

Valves for Delayed Coking

Increased reliability. Increased run time.



MOGAS[®]
A Flowserve Company

Renown for severe service technology, many of our design advancements are the direct result of partnering with end users, technology licensors and EPCs.

Superior Designs

Reliable. Durable. Safe.

As the most trusted severe service technology company, MOGAS' strength is recognized in the harsh environments where reliability, durability and safety are the foundation of successful plant processes.

Delayed coking is a semi-batch process, requiring frequent use of isolation valves during the coke drum switching operation. It is very important for the isolation of the coke drum to be stripped, cooled and decoked. These valves are the safety isolation devices that allow personnel to safely unhead a cooled drum while another drum is 'live'. If the valves do not positively isolate the coker drum, resid could leak into an off-line drum causing a safety hazard to the personnel, including risk of fire and explosion.

The valves isolating the feed heaters are also critical to operation when it becomes necessary to de-coke a heater. If the valves do not isolate, the unit will be shutdown.

MOGAS ball valve designs provide trouble-free operation in this extreme coking application. Over the decades of working in partnership with end users, technology licensors and EPCs, MOGAS is a solutions provider, not just a valve manufacturer. Many of our design advancements are the direct result of creating and customizing a solution that specifically addresses customer's unique process or problem. For example, MOGAS uses CFD modelling to optimize the effectiveness of purging. This has resulted in purge systems that require much less steam than competitive designs, saving thousands of dollars annually in energy costs and reducing operational costs.

Also, MOGAS engineers work directly with the Service department to do on-site failure analysis, so they can continuously improve their valves to perform in even more harsh environments.

The superior design and quality of MOGAS valves reduce maintenance and eliminate valve-related downtime—providing a greater overall return on investment.



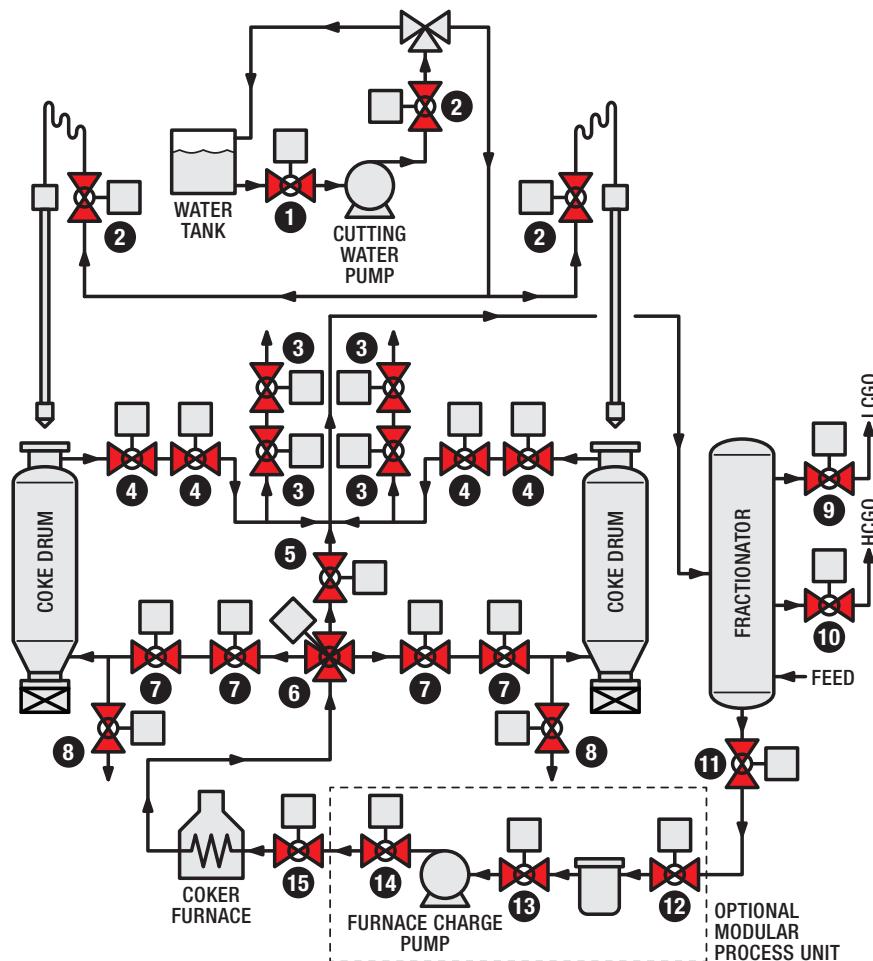
Above: One of several MOGAS 6-inch, ASME 2500 Class C-Series valve sits atop a coke drum in a South American refinery's cutting water application. This industry-proven valve is engineered specifically to perform in high erosion conditions.



