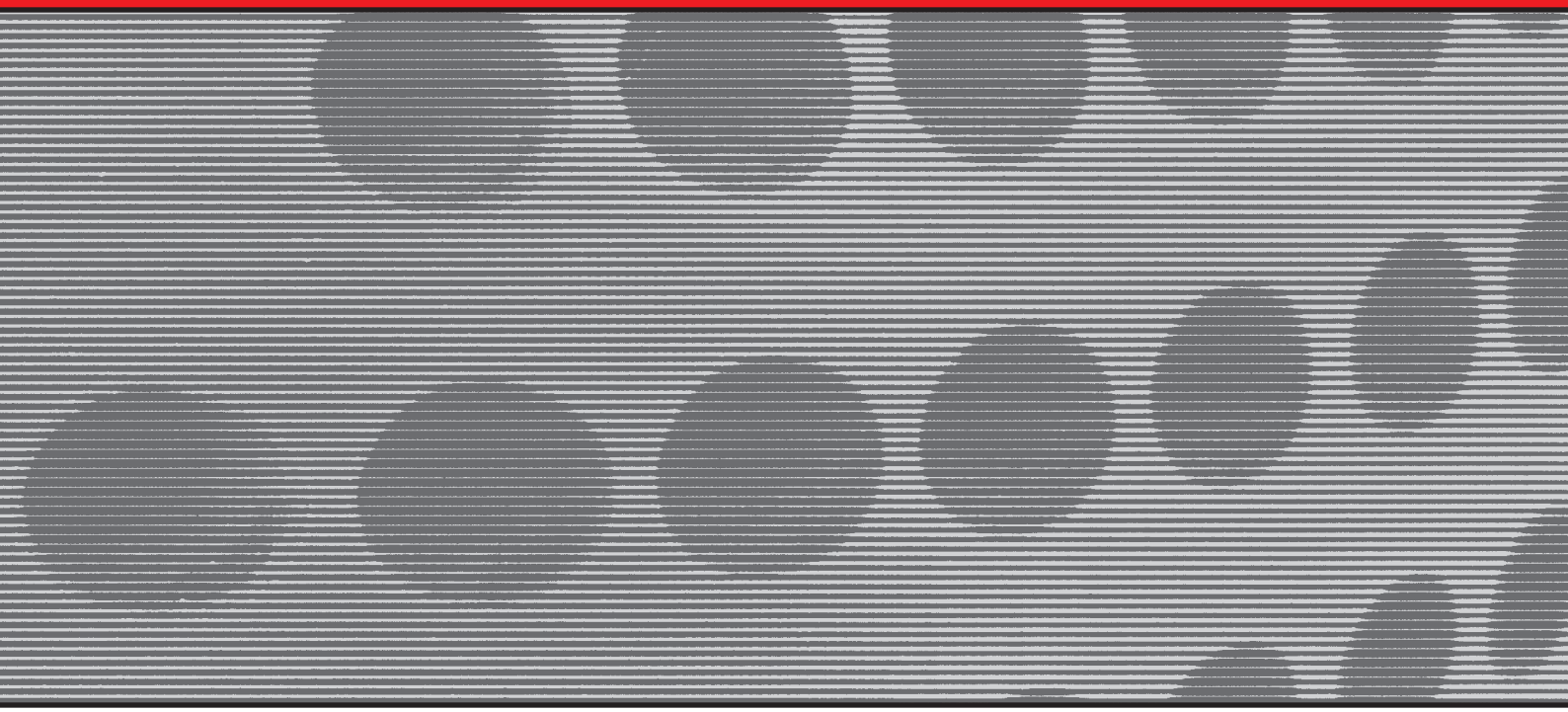
FlexStream®

Rotary Control Technology



MOGAS®

SEVERE SERVICE BALL VALVES

Severe Service Control Valve Solutions

for Gases, Liquids and Multi-phase Fluids

LNG

Anti-surge recycle
Compressor quench
Compressor suction
Flow pressure regulator
Feed gas flow control
Gas-to-flare blowdown
Hot gas bypass
Line depressurizing
Refrigerant level control

Offshore

Compressor anti-surge
Gas-to-flare / vent / blowdown
HIPPS – High Integrity Pressure Protection System
Separator level control
Water / gas injection

