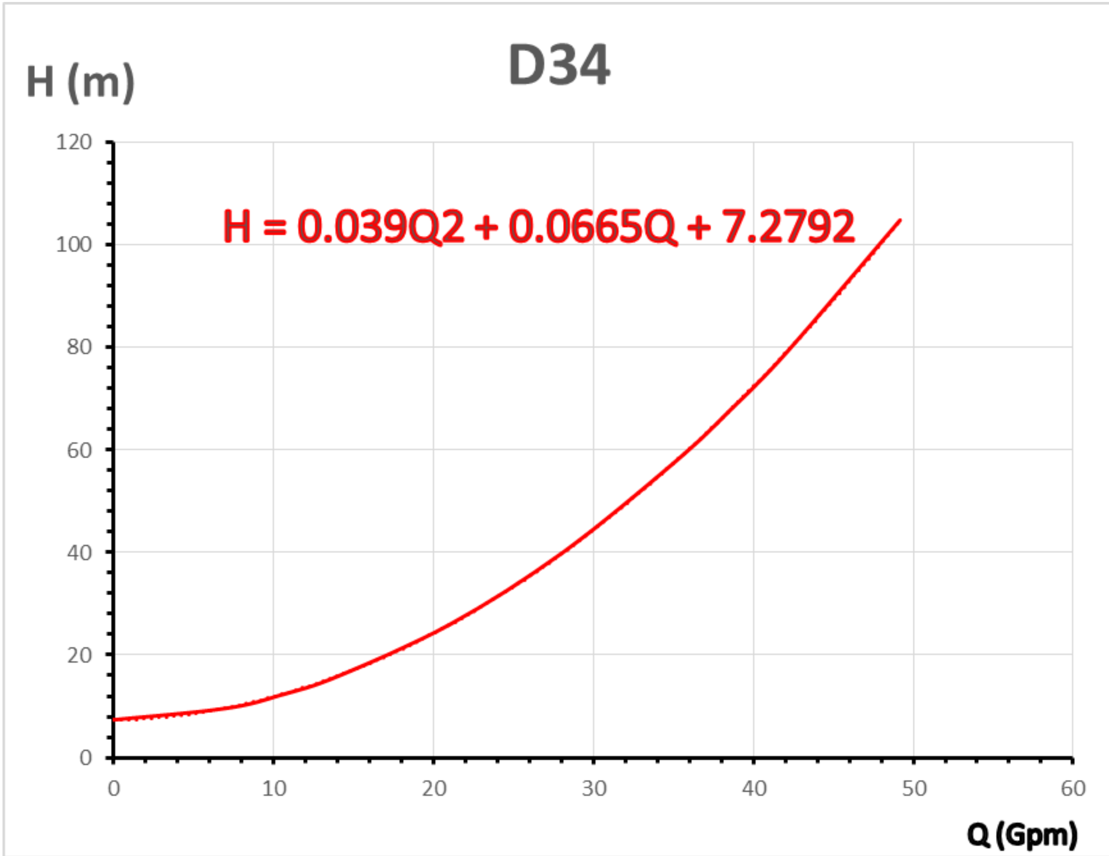
Q(G pm)	Hf	Hs	lateral line	TDH (m)
0	0	7	0	7.35
7.025	0.870395	7	1.274645	9.602293
10.5375	1.803294	7	2.867952	12.25481
14.05	3.033555	7	5.098581	15.88874
21.075	6.341575	7	11.47181	26.05405
28.1	10.73179	7	20.39432	40.03242
35.125	16.16502	7	31.86613	57.78271
38.6375	19.26375	7	38.55802	68.06286
42.15	22.66889	7	45.88723	79.33393
49.175	30.46551	7	62.45762	104.9193



Q(G pm)	TDH (m)
0	7.35
7.543326	10
17.22785	20
23.29928	30
28.12539	40
32.25532	50
35.92436	60
39.25919	70
42.33728	80
45.21014	90
47.91406	100
50.47573	110

- **D34** is full open and its friction drop calculated directly = Δp= **Hf=**$\boldsymbol{K}\ \frac{v^2}{2g}$ where K is friction factor for globe valve full open =7.1
- **D34** require no calculations of Kv

❼ - valve D33 calculations

	Range of flow rates								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
D35	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D23	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D16	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
D17	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D18	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
D32	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D33	9	13.5	18	27	36	45	49.5	54	63
D34	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175

flow velocity

$$V = \frac{Q}{A}$$

Renold number

$$Re = \frac{v * D}{kinematic\ viscosity}$$

swamee-jain equation

$$f = \frac{0.25}{[log10(\frac{\varepsilon}{3.7D} + \frac{5.74}{Re^{0.9}})]^2}$$

darcy-weisbach equation (pipes)

$$Hf = f(\frac{L}{D})\frac{v^2}{2g}$$

darcy-weisbach equation (fittings)

$$Hf = K\frac{v^2}{2g}$$

D33 path elements	Q(Gpm)								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1- ductile pipe (L=1.7m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
1'-pipe entry (k=0.78)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
2- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
3- elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
4- Y strainer (k=1)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
5-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
7-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
8- steel pipe (L=1.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
9-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
10- disc filter	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
11- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
12- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
13- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
14- check valve 6" (k=1.85)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- steel pipe (L=5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- ductile pipe (L=1.3m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
17-gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
18- pvc pipe (L=50m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
19-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
20- pvc pipe (L=270m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
21- branch tee 6" (k=0.9)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
22- gate valve 6" (k=0.12)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
23- pvc pipe (L=145m & D=160mm)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
24- branch tee 6" (k=0.9)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
25- gate valve 6" (k=0.12)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
26- pvc pipe (L=573m & D=160mm)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
27- gate valve 6" (k=0.12)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
28-elbow 6" (k=0.45)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
30- pvc pipe (L=646m & D=110mm)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
31- gate valve 4" (k=0.14)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15
32- branch tee 4" (k=1.02)	16.025	24.0375	32.05	48.075	64.1	80.125	88.1375	96.15	112.175
33- pvc pipe (L=137m & D=110mm)	16.025	24.0375	32.05	48.075	64.1	80.125	88.1375	96.15	112.175
34- gate valve 4" (k=0.14)	16.025	24.0375	32.05	48.075	64.1	80.125	88.1375	96.15	112.175
35-elbow 4" (k=0.51)	16.025	24.0375	32.05	48.075	64.1	80.125	88.1375	96.15	112.175
36-saddle (110mm-63mm) (k=1.7)	9	13.5	18	27	36	45	49.5	54	63
37- pvc riser pipe(L=1.5 m & D=63mm)	9	13.5	18	27	36	45	49.5	54	63
38- elbow 63mm (k=0.54)	9	13.5	18	27	36	45	49.5	54	63
39- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	9	13.5	18	27	36	45	49.5	54	63
40-gate valve 1.5" (k=0.15)	9	13.5	18	27	36	45	49.5	54	63
41- solenoid valve 1.5" (kv=22)	9	13.5	18	27	36	45	49.5	54	63

D33 path elements	V(m/s)								
	V1	V2	V3	V4	V5	V6	V7	V8	V9
1- ductile pipe (L=1.7m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
1'-pipe entry (k=0.78)	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
2- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
3- elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
4- Y strainer (k=1)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
5-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
7-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
8- steel pipe (L=1.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
9-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
10- disc filter	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
11- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
12- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
13- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
14- check valve 6" (k=1.85)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- steel pipe (L=5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- ductile pipe (L=1.3m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
17-gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
18- pvc pipe (L=50m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
19-elbow 6" (k=0.45)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
20- pvc pipe (L=270m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
21- branch tee 6" (k=0.9)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
22- gate valve 6" (k=0.12)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
23- pvc pipe (L=145m & D=160mm)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
24- branch tee 6" (k=0.9)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
25- gate valve 6" (k=0.12)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
26- pvc pipe (L=573m & D=160mm)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
27- gate valve 6" (k=0.12)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
28-elbow 6" (k=0.45)	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.205843	0.308764	0.411685	0.617528	0.82337	1.029213	1.132134	1.235056	1.440898
30- pvc pipe (L=646m & D=110mm)	0.205843	0.308764	0.411685	0.617528	0.82337	1.029213	1.132134	1.235056	1.440898
31- gate valve 4" (k=0.14)	0.205843	0.308764	0.411685	0.617528	0.82337	1.029213	1.132134	1.235056	1.440898
32- branch tee 4" (k=1.02)	0.146932	0.220398	0.293864	0.440797	0.587729	0.734661	0.808127	0.881593	1.028525
33- pvc pipe (L=137m & D=110mm)	0.146932	0.220398	0.293864	0.440797	0.587729	0.734661	0.808127	0.881593	1.028525
34- gate valve 4" (k=0.14)	0.146932	0.220398	0.293864	0.440797	0.587729	0.734661	0.808127	0.881593	1.028525
35-elbow 4" (k=0.51)	0.146932	0.220398	0.293864	0.440797	0.587729	0.734661	0.808127	0.881593	1.028525
36-saddle (110mm-63mm) (k=1.7)	0.251642	0.377463	0.503284	0.754927	1.006569	1.258211	1.384032	1.509853	1.761495
37- pvc riser pipe(L=1.5 m & D=63mm)	0.251642	0.377463	0.503284	0.754927	1.006569	1.258211	1.384032	1.509853	1.761495
38- elbow 63mm (k=0.54)	0.251642	0.377463	0.503284	0.754927	1.006569	1.258211	1.384032	1.509853	1.761495
39- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.625397	0.938095	1.250793	1.87619	2.501586	3.126983	3.439681	3.752379	4.377776
40-gate valve 1.5" (k=0.15)	0.625397	0.938095	1.250793	1.87619	2.501586	3.126983	3.439681	3.752379	4.377776
41- solenoid valve 1.5" (kv=22)	0.625397	0.938095	1.250793	1.87619	2.501586	3.126983	3.439681	3.752379	4.377776

D33 path elements	Re								
	Re1	Re2	Re3	Re4	Re5	Re6	Re7	Re8	Re9
1- ductile pipe (L=1.7m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
19-elbow 6" (k=0.45)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
20- pvc pipe (L=270m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	33827.55784	50741.34	67655.12	101482.7	135310.2	169137.8	186051.6	202965.3	236792.9
24- branch tee 6" (k=0.9)									
25- gate valve 6" (k=0.12)									
26- pvc pipe (L=573m & D=160mm)	14978.8693	22468.3	29957.74	44936.61	59915.48	74894.35	82383.78	89873.22	104852.1
27- gate valve 6" (k=0.12)									
28-elbow 6" (k=0.45)									
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
30- pvc pipe (L=646m & D=110mm)	19266.86862	28900.3	38533.74	57800.61	77067.47	96334.34	105967.8	115601.2	134868.1
31- gate valve 4" (k=0.14)									
32- branch tee 4" (k=1.02)									
33- pvc pipe (L=137m & D=110mm)	13752.85388	20629.28	27505.71	41258.56	55011.42	68764.27	75640.7	82517.12	96269.98
34- gate valve 4" (k=0.14)									
35-elbow 4" (k=0.51)									
36-saddle (110mm-63mm) (k=1.7)									
37- pvc riser pipe(L=1.5 m & D=63mm)	13488.02217	20232.03	26976.04	40464.07	53952.09	67440.11	74184.12	80928.13	94416.16
38- elbow 63mm (k=0.54)									
39- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
40-gate valve 1.5" (k=0.15)									
41- solenoid valve 1.5" (kv=22)									

D33 path elements	f								
	f1	f2	f3	f4	f5	f6	f7	f8	f9
1- ductile pipe (L=1.7m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
19-elbow 6" (k=0.45)									
20- pvc pipe (L=270m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	0.022753	0.020738	0.01947	0.017876	0.016866	0.016144	0.01585	0.01559	0.015146
24- branch tee 6" (k=0.9)									
25- gate valve 6" (k=0.12)									
26- pvc pipe (L=573m & D=160mm)	0.02782	0.025105	0.023415	0.021312	0.01999	0.01905	0.018669	0.018331	0.017757
27- gate valve 6" (k=0.12)									
28-elbow 6" (k=0.45)									
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
30- pvc pipe (L=646m & D=110mm)	0.026098	0.023632	0.022092	0.020171	0.018961	0.018099	0.01775	0.01744	0.016913
31- gate valve 4" (k=0.14)									
32- branch tee 4" (k=1.02)									
33- pvc pipe (L=137m & D=110mm)	0.028458	0.025655	0.023913	0.021749	0.020391	0.019426	0.019036	0.01869	0.018101
34- gate valve 4" (k=0.14)									
35-elbow 4" (k=0.51)									
36-saddle (110mm-63mm) (k=1.7)									
37- pvc riser pipe(L=1.5 m & D=63mm)	0.028629	0.02581	0.02406	0.021889	0.02053	0.019565	0.019175	0.01883	0.018244
38- elbow 63mm (k=0.54)									
39- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
40-gate valve 1.5" (k=0.15)									
41- solenoid valve 1.5" (kv=22)									

D33 path elements	Hf (m H_2o)								
	Hf1	Hf2	Hf3	Hf4	Hf5	Hf6	Hf7	Hf8	Hf9
1- ductile pipe (L=1.7m & D=6")	0.000501541	0.001084	0.001884	0.004134	0.007249	0.011228	0.013541	0.016069	0.021774
1'-pipe entry (k=0.78)	0.001186663	0.00267	0.004747	0.01068	0.018987	0.029667	0.035897	0.04272	0.058146
2- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
3- elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
4- Y strainer (k=1)	0.001736388	0.003907	0.006946	0.015627	0.027782	0.04341	0.052526	0.06251	0.085083
5-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
7-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
8- steel pipe (L=1.5m & D=6")	0.000414916	0.000859	0.001447	0.003039	0.005172	0.007836	0.009366	0.011025	0.014736
9-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
10- disc filter								0.05555	0.410125
11- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
12- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
13- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
14- check valve 6" (k=1.85)	0.003212317	0.007228	0.012849	0.028911	0.051397	0.080308	0.097173	0.115643	0.157404
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- steel pipe (L=5m & D=6")	0.001383054	0.002864	0.004824	0.010131	0.017241	0.026121	0.031218	0.036751	0.049119
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- ductile pipe (L=1.3m & D=6")	0.000383531	0.000829	0.001441	0.003161	0.005543	0.008586	0.010355	0.01288	0.016651
17-gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
18- pvc pipe (L=50m & D=160mm)	0.024036685	0.049265	0.082195	0.169715	0.28457	0.425487	0.505426	0.591559	0.782091
19-elbow 6" (k=0.45)	0.001279782	0.00288	0.005119	0.011518	0.020477	0.031995	0.038713	0.046072	0.062709
20- pvc pipe (L=270m & D=160mm)	0.1297981	0.266031	0.44385	0.916463	1.536678	2.297629	2.729299	3.194417	4.22329
21- branch tee 6" (k=0.9)	0.002211018	0.004975	0.008844	0.019899	0.035376	0.055275	0.066883	0.079597	0.10834
22- gate valve 6" (k=0.12)	0.000294802	0.000663	0.001179	0.002653	0.004717	0.00737	0.008918	0.010613	0.014445
23- pvc pipe (L=145m & D=160mm)	0.059508331	0.122036	0.203683	0.420778	0.705783	1.055557	1.25401	1.467862	1.940984
24- branch tee 6" (k=0.9)	0.00043352	0.000975	0.001734	0.003902	0.006936	0.010838	0.013114	0.015607	0.021242
25- gate valve 6" (k=0.12)	5.78027E-05	0.00013	0.000231	0.00052	0.000925	0.001445	0.001749	0.002081	0.002832
26- pvc pipe (L=573m & D=160mm)	0.056376566	0.114469	0.189802	0.388697	0.648157	0.965105	1.144428	1.337345	1.763191
27- gate valve 6" (k=0.12)	5.78027E-05	0.00013	0.000231	0.00052	0.000925	0.001445	0.001749	0.002081	0.002832
28-elbow 6" (k=0.45)	0.00021676	0.000488	0.000867	0.001951	0.003468	0.005419	0.006557	0.007803	0.010621
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.002548318	0.005734	0.010193	0.022935	0.040773	0.063708	0.077087	0.091739	0.124868
30- pvc pipe (L=646m & D=110mm)	0.388979914	0.79252	1.317113	2.70577	4.521677	6.744042	8.002863	9.358054	12.35239
31- gate valve 4" (k=0.14)	0.000302343	0.00068	0.001209	0.002721	0.004837	0.007559	0.009146	0.010884	0.014815
32- branch tee 4" (k=1.02)	0.001122368	0.002525	0.004489	0.010101	0.017958	0.028059	0.033952	0.040405	0.054996
33- pvc pipe (L=137m & D=110mm)	0.045834288	0.092969	0.154056	0.315253	0.525454	0.782177	0.927413	1.083652	1.428524
34- gate valve 4" (k=0.14)	0.00015405	0.000347	0.000616	0.001386	0.002465	0.003851	0.00466	0.005546	0.007548
35-elbow 4" (k=0.51)	0.000561184	0.001263	0.002245	0.005051	0.008979	0.01403	0.016976	0.020203	0.027498
36-saddle (110mm-63mm) (k=1.7)	0.005486772	0.012345	0.021947	0.049381	0.087788	0.137169	0.165975	0.197524	0.268852
37- pvc riser pipe(L=1.5 m & D=63mm)	0.002585825	0.005245	0.008693	0.017794	0.029668	0.044179	0.052392	0.061229	0.080744
38- elbow 63mm (k=0.54)	0.001742857	0.003921	0.006971	0.015686	0.027886	0.043571	0.052721	0.062743	0.0854
39- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.036680034	0.08253	0.14672	0.33012	0.586881	0.917001	1.109571	1.320481	1.797322
40-gate valve 1.5" (k=0.15)	0.00299022	0.006728	0.011961	0.026912	0.047844	0.074756	0.090454	0.107648	0.146521
41- solenoid valve 1.5" (kv=22)	0.084983781	0.191214	0.339935	0.764854	1.35974	2.124594	2.570759	3.059416	4.164205
total									
	0.86265149	1.792033	3.020241	6.330113	10.7318	16.18747	19.30186	22.72575	30.56947

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Step1- **Δp** of (D33@36GPM)=**TDH**(D34@28.1GPM)-**TDH**(D33)=1.35974 m

$$\Delta p = \frac{Q^2}{Kv^2}$$

Note:- TDH(D33) is the total dynamic head of **D33** path before calculating **Hf** of **D33** solenoid valve, then it recalculated and corrected again after Calculating **Kv**

