



FLowsERVE

VALTEK
Severe Service Equipment

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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

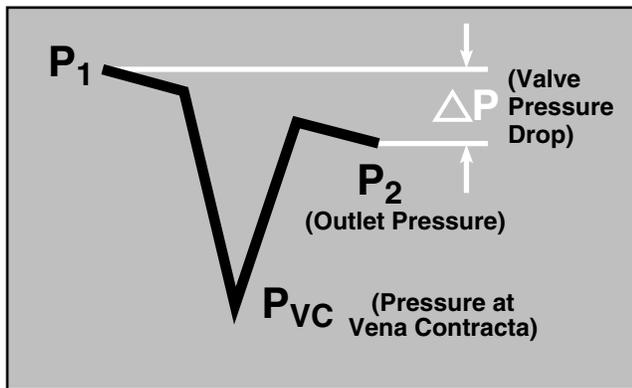


Figure 1: Pressure Profile (single-seated globe-style valve)

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.

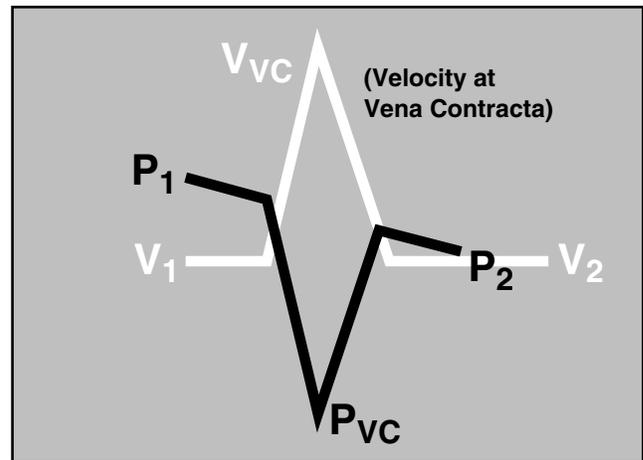


Figure 2: Pressure and Velocity Profiles (single-seated globe-style valve)

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-

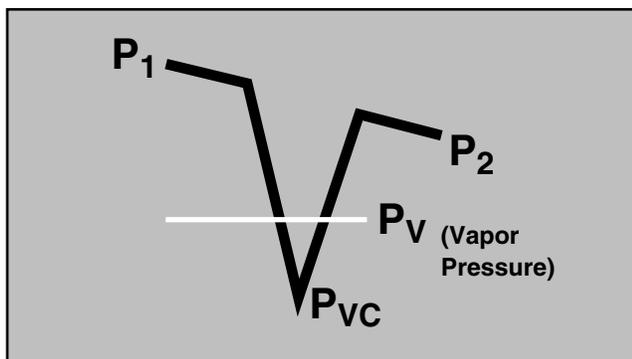


Figure 3: Pressure Profile for Cavitation

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 4: Damage to Trim Parts Caused by Cavitation

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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).

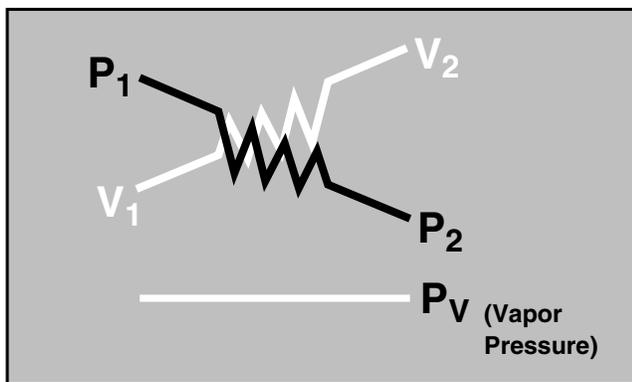


Figure 5: Pressure Profile for Gradual Pressure Reduction

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.

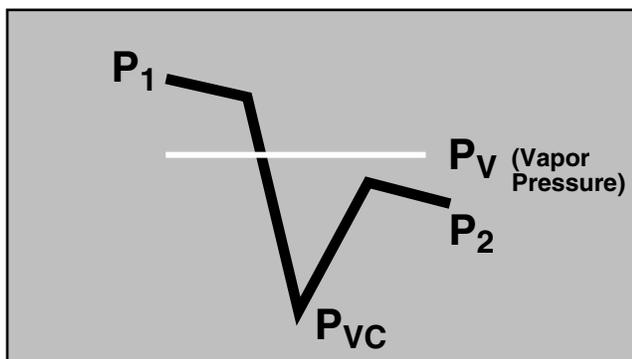


Figure 6: Pressure Profile for Flashing

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).

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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.

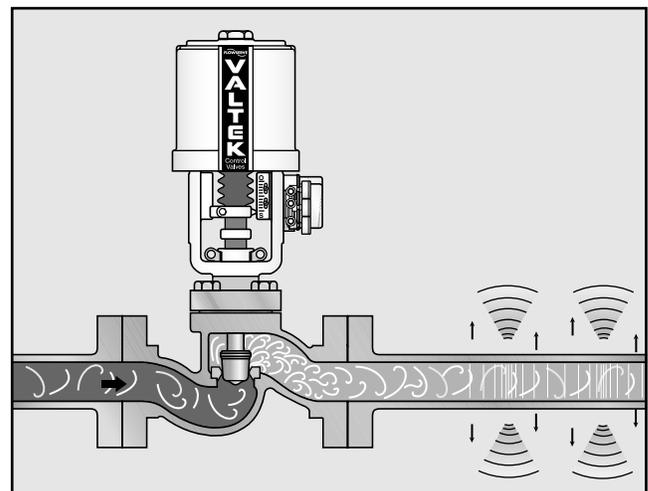


Figure 7: Downstream Turbulence Caused by Vena Contracta in a Valve

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

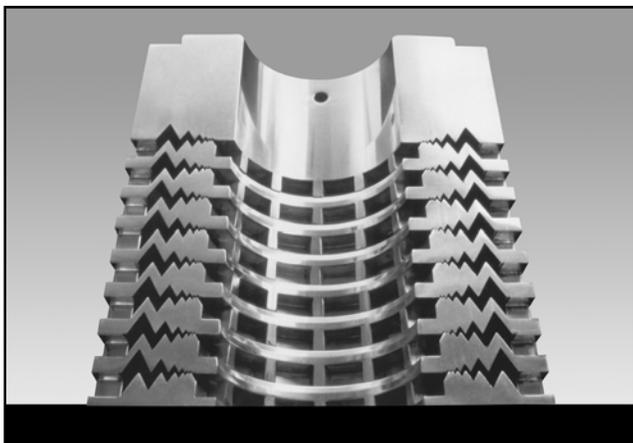


Figure 8: Tiger-Tooth Stack Featuring a Five-tooth Design

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.

