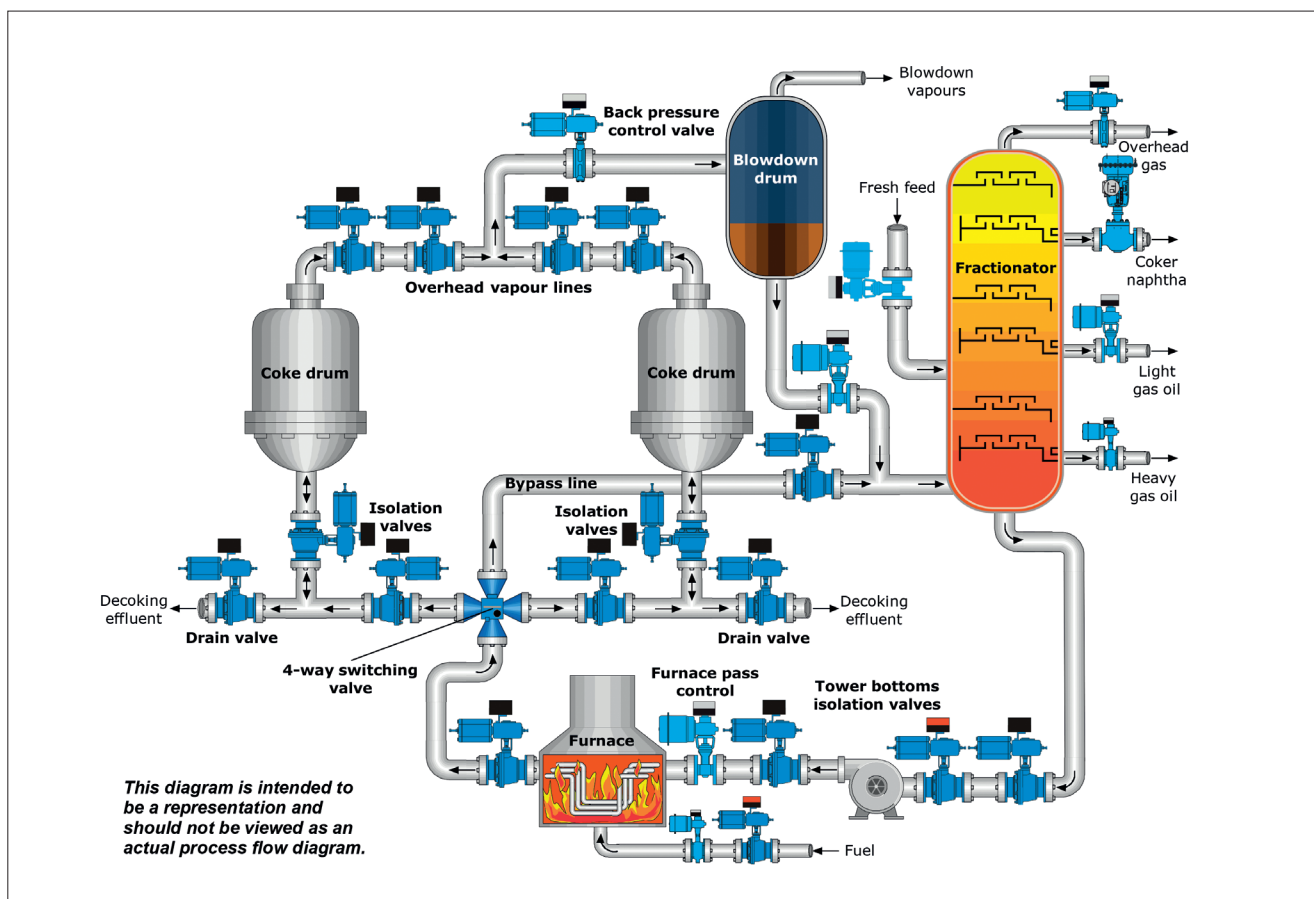


Delayed coking



Process overview

Delayed cokers are used for converting large volumes of heavy residuum to more valuable transportation fuels. Continuous and flexible operation is an important consideration for key equipment to ensure a profitable process.

The entire coking process is typically grouped into three sections – furnace and fractionation, coke drum and coke handling, and the closed blowdown areas. The exact configuration will vary depending on the 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 (540-610 °F). The preheated residue is sent to the bottom of the fractionator before being heated in the furnace to about 500 °C (930 °F). High-pressure steam or boiler feedwater is injected into the furnace coils to optimise velocity and residence time to control the coke formation in the tubes.

The coke drums downstream of the furnace provide sufficient reaction time for coking reactions and make collection of the formed solid coke possible. While one coke drum is being filled for a fixed cycle time, (typically 16 to 18 hours) the other coke drum undergoes cooling, cutting, and drum preparation steps. The closed blowdown system maximises hydrocarbon and water recovery, provides cooling for the coke drums and minimises air pollution.

