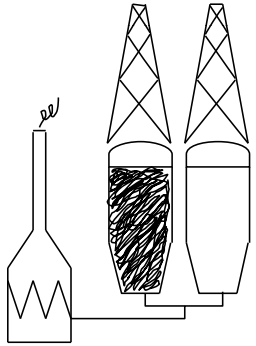
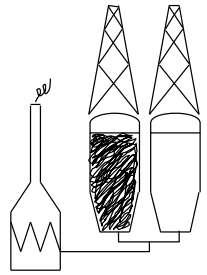
Delayed Coker
Low Coking Temperature Procedures



Presented by Mitch Moloney of **ExxonMobil**

@ coking.com August-2009 Rio de Janiero Conference

Delayed Coker: Low Coking Temperature Procedures



Handling Coke Drums that have experienced Less-than-Required Coking Temperatures

Logic Flow Diagram Recommended

+ Short-Run Drum Procedures

  => Oil Dilution & Drain to Blowdown System

  => Extended Steam Stripping & Quenching

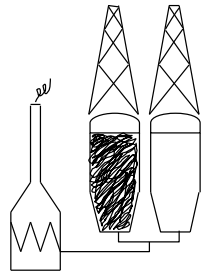
  => Superheated Steam Stripping

+ Low Coking Temperatures

  => When to RETURN to coke drum

  => When to GET OUT of the coke drum

Delayed Coker: Low Coking Temperature Procedures



Short-Run Drum Procedures - Attendant Risks

Risks of Not Properly Handling a Short-Run Drum:

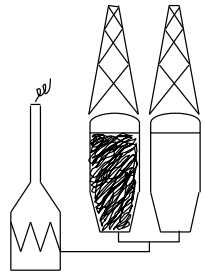
(1) If not properly stripped and cooled, there is risk of fire and explosion

=> Anacortes Coke Drum

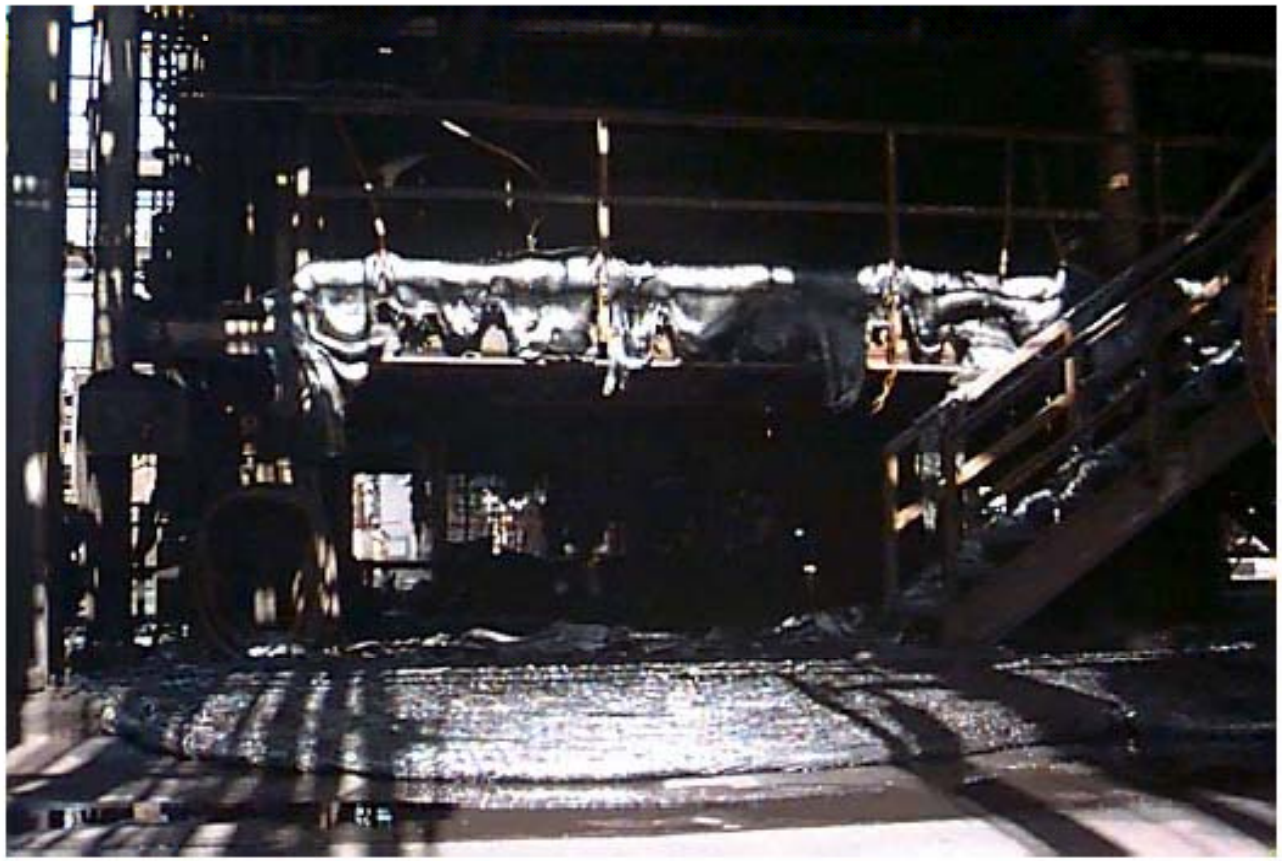
(2) Creating a complete mess on removing the bottom head, that can require a feed cut or train recirculation, if clean-up takes an extended period of time.

