Pedro Amador
VP & Chief Technology Officer – AZZ Incorporated

Enhancing Infrastructure

Coker Vessel Life Extension Repair Implementation

REFCOMM
RIO DE JANEIRO
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CatCracking.com

www.azz.com/wsi
AZZ WSI do Brasil Ltda

Plant located in Barueri – Sao Paulo

Current projects are executed mixing Brazilian with resources coming from Europe and US

Brazilian team

Office
Structural Overlay Life Extension & Skirt Cracking Repair of Delayed Coking Unit Vessels
Petrobras REGAP (Gabriel Passos) Betim Refinery

Refinery Located in Minas Gerais, Brasil
24,000 bpd coking unit (4 coke drums designated as A,B,C & D)

As-found Conditions of the Vessels
- Skirt to Vessel Cracking at the attachment weld location
- Shell Bulging in drums C&D which will lead to crack formation

Several repair options were evaluated for the repair:

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<th>Option</th>
<th>Implementation Schedule</th>
<th>Repair Complexity</th>
<th>Repair Integrity</th>
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<tr>
<td>Window Replacement</td>
<td>Long</td>
<td>High</td>
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<tr>
<td>Section Replacement</td>
<td>Long</td>
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<tr>
<td>Structural Overlay</td>
<td>Short</td>
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Engineered Structural Overlay selected. New technology application for Petrobras. Significant Research and development performed with CENPES to evaluate and qualify this repair process.
Typical Shell Bulging Example

- Common Condition in DCU Vessels
- Associated with low cycle fatigue
- Conventional repair methods have not performed well historically
  - Section Replacement
  - Window replacement

Bulged Area in Coke Drum

Typical Laser Mapping Data
With the Laser Mapping Information and the detailed operating parameters of the vessel, a structural overlay can be designed to significantly modify the structure of the vessel in the affected area to significantly increase fatigue life.
Overlay Designs for REGAP Cokers C & D

Both ID and OD Structural Overlays Installed in Vessels C&D

Internal overlays applied with NiCr Alloy 625

External Overlays applied with ER80S B2

Total Overlay Size
28 sqm (2 Layers)
Application of Structural Overlay on ID of The Vessel

Fully Automated Weld Metal Overlay Welding Systems
Application of NiCr625 Alloy on the ID of the vessel
Application of Structural Overlay on ID of The Vessel

Fully Automated Weld Metal Overlay Welding Systems
Application of NiCr625 Alloy on the ID of the vessel
Removal of Cladding on ID of The Vessel

Existing Cladding Removed
Prior to Overlay Installation on the ID

Skim Gouging Process
For Cladding Removal
Application of Structural Overlay on ID of The Vessel

OD Overlay
Application of Structural Overlay on ID of The Vessel

Close-Up of OD Overlay
Skirt Cracking Repair

In Vessels A, B, C & D Chronic Cracking has been experienced at the upper toe of the skirt to vessel weld.

This cracking is caused by cyclic stresses driven by the expansion and contraction of the vessel inside the skirt.

FEM Analysis of Failure Location

Photo of Cracking at the Skirt to Vessel Interface
During Quench - Skirt is Pushed and then gets Pulled by Knuckle

DISPLACED SHAPE AT THE END OF FILL

DISPLACED SHAPE 1 HOUR INTO QUENCH

(Maximum Stress during quench occurs here)

*Courtesy of Stress Engineering
Skirt Cracking Repair

Repair Process Selection

• Stick Welding (SMAW):
  – Previously performed using this conventional method
  – Re-Cracking Experienced

• Automated Welding:
  – Excavate area to remove previously installed repairs
  – Utilize Temper bead technique and automated welding process
  – Eliminate PWHT
  – Re-Contour geometry to minimize stress concentrations
Skirt Cracking Repair

Automated Welding Application

As-Welded Deposit

Finished Contour of Affected Area
Results

Project Outcome

Safety
Project completed without any recordable safety incidents

Schedule
Original planned schedule 13 days.
Project completed in 16 days.

Advanced automated welding processes utilized to significantly shorten the overall project implementation schedule while achieving a better repair over conventional technologies used in the past.
Contact Information

Pedro Amador
VP & Chief Technology Officer
PedroAmador@azz.com
+ 1 (678) 728-9100
Norcross, GA, USA