Step2- $Kv = Q(m3/h)\sqrt{\frac{1}{\Delta p(bar)}}$

Kv = 22

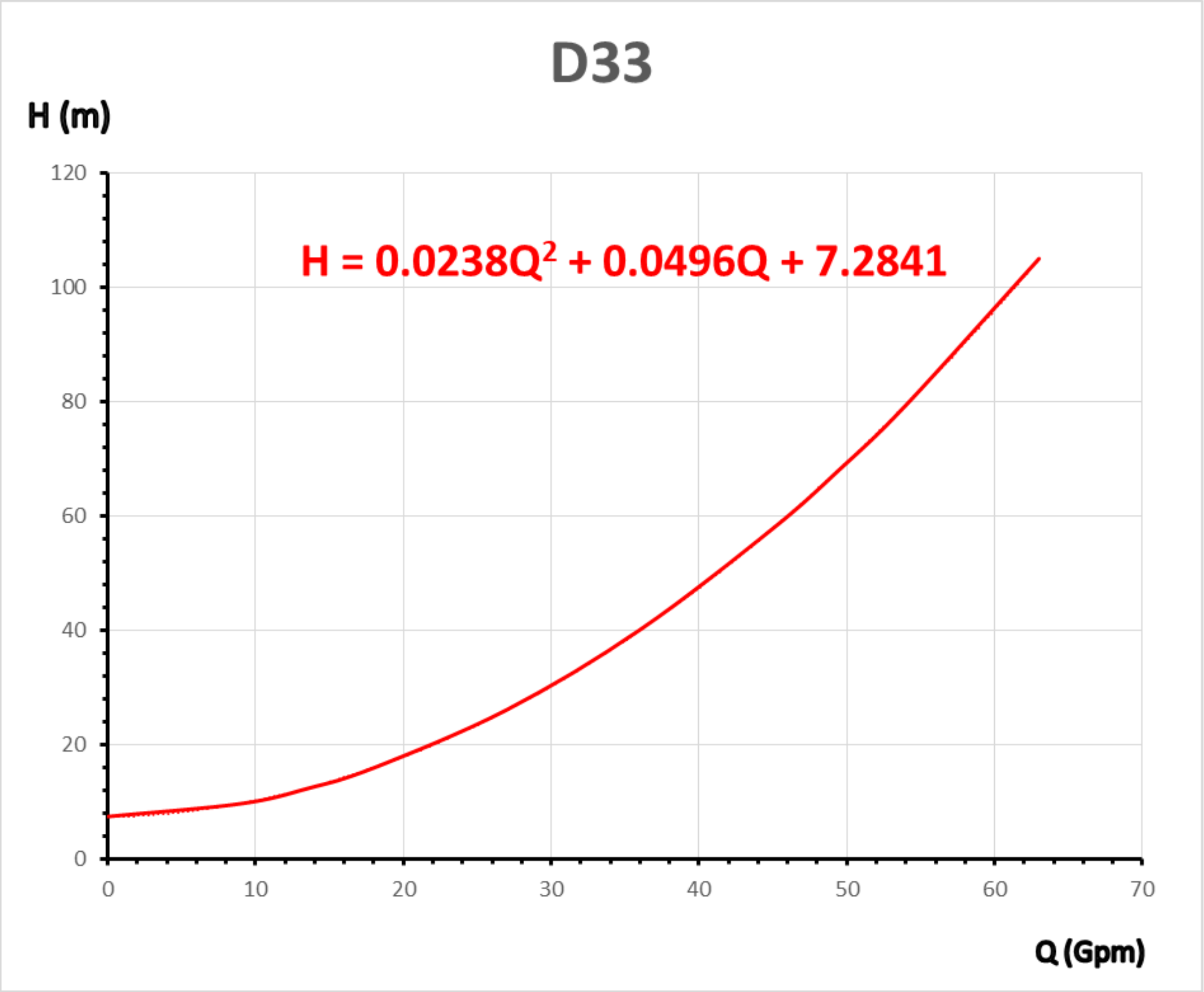
step3- $\Delta p = \frac{Q^2}{Kv^2}$

solenoid valve calculations			
Q		Δp	
Gpm	m3/h	m	bar
0	0	0	0
9	2.044122	0.084984	0.008334
13.5	3.066184	0.191214	0.018752
18	4.088245	0.339935	0.033336
27	6.132367	0.764854	0.075007
36	8.176489	**1.35974**	0.133345
45	10.22061	2.124594	0.208352
49.5	11.24267	2.570759	0.252105
54	12.26473	3.059416	0.300026
63	14.30886	4.164205	0.408369

Step4

Q(G pm)	Hf	Hs	lateral line	TDH
0	0	7	0	7.35
9	0.862651	7	1.274645	9.594162
13.5	1.792033	7	2.867952	12.24298
18	3.020241	7	5.098581	15.87476
27	6.330113	7	11.47181	26.04202
36	10.7318	7	20.39432	40.03243
45	16.18747	7	31.86613	57.80629
49.5	19.30186	7	38.55802	68.10287
54	22.72575	7	45.88723	79.39363
63	30.56947	7	62.45762	105.0284

Step5



Step6

Q(G pm)	TDH
0	7.35
9.691074	10
22.09599	20
29.86972	30
36.04846	40
41.33571	50
46.03281	60
50.302	70
54.24248	80
57.92021	90
61.38163	100
64.66095	110

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❽ - valve D32 calculations

	Range of flow rates								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
D35	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D23	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D16	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
D17	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D18	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
D32	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D33	9	13.5	18	27	36	45	49.5	54	63
D34	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175

flow velocity

$$V = \frac{Q}{A}$$

Renold number

$$Re = \frac{v * D}{kinematic\ viscosity}$$

swamee-jain equation

$$f = \frac{0.25}{[log10(\frac{\varepsilon}{3.7D} + \frac{5.74}{Re^{0.9}})]^2}$$

darcy-weisbach equation (pipes)

$$Hf = f(\frac{L}{D})\frac{v^2}{2g}$$

darcy-weisbach equation (fittings)

$$Hf = K\frac{v^2}{2g}$$

D32 path elements	Q(Gpm)									V(m/s)								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	V1	V2	V3	V4	V5	V6	V7	V8	V9
1- ductile pipe (L=1.7m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
1'-pipe entry (k=0.78)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
2- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
3- elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
4- Y strainer (k=1)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
5-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
7-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
8- steel pipe (L=1.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
9-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
10- disc filter	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
11- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
12- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
13- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
14- check valve 6" (k=1.85)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- steel pipe (L=5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- ductile pipe (L=1.3m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
17-gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
18- pvc pipe (L=50m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
19-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
20- pvc pipe (L=270m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
21- branch tee 6" (k=0.9)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
22- gate valve 6" (k=0.12)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
23- pvc pipe (L=145m & D=160mm)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
24- branch tee 6" (k=0.9)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
25- gate valve 6" (k=0.12)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
26- pvc pipe (L=573m & D=160mm)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
27- gate valve 6" (k=0.12)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
28-elbow 6" (k=0.45)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15	0.097215	0.145822	0.19443	0.291645	0.38886	0.486074	0.534682	0.583289	0.680504
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15	0.205843	0.308764	0.411685	0.617528	0.82337	1.029213	1.132134	1.235056	1.440898
30- pvc pipe (L=646m & D=110mm)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15	0.205843	0.308764	0.411685	0.617528	0.82337	1.029213	1.132134	1.235056	1.440898
31- gate valve 4" (k=0.14)	22.45	33.675	44.9	67.35	89.8	112.25	123.475	134.7	157.15	0.205843	0.308764	0.411685	0.617528	0.82337	1.029213	1.132134	1.235056	1.440898
32- branch tee 4" (k=1.02)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975	0.05891	0.088366	0.117821	0.176731	0.235642	0.294552	0.324007	0.353462	0.412373
33-pvc pipe (L=20m&D=4")	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975	0.05891	0.088366	0.117821	0.176731	0.235642	0.294552	0.324007	0.353462	0.412373
34-saddle (110mm-63mm) (k=1.7)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975	0.179645	0.269467	0.359289	0.538934	0.718578	0.898223	0.988045	1.077867	1.257512
35- pvc riser pipe(L=1.5 m & D=63mm)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975	0.179645	0.269467	0.359289	0.538934	0.718578	0.898223	0.988045	1.077867	1.257512
36- elbow 63mm (k=0.54)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975	0.179645	0.269467	0.359289	0.538934	0.718578	0.898223	0.988045	1.077867	1.257512
37- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975	0.446464	0.669695	0.892927	1.339391	1.785854	2.232318	2.45555	2.678782	3.125245
39-gate valve 1.5" (k=0.15)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975	0.446464	0.669695	0.892927	1.339391	1.785854	2.232318	2.45555	2.678782	3.125245
39- solenoid valve 1.5" (kv=12.3)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975	0.446464	0.669695	0.892927	1.339391	1.785854	2.232318	2.45555	2.678782	3.125245

D32 path elements	Re									f								
	Re1	Re2	Re3	Re4	Re5	Re6	Re7	Re8	Re9	f1	f2	f3	f4	f5	f6	f7	f8	f9
1- ductile pipe (L=1.7m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
1'-pipe entry (k=0.78)																		
2- gate valve 6" (k=0.12)																		
3- elbow 6" (k=0.45)																		
4- Y strainer (k=1)																		
5-elbow 6" (k=0.45)																		
7-elbow 6" (k=0.45)																		
8- steel pipe (L=1.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
9-elbow 6" (k=0.45)																		
10- disc filter																		
11- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
12- gate valve 6" (k=0.12)																		
13- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
14- check valve 6" (k=1.85)																		
15-elbow 6" (k=0.45)																		
16- steel pipe (L=5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
15-elbow 6" (k=0.45)																		
16- ductile pipe (L=1.3m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
17-gate valve 6" (k=0.12)																		
18- pvc pipe (L=50m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
19-elbow 6" (k=0.45)																		
20- pvc pipe (L=270m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
21- branch tee 6" (k=0.9)																		
22- gate valve 6" (k=0.12)																		
23- pvc pipe (L=145m & D=160mm)	33827.55784	50741.34	67655.12	101482.7	135310.2	169137.8	186051.6	202965.3	236792.9	0.022753	0.020738	0.01947	0.017876	0.016866	0.016144	0.01585	0.01559	0.015146
24- branch tee 6" (k=0.9)																		
25- gate valve 6" (k=0.12)																		
26- pvc pipe (L=573m & D=160mm)	14978.8693	22468.3	29957.74	44936.61	59915.48	74894.35	82383.78	89873.22	104852.1	0.02782	0.025105	0.023415	0.021312	0.01999	0.01905	0.018669	0.018331	0.017757
27- gate valve 6" (k=0.12)																		
28-elbow 6" (k=0.45)																		
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)																		
30- pvc pipe (L=646m & D=110mm)	19266.86862	28900.3	38533.74	57800.61	77067.47	96334.34	105967.8	115601.2	134868.1	0.026098	0.023632	0.022092	0.020171	0.018961	0.018099	0.01775	0.01744	0.016913
31- gate valve 4" (k=0.14)																		
32- branch tee 4" (k=1.02)																		
33-pvc pipe (L=20m&D=4")	5514.014738	8271.022	11028.03	16542.04	22056.06	27570.07	30327.08	33084.09	38598.1	0.036766	0.032681	0.030185	0.027127	0.025233	0.0239	0.023363	0.022888	0.022084
34-saddle (110mm-63mm) (k=1.7)																		
35- pvc riser pipe(L=1.5 m & D=63mm)	9628.949157	14443.42	19257.9	28886.85	38515.8	48144.75	52959.22	57773.69	67402.64	0.031346	0.028121	0.02613	0.023671	0.022137	0.021051	0.020613	0.020226	0.019568
36- elbow 63mm (k=0.54)																		
37- sudden contraction (D1=63mm & d2=40mm) (k=1.84)																		
39-gate valve 1.5" (k=0.15)																		
39- solenoid valve 1.5" (kv=12.3)																		

D32 path elements	Hf (m H_2o)								
	Hf1	Hf2	Hf3	Hf4	Hf5	Hf6	Hf7	Hf8	Hf9
1- ductile pipe (L=1.7m & D=6")	0.000501541	0.001084	0.001884	0.004134	0.007249	0.011228	0.013541	0.016069	0.021774
1'-pipe entry (k=0.78)	0.001186663	0.00267	0.004747	0.01068	0.018987	0.029667	0.035897	0.04272	0.058146
2- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
3- elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
4- Y strainer (k=1)	0.001736388	0.003907	0.006946	0.015627	0.027782	0.04341	0.052526	0.06251	0.085083
5-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
7-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
8- steel pipe (L=1.5m & D=6")	0.000414916	0.000859	0.001447	0.003039	0.005172	0.007836	0.009366	0.011025	0.014736
9-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
10- disc filter								0.05555	0.410125
11- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
12- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
13- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
14- check valve 6" (k=1.85)	0.003212317	0.007228	0.012849	0.028911	0.051397	0.080308	0.097173	0.115643	0.157404
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- steel pipe (L=5m & D=6")	0.001383054	0.002864	0.004824	0.010131	0.017241	0.026121	0.031218	0.036751	0.049119
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- ductile pipe (L=1.3m & D=6")	0.000383531	0.000829	0.001441	0.003161	0.005543	0.008586	0.010355	0.012288	0.016651
17-gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
18- pvc pipe (L=50m & D=160mm)	0.024036685	0.049265	0.082195	0.169715	0.28457	0.425487	0.505426	0.591559	0.782091
19-elbow 6" (k=0.45)	0.001279782	0.00288	0.005119	0.011518	0.020477	0.031995	0.038713	0.046072	0.062709
20- pvc pipe (L=270m & D=160mm)	0.1297981	0.266031	0.44385	0.916463	1.536678	2.297629	2.729299	3.194417	4.22329
21- branch tee 6" (k=0.9)	0.002211018	0.004975	0.008844	0.019899	0.035376	0.055275	0.066883	0.079597	0.10834
22- gate valve 6" (k=0.12)	0.000294802	0.000663	0.001179	0.002653	0.004717	0.00737	0.008918	0.010613	0.014445
23- pvc pipe (L=145m & D=160mm)	0.059508331	0.122036	0.203683	0.420778	0.705783	1.055557	1.25401	1.467862	1.940984
24- branch tee 6" (k=0.9)	0.00043352	0.000975	0.001734	0.003902	0.006936	0.010838	0.013114	0.015607	0.021242
25- gate valve 6" (k=0.12)	5.78027E-05	0.00013	0.000231	0.00052	0.000925	0.001445	0.001749	0.002081	0.002832
26- pvc pipe (L=573m & D=160mm)	0.056376566	0.114469	0.189802	0.388697	0.648157	0.965105	1.144428	1.337345	1.763191
27- gate valve 6" (k=0.12)	5.78027E-05	0.00013	0.000231	0.00052	0.000925	0.001445	0.001749	0.002081	0.002832
28-elbow 6" (k=0.45)	0.00021676	0.000488	0.000867	0.001951	0.003468	0.005419	0.006557	0.007803	0.010621
29- sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.002548318	0.005734	0.010193	0.022935	0.040773	0.063708	0.077087	0.091739	0.124868
30- pvc pipe (L=646m & D=110mm)	0.388979914	0.79252	1.317113	2.70577	4.521677	6.744042	8.002863	9.358054	12.35239
31- gate valve 4" (k=0.14)	0.000302343	0.00068	0.001209	0.002721	0.004837	0.007559	0.009146	0.010884	0.014815
32- branch tee 4" (k=1.02)	0.00018042	0.000406	0.000722	0.001624	0.002887	0.004511	0.005458	0.006495	0.008841
33-pvc pipe (L=20m&D=4")	0.001389575	0.002779	0.004563	0.009227	0.015259	0.022583	0.026711	0.031143	0.040898
34-saddle (110mm-63mm) (k=1.7)	0.002796264	0.006292	0.011185	0.025166	0.04474	0.069907	0.084587	0.100665	0.137017
35- pvc riser pipe(L=1.5 m & D=63mm)	0.001442885	0.002913	0.004811	0.009807	0.016304	0.024226	0.028703	0.033517	0.044135
36- elbow 63mm (k=0.54)	0.000888225	0.001999	0.003553	0.007994	0.014212	0.022206	0.026869	0.031976	0.043523
37- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.018693515	0.04206	0.074774	0.168242	0.299096	0.467338	0.565479	0.672967	0.915982
39-gate valve 1.5" (k=0.15)	0.001523928	0.003429	0.006096	0.013715	0.024383	0.038098	0.046099	0.054861	0.074672
39- solenoid valve 1.5" (kv=12.3)	0.142361183	0.320313	0.569445	1.281251	2.277778	3.55903	4.306426	5.125003	6.975698
	total								
	0.849786106	1.773135	2.997756	6.3106	10.73179	16.22598	19.36732	22.82353	30.74863

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Step1- **Δp** of (D32@25.7GPM)=**TDH**(D34@28.1GPM)-**TDH**(D32)=2.277778 m

$$\Delta p = \frac{Q^2}{Kv^2}$$

Note:- TDH(D33) is the total dynamic head of **D32** path before calculating **Hf** of **D32** solenoid valve, then it recalculated and corrected again after Calculating **Kv**

Q		Δp	
Gpm	m3/h	m	bar
0	0	0	0
6.425	1.459276	0.142361	0.013961
9.6375	2.188914	0.320313	0.031412
12.85	2.918552	0.569445	0.055843
19.275	4.377829	1.281251	0.125648
25.7	5.837105	**2.277778**	0.223374
32.125	7.296381	3.55903	0.349022
35.3375	8.026019	4.306426	0.422316
38.55	8.755657	5.125003	0.502591
44.975	10.21493	6.975698	0.684082

Step2- $Kv = Q(m3/h)\sqrt{\frac{1}{\Delta p(bar)}}$

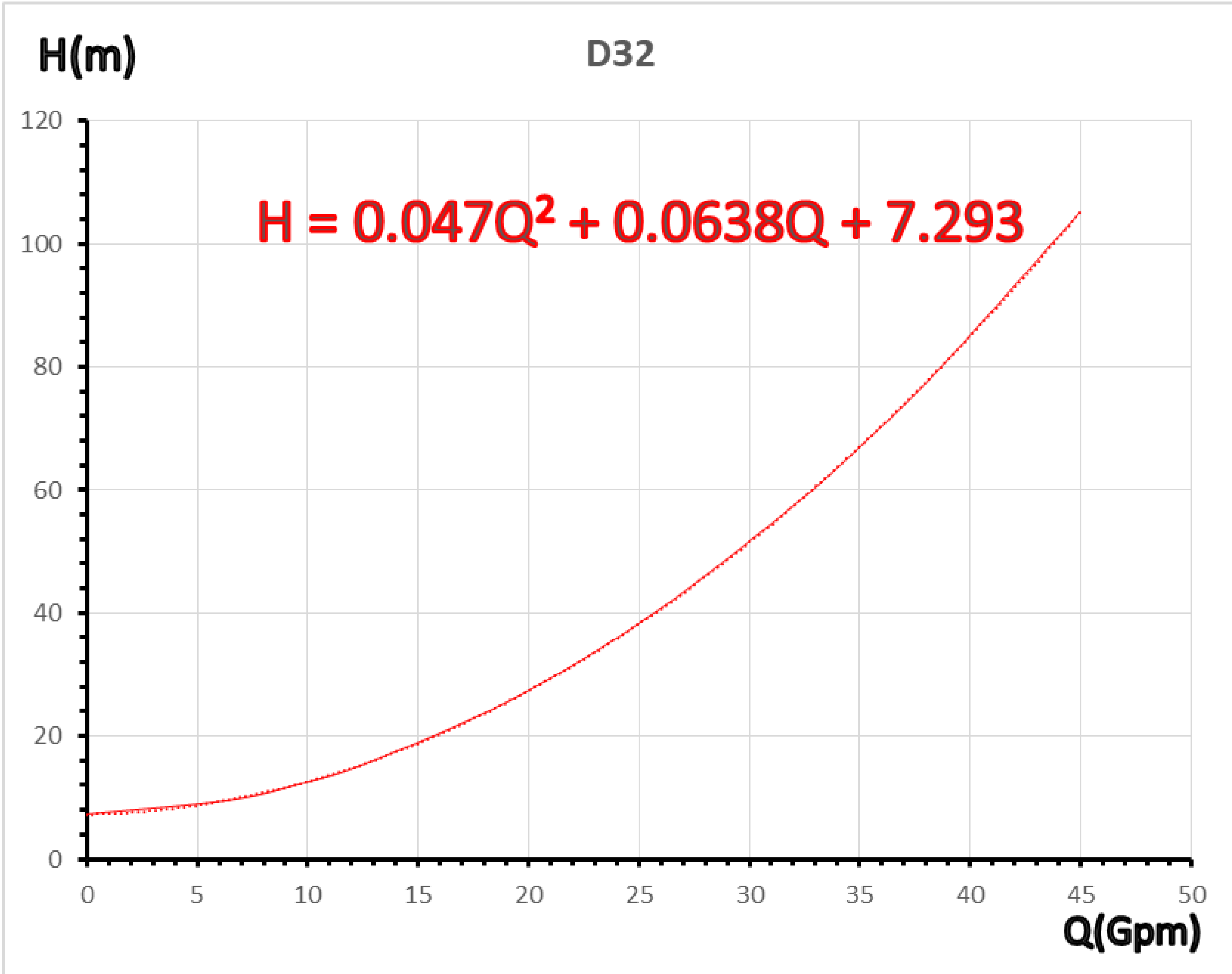
Kv=12.35

step3- $\Delta p = \frac{Q^2}{Kv^2}$

Step4

Q(Gpm)	Hf	Hs	lateral line	TDH (m)
0	0	7	0	7.35
6.425	0.849786	7	1.274645	9.580653
9.6375	1.773135	7	2.867952	12.22314
12.85	2.997756	7	5.098581	15.85115
19.275	6.3106	7	11.47181	26.02153
25.7	10.73179	7	20.39432	40.03242
32.125	16.22598	7	31.86613	57.84672
35.3375	19.36732	7	38.55802	68.17161
38.55	22.82353	7	45.88723	79.4963
44.975	30.74863	7	62.45762	105.2166