Coke drum applications

Since there are typically 12 critical valves involved in coke drum operations, valve performance plays a key-role in ensuring a reliable and safe process. 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 Neles delayed coker valves gives potential cost savings of USD 540 000 in maintenance costs alone.

Tower bottoms isolation valves

These valves are used to isolate the feed pump and furnace pass control valves during maintenance.

These valves must be able to provide reliable and tight shutoff (Class V) during maintenance. They must also be resistant to the abrasion caused by the fluid. There is also a risk of solid deposit formation in the valves. A typical temperature is around 380 °C (720 °F) and the pressure is 2.4-3.5 bar (35-50 psi) before the pump and up to 10-35 bar (150-500 psi) after the pump.

Neles™ solution for tower bottoms valves

Neles modular trunnion mounted ball valves are the valves of choice for tower bottoms isolation valves. For ESD-valves, the **intelligent safety solenoid ValvGuard™** with partial stroke testing capability ensures operability in case of an upset.

- **Spiral wound body joint gasket**, ensuring leak free operation
- **Cavitation and noise reduction option**, with the Q-Trim™
- **Anti-blowout valve shaft**, ensuring the safety of personnel and equipment
- **Advanced diagnostics capability**, increasing safety and allowing plant safety targets to be reached more economically
- **Emergency trip test** simulating an emergency condition, reducing the work needed for proof of compliance with safety regulations

Furnace pass flow control

The furnace pass control valve controls the flow of feed into the furnace which heats the feed on its way to the coke drum.

The feed may be dirty causing problems with valves sticking. Valves should also be able to resist gland leaks. The operating temperature is usually around 380 °C (720 °F).

Neles solution for furnace pass control

Neles Finetrol eccentric rotary plug valves for mild design temperature service (< +425 °C/797 °F) and **Neles rotary ball valves** for higher design temperatures.

- **Reduced emissions**, due to rotary operation which is inherently less prone to leaks
- **Improved energy efficiency**, as reliable control reduces process variability
- **Insensitive to pipe stress**, due to rugged one-piece body construction
- **Fire-safe approved**, ensuring secure operation
- **Impurity and cavitation resistant**, with the patented Q-Trim design



Neles Finetrol rotary plug valve

4-way switching valve

As the feed (vapour-liquid combination) exits the furnace it is prone to heavy coking. Residence time in the furnace is very short in order to minimise 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 feed moving to either coke drum or through the bypass line.

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. Once the feed has been 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. Typical conditions are 510 °C (950 °F) and 7 bar (100 psi).

Neles solution for 4-way switching

With over 30 years of experience, **Neles' 4-way switching ball valve**, is another example of our commitment to technological leadership through design excellence.

- **Optimised process efficiency**, achieved by fully automated 4-way switching
- **Long service life** as the Cr-Mo provides excellent erosion resistant in process conditions with heavy residuum
- **Integral steam purges** eliminating the need for expensive weld heat treatments that conventional purges need
- **Scraper seats**, which are mechanically loaded to maintain constant contact with the ball, removing deposits



Neles 4-way switching valve

Coke drum isolation valves

When the coke drum is active, the pair of valves are open to admit the charge. When the drum becomes inactive for decoking and cleaning, the isolation valve closer to the drum must allow for the flow of steam, water and coke in the reverse flow direction. The fluid that results is the 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.

The coke drum isolation valves are required to flow and isolate in both directions. The fluid is the result of the decoking process and is abrasive in nature. 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 seize up in no time at all. Not only do they seize up, but it is almost impossible to get them clean again. That's why purging plays such an important part in all critical coker valve designs.

Neles solution for coke drum isolation

For coke drum isolation the rugged design features of **Neles full bore metal-seated ball valve** make it the superior application choice.

- **Minimised coking in the valve**, as the full-bore design results in only a minimal decrease in fluid velocity ensuring a short residence time
- **Two body purge ports** in the upper and lower part of the cavity, minimising the flow of residue into the area
- **Optimised steam consumption**, as we can, given process data, calculate the required amount of purge very accurately
- **Coke build-up prevention** by having continuous contact between the seat and the ball effectively wiping the seat surfaces with every cycle
- **Upset resistant**, as the valves have been able to operate even after momentary loss of purge steam

