Coke Drum Laser Profiling

Mike Bazzi, Gilbert Grimaldo, Martin Peacock and Eric Sjerne
IRISNDT
Coke Drums

- Produce Coker Gas Oil and Petroleum Coke
- Large Internally Clad Vessels
- Typically Work in Pairs
- Severe Thermal Cycling that Causes Cracking, Bulging and Distortion
External Drum Inspection

• Welds Susceptible to Cracking
• Inspect Using AUT Shear Wave, Phased Array or TOFD
• Requirement to Detect Small Surface Breaking Cracking Initiated in the HAZ
Internal Drum Inspection

• Bulging and Distortions in Overall Drum Shape
• Fitness for Service Inspection
• Done From Vessel ID Between Coking Cycles or When Down for Maintenance
• ID Surface Must be Cleaned of Coke Residue
Laser Path

• Lower Cable Loop into Drum to Establish a Fixed Reference Line
• Rotating Laser Beam Inserted Into Coke Drum
• Traces Helical Path Over the Drum ID Surface
Data Display

• Use Colour Palette to Denote Distance Between Laser and Drum ID Surface
• Like AUT, Optimize Colour Palette
• Must Centre Diameter Measurements
Data Example – Entire Drum

- Colour Map of Drum Radius
- Polar Angle on X-axis
- Elevation on Y-axis
Data Example – Polar Plot

• Generate Polar Plots at Any Elevation
• Shows Asymmetry in Radius
• Example at Z = 596 inches
Data Example – Vertical Cross Section

- Generate Vertical Cross Sections at Any Azimuth
- Example at Azimuth = 307°
- Bulging Seen Between Elevations of 340 and 640 Inches
Video Inspection

• The Second Component is a High Resolution Video Inspection of the ID Surface
• Detection of Cladding Damage
• Typically All Circumferential and Select Long Seams
Video Data Example

• Capture from Inspection Video
• Image Shows Crack in ID Cladding
Data Usage

- Fitness for Service Evaluation of Drums – Export Radii Data
- Use a BSR to Prioritize and Monitor Bulges
- Determination of Patch Plate Dimensions

$$BSR = \frac{Depth}{Height}$$
New Laser System

- High Resolution Laser System
- Doesn’t Need to Traverse Drum
- Introduced from Top Flange or Bottom Cone
- Typically Combine Multiple Laser Scans
- Generate Positional Point Cloud Data and Video of ID Surface

International Workshop on Smart Materials & Structures, SHM and NDT for the Energy Industry

NDT in Canada 2013 Conference
Laser Data Analysis

- Export Raw Point Cloud Data for Grid Reduction and Analysis
- Generate Triangular Mesh
- Compare to Idealized Cylinder or Generate Cross Sections
Mesh Data – North Projection

• North Facing Data
• All Coke Drum Data
• Comparison to Idealized Cylinder
• Histogram of Deviations
Mesh Data – Full Data

• Four Projections – North, South East and West
• Data for Top and Bottom Heads
Tank Inspection

- Point Cloud and Video Data
External Corrosion Mapping

- External Corrosion on 6 Inch Diameter Piping
- Colour Palette Shows Deviation from Uncorroded Surface
- Offset in Data
Conclusions

• Laser Technology Has Much Flexibility for Surface Inspection
• Significant Cost Reduction Compared to Traversing Laser Systems
• Currently Applying it in Other Areas