TechTalk

Understanding purging system design in heavy-fouling applications

Outline

Purging for Delayed Coking

In high-fouling applications such as heavy oil processing and delayed coking operations, asphaltenes have a tendency to harden and adhere to the ball and seats, and to the internal surfaces of the valve body. Once this occurs, internal clearances become clogged, increasing the required valve break torque and potentially resulting in valve lock-up.

Purging has been demonstrated to be effective in numerous field applications to minimize the detrimental effects of solids build-up. MOGAS recommends purge systems that are designed specifically for valves in delayed coking applications to maximize their operating service life.

The hardening of coke significantly increases break torque from start-of-run to end-of-run, and may eventually cause valve seizure or lock-up.

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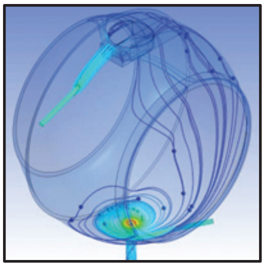

Purging valves in delayed coking applications is critical for a successful operation.

What is Purging?

Purging is the process of injecting a purge media into one or more areas of the valve to minimize the effects of asphaltene accumulation and solids formation (coking)—caused by stagnant and cooled process media—from interfering with the valve operation and/or reducing the valve service life. Purge systems can also include a drain from the valve body to flush the valve cavity to prevent process buildup before and after valve cycling.

In delayed coking applications the purge media is steam, which is introduced at an application-specific temperature and at a pressure that is typically two atmospheres above the process media pressure. Since the purge is always supplying steam to the valve—or 'always on'—it is often referred to as 'continuous purge'.

However, depending on whether the purge area in the valve is sufficiently sealed, it will result in a continuous or intermittent flow:

- Continuous flow: Purge is operating and continuously flowing into the process media. The steam is usually in contact with the process media in this case.
- Intermittent flow: Purge is operating, but not continuously flowing. The steam has no direct contact with the process flow while the valve is in the open or close position. Since there is no direct contact with the process flow, the steam does not flow, but continues to maintain a positive pressure boundary of steam between the flowing media and the body cavity, essentially preventing coke and other contaminants from entering the body cavity.

Why Purge?

Purging in valves is used to:

- prevent solids buildup inside the valve cavities
- prevent internal damage to materials and coatings, thereby extending the life of ball and seats between shut-downs
- prevent an increase in cycling torque
- maintain tight shut-off
- maintain operability of pressure-measuring instruments
- provide valve warm-up in specific applications
- allow draining of trapped liquids
- provide an indication of valve sealing performance measured by purge media consumption

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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.

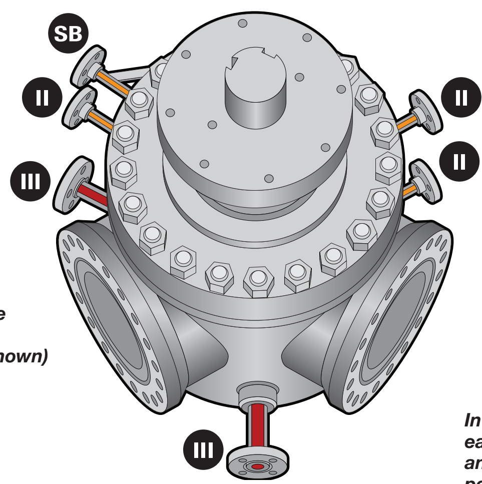
Overhead Line Valves have a similar purging philosophy and layout as block valves.

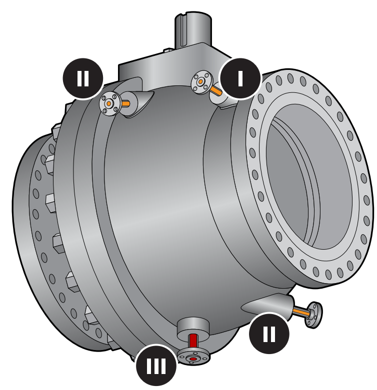
MOGAS switch valve (as shown) comprises:

- *three body purges*
- *two drain purges*
- *one stuffing box purge*

Optional manifold (not shown) reducing connections:

- *two purge inlets*
- *two purge outlets*





In overhead vapor valve purging, each purge type's location and angle is designed to increase valve performance.

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

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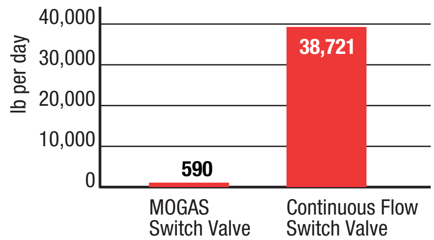
Daily Steam Consumption



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

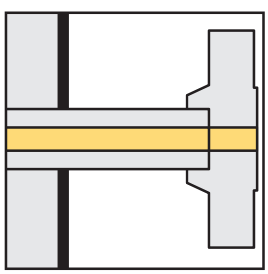
MOGAS Philosophy

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 restriction 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) and clean at all times.
- 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.



MOGAS incorporates socket weld design connections for all purge connection types.

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, such as:

- Female National Pipe Thread (FNPT)
- Compact Flange
- Raised Face Flange (RFF)
- Ring Type Joint (RTJ)
- Clamp Connector (CL)
- Butt Weld (BW)

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

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

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 operation. 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 for keeping the valve clean and ready to operate.

