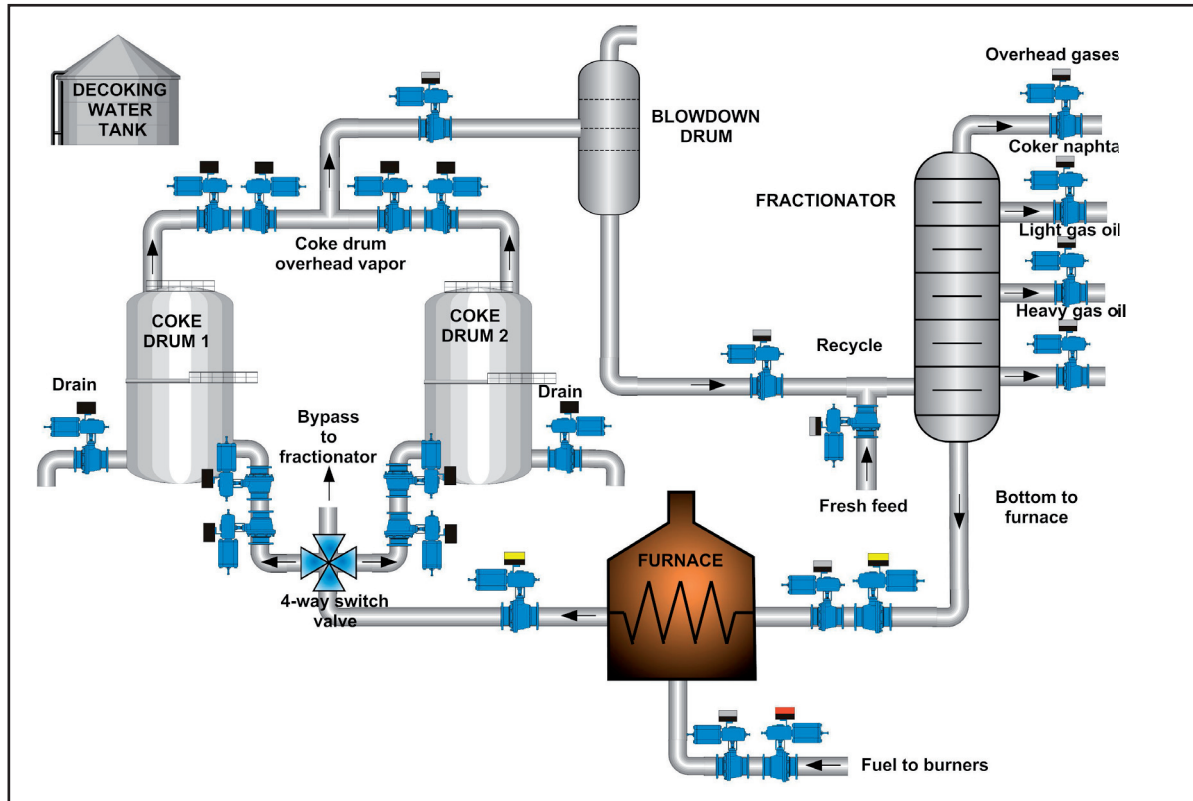


Delayed coking - coke drums



Process overview

Delayed cokers are used for converting large volumes of heavy residuum to more valuable transportation fuels. Flexibility in operation and long-term goals in key-equipment selection is important in design strategy. Continuous operation is important for profitable delayed coking. The entire coking process is typically grouped into three general sections – furnace and fractionation, coke drum and coke handling and the closed blowdown areas. The exact configuration will vary upon refinery's specific design strategy and existing processing capabilities. The most common feedstock is vacuum residue; however, other heavy oil streams are used, such as visbroken tar, slurry oil, tar sands and pitches.

The fresh feed combined with distillate recycle is heated in the feed preheat exchanger train to about 280 – 320 °C. The preheated residue is sent to the bottom of the fractionator before heating in the furnace to about 500 °C. High-pressure steam or boiler feedwater is injected into the furnace coils for optimum velocity and residence time to control the coke formation in the tubes. The coke drums downstream the furnace provides reaction time for sufficient coking reaction and collection of solid coke formed. While one coke drum is being filled for a fixed cycle time, typically 16 to 18 hours, the other coke drum undergoes the cooling, cutting, and drum preparation steps. The closed blowdown system maximizes hydrocarbon and water recovery, provides cooling for the coke drums and minimizes air pollution during normal operations.

