

# Feed Entry Systems For The Modern Delayed Coking Unit

International Refcomm

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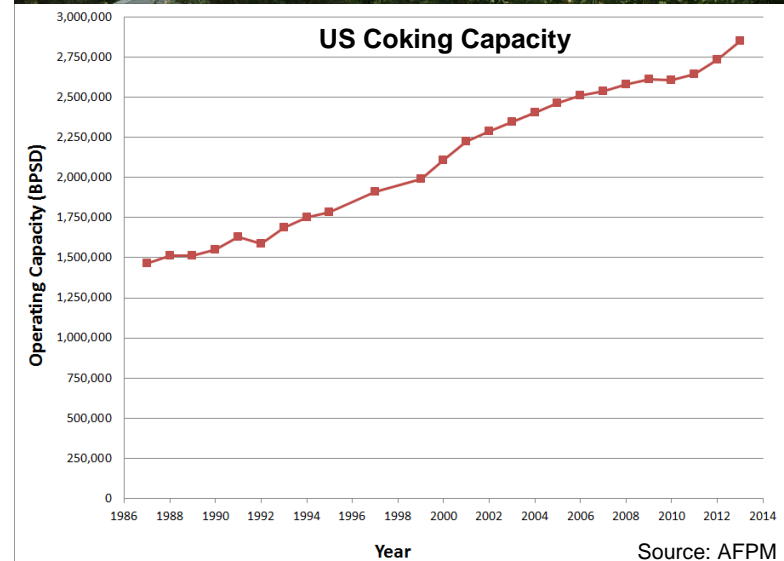
Amec Foster Wheeler

4 October 2017



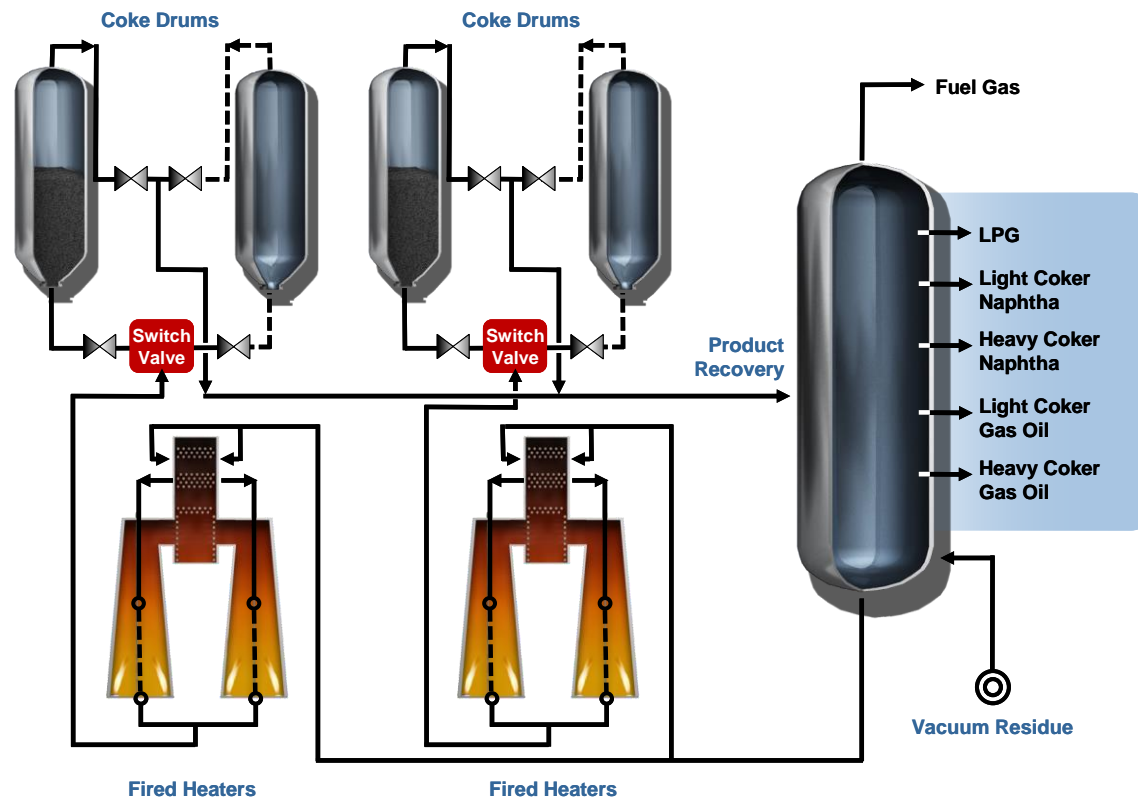
# Delayed Coking

- ▶ Most commonly used residue upgrading process
  - ▶ Over 5,500,000 BPSD installed capacity
  - ▶ Amec Foster Wheeler is market leader
- ▶ Very attractive economics
- ▶ Complete residue conversion
  - ▶ Gas
  - ▶ Naphtha
  - ▶ Gas oils
  - ▶ Coke (disposal not an issue)
- ▶ Specialty coke production
- ▶ Maximized diesel yield with Hydrocracker integration
- ▶ Wide variety of feedstocks



*Photograph courtesy of Petron Corporation*

# Delayed Coking Process Simplified Flowscheme



- ▶ Continuous batch process
- ▶ Typical cycle is 18 hour fill and 18 hour empty
- ▶ Extensive thermal and mechanical stresses on coke drums

# Traditional Coke Drum Design

- ▶ Utilized central, bottom feed entry
- ▶ “Uniform” upward flow in coke drum
- ▶ Bottom unheading was a difficult and dangerous task
  - ▶ Manpower intensive
  - ▶ Time consuming



