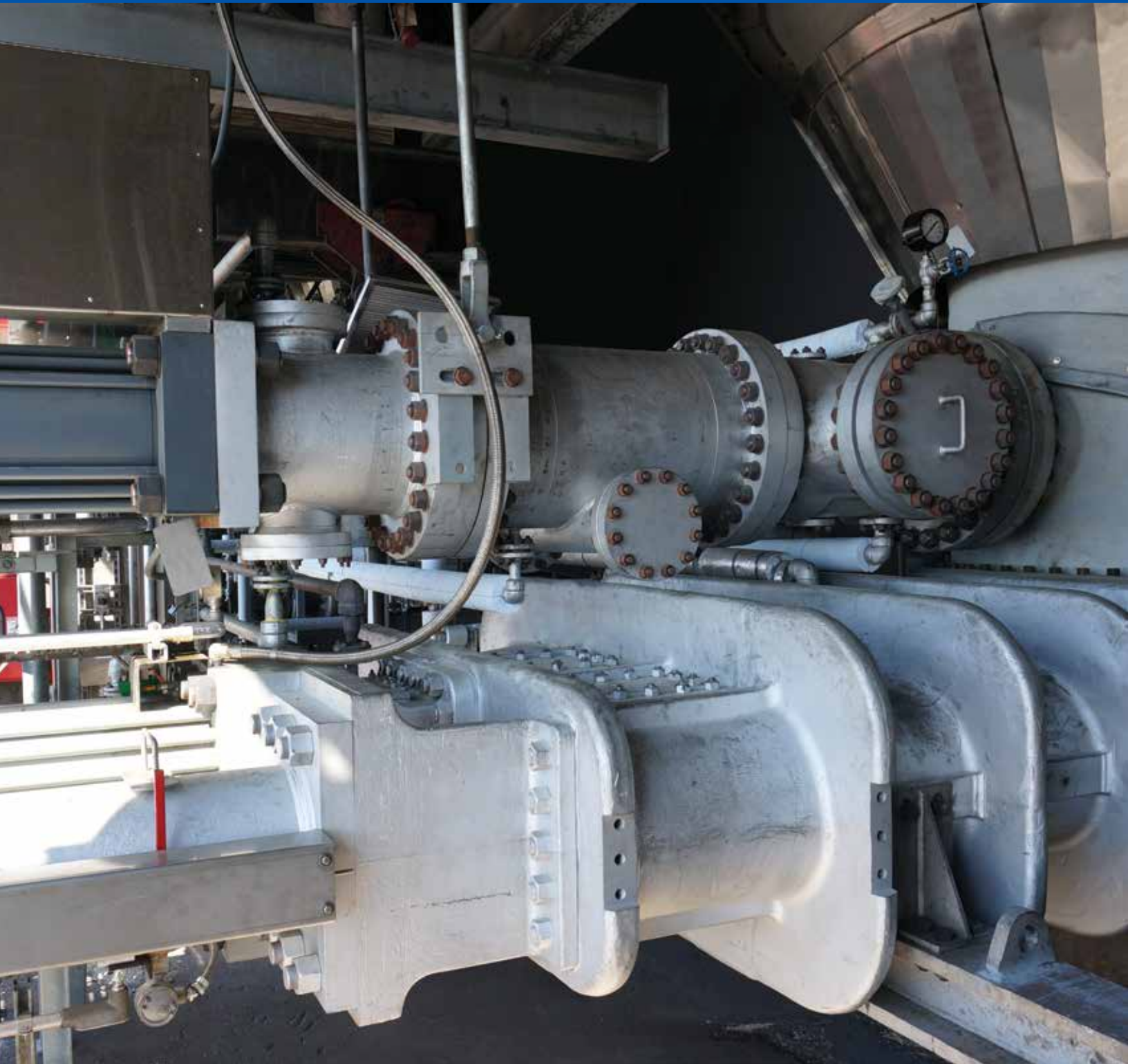




DELAYED COKING

CenterFeed™ Injection Device

INNOVATIVE TECHNOLOGY





World class
products and services
for delayed coking

Leadership and Experience

DeltaValve's extensive experience in designing and building engineered severe-service industrial valves and equipment for delayed coking has made us a world-recognized industry leader. In 2001, DeltaValve designed, engineered, and installed the world's first fully automated, fully enclosed coke drum unheading valve at the Chevron refinery in Salt Lake City, Utah. This new valve technology revolutionized coke drum unheading by replacing traditionally unsafe and unreliable manual or semi-automated unheading equipment, with a fully automated system. The result has been a safer working environment, reduced downtime, and increased productivity.

