CIA INSPECTION INC.

The Latest Advancements in Delayed Coke Drum Inspection Techniques for Improved Vessel Performance and Life Extension

Mr. Les Harold
Managing Director
E: lharold@cia-inspection.com
T: +1 281 714 9354
CIA INSPECTION INC. - COMPANY OVERVIEW

• Widely recognized as the world’s leading coke drum inspection company
• 22+ years dedicated expertise, 1000+ site inspections, 85 years of collective drum evaluation expertise
• 52+ clients, 100’s refinery sites, spanning 25 countries and growing
• Forefront of innovation in coke drum inspection and NDE techniques and continues to set the standards being adopted by the industry worldwide
• Proactive approach (not Reactive) proven to be the most cost effective way to improve operator safety, unit performance, and asset reliability
• Formed strategic partnerships and working relationships with the world’s leading service providers to the Petroleum Coking Industry
• Strategic partnership in Brazil
CIA’s VALUE PROPOSITION

Coke drum management through knowledge
Remote Visual: 
a state of the art, high definition digital video camera with zoom used to visually inspect the internal surface condition, including the dome, cone and nozzles.

Laser Profile: 
a remotely deployed, laser-based range imaging tool designed to profile the internal surface of coke drums in order to locate and measure vessel distortions.

Robotic Crack Detection: 
a telescopically deployed robotic crawler equipped with an NDE sensor (ACFM) used to confirm and measure the presence of ID forming cracks.
COKE DRUM MANAGEMENT THROUGH KNOWLEDGE

• Laser Profiling:
  – Tracking & Trending
  – Cone & Dome Scanning
  – Thermal Bowing or “Banana Effect”
  – Out of Round Calculations
  – Tangent to Tangent Height
  – Improved Bulge Analysis
  – Data Mining & Predictive Guidance

• Robotic Crack Detection:
  – ID crack confirmation and measurement

• Hi-Definition Digital Remote Visual Inspection
  – Increased frequency according to engineering analysis

• Important Partner in any long-term reliability program:
  – Pre-Turnaround Vessel Assessment
  – Baseline Examinations of New to Service Vessels
  – Packaged Engineering Services
  – Engineering Analysis, FFS, RLA, etc.
  – Health Monitoring System, Strain & Temperature Sensor
  – Weld Repair Strategies
  – External Structural Scanning
LASER SCANNING - TRACKING & TRENDING

DRUM IMAGE OR BULGE MAPS

2009

2011
LASER SCANNING - TRACKING & TRENDING

VERTICAL SECTION COMPARISON

AZ = 39.2 - 0.32 => +1.65

AZ = 44.5 - 0.10 => +1.89

AZ = 50.8 + 0.11 => +2.00

POLAR PLOT COMPARISON ACROSS 4th CIRC WELD

-2

-4

+2

+4

0°

90°

180°

270°

315°

135°

162.00

225°
LASER SCANNING – DATA MINING

1 1/4 Chrome Bulge Comparison and Trending

% Radial Growth

Drum Age in Years

- 1 1/4 Chrome
- XYZ Refinery
- Linear (Industry)
- Poly. (XYZ for 2011)
- Poly. (XYZ Post Repair)
THERMAL BOWING / DRUM BOW

Magnitude of bow displayed against height in drum.

Horizontal Bow in mm from reference part way up drum

Vertical Axis in mm from bottom tangent
Findings compared against API/ASTM fabrication standards
ENGINEERING ASSESSMENTS

- Pleased to have formed strategic partnerships and relationships with the world’s leading service providers to the Petroleum Coking Industry
- Integral first-step in any long-term reliability program
- Packaged Engineering Services including:
  - FEA assessments (BSA, PSI)
  - Fitness for Service (FFS) / Remaining Life Assessments (RLA)
  - Others ...