=> Also creates attendant safety risks

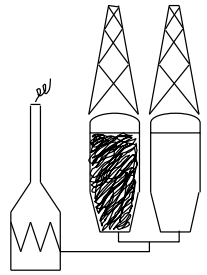
Delayed Coker: Low Coking Temperature Procedures



Creating a Mess in Torrance (jul-2000):



Delayed Coker: Low Coking Temperature Procedures



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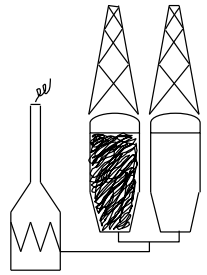

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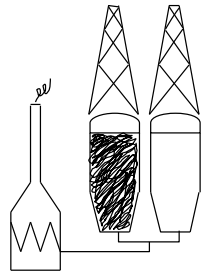


Short-Run Drum Procedures - "Anacortes Drum"

=> Should the feed line plug off, preventing steam or water addition, it will be necessary to wait on the order of 2 to 3 weeks, until the drum has cooled.

=> An "Anacortes" Drum means a refinery-wide power failure occurred, preventing steaming or cooling.

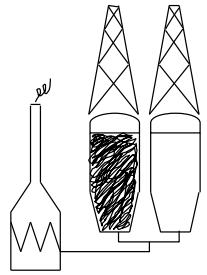
All ExxonMobil sites have done a Formal Risk Assessment and determined how to handle an Anacortes Drum

Baton Rouge & the Jose Upgrader installed connections to their quench water line, that allow the addition of diesel-powered water (available during plant power failures)

=> Jose used firewater and car-sealed valves

=> Baton Rouge uses used existing non-firewater system

Delayed Coker: Low Coking Temperature Procedures



Short-Run Drum Procedures - Establish Site Criteria

Based on Site Experience - Determine Time Criteria that Ensures Completely Coked Resid

XOM Sites range from 4 – 8 hours

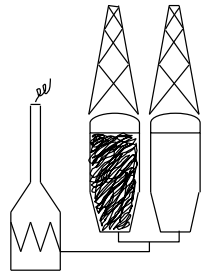
Time Criteria dependent on:

=> Warm-up temperature achieved for drum in question

=> Coke drum feed type

- Atmospheric or Vacuum Resid
- Crude type (asphaltenic or paraffinic)
- % Recycle (natural or distillate)

Delayed Coker: Low Coking Temperature Procedures



Short-Run Drum Procedures - Light Oil Dilution

Repeated Oil Dilution to warm-up condensate drum, followed by steam stripping and normal water quench (a la Joliet Ref & Jose Upgrader)

(1) Inject steam in bottom

(2) Inject LGO through condensate drum and overhead quench, for same period of time as oil was in the drum

(3) Agitate LGO with steam from bottom (can hear liquid)

(4) Block in and drain to condensate drum (pull strainers from blowdown condensate pumps)

