

Friction Losses in Pipe Fittings

Resistance Coefficient K (use in formula $hf = Kv^2/2g$)

Fitting	LD	Nominal Pipe Size												
		½	¾	1	1¼	1½	2	2½-3	4	6	8-10	12-16	18-24	
		K Value												
Angle Valve	55	1.48	1.38	1.27	1.21	1.16	1.05	0.99	0.94	0.83	0.77	0.72	0.66	
Angle Valve	150	4.05	3.75	3.45	3.30	3.15	2.85	2.70	2.55	2.25	2.10	1.95	1.80	
Ball Valve	3	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04	
Butterfly Valve							0.86	0.81	0.77	0.68	0.63	0.35	0.30	
Gate Valve	8	0.22	0.20	0.18	0.18	0.15	0.15	0.14	0.14	0.12	0.11	0.10	0.10	
Globe Valve	340	9.2	8.5	7.8	7.5	7.1	6.5	6.1	5.8	5.1	4.8	4.4	4.1	
Plug Valve Branch Flow	90	2.43	2.25	2.07	1.98	1.89	1.71	1.62	1.53	1.35	1.26	1.17	1.08	
Plug Valve Straightaway	18	0.48	0.45	0.41	0.40	0.38	0.34	0.32	0.31	0.27	0.25	0.23	0.22	
Plug Valve 3-Way Thru-Flow	30	0.81	0.75	0.69	0.66	0.63	0.57	0.54	0.51	0.45	0.42	0.39	0.36	
Standard Elbow	90°	30	0.81	0.75	0.69	0.66	0.63	0.57	0.54	0.51	0.45	0.42	0.39	0.36
	45°	16	0.43	0.40	0.37	0.35	0.34	0.30	0.29	0.27	0.24	0.22	0.21	0.19
	long radius 90°	16	0.43	0.40	0.37	0.35	0.34	0.30	0.29	0.27	0.24	0.22	0.21	0.19
Close Return Bend	50	1.35	1.25	1.15	1.10	1.05	0.95	0.90	0.85	0.75	0.70	0.65	0.60	
Standard Tee	Thru-Flow	20	0.54	0.50	0.46	0.44	0.42	0.38	0.36	0.34	0.30	0.28	0.26	0.24
	Thru-	60	1.62	1.50	1.38	1.32	1.26	1.14	1.08	1.02	0.90	0.84	0.78	0.72
90 Bends, Pipe Bends, Flanged Elbows, Butt-Welded Elbows	r/d=1	20	0.54	0.50	0.46	0.44	0.42	0.38	0.36	0.34	0.30	0.28	0.26	0.24
	r/d=2	12	0.32	0.30	0.28	0.26	0.25	0.23	0.22	0.20	0.18	0.17	0.16	0.14
	r/d=3	12	0.32	0.30	0.28	0.26	0.25	0.23	0.22	0.20	0.18	0.17	0.16	0.14
	r/d=4	14	0.38	0.35	0.32	0.31	0.29	0.27	0.25	0.24	0.21	0.20	0.18	0.17
	r/d=6	17	0.46	0.43	0.39	0.37	0.36	0.32	0.31	0.29	0.26	0.24	0.22	0.20
	r/d=8	24	0.65	0.60	0.55	0.53	0.50	0.46	0.43	0.41	0.36	0.34	0.31	0.29
	r/d=10	30	0.81	0.75	0.69	0.66	0.63	0.57	0.54	0.51	0.45	0.42	0.39	0.36
	r/d=12	34	0.92	0.85	0.78	0.75	0.71	0.65	0.61	0.58	0.51	0.48	0.44	0.41
	r/d=14	38	1.03	0.95	0.87	0.84	0.80	0.72	0.68	0.65	0.57	0.53	0.49	0.46
	r/d=16	42	1.13	1.05	0.97	0.92	0.88	0.80	0.76	0.71	0.63	0.59	0.55	0.50
	r/d=18	45	1.24	1.15	1.06	1.01	0.97	0.87	0.83	0.78	0.69	0.64	0.60	0.55

