Delayed Coking

Process Overview

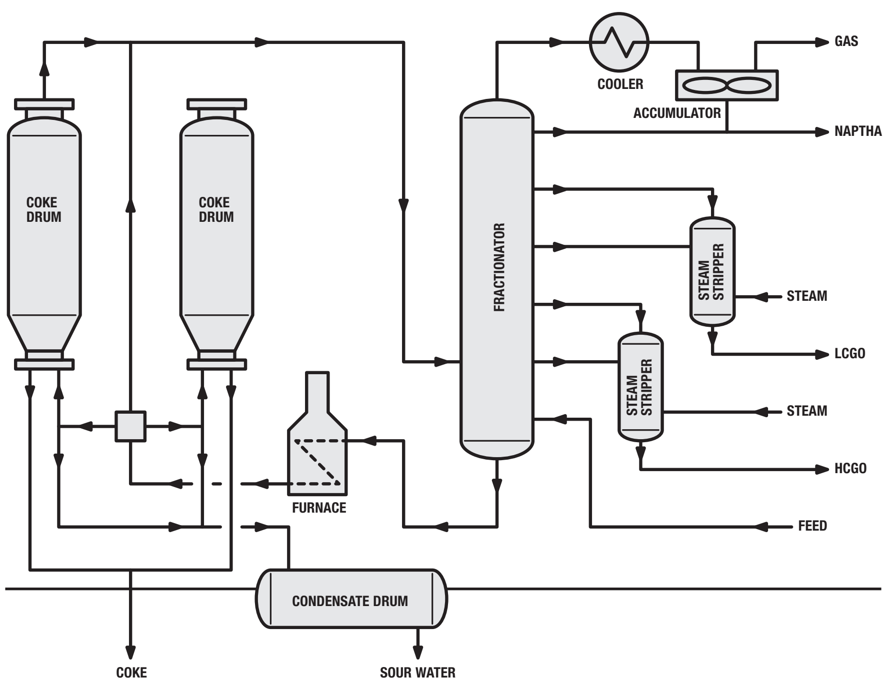
History of the Delayed Coking Process

Petroleum coke was first made by the pioneer oil refineries in Northwestern Pennsylvania in the 1860's. Primitive distillation techniques were used to coke the oil, mainly by boiling oil in stills heated from the bottom by wood or coal fires. By the 1920's the tube furnace with distillation columns were being built, paving the way to the first delayed coker built by Standard Oil in 1929. Delayed coking combined a number of the features and improvements from the development of the thermal cracking process. The use of high temperature for cracking, delaying the coking until the cracked product entered the drum, and the use of two drums enabled the delayed coker to operate on a continuous basis.

The Modern Delayed Coking Process

The delayed coker is the only main process in a modern petroleum refinery that is a batch-continuous process. The flow through the furnace is continuous. The feed stream is switched between two drums. One drum is on-line filling with coke, while the other drum is being steam-stripped, cooled, decoked, pressure checked and warmed up. The overhead vapors from the coke drums flow to a fractionator. This fractionator tower has a reservoir in the bottom where the fresh feed is combined with condensed product vapors to make up the feed to the coker heater.

Simplified Coker Schematic



Delayed Coker Features

Delayed coking is a thermal cracking process used in petroleum refineries to upgrade and convert petroleum residuum (bottoms from vacuum distillation of crude oil) into liquid and gas product streams leaving behind a solid concentrated carbon material—petroleum coke. A fired heater with horizontal tubes is used in the process to reach thermal cracking temperatures of 905° to 941° F (485° to 505° C). With short residence time in the furnace tubes, coking of the feed material is thereby "delayed" until it reaches large coking drums downstream of the heater. Three physical structures of petroleum coke can be produced by delayed coking: shot, sponge, or needle coke. These physical structures and chemical properties of the petroleum coke determine the end use of the material, which can be burned as fuel; calcined for use in the aluminum, chemical, or steel industries; or gasified to produce steam, electricity, or gas feedstocks for the petrochemicals industry.

