



FLowsERVE

VALTEK
Severe Service Equipment

Valtek Severe Service Equipment Introduction

Pressure/Velocity Profiles in Globe Valves

As a fluid travels through a conventional single-seated globe-style control valve, a vena contracta (point of narrowest flow restriction) develops directly downstream of the throttling point. At this location of maximum

velocity, the fluid reaches a minimum pressure and then rapidly recovers to a level less than the inlet pressure (Figure 1). Profiles representative of the pressure and velocity in a gaseous application are shown in Figure 2.

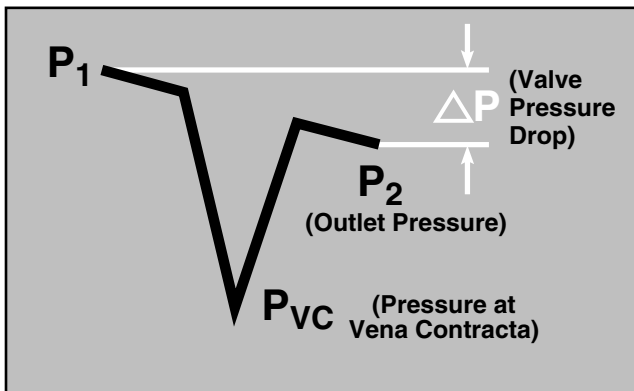


Figure 1: Pressure Profile (single-seated globe-style valve)

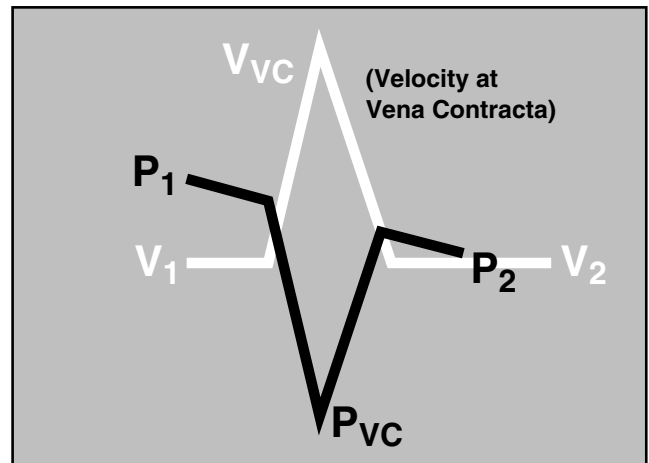


Figure 2: Pressure and Velocity Profiles (single-seated globe-style valve)

LIQUID SEVERE SERVICES

When control valves fail in liquid service, *cavitation* is often the root cause. Cavitation is a two-stage process, illustrated in Figure 3: First, as fluid velocity increases through the restriction at the vena contracta, the pressure of the flowing liquid drops below the vapor pressure of the liquid, causing vapor bubbles to form. Second, as the flow enters the enlarged flow area downstream of the vena contracta the fluid pressure increases. The result-

ant pressure recovery raises the fluid pressure back above the vapor pressure, causing the vapor bubbles to collapse – or implode.

Energy released by collapsing vapor bubbles can result in extensive noise and vibration, often causing severe damage to unprotected metal surfaces (Figure 4).

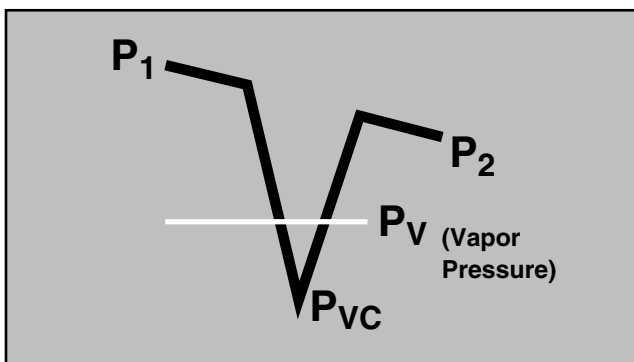


Figure 3: Pressure Profile for Cavitation



Figure 4: Damage to Trim Parts Caused by Cavitation

Valtek Severe Service Equipment Introduction

Incipient (or beginning) cavitation is heard in a piping system as intermittent popping or cracking, but as the pressure drop increases the noise becomes a steady hiss or rattle. Fully developed cavitation results in choking of the liquid flow such that further increases in pressure drop cause no corresponding increase in the flow.

The ideal solution to cavitation is to reduce the pressure from inlet to outlet gradually, avoiding the effects of a large pressure drop at the vena contracta (Figure 5).

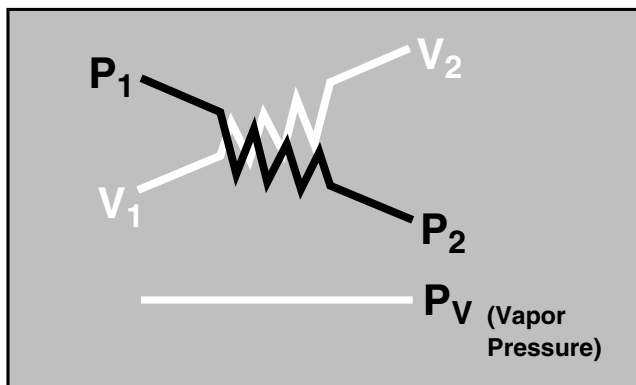


Figure 5: Pressure Profile for Gradual Pressure Reduction

Cavitation can be avoided entirely by not permitting the pressure to fall below the vapor pressure, thereby eliminating any bubble formation and subsequent collapse.

A related liquid service problem is *flashing*, which occurs when pressure at the vena contracta falls below the vapor pressure followed by a pressure recovery that remains below the vapor pressure (Figure 6). This causes vapor bubbles to form in the liquid service, which continue downstream as a liquid-gas mixture.

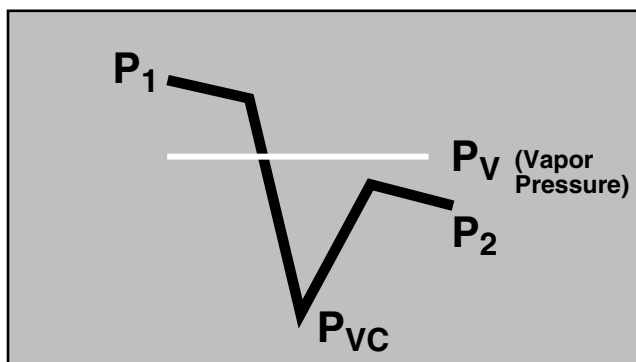


Figure 6: Pressure Profile for Flashing

The increased volume of this mixture increases the overall velocity, which leads to excessive noise and erosion. Eliminating flashing completely is generally not practical and would involve increasing the valve downstream pressure or lowering the vapor pressure of the process. More practical approaches include using hardened materials for affected surfaces, or relocating the valve so that it discharges into a larger vessel and away from critical surfaces.

Sigma: The Cavitation Index

Various cavitation indices have been used to correlate performance data to improve designs of hydraulic process equipment. A cavitation index, called Sigma (σ), has been developed and applied to quantify cavitation in control valves:

$$\sigma = \frac{(P_1 - P_v)}{(P_1 - P_2)}$$

Where:

P_1 = Upstream pressure (psia), measured two pipe diameters upstream from the valve

P_2 = Downstream pressure (psia), measured six pipe diameters downstream from the valve

P_v = Vapor pressure of the liquid at flowing temperature

Sigma is seen as the ratio of the potential for resisting cavity formation to the potential for causing cavity formation. When Sigma is 1.0 or less, flashing is occurring. Through laboratory and field testing results, acceptable operating Sigmas for eliminating cavitation (and its associated choking, noise, and damage) have been established. For example:

Tests indicate that a full-area, single-seated globe valve at 100 percent open with 80° F (vapor pressure of 0.5 psia), 200 psia water and with flow-over-the-plug chokes at a downstream pressure of 56 psia. The choked cavitation index is then:

$$s_{\text{choked}} = \frac{(200 - 0.5)}{(200 - 56)} = 1.39$$

These tests also indicate that cavitation damage (s_{damage}) for this particular style of valve in continuous operation begins at about $s_{\text{damage}} = 1.73$. The point at which incipient cavitation ($s_{\text{incipient}}$) occurs can also be deduced from tests; it is found at a somewhat higher value than s_{damage} (i.e. lower pressure drop).

Valtek Severe Service Equipment Introduction

If this same valve operates wide open at an upstream pressure (P_1) of 500 psia and a downstream pressure (P_2) of 200 psia, and the water temperature increased to 180° F (vapor pressure = 7.5 psia), the operating Sigma is:

$$\sigma_{\text{operating}} = \frac{(500 - 7.5)}{(500 - 200)} = 1.64$$

Because this Sigma value is greater than σ_{choked} , the valve is not choked at these conditions. However, the Sigma is less than σ_{damage} ; therefore, the valve may experience cavitation damage unless special anti-cavitation trim or harder materials are used.

Some of the other factors that affect the intensity of cavitation are the magnitude of the actual service pres-

sure compared with test pressures, the flow path geometry and the fluid purity. By researching these factors, methods of scaling the index for such variables have been established. This geometry and pressure scaling is not accounted for in the use of liquid pressure recovery factor (F_L) and liquid cavitation factor (F_c) in previous valve sizing equations.

Globe valves experience minimal cavitation damage when operating at low pressure (Sigmas between 2 and 1.7). Generally, in these cases, no cavitation control trim is necessary. However, at between Sigma 1.7 and 1.15, some cavitation control is usually required. When the Sigma index for a valve is less than 1.15, the potential for severe cavitation damage exists and a staged pressure drop severe service trim must be included in the valve's sizing.

Table 1: Valtek Trim Solutions to Cavitation Associated with Control Valves

Globe-style Trim	Design	Application	For Sigmas	See Pages
Tiger-Tooth	Stack of expanding teeth discs	To eliminate or minimize cavitation formation	approaching 1.002	6 - 9
ChannelStream	Cartridge or plug with cylinders using intersecting channels	To eliminate or minimize cavitation formation	1.002	10 - 14
MicroCav	Plug with expansion grooves	To eliminate or minimize cavitation formation in low flow services	1.004	15
CavControl	Diametrically opposed jets	To eliminate or minimize cavitation damage	1.15	16 - 18

GASEOUS SEVERE SERVICES

In gas services, noise is generated by high pressure drops across the valve and by subsequent turbulence downstream. As a direct result, noise is radiated to the surrounding area by the downstream piping system (Figure 7). In situations where equipment damage or personal injury could be caused by a noise source, noise attenuation is not only desired, it is mandatory.

With gases, superimposing a velocity profile on the pressure profile (Figure 2) reveals the main component in control valve noise generation. For single throttling point control valves, because of the sharp pressure reduction at the vena contracta, the velocity is greatly increased. Tests have demonstrated that a control valve's sound pressure level increases proportional to the velocity cubed ($SPL \sim V^3$). Noise is generated as velocities in the valve increase and substantial noise can be generated even where velocities are significantly less than sonic.

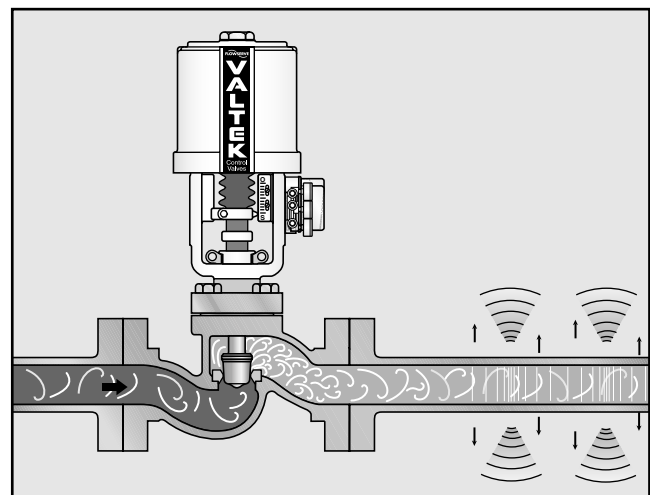


Figure 7: Downstream Turbulence Caused by Vena Contracta in a Valve

Valtek Severe Service Equipment

Introduction

High mechanical vibration levels accompany high acoustic noise levels. Acoustic noise and mechanical vibration levels are greatly compounded (up to 50 times) when the frequency of the excitation matches acoustic and/or mechanical natural frequencies of the system.

Noise suppression trim (source treatment) should always be considered in any high energy (high pressure, high flow) and/or resonant noise/vibration applications.

The solution to high levels of control valve noise is to reduce the pressure from the valve inlet to outlet gradually, avoiding the effects of a large pressure drop at any vena contracta (Figure 5). Thus, for gases, velocities are maintained at acceptable levels throughout the valve and high noise levels are not generated. This requires not only controlling the gas velocity through the valve trim but at all points from the inlet to the outlet of the valve.

Several of the following factors must be considered before expensive noise suppression equipment is chosen: How much noise attenuation is actually required? What are the low or no-cost alternatives to noise attenuation? If noise attenuation devices are necessary, what lower-cost equipment can be specified?

If the predicted sound pressure level (SPL) exceeds 85 or 90 dBA, noise suppression devices should be considered. However, higher noise levels may be accept-

able if the noise is not associated with equipment damage and is located in a remote location away from people. Other possible low-cost alternatives to noise suppression equipment are: (1) insulating the pipe, (2) locating the valve discharge directly into a vessel (allowing the noise to be absorbed by the vessel), (3) relocating the noise source (such as the downstream piping) outside an enclosed area, (4) reversing the flow direction through the valve, or (5) reducing the pressure drop across the valve.

The P_1/P_2 Ratio Index

When excessive sound pressure levels are encountered, special trim must be used to attenuate the noise level. Valtek severe service trim can be installed in globe- and angle-style control valves for use in noise reduction and should be used when a maximum sound attenuation of up to 30 dBA is needed. To establish the design requirements for such trim, Flowserve engineers use a P_1/P_2 ratio, along with other factors, to determine the severity of noise in an application. To obtain the maximum noise reduction for any trim, the service P_1/P_2 ratio must be less than the maximum P_1/P_2 ratio listed for each trim design and size. These ratios can be found in the tables for each noise attenuating trim described in this literature.

Table 2: Flowserve Solutions to Gaseous Noise Associated with Valves

Globe-style Trim / Downstream Device	Design	SPL Reduction	See Pages
Tiger-Tooth Trim	Expanding teeth	Up to 30 dBA	4 - 7
MegaStream Trim	Multi-hole trim	Up to 28 dBA	19 - 25
MegaStream Plate ¹	Downstream multi-hole resistance plate	Up to 15 dBA	26 - 27
MegaStream Diffuser ¹	Downstream multi-hole diffuser	Up to 15 dBA	28 - 29
MegaStream Silencer ¹	Downstream In-line silencer	Up to 30 dBA	30 - 31
Tiger-Tooth Vent Element	Expanding teeth vent	Up to 30 dBA	32

¹Any one of these downstream noise reduction devices in series with a valve can be selected to attenuate noise to the acceptable SPL required. For example, a MegaStream plate or diffuser, when installed downstream from a standard Valtek control valve, provides about the same dBA reduction as a one or two-stage MegaStream valve, but at a lower cost. For extremely high pressure drops where multi-stage valve trim may be considered, a cost-effective option may be to install a MegaStream plate, diffuser or silencer downstream from a smaller one or two-stage MegaStream valve.

Valtek Severe Service Equipment

Tiger-Tooth Trim

Introduction

When installed in a globe-style control valve, Tiger-Tooth trim effectively reduces sound pressure levels up to 30 dBA. Tiger-Tooth trim can also be used to eliminate the damaging effects of cavitation – making it an effective choice for either gas or liquid processes with high pressure drop conditions.

Design

A cross-sectioned view of the Tiger-Tooth control valve stack is shown in Figure 8. The basic Tiger-Tooth design involves highly engineered concentric grooves (or *teeth*) machined into the face and backside of a series of circular stacked discs (called a *stack*), which also acts as a seat retainer. Legs separate one disc from another, providing the correct distance between individual discs. For easy assembly, the entire stack is tack-welded into one concentric unit and clamped in a conventional globe or angle body valve.

With Tiger-Tooth trim, flow passes from the center of the stack through the teeth in a radial, wave-like manner to the outlet, undergoing a series of sudden contractions and expansions. This process reduces fluid pressure in steps without the large, single pressure drop typical of conventional trims.

