# X[iks]-trim

## Severe Service Application Control Valves

### Best Flow Solution

bFS

## Introduction

BFS designed X[iks]-trim incorporates a unique advanced design that is superb at limiting flowing velocities to low levels resulting in valve providing service that is quiet, non cavitating and non-erosive, which answer, the need for a valve capable of handling high differential pressure liquids and gases such as water, oil, steam, natural gas, petroleum products and chemicals

X[iks]-trim's low velocities are achieved through the use of a trim cage made by bonding together a series of individual disks. Each disk has a pattern of carefully controlled orifices and channels(passages) with a multitude of sharps turns(labyrinth) etched or machined into its surface(disk). As the trim's plug travels within the cage the fluid is throttled and forced to travel an extremely torturous path with each turn effecting a stage of pressure drop.

The combined effect of numerous narrow(labyrinth) flow passages, each with many sharp turns and a continually expanding flow path, removes kinetic energy from the fluid while gradually lowering its pressure. In doing so, abrupt velocity increase that are the source of noise are avoided. The additional benefit for liquid flow is the elimination of cavitation and the damage it can do to valve, its trim and the downstream piping.

By its very design X[iks]-trim allows for many more turns of drop than conventional torturous path trims.

Superior to other velocity control trims, X[iks]-trim, through the use of a consistent labyrinth design, typically is more efficient at passing flow or allowing more turns or turns of drop in a given valve size.

By manufacturing the flow passages to extremely close tolerances, X[iks]-trim's calculated of predicted versus actual pressure drops are significantly more accurate than competitors. Hence, velocities are more uniform throughout the entire trim, further guarding against noise, erosion and cavitation.

## X[iks]-trim Benefit

Higher Reliability
Lower Noise
Better Control
Decrease Maintenance Costs
Improved Plant Performance
Increased MW output and reduced leakage costs.
Safer Plant Operating Conditions
Longer Intervals Between Maintenance.
Reduced System Costs Lower Cost of Ownership

**Quieter**

Size for size X[iks]-trim proved quieter than the leading competitor in extensive laboratory testing

**Tight Shutoff**

Equipped with various plugs (unbalanced, balanced, Aux. Pilot) X[iks]-trim can provide shutoff classes ranging from ANSI/FCI 70-2 Class IV, V. VI and MSS-SP-61.
Note: Class VI requires soft seat.

**Easily Serviced**

Quick change design with no threaded or welded in parts. Seat ring is a separate replaceable item

**Resists Plugging and Galling**

A pressure balancing groove around the I.D. of each disc allows the plug to be completely balanced around its circumference, and provides a landing area for entrained debris, thus precluding plug galling. Additionally, bypass in the flow path allow for entrained debris to clear the main fluid flow path.

**Retrofit / Upgrades**

Readily tailored to fit non BFS valves and BFS valves previously supplied without X[iks]-trim.
Contact BFS's aftermarket Department or technical sales Deptartment for details.

## Application

X[iks]-trim is BFS's top-of-the-line high performance specialty trim that offers a proven solution to those severe service applications where a true velocity control trim is the best or possibly the only answer. By limiting the fluid velocities inside the valve, X[iks]-trim design precludes those problems typically associated with high velocity such as erosion, noise, vibration and poor control. Every X[iks]-trim is custom engineered to meet the needs of the toughest liquid, steam and gas services in the power and process industries.

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### Power Plant

Nuclear Power, Fossil Power, Combined Cycle(HRSG), Bio-mass(RDF) and other industries handling high pressure water and steam.

**Feedwater & Condensate**

- Main and booster feedpump recirculation
- Start-up and main feedwater regulation
- Deaerator level control
- Condensate booster pump recirculation
- HP coolant injection
- High level heater drains
- Reheat and superheat attemperator spray
- Reactor core isolation cooling

**Main Steam**

- Atmospheric steam dump and steam venting.
- Turbine bypass (HP, IP, LP)
- Sootblower Control
- Auxiliary steam control
- Turbine seal pressure control
- Once-through boiler start-up

### Oil and Gas / Petrochemical

Up-stream, down-stream / Production, transmission and processing, including natural gas and petrochemicals.

