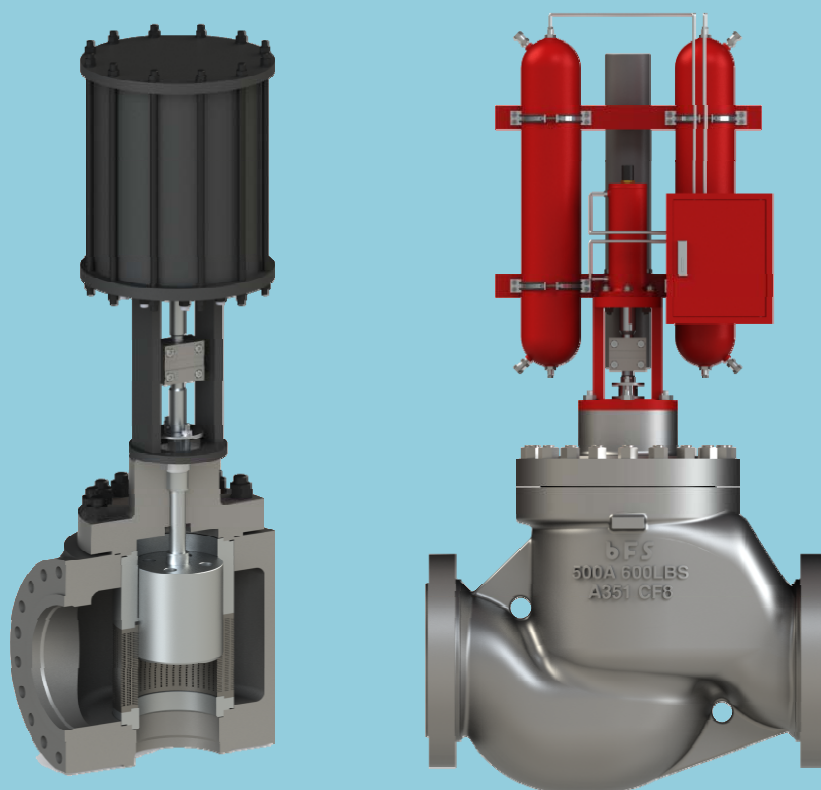




Anti-Surge / Compressor Recycle Valve
X[iks]-Trim & Drilled Multi-Hole Application
AG/AA-Series



Introduction

BFS AS-Series X[iks]-trim valves are specifically designed for application with large capacity flow rates and high differential pressures. Typical installations may be found in compressor surge control, gas to flare, atmospheric vent, or other applications where the ratio of inlet/outlet pressure require substantial levels of noise attenuation and large valve sizes. A variety of options and configurations are available to create effective solutions for our customers' specific applications.

The AS-Series is a valve solution engineered to meet a client's need. As such, the exact product configuration may differ from the general specifications, dependent upon the application. For additional information contact your local BFS Sales representative.

Severe Service Anti-Surge And Compressor Recycle Solution

The optimum solution for safety and reliability, BFS's compressor recycle and anti-surge valve combines premium X[iks]-trim flow control technology with reliable fast stroking actuation. The result is a complete severe service valve solution designed to maximize the reliability, efficiency, and control of your compressor recycle system. Within this solution, the X[iks]-trim disk stack controls flow velocity to provide low noise and exceptional reliability. Flow energy and velocity is controlled to minimize wear and ensure reliable performance and longevity. Control is provided by BFS's fast acting pneumatic actuator which provides one second stroking times, fast and accurate control, and simple and reliable operation. Benefits of this proven design include.

- Fast Actuation and continual control
- Reliable performance with proven technology
- Exceptional shutoff with minimized leakage
- Proven attenuation of noise and vibration.

Contents

	<i>Page</i>
Introduction, Model Numbering System -----	2
Specification, Flow Characteristic -----	3
Features of AG/AA-series -----	4
Anti-Surge Operation -----	5
Anti-Surge Valve Application in Compressor Recycle Service / Actuators -----	7
General Arrangement and Parts Description -----	8
Standard Material Applications -----	9
Flow Coefficients Rated Cv Chart -----	10
Metric Conversion Tables -----	11