*Photograph courtesy of DeltaValve*

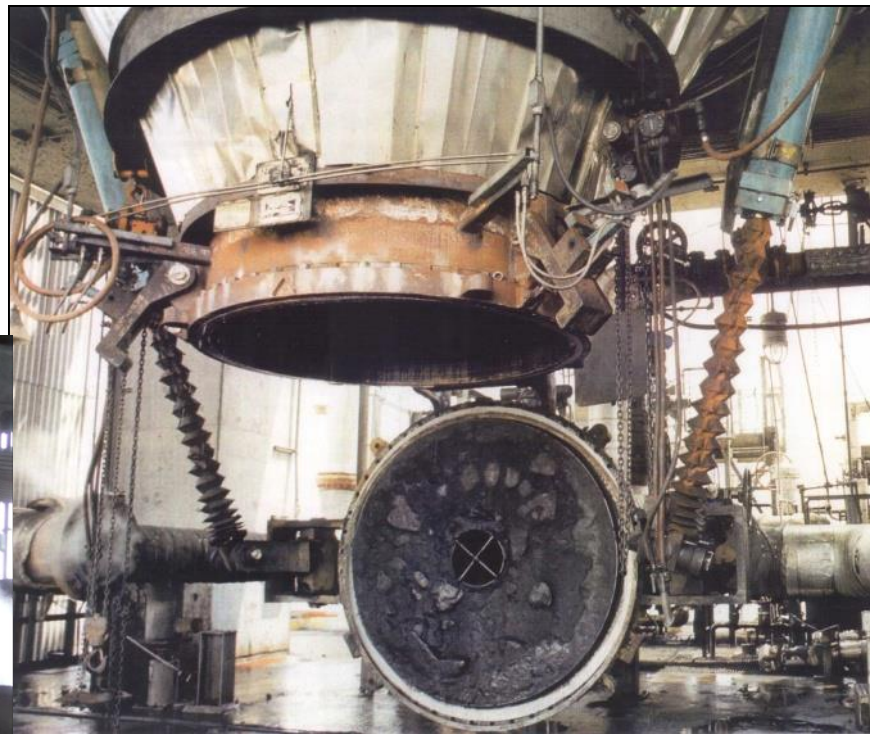


# Traditional Bottom Unheading



*Photographs courtesy of DeltaValve*

# Semi-Automated Bottom Unheading Systems



*Photographs courtesy of Amec Foster Wheeler*

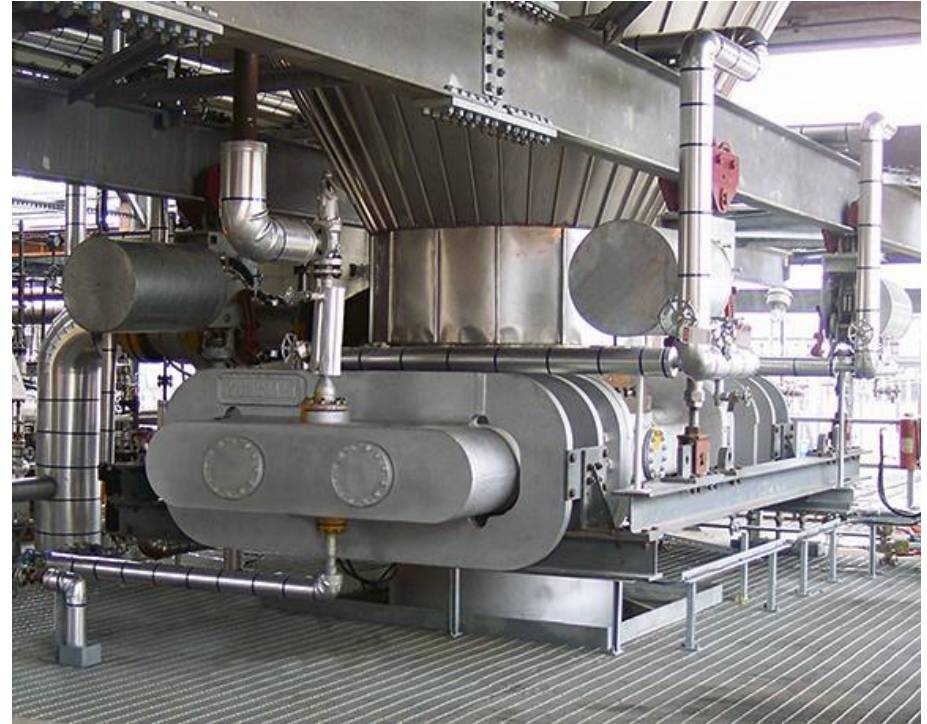
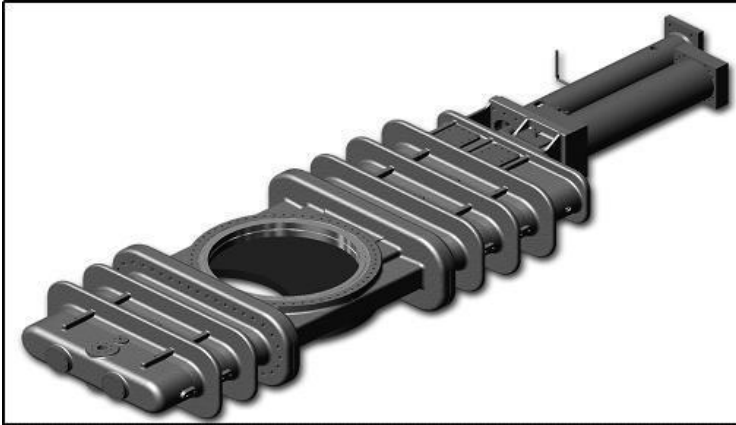


# Problems with Bottom Unheading



*Photographs courtesy of DeltaValve*

# Slide Valve Bottom Unheading Systems



- ▶ Developed by DeltaValve
- ▶ Revolutionized DCU operations
  - ▶ Fully automatic
  - ▶ Safe
  - ▶ Cleaner

- ▶ However introduced a new problem
  - ▶ How to introduce feed into the coke drum

*Photographs courtesy of DeltaValve*

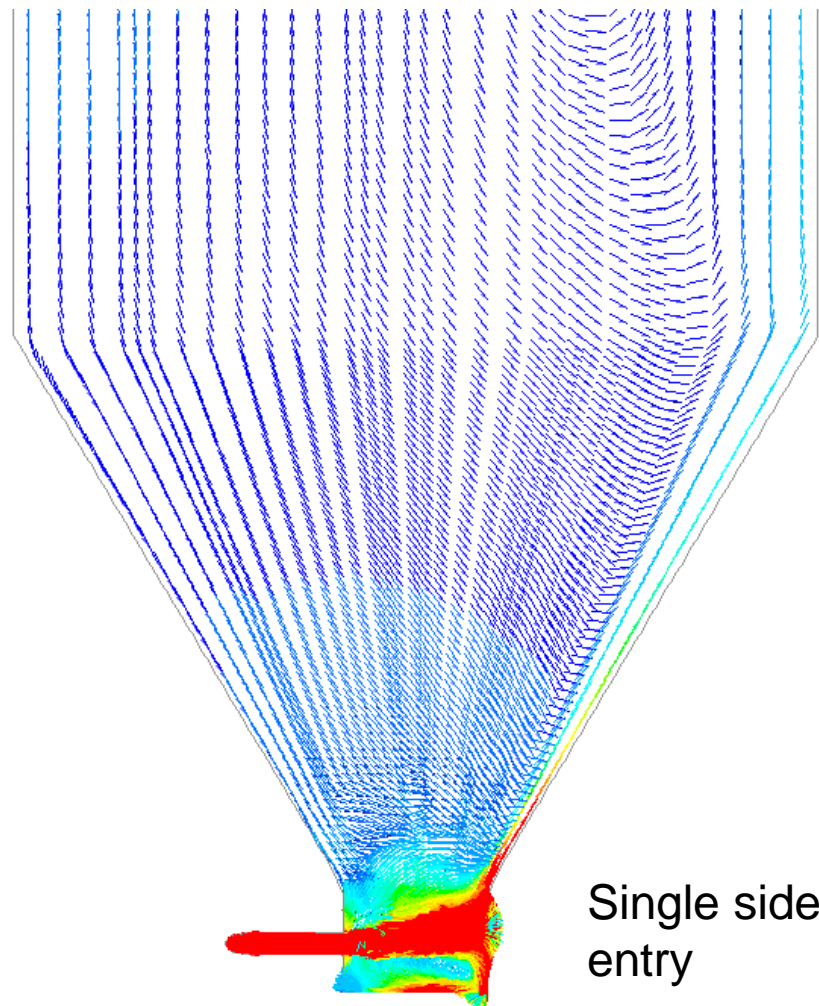
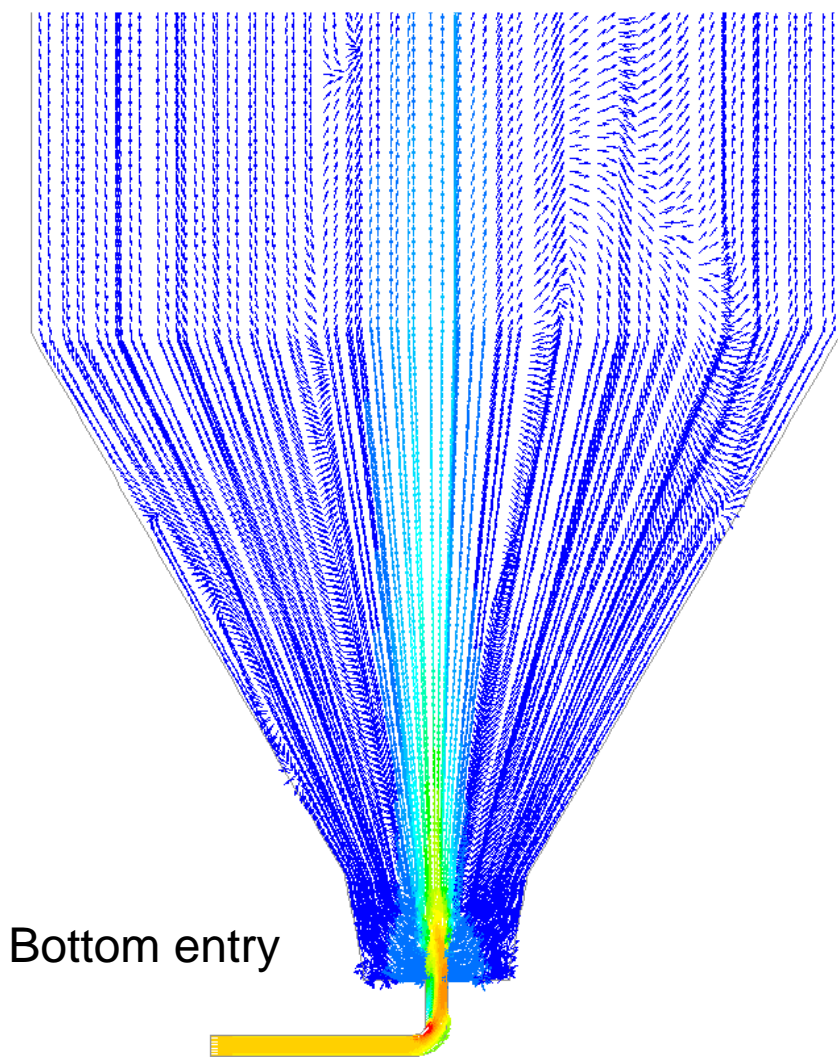