Step5



Step6

Q(G pm)	TDH (m)
0	7.35
6.940752	10
15.77796	20
21.31192	30
25.7098	40
29.4729	50
32.81585	60
35.85417	70
38.65851	80
41.27582	90
43.73918	100
46.07292	110

❾ - valve D18 calculations

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
	Range of flow rates								
D35	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D23	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D16	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
D17	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D18	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
D32	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D33	9	13.5	18	27	36	45	49.5	54	63
D34	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175

flow velocity

$$V = \frac{Q}{A}$$

Renold number

$$Re = \frac{v * D}{kinematic\ viscosity}$$

swamee-jain equation

$$f = \frac{0.25}{[\log 10(\frac{\varepsilon}{3.7D} + \frac{5.74}{Re^{0.9}})]^2}$$

darcy-weisbach equation (pipes)

$$Hf = f(\frac{L}{D})\frac{v^2}{2g}$$

darcy-weisbach equation (fittings)

$$Hf = K\frac{v^2}{2g}$$

D18 path elements	Q(Gpm) Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1- ductile pipe (L=1.7m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
1'-pipe entry (k=0.78)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
2- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
3- elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
4- Y strainer (k=1)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
5-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
7-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
8- steel pipe (L=1.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
9-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
10- disc filter	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
11- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
12- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
13- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
14- check valve 6" (k=1.85)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- steel pipe (L=5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- ductile pipe (L=1.3m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
17-gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
18- pvc pipe (L=50m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
19-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
20- pvc pipe (L=270m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
21- branch tee 6" (k=0.9)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
22- gate valve 6" (k=0.12)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
23- pvc pipe (L=145m & D=160mm)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
24-through tee 6" **(k=0.28)**	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
25-sudden contraction (D1=160mm & d2=110mm) **(k=1.18)**	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
26-gate valve 4" **(k=0.14)**	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
27-pvc pipe (L=234m & D=110mm)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
28-pvc pipe (L=220m & D=110mm)	24.4	36.6	48.8	73.2	97.6	122	134.2	146.4	170.8
29-pvc pipe (L=276m&D=110mm)	14.125	21.1875	28.25	42.375	56.5	70.625	77.6875	84.75	98.875
30-pvc pipe (L=241m & D=110mm)	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
31-saddle (110mm-63mm) (k=1.7)	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
32- pvc riser pipe(L=1.5 m & D=63mm)	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
33- elbow 63mm (k=0.54)	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
34- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
35-gate valve 1.5" (k=0.15)	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
36- solenoid valve 1.5" (kv=16)	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9

D18 path elements	V(m/s) V1	V2	V3	V4	V5	V6	V7	V8	V9
1- ductile pipe (L=1.7m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
1'-pipe entry (k=0.78)	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
2- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
3- elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
4- Y strainer (k=1)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
5-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
7-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
8- steel pipe (L=1.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
9-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
10- disc filter	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
11- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
12- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
13- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
14- check valve 6" (k=1.85)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- steel pipe (L=5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- ductile pipe (L=1.3m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
17-gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
18- pvc pipe (L=50m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
19-elbow 6" (k=0.45)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
20- pvc pipe (L=270m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
21- branch tee 6" (k=0.9)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
22- gate valve 6" (k=0.12)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
23- pvc pipe (L=145m & D=160mm)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
24-through tee 6" **(k=0.28)**	0.122331	0.183496	0.244661	0.366992	0.489322	0.611653	0.672818	0.733983	0.856314
25-sudden contraction (D1=160mm & d2=110mm) **(k=1.18)**	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
26-gate valve 4" **(k=0.14)**	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
27-pvc pipe (L=234m & D=110mm)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
28-pvc pipe (L=220m & D=110mm)	0.223722	0.335583	0.447444	0.671166	0.894888	1.11861	1.230471	1.342332	1.566054
29-pvc pipe (L=276m&D=110mm)	0.129511	0.194267	0.259022	0.388534	0.518045	0.647556	0.712312	0.777067	0.906579
30-pvc pipe (L=241m & D=110mm)	0.070601	0.105901	0.141202	0.211802	0.282403	0.353004	0.388304	0.423605	0.494206
31-saddle (110mm-63mm) (k=1.7)	0.215294	0.322941	0.430588	0.645882	0.861176	1.076469	1.184116	1.291763	1.507057
32- pvc riser pipe(L=1.5 m & D=63mm)	0.215294	0.322941	0.430588	0.645882	0.861176	1.076469	1.184116	1.291763	1.507057
33- elbow 63mm (k=0.54)	0.215294	0.322941	0.430588	0.645882	0.861176	1.076469	1.184116	1.291763	1.507057
34- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.535061	0.802592	1.070123	1.605184	2.140246	2.675307	2.942838	3.210369	3.74543
35-gate valve 1.5" (k=0.15)	0.535061	0.802592	1.070123	1.605184	2.140246	2.675307	2.942838	3.210369	3.74543
36- solenoid valve 1.5" (kv=16)	0.535061	0.802592	1.070123	1.605184	2.140246	2.675307	2.942838	3.210369	3.74543

D18 path elements	Re Re1	Re2	Re3	Re4	Re5	Re6	Re7	Re8	Re9
1- ductile pipe (L=1.7m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
19-elbow 6" (k=0.45)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
20- pvc pipe (L=270m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	33827.55784	50741.34	67655.12	101482.7	135310.2	169137.8	186051.6	202965.3	236792.9
24-through tee 6" **(k=0.28)**									
25-sudden contraction (D1=160mm & d2=110mm) **(k=1.18)**									
26-gate valve 4" **(k=0.14)**									
27-pvc pipe (L=234m & D=110mm)	24244.5006	36366.75	48489	72733.5	96978	121222.5	133344.8	145467	169711.5
28-pvc pipe (L=220m & D=110mm)	20940.38282	31410.57	41880.77	62821.15	83761.53	104701.9	115172.1	125642.3	146582.7
29-pvc pipe (L=276m&D=110mm)	12122.2503	18183.38	24244.5	36366.75	48489	60611.25	66672.38	72733.5	84855.75
30-pvc pipe (L=241m & D=110mm)	6608.235562	9912.353	13216.47	19824.71	26432.94	33041.18	36345.3	39649.41	46257.65
31-saddle (110mm-63mm) (k=1.7)									
32- pvc riser pipe(L=1.5 m & D=63mm)	11539.7523	17309.63	23079.5	34619.26	46159.01	57698.76	63468.64	69238.51	80778.27
33- elbow 63mm (k=0.54)									
34- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
35-gate valve 1.5" (k=0.15)									
36- solenoid valve 1.5" (kv=16)									

D18 path elements	f f1	f2	f3	f4	f5	f6	f7	f8	f9
1- ductile pipe (L=1.7m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
19-elbow 6" (k=0.45)									
20- pvc pipe (L=270m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	0.022753	0.020738	0.01947	0.017876	0.016866	0.016144	0.01585	0.01559	0.015146
24-through tee 6" **(k=0.28)**									
25-sudden contraction (D1=160mm & d2=110mm) **(k=1.18)**									
26-gate valve 4" **(k=0.14)**									
27-pvc pipe (L=234m & D=110mm)	0.024655	0.022389	0.02097	0.019195	0.018074	0.017275	0.016951	0.016664	0.016175
28-pvc pipe (L=220m & D=110mm)	0.02556	0.02317	0.021675	0.019808	0.018631	0.017793	0.017453	0.017152	0.016639
29-pvc pipe (L=276m&D=110mm)	0.029426	0.026481	0.024655	0.022389	0.02097	0.019963	0.019555	0.019195	0.018581
30-pvc pipe (L=241m & D=110mm)	0.034852	0.031076	0.028758	0.025911	0.024143	0.022895	0.022392	0.021948	0.021193
31-saddle (110mm-63mm) (k=1.7)									
32- pvc riser pipe(L=1.5 m & D=63mm)	0.02984	0.026842	0.024986	0.022687	0.02125	0.020232	0.01982	0.019456	0.018838
33- elbow 63mm (k=0.54)									
34- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
35-gate valve 1.5" (k=0.15)									
36- solenoid valve 1.5" (kv=16)									

D18 path elements	Hf (m H_2o) Hf1	Hf2	Hf3	Hf4	Hf5	Hf6	Hf7	Hf8	Hf9
1- ductile pipe (L=1.7m & D=6")	0.000501541	0.001084	0.001884	0.004134	0.007249	0.011228	0.013541	0.016069	0.021774
1'-pipe entry (k=0.78)	0.001186663	0.00267	0.004747	0.01068	0.018987	0.029667	0.035897	0.04272	0.058146
2- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
3- elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
4- Y strainer (k=1)	0.001736388	0.003907	0.006946	0.015627	0.027782	0.04341	0.052526	0.06251	0.085083
5-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
7-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
8- steel pipe (L=1.5m & D=6")	0.000414916	0.000859	0.001447	0.003039	0.005172	0.007836	0.009366	0.011025	0.014736
9-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
10- disc filter								0.05555	0.410125
11- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
12- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
13- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
14- check valve 6" (k=1.85)	0.003212317	0.007228	0.012849	0.028911	0.051397	0.080308	0.097173	0.115643	0.157404
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- steel pipe (L=5m & D=6")	0.001383054	0.002864	0.004824	0.010131	0.017241	0.026121	0.031218	0.036751	0.049119
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- ductile pipe (L=1.3m & D=6")	0.000383531	0.000829	0.001441	0.003161	0.005543	0.008586	0.010355	0.012288	0.016651
17-gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
18- pvc pipe (L=50m & D=160mm)	0.024036685	0.049265	0.082195	0.169715	0.28457	0.425487	0.505426	0.591559	0.782091
19-elbow 6" (k=0.45)	0.001279782	0.00288	0.005119	0.011518	0.020477	0.031995	0.038713	0.046072	0.062709
20- pvc pipe (L=270m & D=160mm)	0.1297981	0.266031	0.44385	0.916463	1.536678	2.297629	2.729299	3.194417	4.22329
21- branch tee 6" (k=0.9)	0.002211018	0.004975	0.008844	0.019899	0.035376	0.055275	0.066883	0.079597	0.10834
22- gate valve 6" (k=0.12)	0.000294802	0.000663	0.001179	0.002653	0.004717	0.00737	0.008918	0.010613	0.014445
23- pvc pipe (L=145m & D=160mm)	0.059508331	0.122036	0.203683	0.420778	0.705783	1.055557	1.25401	1.467862	1.940984
24-through tee 6" **(k=0.28)**	0.000213564	0.000481	0.000854	0.001922	0.003417	0.005339	0.00646	0.007688	0.010465
25-sudden contraction (D1=160mm & d2=110mm) **(k=1.18)**	0.004035132	0.009079	0.016141	0.036316	0.064562	0.100878	0.122063	0.145265	0.197721
26-gate valve 4" **(k=0.14)**	0.000478745	0.001077	0.001915	0.004309	0.00766	0.011969	0.014482	0.017235	0.023458
27-pvc pipe (L=234m & D=110mm)	0.210772005	0.430662	0.71709	1.476861	2.472256	3.692137	4.383703	5.128585	6.775546
28-pvc pipe (L=220m & D=110mm)	0.153259073	0.312583	0.519853	1.068935	1.787443	2.667217	3.165704	3.702449	4.888695
29-pvc pipe (L=276m&D=110mm)	0.074179194	0.1502	0.248603	0.50796	0.845798	1.258083	1.491214	1.741939	2.295165
30-pvc pipe (L=241m & D=110mm)	0.022797838	0.045737	0.075246	0.152544	0.252683	0.374411	0.443083	0.516835	0.679272
31-saddle (110mm-63mm) (k=1.7)	0.004016181	0.009036	0.016065	0.036146	0.064259	0.100405	0.121489	0.144583	0.196793
32- pvc riser pipe(L=1.5 m & D=63mm)	0.001972829	0.003993	0.006608	0.013499	0.022478	0.03344	0.039639	0.046308	0.061026
33- elbow 63mm (k=0.54)	0.001275728	0.00287	0.005103	0.011482	0.020412	0.031893	0.038591	0.045926	0.062511
34- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.026848879	0.06041	0.107396	0.24164	0.429582	0.671222	0.812179	0.96656	1.315595
35-gate valve 1.5" (k=0.15)	0.002188767	0.004925	0.008755	0.019699	0.03502	0.054719	0.06621	0.078796	0.10725
36- solenoid valve 1.5" (kv=16)	0.119798559	0.269547	0.479194	1.078187	1.916787	2.994964	3.623906	4.312748	5.870129
total	0.853373582	1.778418	3.004049	6.316058	10.73179	16.2152	19.34902	22.79622	30.6987

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Step1- **Δp** of (D18@30.8GPM)=**TDH**(D34@28.1GPM)-**TDH**(D18@30.8GPM)

= 1.916787302 m

$$\Delta p = \frac{Q^2}{Kv^2}$$

Q		Δp	
Gpm	m3/h	m	bar
0	0	0	0
7.7	1.74886	0.119799	0.011748
11.55	2.62329	0.269547	0.026434
15.4	3.49772	0.479194	0.046993
23.1	5.246581	1.078187	0.105734
30.8	6.995441	**1.916787**	0.187973
38.5	8.744301	2.994964	0.293706
42.35	9.618731	3.623906	0.355384
46.2	10.49316	4.312748	0.422936
53.9	12.24202	5.870129	0.575663

Note:- TDH(D18) is the total dynamic head of **D18** path before calculating **Hf** of **D18** solenoid valve, then it recalculated and corrected again after Calculating **Kv**

Step2- $Kv = Q(m3/h)\sqrt{\frac{1}{\Delta p(bar)}}$

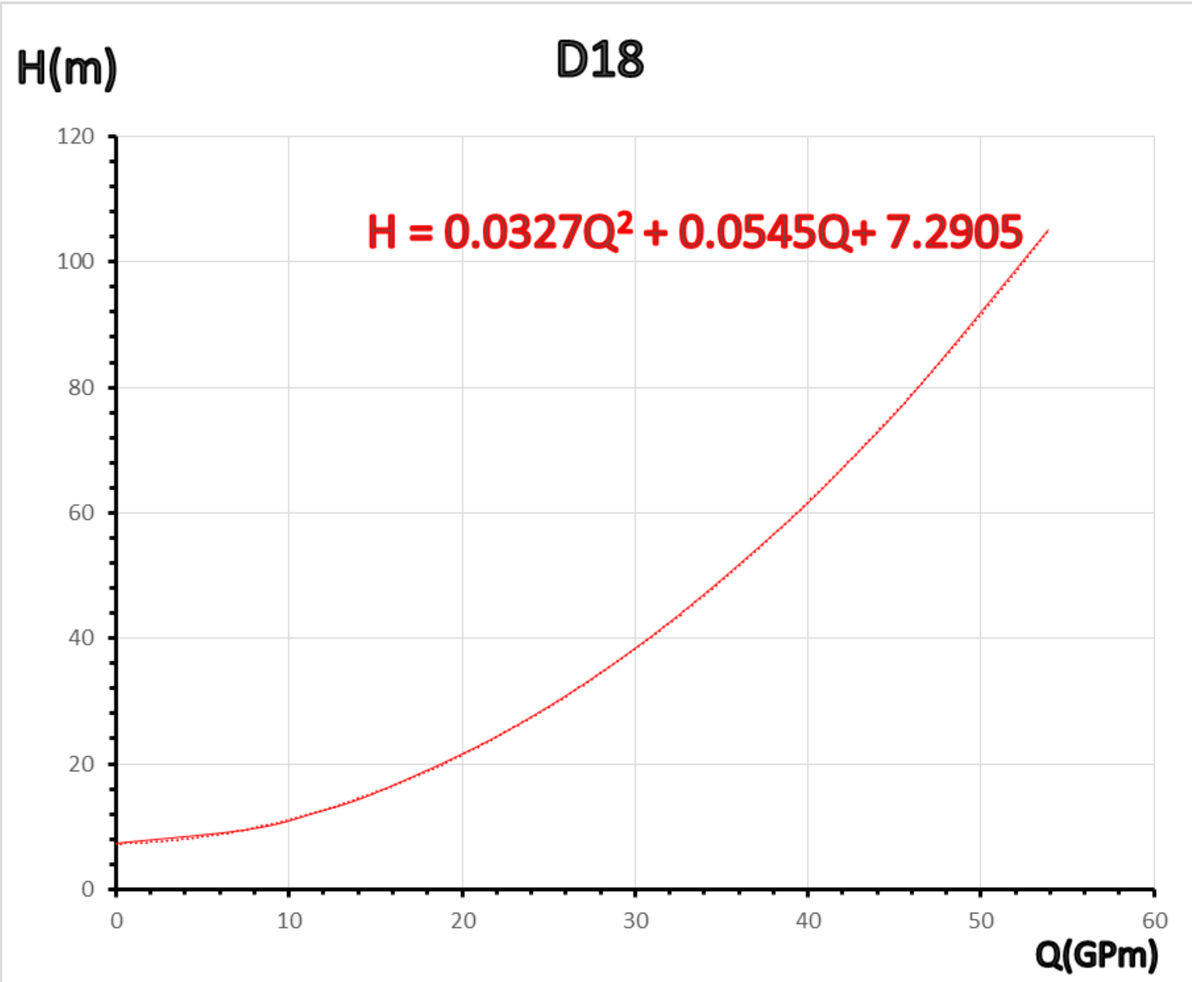
$Kv=16.14$

step3- $\Delta p = \frac{Q^2}{Kv^2}$

Step4

Q(G pm)	Hf	Hs	lateral line	TDH (m)
0	0	7	0	7.35
7.7	0.853374	7	1.274645	9.58442
11.55	1.778418	7	2.867952	12.22869
15.4	3.004049	7	5.098581	15.85776
23.1	6.316058	7	11.47181	26.02726
30.8	10.73179	7	20.39432	40.03242
38.5	16.2152	7	31.86613	57.8354
42.35	19.34902	7	38.55802	68.15239
46.2	22.79622	7	45.88723	79.46763
53.9	30.6987	7	62.45762	105.1641

Step5



Step6

Q(G pm)	TDH (m)
0	7.35
8.307442	10
18.89898	20
25.53283	30
30.80501	40
35.31629	50
39.32393	60
42.96639	70
46.32837	80
49.46614	90
52.41934	100
55.21716	110