In 2016, DeltaValve was acquired by CIRCOR and is a key brand within its energy group.

Today DeltaValve continues to develop new and innovative products to address some of the most challenging applications in delayed coking.

DeltaValve offers a full range of delayed coking products including:

- Top and bottom unheading valves
- CenterFeed™ injection devices
- Isolation valves
- Auto-switch boring/cutting tools
- Cutting tool enclosures/blowout diverters
- Aftermarket, spare parts, and field services
- Installation services

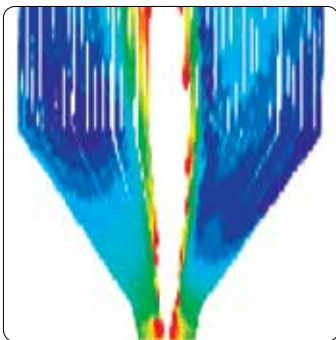
At DeltaValve we strive to deliver safe and reliable products at the very best value for our customers. Our goal is to be "Best in Class" in all we do.



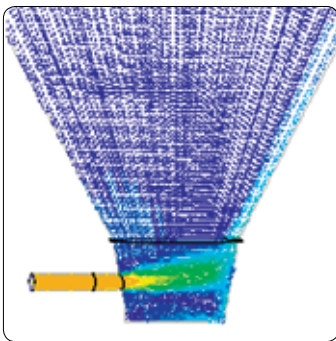


Extended
coke drum life

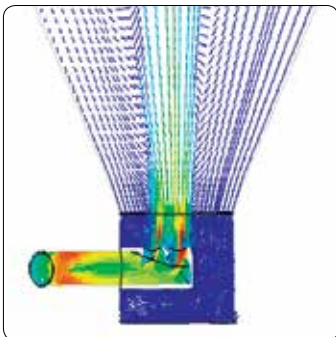
CenterFeed™ Injection Device



Traditional Bottom Feed



Side Feed Injection



CenterFeed Injection

The introduction of DeltaValve's fully automated coke drum unheading valve in 2001 necessitated the development of side feed entry into the coke drum. No longer was it possible to feed resid into the a drum through the bottom flange as was standard practice with traditional manual or semi-automated bottom unheading systems.

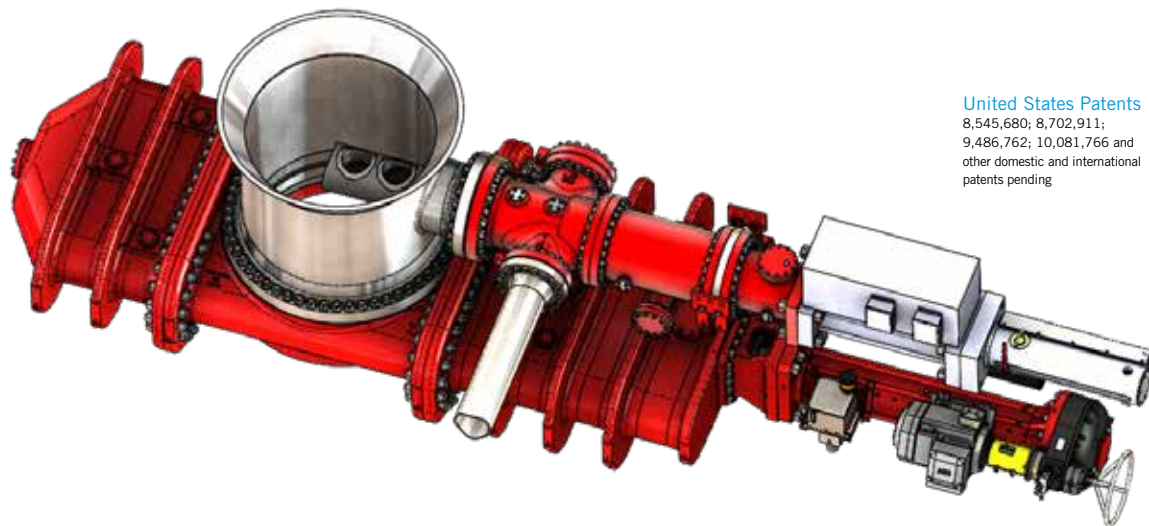
Over the years, various styles of side feed entry technologies emerged; single inlet, dual inlet, and others, some with straight feed lines, others with angled or curved feed lines, each netting different flow patterns and coke bed formations. Eventually, questions began to arise in the industry about how new side feed flow patterns compared to the traditional bottom center feed flow patterns and whether the new flow patterns had any negative effect on the coke drum. Additional questions were also raised regarding the impact on the coke drum wall opposite the side feed inlet. In response to these issues, and in response to customers concerns, DeltaValve evaluated these issues and developed the CenterFeed injection device.