Delayed coking challenges

The target of delayed coking process is to start cracking the heavy feedstock in coking furnace and complete the cracking and coking in the coke drums downstream the furnace. Coking in other process equipment, furnace, fractionator and coke drum overhead line cannot be completely avoided. This must be taken into account throughout the delayed coking process when selecting valves for control, on-off and ESD-applications.

Health, Safety, Environment – Valve leaking poses both an environmental and safety issue due to risk of fire, toxicity and volatility of gases. Emergency shutdown and on/off valves must be able to perform their action in a process or equipment failure.

Top-class products at maximum yield – The market calls for clean products and high quality. It is important that the process is stable, flexible and under control. Proper control valve performance in furnace and fractionation improves the accuracy of throughput control and adversely affects to the plant performance and also the downstream processes.

Maintenance costs - Critical valves in coke drum switching, isolation, draining and overhead control play an extremely important role in successful coke drum and overall process performance. Poorly performing valves in the process must be serviced because they will have a direct impact on the efficiency of the process.

Plant run-time – Refineries are looking for longer plant run-times since downtime means production losses and is a remarkable cost including maintenance costs. This requires reliable equipment and process control.

Metso solutions

We are all tuned up to answer these challenges through our refining application experience and product offering for control, safety and automated on/off duty that ensure high valve performance in delayed coking plants. Our application specific automated coke drum valves are designed for efficient and reliable process operation.

Safety - Metso is the only single source emergency shutdown valve supplier who has the experience and knowledge to combine intelligence with most reliable valves and actuators. Technology selections like rotary stem operation and inherently fire safe design ensure that latest emission and fire safety standards can be applied. Reliable valves with first intelligent, SIL3 approved safety valve controller and partial stroke testing system Neles ValvGuard™ will ensure that plant emergency shutdown valves will always perform properly when needed.

Efficiency - Throughput losses due to heavy residue sticking and poor control performance will be avoided with intelligent control valves. Flow through the process unit may be changed as the need arises with rangeability of 150:1 and further with full bore ball valves. Our advanced intelligent digital valve controllers for control, on-off and ESD applications ensure high positioning accuracy and fast response. Correct valve selection and sizing with our Nelprof-program we can assure the best valve performance and process control.

Availability - Simple rotary designs, same face-to-face dimensions, and global service network and inventory management will help you to optimize your maintenance activities. Rotary valves have been in service for several years without requiring maintenance and show no sign of leakage. The proven performance of Metso valves with long lasting metal seat tightness and shut-off capabilities makes them an ideal solution for control, on-off and critical coke drum applications.

Reliability - Valve performance trend data collected by our smart valve controllers and analysed by Metso FieldCare, open FDT/DTM technology based configuration and condition monitoring software, makes it possible to predict and respond to maintenance requirements and reduce unscheduled downtime. This gives full transparency to the valve performance in process control.

Coke drum applications

Since there are typically 12 critical valves involved in the coke drum operation, valve performance plays a key-role in the operation to minimize operations expense and to ensure coke production and equipment. Effective operation of coke drums increases productivity and extends process up-time. With our enhanced steam purging system, current installations have exhibited an extended service life. Seven years maintenance free operation with Metso delayed coker valves gives potential cost savings of USD 540.000 in maintenance costs alone.

4-way switching valve (1)

Challenge - This is a very challenging application due to the variety of fluids and service parameters. Valves must handle high pressure, heavy residuum at an elevated temperature. As the coker feed (vapor-liquid combination) exits the coke heater it is prone to heavy coking. Residence time in the heater is very short in order to minimize coke accumulation, due to severe thermal cracking, in the heater. The feed then passes through the 4-way switching valve and into the active coke drum. Another critical function of the 4-way switching valve is to keep the



Figure 1. Metso 4-way switching valve for a customer in the USA

feed moving either to drum A, drum B, or to bypass. Once heated above the thermal cracking temperature, any valve, pipe, vessel or pump that the fluid is allowed to stop in will fill with solid coke, rendering it useless.

Metso solution – With over 25 year of experience, the series Y4, 4-way switching valve, is another example of Metso’s commitment to technological leadership through design excellence.

Benefit – Maximum process efficiency is achieved by fully automated Metso 4-way switching. The erosion resistant Cr-Mo body is capable of providing long service life in process conditions of heavy residuum. Our non welded body construction with integral steam purges eliminates the need for expensive and demanding weld heat treatments that conventional purges need.

Metso Service Centers can efficiently refurbish these 4-way switching valves, increasing return on investment and reducing unplanned maintenance costs. Our customers have experienced mainte-

nance free operation of 7 years with average maintenance cost savings of USD 140.000 for each 4-way switching valve.