Model Numbering System

<p>1</p> <div style="border: 1px solid black; width: 40px; height: 20px; margin: 0 auto; display: flex; justify-content: space-between;"> </div> <p>Body series</p> <p>AG / Globe Pattern</p> <p>AA / Angle Pattern</p>	<div style="border: 1px solid black; width: 40px; height: 20px; margin: 0 auto; display: flex; justify-content: space-between;"> </div> <p>Trim Design</p> <p>G2 / Balanced</p> <p>G3/ Aux. Pilot Plug</p>	<div style="border: 1px solid black; width: 40px; height: 20px; margin: 0 auto; display: flex; justify-content: space-between;"> </div> <p>Trim Type</p> <p>M1-Multi-hole 1-stage</p> <p>M2-Multi-hole 2-stage</p> <p>M3-Multi-hole 3-stage</p> <p>XT-X[iks]-trim</p>	<div style="border: 1px solid black; width: 40px; height: 20px; margin: 0 auto; display: flex; justify-content: space-between;"> </div> <p>Body Rating</p> <p>01-150 / 10K</p> <p>02-300 / 20K</p> <p>03-600 / 40K</p> <p>04-900 / 62K</p> <p>05-1500</p> <p>06-2500</p> <p>07-4500</p>	<div style="border: 1px solid black; width: 40px; height: 20px; margin: 0 auto; display: flex; justify-content: space-between;"> </div> <p>Actuator Type</p> <p>DR-Diaphragm/Rever.</p> <p>DD-Diaphragm/Direct</p> <p>CS-Spring Cylinder</p> <p>CD-Double Cylinder</p> <p>EM-Electric Motor</p> <p>HS-Hydraulic Cylinder</p> <p>MH-Manual Handl</p>
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1. AG/AA-series, Valve Specification

- Body Style

; AG / High Capacity Globe.

; AA / High Capacity Angle.

- Body Size :

; 2" to 46" / Over 46"(option)

- Pressure Rating :

; ANSI 150 to 4500, KS(JIS) 10K, 20K,40K, 62K

; DIN, API & Others (Option)

- End Connections :

; RF, RTJ, BW, Etc..

- Bonnet : Bolted type, Pressure Seal type.

; Standard type.

; Extension type.

; Bellows seal type.

; Long Extended type / Cryogenic Service.

- Flow Direction

; Flow to open / Standard.

; Flow to Close / Optional

- Trim Design :

; Balanced,

; Aux. Pilot Plug.

- Trim Form

; MH1S / Multi-Hole 1-Stage Trim

; MH2S / Multi-Hole 2-Stage Trim

; MHMS / Multi-Hole Multi-Stage Trim

; X[iks]-Trim

- Rangeability :

; 30:1, 50:1, 80:1, 100:1. / Option 800:1.

- Seat Leakage

; FCI 70-2. Class IV. V. VI.

; MSS-SP-61

- Materials of Body & Bonnet

; Carbon Steel, Low Temperature Carbon Steel.

; Stainless Steel, Chrome Moly Steels. Nickel Alloy Steel.

; Other materials available on request.

- Materials of Trim

; 316 SS, 316L SS, 410 SS, 630 SS, Monel, Duplex, Inconel, Hastelloy, Other Special Materials & Stellite Facing.

- Actuators

; Spring Diaphragm

; Double Cylinder & Spring Cylinder

; Hydraulic Cylinder with Hydraulic-Power-Unit

; Self Contained Electro-Hydraulic Cylinder

; Gas-Over-Oil Hydraulic Cylinder

- Hand-wheel / Option.

; Worm Gear Box

; Hydraulic Hand Jack.

2. Flow Characteristics

CV

The valve flow coefficient is the number of US. gallons per minute of 60degree F water that will flow through a valve at a specified opening with pressure drop of 1 psi across the valve.

Equal Percentage

Equal percentage is the characteristic most commonly used in process control. The change in flow per unit of valve stroke is directly proportional to the flow occurring just before the change is made. While the flow characteristic of the valve may be equal percentage, most control loops produce an installed characteristic, which approaches linear when the overall system pressure drop is large relative to that across the valve.

Linear

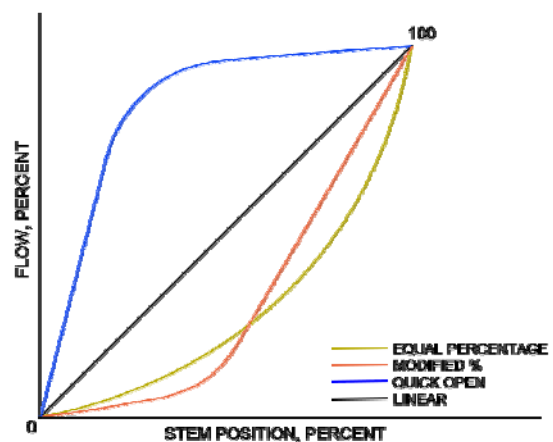
Linear inherent characteristic produces equal changes in flow per unit of valve stroke regardless of plug position. Linear plugs are used on those systems where the valve pressure drop is a major portion of the total system pressure drop.