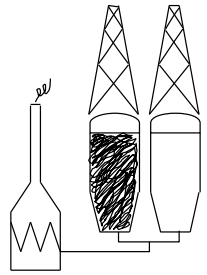
(5) Continue washing and agitation until material is thinned out, based on visual inspection at the warm-up drum

(6) Open little steam until blowdown is available

(7) Open big steam for 30 minutes to blowdown

(8) Cool drum with normal procedure

Delayed Coker: Low Coking Temperature Procedures



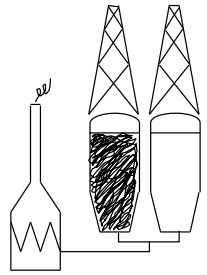
Short-Run Drum Procedures - Superheated Steaming

Take Feed Out of train & pass steam through coker heater to superheat it to +900°F in order to help finish the coking reactions (a la Flint Hills Petroleum Company)

=> Disadvantage of this procedure is that it requires that circulation of resid be stopped

=> Requires comparison of the time required to accomplish this procedure with the other two options presented

Delayed Coker: Low Coking Temperature Procedures



Short-Run Drum Procedures - Extended Steaming

Advantage - Can Cool Resid without Circulating Train

Disadvantage - Can result in a mess to handle or clean up

(a la Beaumont Ref)

=> May be only option in multi-train cokers

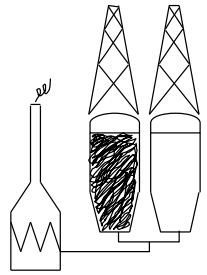
(1) Inject little steam 1-½ hours

(2) Switch drum from combo tower to BD; big steam @ 15 klb/hr for 12 hours

(3) Block steam; start water flow at max rate limited by pressure; fill to 18-ft probe

(4) Shut water, monitor probe; if mid-probe falls, refill with water.
Repeat until mid probe holds water level

Delayed Coker: Low Coking Temperature Procedures



Short-Run Drum Procedures - Extended Steaming (cont'd)

(5) After overhead temp is < 200°F for 1 hour, open drum drain and monitor probe

(6) If drum will not drain, refer to Safe Coke Drum Draining Procedures, which include blowing back the feed line with steam and pressure draining.

Other more drastic measures to consider:

=> Open top head

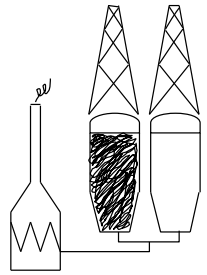
=> Have pit cleaned out and water in pit

A Drill through tarry coke with bit in pilot mode

B Pump out water with submersible pump attached to drill stem

C Drop bottom head and drain water to deck and pit

Delayed Coker: Low Coking Temperature Procedures



Short-Run Drum Procedures - Deciding.....

Baton Rouge used to use either LGO Dilution or Extended Steaming .....

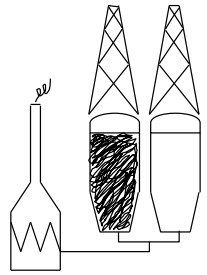
=> Put steam in drum and listened for gurgling

If liquid was detected, usee Joliet procedure, filling with LGO to the 64-ft probe level

If liquid was not present, used extended steaming

Based on a 2008 experience with a drum that was only in service for one hour, they have decided to use the oil dilution procedure for all short run drums and then steam strip .....

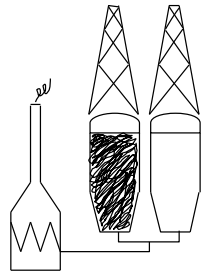
Delayed Coker: Low Coking Temperature Procedures



Baton Rouge Far-East Coker Tar Ball Drum

Geoff Bock – "Over the weekend (1 to 2-nov-08) we switched into coke drum D-501C. After 45 minutes of feed, a crack in the OVHD line developed and we were forced to circulate the drum pair leaving ~1.0 kB of unreacted resid in the drum. We steamed the drum and water filled without any problems feeding and/or draining. After we deheaded the drum, tar slowly flowed out and formed a tar ball."

