Shell Deer Park Refinery

Delayed Coker Incident

March 4, 2004

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Bottom of the Barrel Seminar

April 19, 2005
Outline

• Unit Information
• Incident Details
• Resulting Impacts
  – Plugged Gasoil Product Systems
  – Partially Coked Drum
  – Another Drum Filled With Resid
  – Fractionator Tray Damage
• Investigation Findings
• Recommendations
Delayed Coker Information

- Capacity: 88 MBD
- Feed: Maya Vacuum Resid
- 6 Drums, 3 Heaters, 1 Frac, 1 B/D
- Drums: 28’ ID x 121’ F/F, 89’ T/T
- Startup in 1995, 4 Drums (FW design)
- 2001: Expansion to 6 Drums
- 43 MBD Gasoil Hydrotreater
Incident Details

- Prior Status: Drums 1&2 and Heater 1 down for drum repairs; Drums 3&5 coking, Drum 4 quenching, Drum 6 preparing to warmup
- Frac experienced an upset causing a large, rapid temperature drop (105°F in first 16 minutes)
- Charge Pumps began to cavitate, flow was lost to both Heaters
- Heaters tripped, but some flow was still going to 2 coking drums
- Drum inlet temperatures quickly dropped and never recovered
- Frac Bottom Level got out of control, carrying over resid into HGO and LGO product systems
Incident Details (cont’d)

- Bypassed GOHT to prevent Resid in feed
- Fought Heaters for hours due to Charge Pump cavitation
- Bypassed Drum 5 after 3 hours – Partially Coked “Tarry” Drum
- Bypassed Drum 3 after 9 hours – mostly cooler resid inside
- All Fresh Feed cut out after 9 hours
- Note: Drum 4 quench was not normal; more on this later…
Coker Simplified Flow Scheme

- **COKE DRUMS**: 800°F, 22-24 PSIG
- **CHARGE HEATERS**: 895°F, 925°F
- **VAPOR LINES**: 250-260°F, 16-18 PSIG
- **MAIN FRAC**: 585°F
- **WASH OIL**: HGO P/A
- **SPIEGE OIL LOOP**: WASH OIL
- **REFLUX**: WAX TAILINGS FROM BLOWDOWN, PITCH FEED
- **WGC**: TO GAS PLANT
- **NAPHTHA TO GAS PLANT**: LGO TO GOHT
- **HGO TO GOHT**: WAX TAILINGS
Plugged Product Lines

• Carryover of Resid from Frac plugged:
  – HGO Product and Pumparound lines
  – LGO Product lines
  – Gasoil to Storage lines
  – Blowdown lines to Frac
  – MDO lines

• The plugged lines were critical path for restarting, resulting in 8 day S/D
Plugged Lines: Mitigation

- Removed insulation
- Wrapped thousands of feet of piping with temporary electric tracing
- Heated the piping until the material flowed again
- This process took days and cost big $$.
- There is no quick and easy way to unplug lines containing solid Resid.
Drum 5 – “Tarry” Drum

- Drum 5 had been coking for about 11 hours prior to the heater trips
- Drum was fed for 3 hours after that
- Estimated 4 MB Resid in the drum that didn’t finish coking
- As soon as drum was bypassed, steamed at 7 Mlb/hr for about 4 days
- Had to wait because Blowdown system was not available due to plugging
Drum 5 – “Tarry Drum” (cont’d)

• After weighing our options, decided to quench the drum as best we could.
• Quenching itself went pretty well.
• However, as anticipated, drum would not drain afterwards.
• Since we did get a substantial amount of cooling during quenching, we decided to unhead and try cutting.
Drum 5 – “Tarry” Drum (cont’d)

• Unheading was performed remotely
• Small amount of “black lava” oozed out the bottom as chute was raised
• Cutting was very difficult and took hours; lots of hot spots
• However, in the end the material was safely and successfully removed
• Left with a giant “lava mountain”
Drum 3 – Full of Uncoked Resid

- Fed “cool” Resid for 9 hours after heat loss
- After bypassing steamed at 10+ Mlb/hr for over a week
- Temperatures suggested that Resid was still hot enough to flow
- Several potential options considered
- In the end, it was decided to build a special temporary system to drain the Resid out
- Resid would be blended with cutter right out of the drum and pumped to MFO tanks
- Ratio of cutter/Resid would be controlled to prevent plugging, etc.
Drum 3
Drain System