Left: MOGAS service engineers visit facilities all over the world. These are people with years of actuator, valve, coatings, metallurgy, operations, startup and commissioning experience.

Process Flow Diagram

in a Typical Delayed Coker Unit



Typical operating conditions are:

- High temperature (500 – 1000° F / 260 – 538° C)
- Coking service
- High cycle
- Erosive conditions
- Temperature cycling
- High pressure water service
- High pressure steam blowdown

¹ Recommend ISOLATOR 2.0 or T-Series if size, pressure and temperature conditions are met.

Delayed Coking

Valve Number	Valve Description	Design Temperature Range		Design Pressure Range		Pipe Size		Recommended Valve ¹		
		deg F	deg C	psig	bar g	inches	dn	C-Series/CA-OV	ISOLATOR 2.0	T-Series
1	HP Pump Inlet Isolation	100 – 200	38 – 93	50	3.5	3 – 6	80 – 150		1	1
2	Cutting Water Pump Isolation	100 – 200	38 – 93	2000 – 3000	138 – 207	3 – 6	80 – 150	1		1
3	Quench Extraction	800 – 900	427 – 482	200	14	8 – 14	200 – 350	1		
4	Overhead Vapor Isolation	800 – 900	427 – 482	30	2	16 – 36	400 – 900	1		
5	Coke Drum Bypass Isolation	800 – 1000	427 – 538	550	38	8 – 14	200 – 350	1		
6	Coke Drum Switching	800 – 1000	427 – 538	550	38	8 – 16	200 – 400	1		
7	Coke Drum Feed Isolation	800 – 1000	427 – 538	550	38	8 – 16	200 – 400	1		
8	Quench Extraction Isolation	800 – 900	427 – 482	550	38	3 – 6	80 – 150	1		
9	Light Coker Gas Oil Pump EBV	300 – 600	149 – 316	50	3.5	4 – 10	100 – 250		1	
10	Heavy Coker Gas Oil Pump EBV	300 – 600	149 – 316	50	3.5	4 – 10	100 – 250		1	
11	Frac Bottoms EBV	500 – 850	260 – 455	50	3.5	8 – 16	200 – 400	1		
12	Coke Filter Isolation	500 – 850	260 – 455	50	3.5	4 – 10	100 – 250	1		
13	Furnace Charge Pump Inlet Isolation	500 – 600	260 – 316	50	3.5	4 – 10	100 – 250	1		
14	Furnace Charge Pump Discharge Isolation	500 – 600	260 – 316	550	38	10 – 16	250 – 400	1		
15	Furnace Feed Isolation	500 – 600	260 – 316	550	38	4 – 10	100 – 250	1		
	General Utility Valves (Steam, Water, Condensation)	100 – 300	38 – 149	200 – 300	14 – 20.5	1 – 4	25 – 100	1	1	1
	Drain Valves	100 – 300	38 – 149	200 – 300	14 – 20.5	1 – 4	25 – 100	1	1	1

Valves for Delayed Coking Applications

Continuous Innovation

As a continuous improvement to valve design for delayed coking applications, MOGAS constantly tests and validates their valve designs. For example, MOGAS performs its own high-cycle testing, dynamic torque testing and stem strain gauging to identify the areas of greatest wear in a valve. Also, data is taken from the field to determine the exact amount of service duty that should be applied to actuator and valve stem sizing. This helps avoid valve and actuator failure from increased torque.

MOGAS' R&D group is responsible for new product developments and intensive research projects in areas such as nanotechnology coatings and fluid dynamics. Over the years their technology advancements have resulted in dozens of MOGAS patents and have solved many customer problems.



Coating characterizations are analyzed to understand microstructural properties for conformance to specific specifications.