Quick Open

Quick-open plugs are used for on-off service and are primarily designed to produce maximum flow quickly.

Modified-%

flow characteristic that lies somewhere between linear and equal-percentage. It provides fine throttling at low flow capacity and an approximately linear characteristic at higher flow capacity.



Characteristic Curve

3. Feature of AG/AA-series

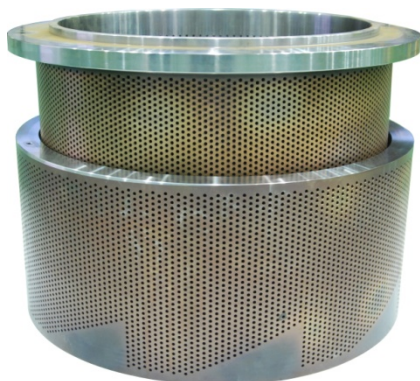
3-1. Custom Engineered Solutions

At BFS we believe our customers deserve the Best Solution for their severe service valve applications. Our broad product portfolio and valve trim technologies allow an uncompromising approach in addressing a client's need, and therefore, each AG/AA-Series valve is custom-Engineered to meet a customer's exact specifications and application conditions. This allows us to offer the most technically advanced and cost-effective solution to your noise and vibration control applications.

3-2. Low Noise Solution

The BFS Best Solution approach allows for the widest range of noise attenuation options, providing the desired noise level at the lowest cost of ownership. These attenuation products range from Drilled Multi-Hole 1-Stage and 2-Stage and Multi-Stage Velocity control Trim or up to as many as stages of labyrinth disk stack type X[iks]-Trim. The selected trim option is always custom-engineered to provide the best results for each unique application.

Drilled-Multi-Hole 1-Stage, 2-Stage and Multi-Stage velocity control trim is selected in most low to moderate pressure drop ratio applications. This technology is customized by modifying the size and spacing of each hole drilled into the cage to provide a minimal sound pressure level (SPL) at the trim exit.



Drilled Multi-Hole Velocity Control Cage

3-3. Customized X[iks]-Trim to Maximize Performance

BFS custom-engineered X[iks]-trim is ideally suited to minimize noise while providing the capacity and control that is necessary in Anti-Surge and compressor recycle applications. For these application, multi-stage X[iks]-trim is in the lower portion of the trim to provide control and

maximize noise attenuation. Slotted or drilled-Multi-Hole-Cage trim can be provided in the upper portion of the stack to provide additional capacity for when compressor bypass is required in addition to anti-surge.



Tortuous Disk Stack X[iks]-trim

3-4. High Capacity X[iks]-Trim

The 3-dimensional Laser cutting multi-path design of BFS's high-capacity X[iks]-trim controls pressure reduction through the solution of the process fluid energy. This is accomplished by directing the gas through discrete flow channels that are designed with multiple stages consisting of 90-degree turns along with the intermediate contractions and expansions in the flow area. The enhanced flow geometry of the X[iks]-trim creates a series of kinetic energy losses, followed by partial energy recoveries at each stage.

Trim velocity control is important for maintaining low aerodynamic noise level within the valve body and trim. High velocity trim exit flow will yield high magnitude sound waves, which lead to valve body vibration in high-pressure letdown application.

As a gas experiences a large reduction in pressure, the volume of the gas expands. This phenomenon will yield a higher down-stream velocity if the piping is designed without considering this volumetric expansion. BFS's AA-series is designed with expanded outlet areas to accommodate this expansion, and minimize the overall system noise level.

3-5. Fugitive Emissions

The valve had to meet all current and possible future fugitive emissions requirements for valve stems. To comply, the compressor recycle valve is fitted with a special inert packing system. This system is made of alternate chevron shaped rings of fluorocarbon material and fluoroelastomer material plus a flexible graphite ring for fire safety. The packing system is rated for a maximum-continuous-use temperature of 260°C and has successfully passed the API607, Third Edition, fire test. The packing also decreased fugitive emissions in volatile organic compounds (VOC's) to levels far below those required by current local, state, and federal regulations, in particular, the clean Air Act. The leakage has been tested to less than 5ppm.

3-6. Fire Protection

Fire protection was provided to ensure reliable operation during a hydrocarbon fire environment. The pneumatic actuator and its control system are completely encased in a fire protection blanket.. During a fire, the blanket protects the valve from heat by the expansion of chemically inert, high temperature insulation fibers, which tightly seals all air gaps and reduces heat penetration of the protective envelope.