Compared to feeding resid directly into the side of a coke drum, independent studies have shown that feeding into the drum directly up the center reduces overall drum stresses, formation of local hot-spots, and top head blowouts. Data indicates that center feeding develops more centralized flow channels, reducing rapid temperature changes on the coke drum wall and improving quench water distribution. In addition to the safety benefits of automated unheading, the CenterFeed is engineered to maximize coke drum life and minimize downtime and maintenance.

The CenterFeed combined the necessity of side feed entry with the desired results of traditional bottom center feed systems. Data from installed units have confirmed significant improvements in uniform thermal distribution and lower thermal transients. Additionally, operational data has confirmed improvements to drum movement, drilling profiles, quench times, and structural vibration. In summary, the benefits of the CenterFeed translate into a significant extension of the calculated operational life of coke drums.



Engineering and Design



United States Patents
8,545,680; 8,702,911;
9,486,762; 10,081,766 and
other domestic and international
patents pending

- **Safety Features:** The CenterFeed is fully enclosed and comes standard with a visual position indicator, positive lockout with sensors, and full safety interlocks.
- **Design Rating:** Standard pressure boundary is designed for full pump shut-off pressure at maximum process temperatures. ASME B16.5 600CL ratings at 950°F [510c]
- **Fully Retractable:** The CenterFeed nozzle assembly extends into the center of the coke drum and retracts completely out of the drum during cutting operations.
- **Feed Line Versatility:** To conform to refinery standards, the feed line connection flange can be configured to accommodate any size feed line from 6 to 18 inches.
- **Engineered Nozzles:** The nozzles are designed to simulate the flow pattern of bottom feed, reducing or eliminating hot-spots, top head blowouts, and drum stresses.
- **Sludge Injection:** The CenterFeed allows refiners to process sludge thereby reducing hazardous material disposal costs.
- **Easy Internal Inspection:** There are three clean-out ports on the CenterFeed; one opposing the feed inlet and two on either side of the device allowing for quick inspection of the internals.
- **Multiple Actuator Options:** Depending on the desired configuration, the CenterFeed can be supplied with either electric, electro-hydraulic, or hydraulic actuation. These options allow full flexibility for specific refinery standards.



Engineered
nozzle design

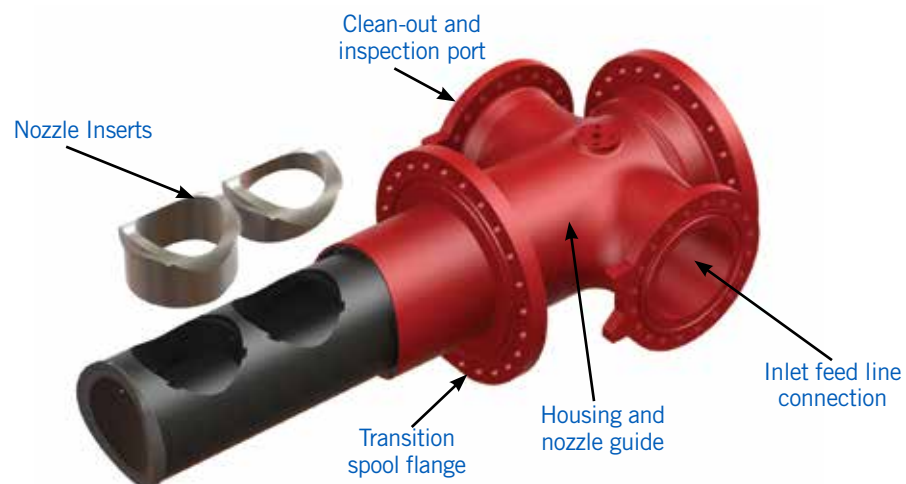
Nozzle Configuration

At the heart of the CenterFeed design is the dual nozzle configuration through which feed enters the coke drum. Significant effort was required to engineer these nozzles to replicate and even improve flow patterns of a bottom feed configuration. A test site was selected where the temperature, pressure, flow parameters, viscosity, specific gravity, and other physical properties of the feed stock were identified. This information was used to construct a kinetic model of the feed stock to determine its fluid properties (vapor phase) at the point of entry into the drum.

