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TECHNICAL BULLETIN

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Subject: **Valve Selection**

INTRODUCTION

The control valve selection process is an extremely complicated subject covering many areas and disciplines. Incorrect selection can result in excessive wear and unacceptable failure of the valve.

Generally, control valve selection is undertaken on the basis of the type of fluid being handled, i.e. Liquids or Gas/Vapour. Other fluid types including multi-phase, require special considerations. Each fluid type has its own characteristics, and can effect the valve in different ways.

Further reference should also be made to the valve sizing section of this manual.

VALVES ON LIQUID SERVICE

This section of the manual deals with the selection of Control Valves that are to be used on incompressible, or liquid flow applications. The main concerns when specifying valves for this type of duty are to ensure that the selected design does not suffer erosion, or induce plug instability and generate high noise.

The main causes of erosion are excessive velocity, and the pressure related phenomena's of cavitating and flashing flow. The manual describes how to identify them and determine if they are likely to be an issue, and also how to mitigate their potential effects on the valve.

Excessive velocity, incorrect flow direction, or high energy levels in the valve can cause plug instability.

High noise levels can be generated by cavitating flows. Flashing flows and high energy conversion and also induce some increases in the noise level in the valve.

Having selected the required trim design for the application, it is important to select the correct materials to ensure smooth operation and long term wear characteristics. The manual makes recommendations in this respect dependant on the process conditions, and the leakage class of the valve.

Flow Direction

The flow direction through the valve will generally be dictated by the plug and trim design. When considering modulating applications, the following rules should be applied.

1. Unbalanced Plugs should be flowed “under” to avoid the instability phenomena known as “bathplugging”. This occurs when the plug is close to the seat, and is caused by the combination of the downward acting, out of balance force, on the plug and the dynamic effects created by the flow as it passes between the plug and seat. It results in the plug being “sucked” back onto the seat, which then

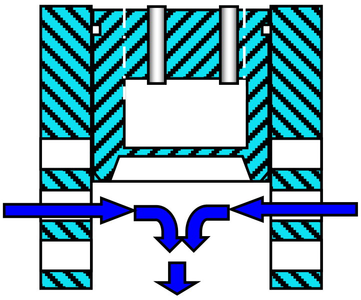
initiates a cyclic oscillation. It can be demonstrated by holding a bath plug just above the outlet when draining a bath, hence the expression. It is easy to envisage the problems it can create when considering the pressures involved in valve applications.

Unbalanced "multiflow" trims have restricted pressure drop limits when flowed "under" in order to prevent the potential erosion due to the impingement of the fluid jets on the body wall.

"Spline" trims are the only exception to this rule, and are inherently flow "over" by design. "Bathplugging" is prevented by ensuring that the trim as an upward acting or have a negligible out of balance area.

2. Single stage balanced plug designs should be flowed "over" to prevent fluid jets damaging the body wall. By flowing the valve in this way, the fluid jets impinge on one another, dissipating energy on themselves, within the trim in an area where erosion resistant materials are being used.

Fig T.1 Flow Impingement



3. Multistage balanced trims may be flowed in either direction depending on the application. For potentially cavitating applications it is an advantage to flow "under" due to the pressure drop distribution through the trim. On high pressure drop applications where cavitation is not an issue, it is better to flow "over", for the same reason. Actual pressure drop limits are given in the data section.

For ON/OFF applications instability is not an issue. Providing that the pressure drop limits are satisfied, the flow direction should be selected so that the out of balance forces assist the valve to achieve its required failure position.

Body Velocity

Excessive body velocity can lead to erosion of the body wall, and to potential mechanical instability of the valve trim. The recommended velocity limits that have been assigned to the Control Valve range consider three aspects in this respect:

- Valve Size
- Valve Body Material
- Trim guiding type.

The recommended velocity limit reduces, as the valve size increases, based on the assumption that generally the bulk flow rate is increasing accordingly.

The erosion resistance of the body material is based on the mechanical properties of the material in terms of toughness and hardness. The standard range of body materials have been split into three groups rated as having low, medium and high erosion resistance. Their recommended acceptable body velocity limits are shown in **Liquid Velocity - Tables LV.1,2,3 & 4.**

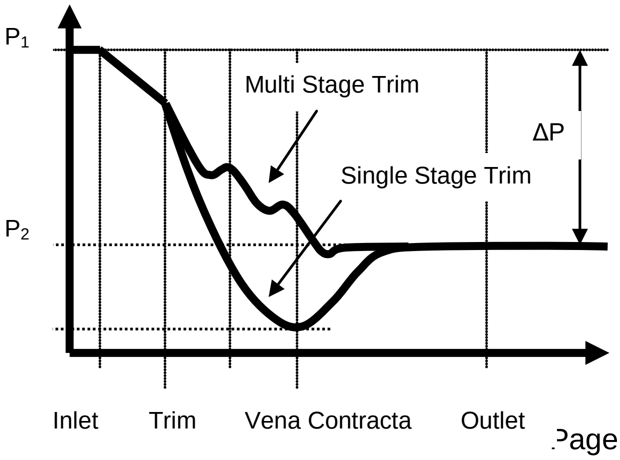
Cage guiding is universally accepted as being the most positive form of plug guiding. As a consequence it is permitted higher velocity limits than seat guided or top and bottom guided designs.