# Single Side Feed Entry



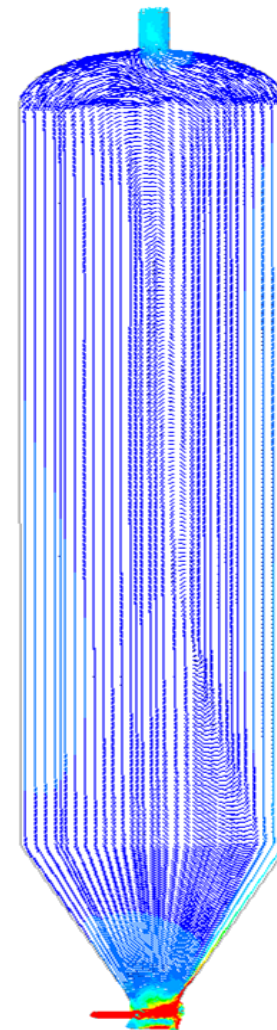
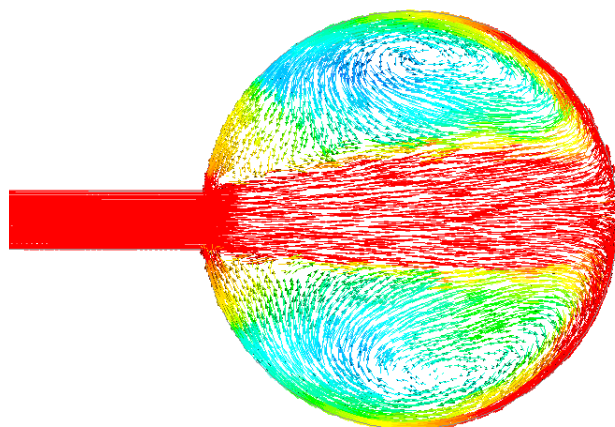
*Photographs courtesy of DeltaValve*

# Flow Patterns In The Coke Drum



# Issues With Single Side Entry Feed Systems

- ▶ Non-uniform flow in the coke drum
- ▶ Non-uniform temperature profiles
  - ▶ Enhanced banana movement
  - ▶ Enhanced thermal fatigue
- ▶ Hot spots
- ▶ Blow-outs
- ▶ Vibration

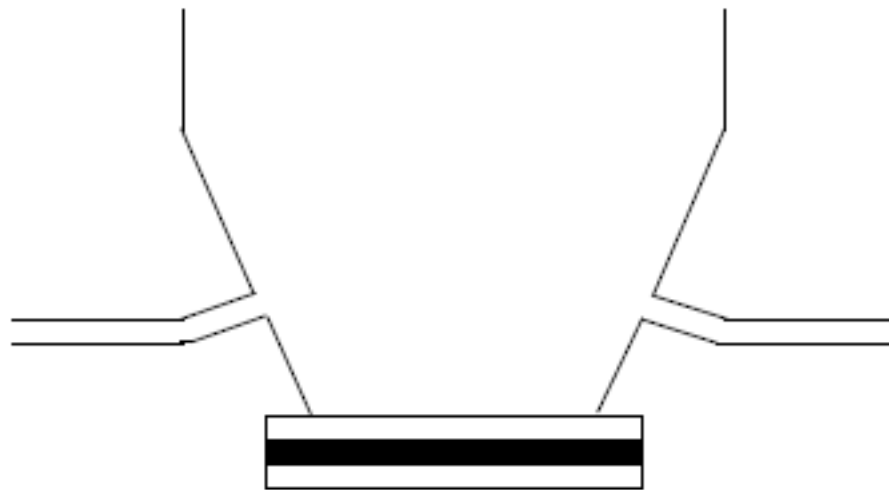




# Dual Feed System

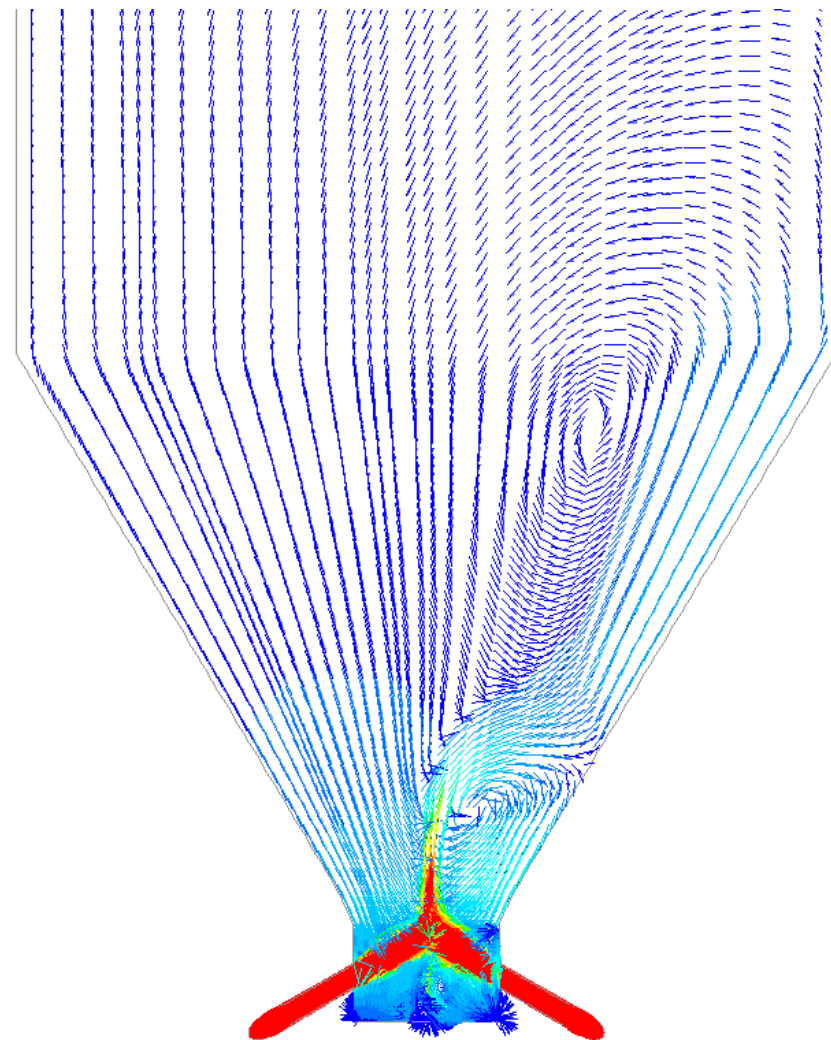
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- Claims more uniform flow than in single side entry systems