Valtek control valves with Tiger-Tooth trim are manufactured in sizes 1.5 through 36-inch, utilizing conventional Valtek globe-style bodies. Both unbalanced and pressure-balanced designs are available (Figures 9 and 10). For smaller parts inventory and lower cost, many parts are interchangeable with conventional Valtek Mark One

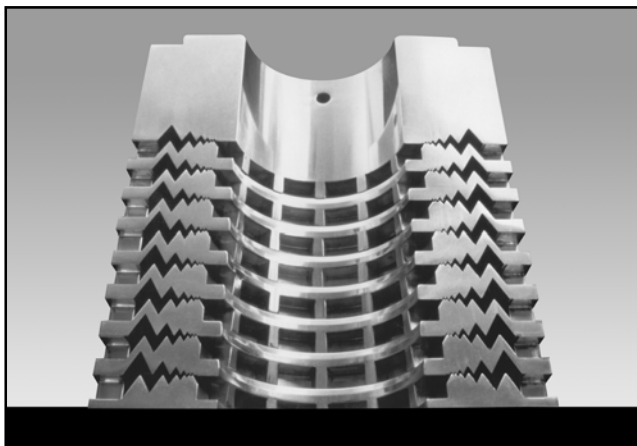


Figure 8: Tiger-Tooth Stack Featuring a Five-tooth Design

globe valves. To minimize costs associated with large globe valve bodies, valves in sizes 16 through 36-inch may be custom-fabricated using an angle body configuration with the inlet at the bottom and the outlet on the side. For applications requiring long strokes, special pneumatic cylinder, hydraulic or electric actuators are available.

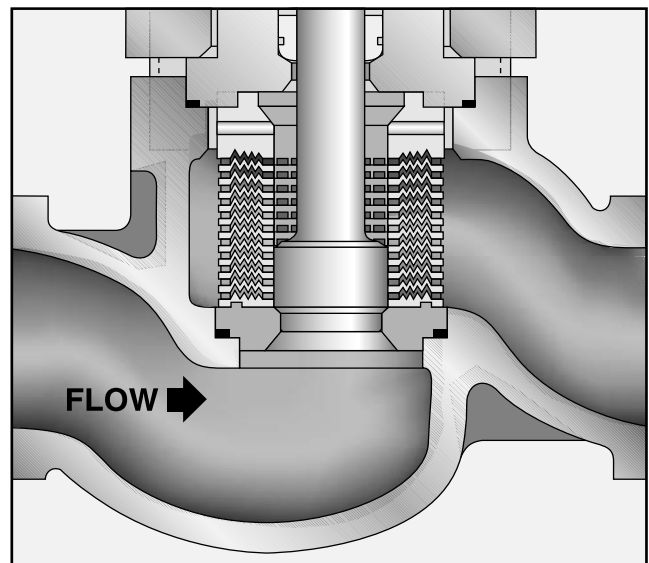


Figure 9: Unbalanced Tiger-Tooth Trim Design

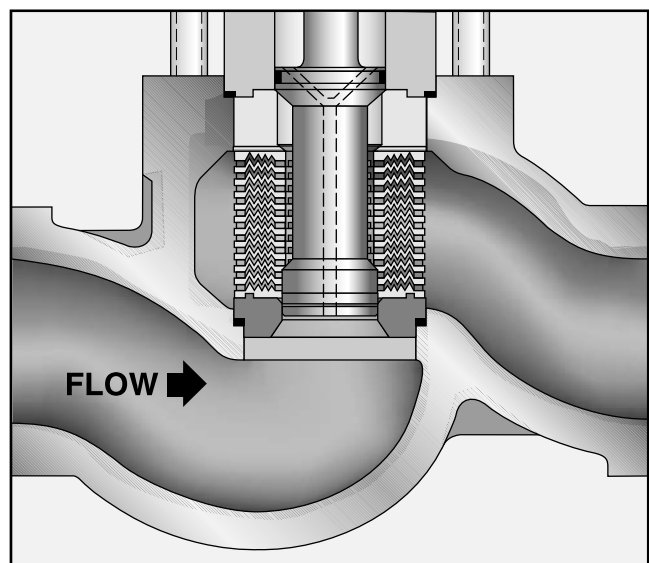


Figure 10: Pressure-balanced Tiger-Tooth Trim Design

Valtek Severe Service Equipment

Tiger-Tooth Trim

Gas Applications

With gases, the Tiger-Tooth design features a unique flow path that permits radial expansion of the fluid. The trim is effective on large pressure reductions in gases, because an additional flow path expansion is provided to handle the increasing volume as the pressure is decreased. This is accomplished by making each tooth and resulting flowpath somewhat larger than the preceding tooth. The increased flow area maintains acceptable gas velocity at every point across the discs.

Liquid Applications

With Tiger-Tooth trim, a series of small, multiple pressure drops prevent cavitation from occurring at any point inside the valve. The amount of pressure drop that can be taken without cavitation occurring is proportional to the difference between the local static pressure and vapor pressure. The expanding Tiger-Tooth design is used with liquids to eliminate most of the pressure drop as the flow first enters the trim. Because the fluid flows under the plug, the smaller teeth in any passage are encountered first, resulting in a higher pressure drop. As the fluid progresses through the stack, the expanding tooth pattern allows the pressure to be reduced in a series of successively smaller pressure drops without excursions below the vapor pressure – avoiding the formation of cavitation altogether.

Velocity Control

One of the fundamental design considerations with Valtek control valves with Tiger-Tooth trim is the establishment of acceptable velocities at every point as the flow passes through the valve. For liquid applications, maintaining valve outlet velocities below 30 feet per second is desirable – although higher velocities may be acceptable depending upon the application and process fluid.

For gaseous control valve applications, keeping the maximum outlet gas velocity below 0.33 Mach is desirable, although higher velocities may be acceptable based on the application.

Velocities must be assessed for the most difficult flowing conditions at the following critical points (as shown in Figure 11):

1. The inlet passageway to the valve
2. The internal flow area of the Tiger-Tooth stack at all plug positions
3. The flow area between the teeth, including inlet and outlet area of the stack

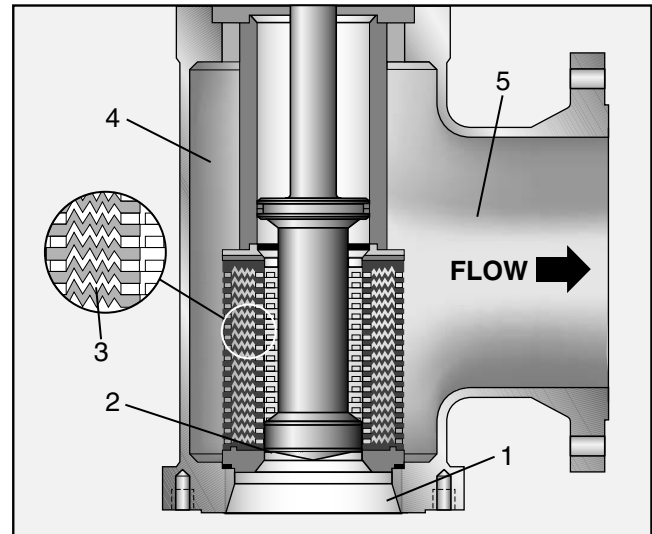


Figure 11: Tiger-Tooth Velocity Check Points

4. The gallery flow area formed between the outside diameter of the Tiger-Tooth stack and the inside diameter of the valve body
5. Outlet passage flow area

Pressure Reduction Through Sudden Expansion and Contraction

An important mechanism acting to reduce the pressure in Tiger-Tooth trim is the sudden expansion and contraction phenomenon that takes place as the flow passes over the teeth. Figure 12 illustrates this mechanism. The Tiger-Tooth valve's ability to gradually reduce pressure is important for the reduction of noise in the process line. Figure 13 is a graphic illustration of the noise attenuation capabilities of Tiger-Tooth valves when installed in high velocity applications.

Flow Characteristics

Tiger-tooth trim is generally designed with a linear flow characteristic. Deviation from the linear characteristic inherent in a stacked disc design is reduced by lead-in areas machined into the valve plug and each individual disc. This permits the next flow passage to begin passing flow before the first passage has reached full capacity. Bi-linear or tri-linear trim can be furnished with portions of the stack having different flow capacities, permitting a flow characteristic approaching an equal percentage characteristic. Tiger-Tooth trim can also be manufactured with a full-open area at the top of the stack to provide additional flow capacity and tolerance for large solids entrained in the process.

Valtek Severe Service Equipment

Tiger-Tooth Trim

Maintenance

All Flowserve trims are designed for easy maintenance and Tiger-Tooth is no exception. Clearance between the stack and plug is designed for an optimum combination of stability and smooth operation. The clamped-in seat, top-entry trim design permits quick disassembly. The Tiger-Tooth stack is easily removed for inspection or cleaning. The Tiger-Tooth stack design is ideal for fluids with entrained particles. Fine and medium-sized particles easily pass through the discs because the design does not include any horizontal boundaries within the stack.

Flow Capacity

The required flow capacity for an application can be determined through the standard ISA sizing equations. The main difference in sizing a standard globe valve and a Tiger-Tooth valve is that the Tiger-Tooth valve is far less likely to choke in either a gas or liquid application.

In choosing a valve for a particular application, the user should consider not only the C_v , but also the velocity and the Sigma value or pressure ratio that must be accommodated. The typical Tiger-tooth trim information given in the tables on page 9 is not intended to provide a complete listing of all available designs. Rather, it can be useful in estimating capabilities of a particular valve size and pressure class.

Table 3: Tiger-Tooth Materials of Construction

Trim Part	Available Materials
Stack	Aluminum-Bronze, 410 stainless steel, 316 stainless steel, 316 stainless steel with Alloy 6 overlay, other alloys as required
Plug	316 stainless steel, 316 stainless steel with Alloy 6 overlay, other alloys as required
Seat Ring	316 stainless steel, 316 stainless steel with Alloy 6 overlay, other alloys as required

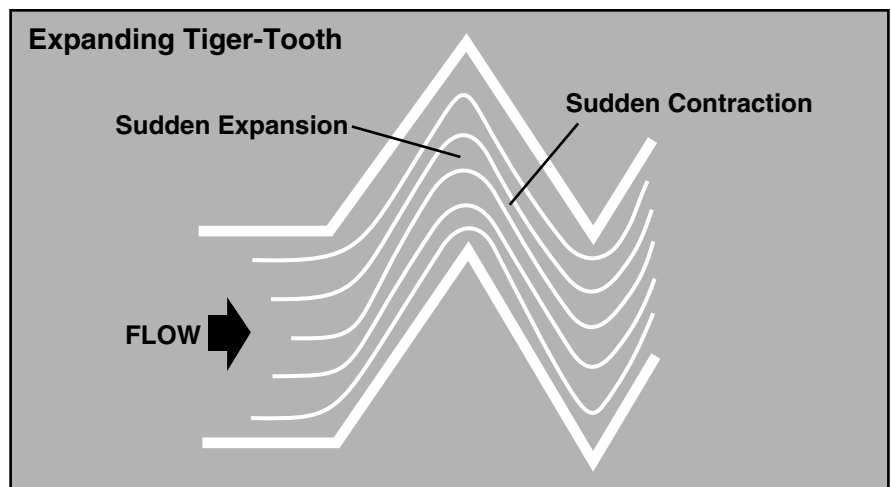


Figure 12: Sudden Expansion and Contraction Caused by Tiger-Tooth Design

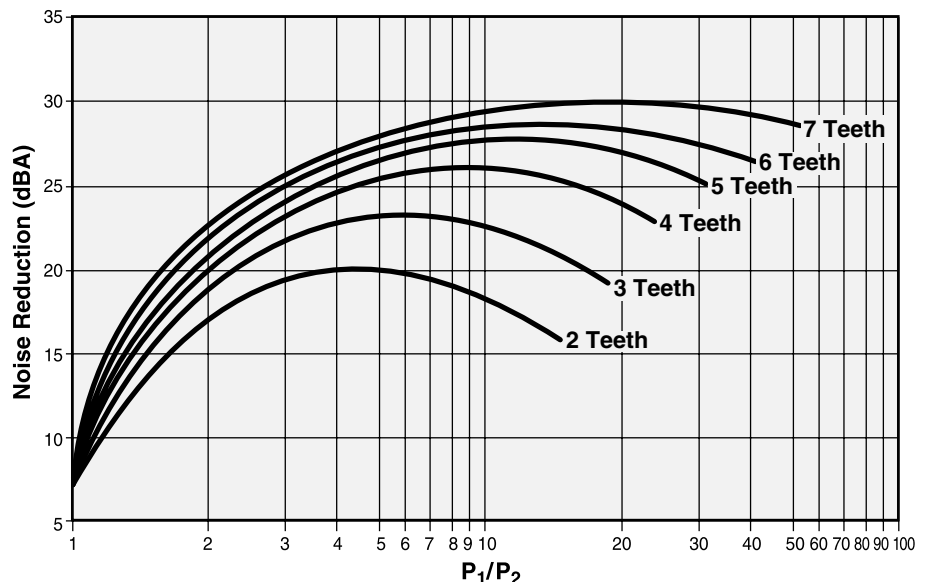


Figure 13: Noise Reduction vs. Number of Tiger-Tooth Teeth

Valtek Severe Service Equipment

Tiger-Tooth Trim

Table 4: Tiger-Tooth Trim Data
Class 150 - 600: Mark One Globe

Body Size	Trim No. (Seat Dia.)	C _v	Stroke	P ₁ /P ₂ Max.	Sigma Min.	No. of Teeth
1.5 to 2	1.50	24	2.0	4.0	0.28	2
	1.12	12	2.0	9.0	0.052	2 - 3
	1.12	7	2.0	16.0	0.016	3 - 4
	1.00	4	2.0	30.0	0.0046	4 - 5
3	2.25	44	2.5	5.0	0.17	2
	1.75	22	2.5	10.0	0.042	3 - 4
	1.25	12	2.5	17.0	0.014	5 - 6
	1.25	7	2.5	31.0	0.0043	6 - 7
4	3.00	80	3.0	4.7	0.20	2
	2.25	36	3.0	10.0	0.042	3 - 4
	1.50	18	3.0	20.0	0.010	5 - 6
	1.50	9	3.0	42.0	0.0023	6 - 8
6	4.00	150	4.0	4.4	0.22	2
	3.25	75	4.0	10.0	0.042	3 - 4
	2.25	37	4.0	20.0	0.010	5 - 6
	2.25	18	4.0	34.0	0.0036	6 - 7
8	5.38	270	6.0	5.0	0.17	2
	4.00	130	6.0	10.0	0.042	2 - 3
	2.75	65	6.0	20.0	0.010	4 - 6
	2.75	32	6.0	40.0	0.0026	6 - 7
10	7.50	500	7.5	5.0	0.17	2
	5.50	250	7.5	10.0	0.042	3 - 4
	4.00	125	7.5	20.0	0.010	5 - 6
	3.50	65	7.5	40.0	0.0026	6 - 7
12	8.50	600	8.0	5.0	0.17	2
	6.00	300	8.0	10.0	0.042	3 - 4
	4.50	150	8.0	20.0	0.010	5 - 6
	4.00	75	8.0	40.0	0.0026	6 - 7
14	9.00	700	8.00	5.0	0.17	2
	6.25	350	8.00	10.0	0.052	4
	4.00	175	8.00	20.0	0.013	6
	4.00	80	8.00	40.0	0.003	8
16	12.00	1100	12.00	5.0	0.17	2
	8.00	550	12.00	10.0	0.042	4
	5.50	225	12.00	20.0	0.010	6
	4.00	110	12.00	40.0	0.0026	8

Class 150 - 600: Fabricated Angle Body

Body* Size	Trim No. (Seat Dia.)	C _v	Stroke	P ₁ /P ₂ Max.	Sigma Min.	No. of Teeth
16	9.50	750	12.0	5.5	0.14	2
	7.00	375	12.0	11.0	0.034	3 - 4
	5.00	200	12.0	20.0	0.010	5 - 6
18	9.50	900	12.0	5.0	0.17	2
	7.50	450	12.0	10.0	0.042	3 - 4
	5.50	225	12.0	20.0	0.010	5 - 6
20	10.75	1100	12.0	4.7	0.20	2
	8.25	550	12.0	9.0	0.052	3 - 4
	6.00	275	12.0	19.0	0.011	5 - 6
24	12.50	1500	18.0	5.5	0.14	2
	9.50	750	18.0	11.0	0.034	3 - 4
	7.00	375	18.0	22.0	0.0085	5 - 6
30	18.50	2800	24.0	5.0	0.17	2
	13.00	1400	24.0	10.0	0.042	3 - 4
	9.50	700	24.0	20.0	0.010	5 - 6
36	22.00	4000	24.0	5.0	0.17	2
	16.00	2000	24.0	10.0	0.042	3 - 4
	11.25	1000	24.0	20.0	0.010	5 - 6

*Outlet body size; inlet sizes can vary depending on application.