(Same as to AG/AA-series)



*Larger Size Globe Style Anti-Surge Valve n/ AG-Series
Globe Pattern Body Anti-Surge Valve with Fast Stroking
Pneumatic Cylinder Actuator*



*X[iks]-Trim Application Anti-Surge Angle Valve / AA-Series
Angle Pattern Body Ant-Surge Valve with Fast Acting
Pneumatic Cylinder Actuator*

4. Anti-Surge Operation

4-1. Severe Service Anti-Surge and Compressor

Recycle Solution

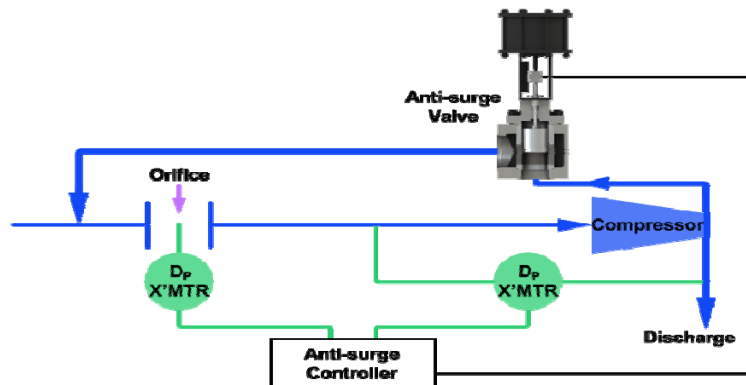
- Fast Actuation and continual control
- Reliable performance with proven technology
- Exceptional shutoff with minimize leakage
- Proven attenuation of noise and vibration

Compressor Recycle Valve Configuration

- Flow Direction
Normal Flow to Open (Under the plug)
- Trim Outlet Velocity Head
Limited 30psi (0.21MPa)
- Larger Outlet Size for Expanding Gas Volume
- Usually Provided with Larger Outlet than Inlet Nozzle.

Actuator Application / Pneumatic Cylinder

- Speed : Fast, 1 or 2second.
- Emergency Trip : Less than 1 second.
- Resolution : Less than 1%
- Components : Low Press. Reliable Accessories.
- Reliability : Very Reliable and Robust.

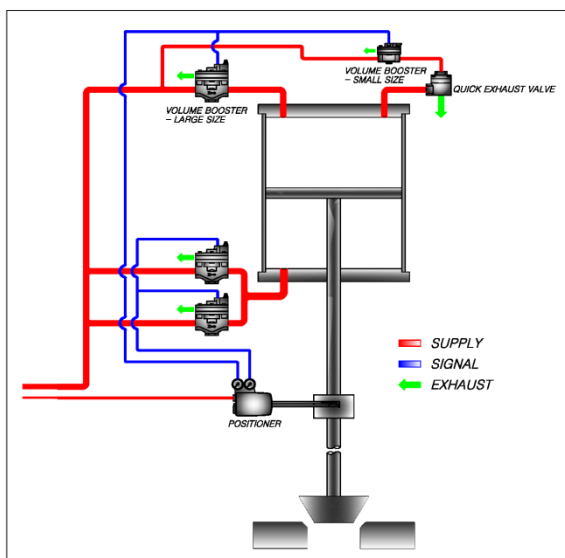


Typical Anti-Surge Valve System

4-2. Accurate Control and Reliable Operation

BFS's wide experience of developing advanced technology valve and actuation systems has led to the development of the most reliable pneumatic actuation system available for a severe service control valve. BFS has supplied this design worldwide for the past 20 years as a reliable, accurate, and fast acting control solution. For anti-surge and recycle applications, BFS's pneumatic actuation system can deliver stroke speeds of less than one second while maintaining precise resolution and control.

Control systems on gas compression trains place great demands on the control valves within the process. Requirements for continual control, with the ability to provide full capacity within seconds, add to the strains on the valves in the system. BFS compressor recycle and anti-surge solutions combine established trim and actuation designs to provide optimal performance and continued valve longevity.



Instrument Tubing for Quick Open / Less Than 1sec.

4-3. Improve Energy Management

During normal operation, any leakage past an anti-surge valve creates wasted energy and increased cost. A leaking anti-surge valve causes fluid to return to the suction side of the compressor, which causes the driver to work harder for the same output. Subsequently, the money spent compressing the additional gas is lost.

