INTRODUCTION

The control valve is the most important single element in any fluid handling system. This is because it regulates the flow of a fluid in the HVAC system. The automated valve is often referred to as the final control element, and is certainly the most important part of any piping system. The system will not operate at an efficient level without a properly sized valve. For valves that are too *oversized*, the results are poor controllability of the system and may cause the valve to hunt or cycle. Valves that are too *undersized* will require a larger pressure drop across the valve to maintain adequate flow and may not provide the required capacity. The results of undersizing a valve will cause the pump to work harder and make the valve very susceptible to the effects of *cavitation*.

To properly select a control valve, it is helpful to have a general knowledge of fluid mechanics, and of the components of a HVAC piping system. This section of the catalog is designed to assist you in the selection of the best control valve for your system. Included are the steps and specific formulas to help you size your valve assemblies correctly. The key to remember is that valve sizing is not an exact science and that often you must select from the best available option.

THE SIX STEPS

There are six steps to correctly size a valve in a piping system. They are as follows:

1) Gather Information
2) Calculate the Cv
3) Select a Valve
4) Correct for Fp
5) Cavitation Check
6) Close-Off Check

STEP 1 - GATHER INFORMATION

For selecting the best valve assembly for the application, the more information you can collect up front, the better. Below is a check list of information required.

Valve Information

1. **Service?** Water, Steam, other Fluid
2. **Required Capacity?** Water in gallons per minute (GPM), Steam in lbs/hour
3. **Desired Pressure Drop of Valve?** 3-5 psi is normal
4. **Temperature of Fluid?** How hot or cold is the medium
5. **System Pressure?** Valve needs to withstand the pressure
6. **Pipe Size?** Fp correction may be required
7. **Type of Valve?** Ball, Globe, Butterfly

Actuator Information

1. **Electric or Pneumatic?**
2. **Double Acting or Spring Return?** Is a fail position necessary?
3. **Power Source?** 120 VAC, 24 VAC, 80 psi air are normal
4. **Control Signal?** 4-20mA, 0-10VDC, 3-15 psi air
5. **Close-Off Requirement?** Size of actuator needed
6. **Accessories?** Switches, feedback, etc.
7. **Ambient Temperature / Conditions?** Weatherproof enclosure, heater, etc.

STEP 2 - CALCULATE THE C_V

The focal point of all valve sizing is the flow coefficient (Cv). The Cv factor is defined as “the number of U.S. gallons per minute of 60°F water that will flow through a fully open valve with a 1 psi drop across it.” This factor is determined by the construction of the valve and will not change. Note that identical valve sizes may have different Cv’s if the body or valve trim is different. This value of Cv is probably the most useful piece of information in sizing a valve. There are two different methods of determining the proper Cv. The first, and most simple, is to use sizing charts. **Note that there are different charts for Chilled or Hot Water and Steam applications.**

Water Sizing Charts

To use the Water Sizing Charts, first determine the pressure drop across the valve to be used. A pressure drop must exist across a control valve if flow is to occur. The greater the drop, the greater the flow at any fixed opening. The pressure drop across a valve varies with the disc

Engineering Data

Valve Sizing

position – from minimum when the valve is fully open to 100% of the system drop when the valve is fully closed.

To size a valve properly, it is necessary to know the full flow pressure drop across it. The pressure drop across a valve is the difference in pressure between the inlet and outlet under flow conditions. When it is specified by the consulting engineer and the required flow is known, the selection of a valve is simplified. But when the pressure drop is not known, it must be computed or assumed. As a rule of thumb, most consulting engineers will allow you to use between 3 to 5 psi drop across a valve for sizing purposes.

In the following example, let's say the application requires a 5 psi drop. Then determine how many GPM will be flowing through the valve (194 GPM in this example). Go down the "5 ΔP" column until you see the closest number to the GPM needed (190 GPM). Follow that row to the far left column under the Cv heading. You now know that you need a valve with a Cv rating of around 85.

Cv	Differential Pressure (PSI)									
	ΔP									
	2	3	4	5	10	15	20	25	30	35
70	99	121	140	157	221	271	313	350	383	414
74	105	128	148	165	234	287	331	370	405	438
75	106	130	150	168	237	290	335	375	411	444
85	120	147	170	190	269	329	380	425	466	503
91	129	158	182	203	288	352	407	455	498	531
100	141	173	200	224	316	—	—	—	—	—
101	143	175	202	226	319	391	452	505	553	598

Note: These tables are based on water at 60°F.
Numbers in the Table are GPM.

Steam Sizing Charts

The Steam Sizing Charts are used in the same way as the water tables. However, with steam different parameters are used. When calculating Cv for steam you must first know the inlet pressure. With water the inlet pressure in not necessary, but with steam it is absolutely necessary. Note that the column headings in the steam charts begin with the inlet pressure.

When sizing steam valves, different pressure drops are used depending on if the valve is for two position or modulating control applications. Each inlet pressure column has two sub columns. The left sub column is for two-position control. The right, or higher pressure drop column, is for modulating control. You should not be alarmed at the seemly high delta pressure that is recommended for steam. Because of the nature of steam and its heating abilities, it requires a high pressure drop for good control.

In the following example, first determine what the steam inlet pressure going to the valve will be (15 psi of steam in this example). Determine if the application is for two position or modulating control (modulating in this example). The left sub column under 15 psi is for two position, low pressure drop, the right sub column is for modulating, high pressure drop. Then determine how many pounds per hour of steam will be passing through the valve. Go down the right sub column until you see the closest number to the required lbs/hr of steam (3380 lbs/hr). Follow that row to the far left column under the Cv heading. You now know that you need a valve with a Cv rating of around 75.

Cv	Inlet Pressure (PSI)							
	ΔP							
	5 lb		10 lb		15 lb		20 lb	
	0.5*	4	1*	8	1.5*	12	2*	14
56	521	1331	818	1942	1093	2448	1359	2860
65	604	1545	949	2254	1268	2842	1577	3320
70	651	1664	1022	2427	1366	3061	1698	3575
75	697	1783	1095	2601	1463	3279	1820	3830
85	790	2021	1241	2947	1658	3716	2062	4341
100	930	2377	1460	3488	1951	4372	2426	5107
115	1069	2734	1680	3988	2244	5028	2790	5873

*For 2 position control.
Higher ΔP for modulating control.

Formulas for Cv

The second method of calculating Cv is by using mathematical equations. While the sizing charts are quick and easy, there are times when you may need to calculate the exact Cv requirement. This may be the case if nothing on the chart comes close.

There are different formulas used to calculate the Cv depending on the line flow medium. Following are the formulas and example solutions.

Valve Sizing Formulas

Water Formulas

Formula 1 $C_V = \dfrac{Q}{\sqrt{\Delta P}}$

Formula 2 $\Delta P = \left(\dfrac{Q}{C_V}\right)^2$

Formula 3 $Q = C_V\sqrt{\Delta P}$

Where: Q = Quantity, Flow Rate in GPM
ΔP = Wide Open Pressure Drop in PSI
C_V = Valve Flow Coefficient

Examples:

Formula 1

Problem: Medium - Water
Flow Rate - 90 GPM (Q)
Pressure loss - 4 PSI (ΔP)
What is C_V of valve required?

Solution: $C_V = \dfrac{Q}{\sqrt{\Delta P}}$

$$C_V = \frac{90}{\sqrt{4}} = \frac{90}{2} = 45$$

Formula 2

Problem: Medium - Water
Flow Rate - 90 GPM (Q)
Use of valve with C_V of 51
What will the pressure loss be?

Solution: $\Delta P = \left(\dfrac{Q}{C_V}\right)^2$

$$\Delta P = \left(\frac{90}{51}\right)^2 = \frac{8100}{51} = 3.1 \text{ psi}$$

Formula 3

Problem: Medium - Water
Use of valve with C_V of 51
How many GPM will flow if ΔP is 4 psi?