Power

Sootblower
Condensate control
Heater drain / dump / level
Deaerator level control
Feedwater control

Refining / Petrochemical

Compressor suction control
Feed gas regulation
Hydrocarbon gas-to-flare
Emergency depressurization
High cycle control / on-off combination valves
Combination start-up and main feed flow control

Transportation / Storage

Bypass flow control
Compressor recycle
Feed gas flow control
Gas fill / withdrawal
Heater temperature control
Pipeline regulator
Pressure control
Separator flow control

FlexStream

Rotary Control Ball Valve Solution

Innovative Technology for Total Control

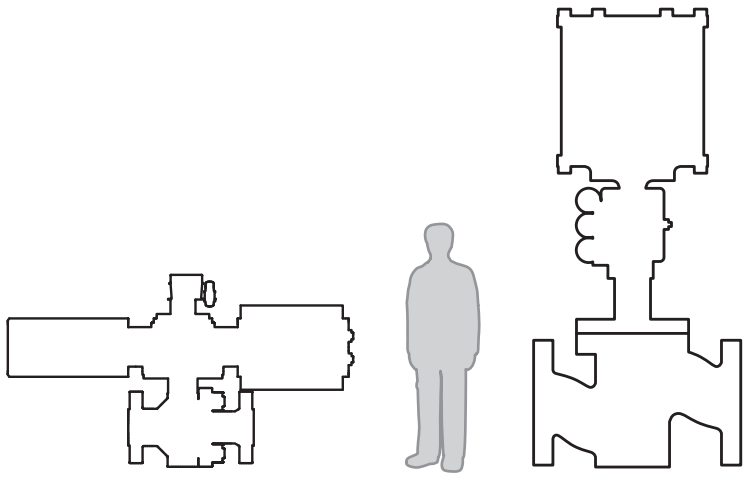
High pressure differential (ΔP) applications have historically been controlled by the vertical rising operation of a globe valve. As process plants have increased through-put, operating pressures and temperatures, many linear globe valves have become unreliable and unstable. Problems such as high friction, shaft wind-up, erosion and backlash have been associated with linear control valves. Continual up and down action can lead to deterioration of stem packing and cause hazardous stem leaks. Stem packing integrity is essential to reduce emissions of volatile organic compounds or gases.

A rotary control ball valve is inherently the best choice with its quarter-turn radial operation, straight-through bore pathway and tight shut-off. The rotary action versus the linear operation is not as susceptible to stem wear, making high-cycling not as problematic. Operating within a quarter-turn circular sphere provides a quick and / or easily maintained response time. The MOGAS FlexStream technology expands upon the ball valve's strengths by adding the capabilities of **precision modulation**, exceptionally **high rangeability** and **characterization**.

Smaller Envelope Size Saves Money

Even when globe valves have been engineered to cope with today's plant operations, because of their linear operating design, the valves have considerably increased their dimensional envelope, adding material and infrastructure costs. The rotary control valve with FlexStream technology has an **overall smaller dimensional envelope** than a traditional linear control valve, which reduces costs associated with valve construction, piping layouts and materials. This **more compact design** allows for **bottom line savings** that can be repurposed for other plant needs.

- *Smaller envelope*
- *Less weight*
- *Greater installation flexibility*
- *Reduced material and infrastructure costs*



14-inch FlexStream Valve
Cv = 6000

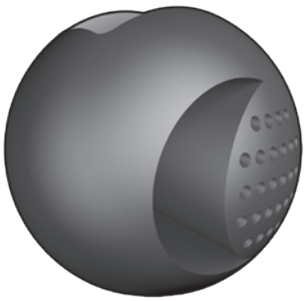
24-inch Globe Valve
Cv = 6050

As demonstrated in this illustration, the overall dimensional envelope of the FlexStream-designed valve is much smaller than the size of a typical globe valve — yet delivers equal rates of Cv.

Application Specific Trim

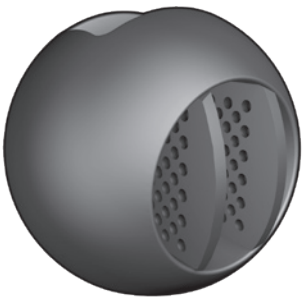
Unprecedented Flexibility

FlexStream VCB



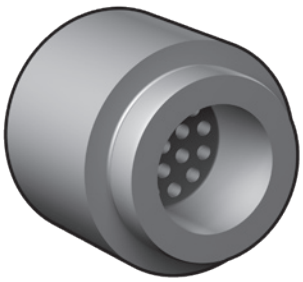
The Velocity Control Ball (VCB) technology utilizes a tortuous path design which provides up to 36 stages of pressure letdown, while being able to deliver a far greater rate of Cv than a linear valve of the same size.