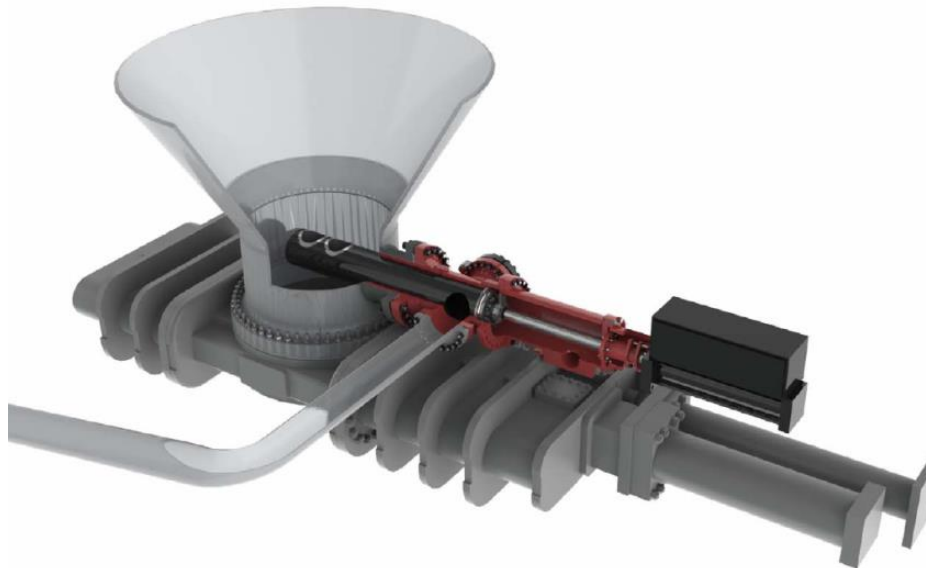
# Dual Feed System

- ▶ Claims more uniform flow than in single side entry systems
  - ▶ Not necessarily the case due to interactions of streams
- ▶ Issues
  - ▶ More complicated piping runs around coke drums
  - ▶ Equalization of flow
  - ▶ Deformation of BUD attachment flange leading to leaks



# Introducing the DeltaValve Center Feed Device

- ▶ Simulates traditional bottom feed entry
- ▶ Based on slide valve unheading technology



*Photograph courtesy of DeltaValve*

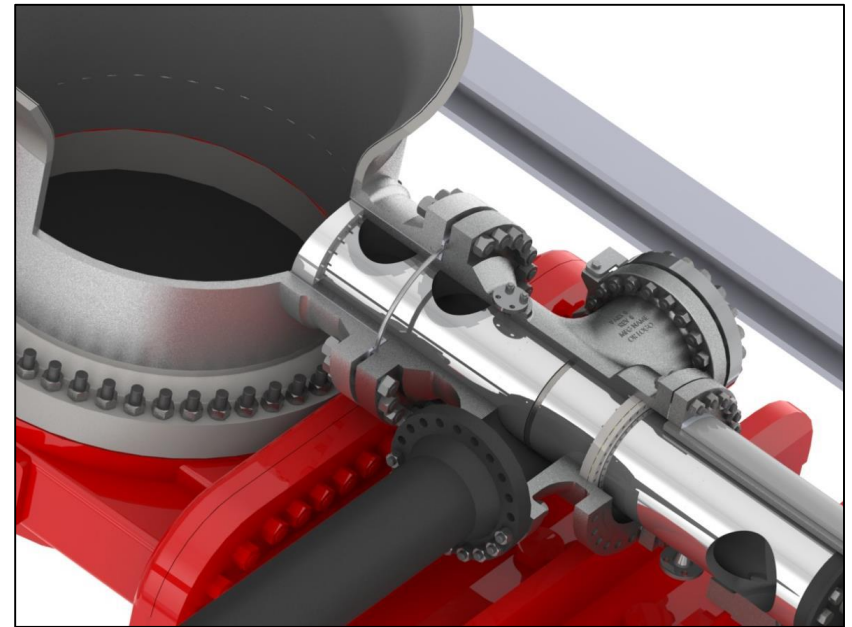
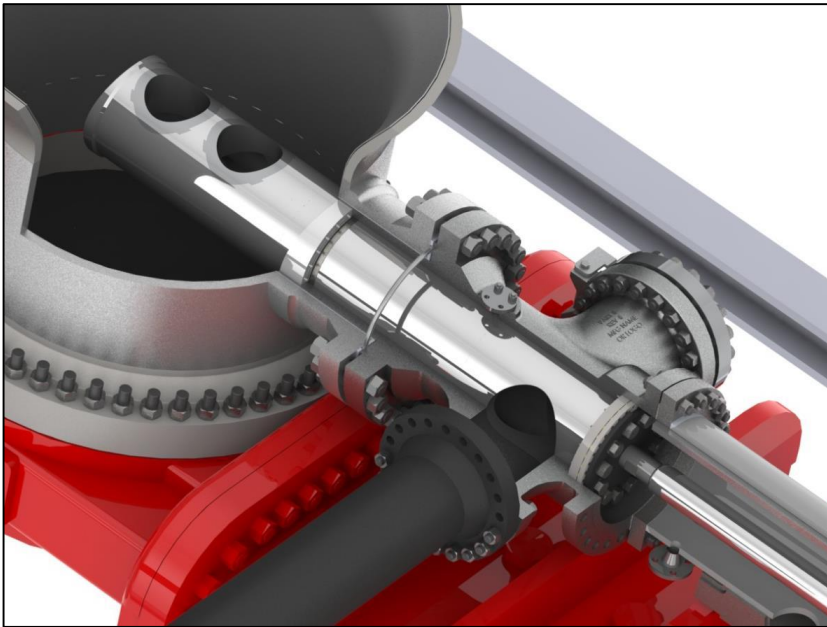




amec  
foster  
wheeler

# Center Feed Device

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*Photographs courtesy of DeltaValve*

# Center Feed Device

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- ▶ Commercially operating (over 5 years successful operation) in 3 locations
- ▶ Benefits observed
  - ▶ Minimum to zero banana effect
  - ▶ Drastic reduction in frequency of hot spots and blowouts
  - ▶ Low differential thermal gradients observed during coking and quenching