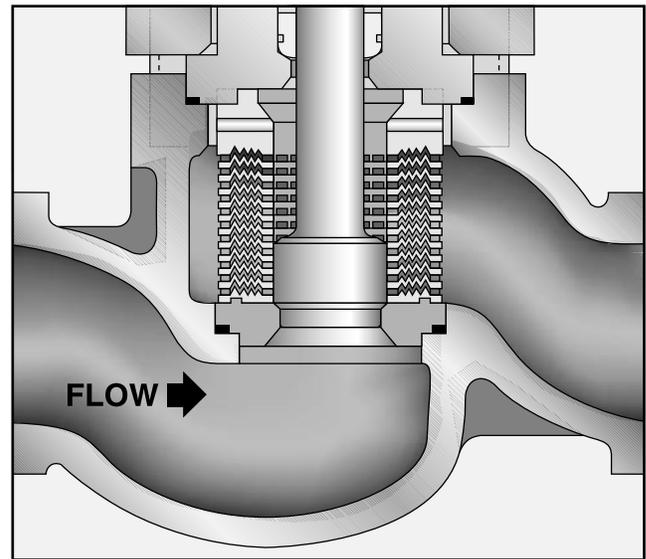


Figure 9: Unbalanced Tiger-Tooth Trim Design

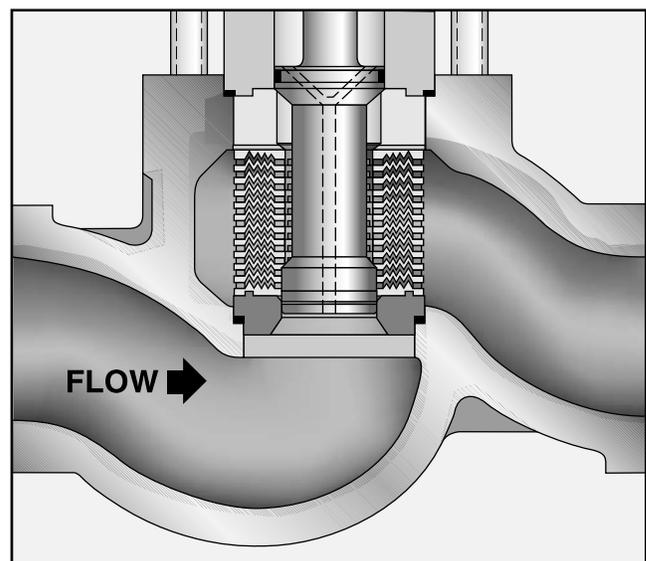


Figure 10: Pressure-balanced Tiger-Tooth Trim Design

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

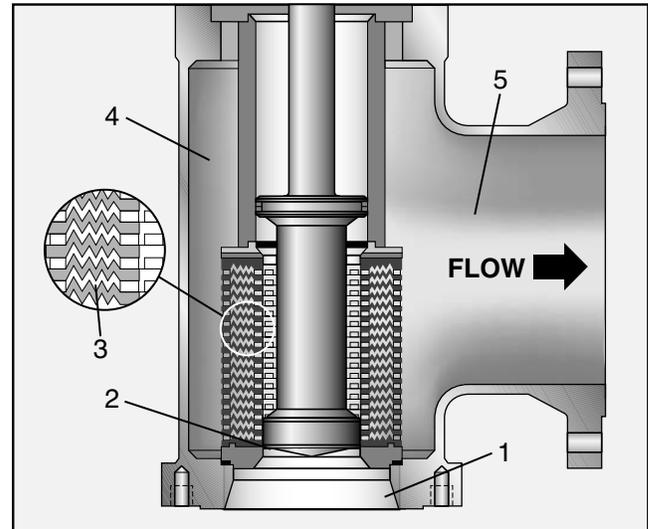


Figure 11: Tiger-Tooth Velocity Check Points

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.

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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 |