Solution: $Q = C_V\sqrt{\Delta P}$

$$Q = 51\sqrt{4} = 51\text{x}2 = 102 \text{ GPM}$$

Valve Sizing Formulas

Liquids Other Than Water Formulas

Formula 4 $C_V = Q\sqrt{\dfrac{Sg}{\Delta P}}$

Formula 5 $\Delta P = Sg\left(\dfrac{Q}{C_V}\right)^2$

Where: Q = Quantity, Flow Rate in GPM
ΔP = Wide Open Pressure Drop in PSI
Sg = Specific Gravity
C_V = Valve Flow Coefficient

Specific Gravity of Common Liquids

Ethyl Alcohol: 0.79
Methyl Alcohol: 0.79
Ethylene Glycol (50%): 1.05
Vinegar: 1.08
Water: 1.00

Examples:

Formula 4

Problem: Medium - Alcohol
Flow Rate - 90 GPM (Q)
Pressure loss - 4 PSI (ΔP)
What is C_V of valve required?

Solution: $C_V = Q\sqrt{\dfrac{Sg}{\Delta P}}$

$$C_V = 90\sqrt{\frac{.79}{4}} = 90\sqrt{.2}$$

$$= 90 \times .2 = 40.5$$

Formula 5

Problem: Medium - Ethylene Glycol
Flow Rate - 90 GPM (Q)
Use of valve with C_V of 45
What will the pressure loss be?

Solution: $\Delta P = Sg\left(\dfrac{Q}{C_V}\right)^2$

$$\Delta P = 1.05\left(\frac{90}{45}\right)^2 = 1.05 \times 4 = 4.2 \text{ psi}$$

Engineering Data

Valve Sizing

VALVE SIZING INFORMATION FOR STEAM

When sizing a valve for steam applications, three steps must be followed:

1) Determine the proper pressure drop that should be used. See below.

2) Calculate the absolute outlet pressure **(P_2)**

3) Calculate the valve flow coefficient **(Cv)**

1) Pressure Drop

2 Position Valves

Use a of 10% of available inlet pressure.

Modulating Valves

- Low pressure (15 psig or less): 80% of available inlet pressure.
- For steam pressures greater than 15 psi: 42% of the absolute inlet pressure.
- When Cv required is between two valve sizes and closer to the smaller valve size, re-size for Cv using 42% of the absolute inlet pressure as pressure drop. Use the valve that is larger than the calculated Cv.
- When Cv required is between two valve sizes, select the larger size.

Note: Do not size steam valves on higher system pressures using a pressure drop greater than 42% of the absolute inlet pressure.

2) Absolute Outlet Pressure (P_2)

Once you have calculated the proper pressure drop you are in position to calculate P_2.

P_2 = Inlet Pressure - ΔP + 14.7

For example: with an inlet pressure of 15 psi, and pressure drop of 12, you would calculate the P_2 as follows:

P_2 = 15 psi - 12 psi + 14.7

P_2 = 3 psi + 14.7

P_2 = 17.7 psi

3) Flow Coefficient (Cv)

With the pressure drop and absolute pressure determined, you can now calculate the Cv.

$$C_V = \frac{\text{lbs/hr}}{3\sqrt{\Delta P \times P_2}}$$

STEP 3 - SELECT A VALVE

Now that you know what the Cv requirements are you can select the valve to fit the application. Select a control valve from ball, globe or butterfly valve with an actuator from electric or pneumatic, double acting or spring return, high or low pressure. Each valve and actuator type has its own specific features and benefits, as well as its suitability to different applications. Consider the space requirements, pipe dimensions, function, valve disc and seat materials, corrosion protection, torque, temperature range and engineering specifications needed for the specific service.

When you have selected the type of automated valve needed refer to the Cv charts in the appropriate section in this manual. Select a valve with the closest Cv rating.

Before making the final selection, Steps 4 through 6 must be taken.

STEP 4 - CORRECT FOR Fp

In sizing control valves, the control valve size will frequently be smaller than the pipe size. This is true because pipe is sized to minimize pressure drop, while control valves are sized to take a relatively high pressure drop for controllability reasons. As fluid flows through a pipe reducer, some turbulence is introduced which results in a slight loss of flow capacity at the valve.

It is recommended that control valves be sized within one size of the pipe, and in no case more than two sizes of the pipe. When valves are sized within one size of the pipe, the amount of reduced flow capacity is minimal, usually less than 1%.

Use the tables in this section to get the actual corrected Cv using the Fp factors. This is especially important in sizing butterfly valves for modulating controls applications.

STEP 5 - CAVITATION CHECK

When dealing with a non compressible fluid such as water and with a high pressure drop, it is very important to verify that your valve will not suffer the effects of cavitation.

Cavitation is a phenomenon that occurs in two stages in a liquid system. The first stage is the formation of voids or cavities (bubbles) within the liquid system. As water passes through the valve, pressure is reduced dramatically – sometimes to the point of a near vacuum. This enables water in essence to "boil" at very low temperatures. Note that the boiling point of water can lower from 212°F to room temperature in a vacuum. The second stage is the collapse or implosion of these cavities back into the liquid state.

The forming of vapor bubbles in itself can be a problem since these bubbles restrict the flow of water through the valve. However, the second stage is a far worse problem. As the bubbles move downstream from the orifice, the pressure stabilizes and the bubbles collapse back to their original liquid state. When this implosion occurs, all the energy from the surface tension forms a micro jet. The energy is concentrated into a very small area. This can virtually destroy the valve and can even destroy the surrounding pipe.

While cavitation rarely happens in HVAC systems, it must be avoided, as this phenomenon not only effects the capacity of the valve but also causes noise, vibration, and erosion to the valve trim and body.

The exact point when cavitation will begin is hard to pinpoint due to many variables. Engineers have found the formula below to be accurate.

Cavitation Point Formula

$\Delta Pm = Kc\,(P_1 - Pv)$

Where: ΔPm = Maximum pressure drop that can be taken across the valve without cavitation

Kc = Cavitation index of the valve. Each valve style has an assigned Kc number

P_1 = Inlet Pressure to the valve in PSIA (absolute)
Absolute = inlet pressure (psi) + 14.7

Pv = Vapor Pressure of water or liquid

Valve Cavitation Indexes

Valve Type	Kc
Ball (Full Port)	.22
Ball (Characterized)	.45
Globe	.50
Butterfly	.30

Vapor Pressure Chart

Water Temperature	Vapor Pressure
up to 100°F	less than 1 (use 1.0)
107°	1.2
113°	1.4
117°	1.6
122°	1.8
126°	2.0
132°	2.4
141°	3.0
152°	4.0
162°	5.0
170°	6.0
176°	7.0
182°	8.0
188°	9.0
193°	10.0
202°	12.0
210°	14.0
212°	14.7

Example

Problem:
1. You have selected a full port ball valve
2. Service is 180°F hot water
3. Inlet pressure is 30 psi

What is the ΔPm?

$$\Delta Pm = Kc\,(P1 - Pv)$$
$$\Delta Pm = .22 \times (44.7 - 8.0)$$
$$\Delta Pm = 8.07$$

Once you have calculated the maximum pressure drop across the valve without causing cavitation, you must check the actual pressure drop of the selected valve. It must have an actual pressure drop of less than the ΔPm. If the selected valve has too great a pressure drop, then you must select a larger valve.

STEP 6 - CLOSE-OFF CHECK

The valve must be able to close. This is a function of the actuator that is used on the valve to automate it. If too small an actuator is used, the actuator will not provide enough force to close off against the line system pressure that affects the valve. If too large an actuator is used, the actuator will not be cost effective. Keep in mind that for the system to function properly it is better to oversize an actuator than undersize.

