Coker Safety and Reliability Lessons Learned

Chevron
Human Energy®

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2015 Coking.com Conference

COKER SAFETY & RELIABILITY

Current Situation

The Delayed Coker industry has had many incidents with severe consequences, including numerous fatalities. There has been great progress in the last 15 years to improve Coker design to reduce personal exposure and improve safety.

Even with all the improvement, Chevron has experienced some near miss and operational reliability incidents. Current focus areas are metallurgy and Inspection.

Near miss, Incidents and Lessons Learned

- **Furnace Outlet**
  - Start-up issues
  - Lock out- tag out incident
  - Erosion of thermowell
  - Erosion – Corrosion at elbows
  - Erosion at velocity steam injection location
- **Absorber- Stripper and Debutanizer**
  - Trace water causing reboiler corrosion
  - Trace water causing vaporline corrosion
- **PROCESS GAS SPONGE ABSORBER HYDROGEN BLISTERING**
- **Delta Valve – 10 Year look back**
- **COKER Shutdown cleanup using RTI**

Desired Outcome

- Provide "lessons learned " to raise awareness & increase focus on Coker safety and reliability.
- Highlight potential vulnerabilities, discuss inspection, training, and incident prevention.

Coker Furnace Incidents

- Coker Startup Issues & Incident
- Furnace Pass Flow Meter - Inadequate lock-out tag-out
- Furnace Outlet Barrel: Outlet Thermowell Erosion
- Furnace Transfer Line Erosion

Coker Startup Issues & Incident

OVERVIEW

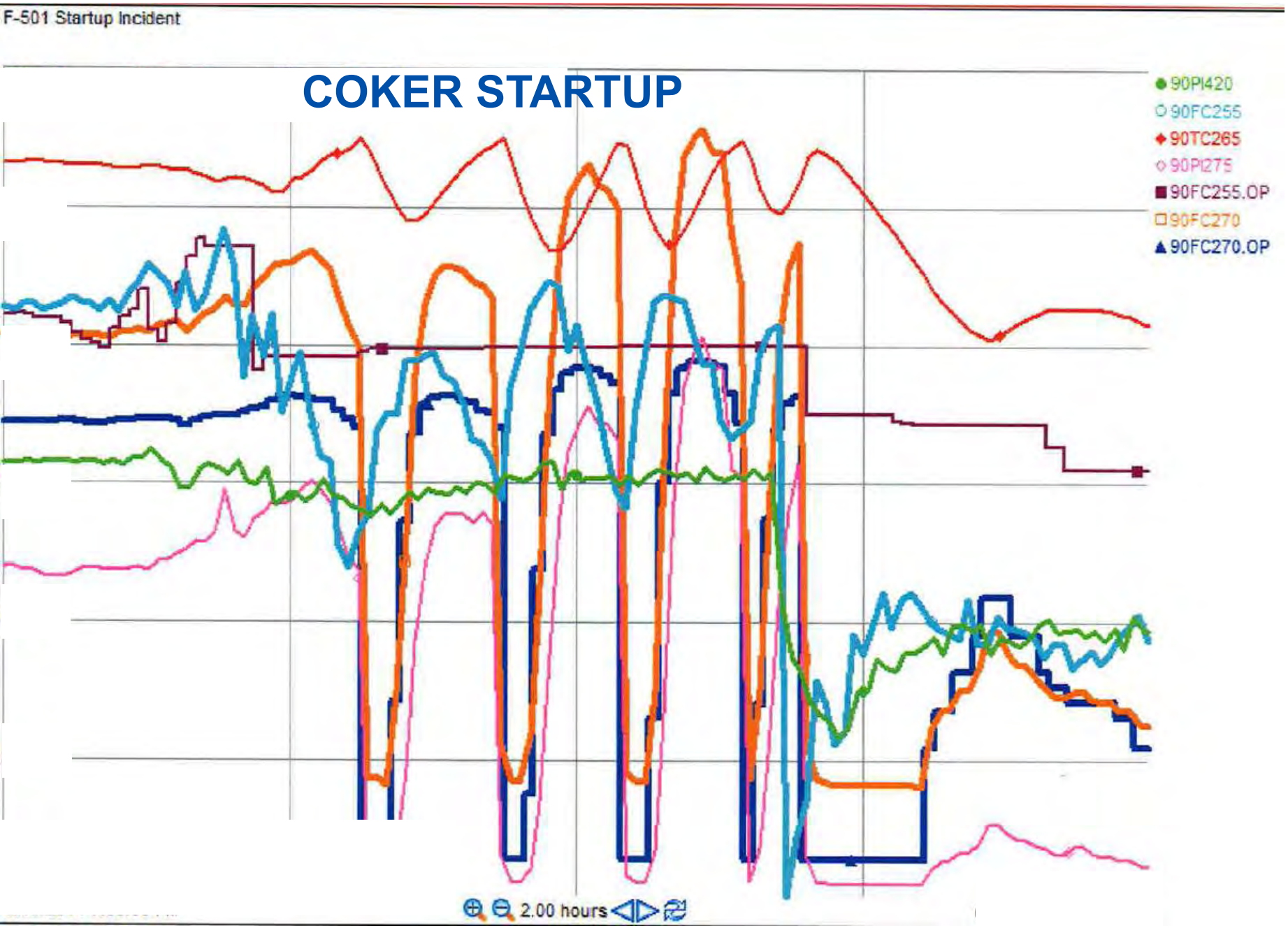
* Charge pump cavitation
* Loss of furnace flames ~ 50% of burners

