System design

Pressure loss in fittings and valves

Pressure loss in fittings

Where the system is complex and intensively uses fittings and changes of direction, it is also possible to approximate the effect on head loss due to the fittings. The following table can be used as a guide to the equivalent pipe length (in metres) for four of the commonly used pipe fittings:

Nominal Size	1/2(15)	3/4(20)	1(25)	1 1/4(32)	1 1/2(40)	2(50)	3(80)	4(100)
Tee (Run)	0.30	0.43	0.52	0.70	0.82	1.22	1.86	2.41
Tee (Side Outlet)	1.16	1.49	1.83	2.23	2.56	3.66	5.00	6.70
90° Elbow	0.46	0.61	0.76	1.16	1.22	1.74	2.41	3.48
45° Elbow	0.24	0.34	0.43	0.55	0.64	0.79	1.22	1.55
Nominal Size	6(150)	8(200)	10(250)	12(300)	14(350)	16(400)	20(500)	24(600)
Tee (Run)	3.75	4.27	5.33	6.10	7.62	8.23	10.67	12.80
Tee (Side Outlet)	9.97	14.94	17.38	20.43	23.78	26.83	35.98	41.77
90° Elbow	5.09	6.40	7.93	9.76	11.28	13.11	17.68	20.43
45° Elbow	2.44	3.23	4.12	4.73	5.49	6.10	7.62	9.15

System design

Pressure loss in fittings and valves

Pressure loss in valves

All thermoplastic valves have a flow factor that is normally described as a K_v value. K_v values are an established means of defining the flow rate in m^3 per hour of water at 20°C through a fully open valve, with a pressure drop of $1kg/cm^2$.

The C_v value is a commonly referenced flow coefficient for valves manufactured in the U.S.A. It is defined as the flow of water through a valve at 60°F (15.54°C) in US gallons per minute, with a pressure drop of 1 psi.

The connection between Flow Factor K_v and Flow Coefficient C_v can be expressed as:

$K_v = 0.86\ C_v$
$C_v = 1.16\ K_v$

The K_v value is also the sizing factor to calculate the pressure drop ($\triangle p$) in bar of a liquid flow across the valve:

$$\triangle p = \frac{\delta \cdot Q^2}{K_v^2}$$

where
$\triangle p$ = Pressure drop (bar)
δ = Density of the liquid (kg/dm^3)
Q = Flow rate (m^3/hr)

For example, calculate the pressure drop in a 50mm DN ball valve that is 50% closed handling 90% sulphuric acid (density $1.81kg/dm^3$) at a flow rate of $12m^3/hr$:

$$\triangle p = \frac{1.81 \cdot 12^2}{51^2}$$

(the K_v value is taken from the pressure drop characteristics table below and is calculated as 204 x 25%)

$$\triangle p = 1.81 \cdot 0.0554$$

$$\triangle p = 0.1002 \text{ bar}$$

If the flow, the maximum pressure drop and the density of the liquid are known, it is possible to calculate the minimum K_v value as follows:

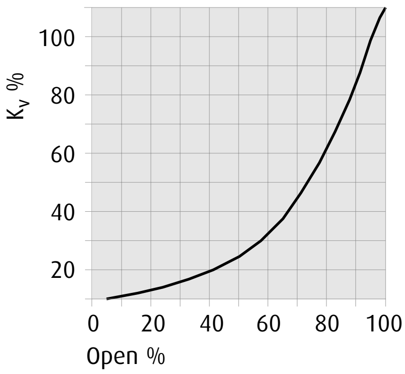
$$\text{Minimum } K_v \text{ value in } m^3/hr = Q \sqrt{\frac{\delta}{\triangle p}}$$

The K_v value for all valves can be read from the appropriate flow chart for each valve type. Kv flow charts give the flow characteristics of each type of valve, from the fully closed to the fully open position.

Typical valve pressure drop characteristics

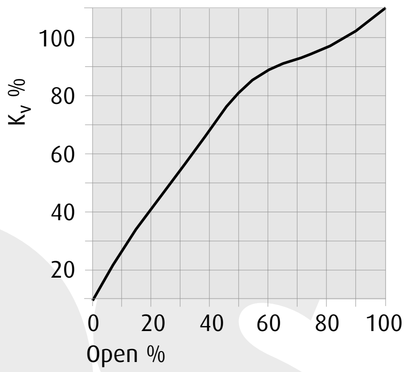
Ball Valve (2-way)

DN (mm)	DN (inch)	K_v value (m^3/hr)
15	fi	12
20	fl	23
25	1	46
32	1⁄	66
40	1fi	105
50	2	204
65	2fi	315
80	3	426
100	4	570



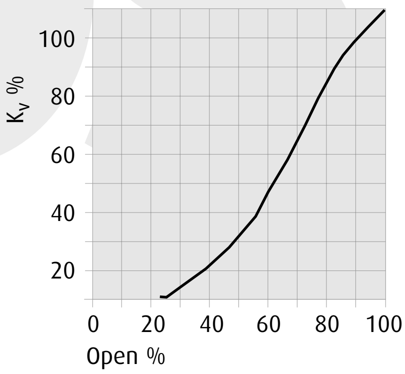
Diaphragm Valve

DN (mm)	DN (inch)	K_v value (m^3/hr)
15	fi	5
20	fl	8
25	1	10
32	1⁄	18
40	1fi	25
50	2	46
65	2fi	78
80	3	120
100	4	162



Butterfly Valve

DN (mm)	DN (inch)	K_v value (m^3/hr)
65	2fi	102
80	3	213
100	4	354
125	5	591
150	6	1122
200	8	1830
250	10	3800
300	12	5400



Check Valve

DN (mm)	DN (inch)	K_v value (m^3/hr)
15	fi	7
20	fl	12
25	1	23
32	1⁄	34
40	1fi	50
50	2	78
65	2fi	117
80	3	156
100	4	210

Line Strainer

DN (mm)	DN (inch)	K_v value (m^3/hr)
15	fi	2
20	fl	4
25	1	6
32	1⁄	11
40	1fi	15
50	2	25
65	2fi	39
80	3	63
100	4	102

The values shown above are average values that are typical for plastic valves. Please enquire for specific K_v values for actual valves.