Note: 3-way valve do not normally require a high close-off rating. This is due to the fact that these valves are only changing the direction of the flow and not stopping the flow. It is easier to divert a force than to stop it dead in it's tracks.

For the close-off rating of a specific valve, please refer to the valve selection charts in the ball, globe or butterfly valve sections of this manual.

While each engineered system is different, there are some general practices used concerning how much pressure drop to take across a control valve. Below are some rules of thumb.

Basic Control Valve Categories

Most of the control valves in the HVAC industry fall into one of the following categories:

1) The control is a two position operation (both water and steam).
2) Proportional control of water, the varying of the amount of water flow.
3) Proportional control of water, the varying of the temperature of the water flow.
4) Proportional control of steam.

Basic Rules

Some of the Rules applicable to the categories of valves are as follows:

1) Two Position Control

A low pressure drop across the valve is desired. Take no more than 10% of the available system pressure as the drop. If the pressure is not known, then choose a line size valve.

For example: With an inlet pressure of 30 psi, the pressure drop of the valve should be 3 psi or less.

2) Proportional Control, Varying Flow

A high pressure drop across the valve is desirable. The delta pressure should equal to the delta pressure across the coil. If the pressure is not known, then use 5 psi.

3) Proportional Control, Varying Temperature

A low pressure drop across the valve is desirable. Take no less 20% of the available system pressure as the drop. The maximum pressure drop should equal to 25% of the delta pressure through full load at full line flow.

For example: Given a system where the amount of water in the coil does not change, but where the valve is controlling the percentage of the constant flow coming from the boiler. By modulating the valve, the temperature of the water entering the coil varies. In this type of system, a low pressure drop is desired across the valve. With 20 psi inlet pressure, a 4 psi maximum drop across the valve is needed.

4) Proportional Control of Steam

A very high pressure drop across the valve is desirable.

A) FOR 15 PSI STEAM OR LESS
Take 80% of the inlet pressure or as the delta pressure or choose a valve at least 1 size smaller than line size.

For example: Given a system with an inlet pressure of 10 psi. The valve should be sized to have an 8 psi pressure drop.

B) FOR GREATER THAN 15 PSI STEAM
Take 42% of the absolute inlet pressure (gauge pressure + 14.7 = absolute pressure)

For example: Given a system with an inlet pressure of 50 psi. The valve should be sized to have a pressure drop of 27.17 psi across the valve.

Note: You should not be alarmed at the seemly high delta pressure that is recommended for steam. Because of the nature of steam and its heating abilities, it requires a high pressure drop for good control.

Process Valve Sizing Formulas

For Heating or Cooling Water

$$\text{gpm} = \frac{\text{Btu / hr.}}{(\text{°F water temp. rise or drop}) \times 500}$$

$$\text{gpm} = \frac{\text{cfm} \times .009 \times \text{change in enthalpy of air - in Btu / \#air}}{\text{°F water temperature change}}$$

For Heating Water With Steam

lbs. steam/hr = 0.50 x gpm x (°F water temp. rise)

For Heating or Cooling Water with Water

$$\text{gpm}_1 = \text{gpm}_2 \times \frac{(\text{°F water}_2 \text{ temp. rise or drop})}{(\text{°F water}_1 \text{ temp. rise or drop})}$$

For Heating Air with Steam Coils

$$\text{lbs. steam/hr} = 1.08\ (\text{°F air temp. rise}) \times \frac{\text{cfm}}{1000}$$

For Heating Air with Water Coils

$$\text{gpm} = 2.16 \times \frac{\text{cfm} \times (\text{°F air temp. rise})}{1000 \times (\text{°F air temp. drop})}$$

For Radiation

$$\text{gpm} = \frac{\text{sq. ft. EDR}}{50}$$

lbs. steam / hr. = 0.24 x sq/ ft. EDR (low pressure steam) (assume 20°F water temperature drop.)

The number of actuators required for specific applications depends on several torque factors. To determine the quantity of actuators required for the installation:

- Obtain the damper torque ratings (ft-lb/ft2 or Nm/m2) from the damper manufacturer.
- Determine the area of the damper.
- Calculate the total torque required to move the damper

  Total Torque = Torque Rating x Damper Area
- Select the total quantity of actuators required:

$$\text{Number of Actuators} = \frac{\text{Total Damper Torque Required}}{\text{SF* x Actuator Torque (Refer to Specifications)}}$$

* Safety Factor: When calculating the number of actuators required, a safety factor should be included for unaccountable variables such as slight misalignment, aging of the damper, etc. A suggested safety factor is 0.80 (or 80% of the rated torque).

Engineering Data

Water Valve Sizing

Cv	Differential Pressure (PSI) ΔP									
	2	3	4	5	10	15	20	25	30	35
.04	.57	.69	.80	.89	1.26	1.55	1.79	2.0	2.2	2.4
.95	1.3	1.7	1.9	2.12	3.0	3.7	4.3	4.8	5.2	5.6
1.3	18	2.2	2.6	2.9	4.1	5.0	5.8	6.5	7.1	7.7
1.4	2.0	2.4	2.8	3.1	4.4	5.4	6.3	7.0	7.7	8.3
1.7	2.4	2.9	3.4	3.8	5.4	6.6	7.6	8.5	9.3	10.1
2	2.8	3.5	4.0	4.5	6.3	7.8	8.9	9.8	11	12
2.2	3.1	3.8	4.4	4.9	7.0	8.5	9.8	11	12	13
2.4	3.4	4.2	4.8	5.4	7.6	9.3	10.7	12	13	14
2.5	3.5	4.3	5.0	5.6	7.9	10	11	13	14	15
3.3	4.7	5.7	6.6	7.4	10.4	13	15	17	18	20
3.6	5.1	6.2	7.2	8.1	11.4	14	16	18	20	21
3.8	5.4	6.6	7.6	8.5	12.0	15	17	19	21	22
4	5.7	6.9	8.0	8.9	12.7	15	18	20	22	24
5	7.1	8.7	10	11	15	19	22	25	27	30
5.5	7.9	9.5	11	12	17	21	25	28	30	33
6	8.5	10.4	12	13	19	23	27	30	33	36
6.2	8.8	10.7	12	14	20	24	28	31	34	37
6.8	9.6	11.8	14	15	22	26	30	34	37	40
7.4	10.5	12.8	15	17	23	29	33	37	41	44
7.5	10.6	13.0	15	17	24	29	34	38	41	44
8	11.3	13.9	16	18	25	31	36	40	44	47
8.2	11.6	14.2	16	18	26	32	37	41	45	49
8.5	12.0	14.7	17	19	27	33	38	43	47	50
9	12.7	15.6	18	20	28	35	40	45	49	53
10.5	15	18	21	23	33	41	47	53	58	62
11	16	19	22	25	35	43	49	55	60	65
12	17	21	24	27	38	46	54	60	66	71
15	21	26	30	34	47	58	67	75	82	89
16	23	28	32	36	51	62	72	80	88	95
17.4	25	30.1	35	39	55	67	78	87	95	104
25	35	43	50	56	79	97	112	125	137	148
30	42	52	60	67	95	116	134	150	164	177
33	47	57	66	74	104	128	148	165	181	195
35.8	51	62	72	80	113	139	160	179	196	212
40	57	69	80	89	126	155	179	200	219	237
42	59	73	84	94	133	163	188	210	230	248
45	64	78	90	101	142	—	—	—	—	—
55	78	95	110	123	174	213	246	275	301	325
56	79	97	112	125	177	217	250	280	307	331

