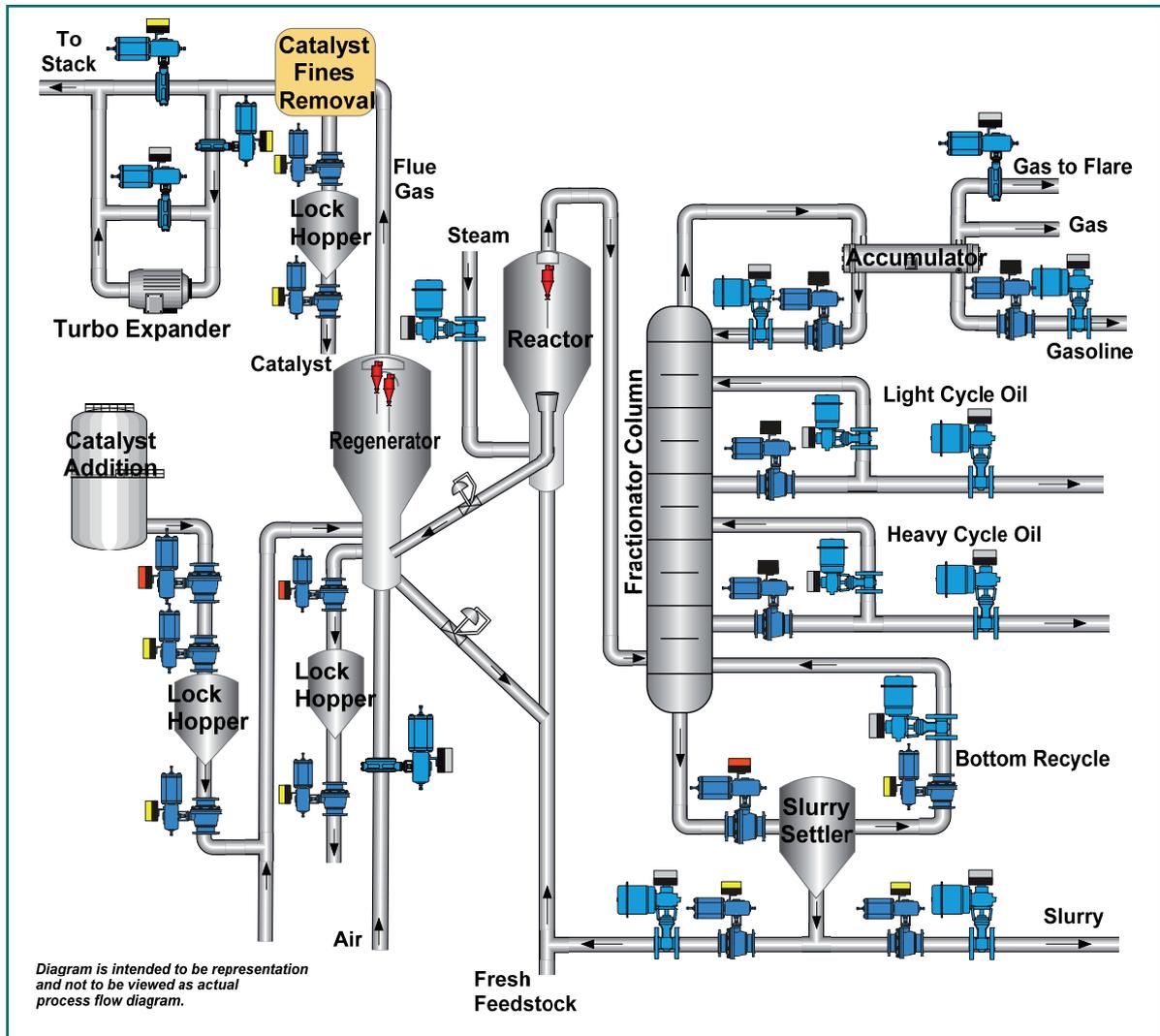


Fluid Catalytic Cracking Unit - FCCU



Process overview

Fluid Catalytic Cracking process is an important and widely used way to convert heavy feedstock into lighter, more valuable products. Various feedstock can be used, such as gas oils, vacuum gas oils or residual materials. Typical products are gasoline, light fuel oils and olefin-rich gases.

Hot catalyst from the regenerator section flows in a fluidized state through the riser tube into the reactor. The incoming feed together with recycling slurry meet hot catalyst, start vaporizing and cracking in reactor.