- Working in close collaboration with Engineering providers particularly to improve the value received from the Robotic Crack Detection:
  - Typical procedure is not optimal
  - Provides value add and thorough understanding of vessel condition
  - Immediate results upon completion of the inspection
REMOTE VISUAL INSPECTION & PCTI’S

1:1 registration between Laser Mapping & RVI
IS THIS A CRACK? IF SO HOW DEEP, HOW SERIOUS?
ROBOTIC CRACK DETECTION

- Rotary Drive
- Video Camera
- Laser System
- Tilt Drive
- Light Weight Boom
- Robotic Crawler equipped with an NDE Sensor

7,940,298 B2
Issued May 10, 2011
ROBOTIC CRACK DETECTION

BENEFITS:

• Online use, remotely deployed
• Immediate and accurate results
• Rapid scheduling and deployment
• No vessel blinding, scaffolding or surface preparation
• Reduced downtime and cost
• Considered a more cost effective, safe, accurate weld examination strategy in comparison to other UT methods

Proven to work in the coke drum environment!
## ROBOTIC CRACK DETECTION - SELECTION CRITERIA

<table>
<thead>
<tr>
<th>CRITERIA:</th>
<th>REASON:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulge patterns &amp; profiles (sharp, deep distortions)</td>
<td>Amplify stress/strain, initiate &amp; propagate bulging-induced cracks</td>
</tr>
<tr>
<td>Location of bulges in close proximity to seam welds</td>
<td>Significant correlation between ID cracking at circumferential welds</td>
</tr>
<tr>
<td>Visual confirmation of crack type indications</td>
<td>Images that appear to have “potential crack type indications”</td>
</tr>
<tr>
<td>Presence of stress cracking sites or &quot;elephant skin&quot;</td>
<td>Precursor to more significant crack propagation</td>
</tr>
<tr>
<td>Distortions occurring across step thickness transition zones</td>
<td>Known region of increased stress concentrations</td>
</tr>
<tr>
<td>Weld repair zones</td>
<td>Material mismatch, weld defect, etc.</td>
</tr>
<tr>
<td>Other engineering based techniques (FEA, BSA, PSI, AET)</td>
<td>Compliments service with theoretical and/or other UT approach</td>
</tr>
</tbody>
</table>
ROBOTIC CRACK DETECTION - SELECTION CRITERIA

Positive Confirmation of Surface Breaking Crack:
- length = 110 mm, depth = 3.4 mm
- SS410 cladding thickness = 2.8 mm

Notes:
- Bulge growth, ripple pattern forming across the weld seam
- Visual confirmation of crack type indications
- Stress cracking present
- Step-thickness transition in outer shell
ROBOTIC CRACK DETECTION – DEPLOYMENT
ROBOTIC CRACK DETECTION - INSPECTION
Since 1991, CIA has been at the forefront of innovation in non-destructive examination (NDE) techniques for the delayed coking industry. With recent advances in HDTV and digitally transmitted video, we are capitalizing on these advanced technologies and upgrading our remote visual inspection service. Currently in operation and schedule is to “roll out” this technology across all inspection units during Q4 2014. The following images were taken during a recent online inspection and field trial and demonstrate the advantages of this technology:

Once again demonstrates CIA’s innovation and market leadership!
HI-DEFINITION DIGITAL VIDEO
HI-DEFINITION DIGITAL VIDEO
HI-DEFINITION DIGITAL VIDEO
HI-DEFINITION DIGITAL VIDEO
EXTERNAL COKER SCANNING

• Perfect solution for:
  – DrumTilt/Lean - used in combination with drum bowing calculations
  – Retrofits - used in combination with internal cone scanning to assist with BUD projects and retrofits
  – General DCU scanning, Kelly structure verticality, crane rails, etc.
DO NOT RE-INVENT THE WHEEL !!!
CIA INSPECTION INC. - YOUR FULL SERVICE PARTNER

- 22+ years of dedicated expertise with 1000+ site inspections completed for industry’s leading refiners,
- Technically superior service, highest quality analysis & reporting and value add service
- ACFM technique is revolutionizing the way drum inspection and weld examination is being employed all across the globe
- Continue to play a lead role in the industry's continued efforts to improve drum reliability and performance
- Safe, accurate and reliable inspection techniques providing partners superior value, service and benefits
- The goal is to be Proactive on issues affecting drum integrity rather than being Reactive to the resulting problems that are inevitable

Thank you!