The calculated fluid properties were introduced as a boundary condition into a computational fluid dynamics model for the purpose of designing and analyzing various geometric configurations of the flow nozzles. The object of the analysis work was to arrive at a nozzle configuration which would deliver the flow of feed into the drum at its center line with a similar or improved flow stream distribution pattern as compared with traditional bottom feed.

Nozzle Design

The specific geometry of each of the two nozzles are engineered to efficiently direct flow upward into the center of the drum. The inner diameter of the nozzle matches the inner diameter of the piping from the furnace to the drum, allowing for consistent flow through the CenterFeed. In the extended position, the nozzle assembly is sealed by spring-loaded seats which use similar sealing methodology as DeltaValve's unheading valves.

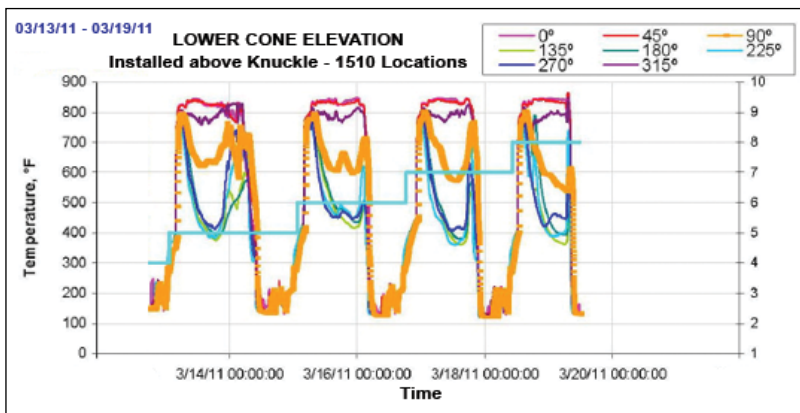




Technology Validation

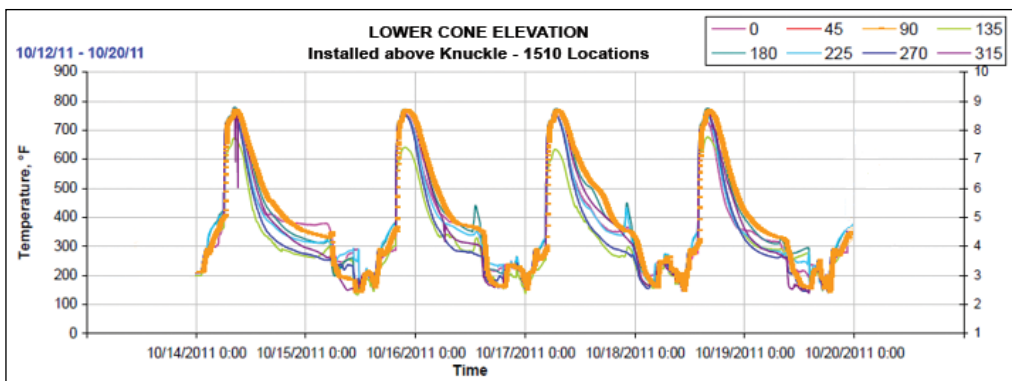
Pre-Installation of CenterFeed

When measuring drum skin temperatures at the time of quench near the inlet feed line of typical side feed configurations, it is common to see temperatures in the range of 400°F. Temperatures opposite the feed line inlet often exceed 800°F. This approximate 400°F circumferential temperature differential is significant and can cause uneven expansion of the drum. Furthermore, during the quench cycle, the measured rate of temperature change approaches -80°F degrees/minute. This dramatic rate of change can contribute to increased drum stresses and reduced drum life.



Post-Installation of CenterFeed

After installation of the CenterFeed, temperature data from the same locations indicated much more even temperature distributions. In most cases, the temperatures were within 50°F of each other. At time of quench, temperatures around the drum were in the range of 300 – 400°F. Because of the lower temperatures, the rate of change during quench is dramatically lower, approximately -40°F degrees/minute compared to -80°F minute/degrees when utilizing side feed. This dramatic reduction in the rate of temperature change results in the significant reduction of drum wall stresses resulting in extended drum life.



