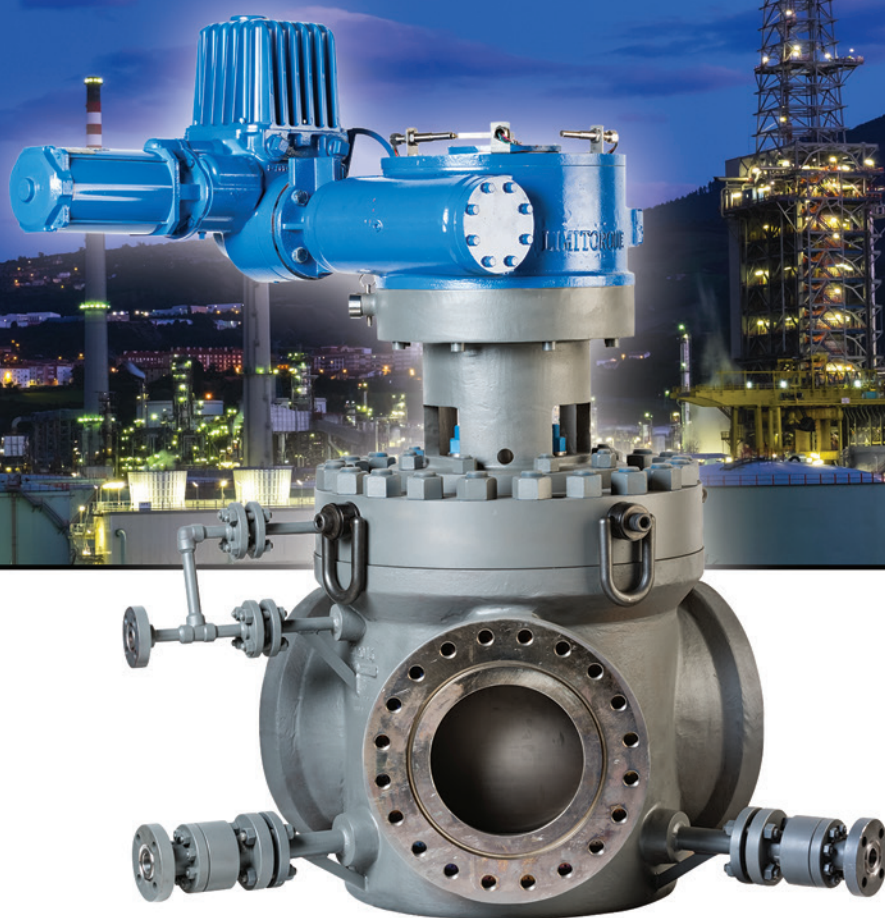


Valves for Delayed Coking

Increased reliability. Increased run time.



MOGAS[®]

Superior Designs

Reliable. Durable. Safe.

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

The coking batch process requires 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, product could leak into an off-line drum causing a safety hazard to the personnel.

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 heavy coking application. Over the decades of working in partnership with end users, technology licensors and EPCs, MOGAS has become 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 valves with purge require much less steam than competitive designs, saving thousands of dollars annually in energy costs.

Also, MOGAS engineers work directly with the Service department to do 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.