1. Charge Coker with LCO, establish levels and pump circulation.
2. Commission steam for Coker structure.
3. Drain (multiple times) fuel gas line with chemical cleaning liquid.
4. Clean plugged furnace charge pump suction screens.
5. During pump switch to electric, significant water hammer & piping vibration.

Coker Startup Issues & Incident

6. Coke from piping caused furnace FC plugging; cleaned multiple control valves, establish flow control.
7. Furnace warm-up, module circulation, feed in to coke drum.
8. **Furnace charge pump cavitation** from flashing seal flush.
9. Low furnace pass flow, high furnace outlet temperatures, fuel gas TC closes; fuel gas on new minimum flow.
10. High CO and O2 in firebox; visual inspection of furnace shows multiple burners were not lit. **Loss of flames with fuel gas into firebox is a HAZARDOUS condition.**

COKER STARTUP



Erratic control, large furnace temperature swings.

Coker Startup Issues: Corrective Action

1. Cleaned furnace charge pump suction screens.
2. Changed the charge pump seal fluid from FCC LCO (with heavy gasoline being dropped to LCO due to refinery processing constraints) to HCGO pumparound.
3. Drain liquid from fuel gas headers.
4. Re-light burners. NOTE: **Low pressure Safety Instrumented System (SIS) fuel gas chop function DID NOT activate because the pressure sensors are upstream of the TC.**
5. With oil flow and furnace burners re-established, returned to minimum flow at desired furnace outlet temperature.
6. Since resid below coking temperature entered the coke drum, feed cycle time extended to increase coking time. Also, increased steam stripping time. There were no tarry drum issues during quench, drain, or coke removal.

Coker Startup Issues: Corrective Action

MAINTENANCE

1. Disconnect fuel gas flanges / open bleeders at low points to verify dry after chemical cleaning.
2. Inspect coke drum vaporlines, column bottoms piping; clean if necessary.

OPERATIONS

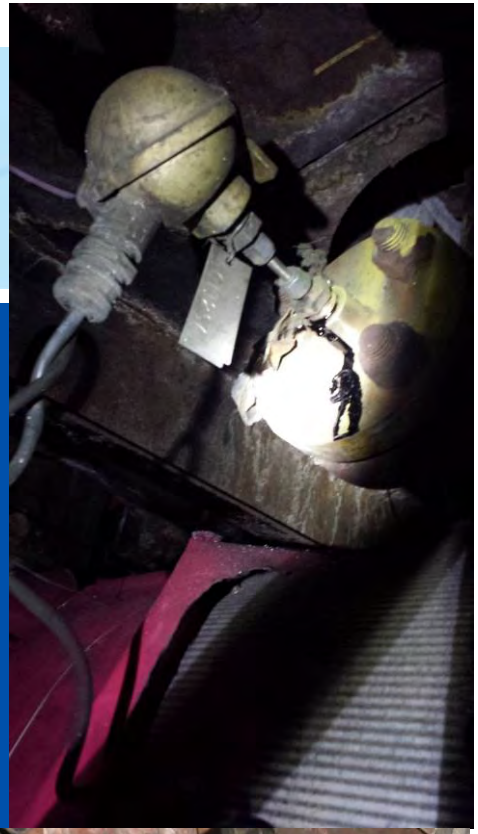
1. Use heavy gasoil, not FCC LCO for startup charge to Coker.
2. FURNACE
   a. Review fuel gas minimum flow guidelines, increase to maintain adequate burner header pressure for flame stability.
   b. Develop short term emergency procedure for low fuel gas burner header pressure in lieu of SIS trip.
   c. Correct SIS fuel gas pressure measurement location.
3. STRUCTURE STEAM. Wait until drum inlet temperature is over 700 F before introducing structure steam (minimize potential for condensed water in system).

Furnace Pass Flow Meter - Inadequate Lock Out – Tag Out

- Poor communication regarding location of isolation between operator releasing equipment and mechanic doing the work on resid orifice pass flow meter plugged tubing.

- Resid sprayed from furnace pass flow orifice meter. Resid at 550 F, 500 psig furnace discharge pump pressure. Resid "auto-ignition" estimated to be 650F.