Class 900 - 1500: Mark One Globe

Body Size	Trim No. (Seat Dia.)	C _v	Stroke	P ₁ /P ₂ Max.	Sigma Min.	No. of Teeth
1.5 to 2	1.38	22	2.0	5.0	0.17	2
	1.12	13	2.0	9.0	0.052	2 - 3
	1.12	7	2.0	18.0	0.013	3 - 4
3	1.12	4	2.0	34.0	0.004	4 - 5
	2.25	40	3.0	6.5	0.10	2
	1.75	22	2.5	9.0	0.052	3 - 4
4	1.25	12	2.5	17.0	0.014	5 - 6
	1.25	7	2.5	31.0	0.004	6 - 7
	3.00	72	3.0	5.0	0.17	2
6	2.25	36	3.0	13.0	0.025	3 - 4
	1.62	18	3.0	20.0	0.010	5 - 6
	1.62	9	3.0	40.0	0.0026	6 - 7
8	3.50	130	4.0	5.0	0.17	2
	3.00	75	4.0	9.0	0.052	3 - 4
	2.50	37	4.0	19.0	0.012	5 - 6
10	2.12	18	4.0	35.0	0.003	6 - 7
	5.50	250	6.0	5.0	0.17	2
	4.00	125	6.0	10.0	0.042	3 - 4
12	2.75	60	6.0	21.0	0.009	5 - 6
	2.75	30	6.0	36.0	0.003	6 - 7
	6.50	410	7.5	5.0	0.17	2
14	5.00	200	7.5	10.0	0.042	3 - 4
	3.50	100	7.5	20.0	0.010	5 - 6
	3.50	50	7.5	40.0	0.0025	6 - 7
16	7.50	500	8.0	5.0	0.17	2
	5.50	250	8.0	9.0	0.052	3 - 4
	4.00	125	8.0	20.0	0.010	5 - 6
18	4.00	60	8.0	40.0	0.0025	6 - 7

Class 2500: Mark One Globe

Body Size	Trim No. (Seat Dia.)	C _v	Stroke	P ₁ /P ₂ Max.	Sigma Min.	No. of Teeth
1.5 to 2	1.38	22	2.0	5.0	0.17	2
	1.12	13	2.0	9.0	0.052	2 - 3
	1.12	7	2.0	18.0	0.013	3 - 4
3	1.12	4	2.0	34.0	0.004	4 - 5
	2.00	35	2.5	5.0	0.17	2
	1.50	18	2.5	10.0	0.042	3 - 4
4	1.25	9	2.5	20.0	0.010	5 - 6
	2.50	55	3.0	5.0	0.17	2
	1.75	28	3.0	12.0	0.029	3 - 4
6	1.75	14	3.0	24.0	0.007	5 - 6
	3.50	100	4.0	5.0	0.17	2
	2.50	50	4.0	10.0	0.042	3 - 4
8	2.25	25	4.0	20.0	0.010	5 - 6
	4.75	200	6.0	5.0	0.17	2
	3.50	100	6.0	10.0	0.042	3 - 4
10	2.62	50	6.0	20.0	0.010	5 - 6

NOTE: Body size, trim number and stroke are in inches.

Valtek Severe Service Equipment ChannelStream Trim

Introduction

ChannelStream trim prevents cavitation from forming and minimizes hydrodynamic noise even under the most severe liquid applications. This unique, patented design not only eliminates cavitation damage, but also provides easy maintenance and long life, even when installed in the most difficult applications. The ChannelStream cartridge may appear similar to other competitive designs because of its drilled holes and close-fitting cylinders but here the similarity ends. Rather than acting as a flow restriction, the drilled holes in the ChannelStream cartridge are used as expansion areas for the fluid as it enters from restrictive channels machined in the outside of all interior cylinders. This prevents the fluid recovery from occurring adjacent to a critical trim surface. Successive intersections of the restrictive channels result in additional pressure losses while expansion holes connected to the channels create a series of expansions and contractions that result in a series of pressure drops. This staged pressure drop eliminates cavitation in most applications and minimizes the energy of cavitation that may still occur in others.

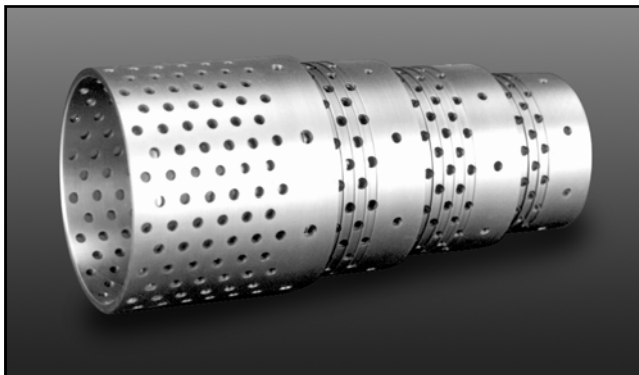
Standard Cartridge Design

The standard ChannelStream trim is designed for flows of $2.5 C_v$ and higher, and utilizes a *cartridge* design in lieu of a seat retainer. With this design, flow is directed over the plug through a series of close-fitting cylindrical stages, called the *cartridge* (Figure 14). Each stage is designed with a series of expansion holes and intersecting circumferential channels that restrict the flow. As shown in Figure 15, flow travels first through the expansion holes in the outer cylinder and then enters the special-engineered channels machined into the outer

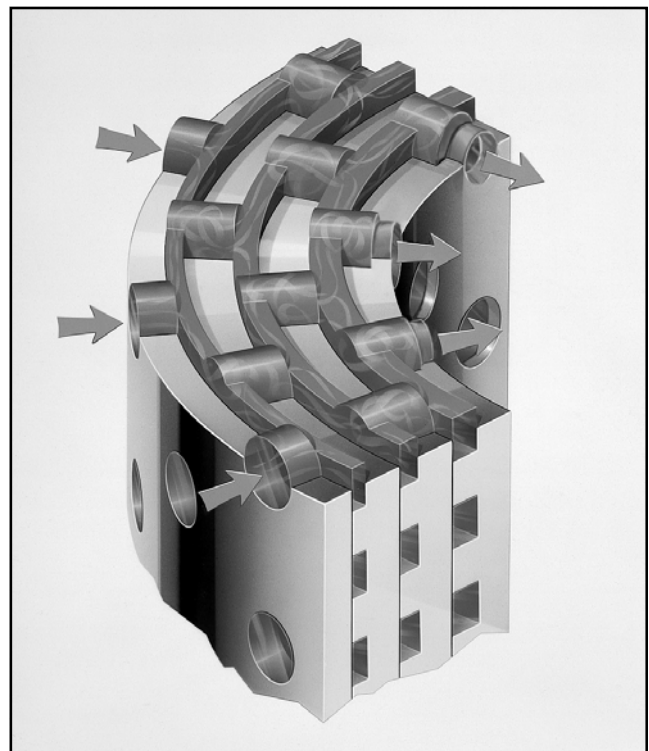
surface of the second cylinder. The liquid is confined to the channel until it reaches the intersecting expansion hole in the second cylinder and passes through to the next restrictive channel, and so forth. This flow path of multiple restrictions and enlargements reduces the pressure gradually across each cylinder, avoiding the sharp pressure drop typical of conventional, single-throttling-point trims.

The number of stages and the flow area of the channels in each stage of the ChannelStream cartridge are designed to produce the desired overall pressure drop, while avoiding cavitation at any point. The flow area of the channel is usually greater in each successive stage in order to minimize the number of stages. This results in higher pressure drops being taken in the outer (or initial) stages as compared with the inner (or final) stages.

A number of holes are machined near the top of the ChannelStream cartridge. Several of these holes allow fluid to vent upstream from the volume above the plug during normal operation. Other holes are for pinning the



**Figure 14: ChannelStream Cartridge
(separated to show individual stages)**

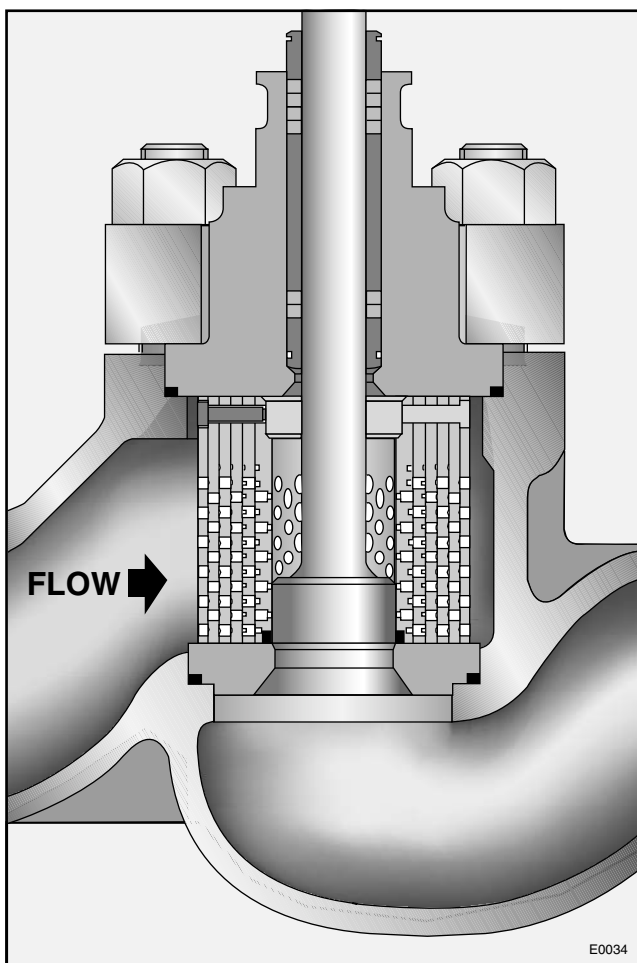


**Figure 15: Flow Path Through
ChannelStream Cartridge**

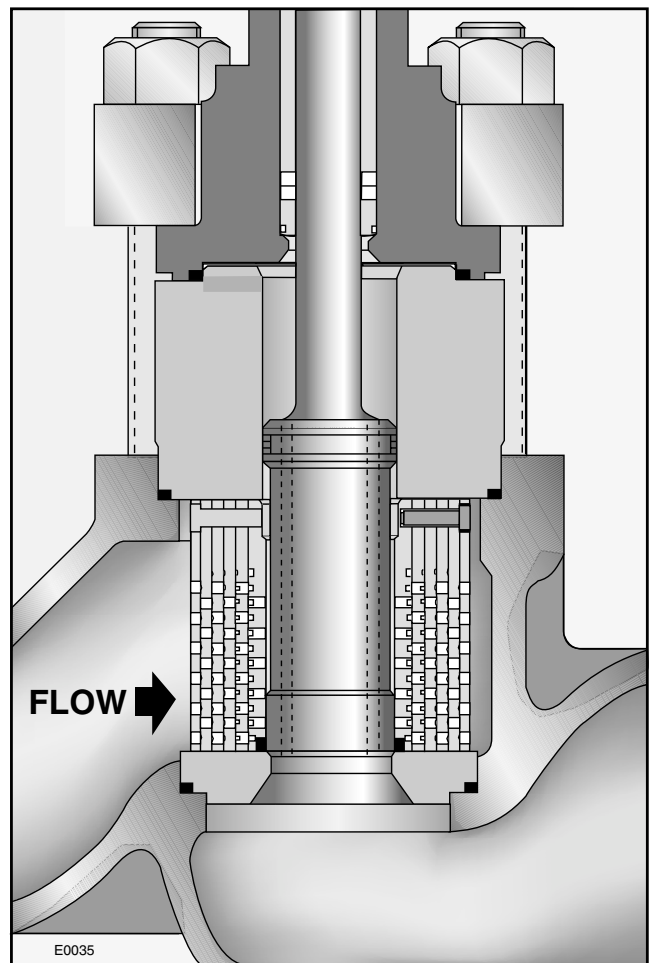
Valtek Severe Service Equipment ChannelStream Trim

stages of trim together in the correct rotational alignment. The pins and alignment holes have shoulders to index the proper position within the cartridge. A small bead weld prevents the pin from loosening. (The bead weld can be easily ground or machined out for disassembly.) The plug fits closely inside the cartridge bore and is designed to uncover or cover the inner expansion holes, controlling the flow. The ChannelStream cartridge can be used with either metal or resilient insert seat rings to obtain the desired shutoff level. Unbalanced and pressure-balanced designs are available. (See Figures 16 and 17.)

Valtek control valves with ChannelStream cartridge trim are manufactured in sizes 1.5 through 36-inch, utilizing conventional Valtek globe-style bodies. For smaller parts inventory and lower cost, many parts are interchangeable with conventional Valtek Mark One globe valves. To minimize costs associated with large globe valve bodies, angle bodies in ANSI Classes 150 through 600 valves in sizes 16 through 36-inch may be custom-fabricated using an angle body configuration with the inlet at the side and the outlet on the bottom. For applications requiring long strokes, long-stroking pneumatic cylinder, electric and hydraulic actuators are available.



**Figure 16: Unbalanced
ChannelStream Trim**



**Figure 17: Pressure-balanced
ChannelStream Trim**

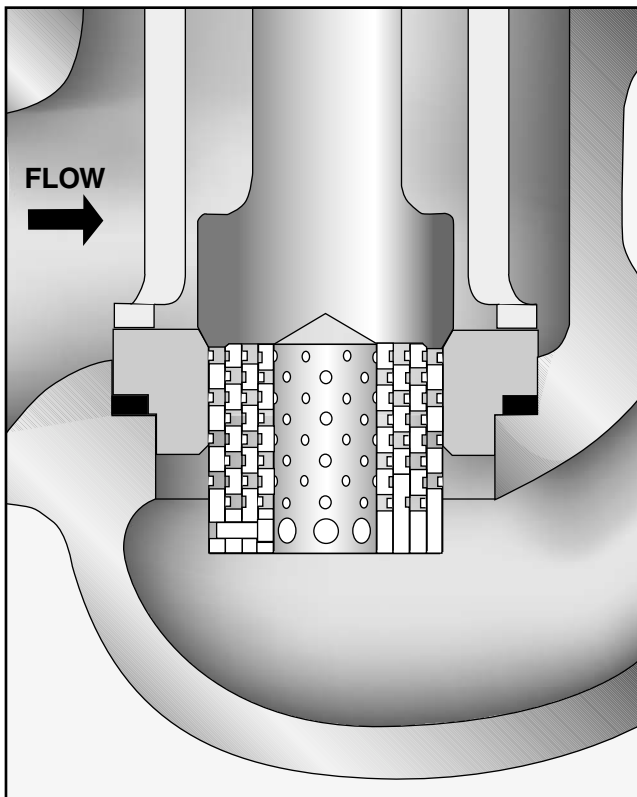
Valtek Severe Service Equipment ChannelStream Trim

Pressure Reduction Mechanisms

Although ChannelStream trim uses many pressure reduction mechanisms, the gradual reduction in pressure through the trim occurs principally as a result of five physical mechanisms:

1. *Sudden expansion* of the flow areas as the liquid exits the restrictive channels and enters the intersecting expansion holes
2. *Frictional losses* due to multiple, small passageways
3. *Turbulent mixing* in the expansion holes
4. *Mutual impingement* of opposing streams in the expansion holes
5. *Directional changes* of the fluid as it passes through the retainer

In addition, the small channel size generates only small, rapidly dissipated vortex turbulence, reducing vortex cavitation associated with larger flow geometrics. The above mechanisms (occurring in multiple stages) minimize pressure recovery.



**Figure 18: ChannelStream
Low Flow Design**

Velocity and Pressure

The velocities at the inlet and outlet of a Valtek control valve with ChannelStream trim are generally designed for a maximum of 30 feet per second while fluid velocities interior to the valve are also closely controlled. In addition, the valve is designed to ensure that the pressure of the fluid in the valve body (including the ChannelStream cartridge) is always greater than the liquid vapor pressure.

Flow Characteristics

ChannelStream trim offers a linear flow characteristic, producing essentially equal changes of flow with equal changes in valve stroke. The linear characteristic cartridge design consists of an axially uniform hole and channel pattern. The linear characteristic is most commonly used for high-drop liquid applications. Non-linear characteristics are available by designing an appropriate non-uniform hole pattern, along with a corresponding axial change in the area of the restrictive channels to produce the desired characteristic.

Maintenance

Many comparative anti-cavitation valves utilize cage designs that can experience sticking problems between the plug head and the cage. The standard ChannelStream cartridge avoids such problems since the cartridge's smooth, continuous inner-stage surface allows close-clearance plug motion.