Cv	Differential Pressure (PSI) ΔP									
	2	3	4	5	10	15	20	25	30	35
65	92	113	130	145	206	251	291	325	356	385
67	95	116	134	150	212	259	300	335	367	396
68	96	116	136	152	215	263	250	340	372	402
70	99	121	140	157	221	271	313	350	383	414
74	105	128	148	165	234	287	331	370	405	438
75	106	130	150	168	237	290	335	375	411	444
85	120	147	170	190	269	329	380	425	466	503
91	129	158	182	203	288	352	407	455	498	531
100	141	173	200	224	316	—	—	—	—	—
101	143	175	202	226	319	391	452	505	553	598
109	154	189	218	244	345	422	487	575	597	645
115	163	199	—	—	—	—	—	—	—	—
145	205	251	290	324	459	562	648	725	794	858
160	226	277	320	358	506	620	716	800	876	947
170	240	294	340	—	—	—	—	—	—	—
179	253	310	358	400	566	693	801	895	980	1059
195	276	338	390	436	617	755	872	975	10681	154
200	283	346	400	447	—	—	—	—	—	—
235	332	407	470	525	743	910	1051	1175	1287	1390
250	354	433	500	559	791	968	1118	1250	1369	1479
275	389	476	550	—	—	—	—	—	—	—
290	410	502	580	648	917	1123	1297	1450	1588	1716
300	424	520	600	671	949	1162	1342	1500	1643	1775
350	495	606	700	783	1107	1356	1565	1750	1917	2071
390	552	676	780	872	1233	1510	1744	1950	2136	2307
425	601	736	850	—	—	—	—	—	—	—
440	622	762	880	984	1391	1704	1968	2200	2410	2603
680	962	1178	—	—	—	—	—	—	—	—
1125	1591	1949	2250	—	—	—	—	—	—	—
1150	1626	1992	2300	—	—	—	—	—	—	—
1750	2475	3031	3500	—	—	—	—	—	—	—
1850	2616	3204	3700	—	—	—	—	—	—	—
2600	3677	4503	5200	—	—	—	—	—	—	—
2650	3748	4590	—	—	—	—	—	—	—	—
3400	4808	5839	—	—	—	—	—	—	—	—
4500	6364	—	—	—	—	—	—	—	—	—

Note: These tables are based on water at 60°F. Numbers in the Table are GPM.

Engineering Data

Steam Valve Sizing

Cv	Inlet Pressure (PSI)																			
	2 lb		5 lb		10 lb		15 lb		20 lb		25 lb		40 lb		50 lb		75 lb		100 lb	
	ΔP																			
	0.2*	1.6	0.5*	4	1*	8	1.5*	12	2*	14	2.5*	16	4*	23	5*	27	7.5*	37	10*	48
.04	2.2	5.9	3.7	9.5	5.9	13.9	7.8	7.5	9.7	20.4	11.6	23.4	17.1	32.4	20.7	38.3	29.8	53	38.8	68
.95	5.2	148.	82	2.6	13.9	32.9	18.5	41.5	23	48.5	27.5	55.5	40.6	77	49.2	90.9	70.8	126	92.2	161
.99	5.4	14.6	9.2	23.5	14.5	34.3	19.3	43.3	24	50.6	28.6	57.8	42.3	80.2	51.3	94.8	73.7	131	96.1	168
1.1	6	16.2	10.2	26.2	16.1	38.1	21.5	48.1	26.7	56.2	31.8	64.3	47	89.1	57	105.3	81.9	146	106.8	187
1.3	7.1	19.2	12.1	31	19	45.1	25.4	56.8	315	66.4	37.6	75.9	55.5	24.3	67.4	124.4	96.8	172	126.2	221
1.8	9.8	27	18.7	43	26.3	62.4	35.1	78.7	43.7	91.9	52.1	105.2	76.9	145.8	93.3	172.3	134.1	238	174.7	306
2.2	12	32.4	20.4	52	32	76	43	96	53	112	63.6	138.5	94	178	114	210.3	164	291	213.6	373
2.5	13.6	37	23	59	37	87	49	109	61	128	72	146	107	203	130	239	186	331	342	424
3.3	18	49	31	79	48	114	64	144	80	169	95	193	141	267	171	316	246	437	320	560
3.6	19.6	53	34	86	53	125	70	157	87	184	104	210	154	292	187	345	268	477	349	611
3.8	20.7	56	35	90	56	132	74	166	92	194	110	222	162	308	197	364	283	503	369	645
4.0	22	59	37	95	58	139	78	176	47	204	116	234	171	324	207	383	298	530	388	679
5	27	74	47	119	73	173	98	219	121	255	145	292	214	405	259	479	372	662	485	848
5.5	30	81	51	131	80	191	107	240	133	281	159	321	235	446	285	526	410	728	534	934
6	33	89	56	143	88	208	117	262	146	306	174	351	256	486	311	574	447	795	582	1018
6.2	34	91	58	147	91	215	121	271	150	317	179	362	265	502	321	593	462	821	601	1052
7.4	40	109	69	176	108	257	144	324	180	378	214	432	316	599	384	708	551	980	718	1256
7.5	41	111	70	178	110	260	146	328	182	383	217	438	320	608	389	718	559	994	728	1273
8.2	45	121	76	195	120	284	160	359	199	419	237	479	350	664	425	785	811	1086	796	1392
8.5	45	125	79	202	124	295	166	372	206	434	246	408	363	689	441	814	633	1126	825	1443
9.0	49	133	84	214	131	312	176	393	218	460	260	526	385	729	466	861	670	1192	874	1528
10.5	57	155	98	250	153	364	205	459	255	536	304	613	449	851	544	1005	782	1391	1019	1782
11	60	162	102	262	161	381	215	481	267	562	318	643	470	891	570	1053	819	1457	1068	1867
15	82	221	139	357	219	520	293	656	304	766	434	876	641	1215	777	1436	1117	1987	1456	2546
16	87	236	149	380	234	555	312	700	388	817	463	935	684	1296	829	1531	1192	2120	1553	2716
17.4	95	257	162	414	254	603	340	761	422	889	503	1016	743	1409	902	1665	1296	2305	1689	2954
25	136	369	232	594	365	867	488	1093	607	1277	723	1460	1068	2025	1296	2393	1862	3312	2427	4244
35.8	195	528	333	851	523	1241	699	1565	867	1828	1036	2091	1529	2900	1856	3427	2667	4742	3475	6077
40	218	590	372	951	584	1387	780	1749	970	2043	1157	2337	1709	3240	2073	3829	2980	5299	3883	6790
45	245	664	418	1070	657	1560	878	1967	1092	2298	1302	2629	1922	3645	2332	4307	3352	5961	4368	7639

Note: The steam capacity is indicated in pounds per hour.
This table is based on saturated steam.

*For 2 position control.
Higher ΔP for modulating control.