Furnace Outlet Barrel: Outlet Thermowell Erosion



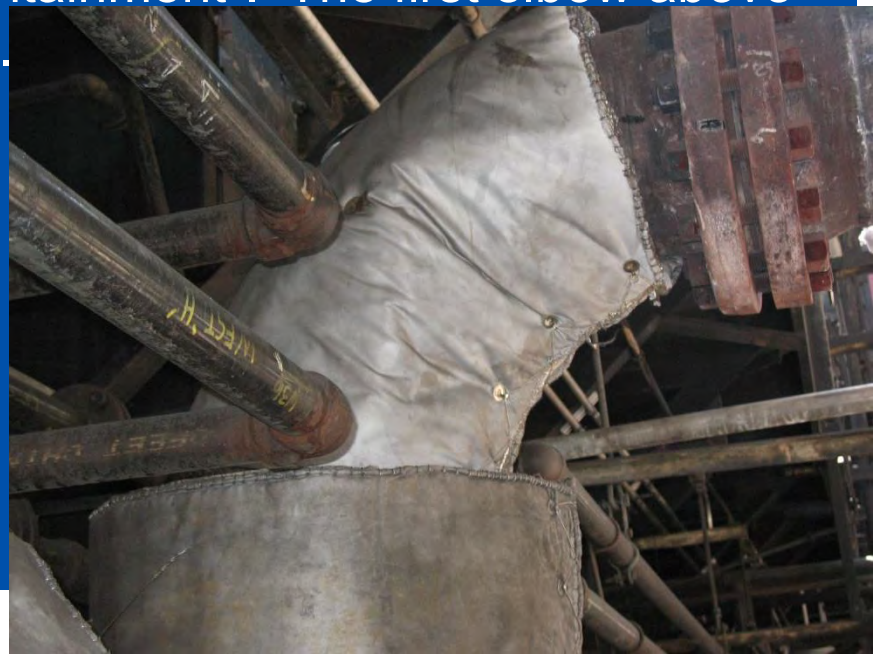
Original Outlet barrel configuration: Steam:air decoking caused thermowell erosion. Resid leaking into the conduit caused false outlet reading, higher furnace firing rate, accelerated coking rate. Thermowells replaced, furnace de-coked.

Outlet barrel configuration can be a source of coke accumulation.

Furnace Transfer Line Erosion

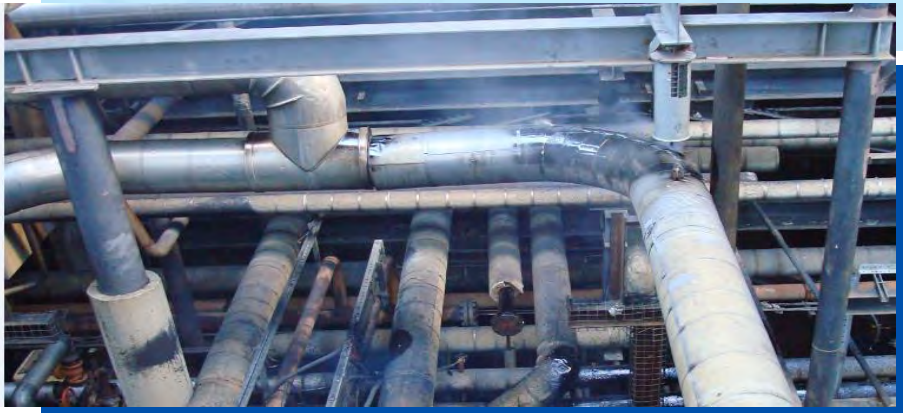
CHALLENGES

1. Furnace transfer line is prone to coke accumulation, increased pressure drop, higher velocity.
2. Furnace outlet transfer line (especially elbows) is vulnerable to erosion and through wall “loss of containment”. The first elbow above outlet barrel is especially vulnerable.



Discussion Topic: Furnace transfer piping configuration

Furnace Transfer Line Erosion



- 2011 – furnace outlet piping erosion at outside of elbow after 4 years. Coke in line increased downstream velocity. OPS discovered after spall, isolated immediately.
- 2013 – elbows flanged for removal to clean, with stellite hard facing on inside.

Furnace geometry: Outlet changed to maintain upward flow, no outlet barrel.

Furnace Transfer Line Erosion

- Quench steam added to furnace outlet from 6:00 position. Lowers outlet temperature during online spall.

2015: Through wall erosion at 12:00 position, slightly downstream after ~3-7 years.

