+1.262.728.5551 main

293 S. Wright Street
Delavan, WI 53115
United States
www.pentair.com

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WHITE PAPER

Pipe Sizing Part 2: Friction Loss Charts

Introduction

Friction Loss Charts help you determine the needed pipe sizes, determine output pressures, etc.

Defining the Problem

The math involved in figuring out pressure loss is very involved. Most plumbing professionals do not have the time for this. For this reason, charts have been assembled as a much quicker way to find out the amount of pressure loss in a water system.

Solution

Below is a friction loss chart using the Williams and Hazen formula. It talks about Head Loss in 100' of pipe and also assumes a 10 year old pipe. Add your equivalent length of pipe from your fittings to your actual length of pipe to get your effective length of pipe. Find the pipe size on the chart (remember this is only the beginning of the chart,) look for the flow rate you will be putting through the pipe, make sure the velocity is correct, and find the type of pipe you are using to pick that multiplier.

1/2" Pipe					3/4" Pipe				
Flow in US GPM	Velocity FPS	Plastic C=140 ID .622	Steel C=100 ID.622	Copper C=130 ID .625	Flow in US GPM	Velocity FPS	Plastic C=140 ID .824	Steel C=100 ID.824	Copper C=130 ID .822
0.5	0.5	0.314	0.582	0.35	1.5	0.9	0.61	1.13	0.70
1	1.1	1.14	2.10	1.26	2	1.2	1.04	1.93	1.21
1.5	1.6	2.38	4.44	2.67	2.5	1.5	1.57	2.91	1.82
2	2.1	4.10	7.57	4.56	3	1.8	2.21	4.08	2.56
2.5	2.6	6.15	11.40	6.88	3.5	2.1	2.93	5.42	3.40
3	3.2	8.65	16.00	9.66	4	2.4	3.74	6.94	4.36
3.5	3.7	11.50	21.30	12.90	4.5	2.7	4.66	8.63	5.40
4	4.2	14.80	27.30	16.40	5	3.0	5.66	10.50	6.57
4.5	4.8	18.30	33.90	20.40	6	3.6	7.95	14.70	9.22
5	5.3	22.20	41.20	24.80	7	4.2	10.60	19.60	12.20
5.5	5.8	26.60	49.20	29.50	8	4.8	13.50	25.00	15.70
6	6.3	31.20	57.80	34.80	9	5.4	16.80	31.10	19.50
6.5	6.9	36.20	67.00	40.20	10	6.0	20.40	37.80	23.70
7	7.4	41.50	76.80	46.10	11	6.6	24.40	45.10	28.20
7.5	7.9	47.20	87.30	52.50	12	7.2	28.60	53.00	33.20
8	8.5	53.00	98.30	59.40	13	7.8	33.20	61.50	38.50
8.5	9.0	59.50	110.00	66.00	14	8.4	38.00	70.50	44.20
9	9.5	66.00	122.00	73.50	16	9.6	48.60	90.20	56.60
9.5	10.0	73.00	135.00	81.00	18	10.8	60.50	112.00	70.40
10	10.6	80.50	149.00	89.40	20	12.0	73.50	136.00	83.50

Important to remember: 1 PSI = 2.31 Feet of Head (FoH)

You can go from PSI to FoH (Feet of Head) by using this formula: PSI x 2.31=FoH or FoH/2.31=PSI. Some people ask, "When will I use this?" but it really is important. It is the basis for everything we do. Most pump curves are written in FoH not PSI therefore at some point you are going to have to change everything into Feet of Head so you can go to a curve and pick a pump. Without understanding this formula it is virtually impossible to choose or troubleshoot a pump.

Example Using the Chart: We are putting 4.5 gallons of water per minute through 100' of ½" plastic pipe and want 50PSI at the other end. What pressure does the pump need to produce, in order to get that result?

In the first column, labelled "Flow in US GPM", go down and find 4.5
Follow that row to the right and we see the water's velocity is 4.8 FPS. That's under 5 so it's OK.
Follow the row to the right until we find the number in the column relating to the type of pipe we are using. In this case it is ½" plastic. We find the number 18.30 there. That is the amount of FoH that is going to be lost, due to friction, in every 100' of 1/2" plastic pipe.

Since we are pumping through 100' of this ½" plastic pipe, the math is:
FoH lost to friction = 18.30 ÷ 2.31 = 7.9 PSI (call it 8 PSI) per 100' of pipe X 1 (since we ARE using 100' of pipe). If we were pumping through 200' of pipe, we would multiply by 2,

Pressure required at the end: 50 PSI
Pressure lost to friction: + 8 PSI (because we are using 100' feet of pipe)

Total Pressure at Pump: 58 PSI

So we need a pump that can flow 4.5 GPM at 58 PSI to work in the system described.

As Flow Rate increases, so does the pressure loss – a LOT

Above, 58 PSI needs to go into the pipe for a flow rate of 4.8 GPM. If we were to allow the max suggested of 7FPS to flow through the pipe, we would only get 2GPM more and it would cost about twice as much pressure lost to friction, about 16PSI. Suddenly, we would need a pump that can push almost 66 PSI in order to work. And that's if we use plastic pipe. With steel pipe we would almost double the losses again.

With steel pipe we lose 33.9 FoH (14.7 PSI) per 100' of pipe. If you had to use steel pipe what could you do?
Answer: **Go up one pipe size**.

If you look at 5GPM on the ½" steel chart your friction loss would be 41.2' of head. But the same flow through the ¾" steel pipe only losses 10.5' of head. Since friction loss is energy loss, that's a 75% savings in energy that our customer would have had to pay to get the water through his ½" steel pipe.

Some Notes On the Chart

The chart is based off the same size ID pipe so when we say plastic we mean Schedule 40, which is the same ID as steel pipe. Velocity is based off of the pipe ID, not type of pipe. So if the ID is the same, the material of construction has little effect on velocity.

Friction loss is measured from the beginning of the pipe to the end of the pipe. Whether the pipe is under water, underground, or in the air there is still friction loss in the pipe. It doesn't matter if the pipe is vertical or horizontal friction loss is always there when the water is moving. The only time there is no friction loss is when the water is not moving.

Also remember that the chart is based on the "average" pipe that has been in place for 10 years. If the system you are working on is much older, or if hard water has left a lot of deposits in the pipe, the piping system could lose much more than the chart above states.