Engineering Data

Steam Valve Sizing

Cv	2 lb		5 lb		10 lb		15 lb		20 lb		25 lb		40 lb		50 lb		75 lb		100 lb	
	ΔP																			
	0.2*	1.6	0.5*	4	1*	8	1.5*	12	2*	14	2.5*	16	4*	23	5*	27	7.5*	37	10*	48
56	305	826	521	1331	818	1942	1093	2448	1359	2860	1620	3271	2392	4536	2903	5360	4171	7418	5436	9546
65	354	958	604	1545	949	2254	1268	2842	1577	3320	1881	3797	2777	5265	3369	6221	4842	8611	6310	11034
70	381	1032	651	1664	1022	2427	1366	3061	1698	3575	2025	4089	2991	5670	3628	6670	5214	9273	6795	11882
75	409	1106	697	1783	1095	2601	1463	3279	1820	3830	2170	4381	3204	6075	3887	7179	5587	9935	7280	12731
85	463	1253	790	2021	1241	2947	1658	3716	2062	4341	2459	4966	3631	6885	4406	8136	6332	11260	8251	14429
100	545	1475	930	2377	1460	3488	1951	4372	2426	5107	2893	5842	4272	8101	5183	9571	7449	13247	9707	16975
115	627	1696	1069	2734	1680	3988	2244	5028	2790	5873	3327	6718	4913	9316	5961	11070	8566	15234	11163	19521
145	790	2138	1348	3447	2118	5028	2829	6340	3518	7405	4195	8471	6195	11746	7516	13878	10801	19208	14075	24613
170	296	2507	1580	4042	2483	5895	3177	7433	4124	8682	4918	9931	7263	13771	8811	16271	12663	22519	16502	28857
200	1090	2949	1859	4755	2921	6935	3902	8744	4852	10214	5786	11684	8544	16201	10366	19143	14898	26494	19414	33950
235	1281	3465	2184	5587	3432	8149	4585	10275	5701	12002	6799	16065	10040	19036	12180	22493	17505	31130	22812	39891
275	1499	4055	2556	6538	4016	9536	5366	12024	6672	14044	7956	20447	11749	22277	14254	26321	20484	36429	26695	46681
350	1907	5161	3253	8321	5112	12136	6829	15303	8491	17875	10126	24828	14953	28352	18141	33500	26071	46264	33975	59412
425	2316	6267	3950	10104	6207	14737	8292	18582	10311	21705	12296	25704	18157	34427	22028	40678	31658	56300	41256	72143
440	2398	6488	4090	10461	6426	15257	8585	19238	10675	22471	12730	37388	18798	35642	22806	42114	32775	58287	42712	74689
640	3488	9437	5949	15215	9347	22192	12487	27982	15527	32685	18516	39725	27342	51844	33172	61257	47672	84781	62126	10839
680	3706	10027	6321	16166	9931	23579	13268	29731	16498	34728	19673	65722	29051	55084	35245	65085	50652	90080	66009	115429
1125	6131	16589	10457	26746	16430	39010	21950	49187	27294	57454	32547	67182	48063	91131	58310	107698	83799	149029	109206	190967
1150	6267	16958	10689	27340	16769	39877	22438	50280	27900	58731	33271	102234	49131	93156	59606	110710	85661	152341	111633	195210
1750	9537	25805	16267	41604	25558	60682	34145	76513	42457	89373	50629	108076	74764	141760	90705	167499	130354	231823	169876	297059
1850	10082	27280	17196	43982	27019	64150	36096	80885	44883	94481	53522	151890	79036	149860	95888	177070	137803	245070	179583	314034
2600	41469	38339	24167	61812	37972	90157	50730	113677	63079	132783	75220	154811	111078	210614	134762	248855	193669	344422	252388	441345
2650	14442	39076	24632	63001	38703	91890	51706	115863	64292	135337	76667	198625	113214	214665	137353	253641	197394	351046	257241	449832
3400	18529	50136	31604	80831	49656	117897	66339	148654	82488	173640	98365	—	145256	275419	176227	325426	253260	450398	330045	577143
4500	24524	66356	41828	—	65722	—	87802	—	109175	—	130189	—	—	—	—	—	—	—	—	—
5400	29429	79628	50194	—	78866	—	105362	—	—	—	—	—	—	—	—	—	—	—	—	—
7000	38148	—	65066	—	102234	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10000	54498	—	92952	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Note: The steam capacity is indicated in pounds per hour.
This table is based on saturated steam.

*For 2 position control.
Higher ΔP for modulating control.

Adusted Cv for Piping Geometry Factor (Fp)

2-WAY CHARACTERIZED BALL VALVES

Model No.	Size	Cv	0.5	0.75	1	1.25	1.5	2	2.5	3	4	5
VCB2101	1/2"	0.4	—	0.40	0.40							
VCB2102	1/2"	0.7	—	0.70	0.70							
VCB2103	1/2"	1.3	—	1.29	1.28							
VCB2104	1/2"	2.6	—	2.5	2.5							
VCB2105	1/2"	4.7	—	4.3	4.1							
VCB2107	1/2"	8.0	—	6.5	5.7							
VCB2207	3/4"	2.5		—	2.5	2.5						
VCB2208	3/4"	4.3		—	4.3	4.2						
VCB2210	3/4"	10.1		—	9.6	9.1						
VCB2209	3/4"	14.7		—	7.1	6.5						
VCB2311	1"	9			—	8.9	8.8					
VCB2313	1"	15.3			—	14.9	14.4					
VCB2312	1"	28.4			—	26.2	23.8					
VCB2414	1-1/4"	14.9				—	14.8	14.5				
VCB2416	1-1/4"	36.5				—	35.0	31.5				
VCB2415	1-1/4"	41.1				—	39.0	34.3				
VCB2517	1-1/2"	22.8					—	22.4	22.0			
VCB2519	1-1/2"	41.3					—	39.2	37.2			
VCB2518	1-1/2"	73.9					—	63.7	55.9			
VCB2620	2"	41.7						—	41.2	40.6		
VCB2622	2"	71.1						—	68.8	65.9		
VCB2621	2"	108						—	100.3	92.0		
VCB2723	2-1/2"	55							—	52.5	50.6	
VCB2724	2-1/2"	72							—	66.6	63.0	
VCB2725	2-1/2"	202							—	132.4	109.3	
VCB2827	3"	124								—	89.7	84.7
VCB2828	3"	145								—	96.8	90.6

3-WAY CHARACTERIZED BALL VALVES

Model No.	Size	Cv	0.75	1	1.25	1.5	2	2.5	3
VCB3101	1/2"	0.60	0.6	0.6					
VCB3102	1/2"	1.0	1.0	1.0					
VCB3103	1/2"	2.4	2.3	2.3					
VCB3104	1/2"	4.3	4.0	3.8	—				
VCB3105	1/2"	8.0	7.9	5.7	—				
VCB3207	3/4"	2.4	—	2.4	2.39				
VCB3208	3/4"	3.8	—	3.8	3.74				
VCB3209	3/4"	12.6	—	11.7	10.86				
VCB3311	1"	8.6		—	8.5	8.4			
VCB3312	1"	22.3		—	21.2	19.9			
VCB3414	1-1/4"	13			—	12.9	12.7		
VCB3415	1-1/4"	34.1			—	32.9	29.9		
VCB3517	1-1/2"	24.0				—	23.6	23.1	
VCB3518	1-1/2"	61.1				—	54.9	49.7	
VCB3620	2"	38.2					—	37.8	37.3
VCB3621	2"	108.5					—	100.7	92.3

Engineering Data

Globe Valve Selection

Adusted Cv for Piping Geometry Factor (Fp)

2-WAY SCREW TYPE (1/2" - 2")

Model No.	NPT	Cv	Pipe Size										
			1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	5"	6"
SDS2-J001	1/2"	.73	.73	.73	.73	.73	.73	—	—	—	—	—	—
SDS2-J002	1/2"	1.8	1.8	1.78	1.76	1.75	1.74	—	—	—	—	—	—
SDS2-J005	1/2"	4.6	4.6	4.24	4.00	3.88	3.82	—	—	—	—	—	—
SDS2-J007	3/4"	7.3	—	7.3	7.11	6.91	6.78	6.64	—	—	—	—	—
SDS2-J012	1"	11.6	—	—	11.6	11.43	11.21	10.92	10.77	10.68	—	—	—
SDS2-J019	1-1/4"	18.5	—	—	—	18.5	18.30	17.74	17.38	17.17	16.94	—	—
SDS2-J029	1-1/2"	28.9	—	—	—	—	28.9	28.16	27.38	26.87	26.32	—	—
SDS2-J047	2"	46.2	—	—	—	—	—	46.2	45.54	44.68	43.53	42.92	—

2-WAY FLANGE TYPE (2-1/2" - 6")