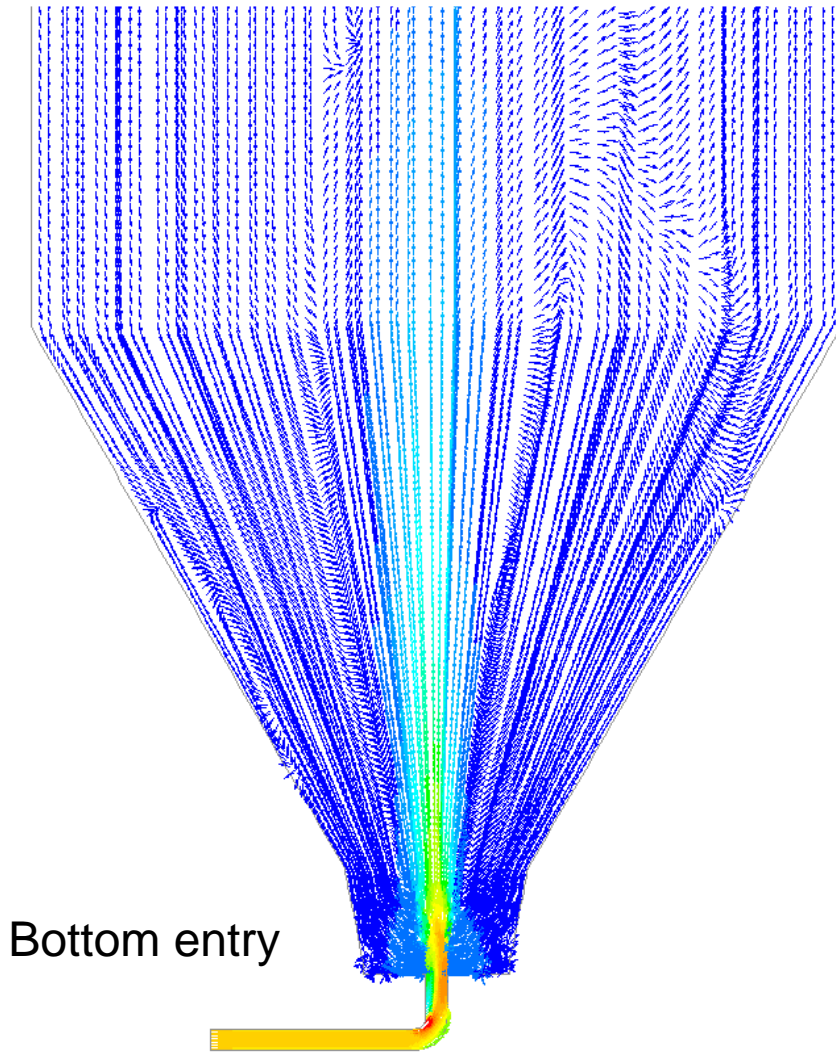


*Photograph courtesy of DeltaValve*

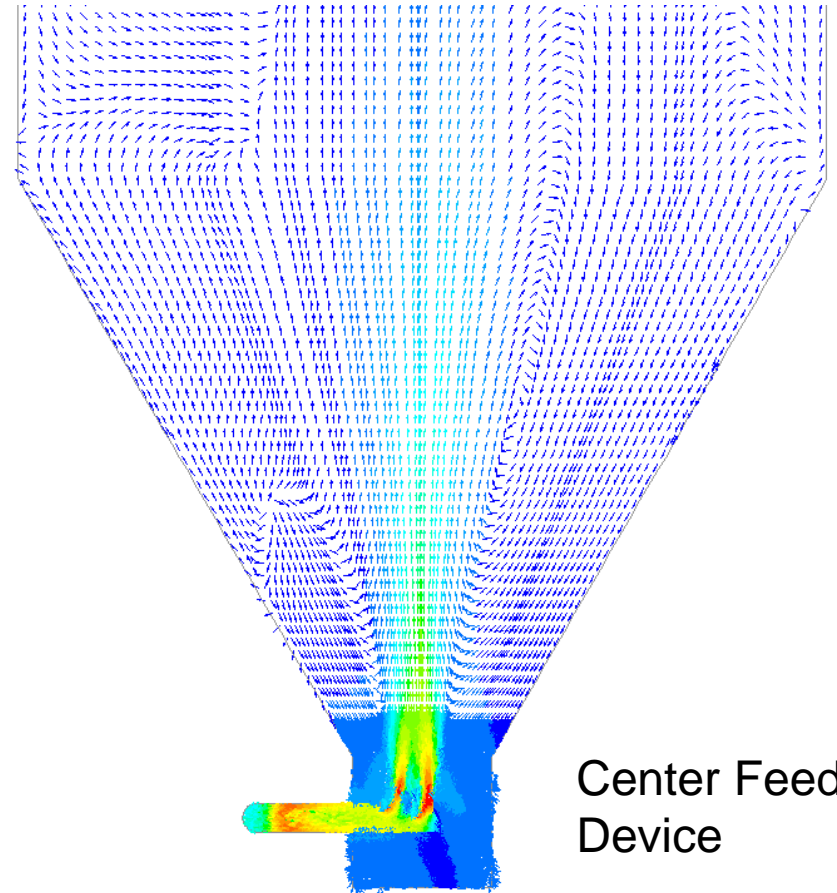


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# Flow Patterns In The Coke Drum