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⑩ - valve D17 calculations

	Range of flow rates								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
D35	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D23	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D16	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
D17	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D18	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
D32	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D33	9	13.5	18	27	36	45	49.5	54	63
D34	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175

flow velocity

$$V = \frac{Q}{A}$$

Renold number

$$Re = \frac{v * D}{kinematic\ viscosity}$$

swamee-jain equation

$$f = \frac{0.25}{[log10(\frac{\varepsilon}{3.7D} + \frac{5.74}{Re^{0.9}})]^2}$$

darcy-weisbach equation (pipes)

$$Hf = f(\frac{L}{D})\frac{v^2}{2g}$$

darcy-weisbach equation (fittings)

$$Hf = K\frac{v^2}{2g}$$

D17 path elements	Q(Gpm)								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1- ductile pipe (L=1.7m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
1'-pipe entry (k=0.78)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
2- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
3- elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
4- Y strainer (k=1)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
5-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
7-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
8- steel pipe (L=1.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
9-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
10- disc filter	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
11- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
12- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
13- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
14- check valve 6" (k=1.85)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- steel pipe (L=5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- ductile pipe (L=1.3m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
17-gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
18- pvc pipe (L=50m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
19-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
20- pvc pipe (L=270m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
21- branch tee 6" (k=0.9)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
22- gate valve 6" (k=0.12)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
23- pvc pipe (L=145m & D=160mm)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
24-through tee 6" (k=0.28)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
26-gate valve 4" (k=0.14)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
27-pvc pipe (L=234m & D=110mm)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
28-pvc pipe (L=220m & D=110mm)	24.4	36.6	48.8	73.2	97.6	122	134.2	146.4	170.8
29-pvc pipe (L=276m&D=110mm)	14.125	21.1875	28.25	42.375	56.5	70.625	77.6875	84.75	98.875
30-saddle (110mm-63mm) (k=1.7)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
31 pvc riser pipe(L=1.5 m & D=63mm)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
32- elbow 63mm (k=0.54)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
33 sudden contraction (D1=63mm & d2=40mm) (k=1.84)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
34-gate valve 1.5" (k=0.15)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
35- solenoid valve 1.5" (kv=12)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975

D17 path elements	V(m/s)								
	V1	V2	V3	V4	V5	V6	V7	V8	V9
1- ductile pipe (L=1.7m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
1'-pipe entry (k=0.78)	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
2- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
3- elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
4- Y strainer (k=1)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
5-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
7-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
8- steel pipe (L=1.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
9-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
10- disc filter	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
11- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
12- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
13- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
14- check valve 6" (k=1.85)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- steel pipe (L=5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- ductile pipe (L=1.3m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
17-gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
18- pvc pipe (L=50m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
19-elbow 6" (k=0.45)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
20- pvc pipe (L=270m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
21- branch tee 6" (k=0.9)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
22- gate valve 6" (k=0.12)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
23- pvc pipe (L=145m & D=160mm)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
24-through tee 6" (k=0.28)	0.122331	0.183496	0.244661	0.366992	0.489322	0.611653	0.672818	0.733983	0.856314
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
26-gate valve 4" (k=0.14)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
27-pvc pipe (L=234m & D=110mm)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
28-pvc pipe (L=220m & D=110mm)	0.223722	0.335583	0.447444	0.671166	0.894888	1.11861	1.230471	1.342332	1.566054
29-pvc pipe (L=276m&D=110mm)	0.129511	0.194267	0.259022	0.388534	0.518045	0.647556	0.712312	0.777067	0.906579
30-saddle (110mm-63mm) (k=1.7)	0.179645	0.269467	0.359289	0.538934	0.718578	0.898223	0.988045	1.077867	1.257512
31 pvc riser pipe(L=1.5 m & D=63mm)	0.179645	0.269467	0.359289	0.538934	0.718578	0.898223	0.988045	1.077867	1.257512
32- elbow 63mm (k=0.54)	0.179645	0.269467	0.359289	0.538934	0.718578	0.898223	0.988045	1.077867	1.257512
33 sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.446464	0.669695	0.892927	1.339391	1.785854	2.232318	2.45555	2.678782	3.125245
34-gate valve 1.5" (k=0.15)	0.446464	0.669695	0.892927	1.339391	1.785854	2.232318	2.45555	2.678782	3.125245
35- solenoid valve 1.5" (kv=12)	0.446464	0.669695	0.892927	1.339391	1.785854	2.232318	2.45555	2.678782	3.125245

D17 path elements	Re								
	Re1	Re2	Re3	Re4	Re5	Re6	Re7	Re8	Re9
1- ductile pipe (L=1.7m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
19-elbow 6" (k=0.45)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
20- pvc pipe (L=270m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	33827.55784	50741.34	67655.12	101482.7	135310.2	169137.8	186051.6	202965.3	236792.9
24-through tee 6" (k=0.28)									
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
26-gate valve 4" (k=0.14)									
27-pvc pipe (L=234m & D=110mm)	24244.5006	36366.75	48489	72733.5	96978	121222.5	133344.8	145467	169711.5
28-pvc pipe (L=220m & D=110mm)	20940.38282	31410.57	41880.77	62821.15	83761.53	104701.9	115172.1	125642.3	146582.7
29-pvc pipe (L=276m&D=110mm)	12122.2503	18183.38	24244.5	36366.75	48489	60611.25	66672.38	72733.5	84855.75
30-saddle (110mm-63mm) (k=1.7)									
31 pvc riser pipe(L=1.5 m & D=63mm)	9628.949157	14443.42	19257.9	28886.85	38515.8	48144.75	52959.22	57773.69	67402.64
32- elbow 63mm (k=0.54)									
33 sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
34-gate valve 1.5" (k=0.15)									
35- solenoid valve 1.5" (kv=12)									

D17 path elements	f								
	f1	f2	f3	f4	f5	f6	f7	f8	f9
1- ductile pipe (L=1.7m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
19-elbow 6" (k=0.45)									
20- pvc pipe (L=270m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	0.022753	0.020738	0.01947	0.017876	0.016866	0.016144	0.01585	0.01559	0.015146
24-through tee 6" (k=0.28)									
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
26-gate valve 4" (k=0.14)									
27-pvc pipe (L=234m & D=110mm)	0.024655	0.022389	0.02097	0.019195	0.018074	0.017275	0.016951	0.016664	0.016175
28-pvc pipe (L=220m & D=110mm)	0.02556	0.02317	0.021675	0.019808	0.018631	0.017793	0.017453	0.017152	0.016639
29-pvc pipe (L=276m&D=110mm)	0.029426	0.026481	0.024655	0.022389	0.02097	0.019963	0.019555	0.019195	0.018581
30-saddle (110mm-63mm) (k=1.7)									
31 pvc riser pipe(L=1.5 m & D=63mm)	0.031346	0.028121	0.02613	0.023671	0.022137	0.021051	0.020613	0.020226	0.019568
32- elbow 63mm (k=0.54)									
33 sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
34-gate valve 1.5" (k=0.15)									
35- solenoid valve 1.5" (kv=12)									

D17 path elements	Hf (m H₂o)								
	Hf1	Hf2	Hf3	Hf4	Hf5	Hf6	Hf7	Hf8	Hf9
1- ductile pipe (L=1.7m & D=6")	0.000501541	0.001084	0.001884	0.004134	0.007249	0.011228	0.013541	0.016069	0.021774
1'-pipe entry (k=0.78)	0.001186663	0.00267	0.004747	0.01068	0.018987	0.029667	0.035897	0.04272	0.058146
2- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
3- elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
4- Y strainer (k=1)	0.001736388	0.003907	0.006946	0.015627	0.027782	0.04341	0.052526	0.06251	0.085083
5-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
7-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
8- steel pipe (L=1.5m & D=6")	0.000414916	0.000859	0.001447	0.003039	0.005172	0.007836	0.009366	0.011025	0.014736
9-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
10- disc filter								0.05555	0.410125
11- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
12- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
13- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
14- check valve 6" (k=1.85)	0.003212317	0.007228	0.012849	0.028911	0.051397	0.080308	0.097173	0.115643	0.157404
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- steel pipe (L=5m & D=6")	0.001383054	0.002864	0.004824	0.010131	0.017241	0.026121	0.031218	0.036751	0.049119
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- ductile pipe (L=1.3m & D=6")	0.000383531	0.000829	0.001441	0.003161	0.005543	0.008586	0.010355	0.012288	0.016651
17-gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
18- pvc pipe (L=50m & D=160mm)	0.024036685	0.049265	0.082195	0.169715	0.28457	0.425487	0.505426	0.591559	0.782091
19-elbow 6" (k=0.45)	0.001279782	0.00288	0.005119	0.011518	0.020477	0.031995	0.038713	0.046072	0.062709
20- pvc pipe (L=270m & D=160mm)	0.1297981	0.266031	0.44385	0.916463	1.536678	2.297629	2.729299	3.194417	4.22329
21- branch tee 6" (k=0.9)	0.002211018	0.004975	0.008844	0.019899	0.035376	0.055275	0.066883	0.079597	0.10834
22- gate valve 6" (k=0.12)	0.000294802	0.000663	0.001179	0.002653	0.004717	0.00737	0.008918	0.010613	0.014445
23- pvc pipe (L=145m & D=160mm)	0.059508331	0.122036	0.203683	0.420778	0.705783	1.055557	1.25401	1.467862	1.940984
24-through tee 6" (k=0.28)	0.000213564	0.000481	0.000854	0.001922	0.003417	0.005339	0.00646	0.007688	0.010465
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.004035132	0.009079	0.016141	0.036316	0.064562	0.100878	0.122063	0.145265	0.197721
26-gate valve 4" (k=0.14)	0.000478745	0.001077	0.001915	0.004309	0.00766	0.011969	0.014482	0.017235	0.023458
27-pvc pipe (L=234m & D=110mm)	0.210772005	0.430662	0.71709	1.476861	2.472256	3.692137	4.383703	5.128585	6.775546
28-pvc pipe (L=220m & D=110mm)	0.153259073	0.312583	0.519853	1.068935	1.787443	2.667217	3.165704	3.702449	4.888695
29-pvc pipe (L=276m&D=110mm)	0.074179194	0.1502	0.248603	0.50796	0.845798	1.258083	1.491214	1.741939	2.295165
30-saddle (110mm-63mm) (k=1.7)	0.002796264	0.006292	0.011185	0.025166	0.04474	0.069907	0.084587	0.100665	0.137017
31 pvc riser pipe(L=1.5 m & D=63mm)	0.001442885	0.002913	0.004811	0.009807	0.016304	0.024226	0.028703	0.033517	0.044135
32- elbow 63mm (k=0.54)	0.000888225	0.001999	0.003553	0.007994	0.014212	0.022206	0.026869	0.031976	0.043523
33 sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.018693515	0.04206	0.074774	0.168242	0.299096	0.467338	0.565479	0.672967	0.915982
34-gate valve 1.5" (k=0.15)	0.001523928	0.003429	0.006096	0.013715	0.024383	0.038098	0.046099	0.054861	0.074672
35- solenoid valve 1.5" (kv=12)	0.14640625	0.329414	0.585625	1.317656	2.342487	3.660156	4.428789	5.270625	7.173906
total									
	0.846225866	1.768007	2.991727	6.305442	10.73179	16.23608	19.38445	22.84908	30.79536

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Step1- **Δp** of (D17@25.7GPM)=TDH(D34@28.1GPM)-TDH(D17@30.8GPM) =2.34249 m

Note:- TDH(D17) is the total dynamic head of **D17** path before calculating **Hf** of **D17** solenoid valve, then it recalculated and corrected again after Calculating **Kv**

$$\Delta p = \frac{Q^2}{Kv^2}$$

Q		Δp	
Gpm	m3/h	m	bar
0	0	0	0
6.425	1.459276	0.146406	0.014358
9.6375	2.188914	0.329414	0.032304
12.85	2.918552	0.585625	0.05743
19.275	4.377829	1.317656	0.129218
25.7	5.837105	**2.342487**	0.229719
32.125	7.296381	3.660156	0.358939
35.3375	8.026019	4.428789	0.434316
38.55	8.755657	5.270625	0.516872
44.975	10.21493	7.173906	0.70352

Step2- $Kv = Q(m3/h)\sqrt{\frac{1}{\Delta p(bar)}}$

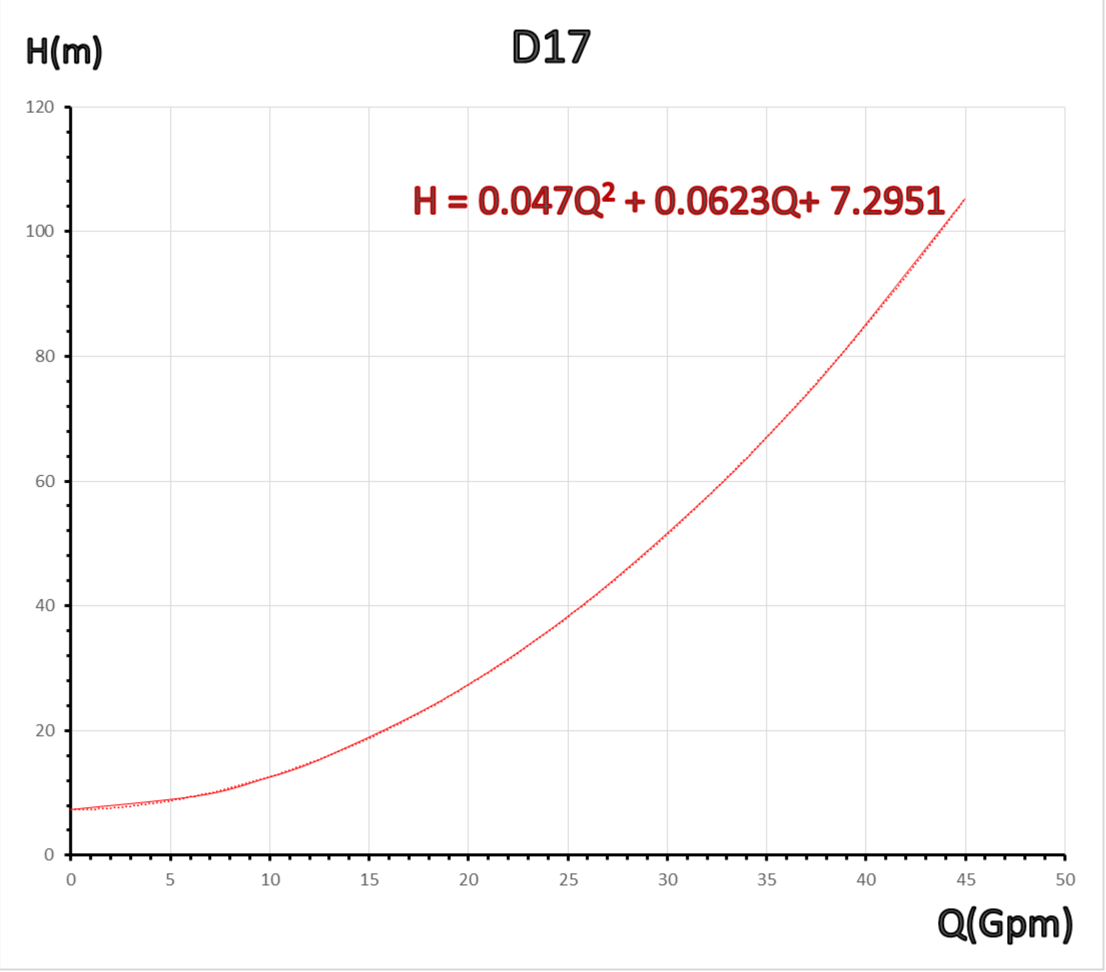
Kv=12.18

step3- $\Delta p = \frac{Q^2}{Kv^2}$

Step4

Q(G pm)	Hf	Hs	lateral line	TDH (m)
0	0	7	0	7.35
6.425	0.846226	7	1.274645	9.576915
9.6375	1.768007	7	2.867952	12.21776
12.85	2.991727	7	5.098581	15.84482
19.275	6.305442	7	11.47181	26.01611
25.7	10.73179	7	20.39432	40.03242
32.125	16.23608	7	31.86613	57.85732
35.3375	19.38445	7	38.55802	68.18959
38.55	22.84908	7	45.88723	79.52313
44.975	30.79536	7	62.45762	105.2656

Step5



Step6

Q(G pm)	TDH (m)
0	7.35
6.952372	10
15.79191	20
21.32637	30
25.72451	40
29.48776	50
32.83082	60
35.86922	70
38.67363	80
41.29099	90
43.75439	100
46.08817	110

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⓫ - valve D16 calculations

	Range of flow rates								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
D35	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D23	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D16	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
D17	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D18	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
D32	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D33	9	13.5	18	27	36	45	49.5	54	63
D34	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175

flow velocity

$$V = \frac{Q}{A}$$

Renold number

$$Re = \frac{v * D}{kinematic\ viscosity}$$

swamee-jain equation

$$f = \frac{0.25}{[log10(\frac{\varepsilon}{3.7D}+\frac{5.74}{Re^{0.9}})]^2}$$

darcy-weisbach equation (pipes)

$$Hf = f(\frac{L}{D})\frac{v^2}{2g}$$

darcy-weisbach equation (fittings)

$$Hf = K\frac{v^2}{2g}$$

D16 path elements	Q(Gpm)								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1- ductile pipe (L=1.7m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
1'-pipe entry (k=0.78)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
2- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
3- elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
4- Y strainer (k=1)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
5-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
7-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
8- steel pipe (L=1.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
9-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
10- disc filter	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
11- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
12- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
13- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
14- check valve 6" (k=1.85)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- steel pipe (L=5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- ductile pipe (L=1.3m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
17-gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
18- pvc pipe (L=50m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
19-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
20- pvc pipe (L=270m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
21- branch tee 6" (k=0.9)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
22- gate valve 6" (k=0.12)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
23- pvc pipe (L=145m & D=160mm)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
24-through tee 6" (k=0.28)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
26-gate valve 4" (k=0.14)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
27-pvc pipe (L=234m & D=110mm)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
28-pvc pipe (L=220m & D=110mm)	24.4	36.6	48.8	73.2	97.6	122	134.2	146.4	170.8
29-saddle (110mm-63mm) (k=1.7)	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
30- pvc riser pipe(L=1.5 m & D=63mm)	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
31- elbow 63mm (k=0.54)	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
32- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
33-gate valve 1.5" (k=0.15)	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
34- solenoid valve 1.5" (kv=18.6)	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925

D16 path elements	V(m/s)								
	V1	V2	V3	V4	V5	V6	V7	V8	V9
1- ductile pipe (L=1.7m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
1'-pipe entry (k=0.78)	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
2- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
3- elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
4- Y strainer (k=1)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
5-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
7-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
8- steel pipe (L=1.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
9-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
10- disc filter	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
11- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
12- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
13- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
14- check valve 6" (k=1.85)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- steel pipe (L=5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- ductile pipe (L=1.3m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
17-gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
18- pvc pipe (L=50m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
19-elbow 6" (k=0.45)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
20- pvc pipe (L=270m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
21- branch tee 6" (k=0.9)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
22- gate valve 6" (k=0.12)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
23- pvc pipe (L=145m & D=160mm)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
24-through tee 6" (k=0.28)	0.122331	0.183496	0.244661	0.366992	0.489322	0.611653	0.672818	0.733983	0.856314
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
26-gate valve 4" (k=0.14)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
27-pvc pipe (L=234m & D=110mm)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
28-pvc pipe (L=220m & D=110mm)	0.223722	0.335583	0.447444	0.671166	0.894888	1.11861	1.230471	1.342332	1.566054
29-saddle (110mm-63mm) (k=1.7)	0.287292	0.430937	0.574583	0.861875	1.149166	1.436458	1.580103	1.723749	2.011041
30- pvc riser pipe(L=1.5 m & D=63mm)	0.287292	0.430937	0.574583	0.861875	1.149166	1.436458	1.580103	1.723749	2.011041
31- elbow 63mm (k=0.54)	0.287292	0.430937	0.574583	0.861875	1.149166	1.436458	1.580103	1.723749	2.011041
32- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.713994	1.070992	1.427989	2.141983	2.855977	3.569972	3.926969	4.283966	4.99796
33-gate valve 1.5" (k=0.15)	0.713994	1.070992	1.427989	2.141983	2.855977	3.569972	3.926969	4.283966	4.99796
34- solenoid valve 1.5" (kv=18.6)	0.713994	1.070992	1.427989	2.141983	2.855977	3.569972	3.926969	4.283966	4.99796