Pressure drop limitations

Trim design and material choice govern pressure drop limits. Exceeding the recommended values increases the potential for erosion due to high velocity levels within the trim. In extreme cases, plug instability can be generated as a result of the amount of energy that is being converted by the valve.

Multistage trims are used on high pressure drop applications, to break down the pressure drop in discreet stages. Reducing the pressure drop in stages reduces velocity levels within the trim, and as a result reduces the potential for erosion.

Fig T.2 Multi Stage Pressure Reduction



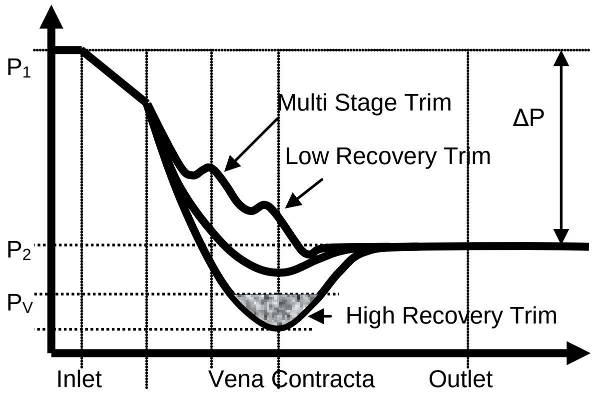
The erosion resistance of the trim material, and the use of heat treatment or hard facing, increases the maximum pressure drop for which a trim design can be used.

In **Liquid Sizing - Tables L.6 and L.7** details of the maximum allowable pressure drops for the various trim designs, and their material combinations are stated.

Cavitation

This is a process whereby the fluid undergoes two changes in state. As the liquid passes through the control valve trim there is an increase in velocity which as shown in Figure T.3 results in a decrease in static pressure.

Fig T.3 Cavitation Formation



If this pressure falls below the vapour pressure of the liquid, vapour bubbles are formed. After the vena contracta the pressure increases back above the vapour pressure (P_V), and the vapour bubbles implode, resulting in the phenomena known as cavitation.

The onset of cavitation effects the valve in three ways:-

1. The flow at the valve trim becomes choked.

2. Valve generated noise increases. Incipient cavitation can sound like someone throwing gravel in the downstream pipe. Fully developed cavitation can be a high pitched scream resulting in mechanical vibration of the valve plug.

3. Trim erosion. When the vapour bubbles implode, material is literally plucked from the adjacent trim surfaces, resulting in erosion that has a rough, pitted appearance.

Cavitation can be eliminated by the use low recovery trims, such as a cage trim valve, or by using multistage trims.

Contour trims such as the BV802 valve trims are high recovery style trim where there is a high degree of pressure recovery after the vena contracta. Fitting a low recovery trim such as a cage guided valve could mean that the static pressure never falls below the vapour pressure.

In a multi stage trim the pressure drop is broken down in stages and therefore the formation of vapour bubbles can be prevented, because the pressure within the trim never falls below the vapour pressure. This principle is detailed in Figure T.3. Since it is the final stage of the trim that is most likely to cavitate, the percentage drop taken per stage reduces on successive stages.

Ideally, cavitation should always be eliminated by multistaging. However, doing so can significantly increase the cost of the valve, and can also increase the size of valve that is required. To minimise these effects consider the following:

1. Dependent upon operating duration, incipient cavitation can be addressed by the selection of erosion resistant materials. In **Liquid Sizing - Table L.3** indicates acceptable levels of incipient cavitation for various trim materials.

2. On many liquid applications, the pressure drop decreases as the flow increases. Therefore, a multistage trim may only be required for the first part of the valve stroke. In these cases it may be possible to use a "varitrim" cage assembly to eliminate cavitation without increasing valve size.

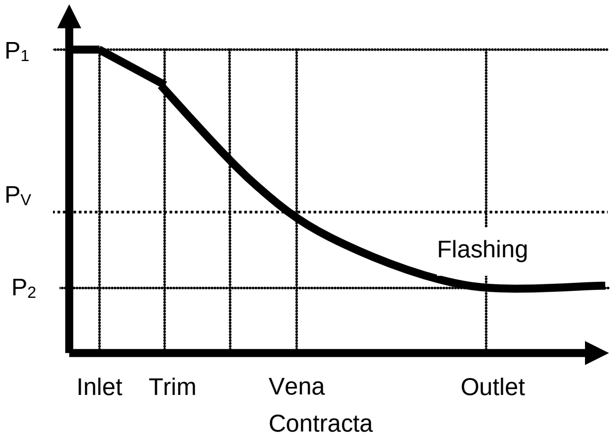
3. For ON/OFF duties, or applications were the turndown requirement is limited, a fixed area outlet baffle or seat exit diffuser can be considered in place of increasing the valve size to accommodate a multistage trim.