Delayed Coking

Benefits of MOGAS Valves

Overhead Vapor Valves and Feed Valves

Maintenance-free Operation

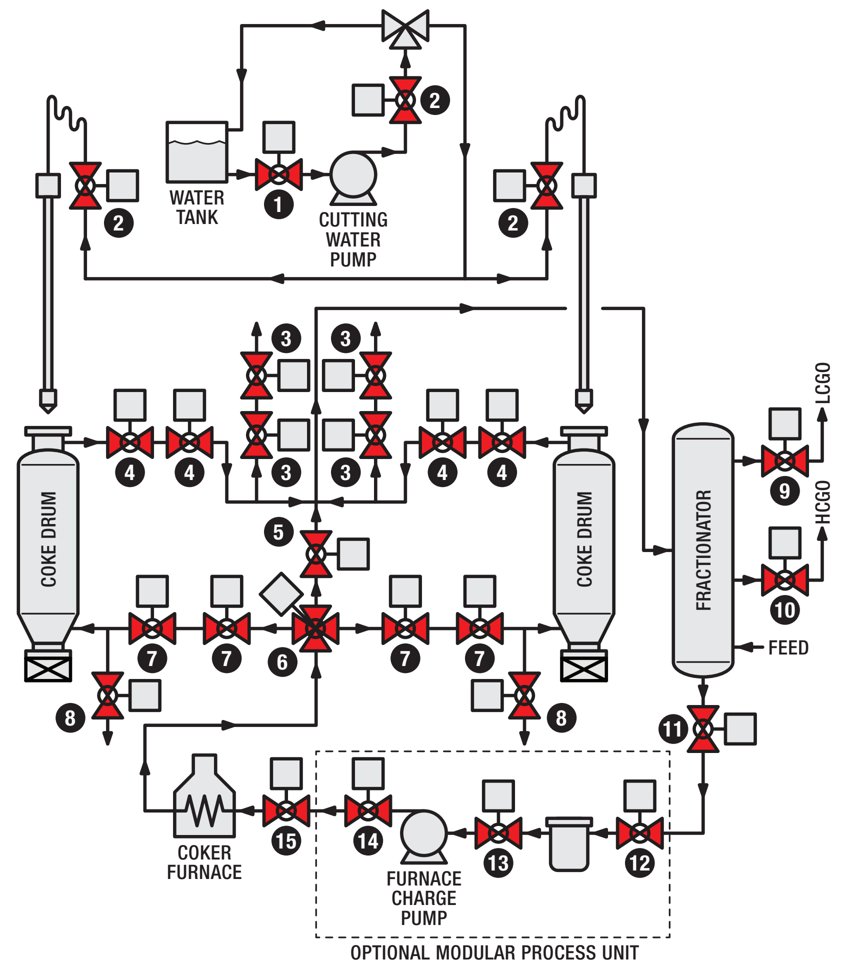
The valves highlighted in this schematic need to operate when called upon because they are part of a sequence of events. One coker drum needs to be filled, while another is isolated and being prepared for the next cycle. This cycle switches back and forth every 12 to 24 hours, depending on the unit's feed rate capacity, which is limited—shorter drum cycles increase total production. If the sequence is upset because a valve locks-up, the refinery cannot move to the next step until the issue is resolved, thus impacting profitability. A coker unit's profitability is dependent on a low feedstock price that is based upon the type of heavy crude bought, and a run-time of 5 to 7 years. Shortening the run time by even one day easily translates as lost revenue. The valves must cycle reliably from full open to full close every time.

