



TECH TIP #47

FRICITION LOSS CHARTS FOR WATER IN PIPES

Pipe friction is the resistance to flow created by the interior surface of the pipe through which a liquid is moving. The smaller the diameter of the pipe, or the greater the rate of flow, the greater the amount of friction (friction loss).

Friction loss is expressed as feet of head in 100 feet of pipe and will vary depending upon the material of which the pipe is made. The following charts show friction losses in steel, copper and plastic pipe.

Loss of Head in Feet, Due to Friction Per 100 Feet of Pipe

These data are for new pipe. Increase by 15% to compensate for aging.

½"			
Flow U.S. Gal. Min.	Steel ID .622"	Copper ID .625"	Plastic ID .622"
0.5	.582	.35	.314
1.0	2.10	1.26	1.14
1.5	4.44	2.67	2.38
2.0	7.57	4.56	4.10
2.5	11.4	6.88	6.15
3.0	16.0	9.66	8.65
3.5	21.3	12.9	11.5
4.0	27.3	16.4	14.8
4.5	33.9	20.4	18.3
5.0	41.2	24.8	22.2
5.5	49.2	29.5	26.6
6.0	57.8	34.8	31.2
6.5	67.0	40.2	36.2
7.0	76.8	46.1	41.5
7.5	87.3	52.5	47.2
8.0	98.3	59.4	53.0
8.5	110.0	66.0	59.5
9.0	122.0	73.5	66.0
9.5	135.0	81.0	73.0
10.0	149.0	89.4	80.5

¾"			
Flow U.S. Gal. Min.	Steel ID .824"	Copper ID .822"	Plastic ID .824"
1.5	1.13	.70	.61
2.0	1.93	1.21	1.04
2.5	2.91	1.82	1.57
3.0	4.08	2.56	2.21
3.5	5.42	3.4	2.93
4.0	6.94	4.36	3.74
4.5	8.63	5.4	4.66
5.0	10.5	6.57	5.66
6.0	14.7	9.22	7.95
7.0	19.6	12.2	10.6
8.0	25.0	15.7	13.5
9.0	31.1	19.5	16.8
10.0	37.8	23.7	20.4
11.0	45.1	28.2	24.4
12.0	53.0	33.2	28.6
13.0	61.5	38.5	33.2
14.0	70.5	44.2	38.0
16.0	90.2	56.6	48.6
18.0	112.0	70.4	60.5
20.0	136.0	83.5	73.5

1"			
Flow U.S. Gal. Min.	Steel ID 1.049"	Copper ID 1.062"	Plastic ID 1.049"
2	.595	.345	.322
3	1.26	.732	.680
4	2.14	1.24	1.15
5	3.42	1.88	1.75
6	4.54	2.63	2.45
8	7.73	4.50	4.16
10	11.7	6.77	6.31
12	16.4	9.47	8.85
14	21.8	12.6	11.8
16	27.9	16.2	15.1
18	34.7	20.1	18.7
20	42.1	24.4	22.8
22	50.2	28.8	27.1
24	59.0	34.0	31.9
26	68.4	39.7	36.9
28	78.5	45.5	42.5
30	89.2	51.6	48.1
35	119.0	68.7	64.3
40	152.0	88.0	82.0
45	189.0	109.0	102.0

1¼"			
Flow U.S. Gal. Min.	Steel ID 1.380"	Copper ID 1.368"	Plastic ID 1.380"
4	.564	.364	.304
5	.853	.545	.460
6	1.20	.765	.649
7	1.59	1.02	.860
8	2.04	1.31	1.10
10	3.08	1.98	1.67
12	4.31	2.75	2.33
14	5.73	3.64	3.10
16	7.34	4.68	3.96
18	9.13	5.81	4.93
20	11.1	7.10	6.00
25	16.8	10.7	9.06
30	23.5	15.0	12.7
35	31.2	20.0	16.9
40	40.0	25.6	21.6
50	60.4	38.7	32.6
60	84.7	54.1	45.5
70	114.0	72.2	61.5
80	144.0	92.4	77.9
90	179.0	115.0	96.6

1½"			
Flow U.S. Gal. Min.	Steel ID 1.61"	Copper ID 1.60"	Plastic ID 1.61"
4	.267	.165	.144
6	.565	.358	.305
8	.962	.611	.520
10	1.45	.923	.786
12	2.04	1.29	1.10
14	2.71	1.71	1.46
16	3.47	2.2	1.87
18	4.31	2.75	2.33
20	5.24	3.31	2.83
25	7.90	5.00	4.26
30	11.1	7.00	6.0
35	14.7	9.35	7.94
40	18.9	12.0	10.2
45	23.4	14.9	12.63
50	28.5	18.1	15.4
55	34.0	21.5	18.35
60	40.0	25.3	21.6
65	46.4	29.0	25.1
70	53.2	33.8	28.7
75	60.4	38.0	32.6
80	68.1	43.1	36.8
85	76.2	47.6	41.2
90	84.7	53.6	45.7
95	93.6	58.8	50.5
100	103.0	65.1	56.6

Courtesy of Sta-Rite Pumps



TECH TIP #47 (Cont.)