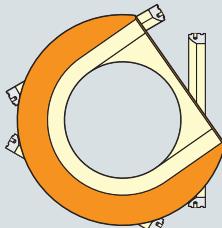
Valves for Delayed Coking Applications

	Key Features	Size, in (dn)	Pressure Class	Body Materials	Maximum Temperature, ° F (° C)
	ISOLATOR 2.0 Low Pressure Isolation Valves • full bore • 2-piece forged body • bi-directional • blowout-proof stem	1 to 12 (25 to 300)	150 to 600	F316*, A105, F9	800 (427) *1000 with 410 Trim (538)
	T-Series Trunnion • Metal or soft seat • Reduced operating torque • Smaller actuator requirements • Blowout-proof stem	3 to 60 (80 to 1500)	150 to 2500	300 Series, Carbon Steel, Chrome Molybdenum	400 (204)
	C-Series Customizable Isolation Valves • engineered specifically for customer application • 2-piece or 3-piece cast or forged body • blowout-proof stem • VORTEX PURGE™	4 to 36 (100 to 900)	150 to 4500	300 Series, Carbon Steel, Chrome Molybdenum	1500 (815)
	DV-4 Coker Switching Valve • patented bonnet reduces coke build up • oversized outlet • purge and drain flush • reliable seat springs	6 to 16 (150 to 400)	600 to 900	A217-C12, A217-C12A, A351-CF8M, A182-F9, A182-F91, A182-F316	1000 (538)

*Other materials are available upon request.

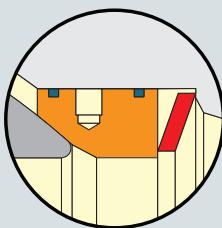
Reliable Switching

DV-4 Features and Benefits



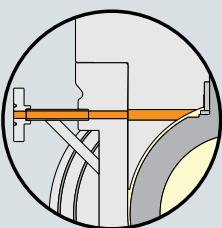
1 Patented oversized outlet

- Permits higher flowrate during switching (90 to 100% compared to less than 60%)
- Minimizes backpressure and coke accumulation in heater



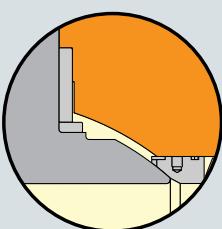
2 Semi-trunnion (sleeve and seat ring supports ball)

- Maintains alignment and equalizes wiping forces
- Prevents uneven seat loading and leakage
- Lowers steam consumption by sealing body cavity
- Keeps process media out of body cavity
- Reduces torque



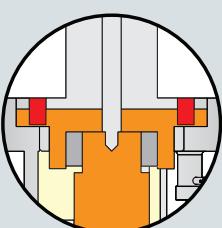
3 Belleville springs with seat rings

- Lowers steam consumption by eliminating bellow spring purge inlets
- Eliminates prone-to-fouling bellow springs



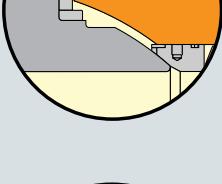
4 Patented, optimized purge system

- Simplifies installation using manifolds for two purge inlets and two purge outlets
 - one packing purge
 - three body purges
 - two drain purges
- Increases switching reliability via body cavity flushing; evacuates body cavity media before and after switching using purge outlets
- Lowers steam consumption; appreciable steam consumption only during switching and body cavity flushing



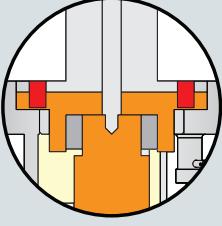
5 Integral flange connections

- Prevents lock-up of the valve due to pipe loads (especially at warm up) because the seats are not coupled to the end flanges



6 Patented bonnet

- Reduces area for coke build-up
- Simplifies repair and trim replacement via true top entry design