While the reactions take place, coke is formed on the catalyst. The spent catalyst is separated from cracked material and being regenerated

through burning off the coke. After regeneration, the catalyst is sent back to the reactor with a lot of heat absorbed in regeneration phase. The cracked hydrocarbons enter a fractionating tower, where it is separated into gas, light cycle oil, heavy cycle oil and slurry. The gasoline product has good overall octane characteristics suitable to be used for gasoline blending.

Metso has many valves installed in fluid catalytic units. This application bulletin describes the requirements and Metso flow control solutions available for the FCCU.

Fluid catalytic cracking challenges

Continuous catalyst regeneration makes it possible to manage the high catalyst coking rate. The constancy of the yields is achieved by catalyst cycling between reaction and regeneration, which ensures the reactor is continuously supplied with freshly regenerated catalyst, and product yields are maintained at fresh catalyst levels. It's critical to control the regenerator temperature carefully to prevent catalyst deactivation by overheating and to provide the desired amount of burn-off. **Reliable and accurate control, on-off and ESD-valve performance is important for total process efficiency.**

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 petrochemical products and high quality. It is important that the process is stable, flexible and under control. Proper control valve performance in reactor, regeneration 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 catalyst handling and addition play an extremely important role in successful catalyst regenerating 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 fluid catalytic cracking processes. Our catalyst handling valves have proven performance history and 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, actuators and smart controllers. 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 and poor control performance will be avoided with high performance rotary 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 valve selection software 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 catalyst handling applications.

Reliability – Valve performance trend data collected by our smart valve controllers and analyzed by Neles 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.

Fluid catalytic cracking applications

1. Stripping steam flow control

Challenge – To maintain the catalyst activity at a useful level, it's necessary to regenerate the catalyst by burning off the coke with hot air. As a result, the catalyst is continuously moved from the reactor to regenerator and back to reactor. Remaining oil on the catalyst is removed by steam stripping before catalyst enters the regenerator. The steam supply to the reactor takes place at a temperature at dry saturated steam.

The dilution steam supply valve has typically following general requirements:

- ❑ Accurate control to minimize the steam consumption
- ❑ Noise reduction capabilities

Metso solution

- ❑ Finetrol, eccentric rotary plug valve.

Benefits

- ❑ Wide rangeability with single valve solution for changing steaming needs.
- ❑ Control accuracy to optimize steam consumption.
- ❑ Reliability to ensure effective oil stripping.
- ❑ Q-trim option for noise reduction
- ❑ Compact package with smart positioner for condition monitoring and to identify maintenance needs.



Picture 1. Finetrol

2. Air flow control

Challenge – The cracking process produces carbon (coke) which remains on the catalyst particle and rapidly lowers its activity. To maintain the catalyst activity at a useful level, it's necessary to regenerate the catalyst by burning off this coke with air. Regeneration is a key part of the FCC process. It's critical to control the regenerator temperature carefully to prevent catalyst deactivation by overheating and to provide

the desired amount of burn-off. This is done by controlling the air flow.

A typical air temperature is around 600 °C.

Metso solution

- ❑ Neldisc high performance triple eccentric disc valve

Benefits

- ❑ Good control combined with long lasting tightness
- ❑ Reliable metal seated, bi-directional tightness for long life cycle
- ❑ Highly modular design and material selection for ease of maintenance and valve selection.
- ❑ Economical control valve for low differential pressures.



Picture 2. Neldisc

3. Catalyst valves

Challenge – Continuously catalyst regenerating makes it possible to manage the high catalyst coking rate. The constancy of the yields is achieved by catalyst cycling between reaction and regeneration, which ensures the reactor is continuously supplied with freshly regenerated catalyst, and product yields are maintained at fresh catalyst levels. Catalyst handling valves play an important role in ensuring proper FCC performance. Reliable and accurate control, on-off and ESD-valve performance is important for total process efficiency.

Catalyst handling valves have typically following general requirements:

- ❑ Leak free isolation to avoid waste or inefficient FCC unit performance
- ❑ Medium build-up resistant design
- ❑ Reliable operation to avoid additional spent catalyst in regenerator, which may cause possible catalyst in flue gas and further emission problems

Regenerator extraction valve – The feedstock is vaporized by the hot regenerated catalyst, the cracking begins, and the resultant vapor carries the catalyst upward through the riser. The heat of combustion raises the catalyst temperature to (620 – 845 °C), and most of this heat is transferred by the catalyst to the oil feed in the feed riser. The regenerator/reactor cycle continues until catalyst is spent and removed from process through extraction valve. A typical temperature here is 760 °C.