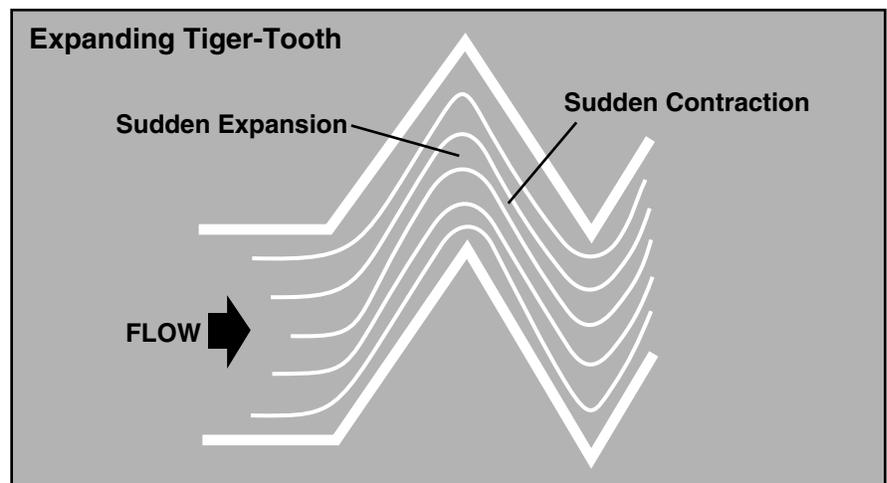


Figure 12: Sudden Expansion and Contraction Caused by Tiger-Tooth Design

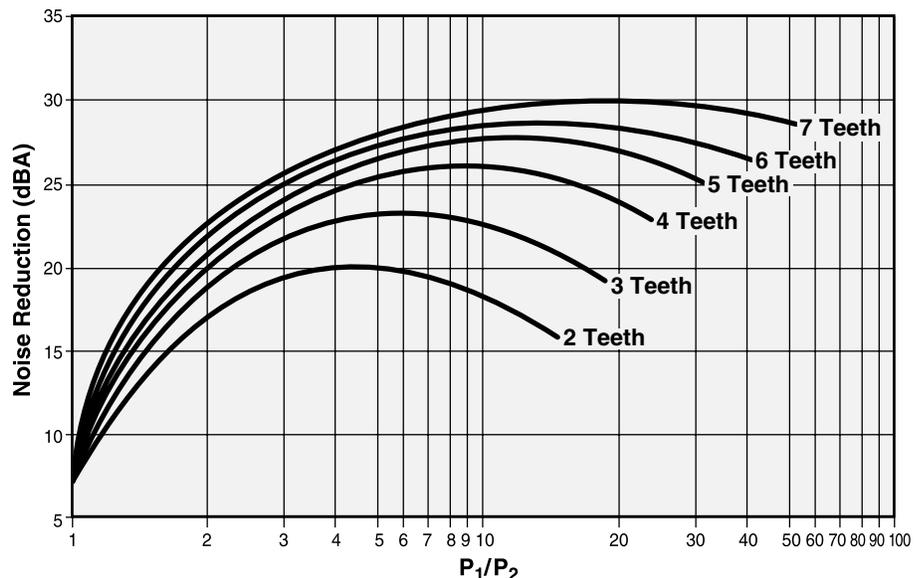


Figure 13: Noise Reduction vs. Number of Tiger-Tooth Teeth

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

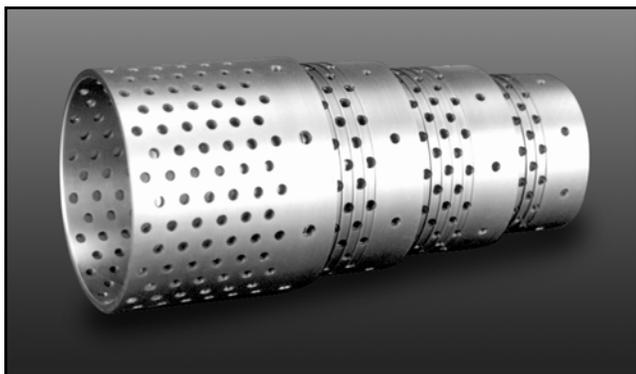


Figure 14: ChannelStream Cartridge (separated to show individual stages)

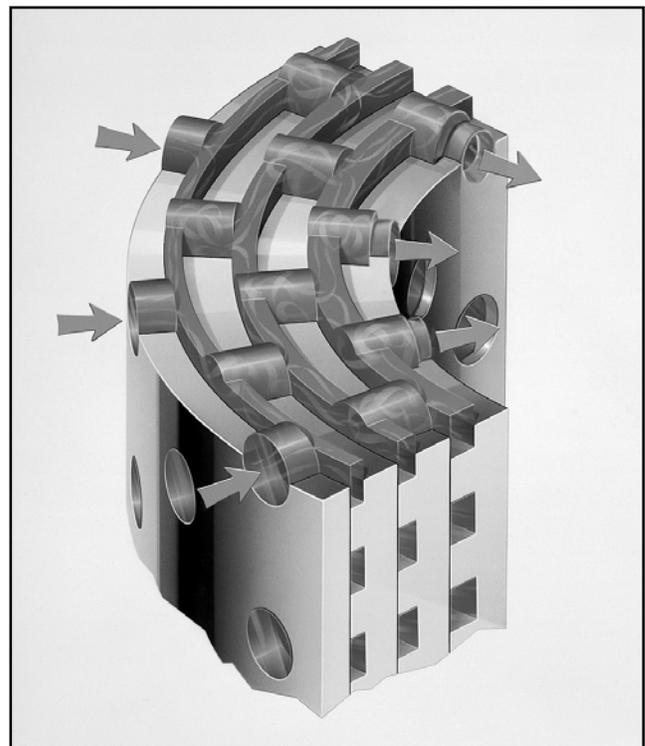
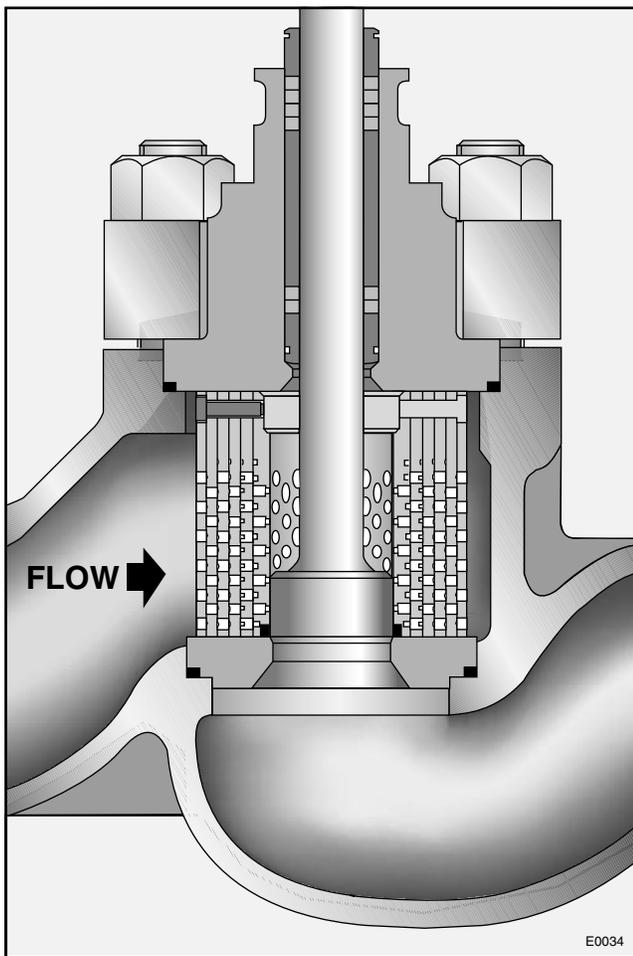