7 Patented two-piece stem adaptor

- Prevents stem and actuator damage using sacrificial pins

8 Dual stem guides

- Prevents misalignment and packing leaks due to side loads

9 Extended mounting bracket

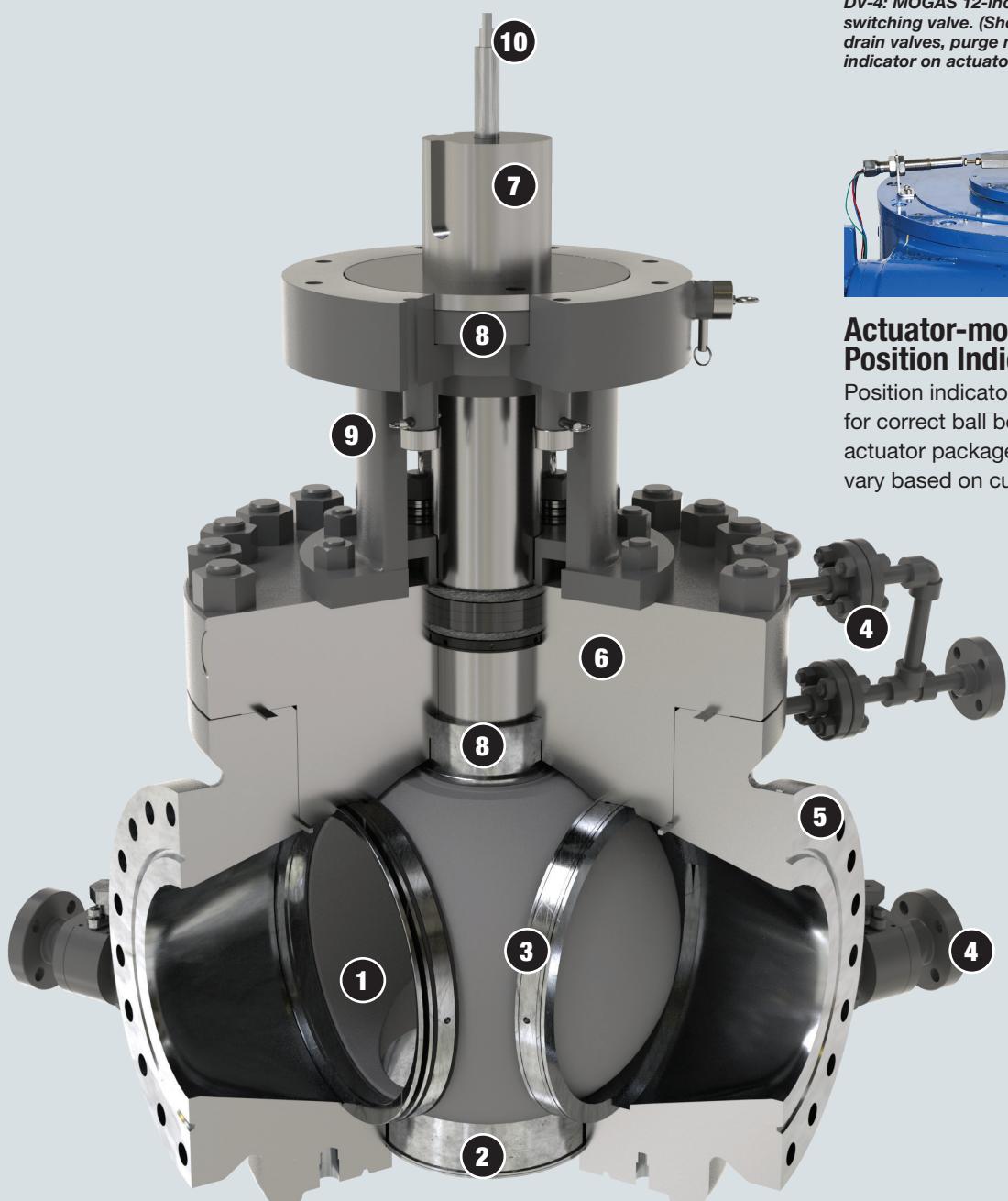
- Allows room for ease of packing maintenance
- Prevents electric motor and gear from high temperature exposure

10 External stem extension rod

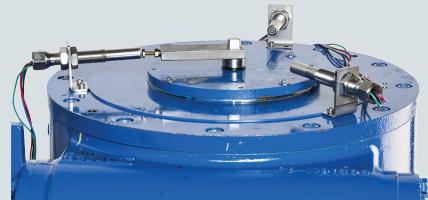
- Indicates true flow and ball bore position
- Verifies flow direction with actuator removed



The DV-4 switch valve features many advantages over existing ball or plug valves on the market today. Backed by innovative R&D, world renowned after sales service and a reputation for quality, the DV-4 represents product advancements in delayed coking switching operations.



DV-4: MOGAS 12-inch, ASME 600 Class, 4-way switching valve. (Shown with ISOLATOR 2.0 drain valves, purge manifold and position indicator on actuator—detailed below.)



Actuator-mounted Position Indicator

Position indicators on actuator align for correct ball bore position (Note: actuator packages and configurations vary based on customer requirements.)

