



Innovative Coke Drum Repairs

Coking.Com Workshop
Galveston, TX
03/24/2009



Welding Services Inc.

Coking.com[®]
MORE PRODUCTION - LESS RISK!

Agenda

- Reasons Coke Drums Crack
- Locations of Cracking
- Who is WSI
- Examples of Innovative Repair Methods
 - Repair/Restore Corrosion with Automated Weld Overlay
 - Skirt to Shell Weld Repair utilizing Temperbead
 - Bulge Repair with Temperbead
 - Skirt Replacement and Shell Repair w/Temperbead
- Conclusion



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Coke Drums

- Why are they cracking and/or bulging
 - Running different feedstocks
 - Operating on shorter cycles
 - Weren't designed for low cycle fatigue or compressive strength of coke
- API Survey of 54 Drums
 - 61% Bulging
 - 97% Circumferential Cracking
 - 78% Skirt Cracking
- Cracking occurs within 5 to 7 years



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Typical Coke Drum Failures

- Cracking
 - Circumferential seam
 - Skirt to Shell welds
 - Shell cracks
- Bulging
 - Circumferential Seams
 - Shell Course
- ID Corrosion
 - Delamination/wear of I.D.



Many skirts are cracking within 5 years of operation



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WSI: Who We Are

Leading Global Specialty Welding Solution Provider, with ...

Unique Competency Set

Applied Welding Technology
Mechanical Repair Design
Global Field Operations
Project Execution Excellence

Broad Services Offering

Erosion/Corrosion Field Services
Field Orbital Welding Services
Shop Erosion/Corrosion Services
Nuclear Repair Services

Serving a Broad Global Energy Customer Base

Safer, Faster, and Better



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WSI Technical Leadership Technology and Engineering

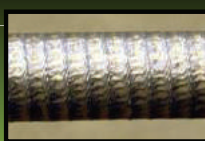
Tooling Engineering



- Mechanical Systems
- High Definition Video
- Controls
- OEM Modifications

- Integrated 3D CAD
- Mockup/Training Center
- Controls Simulation

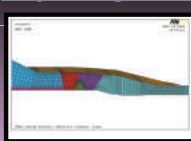
Materials & Welding



- Codes & Standards
- Welding Processes
- Corrosion Coatings
- Metallurgy

- 300+ Traveler Library
- FEA Modeling
- 1050+ Welder Certifications

Project Engineering



- Solution Design
- Application Eng.
- Field Engineering
- Process Procedures

- 600+ Procedures
- Temperbead, E/C, etc.
- Level 3 NDE Capability

Operations Support



- Fleet Maintenance
- Mobilization Staging
- Site Technicians
- System Testing

- 300+ Automatic Systems
- 75 Semi-Auto Systems
- 40 Remote Vision Sets

Applied Engineering Excellence



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Coker Weld Overlay Project

Refinery in Southern California



Welding Services Inc.

Project Overview

- T/A to Retro fit (4) four Coke Drums to accept new Delta Valves
- Coke Drum Material: SA387, Grade C, 1 ¼ Cr ½ Mo, 25mm thick
- Perform repairs to existing 410 explosion bonded cladding by applying over 115sq.m. of Inconel 82 Overlay in cone section above bottom nozzle
- Schedule: 10 days for all four drums total completion

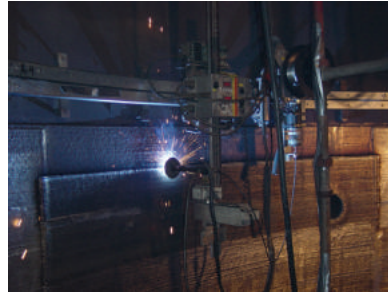


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Customer Challenge

- (2) Large projects occurring in Coker (Installing Delta Valve's and Overlay work)
- Schedule: 10 days
- Reducing Cost
- Improving Quality
- Reducing Safety Instances



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Project Planning

- Provided Planner to coordinate schedule and activities with others
- Developed detailed ventilation plan so other contractor personnel can continue to work while WSI performed our scope
- Provided crew of 8 In-direct personnel for entire project and 8 weld operators per coke drum working two shifts
- All work performed under WSI "R" stamp and QA program



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[Unifuse Vessel Overlay](#)

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WSI Solution

- Utilized 4 **Unifuse** PLC controlled Automated Weld Systems per drum (16 systems)
- Met customer's 10 day schedule
- Took on additional scope during the T/A
- Safety: Zero lost time accidents
- Customer stated: "WSI was the best company out 22 on this T/A...First Class Crew"