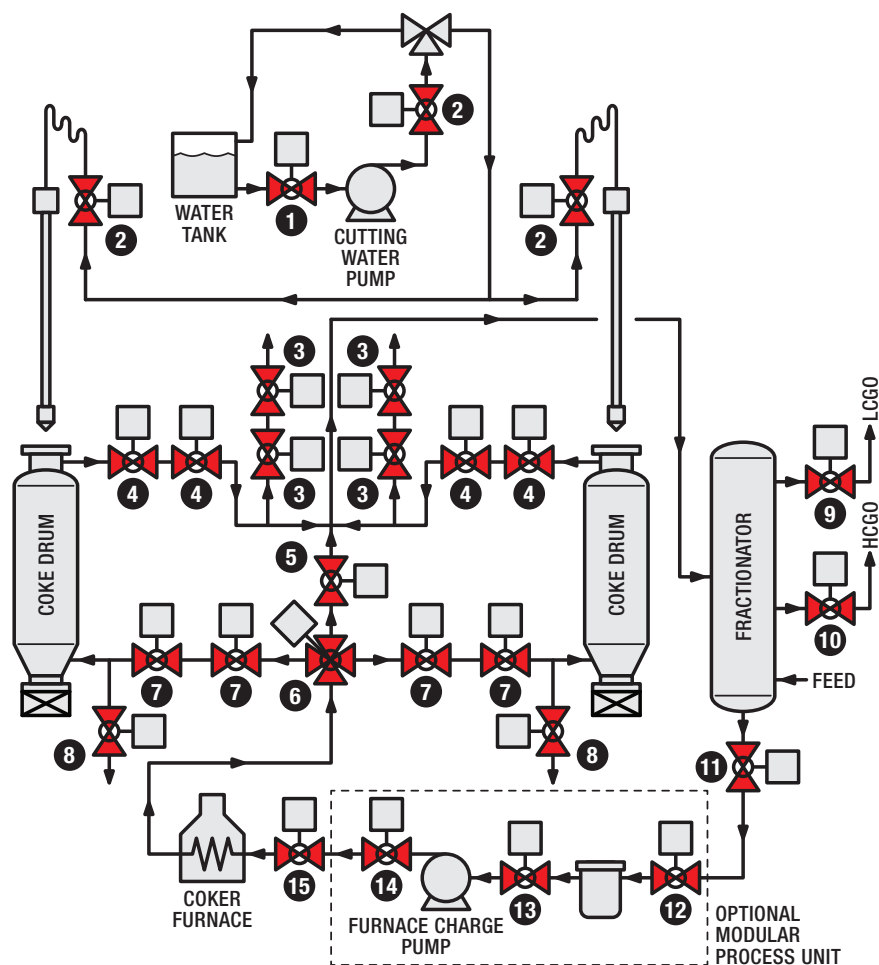


Above: One of several MOGAS 6-inch, ASME 2500 Class C-Series valve sits atop a coke drum in a South American refinery's water cutting application. This industry-proven valve is engineered specifically to perform in slurry and high erosion conditions.

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 – 900° F / 260 – 482° 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.

² Valves 16 and 17 are not represented on process flow diagram.

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 | ISOLATOR 2.0 | T-Series |
| 1 | HP Pump Inlet Isolation | 100 – 200 | 38 – 93 | 50 | 3.5 | 3 – 6 | 80 – 150 | | ● | ● |
| 2 | Cutting Water Pump Isolation | 100 – 200 | 38 – 93 | 2000 – 3000 | 138 – 207 | 3 – 6 | 80 – 150 | ● | | ● |
| 3 | Quench Extraction | 800 – 900 | 427 – 482 | 200 | 14 | 8 – 14 | 200 – 350 | ● | | |
| 4 | Overhead Vapor Isolation | 800 – 900 | 427 – 482 | 30 | 2 | 16 – 36 | 400 – 900 | ● | | |
| 5 | Coke Drum Bypass Isolation | 800 – 900 | 427 – 482 | 550 | 38 | 8 – 14 | 200 – 350 | ● | | |
| 6 | Coke Drum Switching | 800 – 900 | 427 – 482 | 550 | 38 | 8 – 16 | 200 – 400 | ● | | |
| 7 | Coke Drum Feed Isolation | 800 – 900 | 427 – 482 | 550 | 38 | 8 – 16 | 200 – 400 | ● | | |
| 8 | Quench Extraction Isolation | 800 – 900 | 427 – 482 | 550 | 38 | 3 – 6 | 80 – 150 | ● | | |
| 9 | Light Coker Gas Oil Pump EBV | 300 – 600 | 149 – 316 | 50 | 3.5 | 4 – 10 | 100 – 250 | | ● | |
| 10 | Heavy Coker Gas Oil Pump EBV | 300 – 600 | 149 – 316 | 50 | 3.5 | 4 – 10 | 100 – 250 | | ● | |
| 11 | Frac Bottoms EBV | 500 – 850 | 260 – 455 | 50 | 3.5 | 8 – 16 | 200 – 400 | ● | | |
| 12 | Coke Filter Isolation | 500 – 850 | 260 – 455 | 50 | 3.5 | 4 – 10 | 100 – 250 | ● | | |
| 13 | Furnace Charge Pump Inlet Isolation | 500 – 600 | 260 – 316 | 50 | 3.5 | 4 – 10 | 100 – 250 | ● | | |
| 14 | Furnace Charge Pump Discharge Isolation | 500 – 600 | 260 – 316 | 550 | 38 | 10 – 16 | 100 – 400 | ● | | |
| 15 | Furnace Feed Isolation | 100 – 300 | 38 – 149 | 80 | 5.5 | 4 – 10 | 100 – 250 | ● | | |
| 16 | General Utility Valves (Steam, Water, Condensation) ² | 100 – 300 | 38 – 149 | 200 – 300 | 14 – 20.5 | 1 – 4 | 25 – 100 | | ● | ● |
| 17 | Drain Valves ² | 100 – 300 | 38 – 149 | 200 – 300 | 14 – 20.5 | 1 – 4 | 25 – 100 | | ● | ● |