FRICITION LOSS CHARTS

Loss of Head in Feet, Due to Friction Per 100 Feet of Pipe

These data are for new pipe. Increase by 15% to compensate for aging.

Flow U.S. Gal. Min.	2"		
	Steel ID 2.067"	Copper ID 2.062"	Plastic ID 2.067"
10	.431	.268	.233
15	.916	.569	.495
20	1.55	.962	.839
25	2.35	1.45	1.27
30	3.29	2.03	1.78
35	4.37	2.71	2.36
40	5.60	3.47	3.03
45	6.96	4.31	3.76
50	8.46	5.24	4.57
55	10.1	6.22	5.46
60	11.9	7.34	6.44
70	15.8	9.78	8.53
80	20.2	12.5	10.9
90	25.1	15.6	13.6
100	30.5	18.9	16.5
110	36.4	22.5	19.7
120	42.7	26.6	23.1
130	49.6	30.7	26.8
140	56.9	35.2	30.6
150	64.7	40.1	35.0
160	72.8	45.1	39.3
170	81.4	50.5	44.0
180	90.5	56.1	48.9
190	100.	62.0	54.0
200	110.	68.0	59.4

Flow U.S. Gal. Min.	2 1/2"		
	Steel ID 2.469"	Copper ID 2.500"	Plastic ID 2.469"
20	.654	.375	.353
30	1.39	.792	.750
40	2.36	1.35	1.27
50	3.56	2.04	2.22
60	4.99	2.86	2.69
70	6.64	3.82	3.58
80	8.50	4.88	4.59
90	10.6	6.06	5.72
100	12.8	7.37	6.90
110	15.3	8.80	8.25
120	18.0	10.3	9.71
130	20.9	12.0	11.3
140	23.9	13.7	12.9
150	27.3	15.6	14.7
160	30.7	17.6	16.6
170	34.3	19.7	18.5
180	38.1	21.9	20.6
190	42.1	24.2	22.7
200	46.3	26.6	25.0
220	55.3	31.8	29.8
240	66.4	37.4	35.8
260	75.3	43.3	41.6
280	86.3	49.4	46.6
300	98.1	56.8	52.9

Flow U.S. Gal. Min.	3"		
	Steel ID 3.067"	Copper ID 2.985"	Plastic ID 3.067"
10	.1		
15	.1		
20	.2	.132	.125
25	.3	.193	.188
30	.5	.275	.260
35	.7	.346	.335
40	.9	.448	.435
45	1.0	.576	.525
50	1.3	.723	.650
60	1.9	.942	.880
70	2.5	1.56	1.15
80	3.3	1.96	1.45
90	4.1	2.05	1.82
100	4.9	2.37	2.20
110	6.0	2.81	2.63
120	6.9	3.34	3.20
130	8.1	3.82	3.65
140	9.3	4.85	4.20
150	10.6	5.60	4.65
175	12.3	6.85	5.80
200	18.0	8.94	7.80
225	22.0	10.6	9.40
250	27.0	12.9	11.8
275	32.0	15.0	13.7
300	38.0	16.5	15.8
350	49.0	22.4	21.6
400		29.1	
450		45.1	
500		54.4	
550		65.1	
600			

Flow U.S. Gal. Min.	4"		
	Steel ID 4.025"	Copper ID 3.936"	Plastic ID 4.025"
20	.06		
25	.09		
30	.13		
35	.18		
40	.22	.126	.111
45	.28	.152	.148
50	.34	.172	.166
60	.46	.236	.225
70	.62	.341	.294
80	.79	.41	.38
90	1.0	.52	.48
100	1.2	.65	.59
110	1.4	.72	.70
120	1.7	.89	.82
130	1.9	.97	.94
140	2.2	1.23	1.09
150	2.5	1.41	1.22
175	3.4	1.82	1.60
200	4.3	2.40	2.04
225	5.5	2.95	2.50
250	6.6	3.55	3.20
275	7.8	3.95	3.70
300	9.0	4.58	4.30
350	11.8	5.63	5.40
400	16.0	7.28	6.90
450	19.0	9.16	8.60
500	24.0	11.2	10.2
550	29.0	13.5	12.1
600	33.8	16.0	14.0
650		18.4	16.5
700		21.5	18.8

Courtesy of Sta-Rite Pumps



TECH TIP #47 (Cont.)