**Up-stream**

- Choke production
- Separator level control
- Gas lift (injection)
- Overboard dump
- Gas control
- Surge relief
- Gas injection (withdrawal)

**Down Stream**

- Metering stations (active, monitor)
- Compressor recycle (Anti-surge)
- Hot gas bypass
- Emergency depressuring (gas to flare)
- Amine letdown
- Expander bypass
- Vent to atmosphere
- Steam header pressure control

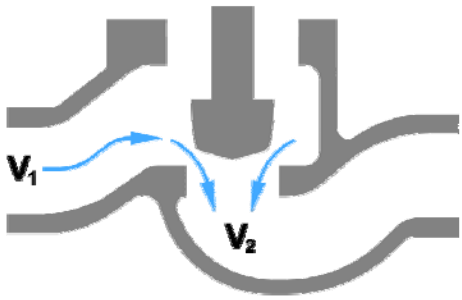
## X[iks]-trim for Velocity Control

### 1. Specifications

1) Turns of Pressure drop
   - up to 60turns.
   - Special designs available
2) Rangeability : as required by application
   - Designed to meet application needs; minimum of 30:1; over 300:1 for larger valve
3) Trim Characteristic : EQ-%, Mod-%, Linear.
4) Valve Size : 1/2" to 48" (Option/over 48")
5) Fluid Temperature Range : -155℃ to 610℃
6) Body Style : Globe, Angle, Z-body.
7) Plug Design : Unbalanced, Balanced, Aux. Pilot.
8) Connection Type
   - Buttweld to ASME B 16.10; Socket Weld to ASME B16.11; Flanged to ASME B16.5 MSS SP-44 and API 605; Special ends including clamped-joint hub configuration.
9) Disk Stack Materials
   - 316 SS, 410 SS, Inconel-718, Chrom-moly alloy steel, duplex,
   - Cobalt Alloy+C.V.D Treatment (HRC 84deg.)
   - Tungsten Carbide
   - CVD treating is possible for all the materials.
10) Plug & Seat Materials
   - 316 SS or 316L SS
   - 410 SS, 416 SS, 17-4PH, Inconel-718
   - F11/F22/F91+Stellite Hard Face
   - C.V.D Treatment /HRC 84deg.
   - Tungsten Carbide
   - Hardfaced when required. (Stellite)

### 2. Flow Dynamic for Design Basic

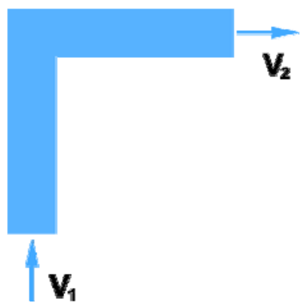
Fluid in the valve reaches its maximum velocity just slightly downstream of the valve trim's orifice in the vena contracta or minimum flowing area. These high velocities produce cavitation, erosion and abrasion, which can quickly destroy the valve. Even before damaging the valve, excessive noise, severe vibration, poor process control and product degradation are observed in many application without velocity control.




*under 30% opening / Vena-contracta*

X[iks]-trim divides flow into many streams to minimize the mass and energy levels. Each flow passage consists of a specific number of right-angle turns to form a tortuous path in which each turn reduces the pressure of the flowing medium by more than one velocity head.


*Pressure Reduction of Multi-Path*



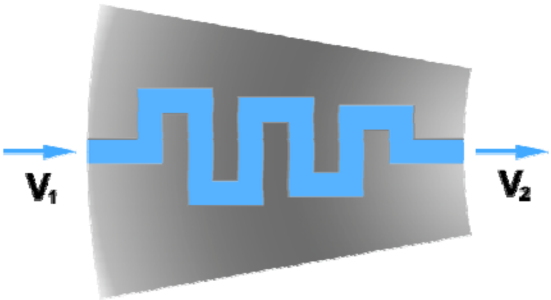

*Tortuous path of angle turn*

The number of turns, N, needed to dissipate the maximum expected differential head across the trim, as labyrinth illustrated, is found by changing the equation from.