Delayed Coker: Low Coking Temperature Procedures



Low Coking Temperatures - Logic Flow Scenarios

=> How to handle coke drums that have experienced less-than-desired coke drum temperatures

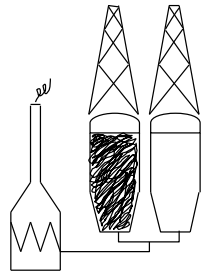
There are three basic scenarios to consider:

(1) Low coke drum temperatures due to train recirculation

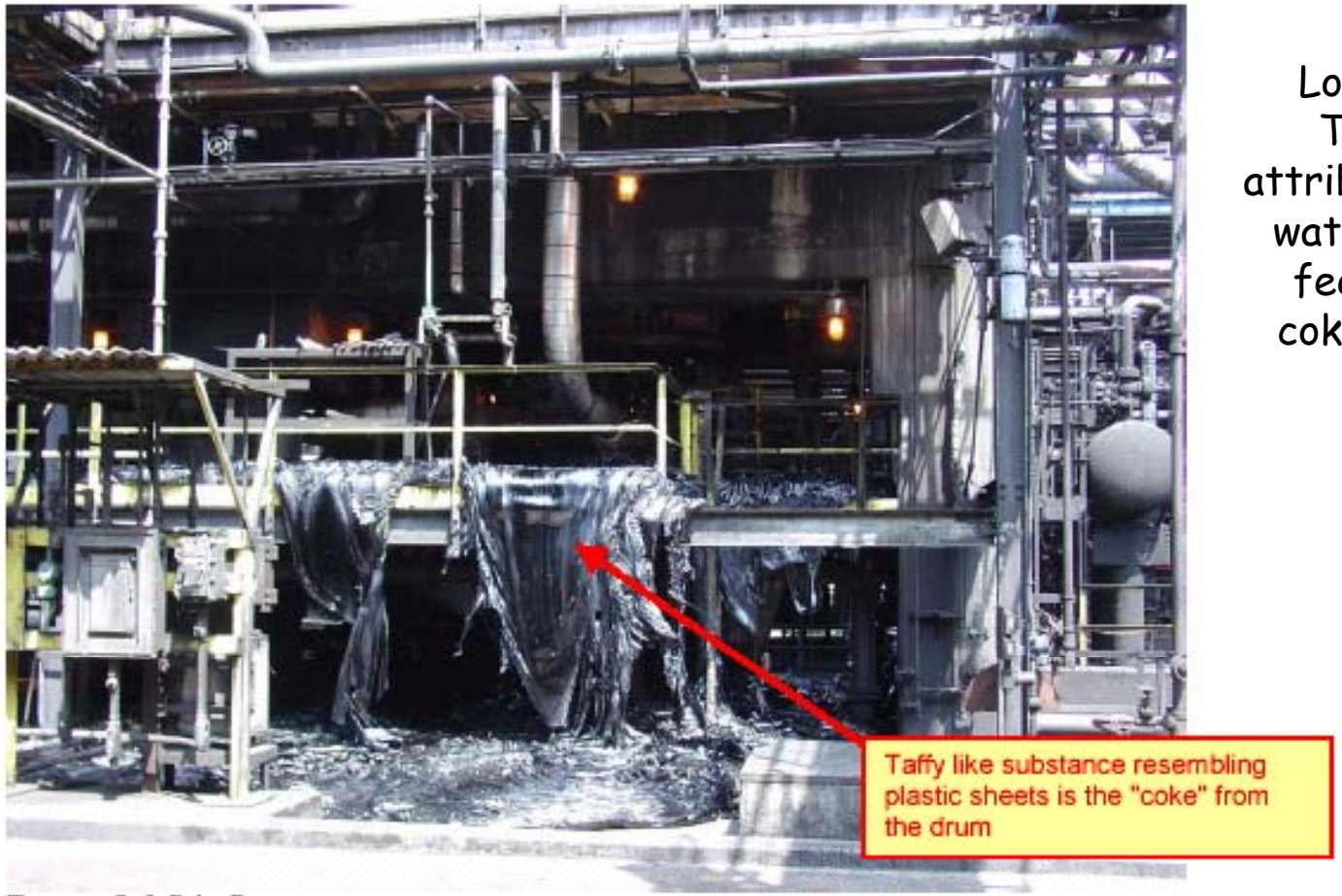
(2) Reduced coke drum inlet temperature while feeding resid

(3) Reduced coke drum outlet temperature while feeding resid

Delayed Coker: Low Coking Temperature Procedures



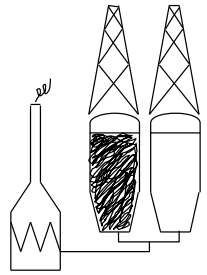
Creating a Mess in Torrance (may-2004):