Anti-cavitation valves are typically constructed with small flow passages that can become plugged by dirt or other debris in the fluid stream. Such devices usually direct the flow initially to the throttling plug before passing it through the restrictive device. This results in sticking and galling as dirt and other material become trapped between the sliding plug and the inside surface of the anti-cavitation device. On the other hand, ChannelStream is designed with two important protective features to minimize such plugging problems: First, flow is first brought through the cartridge; contaminants too large to pass through the small outer channels are trapped at the outer-most stage of the cartridge preventing debris from traveling through the device to the throttling plug. Second, because the inner channels progressively become larger, small particles (which pass through the first set of channels) are easily passed through the rest of the cartridge. In the unlikely event that the cartridge does become plugged, it can be easily disassembled and cleaned.

Valtek Severe Service Equipment ChannelStream Trim

Low Flow Design

For flows of between 0.5 and 2.5 C_v , a special ChannelStream design is utilized where the cartridge is an integral part of the plug (Figure 18), instead of a separate cartridge/seat retainer in the standard design. The cartridge/plug is closely guided in the seat ring. Within the plug head, the cylindrical stages of the ChannelStream are retained. Although located in the plug head and not in the seat retainer, the stages are identical in design and function to the standard cartridge. As the cartridge/plug strokes through the seat, the flow area increases as additional expansion holes are exposed to the flow. Some advantages of using the ChannelStream low flow design is its simplicity; it does not require the use of an angle-style body and can be easily retrofitted into a standard Valtek Mark One valve. With the ChannelStream low flow design, because of the extremely small holes and channels, it should only be applied in clean services.

Flow Capacity

In choosing a valve for a particular application, the user should consider not only the C_v , but also the velocity and the Sigma value that must be accommodated. The required flow capacity of an application can be determined through the standard ISA sizing equations. The main difference in sizing a standard globe valve and a ChannelStream valve is that the ChannelStream valve is far less likely to choke, thus providing more flow for a given flow capacity and pressure drop.

Typical ChannelStream trim information is given in the tables on page 14 is not intended to provide a complete listing of all available designs. Rather, it can be useful in estimating capabilities of a particular valve size and pressure class.

In choosing a valve for a particular application, the user should consider not only the C_v , but also the velocity and the Sigma value that must be accommodated.

**Table 5: ChannelStream Trim
Materials of Construction**

Trim Part	Available Materials
Cartridge (standard design)	316, 410 or 416 stainless steel; Inconel; other alloys as required
Cartridge/Plug (low flow design)	416 stainless steel
Plug (standard design)	316 stainless steel with Alloy 6 overlay; 416 or 420 stainless steel; other alloys as required
Seat Ring	316 stainless steel with Alloy 6 overlay; 410, 416 or 420 stainless steel; other alloys as required

See Valtek Mark One Control Valves technical bulletin for basic valve's materials of construction.

**Table 6: Comparison of Typical Valve Recovery Coefficients,
 F_L and F_i with σ_{choked}^* and $\sigma_{incipient}^{Damage^*}$**

Valve Type	Flow Direction	Trim Size	F_L	F_i	σ_{choked}^*	$\sigma_{incipient}^{Damage^*}$
Globe	over	full area	0.85	0.76	1.38	1.73
	under	all	0.90	0.81	1.23	1.52
Rotary Disk	90° open	full	0.56	0.49	3.17	4.16
Ball	90° open	full	0.60	0.54	2.78	3.43
CavControl	over seat	all	0.92	0.85	1.18	1.20
ChannelStream	over seat	all	~1.0**	***	**	1.30 to 1.001

*These Sigma values do not include size and pressure scale factors for proper application to actual service requirements.

** Choking will not occur when properly applied.

***Does not apply to multi-staged trim valves.

Valtek Severe Service Equipment

ChannelStream Trim

Table 7: ChannelStream Trim Data
Class 150 - 600

Body Size	Trim No. (Seat Dia.)	Stages	Stroke	C _v	σ _{min.}	Bore Area
1.5	1.38	2	1.50	17	.170	1.77
	1.25	3	1.50	11	.070	1.48
	1.12	4	1.50	6	.020	.99
2	1.38	2	1.50	18	.170	1.77
	1.25	3	1.50	12	.070	1.49
	1.12	4	1.50	7	.020	.99
3	2.50	2	2.50	50	.200	5.41
	2.38	3	2.50	34	.080	4.91
	2.00	4	2.50	20	.025	3.55
	1.62	5	2.50	12	.007	2.41
	1.25	6	2.50	7	.002	1.49
4	3.50	2	3.00	85	.200	10.3
	3.12	3	3.00	54	.080	8.3
	2.75	4	3.00	33	.025	6.51
	2.38	5	3.00	21	.007	4.91
	1.88	6	3.00	12	.002	3.14
	6	5.25	2	4.00	175	.200
4.75		3	4.00	105	.080	18.7
4.25		4	4.00	65	.025	15.1
3.50		5	4.00	40	.007	10.3
3.00		6	4.00	25	.002	7.67
8		6.50	2	6.00	320	.200
	6.00	3	6.00	200	.080	29.5
	5.50	4	6.00	130	.025	24.8
	5.00	5	6.00	85	.007	20.6
	4.50	6	6.00	55	.002	16.8
	10	8.75	2	7.50	530	.230
8.38		3	7.50	350	.090	56.7
7.88		4	7.50	230	.028	50.3
7.38		5	7.50	155	.008	44.2
6.88		6	7.50	105	.002	38.5
12		9.75	2	8.00	640	.230
	9.00	3	8.00	400	.090	65.4
	8.38	4	8.00	260	.028	56.7
	7.88	5	8.00	180	.008	50.3
	7.38	6	8.00	125	.002	44.2
	14	11.00	2	8.00	720	.240
10.25		3	8.00	460	.095	84.5
9.50		4	8.00	300	.030	72.8
8.75		5	8.00	200	.008	61.9
8.00		6	8.00	135	.002	51.8

Class 900 - 1500

Body Size	Trim No. (Seat Dia.)	Stages	Stroke	C _v	σ _{min.}	Bore Area
1.5	1.62	2	1.50	20	.170	2.41
	1.38	3	1.50	12	.070	1.77
	1.12	4	1.50	7	.020	1.13
	1.12	5	1.50	4	.006	.99
	2	1.62	2	1.50	20	.170
1.38		3	1.50	12	.070	1.77
1.12		4	1.50	7	.020	1.13
1.12		5	1.50	4	.007	.99
3		2.50	2	2.50	50	.180
	2.38	3	2.50	32	.075	4.91
	2.00	4	2.50	20	.022	3.55
	1.69	5	2.50	12	.007	2.41
	1.69	6	2.50	7	.002	1.49

Class 900 - 1500 (continued)

Body Size	Trim No. (Seat Dia.)	Stages	Stroke	C _v	σ _{min.}	Bore Area
4	3.50	2	3.00	85	.200	10.3
	3.12	3	3.00	53	.080	8.3
	2.75	4	3.00	32	.025	6.49
	2.38	5	3.00	20	.007	4.91
	1.88	6	3.00	12	.002	3.14
	6	5.25	2	4.00	170	.200
4.75		3	4.00	100	.080	18.7
4.25		4	4.00	65	.025	15.0
3.25		5	4.00	40	.007	10.3
3.00		6	4.00	25	.002	7.67
8		6.50	2	6.00	310	.200
	6.00	3	6.00	200	.080	29.5
	5.50	4	6.00	130	.025	24.8
	5.00	5	6.00	85	.007	20.6
	4.50	6	6.00	55	.002	16.8
	10	7.75	2	8.00	490	.230
7.25		3	8.00	310	.090	42.7
6.75		4	8.00	200	.028	37.1
6.25		5	8.00	140	.008	31.9
5.75		6	8.00	95	.002	27.1
12		9.75	2	8.00	630	.230
	9.00	3	8.00	390	.090	65.4
	8.38	4	8.00	250	.028	56.7
	7.88	5	8.00	170	.008	50.3
	7.38	6	8.00	120	.002	44.2
	14	10.25	2	8.00	670	.240
9.50		3	8.00	420	.095	72.8
8.75		4	8.00	270	.030	61.9
8.00		5	8.00	180	.008	51.8
7.38		6	8.00	130	.002	44.2

Class 2500

Body Size	Trim No. (Seat Dia.)	Stages	Stroke	C _v	σ _{min.}	Bore Area
1.5	1.62	2	1.50	20	.170	2.41
	1.38	3	1.50	12	.070	1.77
	1.12	4	1.50	7	.020	1.23
	1.12	5	1.50	4	.006	.99
	2	1.62	2	1.50	20	.170
1.38		3	1.50	12	.070	1.77
1.25		4	1.50	7	.020	1.23
1.12		5	1.50	4	.006	.99
3		2.38	2	2.50	45	.180
	2.00	3	2.50	27	.075	3.55
	1.75	4	2.50	18	.022	2.76
	1.50	5	2.50	11	.007	2.07
	1.25	6	2.50	7	.002	1.48
	4	3.25	2	3.00	75	.200
3.00		3	3.00	50	.080	7.67
2.62		4	3.00	30	.025	5.94
2.25		5	3.00	20	.007	4.43
1.75		6	3.00	12	.002	2.76
6		4.75	2	4.00	150	.200
	4.25	3	4.00	90	.080	15.0
	3.50	4	4.00	55	.025	10.3
	3.00	5	4.00	33	.007	7.67
	2.50	6	4.00	22	.002	5.41

NOTE: Body Size is in inches. Trim Number is in inches of seat diameter. Stroke is maximum plug lift in inches. Bore area of the cartridge is in square-inches.

Valtek Severe Service Equipment

MicroCav Trim

Introduction

MicroCav trim is used to effectively handle cavitation in Valtek control valves that require small flow rates (maximum C_v values from 1.25 to 0.007). To effectively prevent cavitation damage, the preferred application is with an angle-style valve body with hardened trim. A slightly modified design can also be used on a limited basis for globe valve applications.

Design

The MicroCav design utilizes a special plug that is closely guided within the seat ring. The plug head is designed with a series of special-engineered grooves that continually expand as they progress diagonally along the length and around the circumference of the plug head (Figures 19 and 20) — allowing the grooves to continually intersect with each other. The fluid passes through the grooves, experiencing a continual increase in flow area while allowing for staged pressure reduction. Staged pressure reduction takes place as the fluid impinges upon itself when the grooves intersect.

Flow Characteristic

MicroCav trim has a modified equal percentage characteristic and a 40 to 1 rangeability.

Table 8: MicroCav Trim Materials of Construction

Trim Part	Available Materials
Plug	400 series stainless steel, solid Alloy 6
Seat Ring	400 series stainless steel, solid Alloy 6

See Valtek Mark One Control Valves technical bulletin for basic valve's materials of construction.

Table 9: MicroCav Trim C_v Values

Max C_v	Trim No.	Stroke	Max C_v	Trim No.	Stroke
1.25*	1.25 A	1.50	0.120	0.50 F	0.75
1.00*	1.25 B	1.50	0.100	0.50 G	0.75
0.80*	1.00 A	1.50	0.080	0.50 H	0.75
0.70*	1.00 B	1.50	0.070	0.38 A	0.75
0.50	0.69 A	1.00	0.050	0.38 B	0.75
0.42	0.69 B	1.00	0.040	0.38 C	0.50
0.35	0.69 C	0.75	0.030	0.38 D	0.50
0.30	0.50 A	0.75	0.020	0.38 E	0.50
0.25	0.50 B	0.75	0.015	0.38 F	0.50
0.21	0.50 C	0.75	0.010	0.38 G	0.50
0.18	0.50 D	0.75	0.007	0.38 H	0.05
0.15	0.50 E	0.75			

*Requires 1.5 - 2-inch valve.

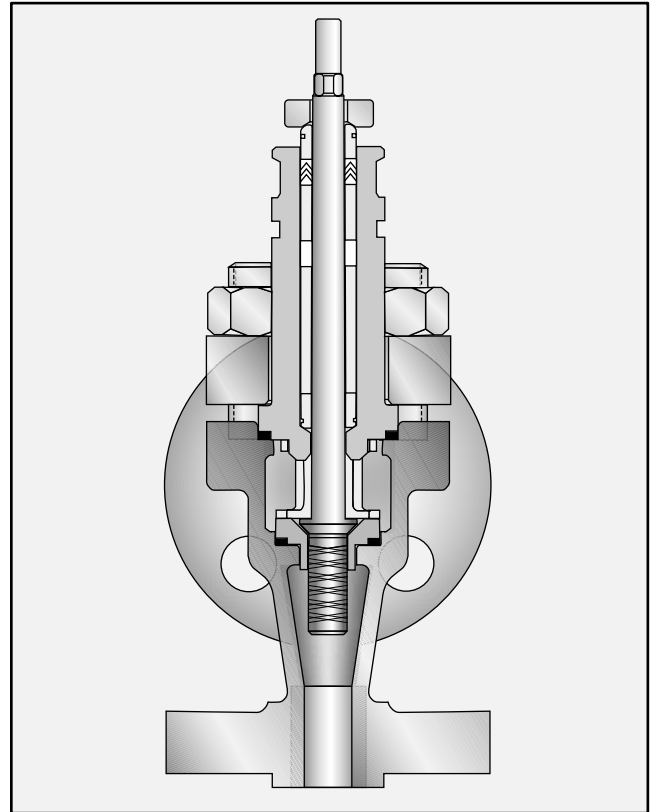


Figure 19: MicroCav Plug Uses Expanding Grooves to Control Cavitation



Figure 20: MicroCav Trim Design

Valtek Severe Service Equipment

CavControl Trim

Introduction

CavControl trim is a cost-effective trim that effectively minimizes cavitation damage to valve components by controlling the location and concentration of cavitation vapor bubble implosion in an area away from metal parts.

Design

CavControl trim utilizes a number of small, diametrically opposed flow holes through the walls of a special seat retainer (Figure 21). Flow direction for valves with CavControl trim is always over the plug. As the valve plug lifts off the seat, increasing pairs of holes are opened. Each hole emits a jet of cavitating liquid, which impinges in the center of the retainer upon the jet of liquid emitted through the opposing hole (Figure 22). The impinging fluid jets form a fluid cushion and an area of pressure recovery that cause the collapse of the vapor bubbles in the fluid stream away from metal parts. Stepped holes are used to ensure orifice type flow rather than tube type flow through the retainer; thus, the vena contracta is established externally rather than inside the retainer itself. The turbulence of the impinging flow promotes the collapse of vapor bubbles at the center of the seat retainer, minimizing damage to valve trim. CavControl trim fits standard Valtek bodies, with both pressure-balanced and unbalanced trims available.

As with all Valtek control valves, CavControl is designed to allow for easy maintenance, reliability, performance and high interchangeability of parts with other valve models. Designs are simple, straightforward and require no special tools.

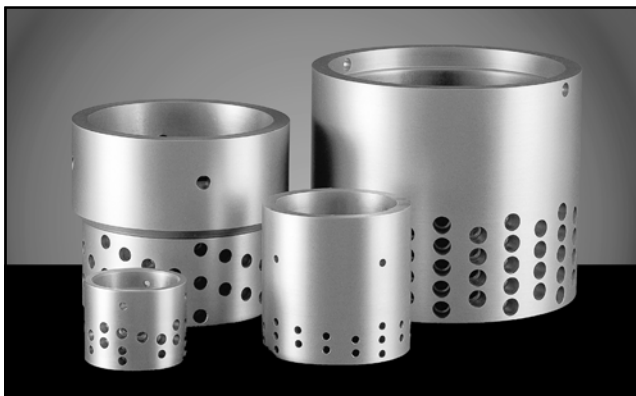


Figure 21: CavControl trim

Flow Capacity and Characteristics

Flow capacity and characteristics are determined by the size and spacing of the holes in the seat retainer (refer again to Figure 21). Different sized holes and variable spacing can be used on the same retainer to achieve a desired flow characteristic.

The required flow capacity of an application can be determined through the standard ISA sizing equations. The main difference in sizing a standard globe valve and a CavControl valve is that the CavControl valve generally has lower pressure recovery and is less likely to choke thus providing more flow for a given flow capacity and pressure drop.

Table 10: CavControl Trim Materials of Construction

Trim Part	Available Materials
Seat Retainer	316 stainless steel or 400 series hardened stainless steel
Plug	316 stainless steel with Alloy 6 facing or 400 series hardened stainless steel
Seat Ring	316 stainless steel with Alloy 6 facing or 400 series hardened stainless steel

See Valtek Mark One Control Valves technical bulletin for basic valve's materials of construction.