BFS's anti-surge X[iks]-trim valves are designed with either a soft or hard seat to ensure either an ANSI/FCI 70-2 Class VI or ANSI/FCI 70-2 Class V shutoff. This design provides dependable and repeatable shutoff for long periods of time over very high pressure differentials. The BFS anti-surge valve minimizes lost energy through leakage and lost production which result in significant cost savings.

4-4. Anti-Surge Valve Application

For turbocompressors, the consequences of surge are severe. Surge is a powerful disturbance that can disrupt or trip a process. It can damage equipment, and in catastrophic incidents, may result in the complete destruction of the compressor rotor. To avoid compressor surge, selection of the correct control valve is mandatory.

Because the consequences of surge are too costly to ignore, surge protection is necessary for all turbocompressors. Properly sized and engineered anti-surge recycle valves and their reliable operation are critical to protect the compressor. The valve capacity must be large enough to prevent surge under all possible operating conditions, including start-up and shut down, without being oversized. An excessively large valve will provide poor control precision and will drive the compressor into choked flow when fully open. The BFS anti-surge valve design maximizes control while providing reliable and safe protection from compressor surge.

5. Anti-Surge Valve Application In Compressor Recycle Service

Application	Delta P (Mpa)	Temperature (°C)	In/Out Size (inch)
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Gas Production			
Separation	21.~ 21	37 ~ 93	4~12 / 6~16
Reinjection	21	37 ~ 65	4~8 / 6~8

Gas			
Hydrogen	0.48 ~ 2.1	37 ~ 54	6~12 / 8~14
Natural Gas	0.48 ~ 1	37 ~ 49	8~24 / 10~30
Ammonia	0.34 ~ 0.69	37 ~ 49	4~8 / 6~12
Air	0.34 ~ 4.8	37 ~ 93	4~16 / 6~24

LNG			
Propane	0.55 ~ 2.7	-7 ~ 120	8~24 / 10~24
Refrigerant	1 ~ 4.8	-45 ~ 100	12~24 / 18~32

Olefins			
Syngas	2.1 ~ 3.4	37 ~ 49	4~8 / 6~10
Propane	0.34 ~ 1	10 ~ 65	6~16 / 8~16
Ethylene	0.63 ~ 3.4	-60 ~ 10	4~6 / 6~10
Multicomponent	0.34 ~ 2.1	37 ~ 65	6~8 / 8~12

Benefits of BFS's Compressor Recycle

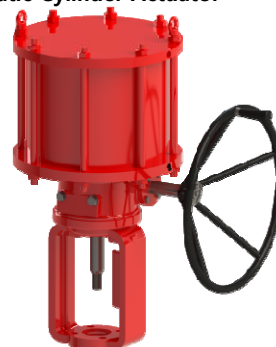
Anti-Surge Valve.

1. One second stroke time to optimize performance and safety.
2. Precise control throughout the operating range of the valve.
3. Repeatable Class V or VI shutoff to minimize leakage.
4. BFS X[iks]-Trim to control fluid velocity and minimize noise and vibration.
5. Control and capacity necessary to protect equipment during surge and bypass conditions.
6. Bilinear flow characterization available to eliminate the need for additional bypass valves.
7. Extended trim life through the reduction of flow velocity through X[iks]-trim.
8. Quick change trim to minimize maintenance cost
9. Reliable design with proven BFS technology.

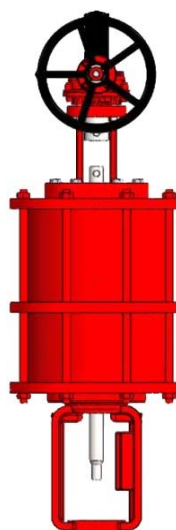
6. Actuator Application for Anti-Surge Valve

6-1. Pneumatic Actuator

Pneumatic Cylinder Actuator



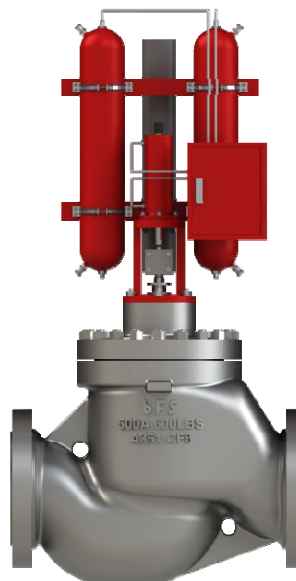
Spring Cylinder Actuator



Double Acting Cylinder with Air Tank (Air Fail Position)

