Innovative Repairs in Coke Drums

Coking.com
Calgary, Alberta
Canada
Agenda

- Reasons Coke Drums Crack
- Locations of Cracks
- Various Repair Methods
- (3) Examples of Innovative Repair Methods
- Test Results from Refinery Validating use of OL for Repair of Bulges
- Test Results for Using OLP in Coke Drums
- Joint Industry Project
Coke Drums

• API Survey of 54 Drums
  – 61% Bulging
  – 97% Circumferential Cracking
  – 78% Skirt Cracking

• Cracking occurs within 5 to 7 years

• Why are they cracking and/or bulging
  – Operating on shorter cycles
  – Running different feedstocks
  – Weren’t designed for low cycle fatigue or compressive strength of coke
Typical Coke Drum Failures

- **Cracking**
  - Circumferential seam
  - Skirt to Shell welds
  - Shell cracks

- **Bulging**
  - Circumferential Seams
  - Shell Course

- **ID Corrosion**
  - Delamination/wear of cladding

Many skirts are cracking within 5 years of operation
Example 1
Repair of ID Corrosion

• Customer was experiencing cracking and delamination of explosion bonded clad in 1999
• WSI removed cladding and applied overlay tying back into explosion bonded clad
• In 2008 Customer was experiencing delamination of explosion bonded cladding around Overlay
• WSI removed delaminated clad and applied Overlay
Example 2
Skirt Cracking

• 2 - Coke Drums
• Tower details:
  – SA-387-Grade 11 material
  – 103 foot tall
  – 26 foot ID
  – Original wall thickness 1.25”
• Turnaround inspection:
  – 2003 T/A repaired weld seams in Coker # 2
  – May 2006 found indications approximately 0.190” deep, 1” long, encompassing entire circumference of weld seam in both drums
Customer Challenge

Client options:

• Stick Welding:
  – Already had contracted with local general contractor to gouge and re-weld, and it was going to take 3 outages to complete.
  – 3 Outages x 5 days = 15 Days required

• Automated Welding:
  – Utilize Temper bead technique
  – Work on both Coke Drums simultaneously
  – Eliminate PWHT
WSI Approach

Engineered Repair Design:

- Utilizing 8 Automated Weld Systems
- Machined and Re-Welded Circ Seam using Temperbead WPS
- Post Soak used, eliminated PWHT
- UT Shear Wave acceptable
- 5 day Schedule for the welding of both Coke Drums
- Savings $$$
  - Customer avoided 10 days of Downtime
- Recently inspected after 660 cycles no cracks
Coker Skirt to Shell
Circumferential Seam Weld Repair
Customer’s Challenge

- 8 - Coke Drums (4 Trains)

- Tower details:
  - Material – SA 387 Grade 11
  - Height: 87 feet
  - Diameter: 21.7 feet
  - Original W.T.: 1.37”

- Customer was experiencing extensive cracking at skirt to shell circ seams 360 degrees all 8 drums
Circ Seam
Evaluation

• Cracks did not penetrate into the base material (shell wall), and customer wanted to perform repairs to cracks with little to no separation while on-line

• Safety and Risk Evaluation
  – Reviewed Refinery’s Past Safety Performance
    • H2S Monitoring
      – Customers existing permanent plant monitors
      – Addition of temporary monitors strategically located
  – Structural Stability Evaluation
    • including wind load
Safety Plan

• Generation of Detailed written Safety Plan
• Focused Training of the team on the specifics on the job and the hazards to watch out for
• Generation of work traveler that incorporates the safety aspects of this evolution
• Heightened Site Safety Presence and monitoring
  – Tented cool down stations for personnel
• Vacated area during emptying of cokers
Repair Plan

• Review Crack Mapping, Structural Stability, and Work Environment
• Crack Excavation
• Pre-Heat: 250 Degrees Utilizing Resistance Heaters
• Root – GTAW Semi-Auto
• Fill – GMAW Semi-Auto
• NDE -Dye Penetrant
• Post Soak (de-gas) – 450 degrees
Schedule

- Schedule was developed with the integrated team: Operations, Maintenance, Safety, Engineering, and Corporate Executives.
- Project Team reviewed and approved the entire plan...Repair and Safety
- This was an emergent project completely mobilized within 2 weeks notification of need in India
Use of Overlay Plate for Fabrication of New Coke Drum

- **Stress Engineering Services** – Evaluation and Assessment
- Comparative Testing OLP versus Explosion Bonded Plate
  - Stress Concentration Factors
  - Mechanical Tests
  - Low/High Cycle Fatigue
Test Results

• Waiting on Completion of Test …will have within next 30 days.
Joint Industry Project

- Develop Test plan to evaluate weld overlay for Coke Drum Service
- Evaluate weld bead strength and SCF from bead contour
- Evaluate compatibility with weld cap overlay at Circ Seam
- Evaluate New Plate Fitness
- Evaluate Field Bulge Overlay
- Perform testing at SES Houston lab if details and special sensors to be used
- Or at WSI if conventional Tests performed
- Metallurgical Review by WSI and SES
- Develop Technical Papers on Results for Presentations
- Compare to Roll and Explosion Bonded