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, they do their 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 due to coke build-up.

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.

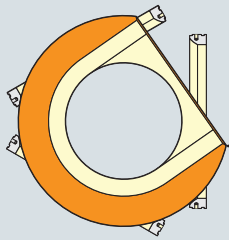


Four 20-in ASME 300 Class overhead vapor valves have been installed since 1991 at this refinery in Kansas, USA. After eight years of continuous service, less than 0.001 inch of the coating was worn away.

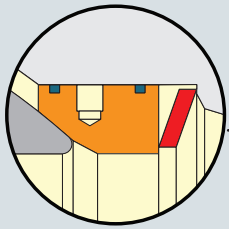
| Valves for Delayed Coking Applications | | | | | |
|---|---|-------------------------|----------------|--|--------------------------------|
| | Key Features | Size, in (dn) | Pressure Class | Body Materials | Maximum Temperature, ° F (° C) |
|  | ISOLATOR 2.0 Low Pressure Isolation Valves <ul style="list-style-type: none">• full bore• 2-piece forged body• bi-directional• blowout-proof stem | 1 to 4 (25 to 100) | 150 to 600 | F316, F9, F53, A105, F22, Ti Gr 12 | 850 (454) |
|  | T-Series Trunnion <ul style="list-style-type: none">• Metal or soft seat• Reduced operating torque• Smaller actuator requirements• Blowout-proof stem | 3 to 60 | 150 to 2500 | 300 Series, Carbon Steel, Chrome Molybdenum | 400 (204) |
|  | C-Series Customizable Isolation Valves <ul style="list-style-type: none">• engineered specifically for customer application• 2-piece or 3-piece 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 <ul style="list-style-type: none">• patented bonnet reduces coke build up• oversized outlet• purge and drain flush• reliable seat springs | 6 to 16 (160 to 400) | 600 to 900 | A217-C12, A217-C12A, A351-CF8M, A182-F9, A182-F91, A182-F316 | 900 (482) |

Reliable Switching

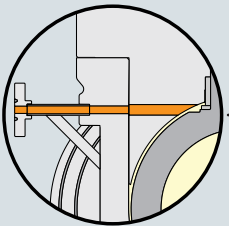
DV-4 Features and Benefits



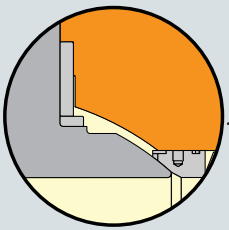
- 1 Patent-pending oversized outlet**
- Permits higher flowrate during switching (90 to 100% compared to less than 60%)
 - Minimizes backpressure and coke accumulation in heater



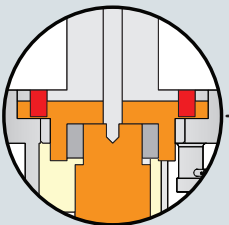
- 2 Semi-trunnion (sleeve and seat ring supports ball)**
- Maintains alignment and equalizes wiping forces
 - Prevents uneven seat loading and leakage
 - Lowers steam consumption by sealing body cavity
 - Keeps process media out of body cavity
 - Reduces torque



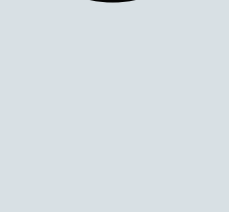
- 3 Belleville springs with seat rings**
- Lowers steam consumption by eliminating bellow spring purge inlets
 - Eliminates prone-to-fouling bellow springs



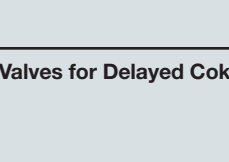
- 4 Optimized purge system**
- Simplifies installation using manifolds for two purge inlets and two purge outlets
 - one packing purge
 - three body purges
 - two drain purges
 - Increases switching reliability via body cavity flushing; evacuates body cavity media before and after switching using purge 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 Patent-pending bonnet**
- Reduces area for coke build-up
 - Simplifies repair and trim replacement via true top entry design