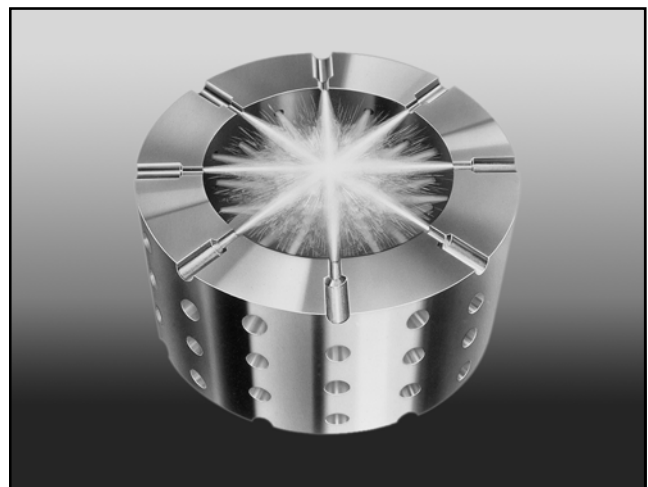


Figure 22: Impinging Flow Path of CavControl Trim

Valtek Severe Service Equipment

CavControl Trim

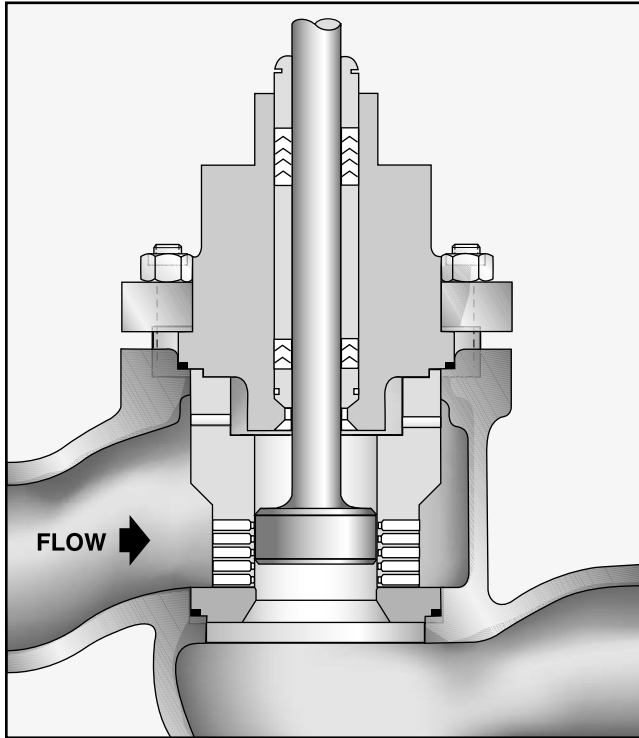


Figure 23: Unbalanced CavControl Trim

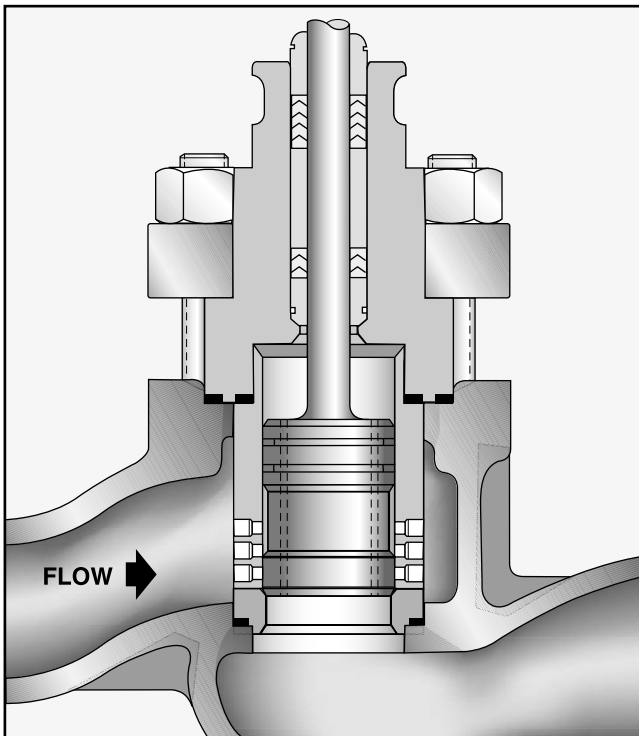


Figure 24: Pressure-balanced CavControl Trim

Table 11: CavControl Trim Data
Class 150-600 C_v Values

Body Size	Trim No.	Stroke	Unbalanced		Pressure balanced	
			Linear	Equal %	Linear	Equal %
1	0.75A	1.00	10.0	9.0	NA	NA
	0.75B	0.75	8.0	7.0	NA	NA
	0.75C	0.75	6.0	6.0	NA	NA
	0.75D	0.75	4.0	4.0	NA	NA
	0.75E	0.75	2.5	2.5	NA	NA
	0.75F	0.75	1.5	1.5	NA	NA
1.5	1.62B	1.50	32.0	32.0	32.0	32.0
	1.62C	1.00	24.0	24.0	24.0	24.0
	1.62D	1.00	16.0	16.0	16.0	16.0
	1.25A	0.75	10.0	10.0	10.0	10.0
	1.25B	0.75	6.0	6.0	6.0	6.0
	1.25C	0.75	4.0	4.0	4.0	4.0
2	1.62A	2.00	46.0	40.0	46.0	40.0
	1.62B	1.50	35.0	35.0	35.0	35.0
	1.62C	1.00	24.0	24.0	24.0	24.0
	1.62D	1.00	16.0	16.0	16.0	16.0
	1.25A	0.75	10.0	10.0	10.0	10.0
	1.25B	0.75	6.0	6.0	6.0	6.0
	1.25C	0.75	4.0	4.0	4.0	4.0
3	2.5	2.00	90.0	70.0	90.0	70.0
	2.25A	1.50	65.0	46.0	65.0	46.0
	2.25B	1.50	44.0	44.0	44.0	44.0
	1.88A	1.00	28.0	28.0	28.0	28.0
	1.88B	1.00	16.0	16.0	16.0	16.0
	1.5	0.75	10.0	10.0	10.0	10.0
	1.25	0.75	4.0	4.0	4.0	4.0
4	3.75A	2.50	165.0	140.0	165.0	140.0
	3.75B	2.00	140.0	110.0	140.0	110.0
	3.00A	2.00	95.0	95.0	95.0	95.0
	3.00B	2.00	65.0	65.0	65.0	65.0
	1.88A	1.50	44.0	44.0	44.0	44.0
	1.88B	1.50	28.0	28.0	28.0	28.0
	1.5	0.75	10.0	10.0	10.0	10.0
6	4.75A	3.00	350.0	310.0	350.0	310.0
	4.75B	2.50	240.0	195.0	240.0	195.0
	4.75C	2.50	160.0	160.0	160.0	160.0
	3.25	2.00	110.0	110.0	110.0	110.0
8	6.50A	4.0	600.0	500.0	600.0	500.0
	6.50B	3.00	540.0	410.0	540.0	410.0
	6.50C	3.00	330.0	330.0	330.0	330.0
	6.50D	3.00	240.0	240.0	240.0	240.0
	3.00	2.00	110.0	110.0	110.0	110.0
10	838.0A	4.0	940.0	900.0	940.0	900.0
	838.0B	3.00	670.0	600.0	670.0	600.0
	838.0C	3.00	510.0	510.0	510.0	510.0
	838.0D	3.00	300.0	300.0	300.0	300.0
12	975.0A	4.0	1000.0	800.0	1000.0	800.0
	975.0B	4.0	800.0	700.0	800.0	700.0
	975.0C	4.0	600.0	600.0	600.0	600.0
	975.0D	4.0	400.0	400.0	400.0	400.0

Valtek Severe Service Equipment

CavControl Trim

Table 11: CavControl Trim Data (continued)
Class 900-1500

Body Size	Trim No.	Stroke	Unbalanced		Pressure-balanced	
			Linear	Equal %	Linear	Equal %
1	0.75A	1.00	9.0	8.0	NA	NA
	0.75B	0.75	8.0	7.0	NA	NA
	0.75C	0.75	6.0	6.0	NA	NA
	0.75D	0.75	4.0	4.0	NA	NA
	0.75E	0.75	2.5	2.5	NA	NA
	0.75F	0.75	1.5	1.5	NA	NA
1.5	1.62B	1.00	21.0	21.0	21.0	21.0
	1.62C	1.00	16.0	16.0	16.0	16.0
	1.62D	0.75	12.0	12.0	12.0	12.0
	1.25A	0.75	10.0	10.0	10.0	10.0
	1.25B	0.75	6.0	6.0	6.0	6.0
	1.25C	0.75	4.0	4.0	4.0	4.0
2	1.62A	1.00	30.0	30.0	30.0	30.0
	1.62B	1.00	24.0	24.0	24.0	24.0
	1.62C	1.00	16.0	16.0	16.0	16.0
	1.62D	0.75	12.0	12.0	12.0	12.0
	1.25A	0.75	10.0	10.0	10.0	10.0
	1.25B	0.75	6.0	6.0	6.0	6.0
	1.25C	0.75	4.0	4.0	4.0	4.0
	2.5	2.00	90.0	65.0	90.0	65.0
3	2.25A	1.50	65.0	55.0	65.0	55.0
	2.25B	1.50	44.0	44.0	44.0	44.0
	1.88A	1.00	28.0	28.0	28.0	28.0
	1.88B	1.00	16.0	16.0	16.0	16.0
	1.50	0.75	10.0	10.0	10.0	10.0
	3.75	2.00	140.0	110.0	140.0	110.0
4	3.00A	2.00	95.0	75.0	95.0	75.0
	3.00B	1.50	65.0	65.0	65.0	65.0
	1.88A	1.50	44.0	44.0	44.0	44.0
	1.88B	1.00	28.0	28.0	28.0	28.0
	4.75A	2.50	240.0	160.0	240.0	160.0
6	4.75B	2.50	160.0	140.0	160.0	140.0
	3.25	2.00	110.0	110.0	110.0	110.0
	3.00	1.50	65.0	65.0	65.0	65.0
	6.50	3.00	500.0	330.0	500.0	330.0
8	5.50A	3.00	330.0	295.0	330.0	295.0
	5.50B	2.50	240.0	240.0	240.0	240.0
	8.38	3.00	700.0	460.0	700.0	460.0
10	7.38A	3.00	460.0	300.0	460.0	300.0
	7.38B	3.00	300.0	200.0	300.0	200.0
	5.50	2.50	200.0	150.0	200.0	150.0

Class 2500

Body Size	Trim No.	Stroke	Unbalanced		Pressure-balanced	
			Linear	Equal %	Linear	Equal %
1	0.75A	1.00	8.0	7.0	NA	NA
	0.75B	0.75	6.0	6.0	NA	NA
	0.75C	0.75	4.0	4.0	NA	NA
	0.75D	0.75	2.5	2.5	NA	NA
	0.75E	0.75	1.5	1.5	NA	NA
1.5	1.62	0.75	12.0	12.0	12.0	12.0
	1.25A	0.75	10.0	10.0	10.0	10.0
	1.25B	0.75	6.0	6.0	6.0	6.0
2	1.25C	0.75	4.0	4.0	4.0	4.0
	1.62A	1.00	30.0	30.0	30.0	30.0
	1.62B	1.00	24.0	24.0	24.0	24.0
	1.62C	0.75	16.0	16.0	16.0	16.0
	1.25A	0.75	10.0	10.0	10.0	10.0
	1.25B	0.75	6.0	6.0	6.0	6.0
	1.25C	0.75	4.0	4.0	4.0	4.0
3	2.25A	1.50	65.0	44.0	65.0	44.0
	2.25B	1.50	44.0	28.0	44.0	28.0
	1.88A	1.00	28.0	16.0	28.0	16.0
	1.88B	0.75	16.0	10.0	16.0	10.0
	1.50	0.75	10.0	6.5	10.0	6.5
4	3.00A	2.00	110.0	70.0	110.0	70.0
	3.00B	1.50	65.0	55.0	65.0	55.0
	1.88A	1.50	44.0	44.0	44.0	44.0
	1.88B	1.00	28.0	28.0	28.0	28.0
6	4.75A	2.50	195.0	160.0	195.0	160.0
	4.75B	2.50	160.0	110.0	160.0	110.0
	3.25	2.00	110.0	65.0	110.0	65.0
	3.00	1.50	65.0	50.0	65.0	50.0

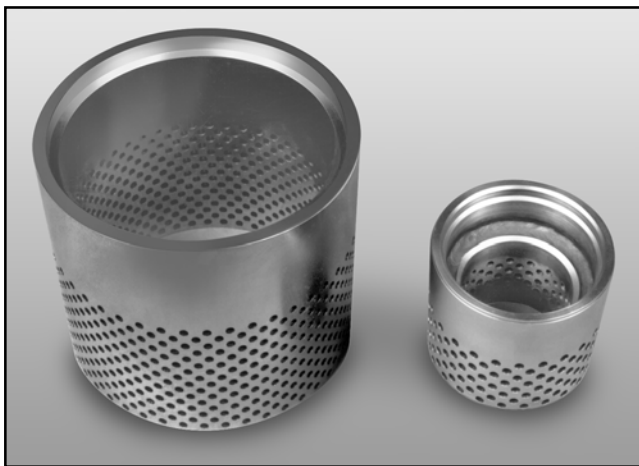
Body size, trim number and stroke are in inches.

Valtek Severe Service Equipment MegaStream Trim

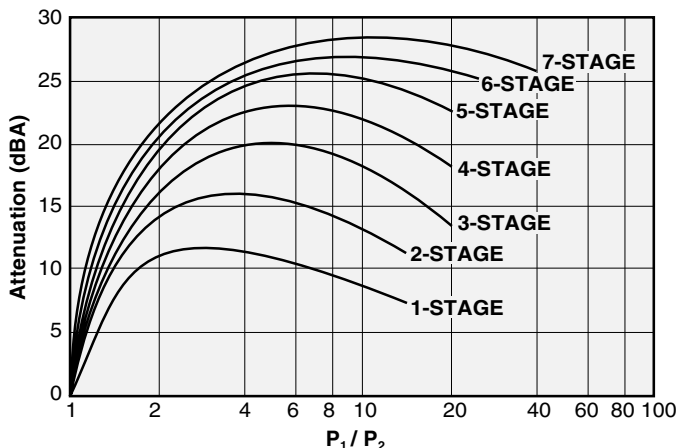
Introduction

MegaStream valve trim effectively reduces control valve noise in a range of gas applications. MegaStream trim is available in two styles (Figure 25): a very economical, interchangeable one- or two-stage design for noise reduction up to 15 dBA, and a highly effective multi-stage design for noise reduction approaching 30 dBA (Figure 26).

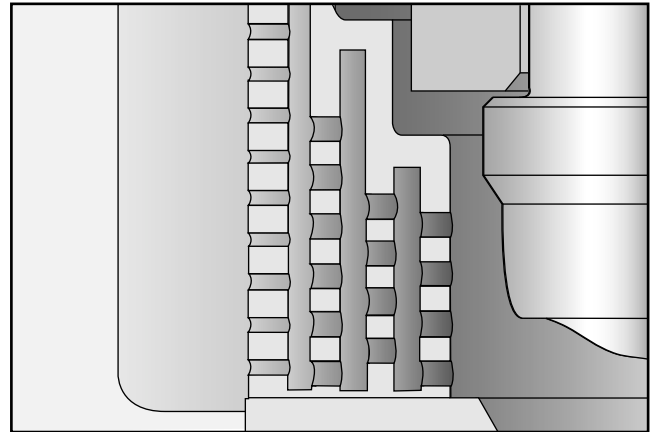
MegaStream trim eliminates the problem of control valve noise by dealing effectively with gaseous pressure reduction, and by controlling turbulence carried into the downstream piping. The pressure drop in MegaStream trim is distributed so that it occurs not only at the throttling point between the plug and seat, but also at



**Figure 25: One and Two-stage
MegaStream Attenuators**

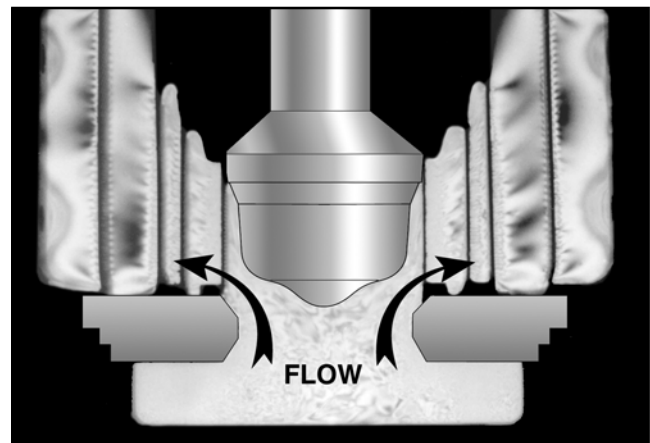


**Figure 26: Noise Reduction Versus
Number of MegaStream Stages**



**Figure 27: Staged Pressure Reduction
Through MegaStream Attenuator**

each stage, from the inside of the attenuator to the outside (Figure 27). This pressure drop occurs largely as a result of the sudden expansions and contractions that take place as the flow passes through the MegaStream trim. Each stage is designed to take a small pressure drop, avoiding the high velocities present in single-throttling-point trims. This gradual pressure reduction is achieved by designing sufficient stages to keep the velocity low.