Note: baffle plates are sometimes used as a means of increasing the backpressure in a valve to ensure that the static pressure does not fall below the vapour pressure. It should be noted that baffle plates are a fixed orifice device and are therefore only suitable for one pressure condition. On valves with a high rangeability then they are in-effective at low flows.

Flashing

This process is a similar phenomena to cavitation whereby the vapour bubbles are formed as the static pressure within the valve reduces below the vapour pressure. If the pressure remains below the vapour pressure as shown in Figure T.4, this phenomena is known as flashing and the fluid passes into the downstream pipework as a two phase mixture.

Fig T.4 Flashing Flow



The onset of cavitation effects the valve in three ways:-

1. The flow across the valve trim is choked.
2. The velocity at the valve outlet increases due to two phase flow.
3. Valve trim and body erosion can occur due to the impingement of droplets in the liquid phase on the valve materials. Liquid droplets carried at high velocity in the vapour phase of the fluid scour the surface of the material leaving erosive wear patterns that are smooth in appearance.

Unlike cavitation, flashing can not be eliminated. It is a function of the operating conditions, and valve design and materials of construction must be carefully selected to counteract its potentially erosive effects. The following guidelines should be applied:

1. The valve flow direction should always be over the plug.
2. If possible use line size valves to minimise the valve outlet velocity.
3. Use Angle bodied valves whenever possible to avoid flow impingement on the valve body.
4. When Globe Valve bodies are used, specify a body protection unit (seat diffuser) when the closed valve differential pressure exceeds 50 bar. The Cv of the body protection unit should be 3 to 4 times the maximum calculated Cv of the application. For spline trims on flashing applications, offer a body protection unit irrespective of the pressure drop.
5. For power plant applications, consider the use of Chrome Moly Alloy steel bodies to increase the erosion resistance of the body material.
6. The type of trim selected will depend on the pressure drop and the amount of flashing. For operating pressure drops up to 50

bar single stage trims will be used, and the level of hardfacing will be determine by the “flash index” (vapour pressure – outlet pressure).

7. For pressure drops above 50 bar it may be possible to use multistage trims. However, to avoid inter-stage erosion, flashing must be confined to the final stage of the valve trim. In **Liquid Sizing - Table L.8** gives details of the percentage pressure drop that is taken across the final stage of the valve trim, and should be used to determine if a cascade trim is suitable for the application. In **Liquid Sizing - Table L.4** gives material selection criteria for single stage trim applications with operating pressure drops in excess of 50 bar.

8. Solid ceramic and tungsten carbide trim options should not be used for operating temperatures above 150^0C, due to potential thermal shock problems. For temperatures above this, use spray deposited tungsten carbide applied to fully stellited (Gr 6) plug and seat.

9. Where valves on flashing applications are closed for long periods of time, protected seat faces should be offered, with class V leakage. Spline trims are not suitable for protected seat faces.

As with cavitation, flashing is required to be considered in the sizing of a control valve and the process can lead to significant erosion damage to valve internals. In order to eliminate or reduce the damage resulting from a valve operating on a flashing application use is again made of low pressure recovery trim designs. In addition the use of advanced materials of construction such as Tungsten Carbide reduces potential erosion, particularly on fluids which have significant amounts of contaminants present.

VALVES ON GAS/VAPOUR SERVICE

This section of the manual deals with the selection of valves that are to be used on compressible fluids, ie, gases and vapours. The main concerns when specifying valves for these duties are noise and potential instability on high pressure drop applications, where high levels of energy are being converted at the valve trim.

Generally speaking erosion due to fluid jet impingement will not occur on clean, dry gas applications, and providing valve generated noise is not an issue, trim designs will tolerate higher pressure drops than when being used on liquid applications. Care must be taken when selecting materials for valves being used on wet, contaminated gas or saturated steam applications, as erosion can become an issue if it is not accounted for. The manual provides guidelines in this respect.

On compressible applications, the gas undergoes physical changes when its pressure is reduced at the valve. Its temperature reduces, and its specific volume increases. The change in specific volume causes an increase in velocity. On high pressure drop applications, the velocity at the outlet of the valve can be much higher than that at the inlet, and can create aerodynamic noise if not addressed. The manual identifies acceptable levels of outlet velocity and provides guidelines on how to reduce velocity levels.

Temperature loss does not normally create a selection issue. However, two points are worthy of note. On high pressure drop applications with relatively low inlet temperatures, the temperature loss can affect the selection of both the valve body and trim material grades. On applications where the gas is not totally dry, the temperature loss can cause “icing” which in extreme cases can lead to plug sticktion and trim blockage on cage guided valves with small holes. In many cases, the customer will not provide the outlet temperature. A simple method of determining it is to assume that the gas’s enthalpy remains constant. The outlet temperature can then be calculated using thermodynamic property data from chemical engineering data books or the internet.

As with liquid duties, certain gas applications in both the power and oil and gas industries, have their own unique requirements. The manual identifies these, and provides selection guidelines.