Figure 15: Flow Path Through ChannelStream Cartridge

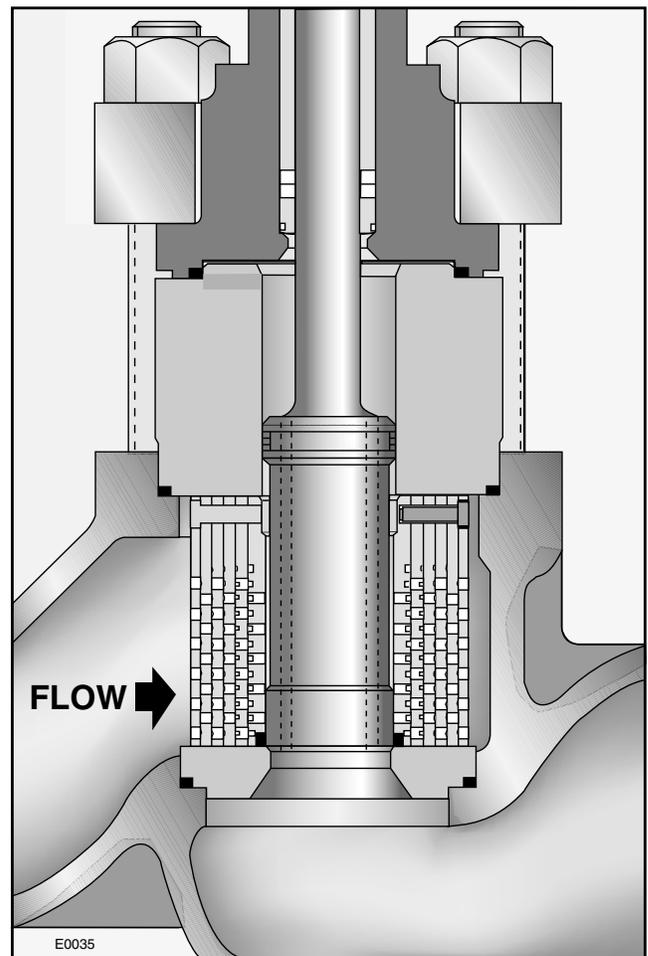
Valtek Severe Service Equipment ChannelStream Trim

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**

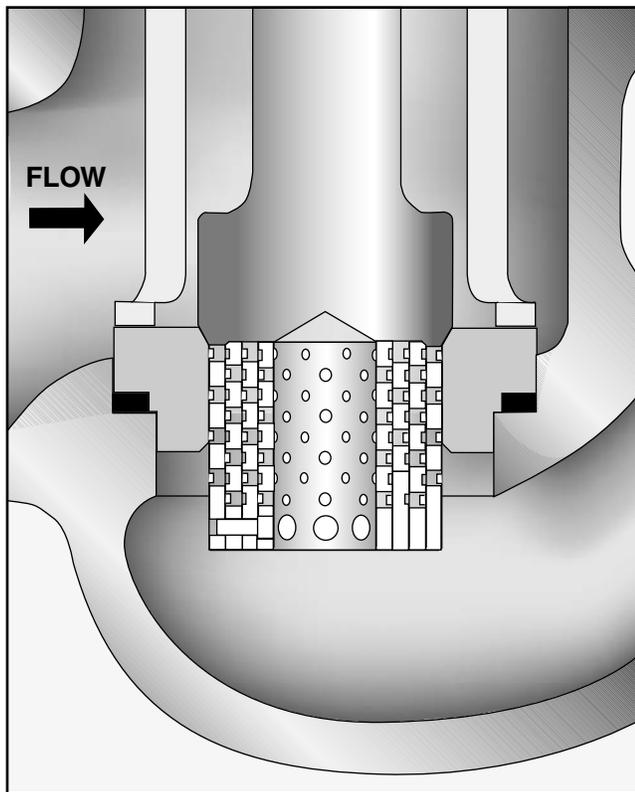
Valtek Severe Service Equipment ChannelStream Trim

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.

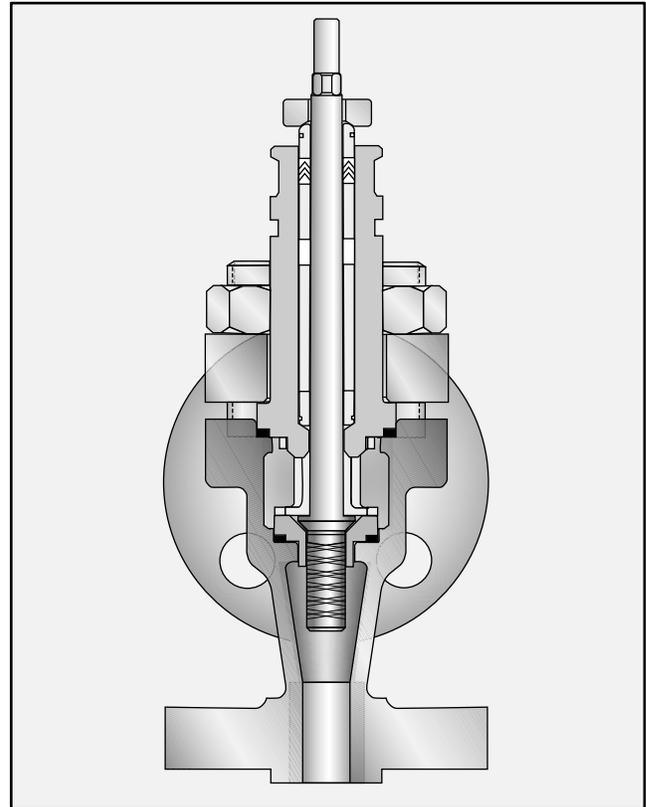


Figure 19: MicroCav Plug Uses Expanding Grooves to Control Cavitation



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.

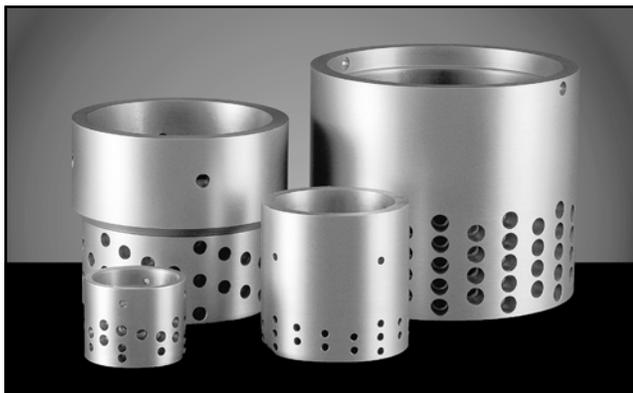


Figure 21: CavControl trim

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.