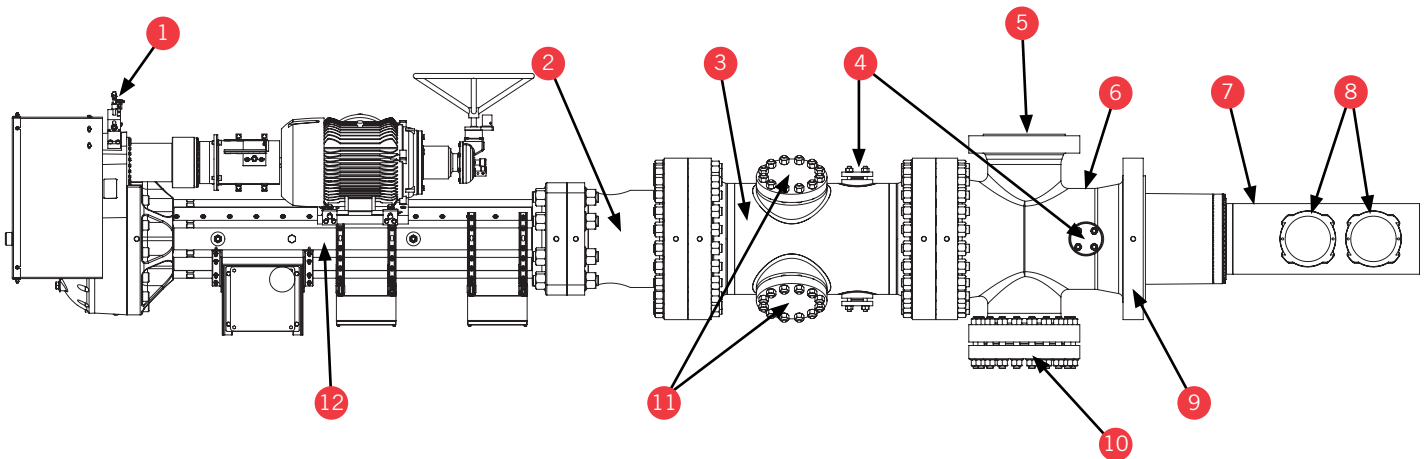


Innovative technology

Technical Specifications

Parts and Materials

Design Standard	ASME B31.3
Construction	Cast, fabricated
Body Housing Material	ASME SA217 C12
Nozzle	ASME SA217 C5 and 182 F5
Actuation	Electric, electro-hydraulic, or hydraulic
Interlocks/Controls	Engineered to plant specifications
Positive Lockout	Removable lockout pin(s)
Purge Media	Steam
Typical Pressure Rating	CL600 - Per ASME B16.5 Group 1.14 Materials (9Cr-1Mo)
Design Pressure	Per CL600 rating. (755 PSIG @ 950°F /52.1 barg @ 510°C)
Inlet Feed Sizes	6" to 18" diameter

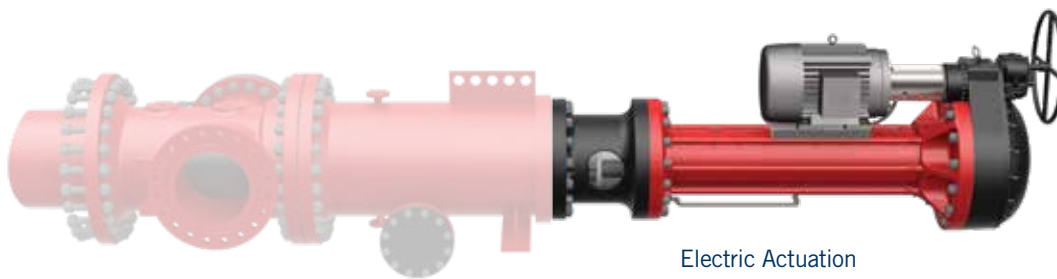


Item	Description	Item	Description
1	Lockout Pin	7	Feed Nozzle
2	Standoff/Yoke	8	Nozzle Inserts
3	Bonnet	9	Transition Spool (Drum Nozzle Inlet) Flange
4	Steam Purge Ports	10	Feedline Clean-Out
5	Inlet Feed Connection	11	Inspection/Clean-Out Ports
6	Body	12	Electric Actuator