**Figure 28: MegaStream Trim Restructuring
of Noise Generating Turbulence**

A basic principle of MegaStream noise control valves is the restructuring of noise generating turbulence. This principle is illustrated in this polariscope display (Figure 28) of MegaStream trim with birefringent fluid. Note the turbulence generated in the fluid as it passes through the seat and how this turbulence decreases as the flow continues through each successive stage.

Valtek Severe Service Equipment MegaStream Trim

One and Two-stage Attenuator Design

MegaStream valves equipped with a one- or two-stage seat retainer (called an *attenuator*) represent an extremely economical and innovative approach to low noise applications by permitting up to 15 dBA noise reduction. A standard attenuator (Figure 29) is constructed from heavy-duty drilled-hole cylinders. Since one standard design exists for each valve size, special engineering is not required. This results in lower costs and quicker deliveries. Because of parts interchangeability with standard seat retainers, one and two-stage attenuators can be fitted into conventional Valtek Mark One valves without special or additional parts. The simplicity of design also permits easy removal and maintenance. Both one and two-stage MegaStream trims are available in either unbalanced or pressure-balanced designs (Figures 30 and 31).

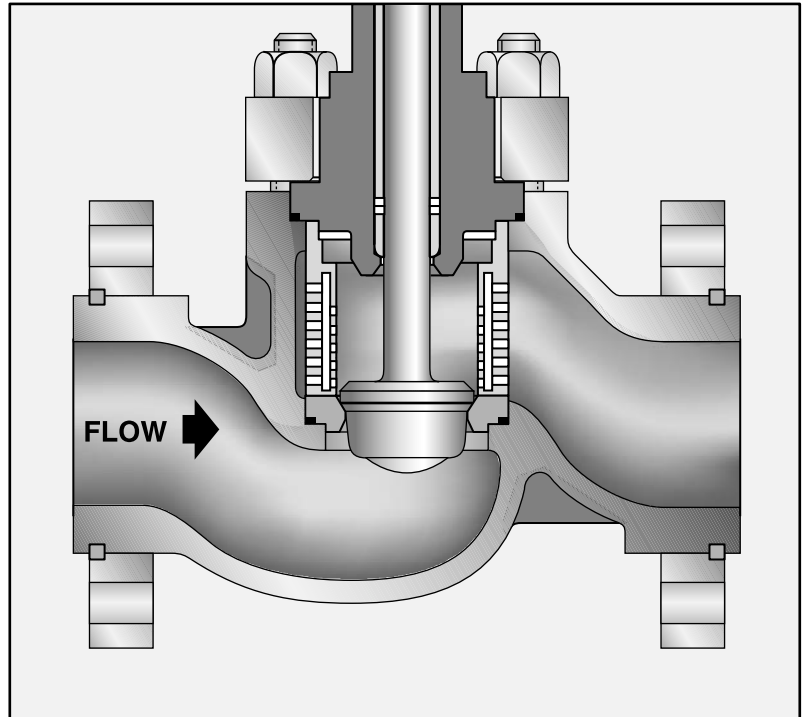


Figure 30: Unbalanced MegaStream Trim



Figure 29: Two-stage MegaStream Attenuator

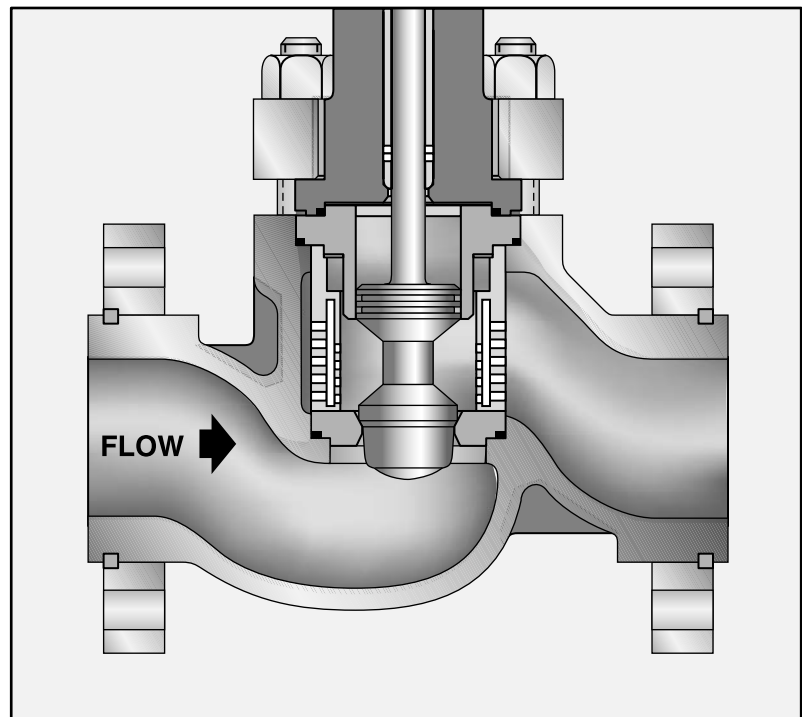


Figure 31: Pressure-balanced MegaStream Trim

Valtek Severe Service Equipment

MegaStream Trim

Multi-stage Attenuator Design

For larger noise reduction levels (up to 30 dBA), multi-stage attenuators incorporate from three to seven drilled-hole stages (Figures 32 and 33), which are welded in place. The outer stage is manufactured to an exact height to allow the proper gasket compression to be applied to both the bonnet and seat gasket.

Multi-stage MegaStream trim (three stages and above), through 14-inch, are usually installed in standard Mark One globe-style valves. (Except for the multi-stage MegaStream attenuator and plug, all other parts of these valves are interchangeable with the Mark One control valve). MegaStream trim for valve sizes 16 through 36-inch can be supplied in a globe valve but are commonly installed in an angle body configuration with the inlet on the bottom and the outlet on the side. Because these bodies are fabricated, the construction usually includes a small inlet with a large outlet – an arrangement ideal for velocity control. As a cost-saving measure, if the downstream side of the valve is protected by a safety valve or is discharged to atmosphere, the body and outlet can be constructed with a lower pressure rating than the inlet. Multi-stage trim is available in both unbalanced and pressure-balanced designs.

Turbulence Control

MegaStream trim effectively lowers the sound pressure levels associated with any turbulence generated within the valve. This turbulence is often carried into the downstream piping, where the localized pressure

changes (resulting from the turbulence) vibrate the relatively thin pipe wall that radiates noise to the surroundings. With the MegaStream attenuator, each successive stage has additional holes or orifices, which increases the flow area and handles the increased gas volume resulting from the pressure drop.

As the flow leaves the final stage of the MegaStream attenuator, the turbulence is limited by controlling the physical size of the individual gas streams. (In other words, the smaller gas stream size exiting the final stage of the MegaStream trim limits the amount of turbulence energy present.) Further, the smaller turbulent eddies are more easily dissipated. The result is a gas stream leaving the valve that contains no large-scale turbulent eddies, which is sufficient to cause substantial noise generation in the downstream piping. The stages also effectively limit much of the sound vibration generated at the throttling area. This attenuating effect is made possible by the acoustic impedance characteristics of the material and design, which provide resistance to further transmission of incident sound energy. This acoustic impedance is especially effective in controlling noise when the plug is throttling close to the seat.

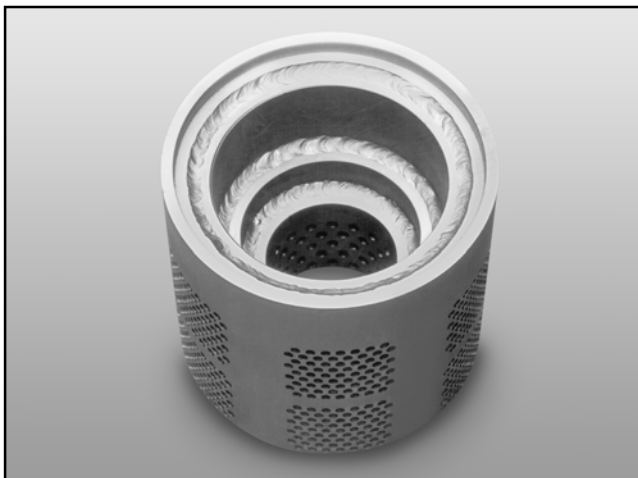


Figure 32: Four-stage MegaStream Attenuator

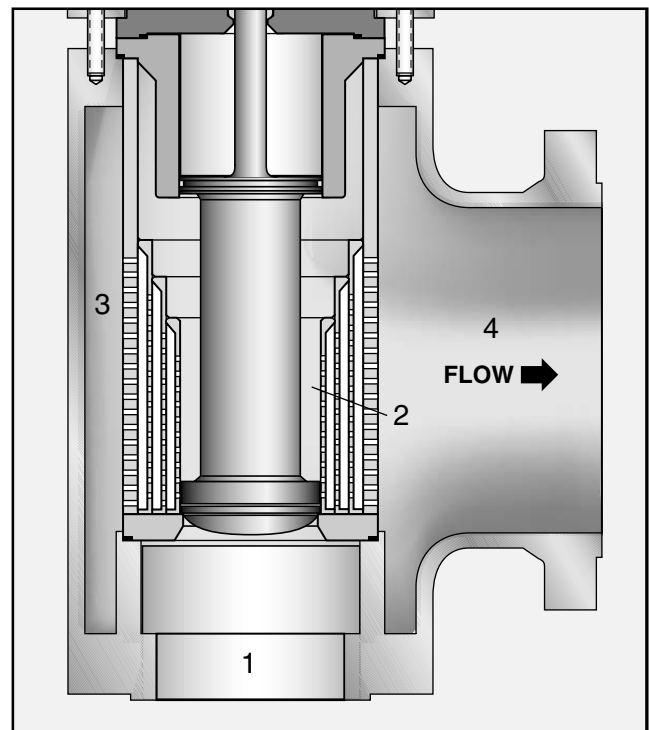


Figure 33: MegaStream Velocity Checkpoints

Valtek Severe Service Equipment

MegaStream Trim

Velocities

One of the fundamental design considerations with Valtek control valves with MegaStream trim is the establishment of acceptable velocities at every point as the flow passes through the valve.

For gaseous control valve applications, keeping the maximum outlet gas velocity below 0.33 Mach is desirable, although higher velocities can be accommodated.

Velocities must be assessed for the most difficult flowing conditions at the following critical points (as shown in Figure 33):

1. The inlet passageway to the valve
2. The internal flow area of the MegaStream attenuator at all plug positions
3. The gallery flow area formed between the outside diameter of the attenuator and the inside diameter of the valve body
4. The valve outlet passage flow area. For proper noise control, the downstream piping must be equal to or larger than the valve outlet size

Flow Characteristics

As with the standard Mark One trim design, the flow characteristic for MegaStream trim is determined by the contour of the plug head. Three characteristics are available: equal percentage, linear and quick-open.

Table 12: MegaStream Trim Materials of Construction

Trim Part	Available Materials
Attenuator	316 stainless steel, Inconel®
Plug	316 stainless steel, 316 stainless steel with Alloy 6, 400 series stainless steel, Inconel, alloys as required
Seat Ring	316 stainless steel, 316 stainless steel with Alloy 6, 400 series stainless steel, Inconel, alloys as required

See Valtek Mark One Control Valves technical bulletin for basic valve's materials of construction.

Valtek Severe Service Equipment

MegaStream Trim

Table 13: MegaStream Trim Data
Class 150 - 600

Body Size	Trim No.	Stages	Stroke	Unbalanced		Pressure-balanced	
				Linear	Equal %	Linear	Equal %
1	0.81	1	0.75	10.3	10.0	NA	NA
	0.50	2	0.75	5.1	5.0	NA	NA
1.5	1.25	1	1.00	23.7	23.0	23.7	23.0
	1.00	2	0.75	15.7	15.3	15.7	15.3
2	1.62	1	1.50	41.4	40.2	41.4	40.2
	1.00	2	0.75	20.5	19.9	20.5	19.9
3	2.62	1	2.00	98	95	98	95
	2.00	2	1.50	63	61	63	61
	1.25	3	1.00	32	31	32	31
4	3.50	1	2.50	174	169	174	169
	2.62	2	2.00	110	107	110	107
	1.62	3	1.50	55	53	55	53
6	5.00	1	3.00	380	370	380	370
	3.50	2	2.50	220	215	220	215
	3.00	3	2.00	157	152	157	152
	2.25	4	2.00	97	94	97	94
8	6.25	1	4.00	630	610	630	610
	5.00	2	3.00	415	405	415	405
	4.00	3	2.50	275	265	275	265
	3.00	4	2.50	170	165	170	165
	2.62	5	2.00	123	119	123	119
	2.00	6	1.50	77	75	77	75
10	8.00	1	6.00	1010	980	1010	980
	6.00	2	4.00	630	610	630	610
	4.50	3	3.00	385	375	385	375
	3.50	4	2.50	245	240	245	240
	3.00	5	2.50	176	170	176	170
	2.62	6	2.00	127	123	127	123
12	9.50	1	6.00	1440	1400	1440	1400
	7.38	2	4.00	930	900	930	900
	6.00	3	4.00	620	600	620	600
	5.00	4	4.00	425	415	425	415
	4.00	5	2.50	280	275	280	275
	3.00	6	2.50	174	169	174	169
	2.62	7	2.00	125	121	125	121
14	10.00	1	6.00	1500	1450	1500	1450
	8.00	2	6.00	1000	970	1000	970
	6.50	3	4.00	720	700	720	700
	5.00	4	3.00	470	460	470	460
	4.00	5	2.50	315	305	315	305
	3.50	6	2.50	230	220	230	220
	2.62	7	2.00	142	137	142	137

Class 150 - 600 (continued)

Body Size	Trim No.	Stages	Stroke	Unbalanced		Pressure-balanced	
				Linear	Equal %	Linear	Equal %
16	12.00	1	6.00	2050	2000	2050	2000
	9.00	2	6.00	1320	1280	1320	1280
	7.25	3	4.00	920	890	920	890
	6.00	4	4.00	640	620	640	620
	5.00	5	3.00	445	430	445	430
	4.00	6	2.50	295	285	295	285
	3.25	7	2.50	199	193	199	193
18	13.25	1	8.00	2500	2450	2500	2450
	10.00	2	6.00	1600	1550	1600	1550
	8.25	3	6.00	1150	1120	1150	1120
	6.75	4	4.00	800	780	800	780
	5.50	5	3.00	550	530	550	530
	4.50	6	3.00	370	360	370	360
20	14.75	1	8.00	3100	3000	3100	3000
	11.00	2	6.00	1950	1890	1950	1890
	9.00	3	6.00	1400	1350	1400	1350
	7.50	4	4.00	980	950	980	950
	6.00	5	4.00	660	640	660	640
	5.00	6	3.00	460	440	460	440
	4.25	7	2.50	320	310	320	310
24	17.75	1	8.00	4500	4300	4500	4300
	13.25	2	8.00	2850	2750	2850	2750
	11.00	3	6.00	2050	1990	2050	1990
	9.00	4	6.00	1430	1380	1430	1380
	7.25	5	4.00	960	930	960	930
	6.00	6	4.00	660	640	660	640
	5.00	7	3.00	450	440	450	440
30	20.00	1	8.00	6250	6100	6250	6100
	16.50	2	8.00	4400	4250	4400	4250
	13.50	3	8.00	3150	3050	3150	3050
	11.00	4	6.00	2150	2100	2150	2100
	9.00	5	6.00	1490	1440	1490	1440
	7.50	6	4.00	1030	990	1030	990
	6.25	7	4.00	700	680	700	680
36	26.50	1	8.00	10100	9800	10100	9800
	20.00	2	8.00	6400	6200	6400	6200
	16.25	3	8.00	4550	4400	4550	4400
	13.25	4	8.00	3150	3050	3150	3050
	11.00	5	6.00	2200	2150	2200	2150
	9.00	6	6.00	1500	1450	1500	1450
	7.50	7	4.00	1020	990	1020	990

This standard MegaStream data table is intended to indicate available designs. Consult Flowserve engineers to determine the suitable designs and options for particular applications.