Absolute Isolation

C-Series Features and Benefits

Common Features for the MOGAS C-Series Valve Line

1 Floating ball design

- Rotating ball does not displace volume or solids
- Straight-through bore path protects sealing surfaces

2 Pressure-energized sealing

- Seat springs maintain constant sealing contact between ball and seats
- Allows for thermal expansion of trim
- Sharp leading edge seat ring technology proven in decades of heavy coking applications 'wipes' sealing surface each time the valve is operated

3 Wide seat sealing surface

- SphereSealSM lapping process on ball and seat set provides 100% sealing contact through the full transition between the open and closed position
- Greater sealing contact area withstands minor scratches or abrasions

4 Independent replaceable seats

- Minimizes maintenance and repair costs

5 Blowout-proof stem design

- One piece design meets industry safety standards
- Withstands severe service torques and maximum working pressures

6 Dual-guided stem design

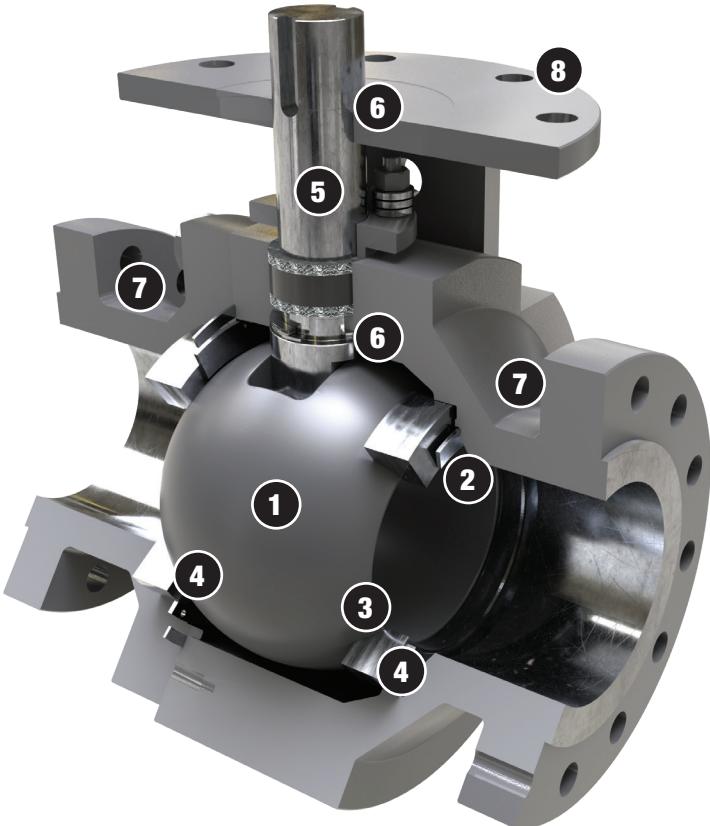
- Pressure-energized inner stem seals serve as thrust bearing and lower stem guide
- Valve stem bushing serves as upper stem guide
- Eliminates lateral movement of valve stem
- Prevents media migration
- Prevents stem packing leaks and risk of fugitive emissions

7 Forged or cast body & end connections

- Greater wall thickness in critical areas provides longer valve life
- 2- or 3-piece designs

8 Heavy-duty mounting flange

- Machined after attaching to ensure precise stem alignment
- Provides structural support for operator mounting
- Provides visual inspection for confirmation of ball position



Application Specific Options

Seat designs	Engineered for maximum performance in application-specific conditions
Live-loaded packing	Ensures constant packing energization Prevents stem packing leaks and risk of fugitive emissions
Body Gaskets	Pressure energized body gasket available to meet industry codes
Materials	Application-specific materials available, including exotics Extends valve life
Coatings	Application-specific coatings provide enhanced erosion and corrosion resistance
Liners and inlays	Liners and inlays can be applied to the through-bore or wetted surfaces
Purge ports	Purge ports are available
End connections	Available end connections include flanged, welded, hub/clamp or RTJ

Case Study

Cutting Water Pump Isolation

Challenge

As the only isolation valve between the pump discharge and cutting tools in a delayed coker unit, tight shut-off is essential. Cutting water valves handle suspended coke fines in recycled feed water under high pressure of 3500 to 5000 psi that erode components.

In 2011 a major South American oil and natural gas plant suffered significant damage to the coke drum in their delayed coker upgrader unit that created financial and safety problems. This damage was caused by leaking valves, which leaked shortly after installation, and were repaired at least annually.

When in the closed position to isolate, the valve—a competitor's 6-inch, ASME 2500 Class valve originally sold as part of the pump package—leaked large amounts of water through the valve's packing onto coke drums, causing the drum to bulge and deform. This, coupled with the country's high humidity, caused the thermal insulation on the coke drum to fail. Coker drums reach 925° F (496° C), and the heat from the uninsulated drum was suffocating to plant employees. The leaking water also produced an unsafe environment on the upper deck, and dripped on to instrumentation and wiring on the lower deck creating a safety hazard.