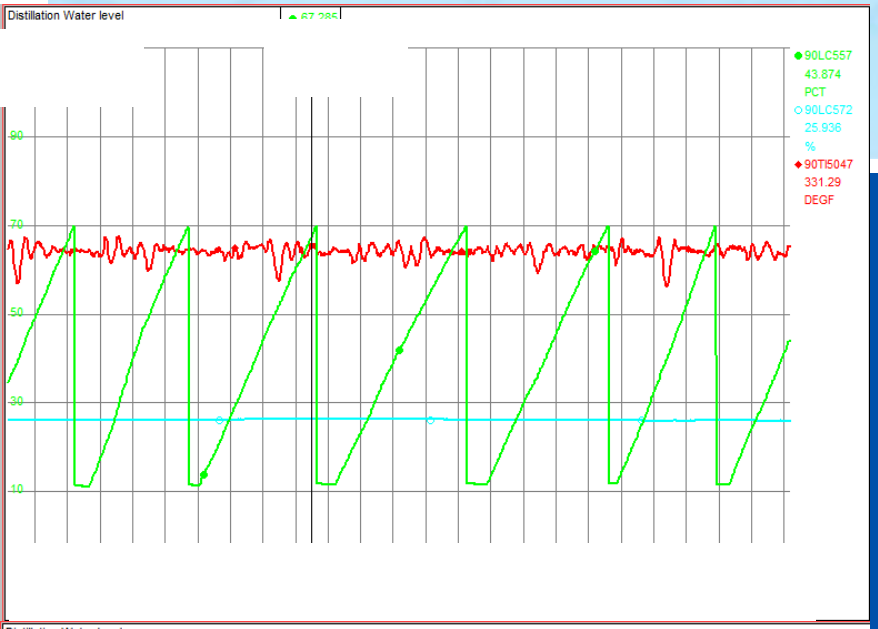
Coke build-up on side walls results in higher velocity.

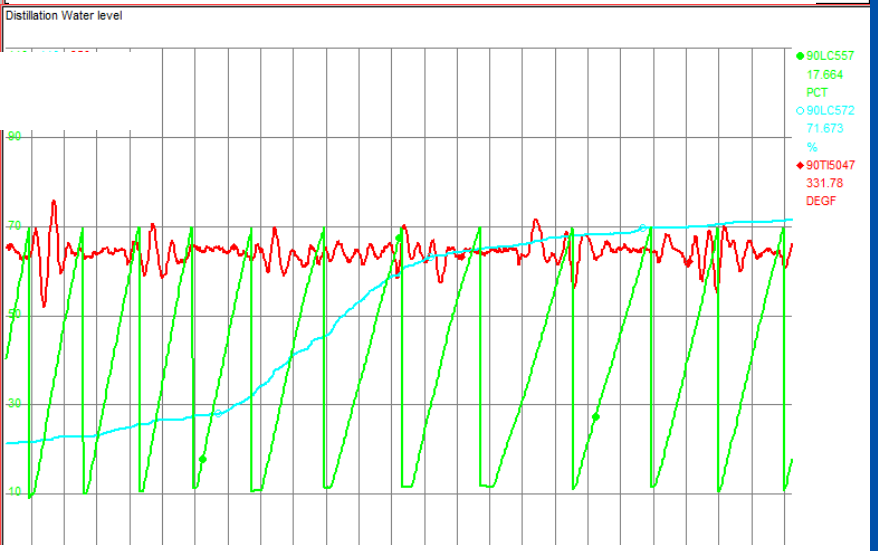
Coker Distillation Incidents

- Absorber – Stripper
- Debutanizer

Stripper Corrosion

Stripper Repairs & Performance





SHUTDOWN REPAIRS

1. Replace tube bundles
2. Repair reboiler shells.
3. Add stainless steel over floor of total draw tray that feeds reboilers.

Current Operation

1. Gap control for absorber – stripper side water draw tray. Tray removes water, very predictable. H2O removal from tray ~ 13.
2. Intermittent water from stripper bottoms to debutanizer.

3. ISSUE: Determining if water is “trapped” belo H2O draw tray. Water vaporized leaves behinc corrosive chloride salts.

Debutanizer Condition

Debutanizer tray 33, “Prussian blue” cyanide salt deposits.
Cause: Trace water in stripper bottoms was not being removed in debutanizer OH reflux drum. Water was being refluxed. After going down a number of trays, the water was vaporized, leaving deposits at the tray where vaporization occurred.

Prior to shutdown, experienced column OH piping loss of containment. Corrosion from ammonium bisulfide accelerated by presence of cyanides.

COKER SPONGE ABSORBER HYDROGEN BLISTERING

HISTORY

1. Long history, no major issues.
2. Water circulation with ammonium polysulfide (APS) injection is used upstream of Sponge absorber.
3. Additional nitrogen, increased ratio of APS per MBPD resid.
4. Wet H2S service, but unexpected problem discovered in shutdown.

Coker Sponge Oil Absorber Hydrogen Blistering

Discovered Hydrogen blistering with cracks in the steel. Wet H2S and possibly cyanides are root cause.