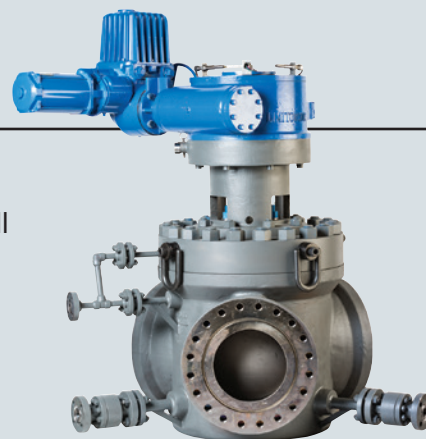
- 7 Patent-pending two-piece stem adaptor**
- Prevents stem and actuator damage using sacrificial pins

- 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.

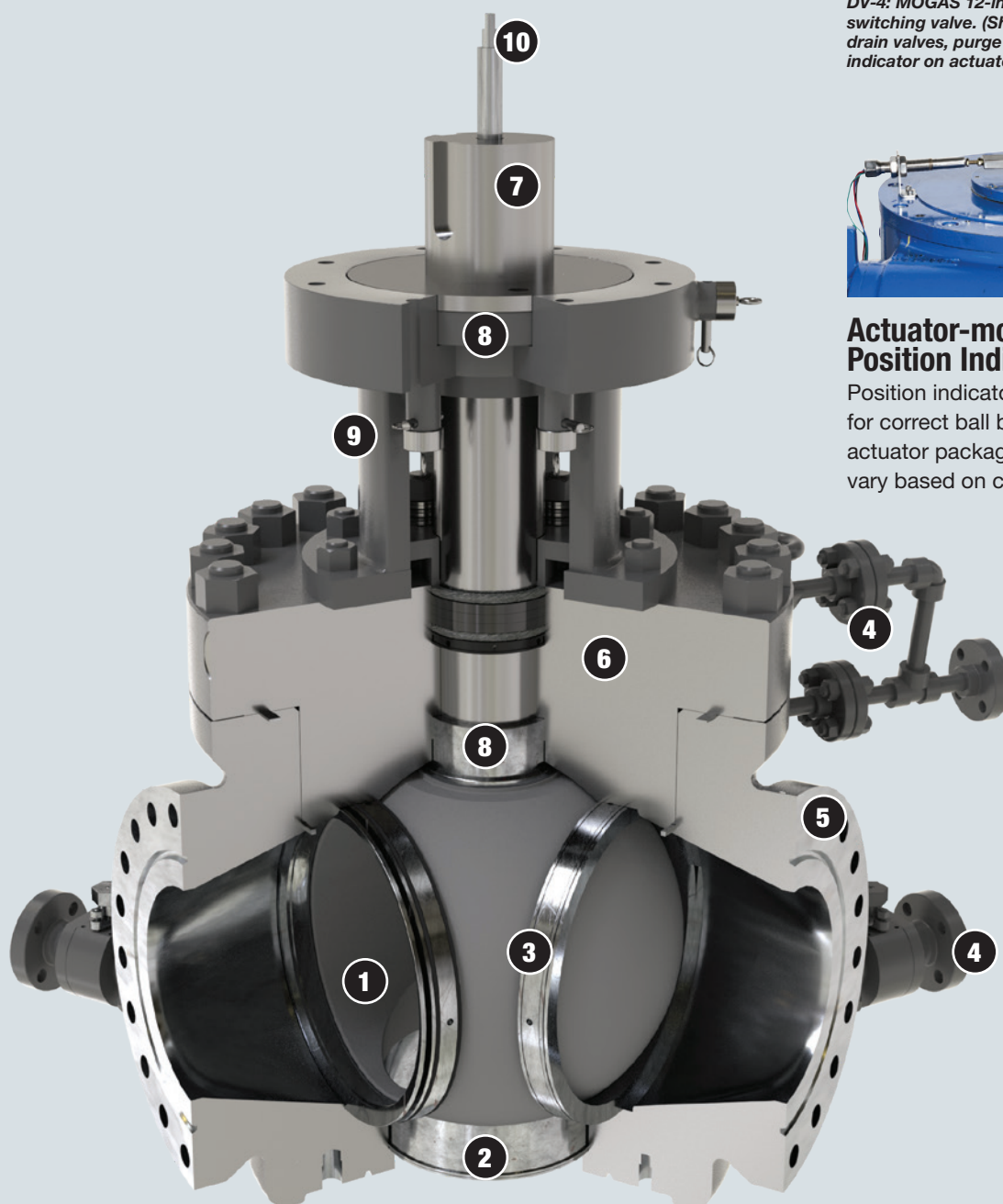


DV-4: MOGAS 12-inch, ASME 600 Class, 4-way switching valve. (Shown with ISOLATOR 2.0 drain valves, purge manifold and position indicator on actuator—detailed below.)



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
- Metal seats wipe sealing surface of ball clean during operation

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

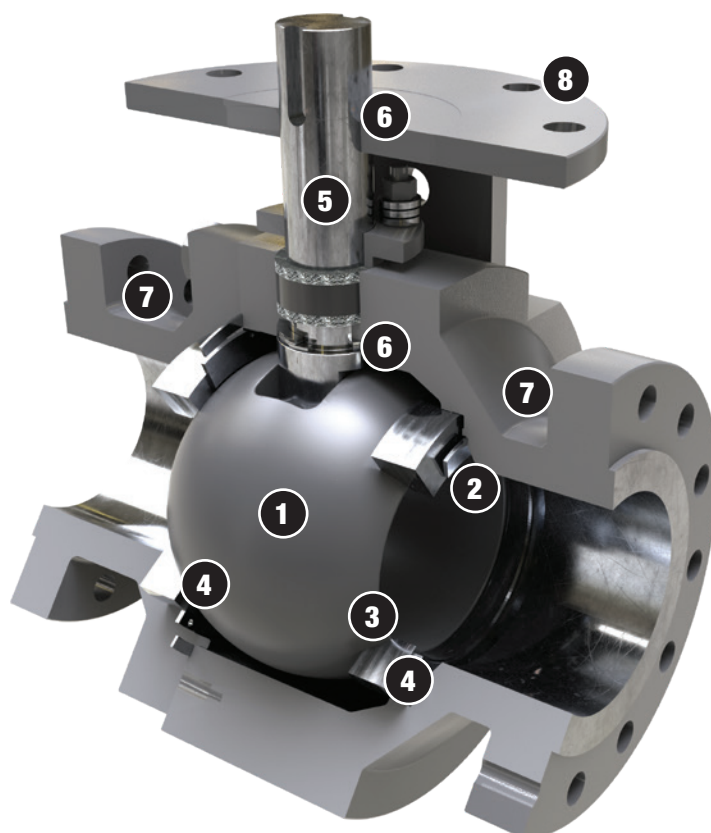
- Pressure-energized inner stem seals serve as thrust bearing and lower stem guide
- Valve stem bushing serves as upper stem guide
- Eliminates lateral movement of valve stem
- Prevents media migration
- Prevents stem packing leaks and risk of fugitive emissions

7 Forged 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