Model No.	NPT	Cv	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"
SDF2-S063	2 1/2"	63.0	63.0	62.50	61.09	60.17	59.61	—	—	—	—	—
SDF2-S100	3"	100	—	100.0	98.07	95.99	94.62	93.10	—	—	—	—
SDF2-S160	4"	160	—	—	160.0	158.28	155.99	152.92	151.26	—	—	—
SDF2-S250	5"	250	—	—	—	250.0	248.06	242.53	238.93	236.75	—	—
SDF2-S400	6"	400	—	—	—	—	400.0	392.26	383.97	378.46	374.86	—

3-WAY SCREW TYPE (1/2" - 2")

Model No.	NPT	Cv	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"	4"	5"	6"
SDS3-J001	1/2"	.73	.73	.73	.73	.73	.73	—	—	—	—	—	—
SDS3-J002	1/2"	1.8	1.8	1.78	1.76	1.75	1.74	—	—	—	—	—	—
SDS3-J005	1/2"	4.6	4.6	4.24	4.00	3.88	3.82	—	—	—	—	—	—
SDS3-J007	3/4"	7.3	—	7.3	7.11	6.91	6.78	6.64	—	—	—	—	—
SDS3-J012	1"	11.6	—	—	11.6	11.43	11.21	10.92	10.77	10.68	—	—	—
SDS3-J019	1-1/4"	18.5	—	—	—	18.5	18.30	17.74	17.38	17.17	16.94	—	—
SDS3-J029	1-1/2"	28.9	—	—	—	—	28.9	28.16	27.38	26.87	26.32	—	—
SDS3-J047	2"	46.2	—	—	—	—	—	46.2	45.54	44.68	43.53	42.92	—

3-WAY FLANGE TYPE (2-1/2" - 6")

Model No.	NPT	Cv	2 1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"
SDF3-S063	2 1/2"	63.0	63.0	62.50	61.09	60.17	59.61	—	—	—	—	—
SDF3-S100	3"	100	—	100.0	98.07	95.99	94.62	93.10	—	—	—	—
SDF3-S160	4"	160	—	—	160.0	158.28	155.99	152.92	151.26	—	—	—
SDF3-S250	5"	250	—	—	—	250.0	248.06	242.53	238.93	236.75	—	—
SDF3-S400	6"	400	—	—	—	—	400.0	392.26	383.97	378.46	374.86	—

Adusted Cv for Piping Geometry Factor (Fp)

2-WAY/3-WAY SERIES 31 (2" - 8") AT 60º ROTATION

ModelNo.	NPT	Cv	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"
NYL2/3-x020	2"	61	61	59	57	55	54	—	—	—	—	—
NYL2/3-x025	2-1/2"	107	—	107	104	98	94	92	—	—	—	—
NYL2/3-x030	3"	154	—	—	154	147	140	136	131	—	—	—
NYL2/3-x040	4"	274	—	—	—	274	265	255	242	235	—	—
NYL2/3-x050	5"	428	—	—	—	—	428	418	393	378	370	—
NYL2/3-x060	6"	567	—	—	—	—	—	567	545	524	510	501
NYL2/3-x080	8"	1081	—	—	—	—	—	—	1081	1048	1008	980

2-WAY/3-WAY SERIES 31 (10" - 20") AT 60º ROTATION

Model No.	NPT	Cv	10"	12"	14"	16"	18"	20"	22"	24"	26"
NYL2/3-x100	10"	1710	1710	1671	1617	1572	—	—	—	—	—
NYL2/3-x120	12"	2563	—	2563	2516	2441	2374	—	—	—	—
NYL2/3-x140	14"	3384	—	—	3384	3338	3258	3182	—	—	—
NYL2/3-x160	16"	4483	—	—	—	4483	4432	4340	4246	—	—
NYL2/3-x180	18"	5736	—	—	—	—	5736	5682	5577	5466	—
NYL2/3-x200	20"	7144	—	—	—	—	—	7144	7087	6971	6843

2-WAY/3-WAY SERIES 31 (2" - 8") AT 90º ROTATION

ModelNo.	NPT	Cv	2"	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"
NYL2/3-x020	2"	144	144	127	111	96	90	—	—	—	—	—
NYL2/3-x025	2-1/2"	282	—	282	245	187	165	154	—	—	—	—
NYL2/3-x030	3"	461	—	—	461	340	274	246	223	—	—	—
NYL2/3-x040	4"	841	—	—	—	841	664	538	442	406	—	—
NYL2/3-x050	5"	1376	—	—	—	—	1376	1132	808	700	649	—
NYL2/3-x060	6"	1850	—	—	—	—	—	1850	1360	1101	988	929
NYL2/3-x080	8"	3316	—	—	—	—	—	—	3316	2633	2142	1898

2-WAY/3-WAY SERIES 31 (10" - 20") AT 90º ROTATION

Model No.	NPT	Cv	10"	12"	14"	16"	18"	20"	22"	24"	26"
NYL2/3-x100	10"	5430	5430	4487	3667	3219	—	—	—	—	—
NYL2/3-x120	12"	8077	—	8077	6892	5590	4974	—	—	—	—
NYL2/3-x140	14"	10538	—	—	10538	9360	7942	6998	—	—	—
NYL2/3-x160	16"	13966	—	—	—	13966	12640	10872	9607	—	—
NYL2/3-x180	18"	17214	—	—	—	—	17214	15902	13962	12454	—
NYL2/3-x200	20"	22339	—	—	—	—	—	22239	20756	18296	16308

Engineering Data

Butterfly Valve Selection

Adusted Cv for Piping Geometry Factor (Fp)

2-WAY SERIES 41 HIGH PERFORMANCE (2-1/2" - 12") AT 60º ROTATION

Model No.	NPT	Cv	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"
MKL2-x025	2-1/2"	78	78	77	74	72	—	—	—	—	—	—	—
MKL2-x030	3"	123	—	123	119	116	113	—	—	—	—	—	—
MKL2-x040	4"	250	—	—	250	243	236	225	—	—	—	—	—
MKL2-x050	5"	360	—	—	—	360	354	338	329	—	—	—	—
MKL2-x060	6"	510	—	—	—	—	510	494	478	468	—	—	—
MKL2-x080	8"	1060	—	—	—	—	—	1060	1029	992	963	—	—
MKL2-x100	10"	1630	—	—	—	—	—	—	1630	1596	1548	1509	—
MKL2-x120	12"	2530	—	—	—	—	—	—	—	2530	2485	2412	2348

2-WAY SERIES 41 HIGH PERFORMANCE (2-1/2" - 12") AT 90º ROTATION

Model No.	NPT	Cv	2-1/2"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"
MKL2-x025	2-1/2"	160	160	152	134	126	—	—	—	—	—	—	—
MKL2-x030	3"	185	—	185	173	162	156	—	—	—	—	—	—
MKL2-x040	4"	375	—	—	375	354	331	304	—	—	—	—	—
MKL2-x050	5"	790	—	—	—	790	734	620	566	—	—	—	—
MKL2-x060	6"	1350	—	—	—	—	1350	1120	961	884	—	—	—
MKL2-x080	8"	2800	—	—	—	—	—	2800	2352	1982	1784	—	—
MKL2-x100	10"	4300	—	—	—	—	—	—	4300	3784	3252	2928	—
MKL2-x120	12"	6650	—	—	—	—	—	—	—	6650	5940	5118	4578

Materials Selection Guide for Resilient Seated Butterfly Valves

Introduction

The Bray Material Selection Guide for butterfly valve seats and discs is intended to be used exactly as its name implies - as a guide to aid in selection of the most cost effective butterfly valve materials. The information tabulated herein is based upon valve usage experience, data from elastomer, metal and other suppliers, data from customers and experienced elastomer compounders, and data from published standard references and literature. Though Bray believes these material recommendations to be valuable in selecting appropriate materials, one must recognize there are a variety of factors which exist for each specific field application. Some of the factors which must be considered are temperature, concentration, velocity, aeration, pressure, presence of other materials in the media, operating frequency, flow conditions, suspended abrasive particles, etc. Each of these factors may have a severe effect on the performance of the material. In addition, these factors can exist in field applications in an endless number of different combinations. As a result, it is not possible to develop a material recommendation chart which accounts for all the given combination of factors for each corrosive media. In addition, the grade of elastomers and the compound itself will determine elastomer performance. With this understanding, Bray explicitly states:

No representation, guarantee, warranty, or responsibility, express or implied, is made by the Bray Material Selection Guide herein because of the complexity and infinite combinations of concentration mixtures, flow conditions, temperatures and other application factors possible in actual service. All responsibility regarding the suitability of materials chosen for an application lies solely with the customer and/or engineering company hired by the customer to assist him. Bray cannot guarantee the accuracy of this Material Selection Guide nor assume responsibility for the use thereof. If one is in doubt, it is always best to test first.