FlexStream DB



The Diffusion Ball (DB) technology is utilized when a single-stage or two-stage pressure letdown is required. The principle is the same as the VCB — media is directed through a series of apertures to control the velocity of the stream.

FlexStream DS



The Diffusion Seat (DS) consists of a number of apertures that are engineered within the downstream seat. When added to a valve assembly, the DS technology provides an excellent low-cost quarter-turn control valve.

Variable Trim Technology

The FlexStream family of control valve technologies gives you complete **flexibility** for your application. Each control valve with FlexStream technology is custom manufactured per application requirements — giving you a tailor-made solution.

FlexStream's flexibility comes from the **variable construction** of the internal trim, both ball and seat. The ball can be custom fabricated to suit high pressure differential (ΔP) applications by increasing the number of pressure letdown stages and / or filling the ball to give greater control range. The seat can be modified to include a number of openings to reduce the pressure on the downstream seat.

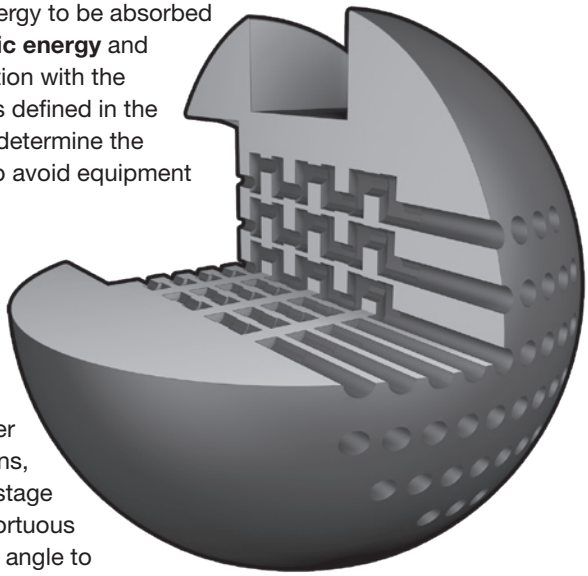
The complete valve assembly can be manufactured as a floating or trunnion ball design in a 2-piece or 3-piece forged body construction. The valve can be a bolted or top-entry body design with flanged, weld-end or compact end connections. The internal trim can be constructed as metal-seated or soft-seated, and in a wide range of material options. FlexStream technology has been designed with optimized features for pressure and flow control, and offers a tight shut-off that meets ANSI Class VI for soft-seated valves and ANSI Class V for metal-seated valves.

Design Standards

- Sizes from 2 to 36 inches
- ASME 150 – 2500 Class
- API 5000 – 15000 Class
- FCI 70-2 ANSI Class VI shut-off
- Live-loaded stem packing
- Anti-blowout stem
- Highest rangeability of any valve type
- Customized seat design
- Excellent fugitive emissions
- Extended temperature range
- **Patented design** (US 7,278,448 B2)

FlexStream VCB & FlexStream DB

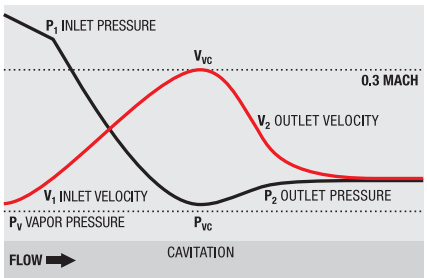
Quiet Technology with Multi-Stage Pressure Letdown
High velocities within a valve are a direct result of the pressure reduction. Velocity can damage the valve internals and downstream equipment. The conversion of pressure energy into velocity results in the generation of noise producing elements within the valve and trim. It is not acceptable to rely on noise as the factor for determining a valve's suitability. The energy to be absorbed can be calculated as **kinetic energy** and should be used in conjunction with the noise and velocity limits (as defined in the ISA and IEC standards) to determine the number of turns required to avoid equipment damage.