D16 path elements	Re								
	Re1	Re2	Re3	Re4	Re5	Re6	Re7	Re8	Re9
1- ductile pipe (L=1.7m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
19-elbow 6" (k=0.45)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
20- pvc pipe (L=270m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	33827.55784	50741.34	67655.12	101482.7	135310.2	169137.8	186051.6	202965.3	236792.9
24-through tee 6" (k=0.28)									
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
26-gate valve 4" (k=0.14)									
27-pvc pipe (L=234m & D=110mm)	24244.5006	36366.75	48489	72733.5	96978	121222.5	133344.8	145467	169711.5
28-pvc pipe (L=220m & D=110mm)	20940.38282	31410.57	41880.77	62821.15	83761.53	104701.9	115172.1	125642.3	146582.7
29-saddle (110mm-63mm) (k=1.7)									
30- pvc riser pipe(L=1.5 m & D=63mm)	15398.82531	23098.24	30797.65	46196.48	61595.3	76994.13	84693.54	92392.95	107791.8
31- elbow 63mm (k=0.54)									
32- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
33-gate valve 1.5" (k=0.15)									
34- solenoid valve 1.5" (kv=18.6)									

D16 path elements	f								
	f1	f2	f3	f4	f5	f6	f7	f8	f9
1- ductile pipe (L=1.7m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
19-elbow 6" (k=0.45)									
20- pvc pipe (L=270m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	0.022753	0.020738	0.01947	0.017876	0.016866	0.016144	0.01585	0.01559	0.015146
24-through tee 6" (k=0.28)									
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
26-gate valve 4" (k=0.14)									
27-pvc pipe (L=234m & D=110mm)	0.024655	0.022389	0.02097	0.019195	0.018074	0.017275	0.016951	0.016664	0.016175
28-pvc pipe (L=220m & D=110mm)	0.02556	0.02317	0.021675	0.019808	0.018631	0.017793	0.017453	0.017152	0.016639
29-saddle (110mm-63mm) (k=1.7)									
30- pvc riser pipe(L=1.5 m & D=63mm)	0.027658	0.024981	0.023315	0.021246	0.019948	0.019027	0.018654	0.018325	0.017764
31- elbow 63mm (k=0.54)									
32- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
33-gate valve 1.5" (k=0.15)									
34- solenoid valve 1.5" (kv=18.6)									

D16 path elements	Hf (m H_2o)								
	Hf1	Hf2	Hf3	Hf4	Hf5	Hf6	Hf7	Hf8	Hf9
1- ductile pipe (L=1.7m & D=6")	0.000501541	0.001084	0.001884	0.004134	0.007249	0.011228	0.013541	0.016069	0.021774
1'-pipe entry (k=0.78)	0.001186663	0.00267	0.004747	0.01068	0.018987	0.029667	0.035897	0.04272	0.058146
2- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
3- elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
4- Y strainer (k=1)	0.001736388	0.003907	0.006946	0.015627	0.027782	0.04341	0.052526	0.06251	0.085083
5-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
7-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
8- steel pipe (L=1.5m & D=6")	0.000414916	0.000859	0.001447	0.003039	0.005172	0.007836	0.009366	0.011025	0.014736
9-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
10- disc filter								0.05555	0.410125
11- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
12- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
13- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
14- check valve 6" (k=1.85)	0.003212317	0.007228	0.012849	0.028911	0.051397	0.080308	0.097173	0.115643	0.157404
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- steel pipe (L=5m & D=6")	0.001383054	0.002864	0.004824	0.010131	0.017241	0.026121	0.031218	0.036751	0.049119
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- ductile pipe (L=1.3m & D=6")	0.000383531	0.000829	0.001441	0.003161	0.005543	0.008586	0.010355	0.012288	0.016651
17-gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
18- pvc pipe (L=50m & D=160mm)	0.024036685	0.049265	0.082195	0.169715	0.28457	0.425487	0.505426	0.591559	0.782091
19-elbow 6" (k=0.45)	0.001279782	0.00288	0.005119	0.011518	0.020477	0.031995	0.038713	0.046072	0.062709
20- pvc pipe (L=270m & D=160mm)	0.1297981	0.266031	0.44385	0.916463	1.536678	2.297629	2.729299	3.194417	4.22329
21- branch tee 6" (k=0.9)	0.002211018	0.004975	0.008844	0.019899	0.035376	0.055275	0.066883	0.079597	0.10834
22- gate valve 6" (k=0.12)	0.000294802	0.000663	0.001179	0.002653	0.004717	0.00737	0.008918	0.010613	0.014445
23- pvc pipe (L=145m & D=160mm)	0.059508331	0.122036	0.203683	0.420778	0.705783	1.055557	1.25401	1.467862	1.940984
24-through tee 6" (k=0.28)	0.000213564	0.000481	0.000854	0.001922	0.003417	0.005339	0.00646	0.007688	0.010465
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.004035132	0.009079	0.016141	0.036316	0.064562	0.100878	0.122063	0.145265	0.197721
26-gate valve 4" (k=0.14)	0.000478745	0.001077	0.001915	0.004309	0.00766	0.011969	0.014482	0.017235	0.023458
27-pvc pipe (L=234m & D=110mm)	0.210772005	0.430662	0.71709	1.476861	2.472256	3.692137	4.383703	5.128585	6.775546
28-pvc pipe (L=220m & D=110mm)	0.153259073	0.312583	0.519853	1.068935	1.787443	2.667217	3.165704	3.702449	4.888695
29-saddle (110mm-63mm) (k=1.7)	0.007151473	0.016091	0.028606	0.064363	0.114424	0.178787	0.216332	0.257453	0.350422
30- pvc riser pipe(L=1.5 m & D=63mm)	0.003256091	0.006617	0.010979	0.022511	0.037575	0.055999	0.066432	0.077662	0.102472
31- elbow 63mm (k=0.54)	0.002271644	0.005111	0.009087	0.020445	0.036346	0.056791	0.068717	0.081779	0.111311
32- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.047808858	0.10757	0.191235	0.43028	0.764942	1.195221	1.446218	1.721119	2.342634
33-gate valve 1.5" (k=0.15)	0.003897461	0.008769	0.01559	0.035077	0.062359	0.097437	0.117898	0.140309	0.190976
34- solenoid valve 1.5" (kv=18.6)	0.160711026	0.3616	0.642844	1.446399	2.571374	4.017776	4.861509	5.785597	7.87484
total									
	0.825392159	1.737459	2.955421	6.273977	10.73179	16.29808	19.48981	23.00645	31.08361

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Step1- **Δp** of (D16@41.1GPM)=TDH(D34@28.1GPM)-TDH(D16@41.1GPM) =2.57137 m

$$\Delta p = \frac{Q^2}{Kv^2}$$

Q		Δp	
Gpm	m3/h	m	bar
0	0	0	0
10.275	2.333706	0.160711	0.01576
15.4125	3.50056	0.3616	0.035461
20.55	4.667413	0.642844	0.063041
30.825	7.001119	1.446399	0.141843
41.1	9.334825	**2.571374**	0.252166
51.375	11.66853	4.017776	0.394009
56.5125	12.83539	4.861509	0.476751
61.65	14.00224	5.785597	0.567373
71.925	16.33594	7.87484	0.772258

Note:- TDH(D16) is the total dynamic head of **D16** path before calculating **Hf** of **D16** solenoid valve, then it recalculated and corrected again after Calculating **Kv**

Step2- $Kv = Q(m3/h)\sqrt{\frac{1}{\Delta p(bar)}}$

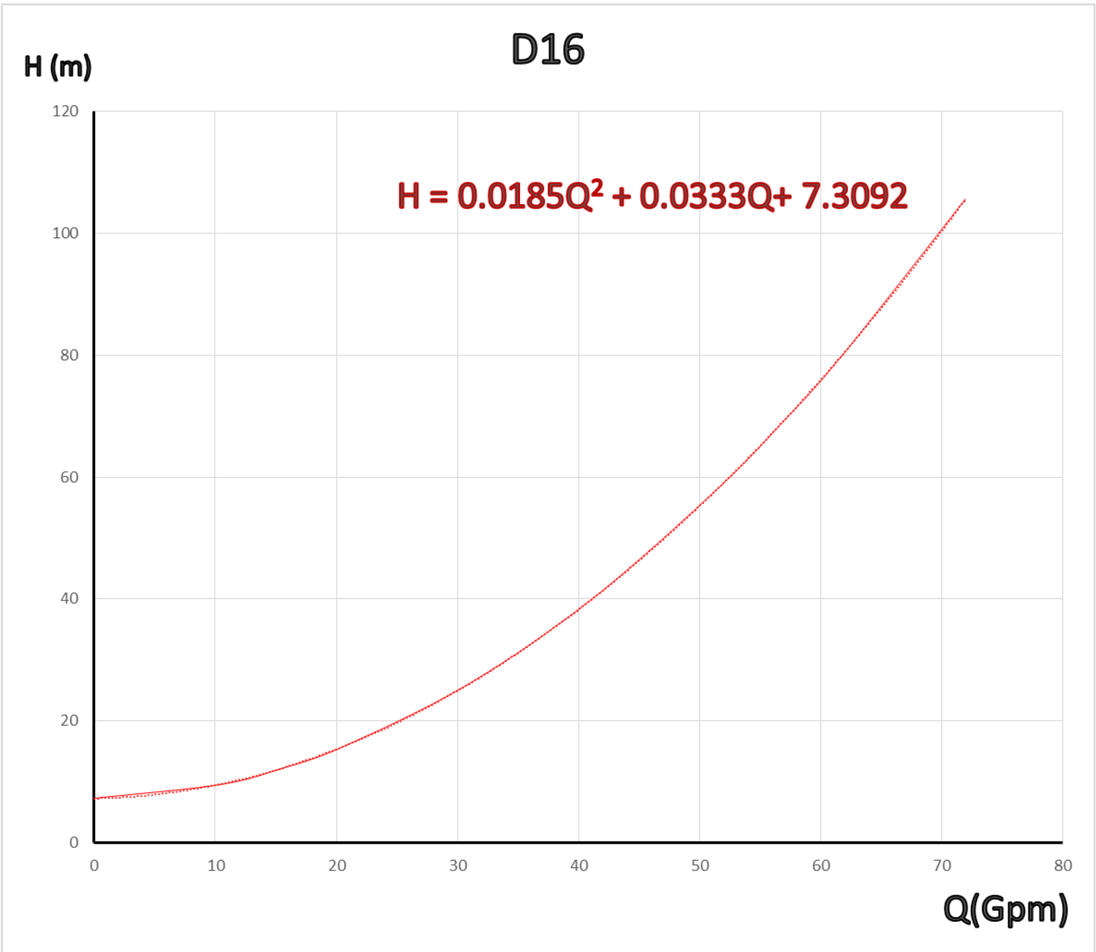
Kv=18.6

step3- $\Delta p = \frac{Q^2}{Kv^2}$

Step4

Q(G pm)	Hf	Hs	lateral line	TDH (m)
0	0	7	0	7.35
10.275	0.825392	7	1.274645	9.555039
15.4125	1.737459	7	2.867952	12.18568
20.55	2.955421	7	5.098581	15.8067
30.825	6.273977	7	11.47181	25.98307
41.1	10.73179	7	20.39432	40.03242
51.375	16.29808	7	31.86613	57.92242
56.5125	19.48981	7	38.55802	68.30022
61.65	23.00645	7	45.88723	79.68836
71.925	31.08361	7	62.45762	105.5683

Step5



Step6

Q(G pm)	TDH (m)
0	7.35
11.19374	10
25.30685	20
34.13341	30
41.14617	40
47.14603	50
52.47566	60
57.31943	70
61.79005	80
65.96242	90
69.88929	100
73.60949	110

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⑫- valve D23 calculations

	Range of flow rates								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
D35	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D23	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D16	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
D17	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D18	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
D32	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D33	9	13.5	18	27	36	45	49.5	54	63
D34	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175

flow velocity

$$V = \frac{Q}{A}$$

Renold number

$$Re = \frac{v * D}{kinematic\ viscosity}$$

swamee-jain equation

$$f = \frac{0.25}{[log10(\frac{\varepsilon}{3.7D} + \frac{5.74}{Re^{0.9}})]^2}$$

darcy-weisbach equation (pipes)

$$Hf = f(\frac{L}{D})\frac{v^2}{2g}$$

darcy-weisbach equation (fittings)

$$Hf = K\frac{v^2}{2g}$$

D23 path elements	Q(Gpm)								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1- ductile pipe (L=1.7m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
1'-pipe entry (k=0.78)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
2- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
3- elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
4- Y strainer (k=1)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
5-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
7-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
8- steel pipe (L=1.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
9-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
10- disc filter	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
11- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
12- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
13- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
14- check valve 6" (k=1.85)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- steel pipe (L=5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- ductile pipe (L=1.3m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
17-gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
18- pvc pipe (L=50m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
19-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
20- pvc pipe (L=270m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
21- branch tee 6" (k=0.9)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
22- gate valve 6" (k=0.12)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
23- pvc pipe (L=145m & D=160mm)	50.7	76.05	101.4	152.1	202.8	253.5	278.85	304.2	354.9
24-through tee 6" (k=0.28)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
26-gate valve 4" (k=0.14)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
27-pvc pipe (L=234m & D=110mm)	28.25	42.375	56.5	84.75	113	141.25	155.375	169.5	197.75
28-branch tee 4" (k=1.02)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
29-pvc pipe (L=89m & D=110mm)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
30-saddle (110mm-63mm) (k=1.7)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
31- pvc riser pipe(L=1.5 m & D=63mm)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
32- elbow 63mm (k=0.54)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
33- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
34-gate valve 1.5" (k=0.15)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
35- solenoid valve 1.5" (kv=4.9)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95

D23 path elements	V(m/s)								
	V1	V2	V3	V4	V5	V6	V7	V8	V9
1- ductile pipe (L=1.7m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
1'-pipe entry (k=0.78)	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
2- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
3- elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
4- Y strainer (k=1)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
5-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
7-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
8- steel pipe (L=1.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
9-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
10- disc filter	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
11- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
12- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
13- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
14- check valve 6" (k=1.85)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- steel pipe (L=5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- ductile pipe (L=1.3m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
17-gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
18- pvc pipe (L=50m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
19-elbow 6" (k=0.45)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
20- pvc pipe (L=270m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
21- branch tee 6" (k=0.9)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
22- gate valve 6" (k=0.12)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
23- pvc pipe (L=145m & D=160mm)	0.219545	0.329318	0.439091	0.658636	0.878182	1.097727	1.2075	1.317273	1.536818
24-through tee 6" (k=0.28)	0.122331	0.183496	0.244661	0.366992	0.489322	0.611653	0.672818	0.733983	0.856314
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
26-gate valve 4" (k=0.14)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
27-pvc pipe (L=234m & D=110mm)	0.259022	0.388534	0.518045	0.777067	1.03609	1.295112	1.424623	1.554135	1.813157
28-branch tee 4" (k=1.02)	0.0353	0.052951	0.070601	0.105901	0.141202	0.176502	0.194152	0.211802	0.247103
29-pvc pipe (L=89m & D=110mm)	0.0353	0.052951	0.070601	0.105901	0.141202	0.176502	0.194152	0.211802	0.247103
30-saddle (110mm-63mm) (k=1.7)	0.107647	0.16147	0.215294	0.322941	0.430588	0.538235	0.592058	0.645882	0.753529
31- pvc riser pipe(L=1.5 m & D=63mm)	0.107647	0.16147	0.215294	0.322941	0.430588	0.538235	0.592058	0.645882	0.753529
32- elbow 63mm (k=0.54)	0.107647	0.16147	0.215294	0.322941	0.430588	0.538235	0.592058	0.645882	0.753529
33- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.267531	0.401296	0.535061	0.802592	1.070123	1.337654	1.471419	1.605184	1.872715
34-gate valve 1.5" (k=0.15)	0.267531	0.401296	0.535061	0.802592	1.070123	1.337654	1.471419	1.605184	1.872715
35- solenoid valve 1.5" (kv=4.9)	0.267531	0.401296	0.535061	0.802592	1.070123	1.337654	1.471419	1.605184	1.872715

D23 path elements	Re								
	Re1	Re2	Re3	Re4	Re5	Re6	Re7	Re8	Re9
1- ductile pipe (L=1.7m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
19-elbow 6" (k=0.45)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
20- pvc pipe (L=270m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	33827.55784	50741.34	67655.12	101482.7	135310.2	169137.8	186051.6	202965.3	236792.9
24-through tee 6" (k=0.28)									
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
26-gate valve 4" (k=0.14)									
27-pvc pipe (L=234m & D=110mm)	24244.5006	36366.75	48489	72733.5	96978	121222.5	133344.8	145467	169711.5
28-branch tee 4" (k=1.02)									
29-pvc pipe (L=89m & D=110mm)	3304.117781	4956.177	6608.236	9912.353	13216.47	16520.59	18172.65	19824.71	23128.82
30-saddle (110mm-63mm) (k=1.7)									
31- pvc riser pipe(L=1.5 m & D=63mm)	5769.876149	8654.814	11539.75	17309.63	23079.5	28849.38	31734.32	34619.26	40389.13
32- elbow 63mm (k=0.54)									
33- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
34-gate valve 1.5" (k=0.15)									
35- solenoid valve 1.5" (kv=4.9)									

D23 path elements	f								
	f1	f2	f3	f4	f5	f6	f7	f8	f9
1- ductile pipe (L=1.7m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	0.024545	0.022592	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	0.030883	0.029671	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
19-elbow 6" (k=0.45)									
20- pvc pipe (L=270m & D=160mm)	0.023023	0.020972	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=145m & D=160mm)	0.022753	0.020738	0.01947	0.017876	0.016866	0.016144	0.01585	0.01559	0.015146
24-through tee 6" (k=0.28)									
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
26-gate valve 4" (k=0.14)									
27-pvc pipe (L=234m & D=110mm)	0.024655	0.022389	0.02097	0.019195	0.018074	0.017275	0.016951	0.016664	0.016175
28-branch tee 4" (k=1.02)									
29-pvc pipe (L=89m & D=110mm)	0.043124	0.037968	0.034852	0.031076	0.028758	0.027136	0.026485	0.025911	0.02494
30-saddle (110mm-63mm) (k=1.7)									
31- pvc riser pipe(L=1.5 m & D=63mm)	0.036288	0.032287	0.02984	0.026842	0.024986	0.023678	0.023152	0.022687	0.021899
32- elbow 63mm (k=0.54)									
33- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
34-gate valve 1.5" (k=0.15)									
35- solenoid valve 1.5" (kv=4.9)									