Positive Isolation

It is very important to isolate 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 Valve Locations



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Valve Number	Valve Description
1	HP Pump Inlet Isolation
2	Cutting Water Pump Isolation
3	Quench Extraction
4	Overhead Vapor Isolation
5	Coke Drum Bypass Isolation
6	Coke Drum Switching
7	Coke Drum Feed Isolation
8	Quench Extraction Isolation

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Valve Number	Valve Description
9	Light Coker Gas Oil Pump EBV
10	Heavy Coker Gas Oil Pump EBV
11	Frac Bottoms EBV
12	Coke Filter Isolation
13	Furnace Charge Pump Inlet Isolation
14	Furnace Charge Pump Discharge Isolation
15	Furnace Feed Isolation

Watercutting Valves

Positive Isolation

MOGAS excels in this difficult service for a number of reasons:

- The 100% contact of the ball and seat prevents media from being trapped. The wide seats scrape the ball clean of residue with each cycle, ensuring long and reliable valve operation.
- The body gasket, trapped in a metal pocket while exposed to line pressure, is protected from line media.
- The combination of the live loaded stem packing gland, inner stem seal and the stem support bushing protects the packing box from leaks and ensures perfectly perpendicular stem rotation that maintains the integrity of the packing.
- A steam purge port of the body prevents the settling of coke particles by maintaining the media in a liquid state during operation.

MOGAS understands the problems of severe service environments because we employ tenured industry experts and engineers with extensive field experience and valve knowledge.

Drain Valves

Positive Isolation

The coke drum drain valves are used to drain the quench water on the “off-line” drum being prepared to decoke. Positive isolation is important because these valves isolate the process from the atmosphere when the drum is “live”. Leakage can cause a serious safety hazard.

Delayed Coking

Key Features

Ball and Seat Assembly

Critical to the success of a valve in delayed coking services is the valve's capabilities to handle heavy, hard coke and the high cycles required by the application. MOGAS tackles these problems by oversizing the sealing seats and lapping them to achieve 100% contact between the sealing areas of the ball and seats.

MOGAS uses a diamond lapping compound and a final hand lap to mate the seats to the ball. Verification is performed using a "bluing" on the ball surface, guaranteeing a better fit. With 100% contact between the ball and seats, scrapers are created at the edges of the upstream and downstream seats. This ensures a continuous wiping action occurs every time the valve is cycled. This cleans the surface of the ball, ensuring zero leakage and consistent torque over the life of the valve.

The sealing surfaces are wide and in full contact with the surface of the ball 100% after the final mate lapping operation.

With a very wide sealing area of 100% contact, there is lower stress exerted on the seat. This is key considering the size of the valves and the cycles they will perform per year. Considering the valves can be as large as 36" and cycle every 12 to 24 hours, this is a tough service. By lowering the stress on the wide sealing area, it extends the life of the sealing components.

Coating Selection

For coking applications MOGAS uses HVOF Chromium Carbide, which is up to 69 Rc. With this coating the ball and seat assembly have compatible growth rates, preventing bond failure at temperature due to excessive shearing stresses between the base material and coating. This benefit manifests itself in the number of cycles the valve can take.

MOGAS 18-inch ball coating with HVOF chrome carbide.

Thermal Expansion

MOGAS selects the best coating for each application so the ball and seats allow equal growth at elevated temperatures and maintain constant full surface sealing between the ball and seats at high temperatures.

Locked-in Downstream Seat

After MOGAS creates the seal between the ball and seats, a seal is established behind the seat. MOGAS laps the downstream seat into the end connection to achieve a metal-to-metal seal. After "bluing" verifies the seal, retaining rings are used to lock the seat in place, thus eliminating the opportunity for coke to develop behind the seat. When doing routine maintenance, this is easily replaceable.

Delayed Coking

Key Features

Fouling Resistant Upstream Seat

MOGAS uses a proprietary upstream seat that minimizes the effect of coke build-up in this key area. MOGAS' philosophy is to either totally eliminate the gaps around the seats, such as in the downstream seat, or open the area around the seat as much as possible. The thermal spring is moved from the inside diameter of the upstream seat to the outside diameter of the seat, thus creating a large gap between the seat and the body. The large gap keeps the coke build-up from locking up the valve.