$V_2 = \sqrt{2gh}\,(Orifice)$

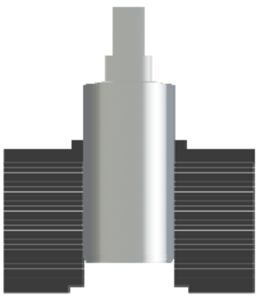
to a new equation

$V_2 = \sqrt{\frac{2gh}{N}}\,(X[iks]\_trim\ element)$

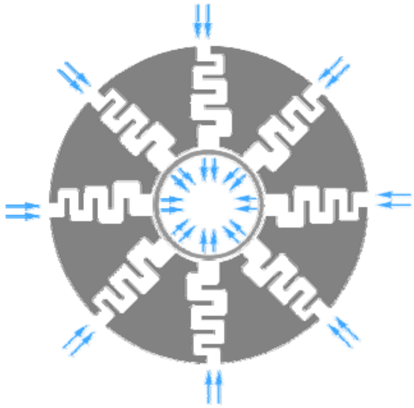



*Pressure reduction of multi-turns*

The number of turns, N, is selected to ensure a specific fluid energy level exiting the channel. Applying this principle to the X[iks]-trim valve's labyrinth disk stack and plug is shown in X[iks]-trim cage & plug. The labyrinth disk has several flow channels, each channel comprising multiple angle turns. Thus X[iks]-trim technology fully controls velocity in each passage on every disk in the cage, and the valve can operate at a controlled, predetermined velocity over its full service range.

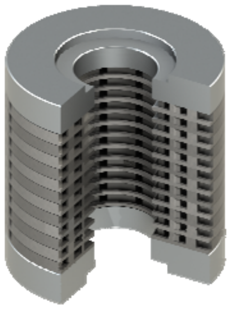


*Labyrinth type disk cage and plug*

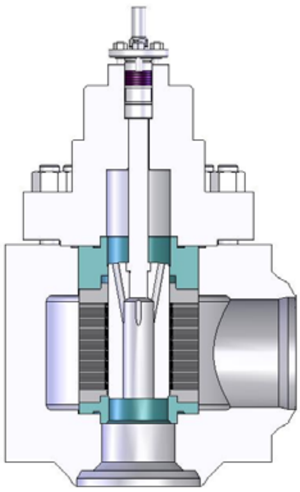


*X[iks]-trim disk / Multi-path Multi-turns*

*Labyrinth Disk*



*Labyrinth Disk Stack Cage / X[iks]-trim*



*X[iks]-trim Application Angle Valve*

## 3. Cavitation Solution

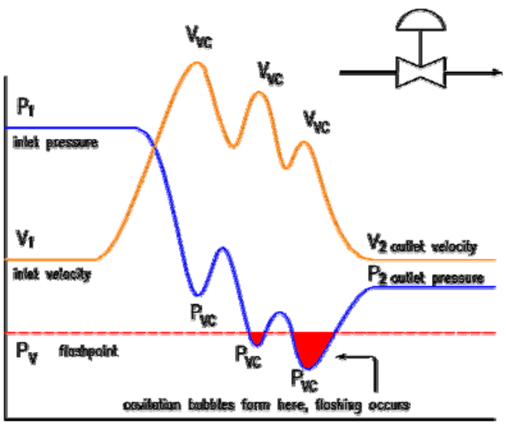
The X[iks]-trim valve eliminates the destructive effects brought about by uncontrolled fluids in today's processes. X[iks]-trim technology does this by first splitting the flow into many small channels so that, if a gas bubble is formed, it is very small and does not have the energy necessary to cause stresses that would result in material failure. Secondly, X[iks]-trim maintains the fluid velocity at minimum levels so that local pressures are unlikely to drop below the vapor pressure of the fluid. Thus none of the adverse effects of bubble collapse can harm the valve as in other valve designs.