Coke drum drain valves

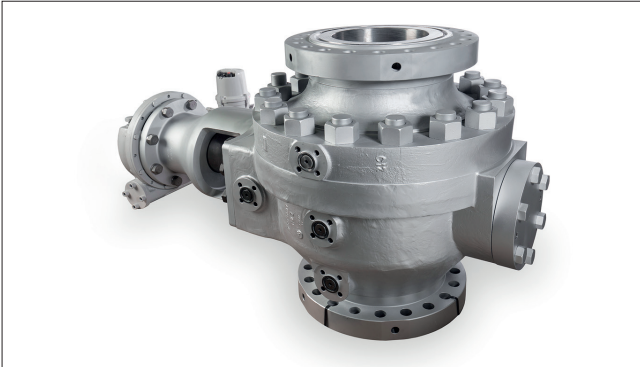
When the coke drum in service is filled to a specific level, the fresh charge from the heater is switched to the empty coke drum. The full drum is isolated and then steamed to remove hydrocarbon vapours and finally cooled by filling it with water. The combination of solid coke, water and steam referred to as decoking effluent is removed from the system through the coke drum drain valve.

This decoking effluent is abrasive in nature, making an abrasion resistant valve required for the task. The fluid pressure and temperature can vary greatly depending on the coke drum operating parameters.

Neles solution for coke drum drain

Neles rugged full-bore abrasion resistant ball valves provide the refiner with superior application performance.

- **Excellent abrasion resistance**, due to the CrMo body, ensuring low maintenance needs and better reliability
- **Low emissions by design**, as rotary operation is inherently less prone to leaks compared to linear valves
- **Simple to automate**, compared to traditional solutions such as wedge or gate valves
- **Field proven maintenance free operation** for periods exceeding six to seven years
- **Fire tested according to API 607**, with select seat and construction designs



Neles ball valve with purge connections

Overhead vapour line valves

Vapour rises out of the active coke drum during normal operation. It passes through both overhead vapour line valves and the overhead vapour line control valve on its way to the fractionator. During decoking, the overhead vapour line valve closest to the now inactive drum must isolate on its upstream side. This prevents decoking effluent from entering the overhead vapour line and contaminating the product. 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.

The valves must be able to provide reliable and tight shut-off. Typically the temperature is around 400 °C (750 °F) and the pressure 4-6 bar (60-90 psi). Optimising steam usage is also a concern to save operating costs.

Neles solution for overhead vapour lines

Neles full-bore metal-seated ball valves are the superior application choice for overhead vapour line service.

- **Tight bi-directional shut-off**, achieved by utilizing a seat that withstands high pressure without damaging the seat seal or bellows
- **Reliable and safe operation**, ensuring that switching between drums is painless
- **Fast stroking times**, as the actuators are sized to quickly rotate the valves, conserving steam
- **High temperature compatible version**, which performs without a hitch in the application temperature range
- **Live-loaded packing** as standard, ensuring long-lasting tightness and low emissions, certified by TA-Luft

Overhead vapour line back pressure control

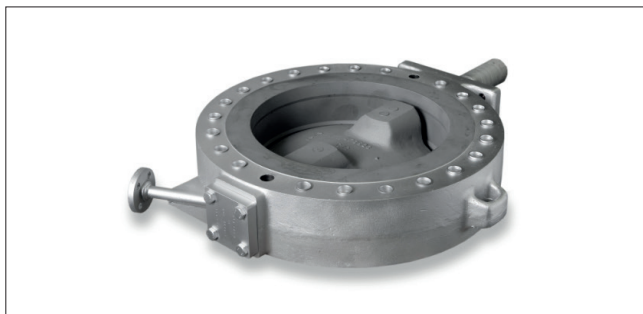
Demand for better utilization of process capacity requires a shorter coke drum cycle time. Hastening the drum warm-up period is one possibility when trying to reduce the overall cycle time. A conventional method of achieving this is to hold back pressure with the overhead vapour line back pressure control valve.

This requires good controllability from the valve assembly. The valve must also be emission proof to prevent hazardous medium from escaping. A safety feature is also needed to prevent drum overpressurization from occurring. Typical process conditions are similar to that of the overhead vapour line valves.

Neles solution for back pressure control

Neldisc™ butterfly valve without a seat ring is the solution for best control performance.

- **No risk of drum overpressurization**, due to the special seatless design of the valve
- **Safe working environment**, as the live-loaded packing prevents toxic vapours from escaping through the packing to the atmosphere
- **Steam purge connection**, allowing the valve to be kept clog-free
- **Low operational torque**, reducing wear and saving costs in actuator sizing
- **Minimised maintenance costs** as the valve has an extremely high cycle life



Neldisc seatless butterfly valve with a purge connection

Benefits

- Longer process runtime
- Meet strict reliability, safety and environmental requirements
- Reduce process variability
- Optimise purge steam consumption
- Reduce production losses
- Minimise maintenance costs
- Robust valve designs

Valmet Flow Control Oy

Vanha Porvoontie 229, 01380 Vantaa, Finland.

Tel. +358 10 417 5000.

www.valmet.com/flowcontrol

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