FRICITION LOSS CREATED BY PIPE FITTINGS

The friction created by fittings is expressed as the equivalent length of straight pipe. For example, the loss through a 1" regular 90° ELL is equal to that created by 5.2 feet of straight 1" steel pipe. Determine total friction by combining fitting loss with pipe loss.

Equivalent Length of Straight Pipe for Various Fittings.
Turbulent Flow Only.

FITTINGS			¼	¾	½	¾	1	1¼	1½	2	2½	3	4
Regular 90° Ell	Screwed	Steel C. I.	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11.0	13.0
	Flanged	Steel C. I.			.92	1.2	1.6	2.1	2.4	3.1	3.6	4.4	5.9
Long Radius 90° Ell	Screwed	Steel C. I.	1.5	2.0	2.2	2.3	2.7	3.2	3.4	3.6	3.6	4.0	4.6
	Flanged	Steel C. I.			1.1	1.3	1.6	2.0	2.3	2.7	2.9	3.4	4.2
Regular 45° Ell	Screwed	Steel C. I.	.34	.52	.71	.92	1.3	1.7	2.1	2.7	3.2	4.0	5.5
	Flanged	Steel C. I.			.45	.59	.81	1.1	1.3	1.7	2.0	2.6	3.5
Tee-Line Flow	Screwed	Steel C. I.	.79	1.2	1.7	2.4	3.2	4.6	5.6	7.7	9.3	12.0	17.0
	Flanged	Steel C. I.			.69	.82	1.0	1.3	1.5	1.8	1.9	2.2	2.8
Tee-Branch Flow	Screwed	Steel C. I.	2.4	3.5	4.2	5.3	6.6	8.7	9.9	12.0	13.0	17.0	21.0
	Flanged	Steel C. I.			2.0	2.6	3.3	4.4	5.2	6.6	7.5	9.4	12.0
180° Return Band	Screwed	Steel C. I.	2.3	3.1	3.6	4.4	5.2	6.6	7.4	8.5	9.3	11.0	13.0
	Flanged	Steel C. I.			.92	1.2	1.6	2.1	2.4	3.1	3.6	4.4	5.9
	Long Rad. Flanged	Steel C. I.			1.1	1.3	1.6	2.0	2.3	2.7	2.9	3.4	4.2
Globe Valve	Screwed	Steel C. I.	21.0	22.0	22.0	24.0	29.0	37.0	42.0	54.0	62.0	79.0	110.0
	Flanged	Steel C. I.			38.0	40.0	45.0	54.0	59.0	70.0	77.0	94.0	120.0
Gate Valve	Screwed	Steel C. I.	.32	.45	.56	.67	.84	1.1	1.2	1.5	1.7	1.9	2.5
	Flanged	Steel C. I.								2.6	2.7	2.8	2.9
Angle Valve	Screwed	Steel C. I.	12.8	15.0	15.0	15.0	17.0	18.0	18.0	18.0	18.0	18.0	18.0
	Flanged	Steel C. I.			15.0	15.0	17.0	18.0	18.0	21.0	22.0	28.0	38.0
Swing Check Valve	Screwed	Steel C. I.	7.2	7.3	8.0	8.8	11.0	13.0	15.0	19.0	22.0	27.0	38.0
	Flanged	Steel C. I.			3.8	5.3	7.2	10.0	12.0	17.0	21.0	27.0	38.0
Coupling or Union	Screwed	Steel C. I.	.14	.18	.21	.24	.29	.36	.39	.45	.47	.53	.65
	Bell Mouth Inlet	Steel C. I.	.04	.07	.10	.13	.18	.26	.31	.43	.52	.67	.95
Square Mouth Inlet	Screwed	Steel C. I.	.44	.68	.96	1.3	1.8	2.6	3.1	4.3	5.2	6.7	9.5
	Re-entrant Pipe	Steel C. I.	.88	1.4	1.9	2.6	3.6	5.1	6.2	8.5	10.0	13.0	19.0
Sudden Enlargement			$b = \frac{(V_1 - V_2)^2}{2g}$ FEET OF FLUID, IF $V_2 = 0$ $b = \frac{V_1^2}{2g}$ FEET OF FLUID										