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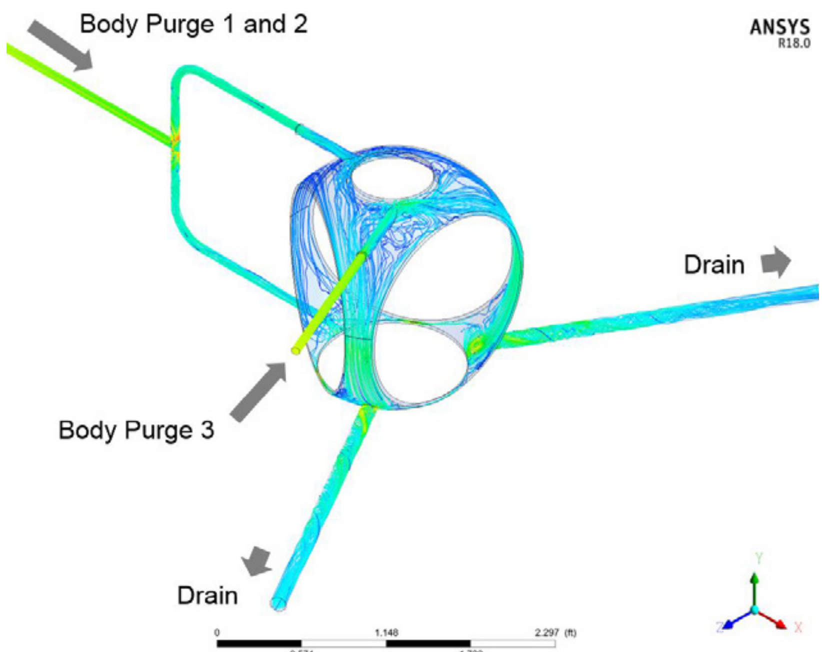
R&D

MOGAS applies the latest technology in every aspect of ball valve design and manufacturing. Computational Fluid Dynamics (CFD) analysis is a major part of the initial design for both the valve and purging systems. MOGAS engineers study CFD results from different purge inlet pressures and flow rates to fully optimize purge coverage in critical valve cavities prone to lock-up.

An effective purge system minimizes steam consumption, improves valve performance and reduces operational and maintenance costs.

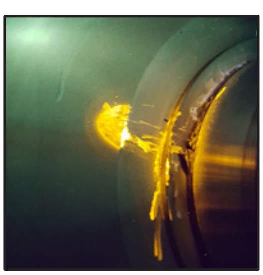


CFD switching valve results show that three body purge inlets combined with two purge outlet drains are enough to cover all valve internals and obtain optimized steam purge coverage.

Additionally, ANSYS Fluent Fluid-Structure Interaction (FSI) is used to determine thermal stresses from the mixing of process and purge fluids at different temperatures.

Test Validation

CFD findings are validated through Fluorescent Microsphere (FM) polymer particles to trace purge flow paths and ensure full purge coverage. Different colored FM particles are injected into the purge ports using a six-jet collision nebulizer and, after disassembling the valve, the FM tracing particles are observed under UV light.



CFD results were validated using fluorescent paint to verify flow coverage predicted by CFD analysis.

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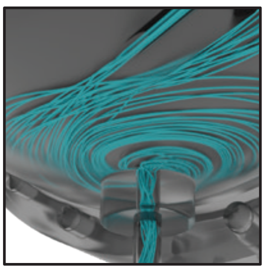
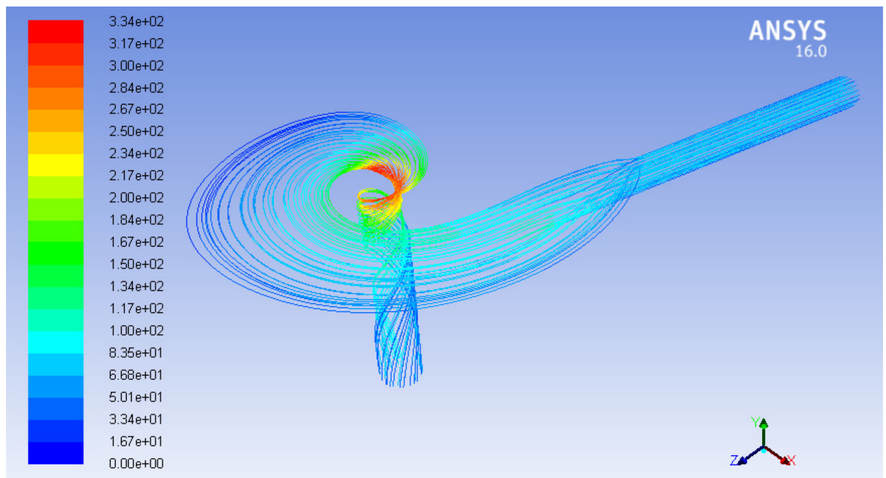
Patent-pending Purge Improvements

Determining the purge location and angle of flow impingement to the ball curvature significantly impacts the trajectory of steam. This unique swirling motion defines MOGAS' patent-pending VORTEX PURGE™ flush method that optimally flushes the bottom of the body cavity and drains residual debris. When compared to typical industry turbulence purges, in mud tests the VORTEX PURGE™ flush design purged 20% more slurry by weight during the same time period.



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.



Conclusion

Purging is effective when established best practices are followed. High-fouling applications, such as heavy oils and delayed coking, benefit from purging through reduced maintenance and downtime, and increased valve service life and performance.

MOGAS is the dominant severe services technology company. We are known for our experience and dedication when working with customers to optimize and solve issues in extreme fouling applications.