D23 path elements	Hf (m H₂o)								
	Hf1	Hf2	Hf3	Hf4	Hf5	Hf6	Hf7	Hf8	Hf9
1- ductile pipe (L=1.7m & D=6")	0.000501541	0.001084	0.001884	0.004134	0.007249	0.011228	0.013541	0.016069	0.021774
1'-pipe entry (k=0.78)	0.001186663	0.00267	0.004747	0.01068	0.018987	0.029667	0.035897	0.04272	0.058146
2- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
3- elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
4- Y strainer (k=1)	0.001736388	0.003907	0.006946	0.015627	0.027782	0.04341	0.052526	0.06251	0.085083
5-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
7-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
8- steel pipe (L=1.5m & D=6")	0.000414916	0.000859	0.001447	0.003039	0.005172	0.007836	0.009366	0.011025	0.014736
9-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
10- disc filter								0.05555	0.410125
11- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
12- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
13- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
14- check valve 6" (k=1.85)	0.003212317	0.007228	0.012849	0.028911	0.051397	0.080308	0.097173	0.115643	0.157404
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- steel pipe (L=5m & D=6")	0.001383054	0.002864	0.004824	0.010131	0.017241	0.026121	0.031218	0.036751	0.049119
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- ductile pipe (L=1.3m & D=6")	0.000383531	0.000829	0.001441	0.003161	0.005543	0.008586	0.010355	0.012288	0.016651
17-gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
18- pvc pipe (L=50m & D=160mm)	0.024036685	0.049265	0.082195	0.169715	0.28457	0.425487	0.505426	0.591559	0.782091
19-elbow 6" (k=0.45)	0.001279782	0.00288	0.005119	0.011518	0.020477	0.031995	0.038713	0.046072	0.062709
20- pvc pipe (L=270m & D=160mm)	0.1297981	0.266031	0.44385	0.916463	1.536678	2.297629	2.729299	3.194417	4.22329
21- branch tee 6" (k=0.9)	0.002211018	0.004975	0.008844	0.019899	0.035376	0.055275	0.066883	0.079597	0.10834
22- gate valve 6" (k=0.12)	0.000294802	0.000663	0.001179	0.002653	0.004717	0.00737	0.008918	0.010613	0.014445
23- pvc pipe (L=145m & D=160mm)	0.059508331	0.122036	0.203683	0.420778	0.705783	1.055557	1.25401	1.467862	1.940984
24-through tee 6" (k=0.28)	0.000213564	0.000481	0.000854	0.001922	0.003417	0.005339	0.00646	0.007688	0.010465
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.004035132	0.009079	0.016141	0.036316	0.064562	0.100878	0.122063	0.145265	0.197721
26-gate valve 4" (k=0.14)	0.000478745	0.001077	0.001915	0.004309	0.00766	0.011969	0.014482	0.017235	0.023458
27-pvc pipe (L=234m & D=110mm)	0.210772005	0.430662	0.71709	1.476861	2.472256	3.692137	4.383703	5.128585	6.775546
28-branch tee 4" (k=1.02)	6.47829E-05	0.000146	0.000259	0.000583	0.001037	0.00162	0.00196	0.002332	0.003174
29-pvc pipe (L=89m & D=110mm)	0.00260429	0.005159	0.008419	0.01689	0.027788	0.04097	0.048384	0.056334	0.073803
30-saddle (110mm-63mm) (k=1.7)	0.001004045	0.002259	0.004016	0.009036	0.016065	0.025101	0.030372	0.036146	0.049198
31- pvc riser pipe(L=1.5 m & D=63mm)	0.000599784	0.001201	0.001973	0.003993	0.006608	0.009784	0.011576	0.013499	0.017735
32- elbow 63mm (k=0.54)	0.000318932	0.000718	0.001276	0.00287	0.005103	0.007973	0.009648	0.011482	0.015628
33- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.00671222	0.015102	0.026849	0.06041	0.107396	0.167805	0.203045	0.24164	0.328899
34-gate valve 1.5" (k=0.15)	0.000547192	0.001231	0.002189	0.004925	0.008755	0.01368	0.016553	0.019699	0.026812
35- solenoid valve 1.5" (kv=4.9)	0.325107334	0.731492	1.300429	2.925966	5.201712	8.127683	9.834497	11.70386	15.93026
total	0.783995112	1.676425	2.882636	6.21064	10.73179	16.42347	19.70304	23.32508	31.66777

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Step1- **Δp** of (D23@15.4GPM)=TDH(D34@28.1GPM)-TDH(D23@15.4GPM) =5.20171 m

Note:- TDH(D23) is the total dynamic head of **D23** path before calculating **Hf** of **D23** solenoid valve, then it recalculated and corrected again after Calculating **Kv**

$$\Delta p = \frac{Q^2}{Kv^2}$$

Q		Δp	
Gpm	m3/h	m	bar
0	0	0	0
3.85	0.87443	0.325107	0.031882
5.775	1.311645	0.731492	0.071735
7.7	1.74886	1.300429	0.127529
11.55	2.62329	2.925966	0.286939
15.4	3.49772	**5.201712**	0.510114
19.25	4.372151	8.127683	0.797053
21.175	4.809366	9.834497	0.964435
23.1	5.246581	11.70386	1.147757
26.95	6.121011	15.93026	1.562225

Step2- $Kv = Q(m3/h)\sqrt{\frac{1}{\Delta p(bar)}}$

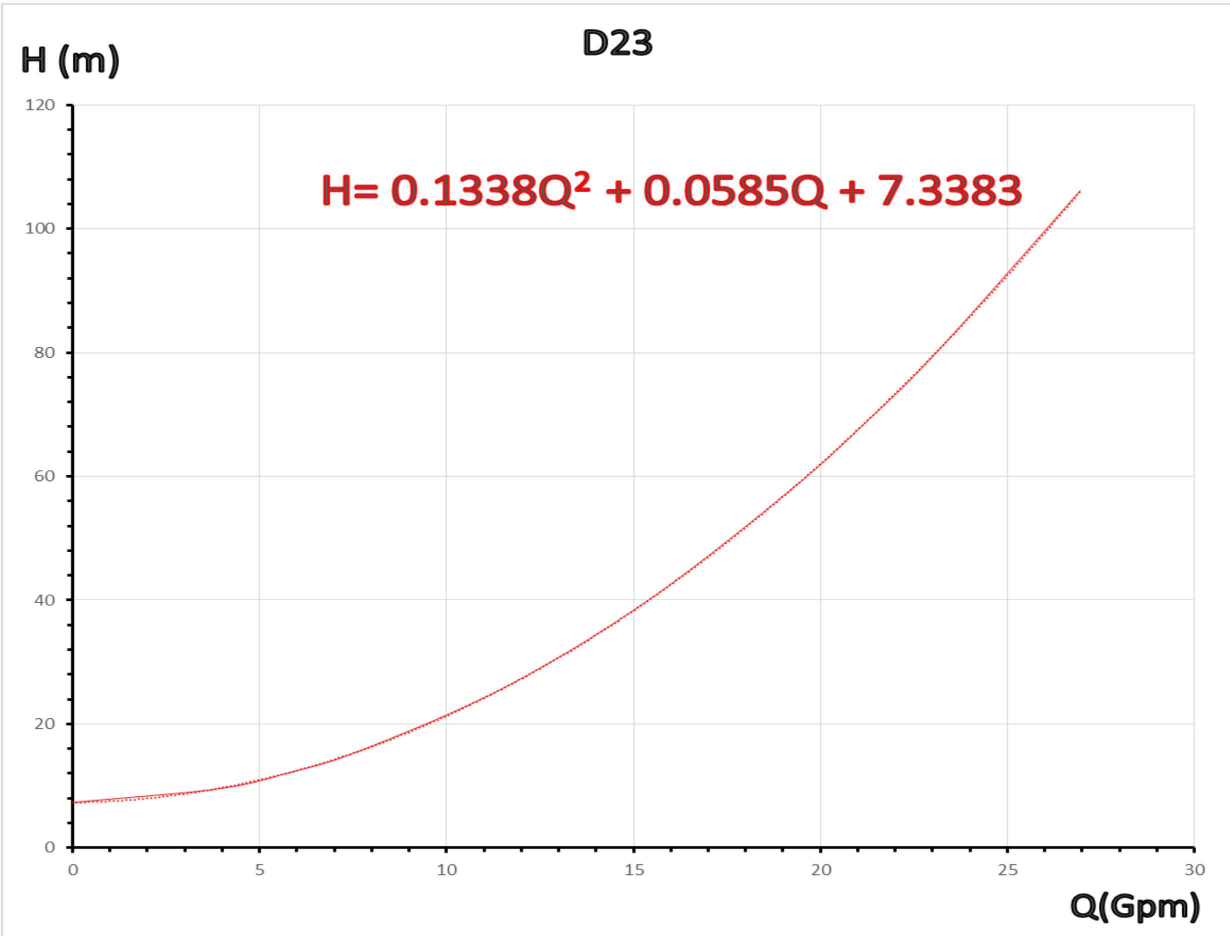
Kv=4.9

step3- $\Delta p = \frac{Q^2}{Kv^2}$

Step4

Q(G pm)	Hf	Hs	lateral line	TDH (m)
0	0	7	0	7.35
3.85	0.783995	7	1.274645	9.511572
5.775	1.676425	7	2.867952	12.1216
7.7	2.882636	7	5.098581	15.73028
11.55	6.21064	7	11.47181	25.91657
15.4	10.73179	7	20.39432	40.03242
19.25	16.42347	7	31.86613	58.05408
21.175	19.70304	7	38.55802	68.52411
23.1	23.32508	7	45.88723	80.02292
26.95	31.66777	7	62.45762	106.1817

Step5



Step6

Q(G pm)	TDH (m)
0	7.35
4.246915	10
9.511721	20
12.79745	30
15.40689	40
17.63901	50
19.62158	60
21.42328	70
23.08611	80
24.63794	90
26.09843	100
27.48202	110

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⑬ - valve D35 calculations

	Range of flow rates								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
D35	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D23	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
D16	10.275	15.4125	20.55	30.825	41.1	51.375	56.5125	61.65	71.925
D17	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D18	7.7	11.55	15.4	23.1	30.8	38.5	42.35	46.2	53.9
D32	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
D33	9	13.5	18	27	36	45	49.5	54	63
D34	7.025	10.5375	14.05	21.075	28.1	35.125	38.6375	42.15	49.175

flow velocity

$$V = \frac{Q}{A}$$

Renold number

$$Re = \frac{v * D}{kinematic\ viscosity}$$

swamee-jain equation

$$f = \frac{0.25}{[log10(\frac{\varepsilon}{3.7D} + \frac{5.74}{Re^{0.9}})]^2}$$

darcy-weisbach equation (pipes)

$$Hf = f(\frac{L}{D})\frac{v^2}{2g}$$

darcy-weisbach equation (fittings)

$$Hf = K\frac{v^2}{2g}$$

D35 path elements	Q(Gpm)								
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1- ductile pipe (L=1.7m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
1'-pipe entry (k=0.78)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
2- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
3- elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
4- Y strainer (k=1)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
5-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
7-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
8- steel pipe (L=1.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
9-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
10- disc filter	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
11- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
12- gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
13- steel pipe (L=0.5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
14- check valve 6" (k=1.85)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- steel pipe (L=5m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
15-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
16- ductile pipe (L=1.3m & D=6")	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
17-gate valve 6" (k=0.12)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
18- pvc pipe (L=50m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
19-elbow 6" (k=0.45)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
20- pvc pipe (L=270m & D=160mm)	54.55	81.825	109.1	163.65	218.2	272.75	300.025	327.3	381.85
21- branch tee 6" (k=0.9)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
22- gate valve 6" (k=0.12)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
23- pvc pipe (L=160m & D=160mm)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
24-elbow 6" (k=0.45)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
26-(3 gate valve 4") (k=0.14)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
27-pvc pipe (L=383m+190m+96m & D=110mm)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
28-(2elbow 4") (k=0.51)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
28-saddle (110mm-63mm) (k=1.7)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
29 pvc riser pipe(L=1.5 m & D=63mm)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
30- elbow 63mm (k=0.54)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
31- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
32-gate valve 1.5" (k=0.15)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95
33- solenoid valve 1.5" (kv=3.9)	3.85	5.775	7.7	11.55	15.4	19.25	21.175	23.1	26.95

D35 path elements	V(m/s)								
	V1	V2	V3	V4	V5	V6	V7	V8	V9
1- ductile pipe (L=1.7m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
1'-pipe entry (k=0.78)	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
2- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
3- elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
4- Y strainer (k=1)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
5-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
7-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
8- steel pipe (L=1.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
9-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
10- disc filter	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
11- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
12- gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
13- steel pipe (L=0.5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
14- check valve 6" (k=1.85)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- steel pipe (L=5m & D=6")	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
15-elbow 6" (k=0.45)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
16- ductile pipe (L=1.3m & D=6")	0.172769	0.259154	0.345538	0.518307	0.691076	0.863845	0.95023	1.036614	1.209383
17-gate valve 6" (k=0.12)	0.184575	0.276862	0.36915	0.553725	0.7383	0.922875	1.015162	1.10745	1.292025
18- pvc pipe (L=50m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
19-elbow 6" (k=0.45)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
20- pvc pipe (L=270m & D=160mm)	0.236217	0.354326	0.472434	0.708651	0.944868	1.181085	1.299194	1.417302	1.653519
21- branch tee 6" (k=0.9)	0.016672	0.025007	0.033343	0.050015	0.066686	0.083358	0.091694	0.10003	0.116701
22- gate valve 6" (k=0.12)	0.016672	0.025007	0.033343	0.050015	0.066686	0.083358	0.091694	0.10003	0.116701
23- pvc pipe (L=160m & D=160mm)	0.016672	0.025007	0.033343	0.050015	0.066686	0.083358	0.091694	0.10003	0.116701
24-elbow 6" (k=0.45)	0.016672	0.025007	0.033343	0.050015	0.066686	0.083358	0.091694	0.10003	0.116701
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	0.0353	0.052951	0.070601	0.105901	0.141202	0.176502	0.194152	0.211802	0.247103
26-(3 gate valve 4") (k=0.14)	0.0353	0.052951	0.070601	0.105901	0.141202	0.176502	0.194152	0.211802	0.247103
27-pvc pipe (L=383m+190m+96m & D=110mm)	0.0353	0.052951	0.070601	0.105901	0.141202	0.176502	0.194152	0.211802	0.247103
28-(2elbow 4") (k=0.51)	0.0353	0.052951	0.070601	0.105901	0.141202	0.176502	0.194152	0.211802	0.247103
28-saddle (110mm-63mm) (k=1.7)	0.107647	0.16147	0.215294	0.322941	0.430588	0.538235	0.592058	0.645882	0.753529
29 pvc riser pipe(L=1.5 m & D=63mm)	0.107647	0.16147	0.215294	0.322941	0.430588	0.538235	0.592058	0.645882	0.753529
30- elbow 63mm (k=0.54)	0.107647	0.16147	0.215294	0.322941	0.430588	0.538235	0.592058	0.645882	0.753529
31- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.267531	0.401296	0.535061	0.802592	1.070123	1.337654	1.471419	1.605184	1.872715
32-gate valve 1.5" (k=0.15)	0.267531	0.401296	0.535061	0.802592	1.070123	1.337654	1.471419	1.605184	1.872715
33- solenoid valve 1.5" (kv=3.9)	0.267531	0.401296	0.535061	0.802592	1.070123	1.337654	1.471419	1.605184	1.872715

D35 path elements	Re								
	Re1	Re2	Re3	Re4	Re5	Re6	Re7	Re8	Re9
1- ductile pipe (L=1.7m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	28439.3151	42658.97	56878.63	85317.95	113757.3	142196.6	156416.2	170635.9	199075.2
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	27514.85356	41272.28	55029.71	82544.56	110059.4	137574.3	151331.7	165089.1	192604
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
19-elbow 6" (k=0.45)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
20- pvc pipe (L=270m & D=160mm)	32172.75699	48259.14	64345.51	96518.27	128691	160863.8	176950.2	193036.5	225209.3
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=160m & D=160mm)	2568.759323	3853.139	5137.519	7706.278	10275.04	12843.8	14128.18	15412.56	17981.32
24-elbow 6" (k=0.45)									
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
26-(3 gate valve 4") (k=0.14)									
27-pvc pipe (L=383m+190m+96m & D=110mm)	3304.117781	4956.177	6608.236	9912.353	13216.47	16520.59	18172.65	19824.71	23128.82
28-(2elbow 4") (k=0.51)									
28-saddle (110mm-63mm) (k=1.7)									
29 pvc riser pipe(L=1.5 m & D=63mm)	5769.876149	8654.814	11539.75	17309.63	23079.5	28849.38	31734.32	34619.26	40389.13
30- elbow 63mm (k=0.54)									
31- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
32-gate valve 1.5" (k=0.15)									
33- solenoid valve 1.5" (kv=3.9)									

D35 path elements	f								
	f1	f2	f3	f4	f5	f6	f7	f8	f9
1- ductile pipe (L=1.7m & D=6")	0.030883	0.029670929	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
1'-pipe entry (k=0.78)									
2- gate valve 6" (k=0.12)									
3- elbow 6" (k=0.45)									
4- Y strainer (k=1)									
5-elbow 6" (k=0.45)									
7-elbow 6" (k=0.45)									
8- steel pipe (L=1.5m & D=6")	0.024545	0.022591552	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
9-elbow 6" (k=0.45)									
10- disc filter									
11- steel pipe (L=0.5m & D=6")	0.024545	0.022591552	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
12- gate valve 6" (k=0.12)									
13- steel pipe (L=0.5m & D=6")	0.024545	0.022591552	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
14- check valve 6" (k=1.85)									
15-elbow 6" (k=0.45)									
16- steel pipe (L=5m & D=6")	0.024545	0.022591552	0.021404	0.019978	0.019124	0.018543	0.018315	0.018118	0.01779
15-elbow 6" (k=0.45)									
16- ductile pipe (L=1.3m & D=6")	0.030883	0.029670929	0.029006	0.028285	0.027898	0.027655	0.027563	0.027486	0.027363
17-gate valve 6" (k=0.12)									
18- pvc pipe (L=50m & D=160mm)	0.023023	0.02097202	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
19-elbow 6" (k=0.45)									
20- pvc pipe (L=270m & D=160mm)	0.023023	0.02097202	0.019682	0.018062	0.017035	0.016302	0.016004	0.015739	0.015288
21- branch tee 6" (k=0.9)									
22- gate valve 6" (k=0.12)									
23- pvc pipe (L=160m & D=160mm)	0.046868	0.041045949	0.03755	0.033335	0.030762	0.028967	0.028248	0.027615	0.026544
24-elbow 6" (k=0.45)									
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)									
26-(3 gate valve 4") (k=0.14)									
27-pvc pipe (L=383m+190m+96m & D=110mm)	0.043124	0.037967982	0.034852	0.031076	0.028758	0.027136	0.026485	0.025911	0.02494
28-(2elbow 4") (k=0.51)									
28-saddle (110mm-63mm) (k=1.7)									
29 pvc riser pipe(L=1.5 m & D=63mm)	0.036288	0.032287237	0.02984	0.026842	0.024986	0.023678	0.023152	0.022687	0.021899
30- elbow 63mm (k=0.54)									
31- sudden contraction (D1=63mm & d2=40mm) (k=1.84)									
32-gate valve 1.5" (k=0.15)									
33- solenoid valve 1.5" (kv=3.9)									