Valtek Severe Service Equipment

MegaStream Trim

Table 13: MegaStream Trim Data (continued)
Class 900 - 1500

Body Size	Trim No.	Stages	Stroke	Unbalanced		Pressure-balanced	
				Linear	Equal %	Linear	Equal %
1	0.81	1	0.75	8.3	8.0	NA	NA
	0.72	1	0.75	7.3	7.1	NA	NA
	0.62	1	0.75	6.5	6.3	NA	NA
	0.50	2	0.75	4.6	4.5	NA	NA
	0.38	2	0.75	3.4	3.3	NA	NA
1.5	1.25	1	1.50	21.1	20.4	21.1	20.4
	1.00	1	0.75	16.6	16.1	16.6	16.1
	1.00	2	0.75	14.8	14.3	14.8	14.3
	0.81	2	0.75	12.6	12.2	12.6	12.2
2	1.62	1	1.50	32.6	31.6	32.6	31.6
	1.25	1	1.50	26.5	25.7	26.5	25.7
	1.00	2	0.75	18.0	17.4	18.0	17.4
	0.81	2	0.75	14.7	14.3	14.7	14.3
3	2.62	1	2.50	84	81	84	81
	2.00	1	2.00	64	62	64	62
	2.00	2	2.00	53	51	53	51
	1.62	2	1.50	47	45	47	45
	1.25	3	1.50	31	30	31	30
4	3.50	1	3.00	147	142	147	142
	3.00	1	2.50	125	121	125	121
	2.62	2	2.50	92	89	92	89
	2.25	2	2.00	84	81	84	81
6	1.62	3	2.00	53	52	53	52
	5.00	1	4.00	315	300	315	300
	4.00	1	3.00	250	245	250	245
	3.50	2	3.00	190	184	190	184
	3.00	2	2.50	170	165	170	165
	3.00	3	2.50	138	134	138	134
8	2.25	4	2.00	90	88	90	88
	6.25	1	6.00	510	190	510	490
	5.00	1	4.00	410	400	410	400
	5.00	2	4.00	340	330	340	330
	4.00	2	3.00	295	285	295	285
	4.00	3	3.00	235	230	235	230
	3.00	4	2.50	156	151	156	151
	2.62	5	2.50	111	107	111	107
10	8.00	1	6.00	810	790	810	790
	7.38	1	6.00	740	720	740	720
	6.25	2	6.00	530	510	530	510
	5.00	2	4.00	460	445	460	445
	4.50	3	4.00	350	335	350	335
	3.50	4	3.00	230	225	230	225
	3.00	5	2.50	164	159	164	159
	2.62	6	2.50	116	112	116	112
12	9.50	1	6.00	1145	1110	1145	1110
	8.00	1	6.00	960	930	960	930
	7.38	2	6.00	740	720	740	720
	6.25	2	6.00	670	650	670	650
	6.00	3	6.00	530	510	530	510
	5.00	4	4.00	365	355	365	355
	4.00	5	3.00	245	240	245	240
	3.50	6	3.00	173	168	173	168
2.62	7	2.50	112	108	112	108	

Class 900 - 1500 (continued)

Body Size	Trim No.	Stages	Stroke	Unbalanced		Pressure-balanced	
				Linear	Equal %	Linear	Equal %
14	9.50	1	6.00	1250	1210	1250	1210
	9.00	1	6.00	1180	1150	1180	1150
	7.38	2	6.00	850	820	850	820
	6.50	2	6.00	780	750	780	750
	5.50	3	6.00	560	540	560	540
	4.50	4	4.00	400	380	400	380
	4.00	5	3.00	280	275	280	275
	3.00	6	2.50	178	173	178	173
	2.62	7	2.50	127	123	127	123
	16	10.50	1	8.00	1570	1530	1570
10.00		1	8.00	1510	1460	1510	1460
8.00		2	6.00	1120	1080	1120	1080
7.38		2	6.00	1050	1020	1050	1020
6.50		3	6.00	830	800	830	800
5.50		4	6.00	610	590	610	590
4.00		5	3.00	375	360	375	360
3.50		6	3.00	275	265	275	265
3.00		7	2.50	195	189	195	189
18		11.50	1	8.00	1940	1880	1940
	11.00	1	8.00	1870	1810	1870	1810
	9.00	2	6.00	1410	1370	1410	1370
	8.00	2	6.00	1280	1240	1280	1240
	7.38	3	6.00	1060	1020	1060	1020
	6.00	4	6.00	750	730	750	730
	5.00	5	4.00	530	510	530	510
	4.00	6	3.00	350	340	350	340
	3.00	7	2.50	215	210	215	210
	20	13.00	1	8.00	2500	2400	2500
12.50		1	8.00	2400	2300	2400	2300
10.00		2	8.00	1760	1710	1760	1710
9.50		2	6.00	1690	1640	1690	1640
8.00		3	6.00	1290	1250	1290	1250
6.50		4	6.00	910	880	910	880
5.50		5	6.00	650	630	650	630
4.50		6	4.00	445	430	445	430
3.50		7	3.00	285	275	285	275
24		15.50	1	8.00	3500	3400	3500
	15.00	1	8.00	3400	3300	3400	3300
	12.00	2	8.00	2550	2450	2550	2450
	11.00	2	8.00	2350	2300	2350	2300
	9.50	3	6.00	1830	1780	1830	1780
	8.00	4	6.00	1340	1300	1340	1300
	6.50	5	6.00	920	890	920	890
	5.50	6	6.00	650	630	650	630
4.50	7	4.00	445	430	445	430	

Valtek Severe Service Equipment MegaStream Trim

Table 13: MegaStream Trim Data (continued)

Class 2500

Body Size	Trim No.	Stages	Stroke	Unbalanced		Pressure-balanced	
				Linear	Equal %	Linear	Equal %
1	0.72	1	0.75	6.2	6.1	NA	NA
	0.62	1	0.75	5.4	5.2	NA	NA
	0.50	2	0.75	3.7	3.6	NA	NA
	0.38	2	0.75	3.00	2.9	NA	NA
1.5	1.00	1	0.75	13.0	12.6	13.0	12.6
	0.81	1	0.75	10.6	10.3	10.6	10.3
	0.72	2	0.75	8.2	7.9	8.2	7.9
	0.62	2	0.75	7.4	7.1	7.4	7.1
2	1.25	1	1.50	21.6	21.0	21.6	21.0
	1.00	1	0.75	17.9	17.3	17.9	17.3
	1.00	2	0.75	15.0	14.6	15.0	14.6
	0.81	2	0.75	12.9	12.5	12.9	12.5
3	2.00	1	2.00	52	50	52	50
	1.50	1	2.00	40	39	40	39
	1.50	2	2.00	34	33	34	33
	1.25	2	1.50	29	29	29	29
4	2.62	1	2.50	87	85	87	85
	2.00	1	2.00	68	66	68	66
	2.00	2	2.00	56	55	56	55
	1.62	2	2.00	49	48	49	48
	1.62	3	2.00	40	39	40	39
6	3.50	1	3.00	177	171	177	171
	3.00	1	2.50	155	150	155	150
	2.62	2	2.50	119	115	119	115
	2.38	2	2.50	110	106	110	106
	2.00	3	2.00	79	77	79	77
	1.62	4	2.00	54	53	54	53
8	5.00	1	4.00	330	320	330	320
	4.00	1	3.00	270	260	270	260
	4.00	2	3.00	225	220	225	220
	3.50	2	3.00	210	200	210	200
	3.50	3	3.00	165	160	165	160
	3.00	4	2.50	117	114	117	114
	2.62	5	2.50	82	79	82	79
	2.00	5	2.50	88	86	88	86
10	5.50	1	4.00	460	440	460	440
	5.00	1	4.00	420	410	420	410
	5.00	2	4.00	340	330	340	330
	4.00	2	3.00	295	290	295	290
	3.50	3	3.00	220	210	220	210
	2.62	4	3.00	139	135	139	135
	2.00	5	2.50	88	86	88	86
12	6.50	1	6.00	650	630	650	630
	6.00	1	6.00	600	590	600	590
	5.00	2	4.00	450	440	450	440
	4.00	2	3.00	360	350	360	350
	4.00	3	3.00	310	300	310	300
	3.00	4	2.50	198	192	198	192
	2.62	5	2.50	144	140	144	140

Valtek Severe Service Equipment MegaStream Plates

Introduction

Similar in many respects to a MegaStream trim attenuator, the MegaStream resistance plate (Figure 34) is installed downstream from a valve as an additional solution to control valve noise. MegaStream plates can be installed between raised face flanges or welded in-line. Typical MegaStream plate applications include gas pressure reducing stations, gas vents and flare systems. MegaStream plates are designed for each individual application, providing sound pressure level (SPL) reductions of up to 15 dBA.



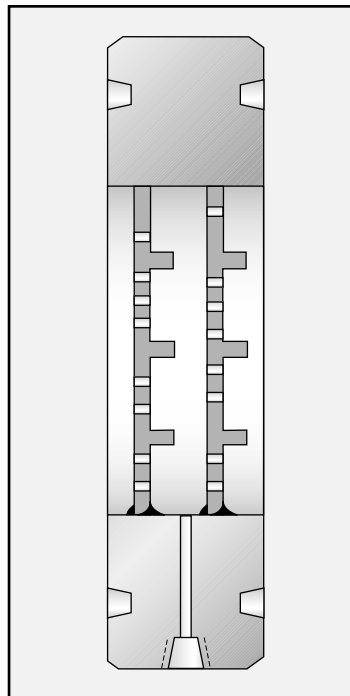
Figure 34:
Two-stage MegaStream Plate

**Table 14: MegaStream Plate C_v
ANSI Class 150 - 600**

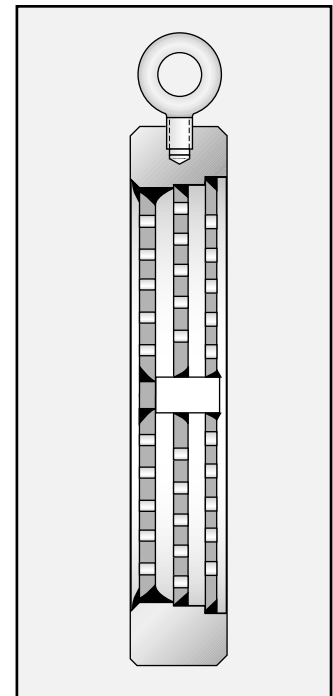
Size	1-stage	2-stage	3-stage
1 1/2	13	8	6
2	23	15	11
3	52	34	26
4	92	60	46
6	208	136	104
8	371	243	185
10	580	380	290
12	835	547	417
14	1136	774	568
16	1484	972	742
18	1879	1231	939
20	2320	1520	1160
24	3340	2188	1670

Design

Each plate incorporates a series of stages (Figures 35 and 36). To control downstream line turbulence, each stage absorbs a portion of the pressure drop through its many multiple orifices. Depending on the type of gas and the pressure drop ratio, these plates may require between one and four stages. Standard MegaStream plates are constructed from carbon steel for both the housing and multi-hole stages. One additional option constructed from 304 stainless steel for both the housing and stages is available. Large plates are available with lifting lugs.



**Figure 35: Two-stage
MegaStream Plate
(with drain)**



**Figure 36:
Three-stage
MegaStream Plate
(with lifting ring)**

NOTE: All values shown at maximum C_v per given size; reduced C_v values are available upon request. C_v data determined with standard 0.19-inch diameter hole size; varying hole sizes will change the above values.

Valtek Severe Service Equipment

MegaStream Plates

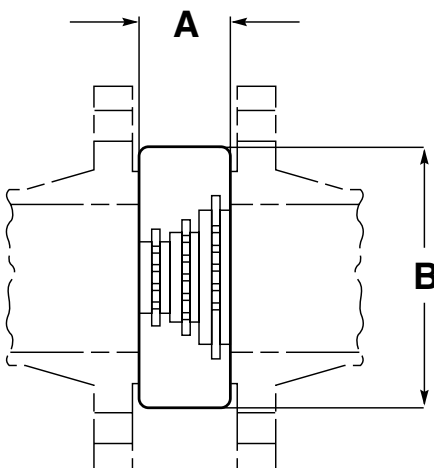


Table 15: MegaStream Plate Dimensions (inches / mm)

Valve Size (inch)	A						B					
	1 Stage		2 Stage		3 Stage		150		300		600	
1½	0.8	19	0.9	22	1.5	38	3.4	86	3.8	95	3.8	95
2	0.8	19	1.3	32	1.5	38	4.1	105	4.4	111	4.4	111
3	0.9	22	1.4	35	1.9	48	5.4	137	5.9	149	5.9	149
4	0.9	22	1.4	35	1.9	48	6.9	175	7.1	181	7.6	194
6	1.3	32	1.6	41	2.4	60	8.8	222	9.9	251	10.5	267
8	1.4	35	1.9	48	2.4	60	11.0	279	12.1	308	12.6	321
10	1.9	48	2.4	60	2.9	73	13.4	340	14.3	362	15.8	400
12	2.4	60	2.8	70	3.4	86	16.1	410	16.6	422	18.0	457
14	2.4	60	2.8	70	3.4	86	17.8	451	19.1	486	19.4	492
16	2.4	60	2.9	73	3.9	99	20.3	514	21.3	540	22.3	565
18	2.4	60	2.9	73	3.9	99	21.6	549	23.5	597	24.1	613
20	2.8	70	3.6	92	4.8	121	23.9	607	25.8	654	26.9	683
24	2.8	70	3.6	92	4.8	121	28.3	718	30.5	775	31.1	791

Valtek Severe Service Equipment

MegaStream Diffusers

Introduction

As with the MegaStream plate, the MegaStream diffuser (Figure 37) can also be used in series with any style of valve to reduce the sound pressure level (up to 15 dBA), while eliminating the need for expensive valve trim. MegaStream diffusers share high pressure drops with the control valve, yet control the sound pressure level by passing the flow through many small openings to eliminate excessive turbulence and energy.

Design

Correct hole size and spacing are critical in determining the performance characteristics of the diffuser, Flowserve custom-engineers each diffuser for a particular application. By design, the length of the diffuser and the number of holes vary to accommodate the flow capacity required. Thus, the capacity of the diffuser is significantly greater than the MegaStream plate.

Table 16: MegaStream Diffuser Specifications

Body Style	Flangeless wafer, outlet head (weld or flange connection), open shell (vent)
Inlet Size	1-42 inch (larger sizes available upon request)
ANSI Rating	150, 300, 600, 900, 1500, 2500
Flow Direction	One-way only
Materials of Construction	Carbon steel (standard), stainless steel and other materials available as required

Available Models

Two standard diffuser models are available:

- GDS: Flowserve’s standard model with installation between the raised face flanges of the valve and line
- GDI: Similar to GDS with welded in-line installation or to mating flanges; outlet is enlarged to eliminate a reducer.