In high ΔP applications a second thermal spring is added. Both springs seal against the body and the seat preventing coke build-up between the springs. A purge can be added to this cavity to ensure the space stays clean. Both systems are well proven in the field.

Body Steam Purge Ports

While MOGAS has taken great care to prevent coke build-up behind the sealing seats, we cannot prevent the body cavity from becoming full as the valve strokes. Our floating ball valve design is not detrimental to the operation of the valve, as long as the coke stays hot and pliable. That is the purpose of the purge system we use. It is not meant to clean or prevent coke from developing around the seat cavities, but to keep the coke around the ball hot. This makes our design very forgiving. Wet steam or low-pressure steam can be used in our design without hurting the performance of the valve. The valve can even operate without the steam purging for a period of time. Our design is built to handle the "real world", which means sometimes that the purge system does not have enough pressure or is completely shut-off.

MOGAS highly recommends purge systems designed specifically for valves in high-fouling applications to maximize their operating service life.

Repairability

MOGAS valves are designed to be easily repaired and re-installed in the field. Special features, such as the precision-machined mounting bracket and stem bushing simplify actuator installation. Two-piece inner stem seals allow easy replacement, rather than requiring shop weld-up and machining of worn areas. Balls, seats and springs are easily replaced in the field; no measurements or pre-loading of the components are required.

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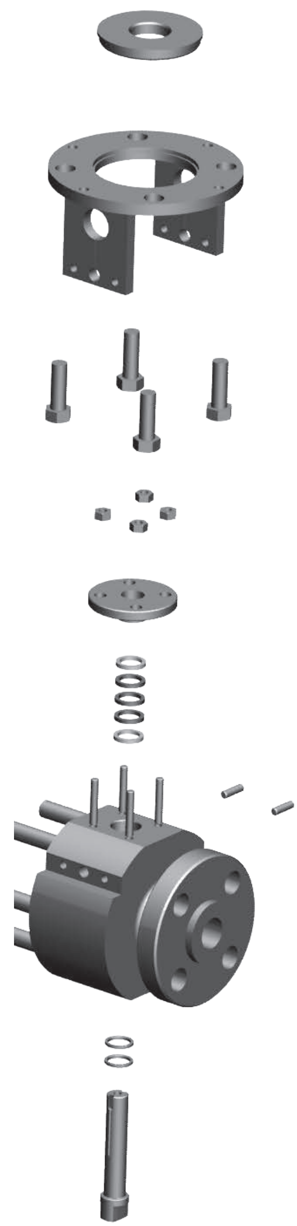
Key Features

Stem Support Bushing

The MOGAS design incorporates a stem bushing above the packing gland and stem. This component—working in unison with the inner bearing supports—eliminates radial stem movement and packing deformation caused by side loading of the stem by the actuator. This eliminates packing failures.



Two-Piece Inner Stem Seal

The MOGAS design material and coating for coking applications is 410SS Chromium Carbide for the two hard-coated and lapped metal thrust bearings. These serve as a pressure energized inner stem seal, as well as a bearing. This prevents catastrophic packing blowout by keeping the stem aligned and solids from entering the packing chamber, and provides extended cycle life.

Live-Loading of Stem Seal

MOGAS offers live loading on their stem packing gland followers to ensure constant packing energization is provided after both thermal and mechanical cycling. For coker applications, the stem packing is Chesterton 1601/5300.

Stem Area

To prevent galvanic corrosion in the stem because of the coker service conditions—which ‘pits’ the stem and causes leakage in the valve—MOGAS uses upgraded materials that are extremely high strength during high temperatures. In coker applications, the high strength blow-out stem is made of A638 Gr. 660 (optional material is 410SS), which is a precipitation hardened, iron based, super alloy bar for high temperature service.

MOGAS®
SEVERE SERVICE BALL VALVES