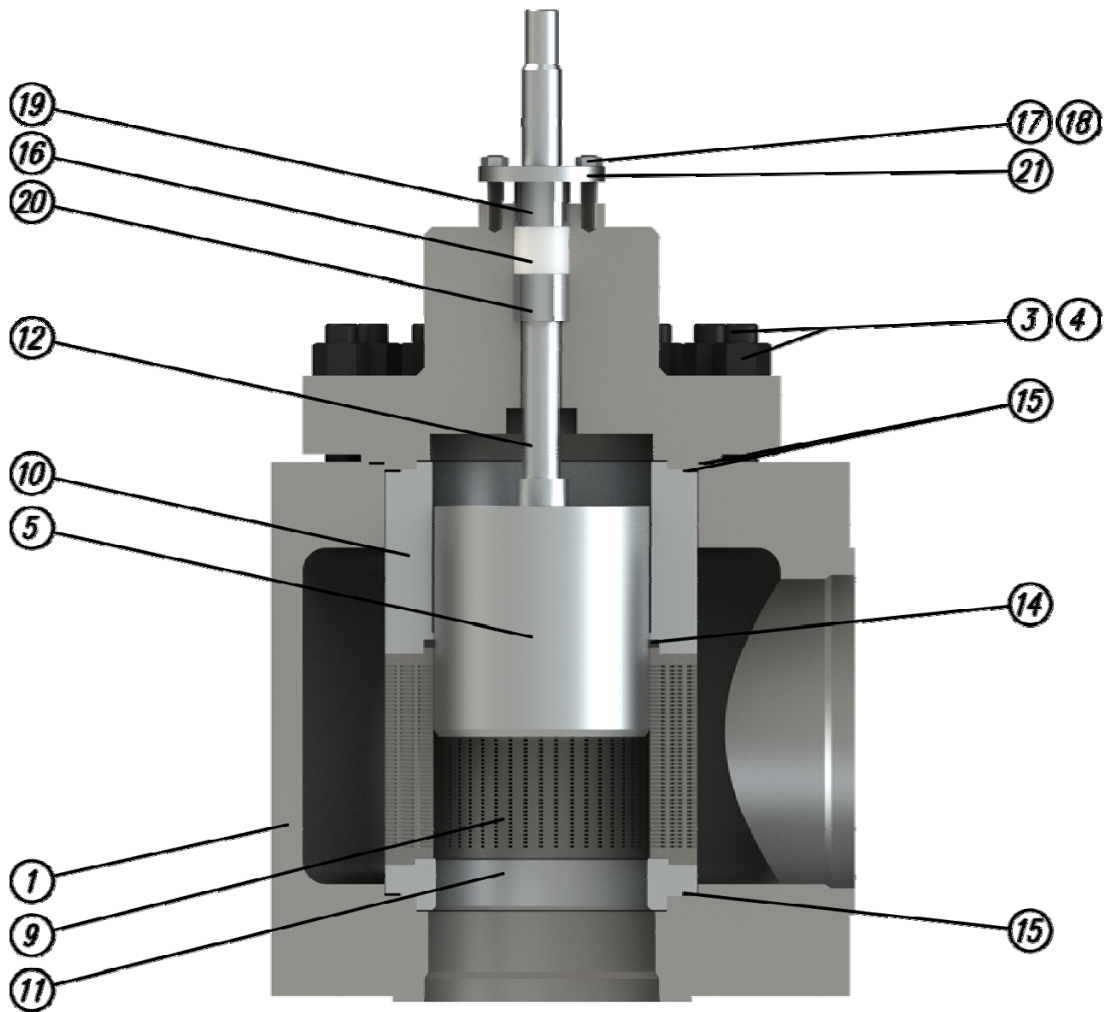
6-2. Gas Hydraulic Actuator

Gas-Over-Oil Hydraulic Cylinder Actuator

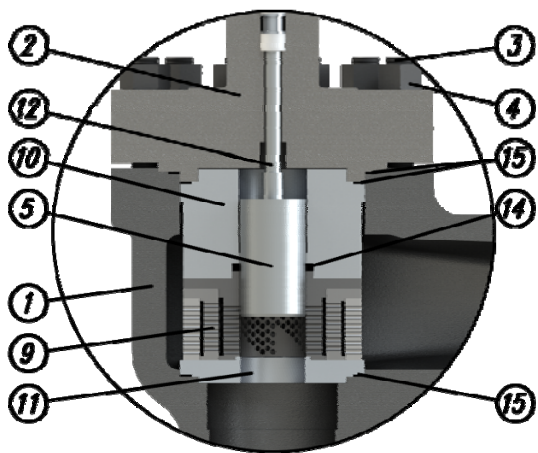


Gas-Over-Oil Electro-Hydraulic Actuator

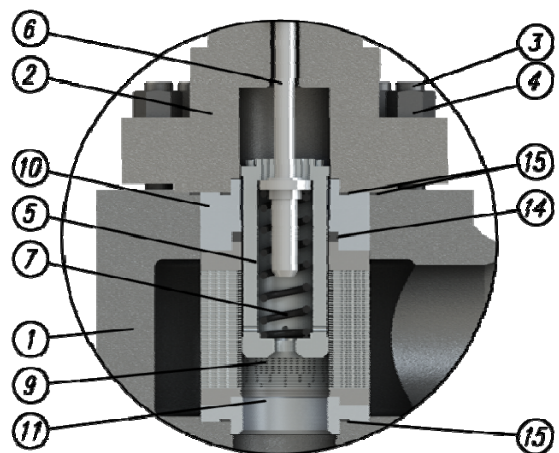
7. General Arrangement and Parts Description



Cut Away View of Angle Style Valve with X[iks]-Trim



Conventional Balanced Cage



Aux. Pilot Plug Balanced Cage

8. Standard Material Application of AG/AA-series

Fluid Temperature / °C		-196	-45	-29	0	+270	+425	+450	+480	
Ref. No	Parts Name	Application Materials								
1	Body					A216-WCB / A105				
						A217-WC6,WC9, C12a / A182-F11, F22, F91, F92				
		A351-CF8 / A351-CF8M / 304 SS, 316 SS,								
2	Bonnet					A216-WCB / A105				
						A217-WC6,WC9, C12a / A182-F11, F22, F91, F92				
		A351-CF8 / A351-CF8M / 304 SS, 316 SS,								
3	Body Studs					SNB7		SNB16		
		Alloy Steel ASTM A193 Gr. B7								
		304 SS								
4	Body Stud Nuts					S45 C		ASTM A194 Gr. 4		
						Alloy Steel ASTM A194 Gr. 2H				
		304 SS								
5	Plug	316 SS or 316 SS + Stellite.								
						410 SS		A182-F11 + Stellite		
6	Pilot Plug					400 Series Stainless Steel / 17-4PH (630SS)		Inconel		
		316 SS or 316 SS + Stellite.								
7	Pilot Spring					17-4PH/630 SS		Inconel		
						17-4PH/630 SS				
8	Retaining Ring	Inconel 718								
9	Cage / Guide	316 SS or 316 SS + Stellite								
						410 SS		A182-F11 + Stellite / Inconel		