**MH3S / Multi-Hole 3-Stage Cage**

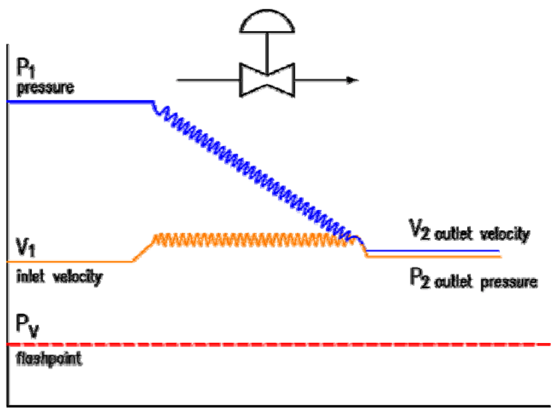
Typical control valve. The high fluid velocity and low number of pressure reducing stages combine to produce insufficient stages to perfect trim from cavitation erosion.

**X[iks]-trim / Labyrinth Disk Stack Cage**

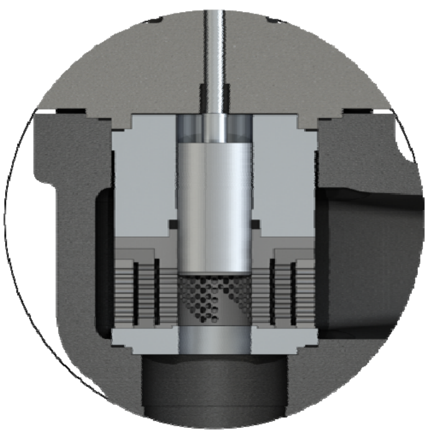
The BFS X[iks]-trim solution. The fluid velocities are kept low and a high number of pressure reducing stages ensures a controlled letdown of the fluid pressure

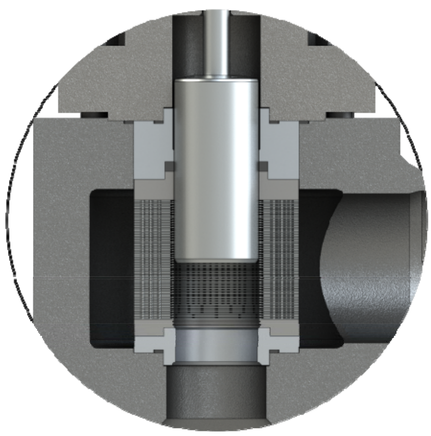



*Drilled Multi-Hole 3-Stage Cage Application*




*Multi-path Multi-turn X[iks]-trim Application*





## 4. Additional

**Recommended**

**Fluid Velocity to Control Cavitation**

Fluid velocity requirements, based on the vapor pressure of the fluid(at design temperature), is governed by the following equation.

$$V = \sqrt{\frac{1000(P_2 - P_v)}{\rho}}$$

| Service Condition | Trim Exit Fluid Velocity |
|---|---|
| Continuous service single phase fluid | 30m/sec |
| Cavitating & Multi-phase fluid | 23m/sec |
| Vibration-sensitive systems | 12m/sec |

*Based on information presented in the publication "Control Valves-Practial Guides for Measurment and Control" edited by Guy Broden. Jr and Paul G. Firedman. 1998 edition published ISA and other sources.*

**Recommended**

**Fluid Kinetic Energy / Velocity Head**

| Service Condition | Kinetic Energy | Velocity Head |
|---|---|---|
| Intermittent Duty | 150psi | 1030kPa |
| Continuous Duty | 70psi | 480kPa |

*Based on information presented in the publication "Control Valves-Practical Guides for Measurement and Control" edited by Guy Broden. Jr. and Paul G. Firedman. 1998 edition published ISA and other sources.*

**Recommended**

**Pipe Line Velocity Limit / Maximum.**

| | |
|---|---|
| Liquid / Water | 6m/sec |
| Gas | 150～200m/sec |
| Saturated Steam | 50～80m/sec |
| Superheated Steam | 80～120m/sec |

*Based on information presented in the publication Velocity Limit in the Flow dynamic Association in Japan*

## 5. Production

**Production to Labyrinth Disk Stack type Cage**

1. Design
   - Tech. Engineering Team in BFS.
   - Calculation By software / BFS owned program

2. Labyrinth Disk Machining
   - Machined / Machining Center
   - Electric Etching for Labyrinth

3. Heat Treatment
   - 410 SS, 416 SS / 400-series Heat Treat. St. St.

4. Plat Polishing
   - Disk / both sides

★. C.V.D Treatment / Option (Special Requirement)
   - HRC Hardness 84deg.
   - Ultra severe Service application
   - Extended life cycle

5. Assembly Disk Stack type Cage
   - Labyrinth disk assembly use a jig
   - Brazed welding / Heat treating Vacuum Furnace.