Water Cutting 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. Water cutting 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 slurry build-up behind downstream seat
- leak-free Grayfoil 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: | Water Cutting 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 unitized 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 required and is essential to remove process buildup from the body cavity and to maintain valve operability.

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

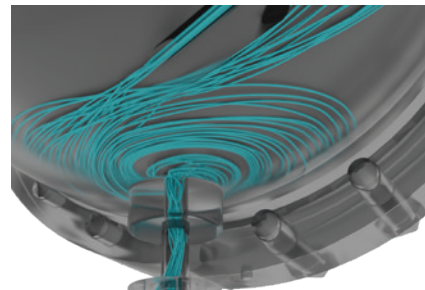
Although socket weld connections are supplied as standard on all purge connections, MOGAS can offer different connection ends if requested by the customer to accommodate customer piping specifications.

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

Panels

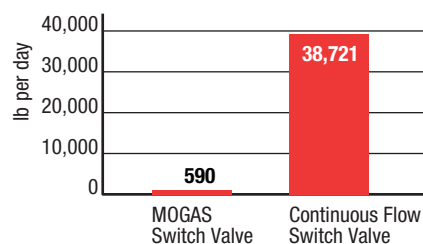
Important to a coker purging system is the proper design and use of specifically engineered purge panels. These minimize the amount of steam through purge ports and maximize the benefit of having purge integral to each valve application.