Valve Flow Direction

The flow direction through the valve will generally be dictated by the plug and trim design. The following are the standard for modulating duties:

- Spline design – Flow over
- Contoured design – Flow under
- Multiflow design – Flow over
- Cascade design – Flow Under

For ON/OFF applications, the single stage trims may be flowed in either direction as required to assist the failure mode, providing that the gas is dry and not contaminated.

Valve Body Velocity

On compressible applications, excessive velocity can cause mechanical instability, and excessive noise.

The velocity at the outlet of the valve will be higher than at the inlet, due to the increase in the specific volume given by the change in pressure and temperature of the gas. As a result, both inlet and outlet velocities need to be considered when the valve is sized.

As with liquid applications, recommended velocity levels reduce with increasing valve size, and cage guided designs are permitted higher velocity levels than their top and bottom guided equivalents.

Outlet velocity is particularly important when considering noise, and it is widely accepted that valve outlet and downstream piping velocity should not exceed 0.3 sonic if a noise limit of 85 dBA is to be achieved. As the downstream velocity increases so does aerodynamic pipe noise, and with it the risk that the aerodynamic noise will dominate the noise level generated by the valve. On intermittent duties higher noise levels may

be acceptable, and in this case higher outlet mach numbers are permissible.
The valve sizing programme will calculate outlet mach numbers that exceed sonic (mach 1.0). In reality, the velocity can not exceed mach 1.0 and the pressure at the outlet of the valve, and in the downstream piping, will increase to a level that corresponds to velocity of mach 1.0.

In **Gas Velocity Calculations – Table GV.2** give details of the maximum allowable velocity for valves on gas/vapour service.

Pressure drop limitations

Providing that the gas is dry and clean, there is little threat of erosion damage and allowable pressure drops are much higher than on liquid applications. In **Gas Sizing - Table G.2 and G.3** details the maximum recommended pressure drops for such duties. In reality, the maximum pressure drop will often be limited by the need to use multistage letdown to provide noise attenuation or control energy conversion levels.

Noise attenuation

Noise attenuation is given by using multistage trims. The predicted noise levels assume that the downstream piping is not insulated. Additional noise attenuation can be given by insulating the piping, the extent being governed by the density and thickness of the material being used. In **Gas Noise Prediction - Figure GN.4** gives details of insulation requirements. In order to ensure the mechanical integrity of the valve, the uninsulated noise level should not exceed 95 dBA.

On occasions, noise data sheets are required which show the expected noise spectrum of a valve. In **Gas Noise Prediction - Tables GN.5 and GN.6** provide the necessary information to be able to complete these sheets.

Energy Levels

The amount of energy being dissipated by the valve trim is a function of the flow through it, and the pressure drop across it. Excessive energy conversion at the valve can result in mechanical vibration of the valve plug.

The amount of energy that a valve is capable of converting will depend on the size and style of the body, and the guiding type and number of stages of letdown in the valve trim.

High Temperature (>550^{0}C)

The most important aspect of high temperature applications is material selection. In addition to being compatible with the line fluid, wear, strength and differential thermal expansion properties must be carefully considered.

1. *Differential Thermal Expansion*

   It is important to ensure that the materials used have coefficients of thermal expansion that are as close together as possible. This will minimise the required clearance between the plug and cage, which will reduce the potential for mechanical vibration.

The body and cage should also have similar coefficients of thermal expansion to reduce the constraining effect that the body has on the expansion of the cage. Because the cage is not free to expand over its upper portion, the bore could become tapered at high temperature leading to sticktion.

2. *Valve Stem*

   The use of 316 St. St. stems should be avoided on high temperature service. Its yield strength reduces at high temperature, and it also has a high coefficient of thermal expansion. This can lead to a tapering of the stem due to the temperature gradient along its length, resulting in stem packing leakage. This can then cause valve sticktion when the packing gland is over tightened to compensate for it.

   Whilst some austenitic stainless steels such as 660 have good creep resistance, they also have high coefficients of thermal expansion, and their use on this type of application should be avoided. Inconel should be the preferred choice.

3. *Stem Packings*

   The use of a graphite based packing can not be avoided, but to reduce friction.

MATERIAL SELECTION

Trim material selection will often be specified by the customer. When this is the case, the choice must be reviewed, and if necessary alternatives proposed in line with our recommended application guidelines.

When selecting trim materials, the following must be considered:

- Corrosion Resistance
- Erosion Resistance
- Galling Resistance
- Temperature Suitability

Corrosion Resistance

Generally speaking, the customer will have specified the required base materials for the body and trim based on his knowledge of the process fluid. Where materials have not been specified, refer to the company’s own corrosion charts.

Erosion Resistance

This is particularly important on high duty liquid applications, or on wet or contaminated gas applications. Where the chosen base material does not have sufficient erosion resistance, hard facings must be applied. The rules for applying hard facing are given in the relevant data tables in Liquid and Gas Sizing.