Pressure can be reduced by turning the fluid flow through a right angle which absorbs energy and controls the velocity. By cascading the pressure over a number of right angle turns, the pressure drop at each stage is evenly distributed. The tortuous path expands at each right angle to ensure velocities remain equal through the turns even though the fluid is expanding, eliminating any potential damage. The larger the pressure drop, the more turns are required to control velocity.

- *Reduces noise*
- *Limits velocity and vibration*
- *Exceptionally high rangeability*
- *Superior control*

Controlled Velocity



By forcing the process fluid to turn through a series of right angles, the fluid can be controlled at each stage of pressure letdown. The right angle turns and expanding flow passageways remove the kinetic energy and velocity in the fluid in a controlled manner.

FlexStream DS

Diffusion Seat Technology
MOGAS valves have predominately performed in isolation applications where a robust design is needed to shut-off critical media or high pressure steam, but there are applications that require a modulating function to control flow or pressure at the valve outlet. Generally these valves have been globe type control valves that suffer significant seat erosion, packing leaks and poor control — resulting in efficiency losses.

Based on the rugged design of the MOGAS valve line, the FlexStream DS (diffusion seat) technology was introduced as an optional replacement to the standard metal seat. The seat is constructed from Inconel 718 and consists of a number of engineered apertures that are manufactured into the seat which provides pressure reduction and controls velocity, avoiding the devastating effects of cavitation, noise and vibration.

Built to a Higher Standard

Technology Selection & Testing Criteria

- *Tight control*
- *Protection of downstream equipment*
- *Limits emissions*

Precision Sizing and Selection

As with most control valve manufacturing companies, the initial sizing and selection process is carried out on customized computer software. The sizing and selection software developed by MOGAS takes into account the guidelines laid down by the relevant ISA and IEC standards developed for control valve selection. All sizing is carried out in accordance with:

- ISA S75.01
- ISA S75.17
- IEC BS EN60534-8.3

The noise level prediction method used by MOGAS is consistent with that identified in the relevant ASME, ISA and IEC standards published on the subject. Extensive noise testing has been carried out on a wide number of our valve and trim combinations to verify the methods used. Calculations and evaluations targeted to identify key selection criteria are contained within the sizing and selection software. These calculations and evaluations include:

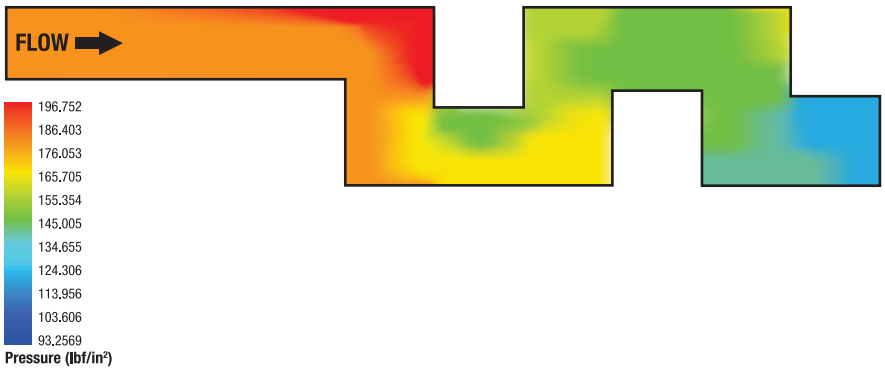
- Cv values
- Kinetic energy values
- Cavitation index values
- Predicted noise levels
- Body / pipeline fluid velocity values
- Total energy calculations

The acceptable values for each area of review must take into account a combined evaluation of all related values. No one single acceptable or unacceptable value for any of the criteria should be considered in isolation. The final selection process takes into account a combination of the information provided by the computer and the application engineering knowledge provided by MOGAS. MOGAS has the capacity to carry out in-house Computational Fluid Dynamics (CFD) to precisely determine the amount of stages needed per application.

Sample of Computational Fluid Dynamics

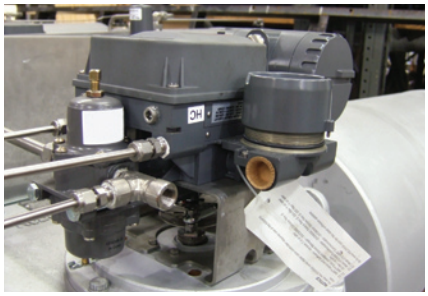
Computational Fluid Dynamics (CFD) is a sophisticated, computationally-based design and analysis technique that ensures the valve meets environmental regulations and industry compliance prior to construction.