D35 path elements	Hf (m H_2o)								
	Hf1	Hf2	Hf3	Hf4	Hf5	Hf6	Hf7	Hf8	Hf9
1- ductile pipe (L=1.7m & D=6")	0.000501541	0.001084	0.001884	0.004134	0.007249	0.011228	0.013541	0.016069	0.021774
1'-pipe entry (k=0.78)	0.001186663	0.00267	0.004747	0.01068	0.018987	0.029667	0.035897	0.04272	0.058146
2- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
3- elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
4- Y strainer (k=1)	0.001736388	0.003907	0.006946	0.015627	0.027782	0.04341	0.052526	0.06251	0.085083
5-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
7-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
8- steel pipe (L=1.5m & D=6")	0.000414916	0.000859	0.001447	0.003039	0.005172	0.007836	0.009366	0.011025	0.014736
9-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
10- disc filter								0.05555	0.410125
11- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
12- gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
13- steel pipe (L=0.5m & D=6")	0.000138305	0.000286	0.000482	0.001013	0.001724	0.002612	0.003122	0.003675	0.004912
14- check valve 6" (k=1.85)	0.003212317	0.007228	0.012849	0.028911	0.051397	0.080308	0.097173	0.115643	0.157404
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- steel pipe (L=5m & D=6")	0.001383054	0.002864	0.004824	0.010131	0.017241	0.026121	0.031218	0.036751	0.049119
15-elbow 6" (k=0.45)	0.000781375	0.001758	0.003125	0.007032	0.012502	0.019534	0.023637	0.028129	0.038287
16- ductile pipe (L=1.3m & D=6")	0.000383531	0.000829	0.001441	0.003161	0.005543	0.008586	0.010355	0.012288	0.016651
17-gate valve 6" (k=0.12)	0.000208367	0.000469	0.000833	0.001875	0.003334	0.005209	0.006303	0.007501	0.01021
18- pvc pipe (L=50m & D=160mm)	0.024036685	0.049265	0.082195	0.169715	0.28457	0.425487	0.505426	0.591559	0.782091
19-elbow 6" (k=0.45)	0.001279782	0.00288	0.005119	0.011518	0.020477	0.031995	0.038713	0.046072	0.062709
20- pvc pipe (L=270m & D=160mm)	0.1297981	0.266031	0.44385	0.916463	1.536678	2.297629	2.729299	3.194417	4.22329
21- branch tee 6" (k=0.9)	1.27496E-05	2.87E-05	5.1E-05	0.000115	0.000204	0.000319	0.000386	0.000459	0.000625
22- gate valve 6" (k=0.12)	1.69995E-06	3.82E-06	6.8E-06	1.53E-05	2.72E-05	4.25E-05	5.14E-05	6.12E-05	8.33E-05
23- pvc pipe (L=160m & D=160mm)	0.000779963	0.001537	0.0025	0.004993	0.008191	0.012051	0.01422	0.016544	0.021645
24-elbow 6" (k=0.45)	6.37482E-06	1.43E-05	2.55E-05	5.74E-05	0.000102	0.000159	0.000193	0.000229	0.000312
25-sudden contraction (D1=160mm & d2=110mm) (k=1.18)	7.49449E-05	0.000169	0.0003	0.000675	0.001199	0.001874	0.002267	0.002698	0.003672
26-(3 gate valve 4") (k=0.14)	2.66753E-05	6E-05	0.000107	0.00024	0.000427	0.000667	0.000807	0.00096	0.001307
27-pvc pipe (L=383m+190m+96m & D=110mm)	0.019576064	0.03878	0.063285	0.126961	0.208878	0.307962	0.363696	0.423452	0.554764
28-(2elbow 4") (k=0.51)	6.47829E-05	0.000146	0.000259	0.000583	0.001037	0.00162	0.00196	0.002332	0.003174
28-saddle (110mm-63mm) (k=1.7)	0.001004045	0.002259	0.004016	0.009036	0.016065	0.025101	0.030372	0.036146	0.049198
29 pvc riser pipe(L=1.5 m & D=63mm)	0.000599784	0.001201	0.001973	0.003993	0.006608	0.009784	0.011576	0.013499	0.017735
30- elbow 63mm (k=0.54)	0.000318932	0.000718	0.001276	0.00287	0.005103	0.007973	0.009648	0.011482	0.015628
31- sudden contraction (D1=63mm & d2=40mm) (k=1.84)	0.00671222	0.015102	0.026849	0.06041	0.107396	0.167805	0.203045	0.24164	0.328899
32-gate valve 1.5" (k=0.15)	0.000547192	0.001231	0.002189	0.004925	0.008755	0.01368	0.016553	0.019699	0.026812
33- solenoid valve 1.5" (kv=3.9)	0.51901503	1.167784	2.07606	4.671135	8.304243	12.97538	15.7002	18.68454	25.43174
total	0.718263392	1.579178	2.766417	6.109236	10.73179	16.62474	20.04546	23.83698	32.6069

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Step1- **Δp** of (D35@15.4GPM)=TDH(D34@28.1GPM)-TDH(D35@15.4GPM) =8.30424 m

Note:- TDH(D35) is the total dynamic head of **D35** path before calculating **Hf** of **D35** solenoid valve, then it recalculated and corrected again after Calculating **Kv**

$$\Delta p = \frac{Q^2}{Kv^2}$$

Q		Δp	
Gpm	m3/h	m	bar
0	0	0	0
3.85	0.87443	0.519015	0.050898
5.775	1.311645	1.167784	0.11452
7.7	1.74886	2.07606	0.203592
11.55	2.62329	4.671135	0.458082
15.4	3.49772	**8.304243**	0.814368
19.25	4.372151	12.97538	1.27245
21.175	4.809366	15.7002	1.539664
23.1	5.246581	18.68454	1.832328
26.95	6.121011	25.43174	2.494001

Step2- $Kv = Q(m3/h)\sqrt{\frac{1}{\Delta p(bar)}}$

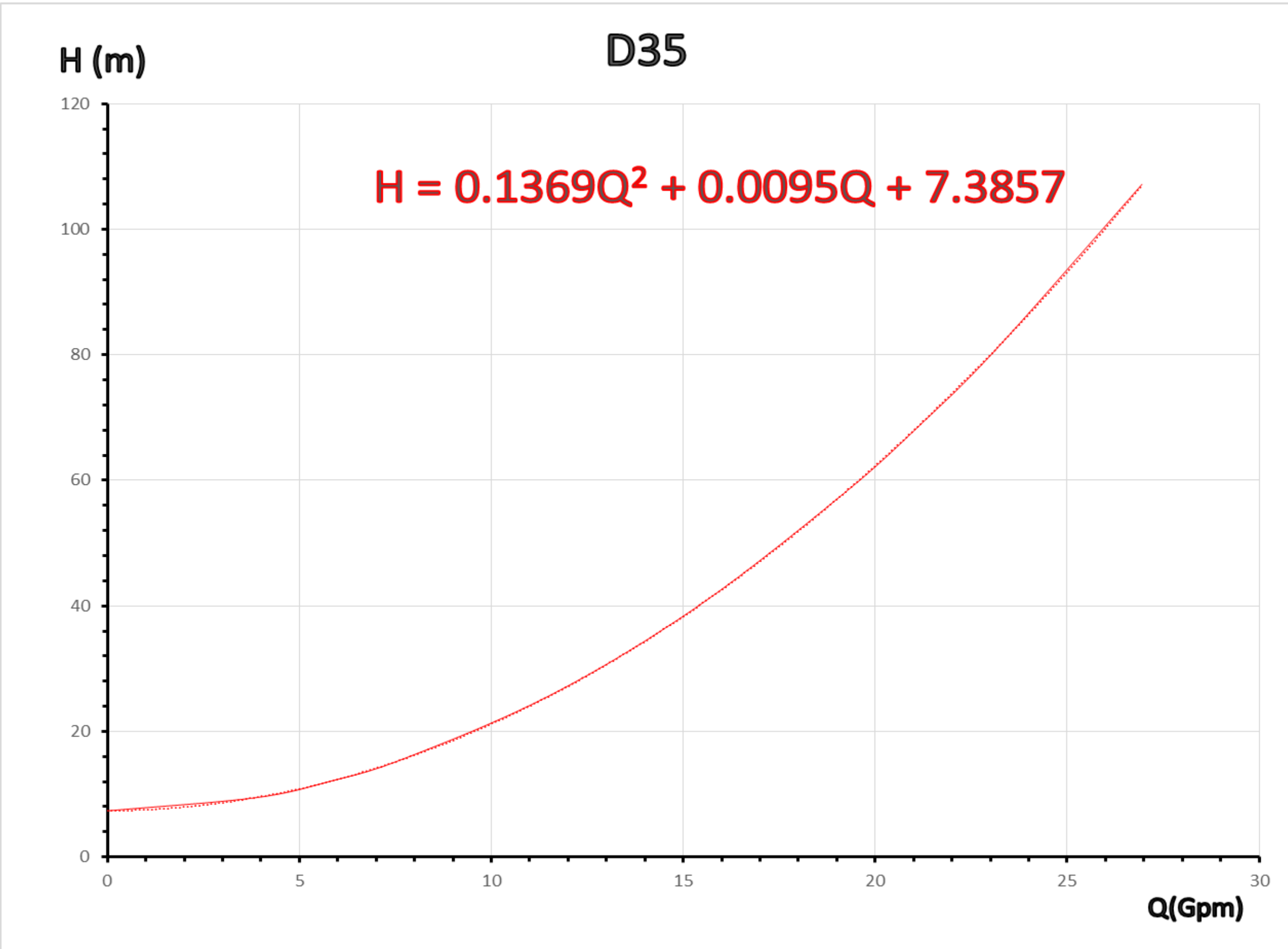
Kv = 3.9

step3- $\Delta p = \frac{Q^2}{Kv^2}$

Step4

Q(G pm)	Hf	Hs	lateral line	TDH (m)
0	0	7	0	7.35
3.85	0.718263	7	1.274645	9.442554
5.775	1.579178	7	2.867952	12.01949
7.7	2.766417	7	5.098581	15.60825
11.55	6.109236	7	11.47181	25.8101
15.4	10.73179	7	20.39432	40.03242
19.25	16.62474	7	31.86613	58.26541
21.175	20.04546	7	38.55802	68.88366
23.1	23.83698	7	45.88723	80.56042
26.95	32.6069	7	62.45762	107.1677

Step5



Step6

Q(G pm)	TDH (m)
0	7.35
4.335386	10
9.564451	20
12.81792	30
15.40019	40
17.60848	50
19.56958	60
21.3516	70
22.99615	80
24.53084	90
25.97514	100
27.34336	110

⑭ - system curve construction

- *System curve constructed from the summation of (Q's) of individual valves at constant (H's) as follow*

D34	
Q(Gpm)	TDH (m)
0	7.35
7.543326	10
17.22785	20
23.29928	30
28.12539	40
32.25532	50
35.92436	60
39.25919	70
42.33728	80
45.21014	90
47.91406	100
50.47573	110

D33	
Q(Gpm)	TDH (m)
0	7.35
9.691074	10
22.09599	20
29.86972	30
36.04846	40
41.33571	50
46.03281	60
50.302	70
54.24248	80
57.92021	90
61.38163	100
64.66095	110

D32	
Q(Gpm)	TDH (m)
0	7.35
6.940752	10
15.77796	20
21.31192	30
25.7098	40
29.4729	50
32.81585	60
35.85417	70
38.65851	80
41.27582	90
43.73918	100
46.07292	110

D18	
Q(Gpm)	TDH (m)
0	7.35
8.307442	10
18.89898	20
25.53283	30
30.80501	40
35.31629	50
39.32393	60
42.96639	70
46.32837	80
49.46614	90
52.41934	100
55.21716	110

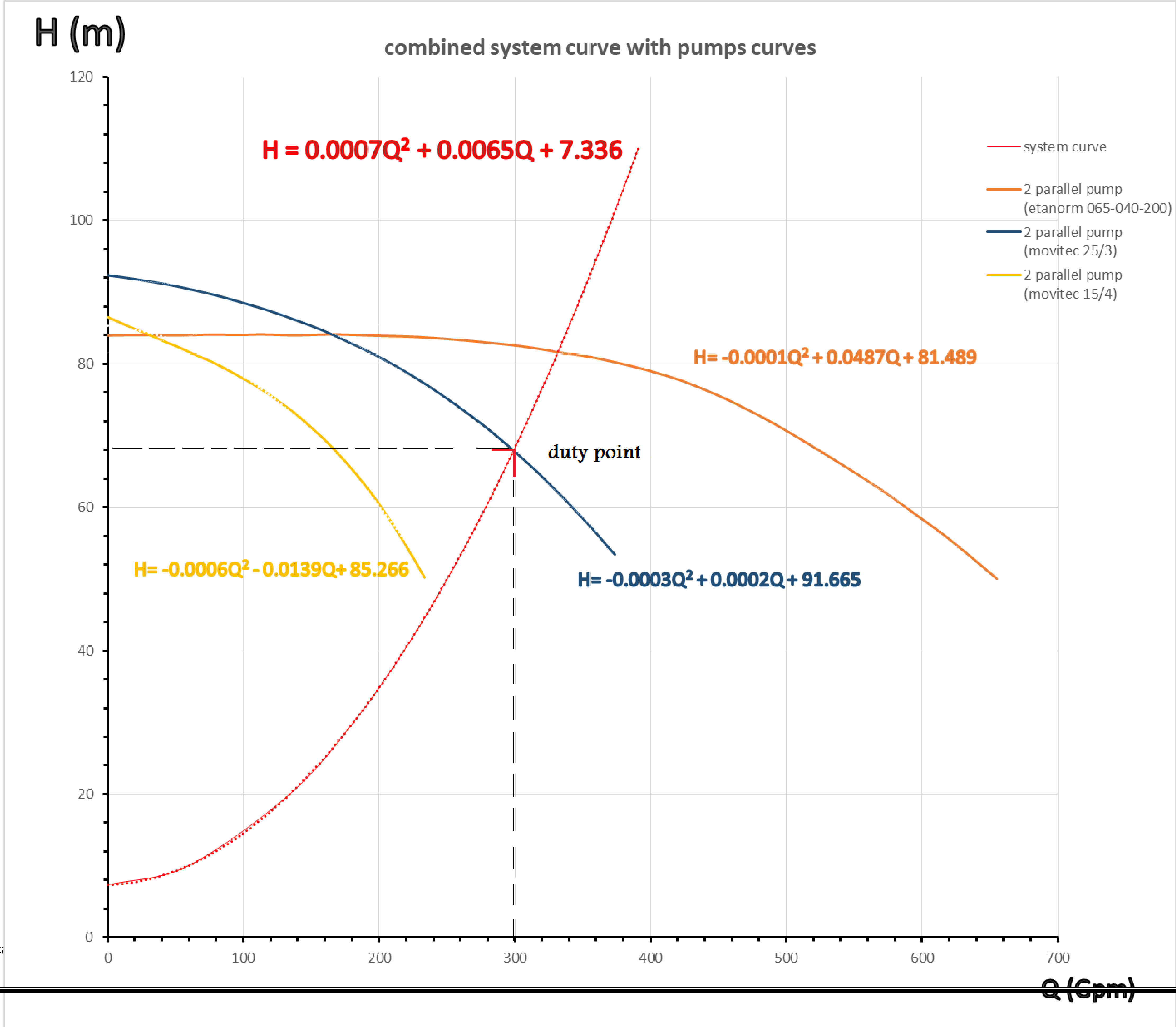
D17	
Q(Gpm)	TDH (m)
0	7.35
6.952372	10
15.79191	20
21.32637	30
25.72451	40
29.48776	50
32.83082	60
35.86922	70
38.67363	80
41.29099	90
43.75439	100
46.08817	110

D16	
Q(Gpm)	TDH (m)
0	7.35
11.19374	10
25.30685	20
34.13341	30
41.14617	40
47.14603	50
52.47566	60
57.31943	70
61.79005	80
65.96242	90
69.88929	100
73.60949	110

D23	
Q(G pm)	TDH
0	7.35
4.246915	10
9.511721	20
12.79745	30
15.40689	40
17.63901	50
19.62158	60
21.42328	70
23.08611	80
24.63794	90
26.09843	100
27.48202	110

D35	
Q(G pm)	TDH
0	7.35
4.335386	10
9.564451	20
12.81792	30
15.40019	40
17.60848	50
19.56958	60
21.3516	70
22.99615	80
24.53084	90
25.97514	100
27.34336	110

combined system curve	
Q(G pm)	TDH (m)
0	7.35
59.21101	10
134.1757	20
181.0889	30
218.3664	40
250.2615	50
278.5946	60
304.3453	70
328.1126	80
350.2945	90
371.1715	100
390.9498	110


H (m)
combined system curve with pumps curves
H = 0.0007Q² + 0.0065Q + 7.336
system curve
2 parallel pump (etanorm 065-040-200)
2 parallel pump (movitec 25/3)
2 parallel pump (movitec 15/4)
H= -0.0001Q² + 0.0487Q + 81.489
duty point
H= -0.0006Q² - 0.0139Q+ 85.266
H= -0.0003Q² + 0.0002Q + 91.665
120
100
80
60
40
20
0
0
100
200
300
400
500
600
700
Q (Gpm)

⓯- recommendations (selected pump)

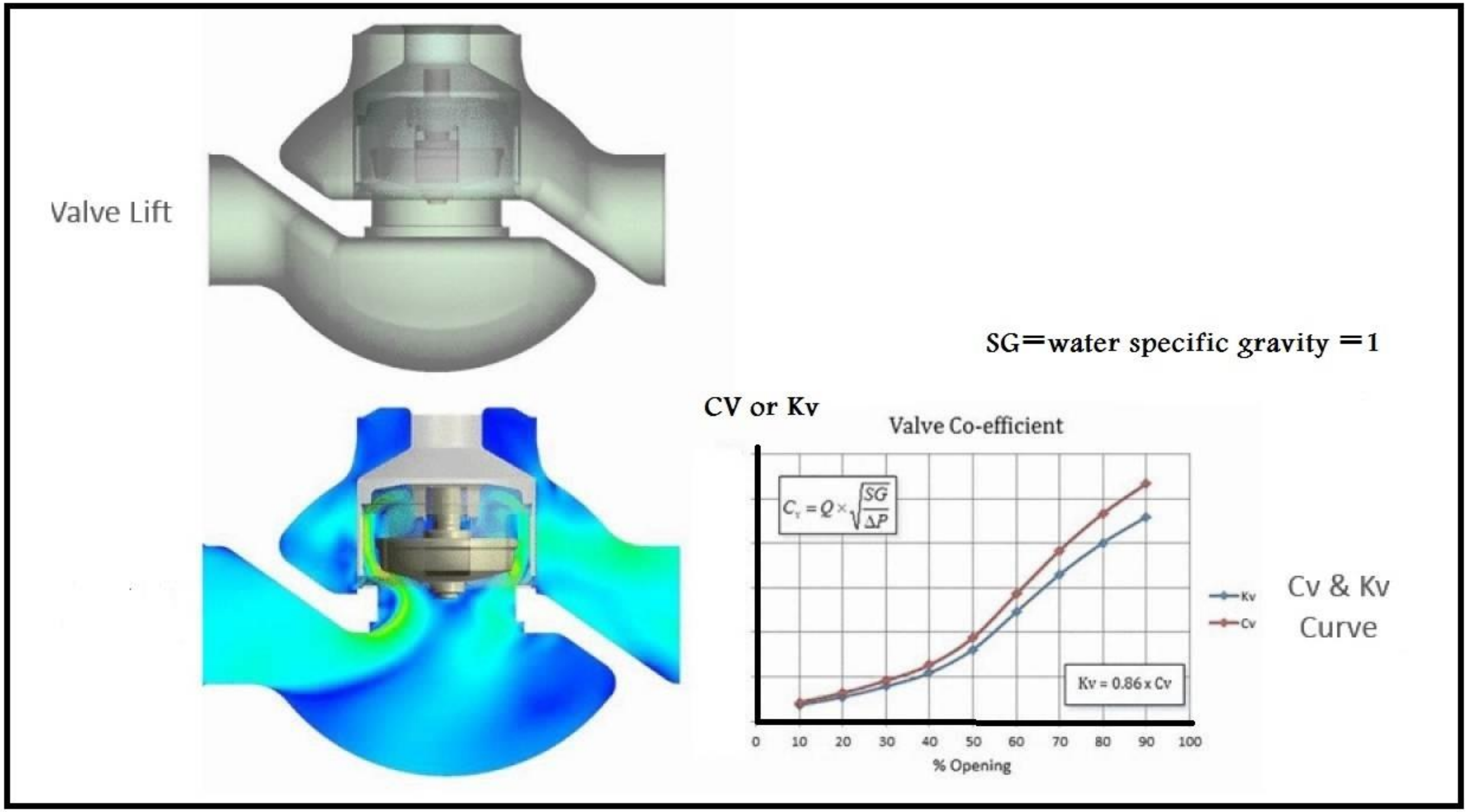
- After construct the system curve shown above and combine it with pumps curves for three different sets of pumps we recommend the set of (***2 parallel pumps KSB brand model movitec 25/3)*** its nominal capacity according contractor BOQ (vertical centrifugal pump **Q=125 Gpm** & **H=5.5 bar)**
- Actual duty point of the 2 parallel pump set(**Q= 293Gpm** & **H=6.5 bar**)
- We recommend after construction of irrigation network, installation of pump room, testing, and commissioning to measure the actual flow as built at each irrigation shift, and recalculate run time of valves in irrigation schedule(decreasing or increasing) to meet you exact demands accurately