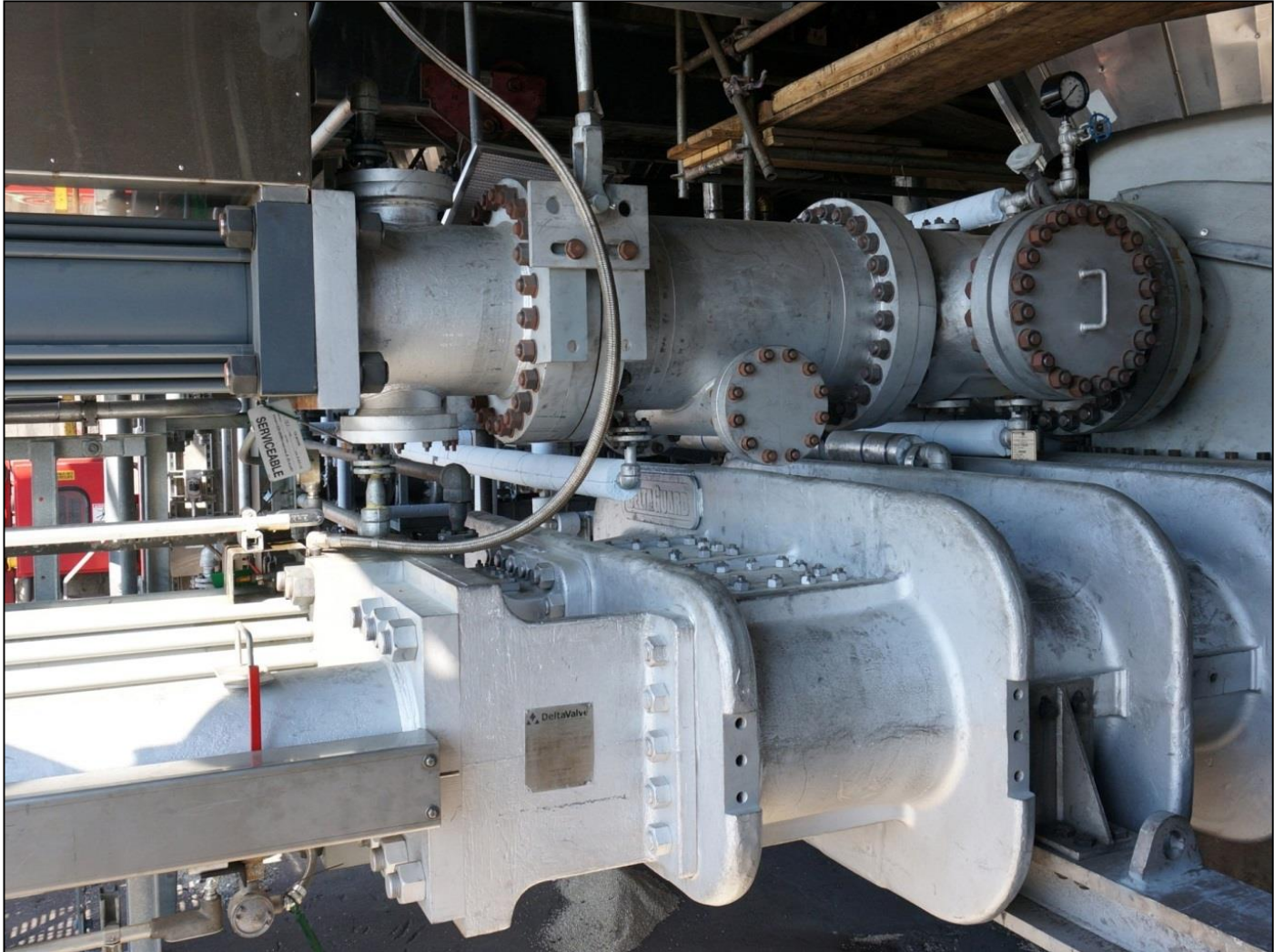
Bottom entry



Center Feed  
Device

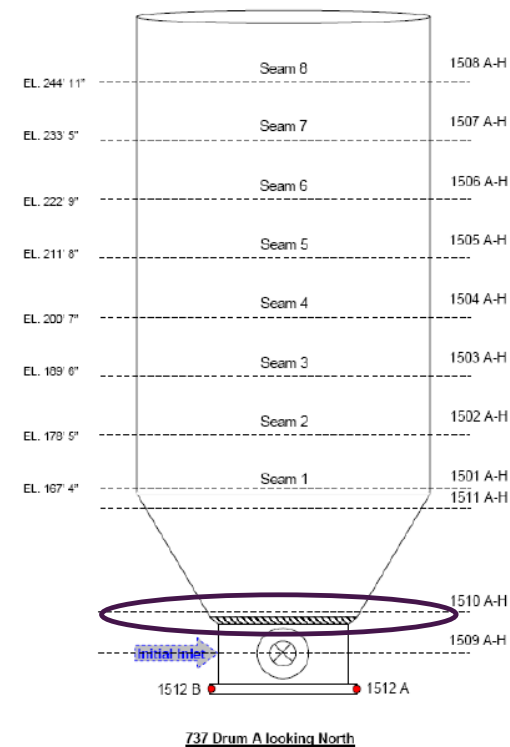
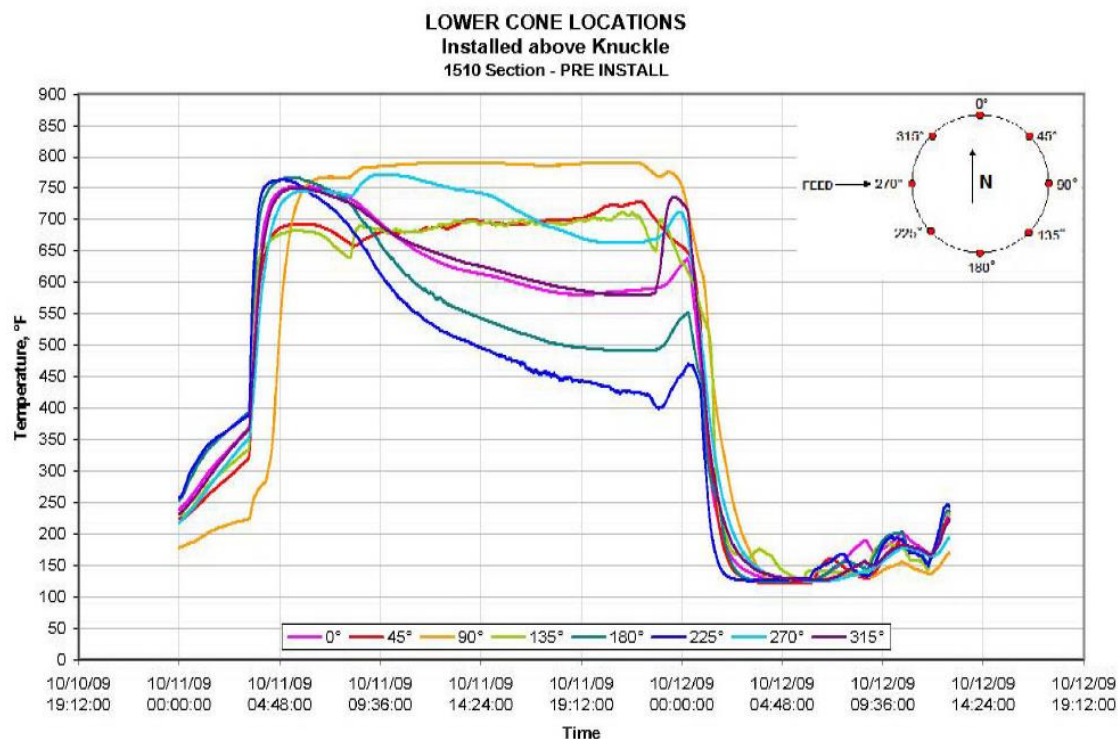


# Center Feed Device Installation

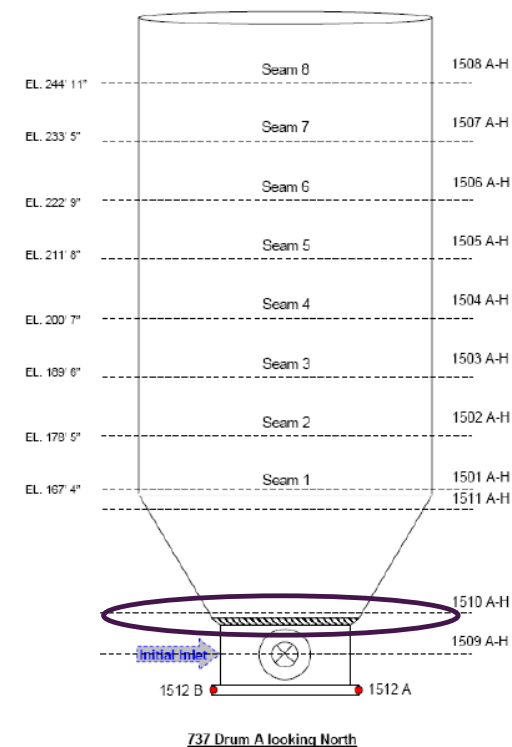
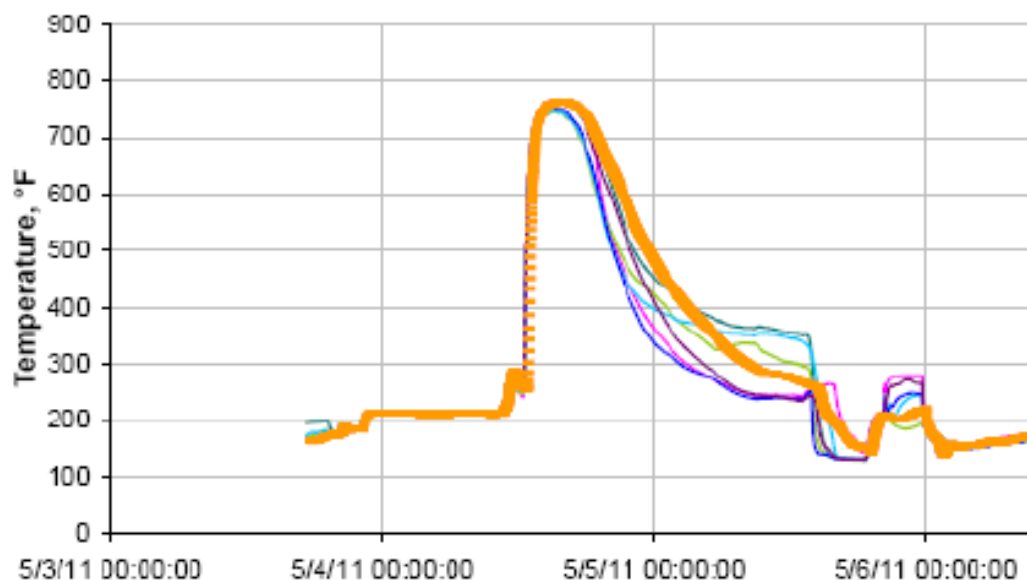