By 2014 it was recognized that ongoing maintenance to these valves was not a viable solution. Potentially, three months of lost production in a single train can accumulate \$9M, or \$100K per day, in lost production revenue, while drum repair costs \$4M. Personnel safety costs are even higher.

Solution

In early 2016 the plant replaced the leaking valves with MOGAS 6-inch, ASME 2500 Class, model CST-1 valves. This industry-proven valve is engineered specifically to perform in slurry and high erosion applications, and features:

- a tracking seat design for true bi-directional shutoff that prevents build-up of coke fines behind downstream seat
- leak-free Grafoil packing and a pressure-energized stem seal that prevents solids accessing stuffing box
- HVOF chrome carbide-coated seats prevent erosion
- Belleville springs that maintain correct seat position for absolute sealing
- Mate-lapped ball and seats with wider sealing surface for absolute shut-off

Results

Almost three years later all MOGAS valves continue to reliably perform as promised under the PERFORMANCE GUARANTEE program. Employee safety and operational efficiency allow the plant to perform profitably, and plant engineers and operations staff have confidence in future uninterrupted production.

Conditions

Application:	Cutting Water Pump Isolation in Delayed Coker
Temperature:	150° F (66° C)
Pressure:	4,205 psig (290 bar g)
Valve Model:	CST-1
Valve Size:	6 inch (150 dn)
No. of Valves:	9



Leaking water from a competitor's valve caused damage to the coke drum's thermal insulation.

"MOGAS valves absolutely isolated our high pressure cutting operation where other valves leaked."

Senior Plant Engineer

Purging

In Delayed Coker Applications

MOGAS has established an industry model for purging philosophy, nomenclature and design. As such, there are up to four purging locations in the ball valve design, which may be incorporated or utilized in combination and quantity for delayed coker applications.

Philosophy

MOGAS delayed coker purging philosophy is to flush and clear the body cavity with steam after each valve cycle. When the valve is not cycling, the purge line remains 'ON' to maintain a positive pressure boundary of steam between the process media and the valve body cavity; minimum consumption of steam occurs. This prevents coke and other contaminants from entering the valve body since steam is only consumed when the valve cycles. The total steam consumption is significantly reduced compared to the current industry standards.

To prevent coke buildup, MOGAS recommends the following:

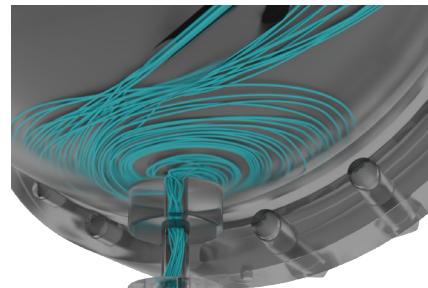
- Use restricted orifices in purge lines to control the flow rate while maintaining purge pressure higher than the process pressure.
- Purge steam pressure must be at least 30 psig above process line pressure.
- Steam must stay dry (super-heated) at all time.
- The valve is designed to operate using a common steam header split into parallel, multiple purges into the body.
- The addition of a drain system is recommended on valve models that receive process buildup in their body cavity. This improves valve operability and extends valve life.

To significantly reduce total purge steam consumption, couple steam purge operation with flush/drain operation to clear coke debris and enable intermittent purging at fully opened and closed positions.

Connections

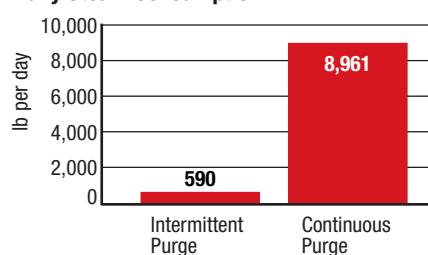
Although socket weld connections are supplied as standard on all purge connections, purge lines are socket welded to valve body and pipe connection end is typically flanged. MOGAS can offer different connection ends to accommodate customer piping specifications.

All purge connections are in accordance with customer and process licensor exact specifications.



MOGAS' patent-pending VORTEX PURGE™ flush concept is more efficient than the typical purge design to remove trapped coke buildup in the valve body cavity.