Mitre Bends	a=0°	2	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02
	a=15°	4	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05
	a=30°	8	0.22	0.20	0.18	0.18	0.17	0.15	0.14	0.14	0.12	0.11	0.10	0.10
	a=45°	15	0.41	0.38	0.35	0.33	0.32	0.29	0.27	0.26	0.23	0.21	0.20	0.18
	a=60°	25	0.68	0.63	0.58	0.55	0.53	0.48	0.45	0.43	0.38	0.35	0.33	0.30
	a=75°	40	1.09	1.00	0.92	0.88	0.84	0.76	0.72	0.68	0.60	0.56	0.52	0.48
	a=90°	60	1.62	1.50	1.38	1.32	1.26	1.14	1.08	1.02	0.90	0.84	0.78	0.72

Note: Fittings are standard with full openings.

Fitting	L/D	Minimum Velocity for Full Disc Lift		Nominal Pipe Size											
		General ft/sec	Water ft/sec	½	¾	1	1¼	1½	2	2½-3	4	6	8-10	12-16	18-24
				K Value											
Swing Check Valve	100	35√V	4.40	2.70	2.50	2.30	2.20	2.10	1.90	1.80	1.70	1.50	1.40	1.30	1.20
	50	48√V	6.06	1.40	1.30	1.20	1.10	1.10	1.00	0.90	0.90	0.75	0.70	0.65	0.60
Lift Check Valve	600	40√V	5.06	16.2	15.0	13.08	13.2	12.6	11.4	10.8	10.2	9.0	8.4	7.8	7.2
	55	140√V	17.7	1.50	1.40	1.30	1.20	1.20	1.10	1.00	0.94	0.83	0.77	0.72	0.66
Tilting Disc Check Valve	5	80√V	10.13						0.76	0.72	0.68	0.60	0.56	0.39	0.24
	15	30√V	3.80						2.30	2.20	2.00	1.80	1.70	1.20	0.72
Foot Valve with Strainer Poppet Disc	420	15√V	1.90	11.3	10.5	9.70	9.30	8.80	8.00	7.60	7.10	6.30	5.90	5.50	5.0
Foot Valve with Strainer Hinged Disc	75	35√V	4.43	2.00	1.90	1.70	1.70	1.70	1.40	1.40	1.30	1.10	1.10	1.00	0.90

Fitting	Description	All Pipe Sizes
		K Value
Pipe Exit	Projecting Sharp-Edged Rounded	1.00

Pipe Entrance	Inward Projecting	0.78
Pipe Entrance Flush	Sharp-Edged	0.50
	r/d=0.02	0.28
	r/d=0.04	0.24
	r/d=0.06	0.15
	r/d=0.10	0.09
	r/d<0.14	0.04

The K values given below are for making estimates of friction loss in cases not covered in the previous tables.

Type of Fitting	K Value
Disk or Wobble Meter	3.4 - 10
Rotary Meter (Star or Cog-Wheel Piston)	10
Reciprocating Piston Meter	15
Turbine Wheel (Double-Flow) Meter	5 - 7.5
Bends w/Corrugated Inner Radius	1.3 - 1.6 times value for smooth bend

Example: Determine L (friction loss in pipe fittings in terms of equivalent length in feet of straight pipe).

Assume a 6" angle valve for Schedule 40 pipe size.

Select the appropriate K value for such and select D and f for Schedule 40 pipe from the table below where K is the pipe diameter in feet.

Pipe Size Inches Sch. 40	D feet	f	Pipe Size Inches Sch. 40	D feet	f	Pipe Size Inches Sch. 40	D feet	f	Pipe Size Inches Sch. 40	D feet	f
½	0.0518	0.027	2½	0.2058	0.018	10	0.8350	0.014	24	1.8857	0.012
¾	0.0687	0.025	3	0.2557	0.018	12	0.9948	0.013	30	2.3333	0.011
1	0.0874	0.023	4	0.3355	0.017	14	1.0937	0.013	36	2.8333	0.011
1¼	0.1150	0.022	5	0.4206	0.016	16	1.250	0.013	42	3.3333	0.010
1½	0.1342	0.021	6	0.5054	0.015	18	1.4063	0.012	48	3.8333	0.010
2	0.1723	0.019	8	0.6651	0.014	20	1.5678	0.012			