Galling Resistance

In order to ensure the valve operates smoothly, without mechanical pick up, it is preferable to have both a differential material and differential hardness between the plug and guide. Table T.2 gives details of acceptable plug and guide material combinations, along with application guidelines. Good galling resistance is particularly important on the following applications:

- *Dry gas duties* – where the line fluid offers no lubrication. It is not acceptable to run like materials against one another on gas applications. Where this is unavoidable, refer to the rules defined in Table T.3.

- *High pressure applications* – where the dynamic side load on the guiding surfaces is increased. For these applications a combination of through hardening and/or full hard facing should be specified.

- *Fast stoking valves* – valves above 150mm with specified operating times of under 5 seconds, should be offered with through hardening and/or full hard facing on the plug and cage as appropriate to the application.

Temperature Suitability

The temperature limits for the standard trim materials are given in data Table T.1. Material selection on both cryogenic and high temperature applications requires careful consideration, due to changes in material properties.

Water treatment

The type of water treatment used in power plants can sometimes lead to corrosion initiated erosion of stellited components. Hydrazine, and certain Amine based treatments are known to attack the cobalt element of overlay causing it to breakdown, and be “washed” away.

On applications where these treatments have been specified, it is best to avoid the use of □atellite. Where possible through hardened 17-4PH and 420 St. St. should be offered. Where hard facing cannot be avoided, specify Colmonoy 5, which is a nickel based hardfacing, with erosion properties similar to □atellite.

It should be noted that these comments apply only to water/condensate applications. There does not appear to be sufficient carry over of the treatment on steam applications to create a corrosion mechanism with □atellite hardfacings and overlays.

Table T.1 Temperature Limits for Trim Materials

Material	**Temperature Range (^{0}C)**	
	min	**max**
316 St. St.	- 196	+ 550
17-4 PH St. St.	- 40	+ 400
17-4 PH St. St. (NACE)	- 79	+ 287
420 St. St.	- 29	+ 550
440 St. St	- 29	+ 400
Duplex St. St.	- 50	+ 370
Super Duplex St.St.	- 50	+ 370
Monel 400	- 196	+ 300
Monel K500	- 196	+ 300
Inconel 625	- 196	+ 593
Hastelloy B2	- 196	+ 538
Hastelloy C276	- 196	+ 538
660 Stainless Steel*	- 196	+ 600

Technical Bulletin Continuation Sheet

Table T.2 Standard Plug and Cage Material Combinations

Valve Type	Material		Temp Range (^{0}C)		Applications
	Plug	Guide	min	max	
BV502 BV503 BV504 BV505	316 St. St.	17-4 PH	- 40	+ 400	Standard for all
	316 & Full Stellite	420 St. St.	+ 400	+ 550	Power & Utility
	316 St. St.	17-4 PH (NACE)	- 40	+ 400	Oil & Gas NACE
	316 & Full Stellite	316 St. St.	- 196	+ 550	Cryogenic
BV500 BV501 BV990 BV992	17-4 PH St. St.	420 St. St.	- 40	+ 400	Power & Utility
	316 & Full Stellite	420 St. St.	+ 400	+ 550	H. temp Power/Utility
	316 St. St.	17-4 PH	- 40	+ 400	Oil & Gas/Refinery
	316 St. St.	17-4 PH (NACE)	- 40	+ 400	Oil & Gas NACE
	316 & Full Stellite	316 St. St	- 196	+ 550	Cryogenic
BV800 BV801 BV802 BV803 BV830 BV831	316 St. St.	440C St. St.	- 49	+ 400	Standard for all
	316 St. St.	Stellite 6	- 196	+ 550	High temperature Cryogenic NACE

Table T.3 Plug Treatment for Non Standard Trim Materials (or where the same plug and cage material is a mandatory customer requirement)

Plug Treatment	Max Inlet Pressure (barg)	Temp Range (^{0}C)	
		min	max
Base Material + Hard Chrome Plate	100	- 40	+ 250
Base Material + Full Stellite 6	400	- 196	+ 550
Note: For BV502 and Bv800 families do not consider the hard chrome option			

SPECIAL DESIGN FEATURES

Body Protection Unit

Purpose

To prevent flow from eroding the base of a globe valve body.

Where used

Body protection devices are used on flashing, two phase or contaminated flow applications. They should be specified when either the operating pressure drop, or the shut off differential exceed 50 bar.

Design Principle

The Body protection unit is a “basket” attached to the exit of the valve seat. It has a solid base, with either holes or ports around its circumference. There is no open in the circumference where the unit is in close proximity to the web supporting the bridge in the valve body. Flow impinges on the base of the diffuser, and is then directed out through the holes or ports. Body protection units are designed to take minimal pressure drop, thereby reducing the velocity of the fluid jets exiting them (see 6.0.1.5). The material of the unit is given in table 6.0.6.X, and is selected to suit the severity of the valve duty.

Flow Direction

Trims fitted with body protection units should always be flowed over the plug.

Design Cv

The design Cv of the body protection unit should be 3 to 4 times the maximum calculated Cv of the application.