Temporary Facility To Transfer Drum 3 Material To MFO

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Drum 3 Draining System

- System worked like a charm
- Draining/blending process took approximately 2 days
- After level was verified to be below 13’ level indicator, draining was stopped
- Estimated 1.5 MB of Resid still inside
- Shortly after that, hot feed was switched into Drum 3
- Foam front moved quickly up the drum, started antifoam
- Had to cut feed and double antifoam rate to stop foam front; cycle lasted almost 24 hrs
Problems on Unit Restart

• During restreaming of the unit, a couple of issues were observed
  – Frac Bottom Temperature was much lower than normal (feed heat integration w/ HGO)
  – No pressure drop in HGO section of tower
• Determined that bottom 9 trays severely damaged
• Had to raise column pressure and fire heaters harder to get feed rate up
• Have been fighting this ever since, but managing to keep going
Investigation Findings

• Cause of Temperature Drop
  – Drum 4 Coke Condensate Valve didn’t fully close
  – PLC indication showed that valve had closed
  – During Drum 4 quench, water flowed through Coke Condensate and into Frac feed zone
  – Essentially, we “quenched” the Frac
  – Trays damaged due to pressure surge from water vaporization

• Resid Carryover
  – Guidelines were not clear on when it is acceptable to cut out fresh feed
  – Operators were under the impression that they could not cut out feed completely
Drums 3&4 Schematic

Valve cracked open
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Blowdown/Coke Condensate System

COKE DRUM

FLOW FROM FEED FILTERS UNIT

LEAN SPONGE OIL FROM E-31002

LEAN SPONGE OIL
FROM E-31002

AC-31003 A/B/C/D/E/F/G/H

V-31010

COKE BLOWDOWN DRUM

TV-31241

BLOWDOWN CONDENSER

FUEL GAS

BLOWDOWN GAS TO FLARE

AC-31002 A/B

V-31011 BLOWDOWN SETTLING DRUM

LOW NOX

SLOP OIL

TO SOUR WATER STRIPPER

V-31010 BLOWDOWN DRUM HEATER

BN-31001 AS TEMP. DROPPED, STARTED SENDING WATER

LOST THIS PUMP AT 11:14

PUMP WAS OUT OF SERVICE. VESSEL WAS BEING PRESSURED OUT.

V-31005 COKE CONDENSATE DRUM

Pump bypass

WAX TAILINGS TO MD COLLECTION SYSTEM

AC-31002 A/B

REFINERY RECYCLE OIL TO V-31008 FRACTIONATOR

BALANCE LINE TO FRACTIONATOR

WAX TAILINGS TO V-31006 FRACTIONATOR

ALTERNATE MAKE UP TO T-31001

SLOP OIL EXCHANGER

BLOWDOWN CIRCULATING OIL PUMP

AS BLOWDOWN CIRCULATING OIL PUMP WAS OUT OF SERVICE, VESSEL WAS BEING PRESSURED OUT.

COKE CONDENSATE STRANERS

PUMP WAS OUT OF SERVICE. VESSEL WAS BEING PRESSURED OUT.

SLOP OIL EXCHANGER

WAX TAILINGS

COKE CONDENSATE DRUM

BLOWDOWN GAS TO FLARE
Investigation Findings (cont’d)

• Partially Coked Drums
  – No consistent guidelines for when to bypass a drum after heat is lost
  – Everyone knew there was a limit, but focus was on troubleshooting the other issues

• General
  – Communications and decision making during event were not structured
Recommendations

• Water in the Frac/Temperature Drop
  – Convert PLC inputs on Coke Condensate valve from external prox switches to internal limit switches
  – Install a low temperature alarm on both Coke Condensate drums
  – Consider upgrading other critical structure valves with MOVs that can be interlocked
  – Provide operator training on the above items and “how to recognize” water in the Frac
Recommendations (cont’d)

• Develop guidelines for managing Frac level excursions and Coker feed system
• Develop guidelines for when to bypass Coke Drums after heat is lost
• Develop guidelines for when to place the GOHT on circulation
• Develop a structured communication and decision making process for managing abnormal situations
• Train operators on all of the above
Questions?