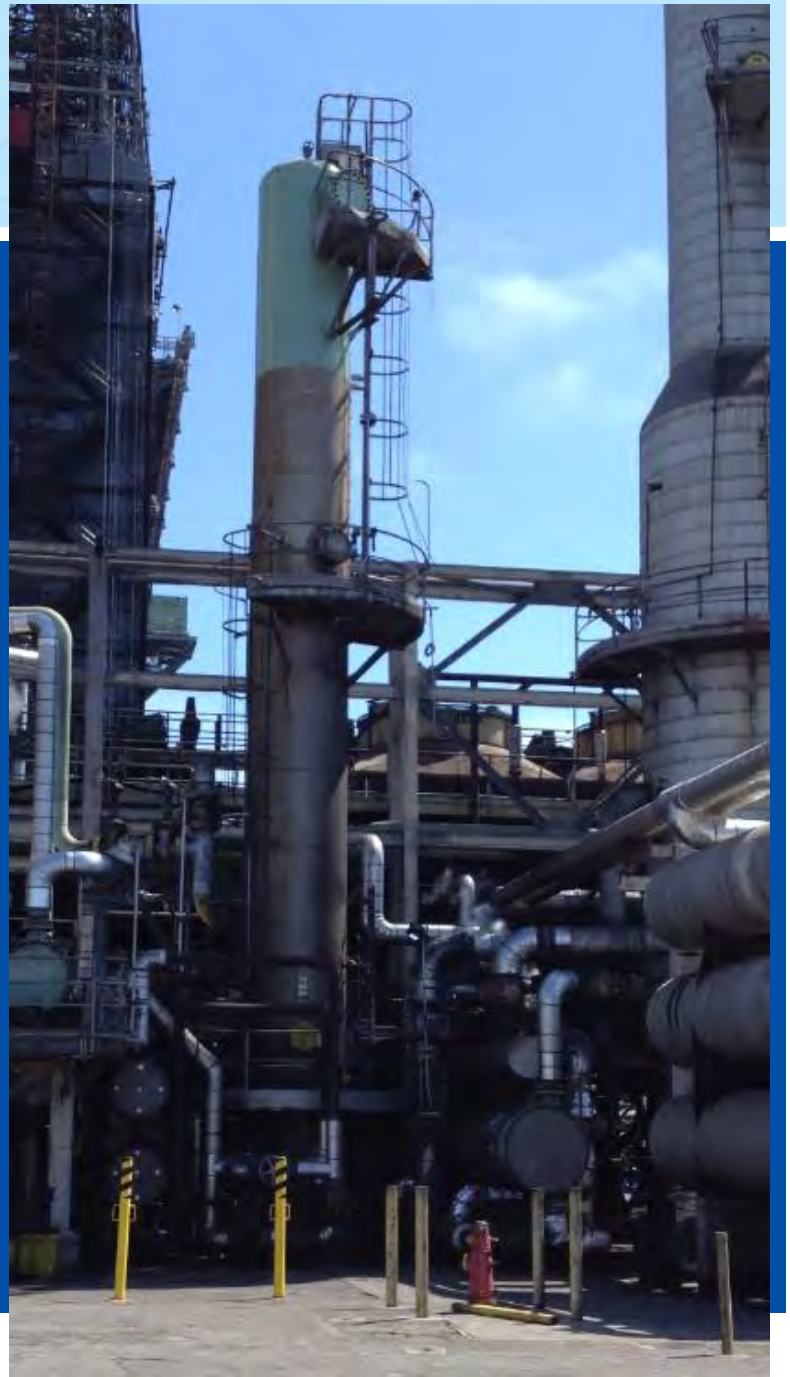
No tray issues. Floating valve caps

Coker Sponge Oil Absorber Repair

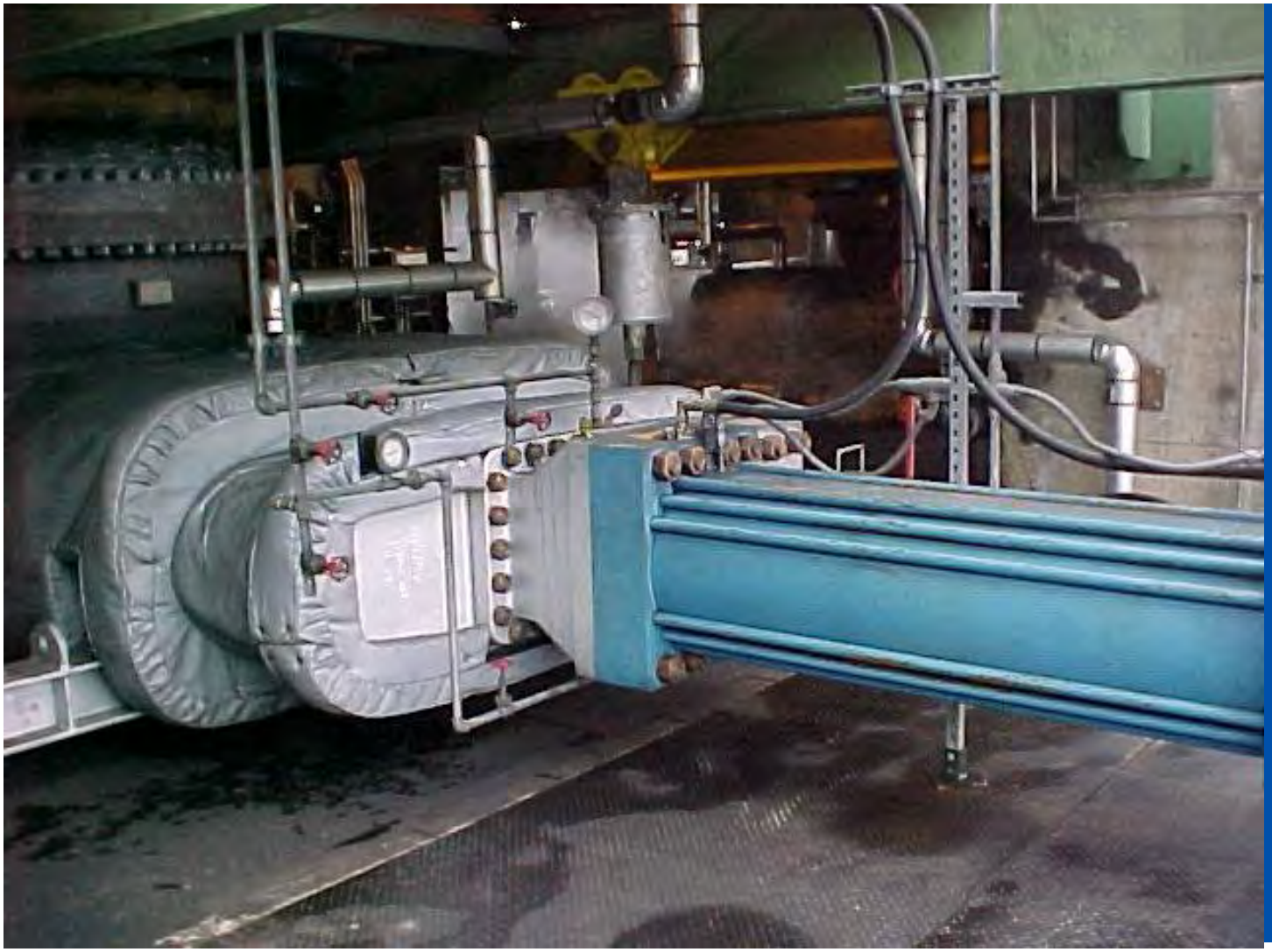
Replaced top 8 feet of Sponge Absorber.