Fig T.5 Detail of a Body Protection Device

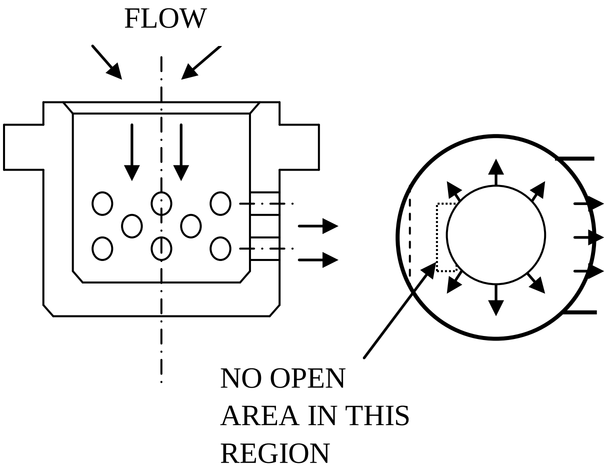
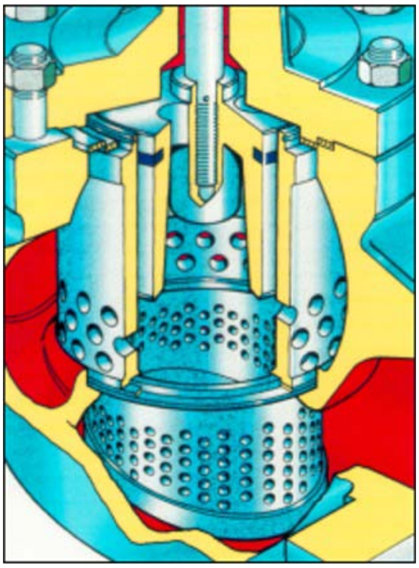


Fig T.6 Body Protection Unit Detail



Protected Seat Face

Purpose

Protected seat face designs are generally used on two phase or contaminated flow applications. Their purpose is to prevent flow from impinging directly onto the sealing faces of the plug and seat, improving the long term sealing and control integrity of the valve.

Design Principle

Metallic sealing between the plug and seat is by flat seating faces. A skirt around the base of the plug prevents flow from impinging on the seat face. Long term, the skirt may be considered as being sacrificial, because any wear will not result in a loss of process control or an increase in seat leakage.

A dead band at the beginning of the valve travel, where plug movement does not start to uncover the holes in the valve cage ensures that flow does not impinge on the sealing face of the seat.

On globe valve applications, the seat will normally be supplied with a body protection unit.

Flow Direction

Flow direction is always over the plug.

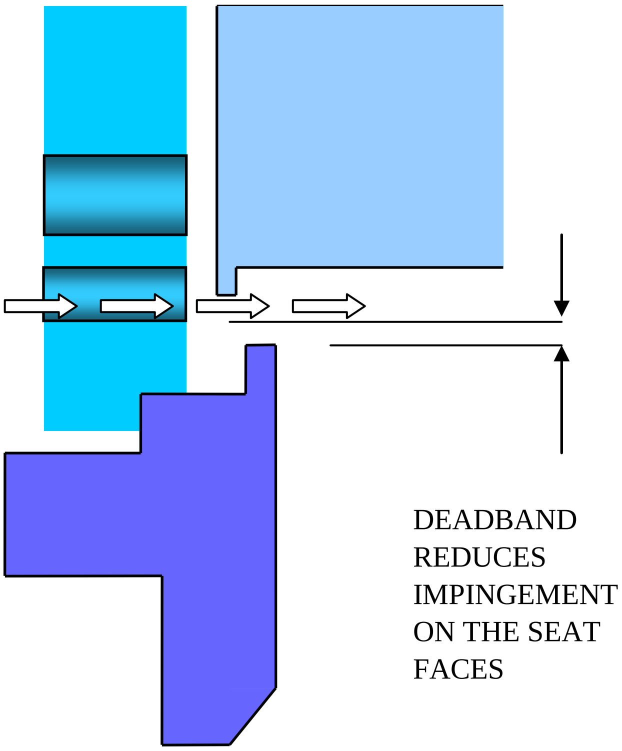
Actuator Sizing

Care must be taken on balanced trims to ensure that the actuator sizing has taken account of the increased out of balance area of the protected seat design. This gives a significantly higher upward acting force when the valve is in the closed position, than the equivalent conventional balanced trim, and as result can impact the size of actuator that is required, especially on air fail close applications.

Design Cv Values

The maximum design Cv that can be achieved for a given valve size is lower than that of the equivalent conventional balanced trim. This is because of the reduced seat bore diameter of the protected seat design.

Fig T.7 Protected Seat Design



Flash Cone Plug

Purpose

To increase the rangeability of a standard plug by reducing its minimum controllable Cv.

Design Principle

The plug incorporates a shallow tapered nose that sits inside the seat. The nose has a number of circumferential grooves along its length. The fit of the taper within the seat restricts the flow through the valve at low openings. The grooves create a multistage pressure reduction effect, adding to the flow restriction. On liquid applications, the multistage effect of the grooves ensures that the taper does not induce cavitation.