As indicated in this CFD of a FlexStream flow passage, the pressure decreases at each right angle pressure reduction stage.



Performance Data and Diagnostics

The rotary control valve with FlexStream technology can be fitted with a variety of smart digital positioners that can deliver a full range of valve performance data. Many modern plants utilizing Distributed Control Systems (DCS) will facilitate communication to these smart positioners via Hart Pass Through I/O Blocks. If the DCS has this capability, it is an easy and cost-effective way to facilitate monitoring, control and diagnostics of smart positioners. This method of connection to diagnostics within the smart positioners is also available via Foundation Fieldbus and other protocols.



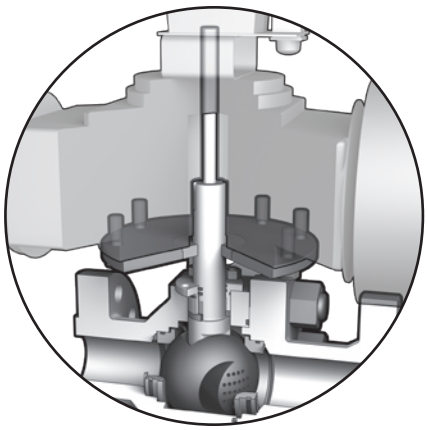
The smart positioner receives feedback of the valve travel position. This allows the instrument to diagnose the valve and actuator to which it is mounted — providing cost effective, preventative maintenance information.

Rotary control valves with FlexStream technology are factory set to release the power of the selected positioner. A benchmark test of the unit in its new condition is taken and stored at MOGAS along with the final documentation package. The benchmark sets up the positioner from its factory default settings and establishes limits for cycle counters and travel alerts. These should be set to suit loop and plant conditions.

Another critical item is to **footprint** the valve travel versus input curve to enable overlaying of ideal versus current and future graphs for use in predictive maintenance and determining actual valve condition. MOGAS offers a service where our skilled technicians can monitor critical positioner alerts and advise the customer of the alert condition. Items such as high torque, high deviation alerts and high cycle counter alerts can all indicate more serious underlying problems, which, if left unchecked, can cause further valve deterioration and loop problems.

Direct-Coupled Actuator – Increased Accuracy

The actuator and valve have a close-coupled connection utilizing a direct drive mechanism that takes out any tolerance buildup normally found in the more traditional actuator valve mounting. The upper stem is engineered to come through the live-loaded gland packing, through the body mounting flange stem bushing and into the actuator, to give a direct drive from the actuator to the ball. Using a direct, integral mounting flange ensures the top surface is parallel to the valve bore and perpendicular to the stem. When specifically designed, the control system can allow valves to fail close in less than three seconds on loss of power or air while keeping accuracy to within +/– 1% in the control mode.



Traditionally, quarter-turn actuators have been mounted via multiple linkages, increasing tolerances and lowering accuracy. FlexStream-designed valves utilize a one-piece stem that is custom- made to fit directly into the actuator drive, eliminating lost motion.

FlexStream

Rotary Control Technology

These FlexStream-designed valves are installed in a gas storage (salt cavern) facility. The valves have the unique capability to control pressure letdown in both the Cavern Fill and Cavern Withdrawal modes.

Rangeability

The rangeability is greater than to 500:1. The rangeability is limitless by providing a control trim element at flow conditions only where it is necessary. The rest of the ball flow passage can be left open to provide a low-pressure letdown, high-capacity opening.