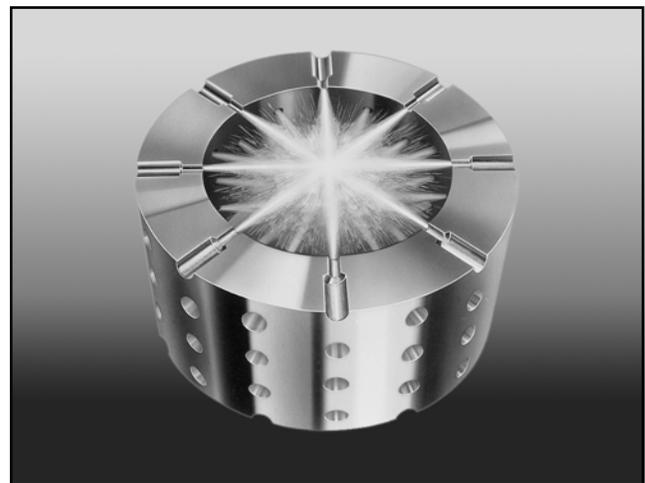


Figure 22: Impinging Flow Path of CavControl Trim

Valtek Severe Service Equipment

CavControl Trim

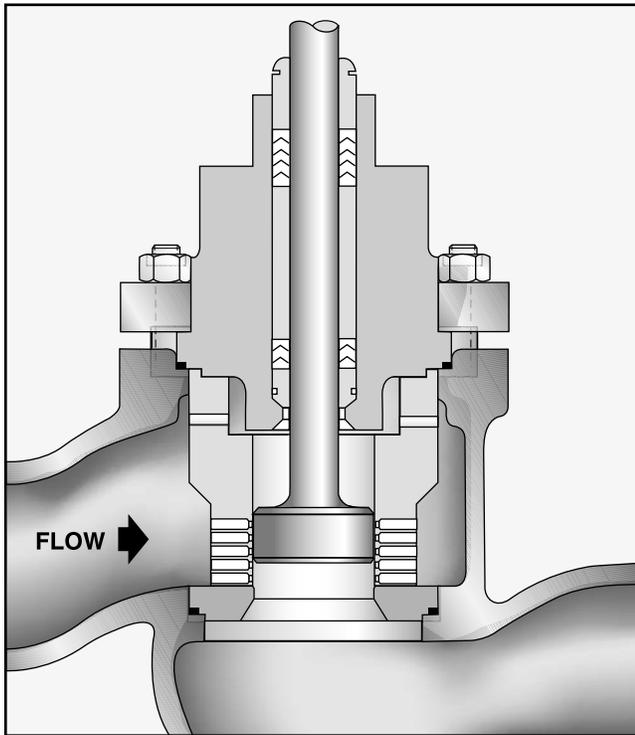


Figure 23: Unbalanced CavControl Trim

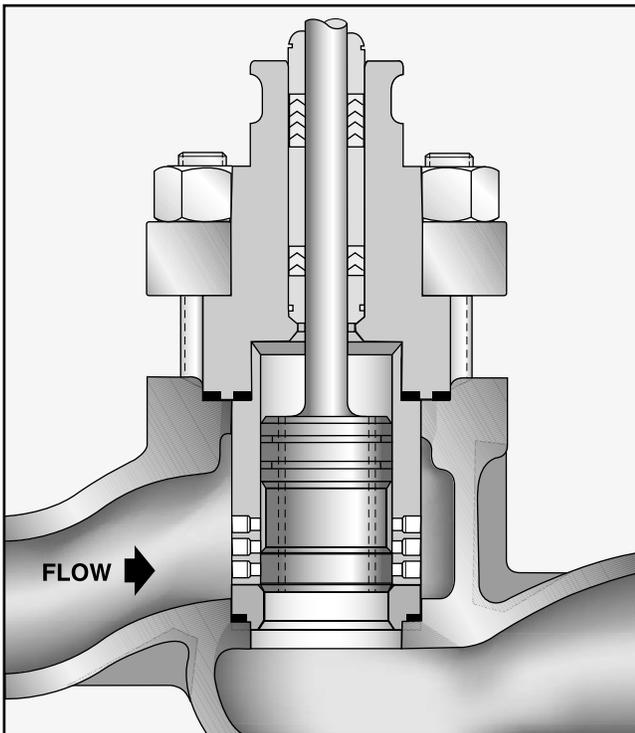


Figure 24: Pressure-balanced CavControl Trim

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 |
| | 3.75A | 2.50 | 165.0 | 140.0 | 165.0 | 140.0 |
| 4 | 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 |
| | 4.75A | 3.00 | 350.0 | 310.0 | 350.0 | 310.0 |
| 6 | 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 |
| | 6.50A | 4.0 | 600.0 | 500.0 | 600.0 | 500.0 |
| 8 | 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 |
| | 838.0A | 4.0 | 940.0 | 900.0 | 940.0 | 900.0 |
| 10 | 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 |
| | 975.0A | 4.0 | 1000.0 | 800.0 | 1000.0 | 800.0 |
| 12 | 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