Flow Direction

Flow direction is always over the plug.

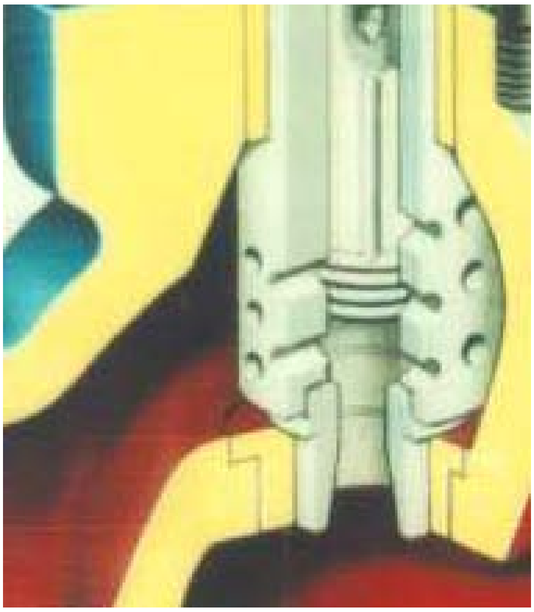
Actuator Sizing

Care must be taken on balanced trims to ensure that the actuator sizing has taken account of the increased out of balance area given be the reduced seat bore. This gives a significantly higher upward acting force when the valve is in the closed position than the equivalent conventional balanced trim. As a result it can impact on the size of actuator that is required, especially on air fail close applications.

Design Cv Values

The maximum design Cv that can be achieved for a given valve size is lower than that of the equivalent conventional balanced trim. This is because of the reduced seat bore diameter, and the effect of the taper in the fully open position.

Fig T.8 Flash Cone Plug



Pilot Balanced Trim

Purpose

To provide a high degree of shut off in the closed position, with reduced actuation forces.

Where Used

The pilot balanced design is generally used on higher temperature applications where the required leakage cannot be achieved by using a conventional spring energised resilient plug seal.

Design Principle

The plug assembly is made up of two plugs, the main, and a smaller inner plug called the pilot. When the valve is in the closed position, they act as an unbalanced plug, and the valve inlet pressure generates a very high seating stress. When the valve is required to open, the actuator opens the pilot plug, evacuating the pressure above the main plug, allowing it to open. There is a spring between the main and pilot plugs to ensure that they remain in contact with one another. The force given by the spring is supplemented by an out of balance force generated by the differential area of the stepped main plug. A balancing ring on the main plug ensures that the inlet pressure can not be re-established above the main plug while the valve is in the open position, but provides sufficient leakage to ensure that it does when the valve is in the closed position.

Flow Direction

The principle can only work if the valve flow direction is over the plug.

Design Cv

Design Cv values are approximately 10% lower than the equivalent conventional balanced trim, because of the loss in main plug travel given by the pre-travel of the pilot plug.

Size Restrictions

The Pilot Balanced design cannot be accommodated in valve sizes smaller than 100mm.

Application Restrictions

A number of problems have arisen when pilot balanced designs have been used on high temperature, high energy steam applications. Turbine bypass applications have been a notable issue. However, other steam applications have also presented problems. The main issue has been one of control stability. This has occurred on both fast acting and standard speed applications, and in most cases unsympathetic upstream piping has been a contributory factor. It is therefore important to ensure that the customer complies with our piping installation requirements.

Actuator Sizing

Control instability with pilot balanced trims is also caused by the dynamic interaction of the flow forces acting on the main and pilot plugs. This is difficult to quantify, even by using complex CFD analysis. However, field experience has shown that on higher energy applications, better control has been achieved by using double acting piston actuators.

Fig T.9 Pilot Balanced Trim Detail

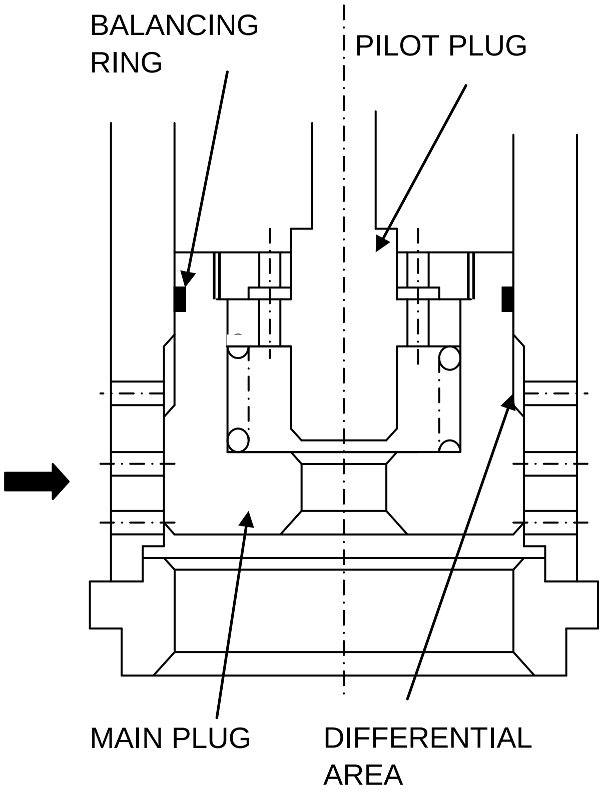
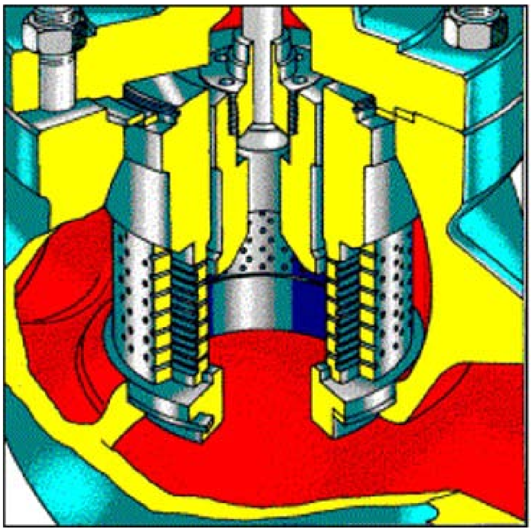