Each purge type and each purge fluid receives a custom engineered solution to managing its purge. Some applications require more flow, while many require little to no flow at all. Some applications only require a purge envelope to maintain optimal efficiency of keeping the valve clean and ready to operate.



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.



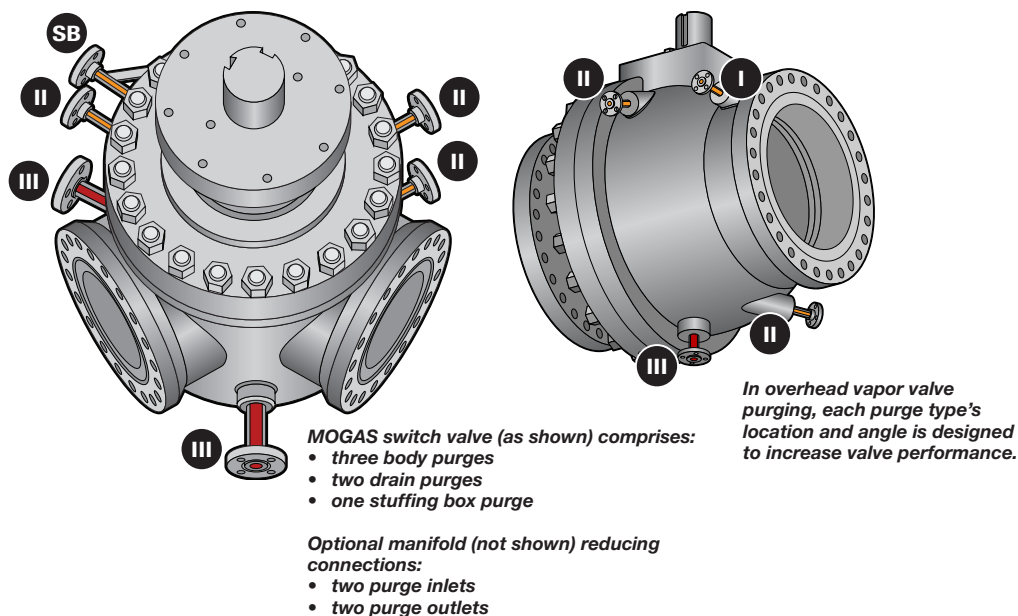
Multiple purge input lines can be combined into a shared cabinet based on geographical location of the purged valves in the plant.

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 to a Class IV or Class V, depending on valve size and media going through the valve.

Overhead Line Valves have a similar purging philosophy and layout as block valves.



| 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.



MOGAS valves are designed to be repaired in situ. Balls, seats and springs are easily replaced; no measurements or preloading are required.

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

Asset Management Plan

Optimize Your Investment

Getting more **value** for every dollar is now more important than ever. To help **minimize your total cost of ownership** while truly benefiting from predictive maintenance, MOGAS offers the **MORE™ Asset Management Plan**—a totally customizable valve purchase and service plan. Whether you buy a few valves or several hundred valves, you can choose from a variety of options to help optimize your investment.

On-site Services

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

Managed Inventories

- Revolving dedicated inventory (located and managed at MOGAS facility)
- On-site inventory (for emergency use)

Walkdown Evaluations

- On-site inspection of installed valves
- Customized reports

Valve Management Program (Online)

- Initial setup, input, links to P&ID and maintenance reports
- Repair history
- Performance analysis reports
- Incident reports
- Valve repair cost
- Valve torques
- Revised bills of material
- Revised drawings
- Predictive / preventive maintenance recommendations

Certified Training

- Lunch-n-learns
- Valve installation & operation (hands-on)
- Maintenance & troubleshooting

Get **MORE™**...with **MOGAS®**

MANAGING OPERATION & REPAIR EXPENSES

- *Technical Assistance*
 - *Dependable Operation*
 - *Preventive Maintenance*
 - *Data Collection*
 - *Proactive Communications*
 - *Value Pricing*
-

Confidence for Tomorrow

A Warranty is Not a Performance Guarantee



CONFIDENCE

PREDICTABILITY

RISK FREE DECISIONS

IMPROVED SAFETY

ENHANCED RELIABILITY

LESS DOWNTIME

ANTICIPATED BUDGETS

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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www.mogas.com**