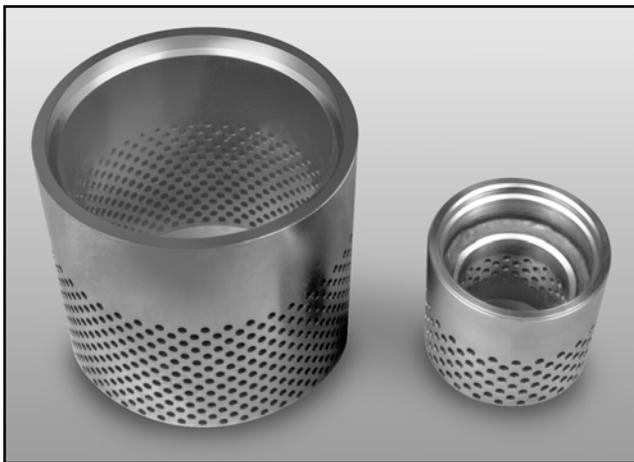


Figure 25: One and Two-stage MegaStream Attenuators

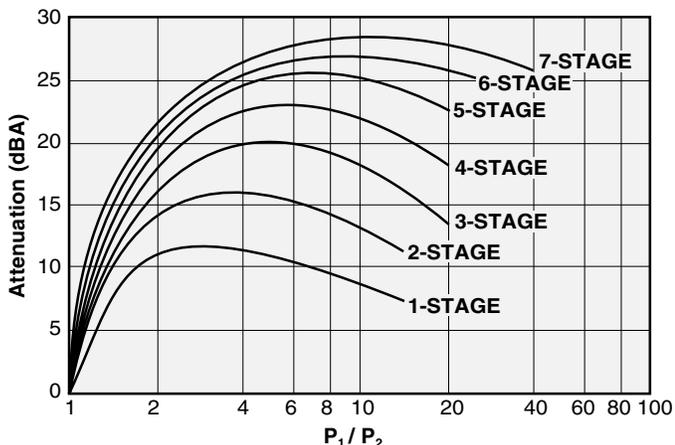


Figure 26: Noise Reduction Versus Number of MegaStream Stages

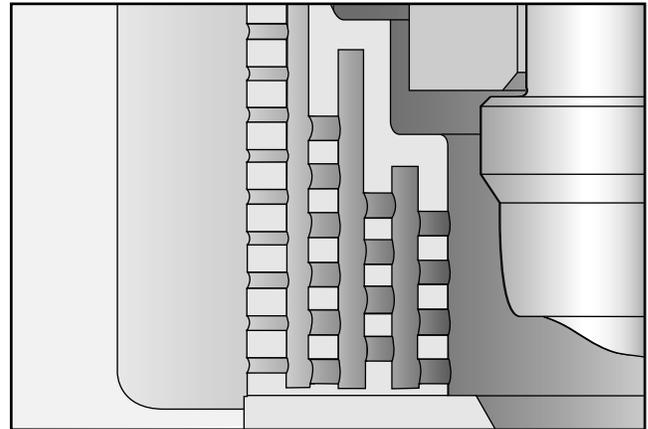


Figure 27: Staged Pressure Reduction Through MegaStream Attenuator

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.

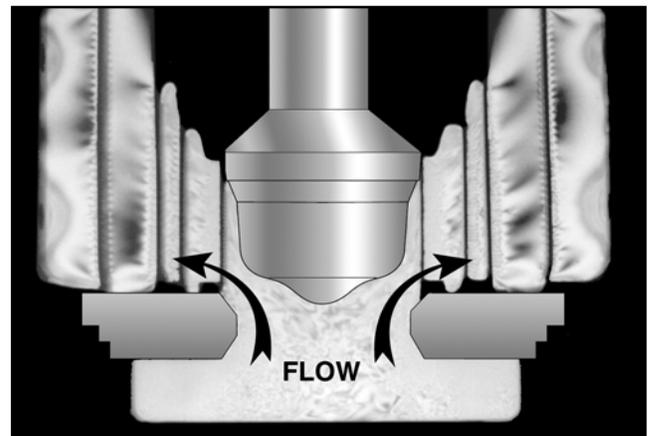


Figure 28: MegaStream Trim Restructuring of Noise Generating Turbulence

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).

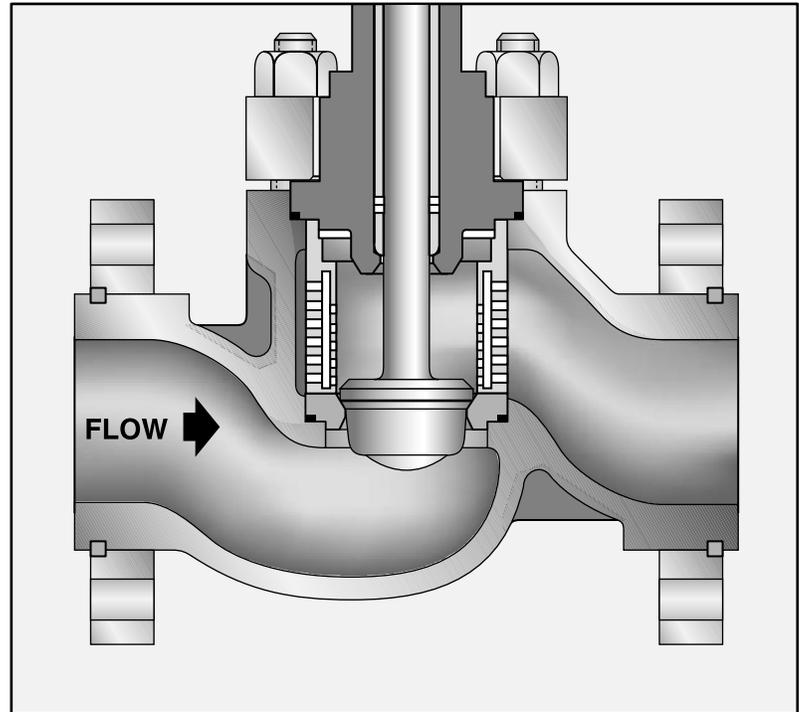


Figure 30: Unbalanced MegaStream Trim



Figure 29: Two-stage MegaStream Attenuator

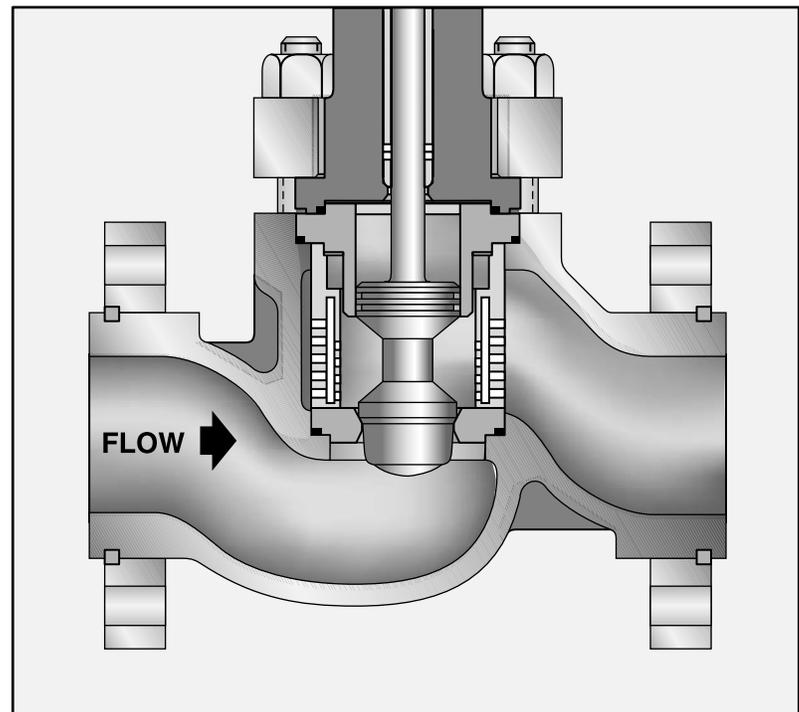


Figure 31: Pressure-balanced MegaStream Trim

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.