Friction Loss of Water in Pipe Fittings in Terms of Equivalent Length - Feet of Straight Pipe

Nominal pipe size	Actual inside diameter inches d	Friction factor f	Gate valve - full open	90° elbow	Long radius 90° or 45° std elbow	Std tee - thru flow	Std tee - branch flow	Close return bend	Swing check valve - full open	Angle valve - full open	Globe valve - full valve	Butter-fly valve	90° Welding elbow		Mitre bend	
													r/d =	r/d =	45°	90°
½	.622	.027	.41	1.55	.83	1.04	3.11	2.59	5.18	7.78	17.6					
¾	.824	.025	.55	2.06	1.10	1.37	4.12	3.43	6.86	10.3	23.3					
1	1.049	.023	.70	2.62	1.40	1.75	5.25	4.37	8.74	13.1	29.7					
1¼	1.380	.022	.92	3.45	1.84	2.30	6.90	5.75	11.5	17.3	39.1					
1½	1.610	.021	1.07	4.03	2.15	2.68	8.05	6.71	13.4	20.1	45.6					
2	2.067	.019	1.38	5.17	2.76	3.45	10.3	8.61	17.2	25.8	58.6	7.75	3.45	2.07	2.58	10.3
2½	2.469	.018	1.65	6.17	3.29	4.12	12.3	10.3	20.6	30.9	70.0	9.26	4.12	2.47	3.08	12.3
3	3.068	.018	2.04	7.67	4.09	5.11	15.3	12.8	25.5	38.4	86.9	11.5	5.11	3.07	3.84	15.3
4	4.026	.017	2.68	10.1	5.37	6.71	20.1	16.8	33.6	50.3	114	15.1	6.71	4.03	5.03	20.1
5	5.047	.016	3.36	12.6	6.73	8.41	25.2	21.0	42.1	63.1	143	18.9	8.41	5.05	6.31	25.2
6	6.065	.015	4.04	15.2	8.09	10.1	30.3	25.3	50.5	75.8	172	22.7	10.1	6.07	7.58	30.3
8	7.981	.014	5.32	20.0	10.6	13.3	39.9	33.3	66.6	99.8	226	29.9	13.3	7.98	9.98	39.9
10	10.02	.014	6.68	25.1	13.4	16.7	50.1	41.8	83.6	125	284	29.2	16.7	10.0	12.5	50.1
12	11.938	.013	7.96	29.8	15.9	19.9	59.7	49.7	99.4	149	338	34.8	19.9	11.9	14.9	59.7
14	13.124	.013	8.75	32.8	17.5	21.8	65.6	54.7	109.4	164	372	38.3	21.8	13.1	16.4	65.6
16	15.00	.013	10.0	37.5	20.0	25.0	75.0	62.5	125.0	188	425	31.3	25.0	15.0	18.8	75.0
18	16.876	.012	16.9	42.2	22.5	28.1	84.4	70.3	140.6	210	478	35.2	28.1	16.9	21.1	84.4
20	18.814	.012	12.5	47.0	25.1	31.4	94.1	78.4	156.8	235	533	39.2	31.4	18.8	23.5	94.1
24	22.628	0.12	15.1	56.6	30.2	37.7	113	94.3	188.6	283	641	47.1	37.7	22.6	28.3	113
30	28	.011	18.7	70	37.3	46.7	140	117	234.0				46.7	28	35	140
36	34	.011	22.7	85	45.3	56.7	170	142					56.7	34	43	170
42	40	.010	26.7	100	53.3	66.7	200	167					66.7	40	50	200
48	46	.010	30.7	115	61.3	76.7	230	192					76.7	46	58	230
L/D			8	30	16	20	60	50	½ to 6 = 100 24 to 48 = 50	150	340		20	12	15	60

NO.	SIMBOL	KETERANGAN	CAPACITY
1		Klep	2
2		Vacuum Ejector	1
3		Flange	2
4		Pompa	1
5		Globe Valve	2
6		Elbow	7