Fig T.10 Pilot Balanced Trim



Technical Bulletin Continuation Sheet

Baffle Plates

Definition

A baffle is a flat plate, perforated by a multitude of drilled holes. Generally speaking they are used on high pressure drop gas applications. Their purpose is to provide additional noise attenuation to that given by the valve trim, and to reduce valve body velocity by generating back pressure. They can be used as an anti-cavitation device on liquid applications, but being a fixed area device they will only be effective across a limited flow range, and their use is normally restricted to ON/OFF applications.

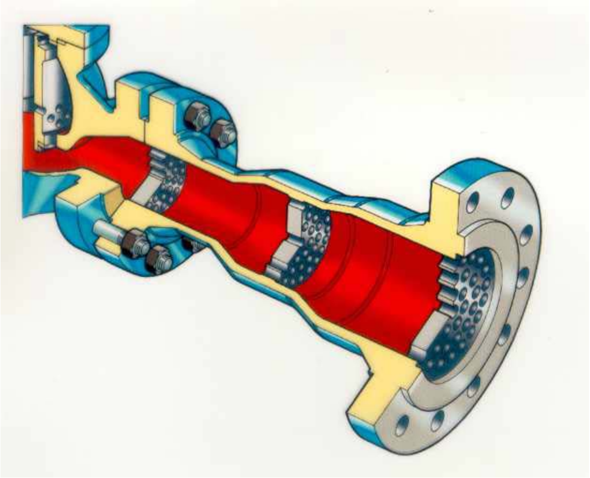
Usually the baffles plates will be a larger diameter than the valve body, and will be housed in a silencer section that is attached to the outlet of the valve. Recommended silencer outlet velocity levels are the same as for valve bodies.

Providing velocity and Cv requirements can be met, it is acceptable to supply valves with an outlet baffle. Where the valve is “flow over”, further noise attenuation can be given by a seat baffle. Typical arrangements are shown below.

Sizing

In order to avoid choked flow, the ratio between the baffle inlet and outlet pressure must not exceed 2:1.

Fig T.11 Silencer Section



Technical Bulletin Continuation Sheet

Conversion Nose Trims

Purpose

The conversion nose plug is used on severe service duties. The picture below shows the application of a conversion nose trim with carbide nose and seat face.

Where Used

The conversion nose plug can be applied to several severe service duties.

On a contaminated process with fluid inclusions, such as sand, the conversion nose is ideal for obtaining two stages of pressure letdown. On a normal cascade trim the fluid inclusions could block up the galleries of the cage. With a conversion nose plug, one stage of pressure letdown is in the plug nose. This means that as the plug moves up and down in the seat ring, then effectively the trim is self cleaning because the inclusions would be flush through the holes in the plug. The plug nose and seat ring would be made from carbide for contaminated duties.

On Flashing duties where the pressure drop is too severe for a single stage trim then a conversion nose plug can be used to good effect. Using a cascade trim could mean inter-stage flashing in the galleries. The gallery created between the plug and cage means that flow area is increased which reduces the effect of velocity.

The trim can be applied on valves with high vibration levels where the increased plug guiding through the seat improves stability.

Design Principle

The plug incorporates a parallel nose that sits inside the seat. The nose is drilled with a number a radial holes to obtain one stage of pressure letdown. Slots can be put in the bottom of the plug nose to aid flushing of the trim.

Flow Direction

Flow direction is normally over the plug, but can be flowed under for increased stability in the flow areas in the reduced plug bore permit.

Actuator Sizing

Care must be taken on balanced trims to ensure that the actuator sizing has taken account of the increased out of balance area given be the reduced seat bore.

Design Cv Values

The maximum design Cv that can be achieved for a given valve size is lower than that of the equivalent conventional balanced trim due to the reduced bore of the plug nose.

Fig T.12 Conversion Nose Plug