Maintained upstream sour water circulation with APS to remove cyanides from Coker tail gas.

Discussion Topic: Determining if all cyanides in Coker tail gas have been removed.

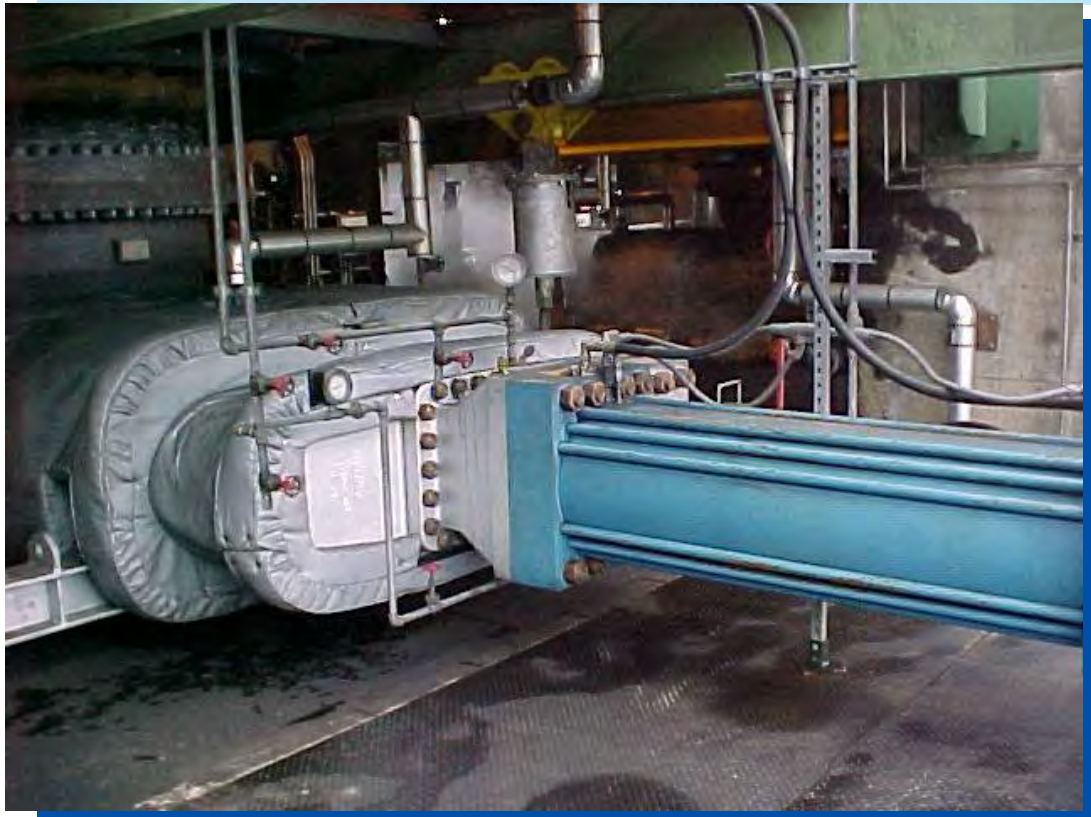


Automatic TOP and Bottom Unheading with Delta Valves – 10 Year Look back



- The old coke drum unheading was a SAFETY risk with potential for personal exposure, and injuries occurred during mechanical top and bottom unheading.