Daily Steam Consumption



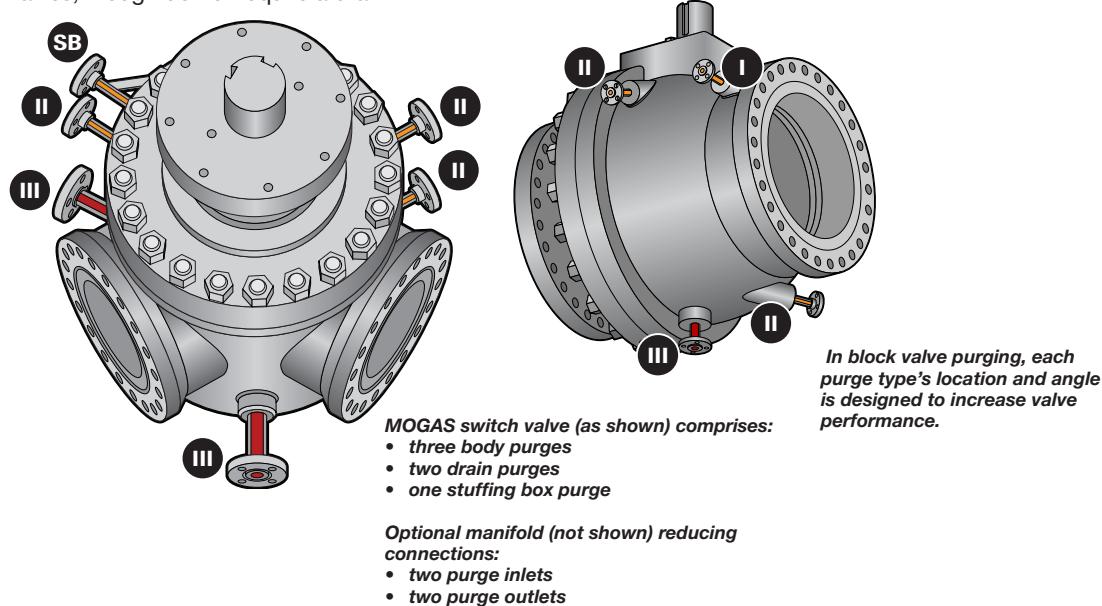
Estimated daily steam consumption at two-cycles/day and using MOGAS recommendations, including flush/drain intermittent flow.

Purge Types

Switch valves require three body purge inlets and two drains to effectively reduce coke build-up in the valve. The three **Type II** body purge connections and one stuffing box (**SB**) connection are active at all times during coker unit operations. The two **Type III** drains are opened only for short intervals before and after the switching operation. Although body purging is continuously engaged to maintain positive cavity pressure, steam consumption is minimized when the valve is not switching. This is because of the precisely engineered sealing clearances that isolate the body cavity from the process media.

Block valves include drum feed and bypass isolation functions located around the switch valve, and at other isolation locations on the delayed coker unit. The purge configuration here is two **Type II** body purges for full cavity coverage, one **Type I** seat purge and one **Type III** drain. As in the switch valve, purge is continuously on, and the drain is operated for brief periods before and after the valve is actuated. Here too, steam purge consumption is minimized or virtually eliminated. However, the process sealing capability is improved in accordance with API 598, depending on valve size and media going through the valve.

Overhead Vapor Valves have a similar purging philosophy and layout as block valves, though do not require a drain.



TYPE	DESCRIPTION	PURPOSE	FLOW PHILOSOPHY	MOGAS PHILOSOPHY	MOGAS OPERATION
Type I	Seat Pocket	Protects spring cavity from solid formations	Continuous or Intermittent	Intermittent (block or overhead valves)	Valve cycling = high volume purge flow; Valve fully open/closed = reduced purge flow
Type II	Body Cavity	Keeps body cavity pressurized. Cleans during purge/drain process.	Continuous or Intermittent	Intermittent	Valve cycling = high volume purge flow; Valve fully open/closed = reduced purge flow
Type III	Drain	Clean during purge/drain process before/after cycling valve	Intermittent	Intermittent	When activated, converts Type I and Type II purges into continuous flow for all valve positions.
SB	Stuffing Box	Maintains positive pressure boundary in the packing chamber	Continuous or Intermittent	Intermittent	All valve positions = no flow

Service

Global Capabilities



We provide exceptional service for unique locations—everyday, everywhere.



Service evaluations by MOGAS engineers can identify areas for performance improvements, such as at this coking unit in Central Asia.

Service Excellence in Action

When you select MOGAS products, service is a big part of what comes with them. The MOGAS commitment to service means more than basic repairs. It also means timely access to our knowledgeable and experienced team of experts—anytime, anywhere in the world. And when our team becomes part of your team, you can trust that we will do everything we can to come through for you.