Trim Versatility

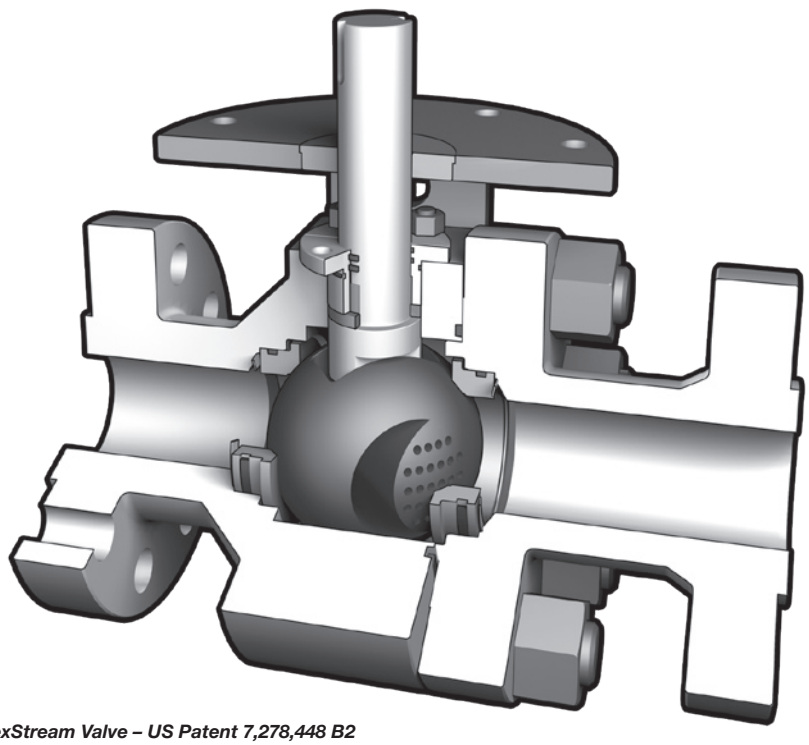
Based on the FlexStream valve's body cavity design, the control trim is interchangeable. If the valve's Cv needs adjustment, a new ball with new flow characteristics can be placed within the existing valve body. This allows for a reduction in spare parts inventory.

Long Service Life

Solid metal seat construction provides long service life in demanding applications. The constant wiping action of the seat across the ball's sealing surface prevents scale and sludge buildup, and provides excellent service on steam, gases, slurries and various liquid applications.

Controllability

Traditionally quarter-turn actuators have been mounted via multiple linkages, increasing tolerances lowering accuracy. FlexStream has a one-piece stem that is designed to fit directly into the actuator drive, making the positioner drive come directly from the valve stem.



FlexStream Valve – US Patent 7,278,448 B2

Leak-Tight Shutoff

Leak-tight shut-off plays an essential role in efficiency, safety and plant productivity. MOGAS has developed flow control valves whose performance meets the demanding ANSI FCI 70-2 shutoff leakage standards.

Improved Environmental Capabilities

Live-load packing and anti-extrusion rings combined with PTFE or graphoil stem packing ensure a leak-free stem, even during large temperature and pressure fluctuations. With linear rising stem valves, it is extremely difficult to maintain a leak-free stem seal.

Sour Service Capability

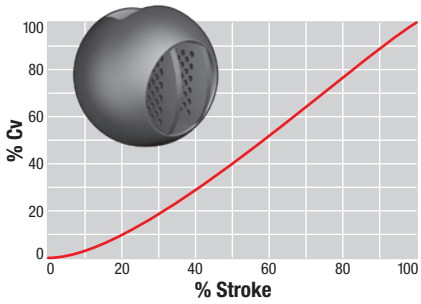
Optional materials are available that comply with NACE MR0175-2002.

Excellent Flow Characteristic

Precise contouring of the FlexStream-designed ball provides an equal percentage, linear and modified flow characteristic. Each trim set is customized per the valve's flow performance curve with application-specific flow demands to optimize system performance and life. Individual disc flow characteristics are progressively varied, including passage size and expansion ratios, to correspond with density and provide smooth control of fluid processes. FlexStream technology allows up to 36 stages of pressure letdown while being able to deliver much greater Cv.

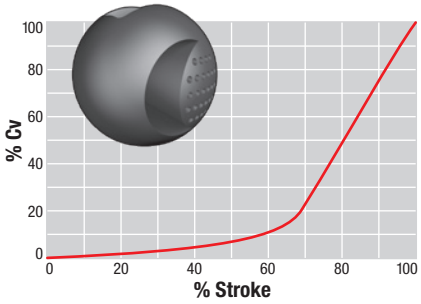
In this compressor station located in Beijing, China, these FlexStream valves are precisely controlling Pressure Reduction to safeguard the local gas distribution networks.