Bottom Unheading

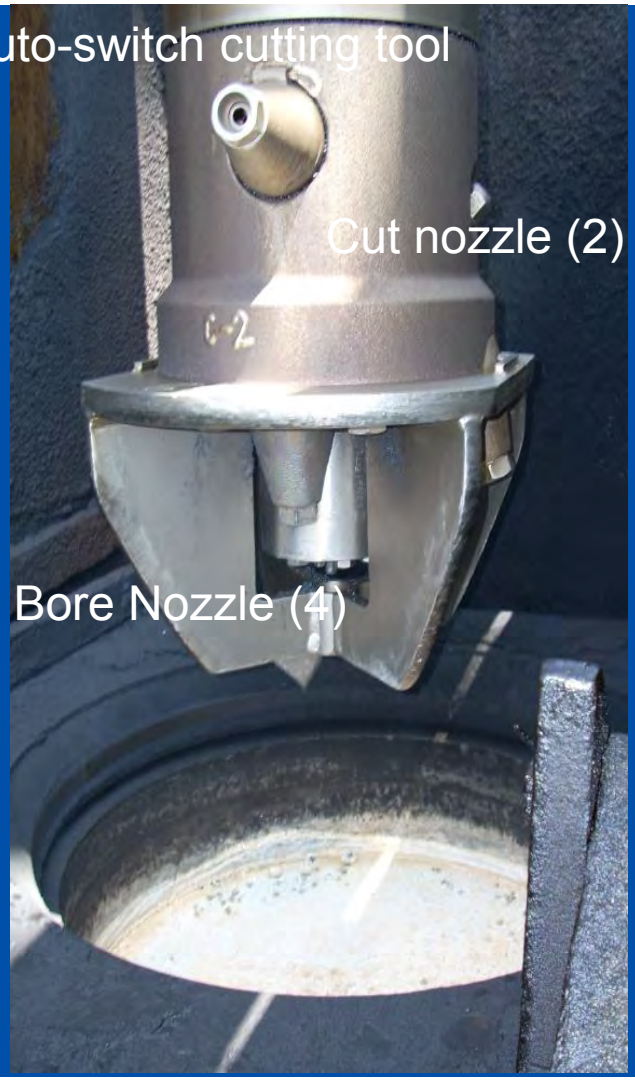


The new system has revolutionized the industry; there has been a dramatic improvement in Coker Safety.

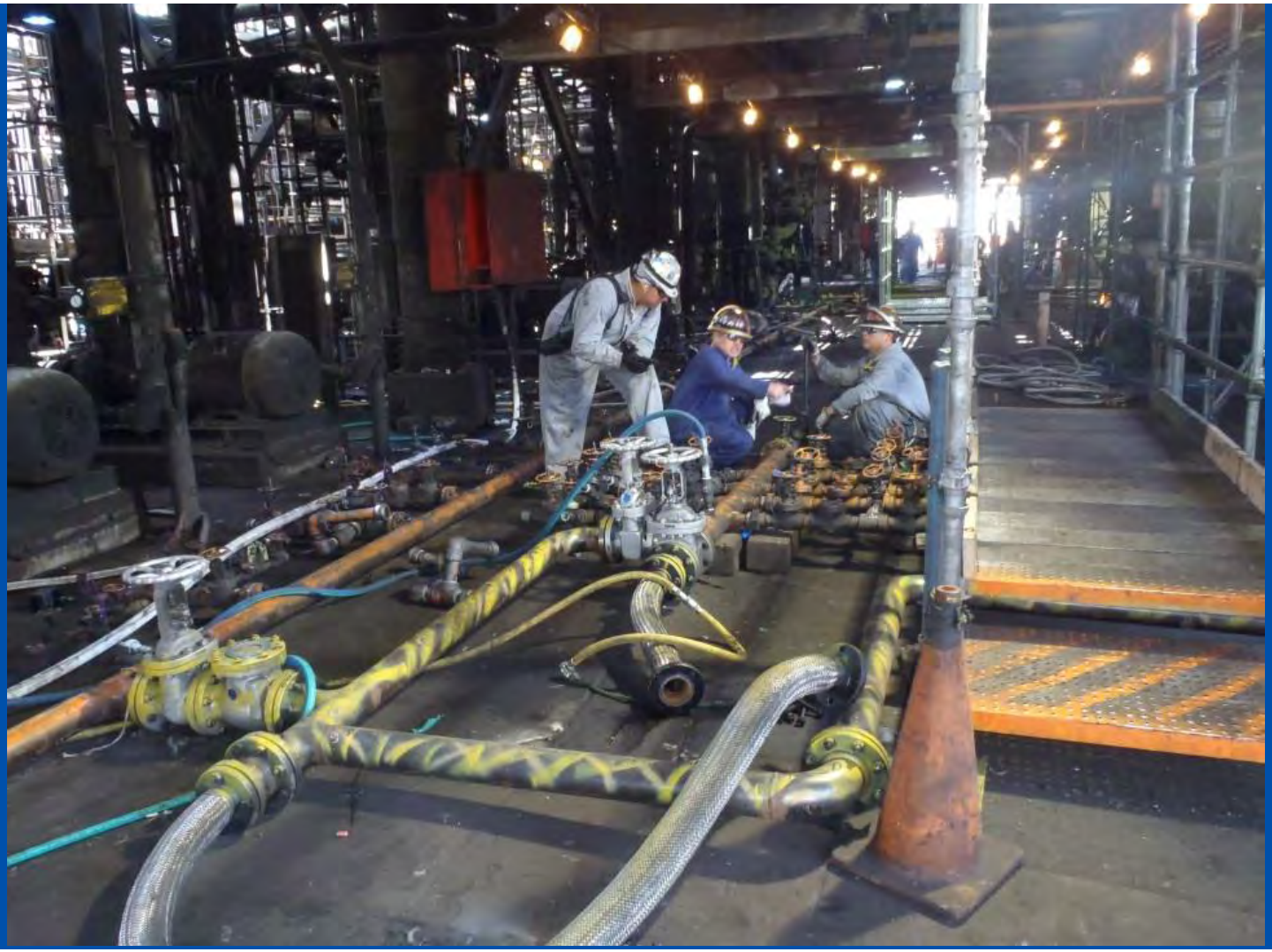
- No Loss of Containment incidents.
- No SAFETY incidents associated with valve operation.