When you have a problem, our technical advisors get to the root of it. They will look at your entire application to accurately identify and solve the issue. Using a comprehensive approach helps you improve equipment reliability and operational efficiency, as well as reduce costs. Our core services include:

Project Support

- Installation, startup and commissioning
- Shutdown planning and implementation
- Procurement and contract management

Preventive Maintenance

- Complete system inspection
- Routine maintenance, valve repacking
- Valve asset management

Repair, Refurbish & Customization

- 24-hour emergency response
- Troubleshooting
- Valve performance analysis
- 3D finite analysis
- High pressure testing
- Online repair documentation

MORE™ Asset Management Plan

Featured Services

+1 (844) 6-GET-MORE

On-site Services

Buying a critical severe service valve can have serious consequences if not installed properly. MOGAS service technicians are available to help ensure the reliability, safety and dependability of your operations and our MOGAS isolation and / or rotary control valves.

- Start-up and commissioning assistance
- Field support and troubleshooting
- Quarterly walkdowns
- Major shutdown planning

Managed Inventories

Excess inventory or unavailable replacements can be quite costly. By evaluating critical path valves and traditional run-to-failure timelines, the **right** inventory can be readily available when needed. The

MORE Asset Management Plan can help with

- Revolving dedicated inventory
- On-site inventory
- Eliminating inactive inventory, lowering plant costs.

Certified Training

When choosing from the menu of services offered through the **MORE** Asset Management Plan, one of the optional items is certified training. This can range from ongoing multiple half-day sessions to lunch-n-learns to hands-on interactive instruction. Classroom training includes valve explanations, proper valve installation / operation, actuator setting, and more. Participants receive troubleshooting guides and training materials, and certificates for Continuing Education requirements upon completion of each class.

Valve Management Program (VMP) Online

The MOGAS Valve Management Program (VMP) is an online tool that collects valuable data that MOGAS engineers use to analyze the dynamics and kinematics of each valve and associated activities to maintain optimal valve performance. The VMP is available to authorized plant personnel 24 hours a day / 365 days a year through the internet.

This quick availability of data offers instant knowledge, including standard documentation of:

- Bill of materials
- Test certificates
- Valve assembly drawings
- Actuator drawings

Data Storage

- History tracking
- Repair history
- Performance analysis reports
- Incident reports
- Valve repair cost
- Valve torques
- Revised BOMs
- Revised drawings

Customized Data Reports

The data uploaded into the online VMP can be arranged to create output reports, graphs and other information for the user to track Key Performance Indicators (KPIs).

Predict and Improve Performance

By examining a company's history of valve purchases and repairs, recommendations can often be made for expenditures resulting in significant overall cost savings.

Get **MORE**™...with MOGAS.

MANAGING OPERATION & REPAIR EXPENSES

- *Improved Safety*
- *Enhanced Reliability*
- *Predictive Maintenance*
- *Anticipated Budget*
- *Less Downtime*
- *Value Pricing*

Order Tracking

Delivery deadlines, planned installation dates, scheduled outages and turnarounds are all thrown off if the equipment is not on-site and ready to go. The ability to check online the status of valve orders (both open and closed orders) can be extremely helpful in avoiding expediting costs.

Walkdown Evaluations

Severe service valves, and the equipment they protect, represent significant capital investments for a plant. To protect that investment, improve safety, and increase the performance of a facility, customers may choose to participate in a non-biased inspection of valves.

These inspections offer a review of your operations, coupled with our technology to detect issues related to leaks, torque, noise or cycling. Customized reports, along with recommendations, are then presented to plant managers or reliability engineers, as well as operations and maintenance personnel.

Confidence for Tomorrow

A Warranty is Not a Performance Guarantee



CONFIDENCE
PREDICTABILITY
RISK FREE DECISIONS
IMPROVED SAFETY
ENHANCED RELIABILITY
LESS DOWNTIME
ANTICIPATED BUDGETS
LIFETIME WARRANTY

Only from MOGAS

Due to continuous years of research and development, coating improvements, proven manufacturing techniques and application experience, we now offer an unprecedented application-specific PERFORMANCE GUARANTEE on our metal-seated isolation and control valves. Years of continual valve performance analysis, field reports and statistical service data from around the globe provide the information required to guarantee our valves for a performance time period. Now every MOGAS valve comes with a statistically driven, application-specific PERFORMANCE GUARANTEE... *plus a Lifetime Warranty on materials and workmanship.*

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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