6. Precision Machined
   - Disk Stack Cage Inside.
   - Cylinder polishing

7. Quality Control Document
   - Mill Sheet.
   - Dimension Check Sheet.
   - Heat Treatment Curve Record.
   - WPS/PQR : If need.
   - NDE : PT or MT.
   - Performance Curve & Information Drawing.

## 6. C.V.D.

**CVD / CHEMICAL VAPOR DEPOSITION.**

Using the CVD process to improve the wear life of metal components. This is not for simple coating on the material surface, but for a surface penetration.

So, the CVD treated material has no flaking which usually takes place in the coated material such as in Titanium Carbide and Tungsten Carbide Coating etc.

**WHAT IS "CVD"**

CVD is thermo-chemical surface treatment in which metal atoms are diffused into the surface of a workpiece to form CVD layer with the base material.

CVD has been proven to have more than several times the wear life of metal parts that were previously tungsten and titanium carbide coating, carburized, nitride, nitro-carburized, or hard chrome plated in numerous applications.

**FEATURES**

Excellent wear resistance from surface hardness of 1700 – 2300HV achieved on steel and nickel, cobalt based alloys, tungsten carbide, titanium carbide. Proven to have more than several time the wear life of many components. Hardness is retained at high service temperature 650deg. C.

CVD increases acid corrosion resistance, Hydrochloric, Sulfuric and Phosphuric acids in particular.

**PROPERTIES OF CVD LAYERS**

The hardness of layers on steel ranges between 1700 and 2300HV (77 – 88 HRC). Hardness of layers varies with base material, Layers also retain hardness up to subcritical temperature 650deg. C.

Layers' depth ranges from 20 to 150micronM depending on base material and application with the layer depth being matched to the intended application.

**RESISTANCE TO ACIDS**

CVD can increase the resistance of low alloy steel to acids such as sulfuric, Phosphoric and Hydrochloric. CVD austenitic stainless steel has excellent resistance to Hydrochloric acid.

**MATHERIAL SELECTION**

CVD can be applied to a wide range of steel alloys including carbon steel, low alloy steel, tool steel and stainless steel. Especially, base materials such as nickel based alloys, cobalt based alloys and molybdenum can be treated.

Nickel alloy, Cobalt-alloy can be treated without sacrificing corrosion resistance, as well as producing extreme hard surface wear resistance. The wear resistance of sintered carbide such as tungsten carbide, titanium carbide, is excellent.

**APPLICATION**

1. Valve components used in high erosive or corrosive environments such as severe service metal seat ball valves and globe valves in power plants, poly-silicon plants, gold mining, off-shore (Oil & Gas / Choke Valves) and coal chemical(IGCC) plants.
   - Ball Valves : Ball & Seat.
   - Globe Valves : Trim Parts (Plug, Seat & Cage)
   - Choke Valves : Trim Parts (Plug, Seat, Ventri-Guide & Cage./ Punched Disk stack)
2. Pump components such as impellers or housings that are exposed to high flow rates of abrasive materials.
3. Extrusion and injection molding augers, barrels and die components to reduce friction and increase service life.
4. Control and regulating globe valves, CVD SS431, SS410 steel materials lasts several times longer than satellite hard facing components (Stellite #6 Overlay / HRC45. CVD Treatment HRC84)
5. Gear, cutters separators, slurry transfer or chopping components used in highly abrasive conditions.
6. Grinding rotor and stator of homogenizer, screws of extruder in chemical and paper plants.

**NOTE / Tungsten Carbide Hardness / HRC 70**