CHEVRON EXPERIENCE – 10 + Years
14 coke drums

Top Unheading



Coker Shutdown Clean-Up with Refined Technologies Incorporated (RTI)



Coker Shutdown Clean-Up with Refined Technologies Incorporated (RTI)

- Extensive pre-shutdown equipment installed to allow steam and chemical to be routed to all desired locations.
- Introduces tripping hazards.

Upper Section Main Fractionator

Column entry with appropriate personal protection equipment

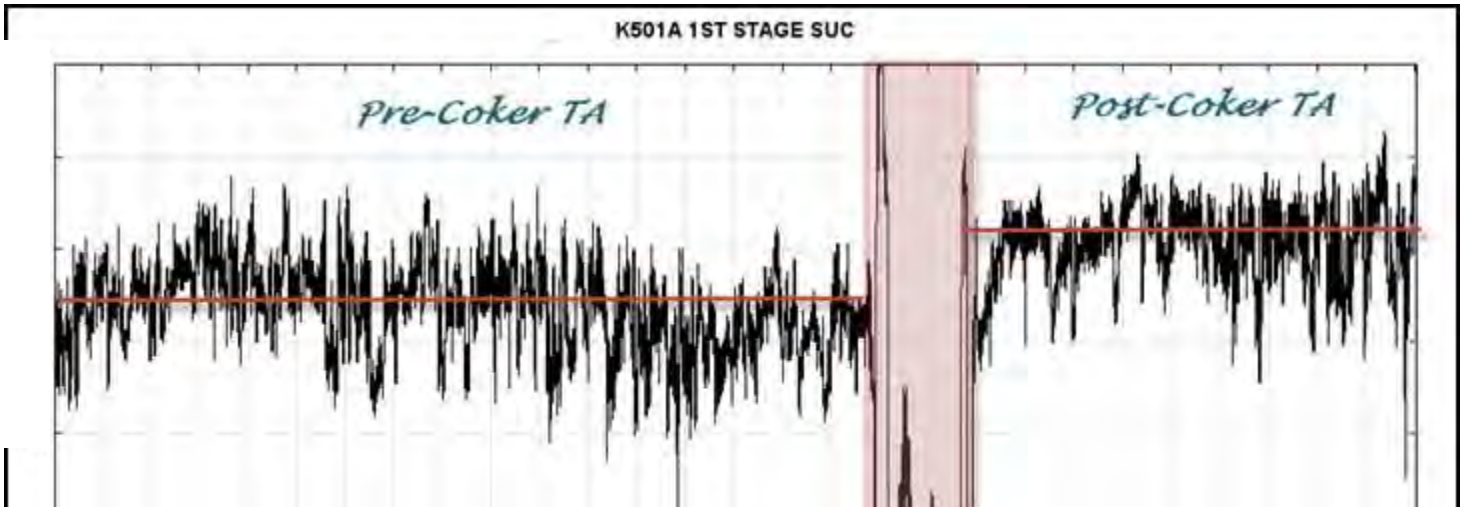
Coker SHUTDOWN CLEANUP

Tunnel column by removing tray deck manways to allow inspection. Column condition was very good, trays were very clean.

Coker SHUTDOWN CLEANUP

Some coke and sludge on bottom HCGO chimney draw tray

Coker STARTUP ISSUE



Upon startup, the overhead fin fan cooling performance was significantly worse.

Lesson Learned: Column chemical cleaning needs to have OH exchanger cleaning to follow.

Coker Safety and Reliability Lessons Learned

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QUESTIONS ?