

Sizing and Selection of Butterfly Valves

Introduction

When selecting a butterfly valve for water applications you must first determine the requirements of the valve assembly. The first question to ask is, "Will the valve be used for "Isolation" or "Proportional Control" of the fluid?" and "Does the application require a 2-way or 3-way assembly?"

2-way and 3-way Isolation Valves

When selecting a valve for isolation purposes, it is seldom necessary to calculate flow requirements beyond the published C_v 's (flow coefficients)* of the valve. These valves are typically line size and require the lowest pressure drop available in the full open position. It may be possible to supply a valve smaller than the actual line size and still obtain a low-pressure drop. However, the cost of reducing flanges will typically offset any savings incurred by reducing the valve size. The following charts, Tables 1 & 2, provide flow coefficients for the Keystone Figure 222 and AR2 valve assemblies.

2-Way and 3-Way Proportional Control Valves

Control Valves are the most important element of a fluid handling system and proper selection of these valves is crucial for efficient operation of the process. When sizing butterfly valves for control, it is imperative to have certain requirements of the system.

You must have:

- **Maximum flow requirement:** This would be equivalent to the design flow and provided or converted to gallons per minute.
- **Maximum pressure drop allowed:** The Consulting Engineer usually provides this factor and are typically 3 to 5 pounds max. However, the pressure drop should never exceed one half of the inlet pressure.

Without these two factors, selection of a control valve would be simply a guess.

Sizing Example

With this information and assuming the media is water or a similar media (glycol/water mix), a control valve can be properly sized for the application by following these steps:

1. **Calculate the required C_v :** Using the following formula and the information required above, you could calculate the flow coefficient (C_v) of the control valve.

$$C_v = \frac{\text{GPM}}{\sqrt{\Delta P}}$$

Whereas: GPM = The maximum flow requirement
P = The maximum pressure drop (5 psi)

Example

The line size is 6" and the required flow is 600 GPM with a maximum pressure drop of 5 psi. The square root of 5 is equal to 2.236. When divided into 600, the required C_v for this application is: 268.336.

2. **Select your valve size:** Using the Flow Coefficients (C_v 's), select the appropriate valve size. If your required C_v is in between valve sizes, choose the larger size valve. When selecting a 3-way assembly, the C_v of the run should be selected.

Example

The line size is 6" and the calculated required C_v is 268.336. The valve selected is a 4" with a rated C_v of 647.

Butterfly valves are high capacity valves and require very little pressure drop to control flow, which allows for reduction from the line size when sizing valves. This pipe reduction affects the flow characteristics and will reduce the effective C_v of the valve. This phenomenon is known as the piping geometry factor (F_p), which brings us to the final step in valves sizing.

reference

2-way Flow Coefficients (Cv's)

Size	Degrees Open								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
2"	0	1.3	5	14	26	40	52	59	60
2-1/2"	0	1.4	6	21	44	74	107	138	151
3"	0.7	1.5	8	29	67	115	175	234	262
4"	1.7	15	48	107	196	318	463	589	647
5"	3	32	99	206	362	579	832	1045	1141
6"	4	47	145	295	510	810	1160	1450	1580
8"	6	84	239	450	751	1190	1754	2385	2892
10"	9	133	360	652	1064	1683	2524	3596	4593
12"	12	192	509	899	1449	2288	3470	5085	6682
14"	75	340	770	1400	2200	3400	5600	7900	10000
16"	100	440	1000	1800	2800	4500	7400	10800	13000
18"	130	570	1300	2300	3600	5800	9600	15000	18000
20"	150	710	1600	2900	4600	7200	12000	18400	22000

Table Note

- Flow Coefficients (Cv) = The amount of water in gallons per minute, at 60°F that will pass through a given orifice with a one pound pressure drop.

3-way Flow Coefficients (Cv's)

Size	Degrees Open									
	Run 0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
Branch	90°	80°	70°	60°	50°	40°	30°	20°	10°	0°
2"	54	53	49	43	38	40	44	52	57	58
2-1/2"	114	108	93	74	52	64	78	102	126	135
3"	188	178	148	114	55	95	120	165	210	229
4"	385	374	348	313	150	295	345	419	482	511
5"	642	627	600	563	270	549	630	740	829	870
6"	935	909	867	809	483	780	895	1051	1180	1242
8"	1688	1573	1424	1271	796	1175	1367	1661	1994	2254
10"	2667	2430	2132	1856	1142	1685	1971	2439	3046	3570
12"	3938	3531	3019	2579	1629	2312	2715	3401	4368	5240
14"	5109	4825	4416	3719	2433	3514	3992	5259	6342	7173
16"	6735	6462	5832	4904	3213	4498	5265	6943	8567	9410
18"	9060	8724	7650	6372	4433	5778	6815	9056	11695	12785
20"	11229	10799	9545	7901	5619	7339	8449	11309	14423	15770

Table Notes

- Three-way valve assemblies Cv's are corrected from published two-way Cv's to account for line losses generated by the tee, and are calculated values only. The pipe friction losses are a function of fluid velocity through the pipe and the three-way Cv's listed are apparent for full flow through the pipe. Operation at less than full capacity (lower velocity) will increase the actual Cv's

Sizing and Selection of Butterfly Valves (continued)

3. Piping Geometry Factor: Reducing pipe sizes for installation of a smaller than pipe size valves will reduce the effective Cv of the valve. The greater the pipe reduction, the greater loss of Cv. Using the Adjusted Cv's for Piping Geometry Factors chart, verify that the corrected Cv, for the valve size selected, meets or exceeds the required Cv calculated in step 2.

Note: 3-way Cv's have already been adjusted.

Adjusted Cv's for Piping Geometry Factors

Size	Pipe Size													
	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	22"	24"
2"	47	38												
2-1/2"		125	79											
3"			189	149										
4"				505	408									
5"					947	685								
6"						1138	916							
8"							2256	1822						
10"								3812	3123					
12"									5747	4811				
14"										8900	7600			
16"											11830	10140		
18"												16560	14580	
20"													20460	18260

**6-inch 3-way Assembly at Constant Valve Differential Pressure
(corrected for tee loss)**