Linear Curve



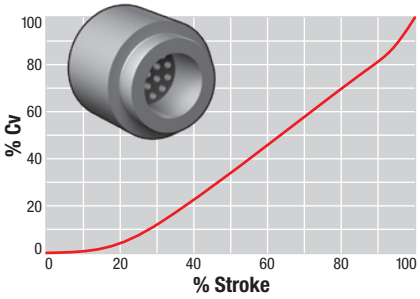
The flow capacity is directly proportional to the valve travel.

Modified Curve



FlexStream has the capability to be designed to create characterization to match any pump or compressor curve.

Equal Percentage Curve

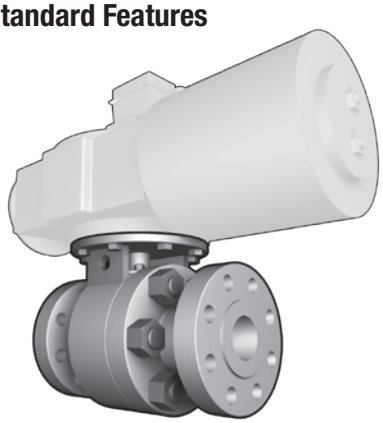


The flow capacity increases by the same percentage for each increment of travel.

FlexStream

Technical Specifications

Standard Features



Design Parameters
ASME / ANSI B16.34, B16.10

Shut-off class
ANSI FCI 70-2
Class IV, V, VI

End Connections
Flanged / Butt Weld /
Socket Weld / Clamped

Actuation
Pneumatic / Hydraulic / Electric

Rangeability
Greater than 500:1

Temperature Rating
–196 C to 900 C
–321 F to 1652 F

Sour Service
NACE MR 0175 – 2002

Pressure Class
ASME 150 / 300 / 600 / 900 / 1500 / 2500
API 5000 / 10,000 / 15,000

Actuator Accessories
4/20mA / HART / Fieldbus
EXD – Position Indicators
EXD – Solenoid Valves

The FlexStream construction materials range from the more traditional Carbon Steels (A105 / LF2 / LF3), Alloy Steels (F5 / F9 / F11 / F22), Stainless Steels (F304 / F316) into the more exotic materials such as Duplex and Hastelloy, with the possibility of weld overlay of Inconel on the body and Stellite and Tungsten Carbide on the ball and seats.

Materials

Industry	Description			
	Body	Ball / Coating	Seat / Coating	Packing
LNG	A105	316SS	316SS	PTFE
	LF2	316SS	316SS	PTFE
	316SS	316SS	316SS	PTFE
Offshore	A105	17-4PH / HVOF-CC	17-4PH / HVOF-CC	PTFE
	F53	F53 / HVOF-CC	17-4PH / HVOF-CC	Graphite
	316SS	316SS / HVOF-CC	17-4PH / HVOF-CC	Graphite
Power Generation	A105	410SS / HVOF-CC	410SS / HVOF-CC	Graphite
	F22	410SS / HVOF-CC	410SS / HVOF-CC	Graphite
	F11	410SS / HVOF-CC	410SS / HVOF-CC	Graphite
Refining / Petrochemical	A105	17-4PH / HVOF-CC	17-4PH / HVOF-CC	Graphite
	F347	17-4PH / HVOF-CC	17-4PH / HVOF-CC	Graphite
	F316	17-4PH / HVOF-CC	17-4PH / HVOF-CC	Graphite
	F5	17-4PH / HVOF-CC	17-4PH / HVOF-CC	Graphite
	F9	17-4PH / HVOF-CC	17-4PH / HVOF-CC	Graphite
Transmission & Storage	A105	17-4PH / HVOF-CC	17-4PH / HVOF-CC	PTFE
	CF2	17-4PH / HVOF-CC	17-4PH / HVOF-CC	PTFE