*Photograph courtesy of DeltaValve*

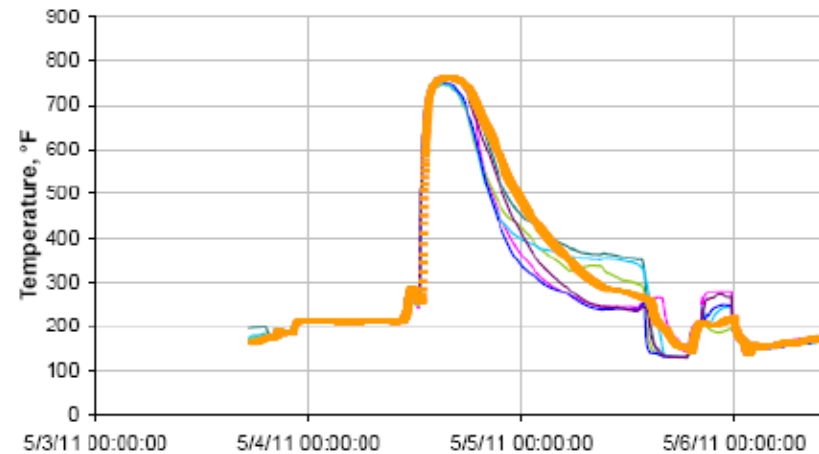
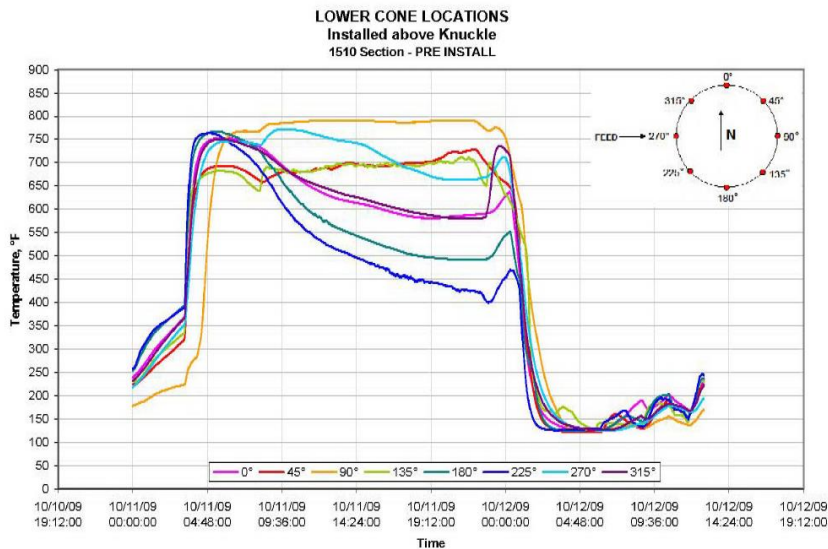
# Coke Drum Temperature Profiles Side Entry



# Coke Drum Temperature Profiles Center Feed Device



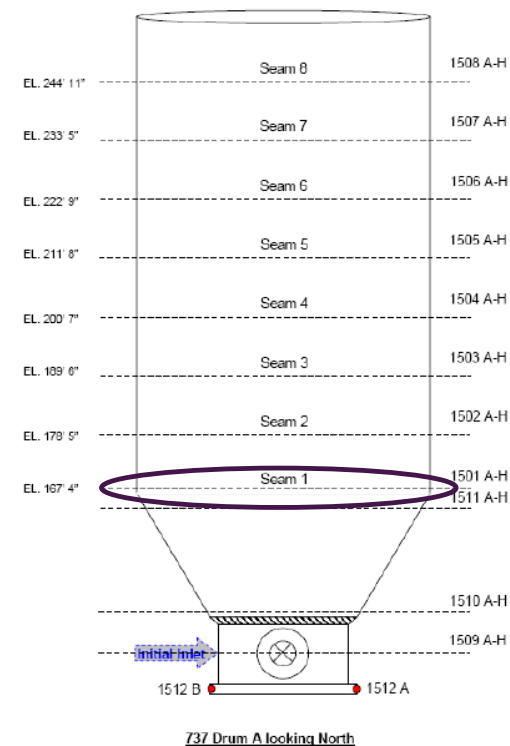
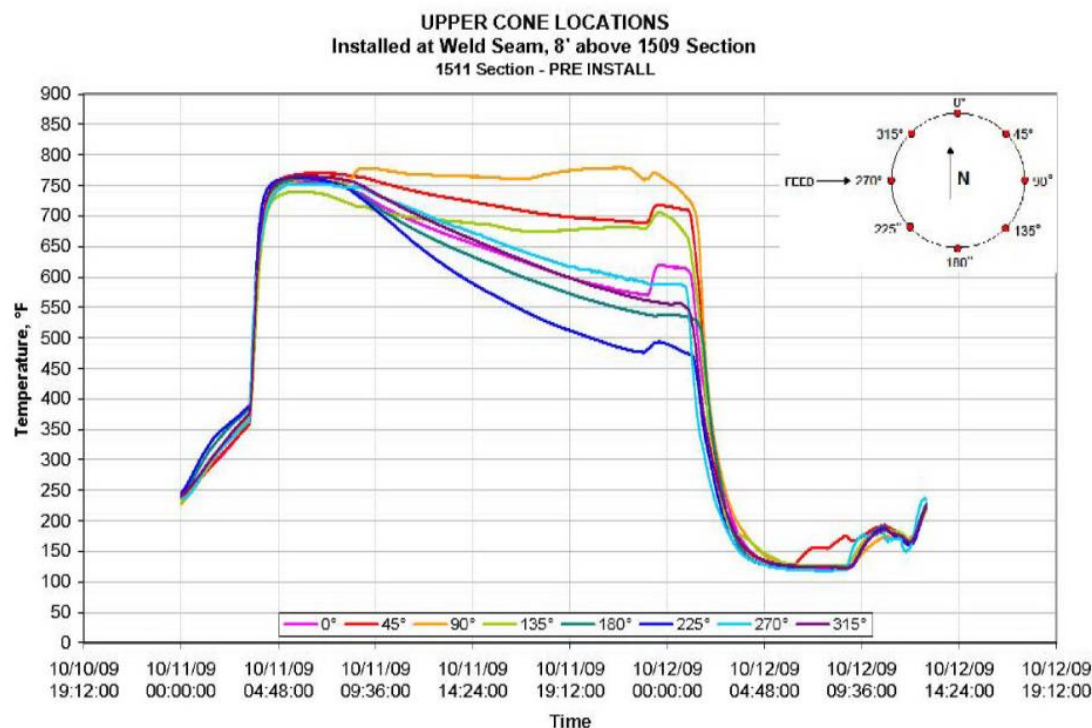
# Temperature Profile Improvement With Center Feed Device