Torrance Soft Coke Drum

Low Coke Drum Temperature attributed to quench water leaking into feed line during coking operations

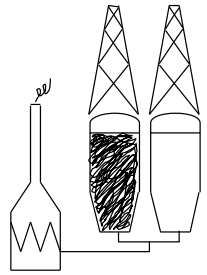
Delayed Coker: Low Coking Temperature Procedures



Creating a Mess - Bakersfield (2005):

Cause of Low Temperature Unknown

Delayed Coker: Low Coking Temperature Procedures



Scenario (1) Controlled Coke Drum Train Circulation

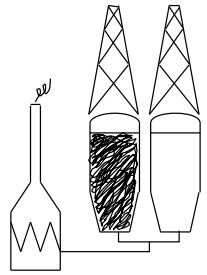
The keys are as follows:

(1) Completely displace the resid in the feed line
(from the switch valve outlet into the coke drum) with steam
(6 - 10 klb/hr is a good rate)

(2) Maintain stripping steam (at least 8 klb/hr) into the coke bed,
until a decision is made on how to proceed.

=> The stripping steam will maintain flow channels in the coke bed
and keep temperature at ~400°F minimum.

Delayed Coker: Low Coking Temperature Procedures



Scenario (1) Controlled Coke Drum Train Circulation

(A) IF, after switching out of the drum (drum has been coking from 0-6 hours), you can return to the drum for more than 6 hours (regardless of the cycle time), THEN return to the coke drum with resid feed.

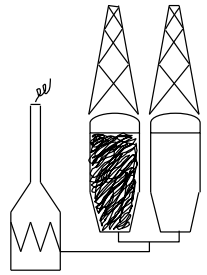
=> Increase coking temp 5 - 10 °F above normal (cut feed if necessary) This will ensure that the resid is properly coked, and will avoid foam carryover to the Main Fractionator during steam stripping.

IF the drum had been coking less than the site's short-run drum criteria (4 - 8 hours normally) prior to recirculation, THEN take precautions against a possible coke fallout on deheading.

Precautions would include:

+ Making sure the drum is completely drained
+ If a cart deheader is being used, treat the drum as if a fall out was going to occur

Delayed Coker: Low Coking Temperature Procedures

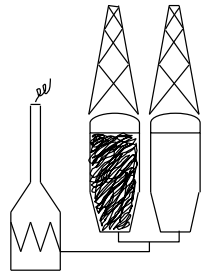


Scenario (1) Controlled Coke Drum Train Circulation

(B) IF coking lasted less than the site's short-run drum criteria,
AND it is not possible to return to the coke drum for more than 6 hours of coking,
THEN unhead the drum utilizing the site short run drum procedure

(C) IF coking lasted more than the site's short-run drum criteria,
AND it is not possible to return to the coke drum for more than 6 hours of coking,
THEN perform the normal drum decoking procedure.

Delayed Coker: Low Coking Temperature Procedures



Scenarios (2 & 3)
Low Coke Drum Inlet and/or Outlet Temperature(s)

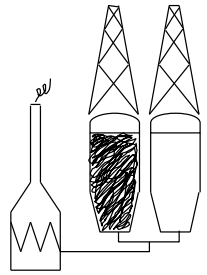
=> A more dangerous situation is when the coke drum suffers an extended period of low coke drum temperature while feeding resid.

Both the inlet and outlet temperatures of the coke drum MUST be considered

Possible causes of a low inlet temperature are:

- feed pump trip
- unstable feed pumping
- fuel gas trip(s)
- heater instrumentation problems
- leaking quench water into feed line

Delayed Coker: Low Coking Temperature Procedures



Scenarios (2 & 3)
Low Coke Drum Inlet and/or Outlet Temperature(s)

Possible causes of a low outlet temperature are:

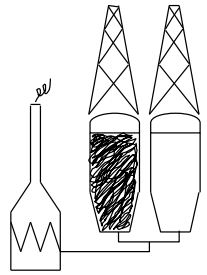
- Leakage of water from a leaking cutting water line onto top head
- Leakage of cold quench oil into the coke drum

These basic points should be considered:

- Uncoked resid in the drum can cause
  - + high foaming
  - + poor quenching
  - + dangers when deheading

- More coke will be made during the period of reduced COT or DOT

Delayed Coker: Low Coking Temperature Procedures



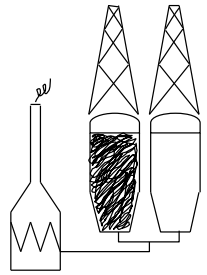
Scenarios (2 & 3)
Low Coke Drum Inlet and/or Outlet Temperature(s)

IF temperature is low in the middle of cycle for a couple of hours, but no more than 15% of total coking cycle (2 - 3 hours), THEN it should be possible to recover by doing any or all of the following steps:

- raising temperature
- using additional steam (heater velocity steam is the easiest source)
- cutting rate back
- lengthening the cycle time (if possible)
- recycle light distillate (if Conoco Technology)

(Note that drum will foam more and fill up faster than normal):

Delayed Coker: Low Coking Temperature Procedures



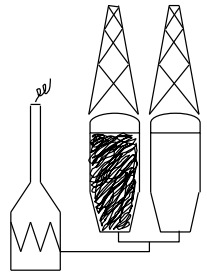
Scenarios (2 & 3)
Low Coke Drum Inlet and/or Outlet Temperature(s)

=> It is important to assess how much the COT has dropped versus a recommended minimum of 900°F

=> Determine if there are changes in other factors that may worsen or improve the situation:

+ feed quality
+ resid cut point
+ operating pressure
+ natural recycle %
+ distillate recycle %

Delayed Coker: Low Coking Temperature Procedures



Scenarios (2 & 3)
Low Coke Drum Inlet and/or Outlet Temperature(s)

=> IF temperature is LOW in the beginning of cycle,
AND you cannot recover, there are two options:

(1) Switch out, circulate train and perform a short-run drum procedure

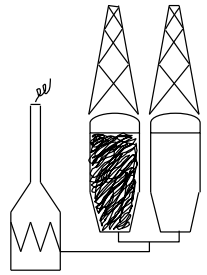
(2) Stay in drum and prepare to deal with the possibility of a partial coke fall-out

Option (1) applies to cokers not well equipped to deal with coke falls

Option (2) applies to cokers with automatic bottom deheading facilities

If you return to the drum,
=> make sure to maximize pressure and antifoam dosage to reduce the chance of foamover

Delayed Coker: Low Coking Temperature Procedures



Scenarios (2 & 3)
Low Coke Drum Inlet and/or Outlet Temperature(s)

=> IF temperature is LOW at the end of cycle, the chance for foamover is much higher during steaming and quenching. The options are:

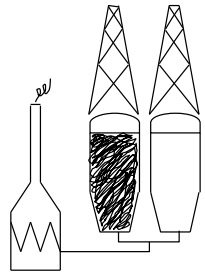
(1) Extend coking cycle once the temperature has returned (only possible if outage permits), cutting rate, increasing COT's and pass velocity steam

(2) Switch out as soon as possible, if the other coke drum is warmed and ready, and perform an extended steam stripping

=> Maximize antifoam & coke drum pressure

=> Cut rate and extend cycle times to accommodate soft coke procedure, if needed

Delayed Coker: Low Coking Temperature Procedures



Baton Rouge Story (Mike Tracey):

"On our West Coker, we were in a coke drum during the very early part of the cycle (coke bed not really established) and had a furnace firing trip. Feed continued to flow through the furnace while we tried to restart the firing. We accumulated a significant pool of unreacted resid which built up much more quickly, since we were below cracking temperature. The issue we faced when we restored furnace firing was that we saw significant drum foaming. To avoid a foamover, the Controller cut COT, but resid continued to flow to the coke drum and still wasn't fully reacting. The issue is that all that accumulated unreacted resid tries to crack at the same time resulting in a very significant vapor surge and resultant foaming, which can easily cause a foamover. Trouble is that you are between the devil and the deep blue sea at that point. The longer you go without raising COT's, the worse the ultimate foaming potential will be. We finally took the steps of cutting feed rate, injecting maximum antifoam, raising coke drum pressure to suppress foaming, etc. while keeping COT's at or just below typical targets. Things worked out OK, but the keys are to restore COT's as soon as possible to get the accumulated resid reacting again and don't be shy about really whacking back feed."