How to Use this Guide

State at Room Temperature

This condition identifies the physical state of the corrosive media at room temperature as follows:

G - Gas

L - Liquid

S - Solid

Disc Materials and Seat/Disc Materials

Under each grouping, the primary materials offered has been graded for their suitability to the media and the conditions stated. The grading system is as follows:

A - Recommended, generally little or minor effect based on valve usage experience and recommendations from suppliers.

B - May sometimes be used depending upon the conditions of application such as concentration and temperature. Testing is recommended before fullscale usage.

N - Not Recommended for usage.

Blank - Insufficient evidence available.

Recommended Materials for Disc and Seat/Disc

For each media and condition, we have placed an asterisk by the disc and seat material recommended by Bray. The material given an asterisk depends on two factors:

1) The material is rated A for compatibility with the media conditions;

2) it is the most economical material offered as a disc in combination with the most economical seat material.

Engineering Data

Butterfly Valve Selection

Corrosive Media	Physical State	Condition	Ductile Iron	Nylon-Coated Ductile Iron	Aluminum Bronze	316 S.S.	Condition	EPDM	Buna-N	PTFE
Ethylene GlycoL	L	<100°F	A*	A	A	A		A*	A	A
Freon 11	G		N	B	A*	A	<70°F	N	A*	A
Freon 12	G		N	B	A*	A		B	A*	A
Freon 13	G		N	B	A*	A		B	A*	A
Freon 13B1	G		N	B	A*	A		B	A*	A
Freon 21	G		N	B	A	A*		N	N	A*
Freon 22	G		N	B	A	A*		N	N	A*
Freon 113	G		N	B	A*	A		N	A*	A
Freon 114	G		N	B	A*	A		B	A*	A
Freon 114B2	G		N	B	A	A*		N	B	A*
Freon 115	G		N	B	A*	A			A*	A
C318	G		N	B	A*	A		B	A*	A
Glycois	L		A*	A	A	A		A*	A	A
Propylene GlycoL	L	<150°F	B	A*	B	B		N	A*	A
Steam and Hot Water	L	<250°F	N	A*	A	A	<250°F	A*	N	A
Water, Brackish	L		N	A*	A	A		A*	A	A
Water, Carbonated	L		N	A*	N	A		A*	A	A
Water, Chilled	L		N	A*	A	A		A*	A	A
Water, Chlorine	L	<4%		B		A*	<4%	N	N	A*
Water, Chlorine, Saturated	L			B		A*		A	N	A
Water, Chlorine, High Content	L		N	A*	A	B		A*	A	A
Water, Cooling	L		N	A*	A	A		A*	A	A
Water, Deionized, Demineralized	L		N	A*	N	A		A*	A	A
Water, Distilled	L		N	A*	N	A		A*	A	A
Water, Fresh	L		N	A*	A	A		A*	A	A
Water, Hot Water Heating	L		N	A*	A	A		A*	N	A
Water, Paint Spray Reclamation	L		B	A*	A	A		A*	A	A
Water, Salt, Sea Water	L		N	A*	A	A		A*	A	A
Water, Swimming Pool (Chlorinated)	L		N	A*	A	A		A*	A	A

Engineering Data

Control Valve Terminology

Actuator That part of an automatic control valve which causes the valve stem to move.

Absolute Pressure 14.7 + gauge pressure (psi).

Ambient Temperature Rating Temperature surrounding an actuator or valve body.

Angled Body A two way valve body that has end fittings at right angles to each other.

Authority, Valve The ratio of valve pressure drop to total branch pressure drop at design flow. The total branch pressure drop includes the valve, piping coil, fittings, etc.

Butterfly Valve A valve with a cylindrical body, a shaft, and a disc that rotates on an axis. The position of the disc determines the fluid flow. They can be used in two way or three way mixing or diverting valve applications for two-position or proportional water control.

Booster Pump Pump used in secondary loops of hydropic systems to raise pressure for that section of the system.

Cavitation The forming and imploding of vapor bubbles in a liquid due to decreased, then increased, pressure as the liquid flows through a restriction.

Compressible Fluids Capable of being compressed. Gas and Vapor are compressible fluids.

Contoured Plug Shaped end of valve disc that controls the flow of the medium through the valve. Used for smaller sized equal percentage valves.

Control Loop Chain of components which makes up a control system. If feedback is incorporated it is a closed loop; if there is no feedback, it is an open loop system.

Controlled Medium Whatever fluid is being controlled - hot water, chilled water or steam.

Close-Off Rating Maximum allowable pressure drop (inlet to outlet) that the valve body will tolerate when fully closed. The power available from the actuator usually determines the close-off rating.

Critical Pressure Drop The pressure drop across a valve which causes the maximum possible velocity of steam through the valve.

Close-Off Rating of Three Way Valves The maximum pressure difference between either of the two inlet ports and the outlet port for mixing valves, or the pressure difference between the inlet port and either of the two outlet ports for diverting valves.

Design Conditions Space temperature conditions that require the full heating or cooling requirements of a system.

Direction of Flow The correct flow of the controlled fluid through the valve is usually indicated on the valve body. If the flow of the fluid goes against the indicated direction, the disc can slam into the seat as it approaches the closed position. The result is excessive valve wear, hammering, and oscillations. In addition, the actuator must work harder to reopen the closed valve since it must overcome the pressure exerted by the fluid on top of the disc rather than have the fluid assist in opening the valve by exerting pressure under the disc.

Diverting Valve Three-way valve that has one inlet and two outlets. Water entering the inlet port is diverted to either if the two outlet ports in any proportion desired by moving the valve stem.

Dynamic Pressure The pressure of a fluid resulting from its motion. Total Pressure - Static Pressure = Dynamic Pressure (Pump head).

End Fitting Part of the valve body that connects to the piping. Union, screwed, flared, sweat, and flanged are typical examples of end fittings.

Equal Percentage Characteristics In a valve having an equal percentage characteristic, like movements of the valve stem at any point of the flow range changes the existing flow an equal percentage regardless of existing flow. Example: Suppose a valve stem has been lifted 30 percent of its total lift and the flow at this time is 3.9 gal/min. Now assume that the valve opens an additional 10 percent of its full travel and that the flow increases to 6.2 gal/min or 60 percent increase. Next, suppose that the valve stem moves an additional 10 percent so that it is now 50 percent open. The flow now will be 10/gal/min or another 60 percent increase in flow.

Engineering Data

Control Valve Terminology

Flanged-End Connections A valve that connects to a pipe by bolting a flange on the valve to a flange screwed onto the pipe. Flanged connections are typically used on large valves only.

Flashing Condition resulting when the pressure downstream of a control valve is less than the upstream vapor pressure causing part of the liquid to change to a vapor. In effect the liquid suddenly flashes to a vapor. This high velocity two-phase steam may cause mechanical difficulties and may call for the valve to be made of more resistant materials than for single-phase flow.