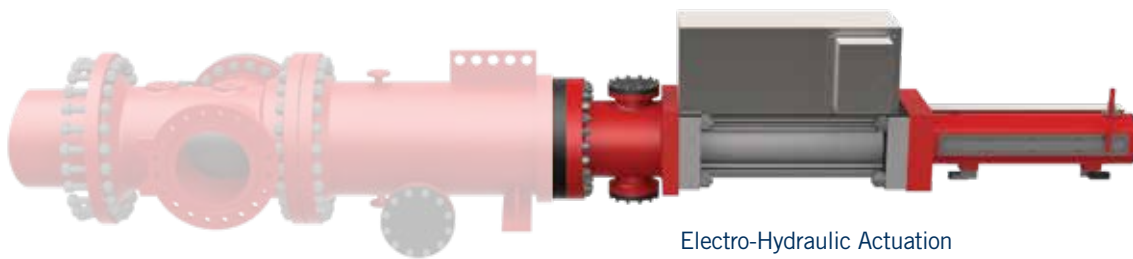


Actuator Options

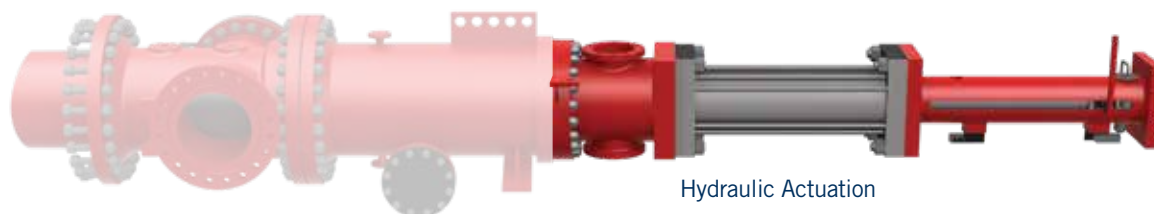
The CenterFeed is designed for use with electric, electro-hydraulic, or hydraulic actuation systems. Electric actuators offer a shorter overall length and minimize ongoing maintenance. Electro-hydraulic and hydraulic configurations utilize a double rod hydraulic cylinder, where one rod is attached to the CenterFeed nozzle and the opposite rod is connected to a visual indicator on the lockout shaft. The electro-hydraulic version uses a stainless steel box mounted directly on top of the hydraulic cylinder which contains the motor, hydraulic pump, reservoir, and control valves.



Electric Actuation



Electro-Hydraulic Actuation



Hydraulic Actuation



Safe and reliable equipment
for the delayed coker

Additional DCU Equipment



Bottom Unheading Valve

DeltaValve's bottom unheading valve connects to the bottom of the coke drum's transition spool and creates a totally enclosed system from the top head to the discharge chute. With the push of a button from a remote location, safe and reliable unheading can be achieved. The bottom unheading valve is inherently safe, easy to operate, and designed to be maintenance-free from turnaround to turnaround.



Top Unheading Valve

The DeltaValve top unheading valve mounts directly to the drum to create a permanent top head connection. Just like the bottom unheading valve, the top unheading valve uses patented dynamic seating technology that is tight-sealing, robust, and reliable.



Cutting Tool Enclosure

The cutting tool enclosure mounts directly to the top unheading valve and is designed to protect personnel and equipment by containing the cutting tool when not in the drum, and also diverting coke, steam, and water away from the cutting deck in the event of a drum eruption. The built-in drill stem guide controls and stabilizes the drill stem during coke boring and cutting.



Auto-Switch Boring/Cutting Tool

DeltaValve's auto-switch boring/cutting tool provides a high level of safety and reliability during de-coking operations by allowing the tool to remain in the drum when switching between boring/cutting modes. Contact with the tool is not required to switch between boring/cutting modes.

Isolation Valves and Controls

DeltaValve's line of isolation valves are designed for on/off as well as continuous operation in the partially open (throttling) position, while isolating body internals from the process. These valves are available with a complete suite of electric and hydraulic actuator options and complete PLC-based control systems with safety interlocks and sequence controls. This design provides for quick and efficient in-line removal or replacement of all internal components.



Installation Services

By managing the engineering, procurement, and construction work associated with the installation of our unheading valves and other equipment, we provide strategic value added services to our clients.

DeltaValve partners with engineering and construction companies who specialize in coker revamps. Together we have successfully managed numerous projects. Please contact us for references.