10	Seat Ring	316 SS or 316 SS + Stellite								
						410 SS		A182-F11 + Stellite / Inconel		
11	Plug Stem					316 SS				
						17-4PH/630SS				
		Inconel, A286 Super Alloy. ASTM A638 Gr. 660								
12	Guide Bushing					440C SS / ASTM A276 TY 440C				
		Standard with Stainless Steel Body Materials / Stellite.								
13	Balance Seal					RTFE+316SS				
						Graphite+Inconel				
						Carbon-Ring / Metal-Ring				
14	Body Gasket					316 SS Teflon Filler / Spiral Wound				
		316 SS with Flexible Graphite Filler / Spiral Wound								
15	Packing					Braided Teflon or V-Teflon.				
						Molded Graphite, Flexible Graphite				
16	Packing Studs	304 SS								
17	Packing Studs Nuts	304 SS								
18	Packing Follower	304 SS								
19	Packing Spacer	316 SS								
20	Packing Flange	A351-CF8 or 304 SS								

*** Option Materials ,**

A351-CF3, 3M. Monel, Hastelloy-C/B, Duplex, Titanium, Inconel, Al-Bronze, Aluminium, Other requirements.

** Materials designed for these parts conform to NACE MR0103 Class III bolting requirements.*

** Materials designed for these parts conform to NACE MR0103 Class I or II bolting requirements.*

** Materials and processes in accordance with the requirements of NACE MR0103. Applications requiring compliance to NACE MR0175-2003 or ISO 15156 must be reviewed by BFS.*

9. Flow Coefficients / Rated Cv

AA-Series / Angle Pattern Type Body.