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Bulge Repair of Coke Drum Utilizing Temperbead

Refinery in Canada

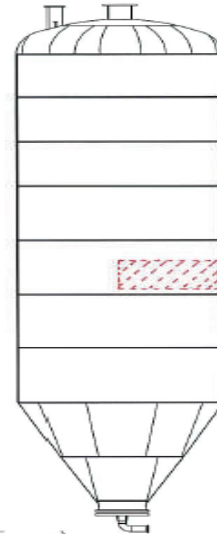


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Bulging Coke Drum

- 8 Coke Drums
- Material: SA 263 Grade C
- Wall Thickness: 22.3mm
- Diameter: Ranging from 7925mm to 9755mm.
- Size: Ranging from 20m to 29m.
- One of the Cokers was experiencing bulging due to fire in drum



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ABLA

Bulge Severity and Growth

- Customer used Stress Engineering's BIF to **evaluate bulge severity** of the drum surface.
- Result were intended as a guide to **rank bulges** for inspection priority as a function of their likelihood to encourage cracking.
- BIF factor **correlates** the geometric bulging patterns of past cracking histories, developed from examing other coke drums, to the bulges on the coke drum.

BIF	Internal Cracking Likelihood
$\geq +2$	Severe
+1.5 to +2	Very High
+1 to +1.5	High
+0.75 to +1	Medium
0 to +0.75	Low

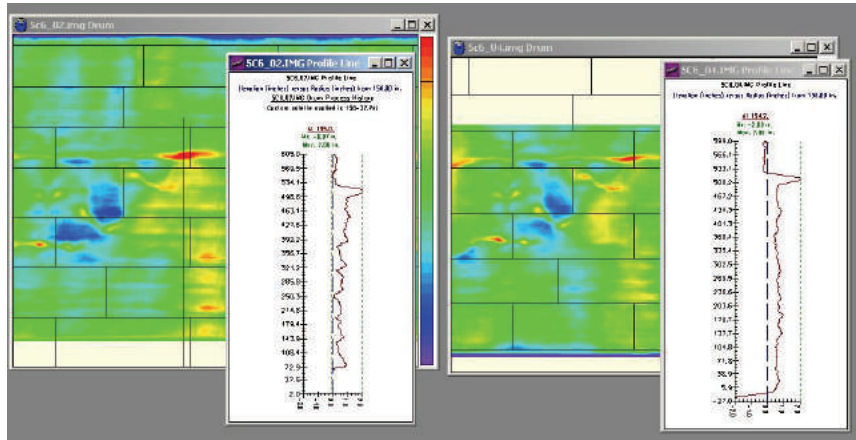
- Of the eight drums reviewed, 1 Drum was identified with the most severe bulging at 2 Locations. We name them Bulge A & Bulge B.



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Compare 2002 and 2004 Bulges



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FEA Performed

- Stress Engineering performed FEA to validate overlay as “fix” for the problem
- Weld overlay reduces the stress on the bulge
 - Bulge peak hoop stress was reduced by 43% and 49% respectively on weld ID and OD
 - Bulge peak axial stress was reduced by 43% and 49% respectively on weld ID and OD
- The life of the repaired bulge is controlled by the hoop stress at the taper
- Increased Life Expectancy of Coke Drum by over 3X



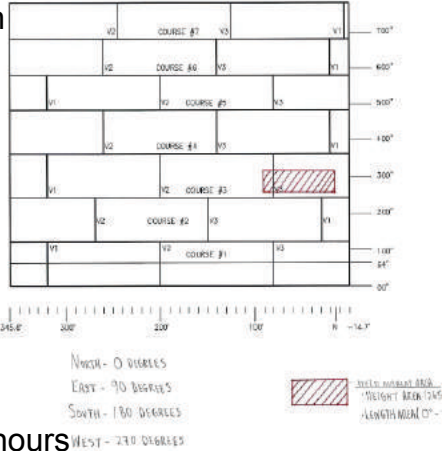
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Bulge Overlay

- Bulged area overlaid: 6.5m x 2m

- Applied Alloy 625, 955mm thick (2 layers), overlay utilizing temperbead utilizing (2) PLC controlled Unifuse Weld Systems