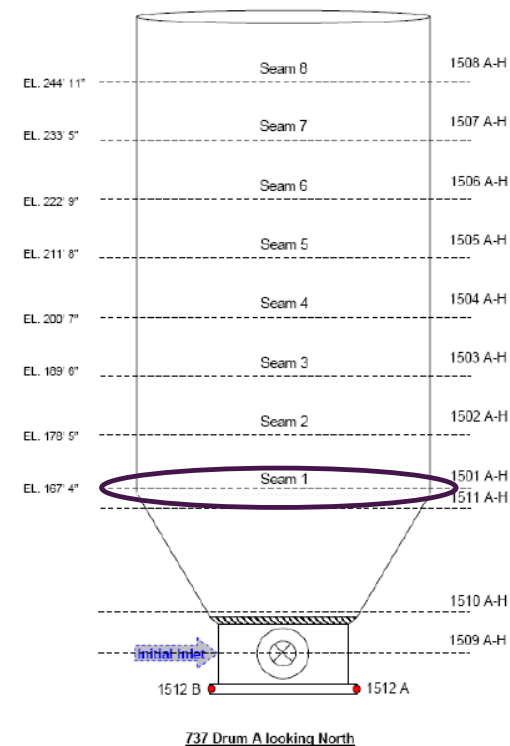
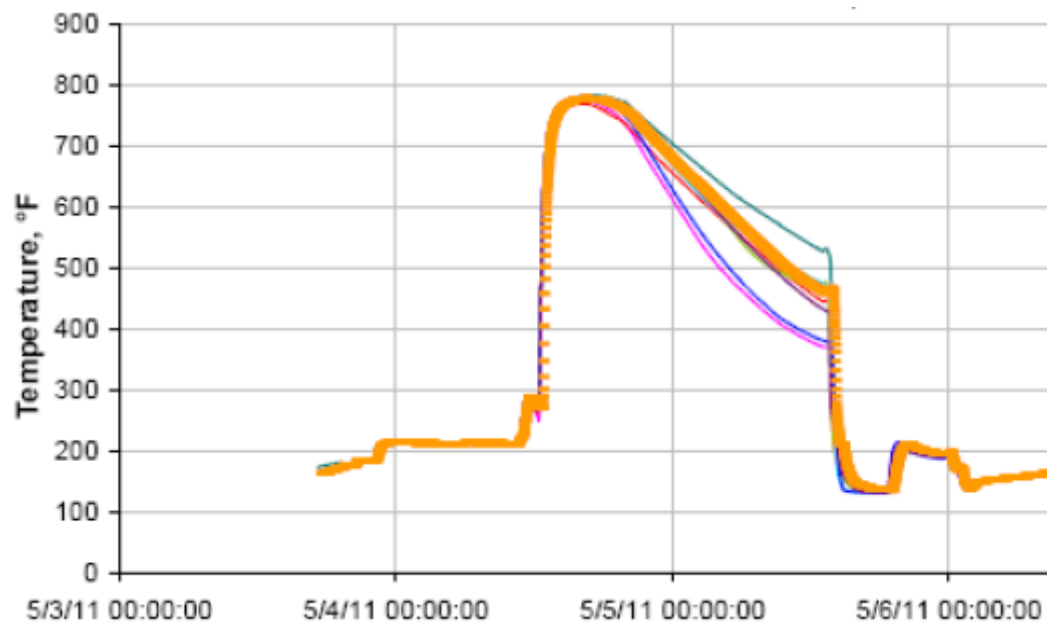
- ▶ Large circumferential temperature gradients
- ▶ Non-uniform flow in the drum
- ▶ Uniform temperature gradients
- ▶ Uniform flow
- ▶ Coke insulation layer
- ▶ Lower wall cooling rates during quench



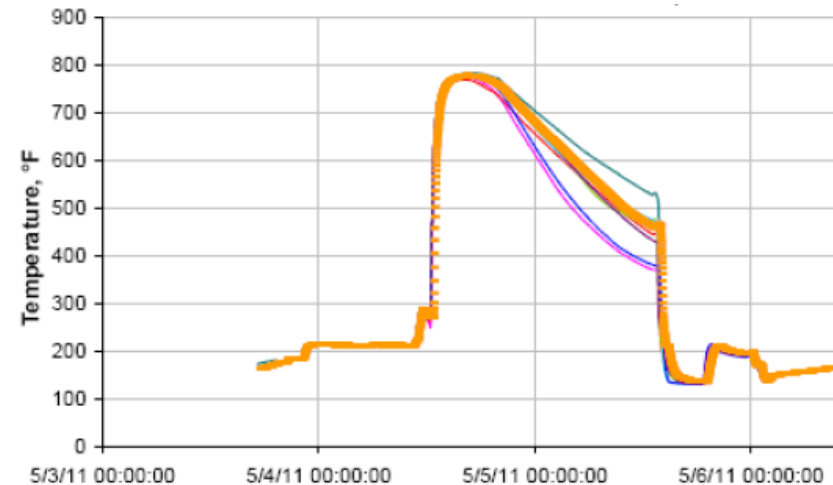
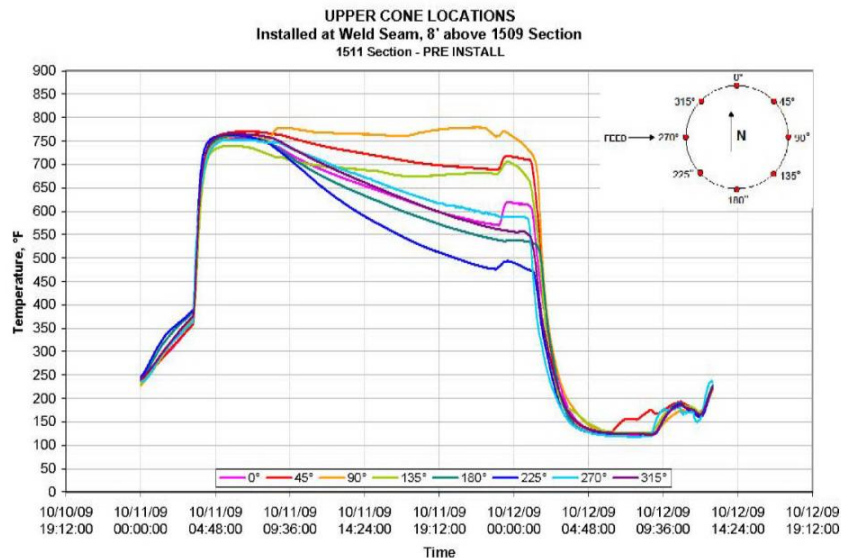
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# Coke Drum Temperature Profiles Center Feed Device



# Temperature Profile Improvement With Center Feed Device



- ▶ Large circumferential temperature gradients
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# Coke Drum Movement

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- Circumferential temperature gradients result in “Banana Movement” of the drum
- The Banana Movement can be calculated

$$BM = 1.2 X (R + 0.5D) X (1 - \cos \alpha)$$

$$\text{where } \alpha = \frac{57.2956 X \gamma X L X (T_h - T_c) X (1 + \gamma X T_c) X \pi}{(180 X D)}$$

$$\text{and } R = \frac{D}{(\gamma X (T_h - T_c))}$$

D = coke drum diameter

L = coke drum length

T<sub>h</sub> = hot side temperature

T<sub>c</sub> = cold side temperature

γ = coefficient of thermal expansion



# Banana Movement

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Condition	Calculated Banana Movement (in)	Observed Banana Movement (in)
Side entry	6.7	~ 6
Center Feed Device	3.1	~ 3

*The Center Feed Device results in a significant reduction in the Banana Movement of the coke drum*

# DeltaValve – Amec Foster Wheeler Alliance

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- ▶ In March 2016 DeltaValve and Amec Foster Wheeler entered into an alliance to promote, sell and install the Center Feed Device
  - ▶ Amec Foster Wheeler fully endorses the Center Feed Device
  - ▶ The Center Feed Device is now Amec Foster Wheeler's standard feed entry system for all new DCUs
  - ▶ Both DeltaValve and Amec Foster Wheeler can sell the Center Feed Device into existing units
  - ▶ Amec Foster Wheeler can provide the necessary engineering to support a Center Feed Device retrofit
  - ▶ Amec Foster Wheeler can provide installation services for retrofits

# Summary

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- ▶ Traditional and current coke drum feed entry systems have issues
  - ▶ Safety
  - ▶ Environmental
  - ▶ Coke drum life
- ▶ The Center Feed Device improves coke drum operation
  - ▶ More uniform temperature gradients
  - ▶ Reduced thermal and mechanical stress on the drums
  - ▶ Reduced Banana Movement of the coke drums
  - ▶ Reduced maintenance and operational costs
  - ▶ Demonstrated performance
- ▶ DeltaValve and Amec Foster Wheeler have formed an alliance to promote the Center Feed Device

A circular logo composed of several overlapping, semi-transparent colored segments in shades of teal, yellow, and purple, arranged in a pinwheel-like pattern.

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foster  
wheeler

connected  
excellence  
in all we do

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