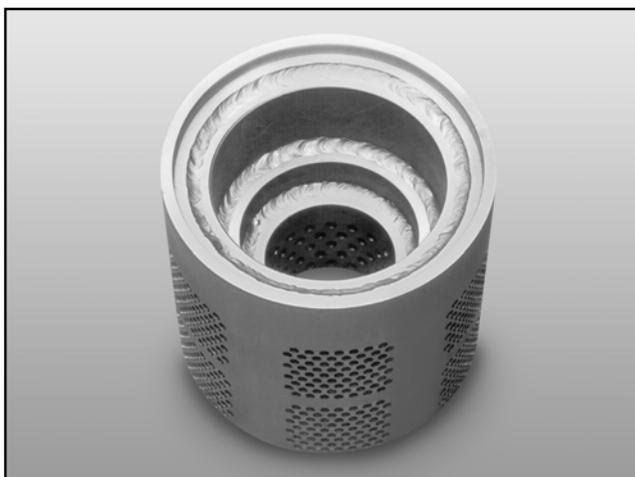


Figure 32: Four-stage MegaStream Attenuator

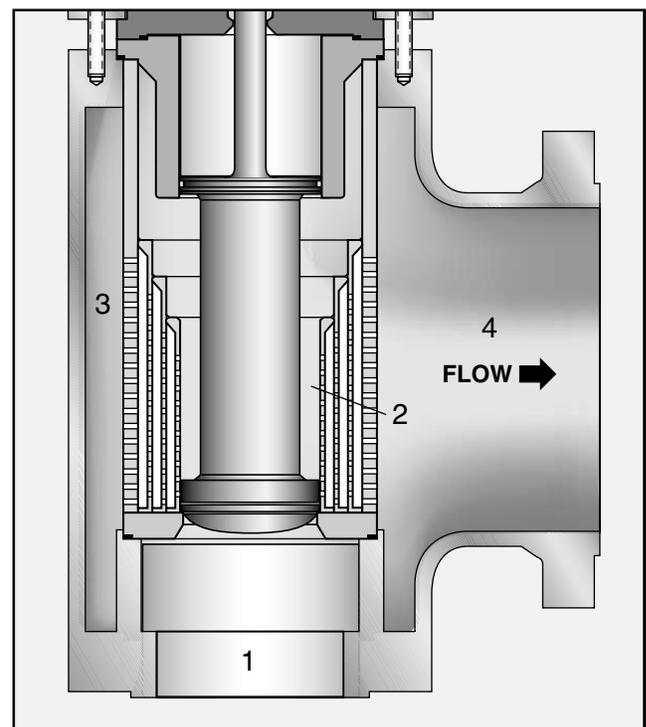


Figure 33: MegaStream Velocity Checkpoints

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 | 490 | 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 |
| | 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 |
| | 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.

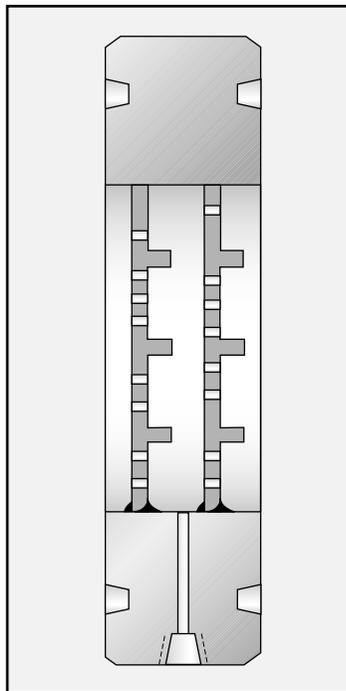


Figure 35: Two-stage MegaStream Plate (with drain)

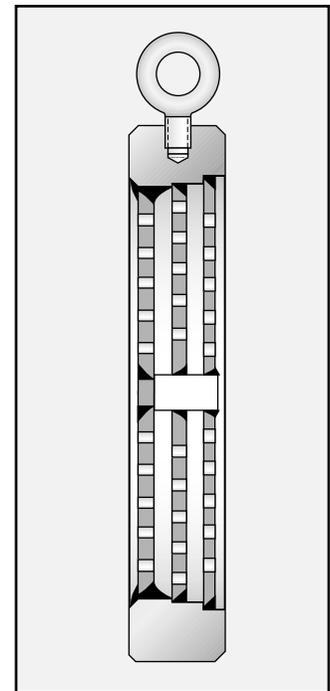


Figure 36: Three-stage MegaStream Plate (with lifting ring)

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

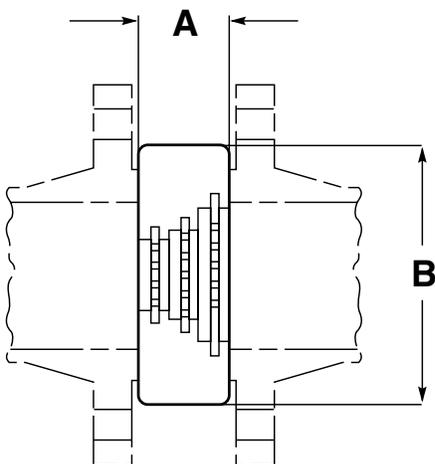


Table 15: MegaStream Plate Dimensions (inches / mm)

| 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:

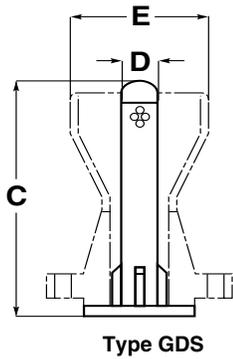
- GDS: Flowserve's standard model with installation between the raised face flanges of the valve and line
- GDI: Similar to GDS with welded in-line installation or to mating flanges; outlet is enlarged to eliminate a reducer.



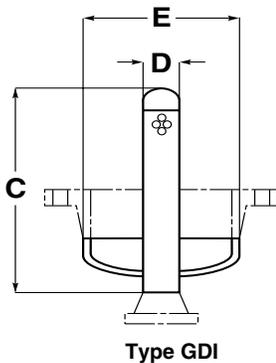
Figure 37: GDS MegaStream Diffuser

Valtek Severe Service Equipment

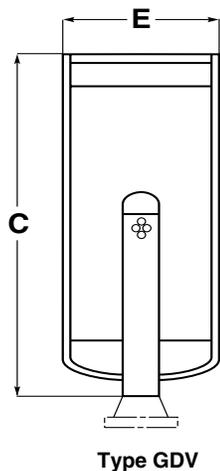
MegaStream Diffusers

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.