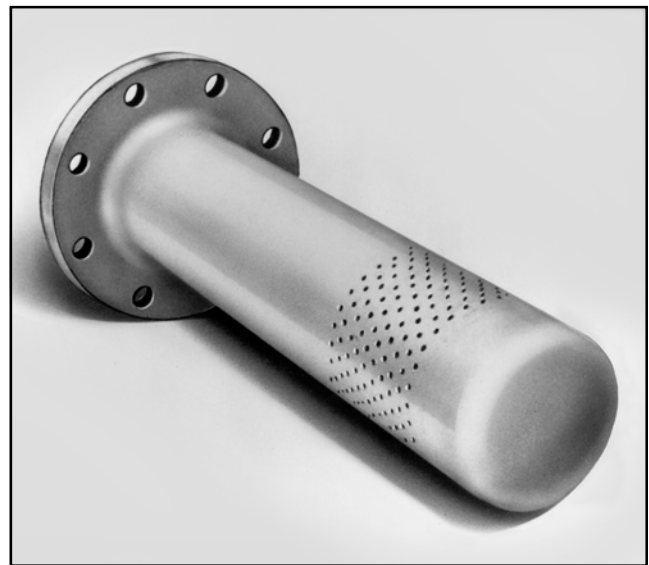
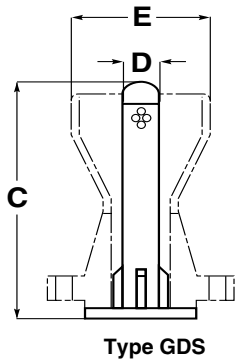


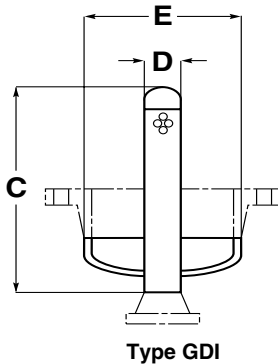
Figure 37: GDS MegaStream Diffuser

Valtek Severe Service Equipment

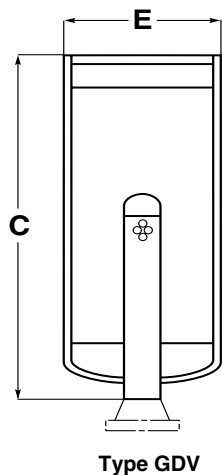
MegaStream Diffusers

Table 17: MegaStream Diffuser Dimensions (inches / mm)

Type GDS

Size (in.)	Max C _v	C		D ¹	Series ² Maximum Weight									
					150		300		600		900			
1	36	11.0	279	Diameter to fit inside flange bore	3.4	1.5	3.4	1.5	3.4	1.5	3.4	1.5		
2	141	17.5	445		9.3	4.2	9.3	4.2	9.3	4.2	12.9	5.9		
3	313	17.5	445		18.2	8.3	18.2	8.3	22.4	10.2	31.7	14.4		
4	544	32.5	826		30.6	13.9	30.6	13.9	39.5	17.9	57.4	26.0		
6	1232	46.5	1181		76.0	34.5	76.0	34.5	124.0	56.2	154.0	69.9		
8	2361	70.0	1778		113.0	51.3	139.0	63.0	254.0	115.2				
10	3722	76.5	1943		173.0	78.5	337.0	152.9	453.0	205.4				
12	5377	91.0	2311		249.0	112.9	508.0	230.4						
14	6752	100.0	2540		319.0	144.7	662.0	300.3						
16	8902	114.0	2896		413.0	187.3	761.0	345.2						
18	11346	128.5	3264		597.0	270.8	1261.0	572.0						
20	14100	143.0	3632		873.0	396.0	1698.0	770.2						
24	20460	168.5	4280		1248.0	566.1								


Type GDI

Size (in.)	Max C _v	C		D ¹	E ³	Series ² Maximum Weight									
						150		300		600		900			
1	36	11.0	279	1.3	33	3.5	89	4.1	1.9	4.1	1.9	4.1	1.9	4.1	1.9
2	141	17.5	445	2.4	60	4.5	114	9.6	4.4	9.6	4.4	9.6	4.4	13.2	6.0
3	313	26.0	660	3.5	89	6.6	168	22.1	10.0	22.1	10.0	26.3	11.9	35.6	16.1
4	544	32.5	826	4.5	114	8.6	219	38.7	17.6	38.7	17.6	47.6	21.6	65.5	29.7
6	1232	46.5	1181	6.6	168	12.8	324	96.6	43.8	96.6	43.8	114.0	51.7	174.0	78.9
8	2361	70.0	1778	8.6	219	16.0	406	138.0	63.0	164.0	74.4	280.0	127.0		
10	3722	76.5	1943	10.8	273	20.0	508	209.0	94.8	373.0	169.2	489.0	221.8		
12	5377	91.0	2311	12.8	324	24.0	610	296.0	134.3	555.0	251.7				
14	6752	100.0	2540	14.0	356	30.0	762	391.0	177.4	734.0	332.9				
16	8902	114.0	2896	16.0	406	36.0	914	510.0	231.3	858.0	389.2				
18	11346	128.5	3264	18.0	457	36.0	914	690.0	313.0	1345.0	610.1				
20	14100	143.0	3632	20.0	508	42.0	1067	1003.0	455.0	1828.0	829.2				
24	20460	168.5	4280	24.0	610	48.0	1219	1418.0	643.2						


Type GDV

Size (in.)	Max C _v	C		E ⁴	Series ² Maximum Weight										
					150		300		600		900				
1	36	17.0	432	3.5	89	13.1	5.9	13.1	5.9	13.1	5.9	13.1	5.9		
2	141	25.5	648	4.5	114	29.6	13.4	29.6	13.4	29.6	13.4	33.2	15.1		
3	313	34.5	876	6.6	168	71.1	32.3	71.1	32.3	75.3	34.2	84.6	38.4		
4	544	44.0	1118	8.6	219	93.7	42.5	93.7	42.5	103.0	46.7	121.0	54.9		
6	1232	55.0	1397	12.8	324	188.0	85.3	188.0	85.3	236.0	107.0	266.0	120.7		
8	2361	80.0	2032	16.0	406	325.0	147.4	351.0	159.2	466.0	211.4				
10	3722	87.0	2210	20.0	508	460.0	208.7	624.0	283.0	740.0	335.7				
12	5377	104.0	2642	24.0	610	652.0	295.7	911.0	413.2						
14	6752	115.0	2921	30.0	762	880.0	399.2	1223.0	554.7						
16	8902	128.0	3251	36.0	914	1166.0	528.9	1514.0	686.7						
18	11346	144.0	3658	36.0	914	1448.0	656.8	2112.0	958.0						
20	14100	150.0	3810	42.0	1067	1978.0	897.2	2803.0	1271.4						

Notes: All dimensions are in inches/mm and weights are in lbs/kg and are for estimations only.

(1) Actual diffuser diameter.

(2) Series designates pressure rating of diffuser identical to pressure rating of same class flange.

(3) Typical diameter. Pressure rating of head equal to schedule 40 pipe of same diameter. Diffuser rating per note 2. E = 2D.

(4) Typical diameter. Actual diameter established so that exit velocity < 400 ft./sec.

See MegaStream control valve bulletin for one and two-stage MegaStream valve dimensions. Contact factory for Tiger-Tooth attenuator and in-line silencer dimensions.

Valtek Severe Service Equipment

MegaStream Vent Silencers

MegaStream Vent Silencers

In a blowoff or vent system, tremendous energy in the form of noise is released at the open exit. Vent silencers attenuate this noise energy before it is released to the outside environment. MegaStream vent silencers are very effective in attenuating very high noise levels created when high pressure gases are released to the atmosphere. When engineered in conjunction with an upstream control valve, the entire system can be optimized to attenuate the noise in smaller, less expensive solutions. Flowserve engineers can provide an optimized solution when presented with both the control valve and silencer requirements. (See Figure 38.)

The MegaStream vent silencer is available in a variety of materials, and mounting configurations. The model number for MegaStream vent silencers is GDV.

MegaStream vent silencers are custom designed for maximum noise attenuation. Contact factory for dimensions.



Figure 38: MegaStream Vent Silencer

Valtek Severe Service Equipment MegaStream In-line Silencers

Introduction

For pipe noise applications beyond the range of MegaStream plates and diffusers, or control valve severe service trim, Flowserve provides an in-line silencer (Figure 36), which may be installed separately or in series with one of the other devices. The Valtek silencer consists of a series of tuned chambers and tubes filled with sound absorbing material (Figure 40), and is designed with staged pressure reduction.

As with MegaStream vent silencers, in-line silencers are also custom designed for maximum noise attenuation. Contact factory for dimensions.

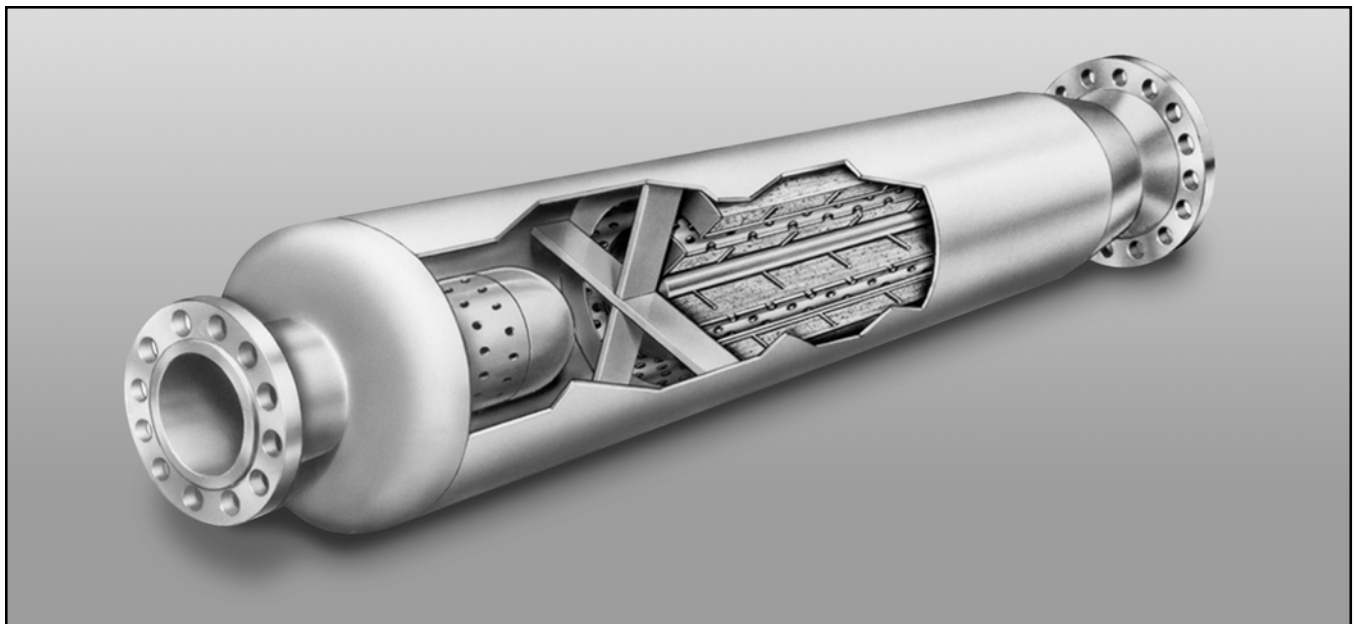


Figure 39: MegaStream In-line Silencer

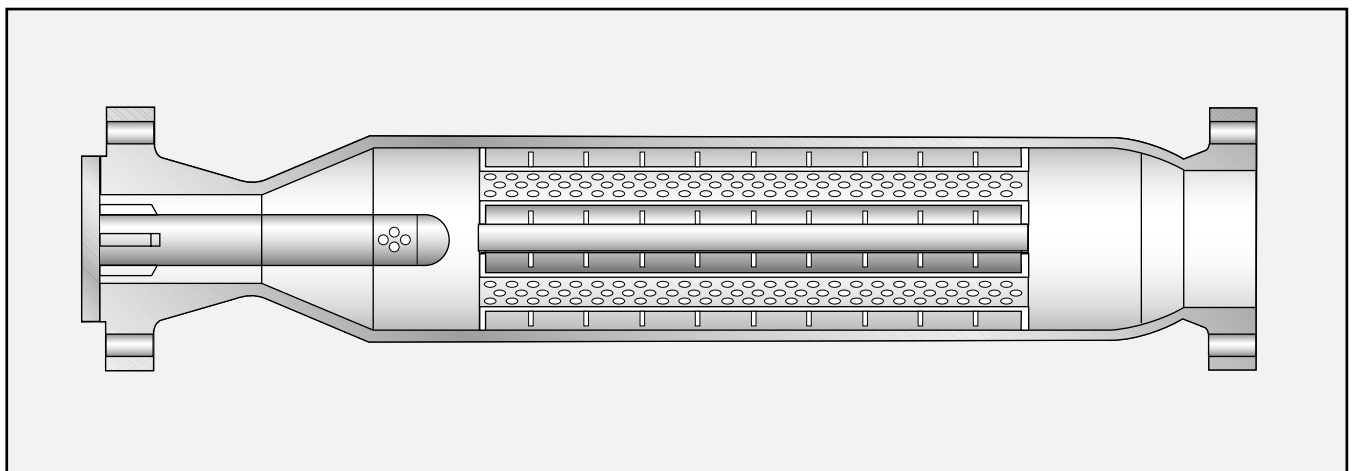


Figure 40: Construction of MegaStream In-line Silencer

Valtek Severe Service Equipment

Tiger-Tooth Vent Elements

Introduction

For extremely difficult venting applications, a Tiger-Tooth stack (Figure 41) can be installed downstream from a valve to provide excellent noise control. By the addition of more discs, the stack can be lengthened to

accommodate the flow and attenuation requirements. The stack is clamped in place by the housing and can be easily disassembled for routine maintenance. Tiger-Tooth stacks are available in sizes 1.5 through 42-inch.

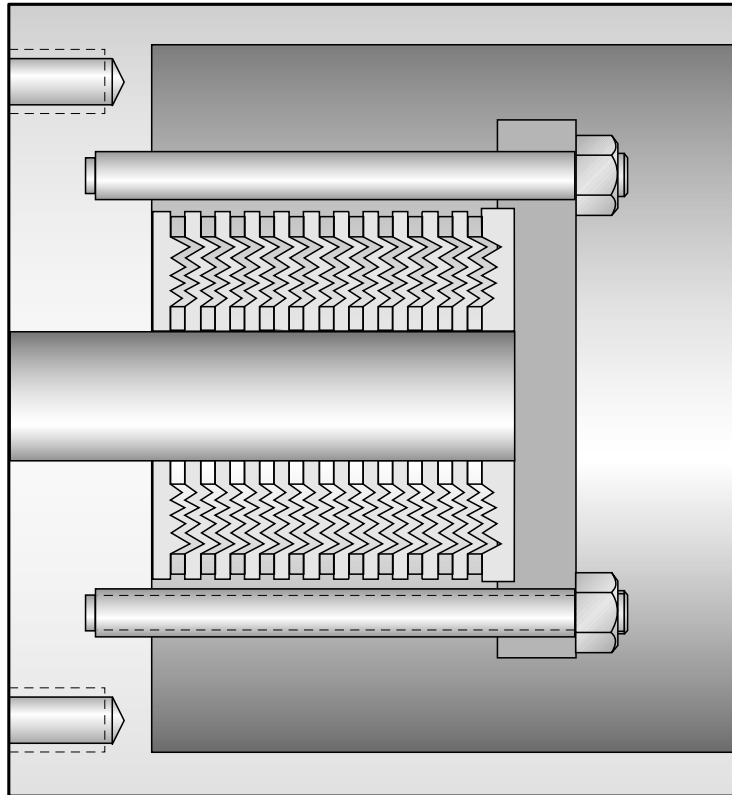


Figure 41: Tiger-Tooth Vent Element

Flowserve Corporation has established industry leadership in the design and manufacture of its products. When properly selected, this Flowserve product is designed to perform its intended function safely during its useful life. However, the purchaser or user of Flowserve products should be aware that Flowserve products might be used in numerous applications under a wide variety of industrial service conditions. Although Flowserve can (and often does) provide general guidelines, it cannot provide specific data and warnings for all possible applications. The purchaser/user must therefore assume the ultimate responsibility for the proper sizing and selection, installation, operation and maintenance of Flowserve products. The purchaser/user should read and understand the Installation Operation Maintenance (IOM) instructions included with the product, and train its employees and contractors in the safe use of Flowserve products in connection with the specific application.

While the information and specifications presented in this literature are believed to be accurate, they are supplied for informative purposes only and should not be considered certified or as a guarantee of satisfactory results by reliance thereon. Nothing contained herein is to be construed as a warranty or guarantee, express or implied, regarding any matter with respect to this product. Because Flowserve is continually improving and upgrading its product design, the specifications, dimensions and information contained herein are subject to change without notice. Should any question arise concerning these provisions, the purchaser/user should contact Flowserve Corporation at any of its worldwide operations or offices.

For more information, contact:

For more information about Flowserve, contact www.flowserve.com or call USA 972 443 6500

Regional Headquarters

1350 N. Mt. Springs Prkwy.
Springville, UT 84663
Phone 801 489 8611
Facsimile 801 489 3719

12 Tuas Avenue 20
Republic of Singapore 638824
Phone (65) 862 3332
Facsimile (65) 862 4940

12, av. du Québec, B.P. 645
91965, Courtaboeuf Cedex,
France
Phone (33 1) 60 92 32 51
Facsimile (33 1) 60 92 32 99

Quick Response Centers

5114 Railroad Street
Deer Park, TX 77536 USA
Phone 281 479 9500
Facsimile 281 479 8511

104 Chelsea Parkway
Boothwyn, PA 19061 USA
Phone 610 497 8600
Facsimile 610 497 6680

1300 Parkway View Drive
Pittsburgh, PA 15205 USA
Phone 412 787 8803
Facsimile 412 787 1944

Flowserve and Valtek are registered trademarks of Flowserve Corporation.