- Temperbead eliminated the need for PWHT

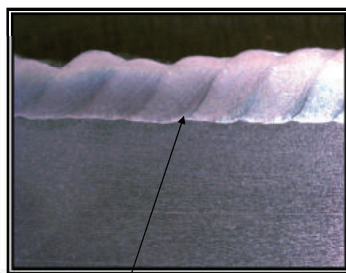
- Post Soak of 450° F(233C) for 2 hours to eliminate any potential for hydrogen



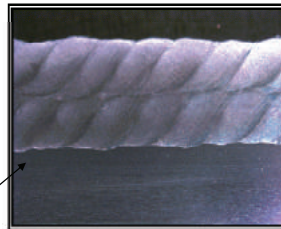
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Temperbead Welding



HAZ created by 1st weld layer



HAZ is tempered by deposition of successive layers



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Conclusion

- Assessment by Stress Engineering quantified remaining life of bulge, and validated overlay process
- Overlay extended life of drum (bulged area) by 3X
- Unifuse® Overlay controls enabled temperbead application and increased productivity



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Skirt to Shell Weld Repair with Temperbead Process

Refinery in Northern California



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Skirt Cracking

- 2 - Coke Drums
- Tower details:
 - SA-387-Grade 11 material
 - 31.7m tall
 - 8m ID
 - Original wall thickness 31.75mm
- Turnaround inspection:
 - 2003 T/A repaired weld seams in Coker # 2
 - May 2006 found many indications approximately 5mm deep, 25mm long, throughout the entire circumference of the weld seam in both drums



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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



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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***



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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



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Skirt Replacement and Shell Cracking with Temperbead In Refinery in Southern CA.



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Customer's Challenge

- 12 Drums
- Material: SA 387-12-CL2
- Drum Thickness: 1.377"
- Height: 90' Tan - Tan
- Diameter: 18'5" ID
- Customer was experiencing cracking below skirt to shell weld. Changed the skirt design (key hole slot) to reduce stress on skirt to shell weld.



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Cutting Out the Skirt Windows



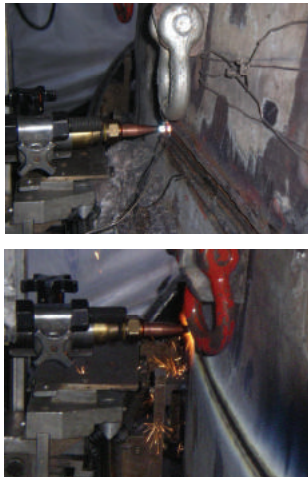
- Set up torch to cut out window sections
- Windows were set up to be cut in 3 sections; Total of 9 windows – 3 stages
- The windows were cut approximately 10' apart from each other.



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Cutting Skirt Windows.



- Track guided torch in action.
- The torch cut a slice 90 degree in to the skirt.
- Then the bevels were cut after the window was removed.



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Shell Crack Removal

- The crack was excavated with the carbon arc gouge process.
- The cracks ranged in depth from approximately 0.188" to 0.75"
- The cracks were removed to a minimum of 0.380" to ensure that the entire crack was removed.
- If the crack still existed at 0.380" then more excavation was done.
- MT was performed to ensure cracks removed



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Shell Crack Removal



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Shell Crack Repairs

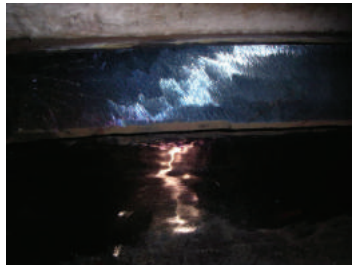
- 1st and 2nd layer of temper bead welded then in process MT performed
- After all of the welding and the 2 hour heat soak was completed a UT shear wave was done to check the area for flaws.
- If no flaws were found the area set for 24 hours to look for delayed cracking. After the 24 hour wait, another UTSW was done.
- If this UTSW was good then the window repairs started in this section of the skirt.



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Fitting the windows



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Welding Skirt Window

- GMAW and SMAW Temperbead procedure utilized for P4
- Geometry dictated process
- Butter layer applied over 1 ½" backing strap
- Subsequent passes applied
- Post Weld Heat Soak 550 degrees for 2 Hours
- UT Shear Wave performed for Final Inspection



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Finish ground window



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Conclusion

Keys to Innovative Repair of Coke Drums

- Pre-Planning
- Technology
- Innovation

Value these keys provide:

- Reduced Schedule
- Lower Cost
- Improved Quality/Longevity



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Questions.....

Thanks....

Derrick Rogers



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