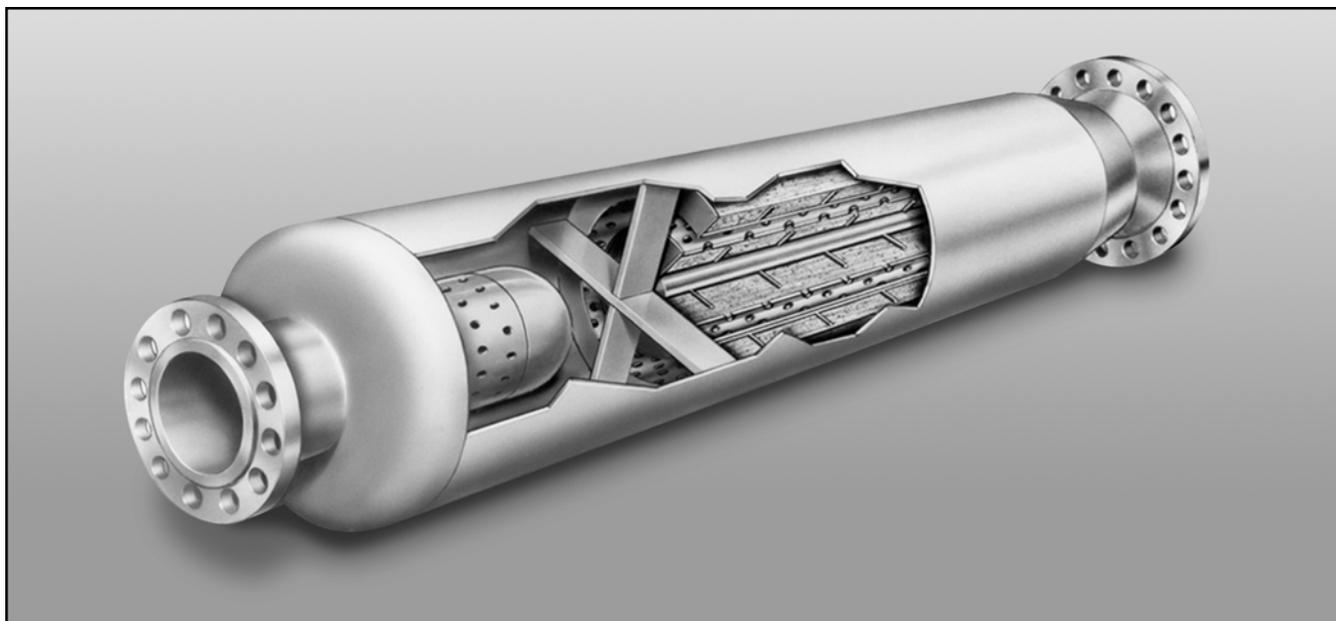


Figure 39: MegaStream In-line Silencer

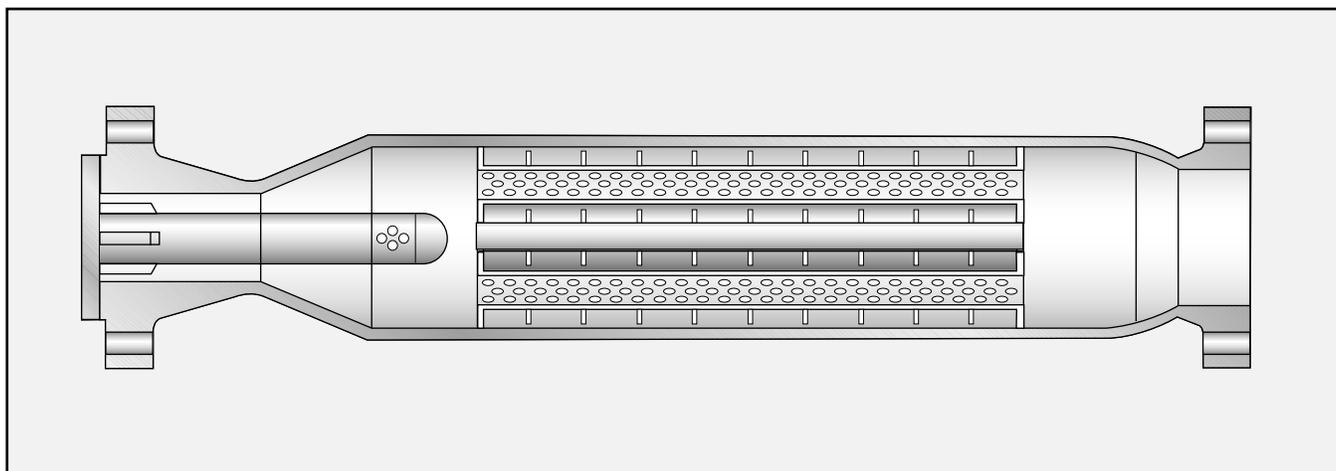


Figure 40: Construction of MegaStream In-line Silencer

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.

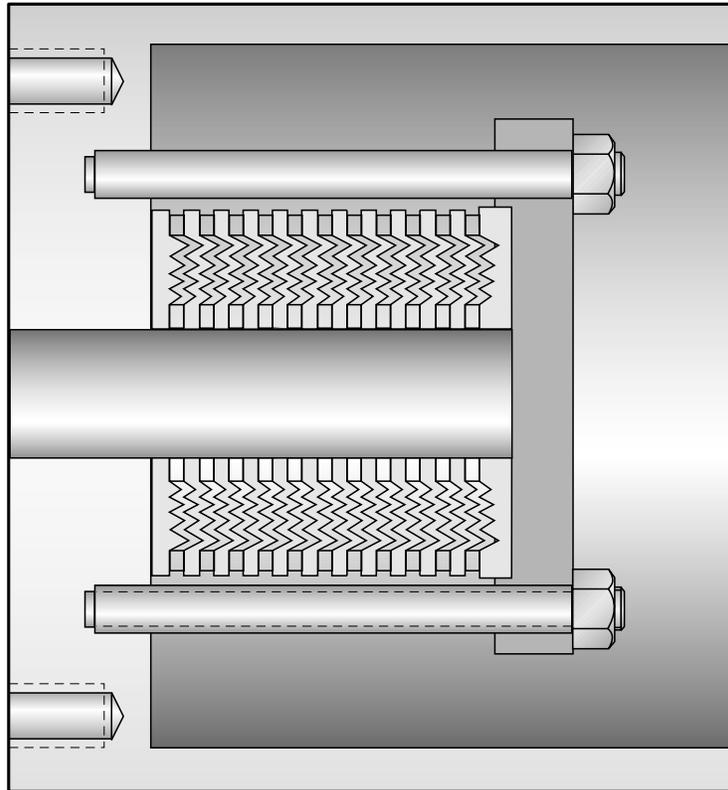


Figure 41: Tiger-Tooth Vent Element

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.

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