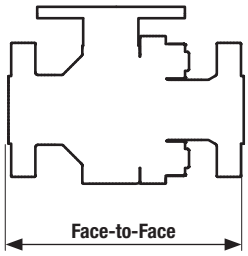
Cv

Valve Size (inches)	Class				
	150	300	600	900	1500
2	3 to 498			3 to 432	
3	7 to 1176			7 to 1071	6 to 978
4	13 to 2159			13 to 2014	12 to 1749
6	31 to 5076			28 to 4641	25 to 4019
8	53 to 9300			50 to 8120	42 to 7023
10	85 to 14866		81 to 14096	75 to 12996	65 to 11289
12	123 to 21800		118 to 20857	105 to 18579	92 to 16045
14	150 to 26306		141 to 23750	127 to 21809	110 to 18818
16	198 to 34814		185 to 31549	166 to 28181	144 to 25011
18	246 to 44568		232 to 40507	211 to 36041	182 to 32135
20	307 to 55956		284 to 50648	260 to 45257	228 to 40182
24	450 to 73000		412 to 69972	375 to 66143	328 to 59115
30	716 to 82345		637 to 74461	586 to 71604	516 to 62880
32	761 to 155127		696 to 134462	639 to 122934	565 to 107957
36	1020 to 199003		932 to 182500	860 to 167840	761 to 147559

Minimum Cv based on 12 pressure letdown stages.
Minimum Cv based on FlexStream trim filling the ball 100% and fully open.
Standard minimum controllable flow is 10% of stroke.

Face-to-Face Dimensions – Raised Face Flange (mm)

DN	Pressure Class						
	150	300	400	600	900	1500	2500
50	178.05	215.90	—	292.10	368.05	368.05	451.10
65	191.01	241.05	—	329.95	419.10	419.10	508.00
80	202.95	282.96	—	356.11	381.00	469.90	578.10
100	229.11	305.05	405.89	432.05	456.95	546.10	673.10
150	393.95	403.10	495.05	559.05	610.11	705.10	913.89
200	456.95	501.90	596.90	659.89	737.11	832.10	1022.10
250	532.89	567.94	673.10	786.89	837.95	991.11	1270.00
300	610.11	647.95	762.00	837.95	964.95	1130.05	1421.89
350	686.05	762.00	826.01	889.00	1028.95	1257.05	—
400	762.00	837.95	901.95	991.11	1130.05	1384.05	—
450	864.11	913.89	977.90	1091.95	1218.95	—	—
500	913.89	991.11	1054.10	1194.05	1321.05	—	—
550	—	1091.95	1143.00	1294.89	—	—	—
600	1067.05	1143.00	1231.90	1397.00	1548.89	—	—
650	—	1245.11	1308.10	1448.05	—	—	—
700	1245.11	1345.95	1397.00	1548.89	—	—	—
750	1294.89	1397.00	1524.00	1651.00	—	—	—
800	1372.11	1524.00	1651.00	1778.00	—	—	—
850	1472.95	1626.11	1778.00	1929.89	—	—	—
900	1524.00	1726.95	1880.11	2083.05	—	—	—



Face-to-Face Dimensions – Raised Face Flange (inches)

Valve Size (inches)	Pressure Class						
	150	300	400	600	900	1500	2500
2	7.01	8.50	—	11.50	14.49	14.49	17.76
2.5	7.52	9.49	—	12.99	16.50	16.50	20.00
3	7.99	11.14	—	14.02	15.00	18.50	22.76
4	9.02	12.01	15.98	17.01	17.99	21.50	26.50
6	15.51	15.87	19.49	22.01	24.02	27.76	35.98
8	17.99	19.76	23.50	25.98	29.02	32.76	40.24
10	20.98	22.36	26.50	30.98	32.99	39.02	50.00
12	24.02	25.51	30.00	32.99	37.99	44.49	55.98
14	27.01	30.00	32.52	35.00	40.51	49.49	—
16	30.00	32.99	35.51	39.02	44.49	54.49	—
18	34.02	35.98	38.50	42.99	47.99	—	—
20	35.98	39.02	41.50	47.01	52.01	—	—
22	—	42.99	45.00	50.98	—	—	—
24	42.01	45.00	48.50	55.00	60.98	—	—
26	—	49.02	51.50	57.01	—	—	—
28	49.02	52.99	55.00	60.98	—	—	—
30	50.98	55.00	60.00	65.00	—	—	—
32	54.02	60.00	65.00	70.00	—	—	—
34	57.99	64.02	70.00	75.98	—	—	—
36	60.00	67.99	74.02	82.01	—	—	—

Severe Service

The MOGAS Definition

- Extreme temperatures
- High pressures
- Abrasive particulates
- Acidic products
- Heavy solids build-up
- Critical plant safety
- Large pressure differentials
- Velocity control
- Noise control

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