Body Size (inch)	X[iks]-Trim / Number of Turns				MH1S Trim	MH2S Trim	MH1S Trim
	8	16	24	36			
4 x 6	100	70	38	25	200	110	80
4 x 8	140	98	53	35	265	140	100
4 x 10	175	125	66	44	300	165	120
6 x 6	220	154	84	55	320	175	130
6 x 8	275	192	105	68	425	225	160
6 x 10	325	230	125	80	500	275	200
8 x 8	450	315	170	112	575	310	220
8 x 10	525	368	200	130	650	350	250
8 x 12	550	385	210	138	900	500	360
10 x 10	600	420	230	150	850	475	345
10 x 16	660	462	250	165	1000	550	400
10 x 18	700	490	266	175	1200	680	490
10 x 20	730	510	278	182	1750	970	700
12 x 12	1050	735	400	260	1100	600	430
12 x 16	1200	840	460	300	1200	680	490
12 x 18	1280	900	485	320	1350	720	520
12 x 20	1320	920	500	330	1600	880	640
12 x 24	1350	945	510	338	2250	1250	910
16 x 16	1400	980	532	350	1750	950	690
16 x 20	1525	1065	580	380	2250	1250	900
16 x 24	1600	1120	608	400	2800	1520	1100
16 x 30	1650	1155	627	410	3500	1930	1400
20 x 20	1600	1120	610	400	2500	1380	1000
20 x 24	1800	1260	685	450	2750	1520	1105
20 x 30	1950	1365	740	485	3700	2000	1460
20 x 36	2100	1470	800	525	5000	2750	2000
24 x 24	2150	1500	820	540	3500	1930	1405
24 x 30	2400	1680	910	600	4500	2500	1800
24 x 36	2500	1750	950	625	8400	3500	2555
30 x 30	3000	2100	1140	750	9400	5000	3650
30 x 36	3600	2520	1370	800	13500	7000	5100

Approximate Cv values are intended for estimation only. The actual Cv will vary depending on the number of turns, stroke length, and resistance factor of each valve design. The specific Cv values will be determined by a BFS engineer.

These values represent typical construction. Larger or reduced capacity available upon request, consult factory.

AG-Series / Globe Pattern Body

Same as to CG-Series Cv Chart available.

Selection Instruction

Specifying an energy management or low noise product involves sound engineering judgment and application understanding. BFS has developed a computer-based valve sizing and selection program to aid our application specialists in choosing the correct valve. Each AG/AA-Series valve is specified with the best solution number of turn or stages according to the noise requirements and pressure drop ratio. Please contact your local BFS representative for application assistance.

10. Metric Conversion Tables

LENGTH		
Multiply	By	To Obtain
millimeters	0.039	inches
centimeters	0.394	inches
inches	2.54	centimeters
feet	30.48	centimeters
feet	0.304	meters

AREA		
sq. centimeters	0.155	sq. inches
sq. centimeters	0.001076	sq. feet
sq. inches	0.452	sq. centimeter
sq. inches	0.00694	sq. feet
sq. feet	929	sq. centimeter

FLOW RATES		
gallons US Minute	3.785	liters/min
gallons US Minute	0.133	cubic feet/hour
gallons US Minute	0.227	cubic meter/hour
cubic feed minute	7.481	GPM
cubic feed hour	0.1247	GPM
cubic feed hour	0.01667	cubicfeet/min
cubic meter hour	4.403	GPM
cubic meter hour	35.31	cubic feet / hour

VELOCITY		
feed per second	0.3048	meter/second
feed per second	1.097	km/hour
feed per second	0.6818	miles/hr

Temperature Conversion
$F \text{ (Fahrenheit)} = C \text{ (9/5)} + 32$
$C \text{ (Celsius)} = (F - 32) \cdot 5/9$

VOLUME AND CAPACITY		
Multiply	By	To Obtain
cubic feet	28.32	liters
cubic feet	7.4805	gallons
liters	61.02	cubic inches
liters	0.03531	cubic feet
liters	0.264	gallons
gallons	3785.0	cubic centimeter
gallons	231.0	cubic inches
gallons	0.1337	cubic feet

WEIGHT		
pounds	0.453	kilogram
kilogram	2.205	pounds

PRESSURE AND HEAD		
pound / sq. inches	0.06895	bar
pound / sq. inches	0.06804	atmosphere
pound / sq. inches	0.0703	kg/cm2
pound / sq. inches	2.307	ft of H2O (4°C)
pound / sq. inches	0.703	m of H2O (4°C)
pound / sq. inches	5.171	centimeter of hg (4°C)
pound / sq. inches	2.0	inch of hg (4°C)
atmosphere	14.7	psi
atmosphere	1.013	bar
atmosphere	1.033	kg/cm2
atmosphere	101.3	kPa
bar	14.5	psi
kilogram/sq centimeter	14.22	psi
kilo Pascal	0.145	psi



Best Flow Solution

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