Coke drum isolation valves (2)

Challenge - The coke drum isolation valves are required to flow and isolate in both directions. When the coke drum is active, the pair of valves is open to admit the charge. When the drum becomes inactive for decoking and cleaning, this isolation valve must allow for the flow of steam, water and coke in the reverse flow direction. This fluid is the result of the decoking process and is abrasive in nature. Fluid is then removed from the system through the coke drum drain valve. At the same time, the second coke drum isolation valve must isolate to prevent the back-flow of decoking slurry to the 4-way switching valve.

Metso solution – For coke drum isolation the rugged design features of the Metso series MBV full bore metal-seated ball valve, make it the superior application choice. With Metso’s advanced calculator the steam consumption of all critical valves can be calculated very accurately.



Figure 2. Metso MBV coke drum isolation valve

Benefit – There is no room for errors when handling this heavy residuum that is processed in the delayed coker. If the product is allowed to creep into the ball/seat or steam bearing areas, the valves will just seize up in no time at all. Not only do they seize up, but it is almost impossible to get them clean again. Take it from a valve rebuilding expert who worked on this project, “It’s the toughest nastiest tar you’ll ever see in your life.” So that’s why purging play such an important part of all critical coker valve’s design.

Our customers have experienced maintenance free operation of 7 years with average maintenance cost savings of \$400.000 for each pair of coke drums.

Overhead vapor line valves (3)

Challenge - Vapor rises out of the active coke drum during normal operation. It passes through both overhead vapor line valves and the overhead vapor line control valve on its way to the fractionator.

During decoking, the overhead vapor line valve closest to the now inactive drum must isolate on its upstream side. This prevents the steam, water and coke that result from the decoking process from entering the overhead vapor line and contaminating the product rising out of the other active coke drum. Simultaneously, the second valve of the pair must isolate on its downstream side. This prevents product rising out of the active drum from being wasted by mixing with the decoking effluent.

Metso solution – Metso series MBV, full-bore metal-seated ball valves, make it the superior application choice for overhead vapor line service. Metso also offers a line of actuators and instrumentation to suit specific design requirements.



Figure 3. Metso 24" MBV at customer's Coker plant

Benefit – Knowing that steam conservation is also a concern, the actuators on the Metso valves are sized to rotate the valves quickly from full open to full close. Typically, all of the stroking times on any size of 2-way valve are under one minute. This means that a minimal amount of steam will be used to keep the accumulation of residuum under the ball to an absolute minimum. Metso also precisely calculates steam flow into all purge ports. We recommend orifices at each purge port that control a constant steam flow rate to each purged area thus minimizing the total steam required. Less steam means more profit.

Coke drum drain valves (4)

Challenge - When the coke drum in service is filled to a specific level, the fresh charge from the heater is switched to the empty coke drum. The full drum is isolated, steamed to remove hydrocarbon vapors and cooled by filling with water.

The combination of solid coke, water and steam referred to as decoking effluent is removed from the system through the coke drum drain valve. The fluid pressure and temperature can vary heavily depending on the coke drum operating parameters.

Metso solution –The rugged full-bore, abrasion resistant X-MBV ball valve provides the refiner with superior application performance. Metso manufactures a full line of ball valves that are up to the significant and varied challenges of the delayed coker service, as well as actuation and instrumentation to suit specific design requirements.

Benefit – This again is a very demanding application due to the abrasive nature of the decoking effluent. The full bore CR-Mo body provides excellent abrasion resistance to ensure low maintenance and better reliability.

Overhead Vapor Line Back Pressure Control Valve (5)

Challenge – Demand for better process efficiency requires shorter coke drum cycle time. Faster drum warm-up period is one possibility when reducing the overall cycle time. A conventional method is to hold back pressure with the combined overhead vapor line back pressure control valve. This requires good controllability from the valve assembly.

Metso solution – Metso's special butterfly valve, without seat ring, is the solution for best control performance.



Figure 4. Metso Neldisc special butterfly valve

Benefit – Safe working environment, low fugitive emissions, is ensured with live-loaded packing and a steam purge connection. It prevents the travel of toxic vapors through the packing to the atmosphere. With our sealless design the valve is never sealed to avoid drum overpressurization that is a major safety benefit.

The information provided in this bulletin is advisory in nature, and is intended as a guideline only.
For specific circumstances and more detailed information, please consult with your local automation expert at Metso.

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