We offer the following:

- Project management
- Detailed engineering management
- Installation engineering management
- Procurement management
- Construction management
- Commissioning supervision
- Training



Highly trained technicians
offering superior service

OEM Parts and Service



DeltaValve offers a full line of OEM spare parts for its entire product line. Additionally, DeltaValve's service technicians are available to respond to our customers' needs in a timely and efficient manner. Our network of technicians are highly trained to evaluate, troubleshoot, and resolves issues. They are backed by our engineering group allowing for quick access to technical expertise, drawings, bills of materials, and other relevant data to expedite practical and reliable solutions.

Core services provided by the DeltaValve service team are:

- DeltaValve equipment installations
- Site acceptance tests
- Commissioning supervision
- Site audits
- Turnaround service
- Maintenance and repair
- Equipment rebuilds
- Equipment storage
- Hydraulic flush services
- Electrical loop checks
- On-site training
- Bolt tensioning/torquing
- Valve/equipment maintenance and service



DeltaValve's network of global facilities offer support and technical assistance to our large and growing base of worldwide customers.



Quality

DeltaValve complies with all aspects of the ISO 9001:2015 certified quality management system, and provides customers with the highest level of quality.

DeltaValve Design Standards

Unheading valves

- ASME and BPVC, Section VIII Div. I and II

Isolation valves

- ASME B16.34, API 598 and API 600

Center feed devices

- ASME B31.3

DeltaValve maintains the following stamps and design certifications:

- ASME
- “U” Stamp, Division I
- “R” Stamp
- National Board Registration
- Pressure Equipment Directive (PED) (2014/68/EU)

DeltaValve manufactures to the following certifications per international requirements:

- Canadian Registration Number (CRN)
- TR CU (formerly GOST-R)
- KHK
- Others as required

DeltaValve has experience installing equipment in flameproof/explosion proof, non-incendiary, intrinsically-safe hazardous areas utilizing the following standards:

- | | | |
|---------|-----------|---------|
| • IECEx | • InMetro | • NEMA |
| • PESO | • UL | • TIIS |
| • ATEX | • KOSHA | • CSA |
| • JIS | • TR CU | • NEPSI |

DeltaValve complies with international certifications and standards, and has unheading valves installed in over 100 refineries and in more than 20 countries around the world.

Quality Assurance Documentation

- ISO 9001:2015 certificate
- Quality assurance manual
- Additional international certifications as required.

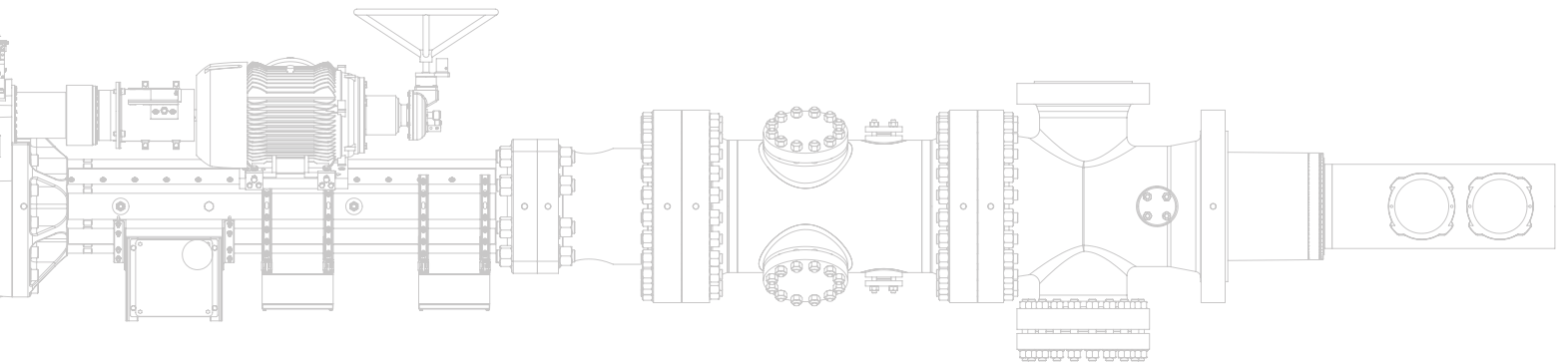


Final Assembly and Testing

Our equipment is assembled and tested at our facilities in Houston, Texas, Salt Lake City, Utah, and Coimbatore, India. As part of our quality control protocol, each critical component is inspected and reviewed before installation for proper functionality and product quality.



NOTES:





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