⑯ - valves adjusting

- According the upper calculation we recommend solenoid valve of flow control option to achieve network balancing and keep you exact demands, and adjust the valves flow control (valve opening) according the pre-calculated **Kv's** as follow

valve	valve Kv	valve openning
D33	22	
D32	12.3	
D18	16	
D17	12.2	
D16	18.6	
D23	4.9	
D35	3.9	

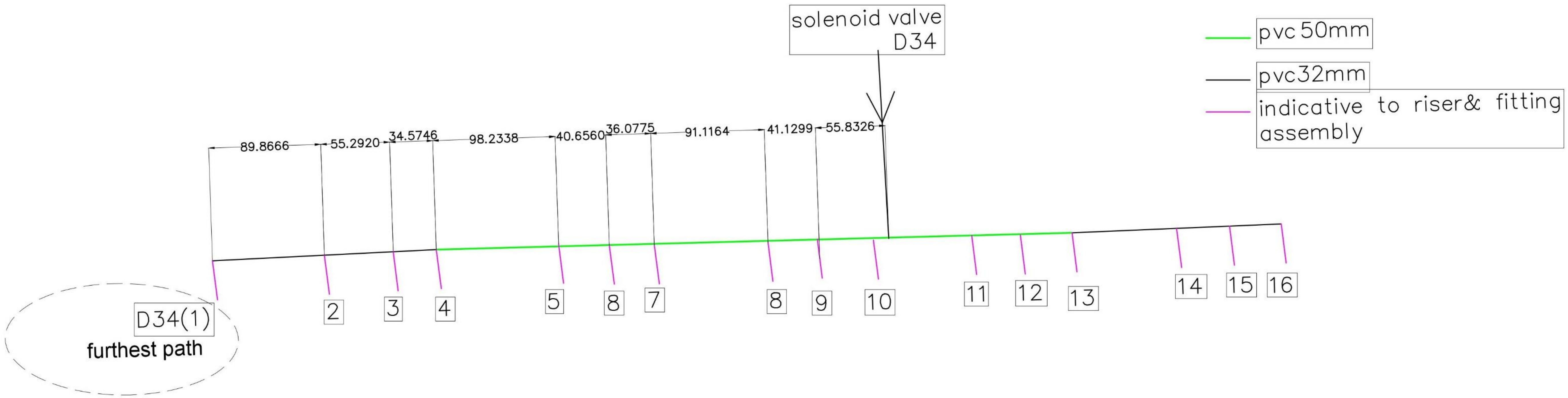
- Notice:- the actual valve opening according the above calculated **Kv's** is not defined here in this calculations you can get it from the valve manufacturer catalogues as follow:-
- (the below chart, just indicative but, it is not the actual for this design)



__Notice__:- this is indicative characteristic valve chart not the actual for you valves, just for illustration only

⑰- later line calculations

- Lateral line calculation based on the the exit of solenoid valve **D34** the results of this lateral network calculations taken with safety factor to calculate the main calculations for all the valves of shift no-11 assuming they has approximately similar later network



lateral lines network dimensions

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Range of flow rates

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
D34(1)	**0.55**	**0.825**	**1.1**	**1.7**	**2.2**	**2.8**	**3**	**3.3**	**3.9**

Q(Gpm)

D34(1) path elements	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
sudden expansion(d=40mm&D=50) **(K=0.59)**	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
pvc pipe(L=1.5m&d=50mm)	6.425	9.6375	12.85	19.275	25.7	32.125	35.3375	38.55	44.975
branch tee(50mm) **(k=1.14)**	4.075	6.1125	8.15	12.225	16.3	20.375	22.4125	24.45	28.525
pvc pipe(L=8.6m&d=50mm)	4.075	6.1125	8.15	12.225	16.3	20.375	22.4125	24.45	28.525
pvc pipe(L=12m&d=50mm)	3.525	5.2875	7.05	10.575	14.1	17.625	19.3875	21.15	24.675
pvc pipe(L=10m&d=50mm)	3.45	5.175	6.9	10.35	13.8	17.25	18.975	20.7	24.15
pvc pipe(L=23m&d=50mm)	2.9	4.35	5.8	8.7	11.6	14.5	15.95	17.4	20.3
pvc pipe(L=9m&d=50mm)	2.35	3.525	4.7	7.05	9.4	11.75	12.925	14.1	16.45
pvc pipe(L=10m&d=50mm)	2.275	3.4125	4.55	6.825	9.1	11.375	12.5125	13.65	15.925
pvc pipe(L=25m&d=50mm)	1.725	2.5875	3.45	5.175	6.9	8.625	9.4875	10.35	12.075
sudden contraction(D=50&d=32) **(k=2)**	1.725	2.5875	3.45	5.175	6.9	8.625	9.4875	10.35	12.075
pvc pipe(L=9m&d=32mm)	1.175	1.7625	2.35	3.525	4.7	5.875	6.4625	7.05	8.225
pvc pipe(L=14m&d=32mm)	1.1	1.65	2.2	3.3	4.4	5.5	6.05	6.6	7.7
pvc pipe(L=23m&d=32mm)	0.55	0.825	1.1	1.65	2.2	2.75	3.025	3.3	3.85
elbow 32mm **(k=0.66)**	0.55	0.825	1.1	1.65	2.2	2.75	3.025	3.3	3.85
sudden contraction(D=32&d=20) **(k=2.5)**	0.55	0.825	1.1	1.65	2.2	2.75	3.025	3.3	3.85
pvc pipe(L=1.5m&d=20mm)	0.55	0.825	1.1	1.65	2.2	2.75	3.025	3.3	3.85
3 elbow 20mm **(k=0.75)**	0.55	0.825	1.1	1.65	2.2	2.75	3.025	3.3	3.85
pvc pipe(L=1.5m&d=20mm)	0.55	0.825	1.1	1.65	2.2	2.75	3.025	3.3	3.85

V(m/s)

D34(1) path elements	V1	V2	V3	V4	V5	V6	V7	V8	V9
	0.446464	0.669695	0.892927	1.339391	1.785854	2.232318	2.45555	2.678782	3.125245
sudden expansion(d=40mm&D=50) **(K=0.59)**	0.25262	0.378929	0.505239	0.757859	1.010478	1.263098	1.389407	1.515717	1.768337
pvc pipe(L=1.5m&d=50mm)	0.25262	0.378929	0.505239	0.757859	1.010478	1.263098	1.389407	1.515717	1.768337
branch tee(50mm) **(k=1.14)**	0.160222	0.240333	0.320443	0.480665	0.640887	0.801109	0.881219	0.96133	1.121552
pvc pipe(L=8.6m&d=50mm)	0.160222	0.240333	0.320443	0.480665	0.640887	0.801109	0.881219	0.96133	1.121552
pvc pipe(L=12m&d=50mm)	0.138597	0.207895	0.277193	0.41579	0.554387	0.692983	0.762282	0.83158	0.970177
pvc pipe(L=10m&d=50mm)	0.135648	0.203472	0.271296	0.406943	0.542591	0.678239	0.746063	0.813887	0.949535
pvc pipe(L=23m&d=50mm)	0.114023	0.171034	0.228046	0.342068	0.456091	0.570114	0.627125	0.684137	0.79816
pvc pipe(L=9m&d=50mm)	0.092398	0.138597	0.184796	0.277193	0.369591	0.461989	0.508188	0.554387	0.646785
pvc pipe(L=10m&d=50mm)	0.089449	0.134173	0.178898	0.268347	0.357796	0.447245	0.491969	0.536694	0.626142
pvc pipe(L=25m&d=50mm)	0.067824	0.101736	0.135648	0.203472	0.271296	0.33912	0.373032	0.406943	0.474767
sudden contraction(D=50&d=32) **(k=2)**	0.1718	0.2577	0.3436	0.5154	0.6872	0.858999	0.944899	1.030799	1.202599
pvc pipe(L=9m&d=32mm)	0.117023	0.175535	0.234046	0.351069	0.468092	0.585116	0.643627	0.702139	0.819162
pvc pipe(L=14m&d=32mm)	0.109554	0.16433	0.219107	0.328661	0.438214	0.547768	0.602545	0.657321	0.766875
pvc pipe(L=23m&d=32mm)	0.054777	0.082165	0.109554	0.16433	0.219107	0.273884	0.301272	0.328661	0.383437
elbow 32mm **(k=0.66)**	0.054777	0.082165	0.109554	0.16433	0.219107	0.273884	0.301272	0.328661	0.383437
sudden contraction(D=32&d=20) **(k=2.5)**	0.152875	0.229312	0.305749	0.458624	0.611499	0.764374	0.840811	0.917248	1.070123
pvc pipe(L=1.5m&d=20mm)	0.152875	0.229312	0.305749	0.458624	0.611499	0.764374	0.840811	0.917248	1.070123
3 elbow 20mm **(k=0.75)**	0.152875	0.229312	0.305749	0.458624	0.611499	0.764374	0.840811	0.917248	1.070123
pvc pipe(L=1.5m&d=20mm)	0.152875	0.229312	0.305749	0.458624	0.611499	0.764374	0.840811	0.917248	1.070123

Re

D34(1) path elements	Re1	Re2	Re3	Re4	Re5	Re6	Re7	Re8	Re9
sudden expansion(d=40mm&D=50) **(K=0.59)**									
pvc pipe(L=1.5m&d=50mm)	11418.4	17127.6	22836.8	34255.2	45673.61	57092.01	62801.21	68510.41	79928.81
branch tee(50mm) **(k=1.14)**									
pvc pipe(L=8.6m&d=50mm)	7242.021	10863.03	14484.04	21726.06	28968.08	36210.11	39831.12	43452.13	50694.15
pvc pipe(L=12m&d=50mm)	6264.57	9396.856	12529.14	18793.71	25058.28	31322.85	34455.14	37587.42	43851.99
pvc pipe(L=10m&d=50mm)	6131.282	9196.923	12262.56	18393.85	24525.13	30656.41	33722.05	36787.69	42918.97
pvc pipe(L=23m&d=50mm)	5153.831	7730.746	10307.66	15461.49	20615.32	25769.15	28346.07	30922.99	36076.82
pvc pipe(L=9m&d=50mm)	4176.38	6264.57	8352.761	12529.14	16705.52	20881.9	22970.09	25058.28	29234.66
pvc pipe(L=10m&d=50mm)	4043.092	6064.637	8086.183	12129.27	16172.37	20215.46	22237	24258.55	28301.64
pvc pipe(L=25m&d=50mm)	3065.641	4598.461	6131.282	9196.923	12262.56	15328.2	16861.02	18393.85	21459.49
sudden contraction(D=50&d=32) **(k=2)**									
pvc pipe(L=9m&d=32mm)	3323.456	4985.185	6646.913	9970.369	13293.83	16617.28	18279.01	19940.74	23264.2
pvc pipe(L=14m&d=32mm)	3111.321	4666.981	6222.642	9333.963	12445.28	15556.6	17112.27	18667.93	21779.25
pvc pipe(L=23m&d=32mm)	1555.66	2333.491	3111.321	4666.981	6222.642	7778.302	8556.133	9333.963	10889.62
elbow 32mm **(k=0.66)**									
sudden contraction(D=32&d=20) **(k=2.5)**									
pvc pipe(L=1.5m&d=20mm)	2598.87	3898.305	5197.74	7796.61	10395.48	12994.35	14293.78	15593.22	18192.09
3 elbow 20mm **(k=0.75)**									
pvc pipe(L=1.5m&d=20mm)	2598.87	3898.305	5197.74	7796.61	10395.48	12994.35	14293.78	15593.22	18192.09

f

D34(1) path elements	f1	f2	f3	f4	f5	f6	f7	f8	f9
sudden expansion(d=40mm&D=50) **(K=0.59)**									
pvc pipe(L=1.5m&d=50mm)	0.029935	0.026927	0.025064	0.02276	0.02132	0.020301	0.019889	0.019525	0.018907
branch tee(50mm) **(k=1.14)**									
pvc pipe(L=8.6m&d=50mm)	0.033967	0.03034	0.028112	0.025373	0.023671	0.022471	0.021987	0.021559	0.020834
pvc pipe(L=12m&d=50mm)	0.035425	0.031566	0.029202	0.026303	0.024506	0.023239	0.022729	0.022279	0.021515
pvc pipe(L=10m&d=50mm)	0.03565	0.031755	0.029369	0.026445	0.024633	0.023357	0.022843	0.022389	0.021619
pvc pipe(L=23m&d=50mm)	0.037543	0.03334	0.030775	0.027641	0.025703	0.024341	0.023793	0.023309	0.02249
pvc pipe(L=9m&d=50mm)	0.040046	0.035425	0.032619	0.029202	0.027098	0.025622	0.025029	0.024506	0.02362
pvc pipe(L=10m&d=50mm)	0.040454	0.035764	0.032918	0.029455	0.027323	0.025829	0.025228	0.024699	0.023802
pvc pipe(L=25m&d=50mm)	0.044209	0.038869	0.03565	0.031755	0.029369	0.027702	0.027034	0.026445	0.02545
sudden contraction(D=50&d=32) **(k=2)**									
pvc pipe(L=9m&d=32mm)	0.043082	0.037948	0.034847	0.031091	0.028789	0.027179	0.026534	0.025966	0.025004
pvc pipe(L=14m&d=32mm)	0.044015	0.038718	0.035523	0.031658	0.029293	0.02764	0.026978	0.026395	0.025409
pvc pipe(L=23m&d=32mm)	0.055994	0.048468	0.044015	0.038718	0.035523	0.033313	0.032432	0.031658	0.030356
elbow 32mm **(k=0.66)**									
sudden contraction(D=32&d=20) **(k=2.5)**									
pvc pipe(L=1.5m&d=20mm)	0.046759	0.040984	0.037518	0.033346	0.030803	0.029032	0.028324	0.027701	0.02665
3 elbow 20mm **(k=0.75)**									
pvc pipe(L=1.5m&d=20mm)	0.046759	0.040984	0.037518	0.033346	0.030803	0.029032	0.028324	0.027701	0.02665

Hf

D34(1) path elements	Hf1	Hf2	Hf3	Hf4	Hf5	Hf6	Hf7	Hf8	Hf9
	0.0064	0.014401	0.025602	0.057604	0.102408	0.160012	0.193615	0.230418	0.313624
sudden expansion(d=40mm&D=50) **(K=0.59)**	0.001919	0.004318	0.007676	0.017271	0.030705	0.047976	0.058051	0.069086	0.094034
pvc pipe(L=1.5m&d=50mm)	0.003231	0.00654	0.010822	0.022111	0.036821	0.054783	0.064943	0.075873	0.1
branch tee(50mm) **(k=1.14)**	0.001492	0.003356	0.005966	0.013424	0.023865	0.03729	0.045121	0.053697	0.073088
pvc pipe(L=8.6m&d=50mm)	0.008456	0.016994	0.027993	0.056847	0.094285	0.139848	0.165573	0.193215	0.254138
pvc pipe(L=12m&d=50mm)	0.009208	0.018461	0.030362	0.061531	0.101915	0.151013	0.178716	0.208473	0.274024
pvc pipe(L=10m&d=50mm)	0.007397	0.014824	0.024375	0.049383	0.081777	0.121156	0.143372	0.167235	0.219797
pvc pipe(L=23m&d=50mm)	0.012659	0.025294	0.041508	0.083881	0.138671	0.205189	0.24269	0.28295	0.371579
pvc pipe(L=9m&d=50mm)	0.00347	0.006906	0.011305	0.022771	0.037565	0.055498	0.065598	0.076436	0.100277
pvc pipe(L=10m&d=50mm)	0.00365	0.00726	0.01188	0.023917	0.039443	0.058258	0.068853	0.080221	0.105226
pvc pipe(L=25m&d=50mm)	0.005733	0.011341	0.018492	0.037061	0.060937	0.08981	0.106049	0.123459	0.161714
sudden contraction(D=50&d=32) **(k=2)**	0.003009	0.00677	0.012035	0.027078	0.048139	0.075217	0.091013	0.108313	0.147426
pvc pipe(L=9m&d=32mm)	0.009529	0.018886	0.030831	0.061893	0.101885	0.150295	0.17754	0.206761	0.271005
pvc pipe(L=14m&d=32mm)	0.013273	0.02627	0.042848	0.08592	0.141333	0.208374	0.246092	0.286538	0.37544
pvc pipe(L=23m&d=32mm)	0.006935	0.013506	0.021806	0.043157	0.070393	0.103146	0.121506	0.141154	0.184222
elbow 32mm **(k=0.66)**	0.000101	0.000227	0.000404	0.000908	0.001615	0.002523	0.003053	0.003634	0.004946
sudden contraction(D=32&d=20) **(k=2.5)**	0.002978	0.0067	0.011912	0.026801	0.047647	0.074448	0.090082	0.107205	0.145918
pvc pipe(L=1.5m&d=20mm)	0.004915	0.009692	0.015773	0.031543	0.0518	0.076284	0.090053	0.104813	0.137246
3 elbow 20mm **(k=0.75)**	0.00268	0.00603	0.01072	0.024121	0.042882	0.067003	0.081074	0.096484	0.131326
pvc pipe(L=1.5m&d=20mm)	0.004915	0.009692	0.015773	0.031543	0.0518	0.076284	0.090053	0.104813	0.137246
total	0.111948	0.227469	0.378083	0.778769	1.305886	1.954408	2.323047	2.720776	3.602276

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Q(Gpm)	Hf	Hst	exit pressure	TDH (m)
0	0	1	10	11
0.55	0.111948	1	10	11.11195
0.825	0.227469	1	10	11.22747
1.1	0.378083	1	10	11.37808
1.65	0.778769	1	10	11.77877
2.2	1.305886	1	10	12.30589
2.75	1.954408	1	10	12.95441
3.025	2.323047	1	10	13.32305
3.3	2.720776	1	10	13.72078
3.85	3.602276	1	10	14.60228

- From the above lateral calculation the **TDH** for the furthest path = 1.2 bar take it =2 bar in the main calculation of **D34 @ 28.1Gpm** and for **D34** range of flow rates keep the opposed lateral TDH using the relation between H α Q2 or

$$\frac{H_1}{H_2} = \frac{{Q_1}^2}{{Q_2}^2}$$

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