Flow Characteristic Relation between flow through the valve as the stem travel is varied between 0 and 100 percent.

Flow Characteristic, Inherent Flow characteristic when constant pressure drop is maintained across the valve.

Flow Characteristic, Installed Flow characteristic when pressure drop across the valve varies as dictated by flow and related conditions in system in which the valve is installed.

Flow Coefficient, Cv The quantity of water, in gallons per minute at 60°F, that will flow through a given valve with pressure drop of 1 PISA (also called capacity index).

Flow Rate The amount of fluid passing a given point per unit of time. Units are gallons per minute (gpm) for water and pounds per hour for steam.

Full Port Maximum flow capacity possible for particular end fitting size.

Gauge Pressure Pounds per square inch (psi) as read on a gauge.

GPM Gallons per minute.

Incompressible Description of liquids, because their change in volume due to pressure is negligible.

Laminar Flow Also known as viscous or streamlined flow. A non-turbulent flow regime in which the stream filaments glide along the pipe axially with essentially no transverse mixing. This occurs at low Reynolds numbers, is usually associated with viscous liquids, and rarely occurs with gas flows in valves. Flow rate varies linearly with ΔP.

Linear Characteristic This flow-lift relationship, if plotted on rectilinear coordinates approximates a straight line, giving equal volume changes for equal lift changes, regardless of percent of valve opening.

Load The demand on the mechanical equipment in a HVAC system.

Load Change A change in building heating or cooling requirements as a result of lights, machinery, people, outside air temperature variations, solar effect wind etc.

Maximum Pressure and Temperature The maximum pressure and temperature limitations of fluid flow that a valve can withstand. These ratings may be due to valve packing, body, disc material, or actuator limitations. The actual valve body ratings are exclusively for the valve body and the maximum pressure and temperature ratings are for the complete valve (body and trim). Note that the maximum pressure and temperature ratings may be less than the actual valve body ratings.

Mixing Valve Three way valve having two inlets and one outlet. The proportion of the fluid entering each of the two outlets can be varied by moving the valve stem. Not suitable for diverting applications

Normally Closed (N.C.) Condition of the valve upon a loss of power or control signal to the actuator.

Normally Open (N.O.) Condition of the valve upon a loss of power or control signal to the actuator.

Packing Material used to seal the valve stem so that the controlled medium will not leak. TFE V rings and graphite rings are typical materials used.

Port Flow controlling opening between the seat and disc when the valve is wide open.

Positive Positioner Device that eliminates the actuator shaft positioning error due to load on the valve.

Pressure Drop (AP) The difference in pressure between inlet and outlet of the control valve.

PSI Pounds per square inch. PSIA - Pounds per square inch absolute. PSIG - Pounds per square inch gauge.

Rangeability The ratio of the maximum controllable flow to the minimum controllable flow. For instance, a valve with a rangeability of 50 to 1 having a total flow capacity of 100 gal/min, fully open, will control flow accurately down as low as 2 gal/mint The valve may or may not have tight shut-off.

Rated Flow For a coil this is the flow through the coil which will produce full rated heat output of the coil.

Reduced Port Smaller flow capacity that is possible for particular end fitting.

Reducer A pipe fitting that is used to couple a pipe of one size to a pipe of a different size. When flow is from the smaller pipe to the larger pipe an increaser may be used.

Reynold's Number A dimensionless criterion of the nature of flow in pipes. It is proportional to the ratio of dynamic forces to viscous forces: the product of diameter, velocity, and density divided by absolute viscosity.

Saturated Steam The maximum amount of vapor that can exist at specific temperature and pressure.

Screwed-End Connection A valve with threaded pipe connection. Valve threads are usually female, but male connections are available for special applications. Some valves have an integral union fitting for easier installation.

Seat The stationary portion of the valve which when in contact with the movable portion (valve disc, stem, etc.) stops flow completely.

Spring Range Control pressure range through which the signal applied must change to produce total movement of the controlled device from one extreme position to the other.

Spring Range, Actual Control pressure range that causes total movement under actual conditions to overcome forces due to spring force, fluid flow, friction, etc.

Spring Range, Nominal Control pressure range that causes total movement when there is no external force opposing actuator.

Static Pressure Rating Maximum pressure (inside to outside the body) that will tolerate before leaking Pressure varies with temperature.

Stem The cylindrical shaft which is moved manually or by an actuator to which the throttling plug, ball, or water is attached.

Straightway Body A two way valve body that has end fittings on opposite sides.

Stroke The total distance that the valve stem travels or moves. Also known as lift.

Superheated Steam Steam at a temperature higher than saturation temperature at the given pressure.

System Pressure Drop (ΔP) The difference in pressure between supply and return mains in a hydropic system.

Total Pressure The sum of the Static Pressure and the Dynamic Pressure.

Three-Way Valve Valve with three connections, one of which is a common and two flow paths.

> **Bypass or Diverting Valve** Common connection is the only inlet: Fluid entering this connection is diverted to either outlet.
>
> **Mixing Valve** Two connections are inlets and the common is the outlet. Fluid from either or both inlets is selected to go out the common connection.

Tight Shut-off A valve having tight shut-off that will have virtually no flow or leakage in its closed position.

Trim All parts of the valve which are in contact with the flowing media but are not part of the valve shell or casting. Disc, stem, ball, throttling range packing rings, etc., are all trim components.

Turbulent Flow A flow regime characterized by random motion of the fluid particles in the transverse direction as well as motion in the axial direction. This occurs at high Reynolds numbers and is the type of flow most common in industrial fluid systems. Flow varies as the square root of ΔP.

Turndown Ratio between maximum usable flow and minimum controllable flow. The turndown is usually less than rangeability.

Engineering Data

Control Valve Terminology

Two Way Valve Valve with single flow path-one inlet and one outlet.

Uncontrollable Flow The flow rate at low load conditions that ;causes the valve to hunt or cycle. Typically occurs within the first 10% of valve stroke.

Valve A controlled device which will vary the rate of flow of a controlled medium such as water or steam.

Valve Body The portion of the valve casting through which the controlled medium flows.

Valve Disc A movable part of the valve which makes contact with the valve seat when the valve is closed.

Valve Flow Characteristic The relationship between the stem travel, expressed in percent of travel, and the flow of the fluid through the valve, expressed in percent of full flow.

Valve Guide The part of the globe valve throttling plug which keeps the disc aligned with the valve seat.

Valve Pressure Drop The portion of the system pressure drop which appears across the valve. For valve sizing this drop is across a fully open valve.

Wire Draw A small eroded area or thin slit on a valve seat or plug. This is the result of a high velocity fluid acting on the surfaces when the valve is just above the seat.

CONVERSION FACTORS

1 lb./sq. in	2.04 inches mercury
1 lb./sq. in	2.3 feet water
1 lb./sq. in	27.7 inches water
1 kg/sq. cm	14.2 lb./sq. in
1 U.S. Gallon Water	231 cubic inches
1 U.S. Gallon Water	8.33 pounds
1 Cubic Foot	1728 cubic inches
1 Cubic Foot Water	62.4 pounds water
1 Cubic Foot Water	7.5 U.S. gallons
1 Cubic Meter	264 U.S. gallons
1 U.S. Gallon Water	0.83 imperial gallons
1 Liter	0.264 gallons
1 lb. Water	454 grams
1 lb. Water	7000 grains
1 lb. Steam/hr.	1000 Btu/hr
1 Ton (refrigeration)	12,000 Btu/hr.
1 EDR (steam)	240 Btu/hr. (coil temp. = 215° F)
1 EDR (water)	200 Btu/hr. (coil temp. = 197° F)
1 MBH	1000 Btu/hr.
1 Watt	3.41 Btu/hr.

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