Flue gas catalyst separation valves – Hot flue gases exit the regenerator through cyclones where catalyst is separated and recycled to reactor. A typical temperature here is 760 °C.

Metso Solution

Neles seat supported ball valve with solid proof seat. The Neles J type solids proof seats prevent catalyst dust from getting behind the seats that precludes the possibility of torque increase. The seats provide constant loading between the seat and the ball to be in continuous contact. The materials of construction are selected for maximum resistance to abrasion damage allowing for long cycle life. We recommend to use special hard coatings on ball and seat sealing surfaces.

Benefits

- ❑ Safety, long lasting tightness and cycle life
- ❑ Reliable operation with wiping seat design
- ❑ Emission proofing with rotary technology and standard live loaded packing
- ❑ Field proven performance
- ❑ No cavities to get catalysts trapped



Picture 3. Neles seat supported ball valve

Catalyst addition valves – Each day, several tons of fresh catalyst are added to replace losses through the cyclones and to maintain the activity of the unit's inventory at an acceptable level. A typical temperature here is ambient.

Metso Solution

- ❑ Jamesbury 9150 series soft-seated ball valve with Xtreme seats has proved to be the right choice as catalyst addition valves.

As an option to traditional solenoid valve and limit switches, Metso can offer also intelligent on-off valve controller Neles SwitchGuard, that gives the possibility to control the valve opening and closing strokes and also provides diagnostics about the valve performance.

4. Fractionator bottom slurry valves

Challenge – The remaining heavy residual oil, together with any catalyst carryover, collects at the bottom of the fractionator and recycles back to the reactor for the catalyst to be used in the reactor. Bottom recycle is used to recover heat for feed preheat through kettle boilers and exchangers. The fluid is known as catalyst oil slurry and its control and isolation, due to its highly abrasive nature and temperature, provide a demanding valve application. The typical temperature of bottom slurry is 370 °C.



Picture 4. Finetrol

Metso Solution for control valves

- ❑ Finetrol eccentric plug valve with stellite seat construction and flow to close direction
- ❑ E-series ceramic valve in extreme erosive cases

Benefits

- ❑ Rotary technology for low emissions
- ❑ Long cycle life
- ❑ Erosion resistant design for both medium and high erosive applications

Metso solution for on-off valves

- ❑ Neles seat supported ball valves XA with high temperature metal seats.

Benefits

- ❑ Rotary technology for low emissions
- ❑ Long cycle life
- ❑ Erosion resistant design

5. Expander valves

The flue gas from the FCC process exiting the regenerator has significant pressure, temperature and volume, and it is a source of useful energy that represents an energy cost-saving opportunity to a refinery. Using an expander could maximize recovery of available energy from the flue gas. This energy can then be used to drive the compressor that provides air to the regenerator (the main air blower) or an electric generator.

Challenge – The expander valves should be able to work under very high temperature (up to 760 °C). The flue gas may entrain some abrasive catalyst particles. Fast closing / opening, suitable shut-off capabilities and reliability over long periods are required. Huge thermal shock and inconstant temperature during the emergency case may lead to destructive high pressure loaded on seat by disc.

Expander inlet valve – In normal service the expander inlet valve controls the upstream pressure to ensure the constant pressure of the regenerator. The valve should be able to close in less than 0.6 seconds from any open position.

Main bypass valve – In normal service the main bypass valve remains fully closed. The valve should be able to open in less than 0.6 seconds in case of an expander trip.

Small bypass valve – The small bypass valves is used for synchronizing the expander and overspeed control. In normal operation the small bypass valve remains in an intermediate control, and shall be able to fully open in less than 1 seconds in a case of expander trip. Defined small leakage might be required in case the pipe cool too much potentially below the dew point. Huge thermal shock and inconstant temperature during the emergency case may lead to destructive high pressure loaded on seat by disc.

Metso solution

- ❑ Standard and high temperature applications Mapag butterfly valve TYPE BW for leakage classes V & VI
- ❑ Standard and high temperature applications Mapag butterfly valve TYPE BD for leakage classes II, III, & IV
- ❑ Neles Triple eccentric disc valve for lower temperature applications (up to 600 °C)

Benefits

- ❑ Special aperture brings seat element in good operation condition
- ❑ Special aperture on maintenance, in BW case, seat and sealing element is changeable
- ❑ Special designed flexible seat against thermal shock and avoid overstress
- ❑ Customized engineering design ability
- ❑ Long cycle life
- ❑ Erosion resistant design



Picture 5. Mapag type BW valve

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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