WIDE BAND ULTRASOUND IN LINE INSPECTION

PPSA Annual Seminar, 2017
Craig Hall, Rolf Sporkel, Willem Vos
Who is the presentation for?
Halfwave Background
Through the years

[Logos for DNV·GL, Chevron, and Shell]
ACOUSTIC RESONANCE TECHNOLOGY

Theory Behind Acoustic Resonance
Basic functionality of Acoustic Resonance Technology (ART)

**Emitting**
- Transducer shooting a broadband (multiple frequency) sound signal towards a target
- Signal duration is sufficiently long to generate oscillations in target

**Listening**
- As the oscillating target continues to be struck by the sound signal, resonance occurs in the target i.e. oscillations are greatly amplified
- These resonating frequencies are characteristic of the thickness and material of the target
- The tool records the returning sound signal

**Interpreting**
- Direct measurement of thickness is revealed in the returning sound signal
- The frequencies that resonate (i.e. become amplified) are used to calculate the thickness of the steel
- time-of-flight (TOF) measurement allows for accurate caliper/geometry measurement

**Resonating frequencies are easily identified**

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**Emitting sound signal towards a target (e.g. pipeline wall)**
- **Transducer**
- **Target** (e.g. pipe wall)
- **Sound signal**

**Resonance occurs in target - returning sound signal recorded**
- **Resonance occurs**
- **Returning sound signal**

**Identifying resonant frequencies allows for direct measurement of target thickness**
- **Amplitude (dB)**
- **Frequency (kHz)**

- 500
- 600
- 700
- 800
Acoustic Resonance
Not a new technology

- Standard method for WT testing up to the 1970-s
- Images only available in black & white, old text books
- Replaced by pulse-echo on basis of cost, not effectiveness
ART Scan™
Product Overview

• 16 – 26 inch (128 channel)
• 24 – 30 inch (192 channel)
• 28 – 42 inch (192 channel)
• 36 – 48 inch (512 channel) Q3 2018 NPI
• 48 – 56 inch (624 channel) Q3 2018 NPI
• Wall Thickness: more than 100 mm
• Speed range: 0.1 – 5 m/s
• 3 odometers & IMU (gyros & accelerometers)
• Intrinsically safe, pressure and temperature recording, ELF pig tracker
• Reporting done in-house, to POF specs.
ART Scan™

Product Overview

- **Depth rating**: up to 3,000 meters
- **ROV**: Compatible with all types and makes of ROV
- **Weight tooling**: 150 kg / Neutral Bouyancy
- **Spread**: 2 containers (1.2m x 1.5m x 1.5m, 250 kg)
- **Communications**: Fiber through ROV umbilical
- **Pipe diameters**: 6 to 17 inch
- **Data visualization**: Real time
- **Inspection applications**: Rigid and flexible piping
- **Inspection techniques**: TOF & ART
- **Inspection capabilities**: X-1mm step, Y-1mm step
- **Steel thickness**: 10-100 mm
- **Personnel**: 2 man team for offshore operations
- **USP**: *Scans Pipe Through the Coating.*

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Differentiation

Key Advantages of Acoustic Resonance

- Direct WT Readings in Gas Lines
- Ability to measure through coating/wax
- Detection of External Coating Disbondment

- Non-Contact Measurement
  - Dual Diameter Capabilities
  - Bidirectional Capability
  - Low velocity WYE passage

- Higher accuracy: fewer digs vs MFL
MEASUREMENT THROUGH WAX

Reducing cleaning expenditure
Penetration of Wax Layer

- Chart shows attenuation of sound through wax at different frequencies
- Low attenuation 400KHz to 1,2 Mhz bandwidth (ART Domain)
- ART measures wall thickness through wax
- ART also measures thickness of wax layer
- Traditional ultrasound operates at frequencies of 5 MHz and higher
With wax, chirp, top

**toa plot**

Test plate (wax, top, chirp) - time-of-arrival processing

**ART plot**

Test plate (wax, top, chirp) - ART processing
CASE STUDY: 24” CRUDE LINE GULF OF MEXICO

Q3 2016 Operation
24” Crude Line Gulf of Mexico

- 24” x 132.5 km
- Inspection in Crude Oil > 300’000 BPD
- Offshore vertical launch onshore receive
- Challenging Wye Passage (from 3 to 8 ft/s)
- Non Return Valves
- 12.4mm – 27mm wall thickness
- Inspection performed July 2016
Piggability Evaluation
ART Scan Configuration
ART Scan Operations, vertical launch
ART Scan Operations, 2 days later
24” Crude Line Gulf of Mexico

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- Field Verification
Excavated Feature (II)

- Corrosion Feature under pipe support detected
- Field Verification
- Nominal WT: 0.985 inch
- 6 o-clock metal loss feature called
- Support removed
- Feature depth verified in field

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CRUDE LINE IN NORTH SEA
Crude Line in North Sea
Pipeline Description

• 18 inch
• Crude Oil with Wax
• Length <20 km
• Constructed mid-80’s
• Internal Flow Coating FBE
Crude Line in North Sea

Several challenges

• Low flow speeds
• Wye passage
• Wax deposition

• Plus side: Highly Experienced Operator
Crude Line in North Sea

Solutions

• Piggability Study
• Pigging Loop Constructed, Pigging Trials Performed
• Camera Installed
• Over 20 runs performed
• Speeds down to 0.04 m/s
Crude Line in North Sea

Solutions

- Piggability Study
- Pigging Loop Constructed, Pigging Trials Performed
- Tool Mobilized
- Field Work Completed
- Final Report Issued (2017)

- Samples from report

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Crude Line in North Sea
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Inspection Results

- Wax detected ~250 m into the line, mostly near 6 o'clock
- Typically about 200 mm wide, narrows to the end of the line
- Several metal loss features found, even under wax
- Internal Features mostly near bottom
- External Features mostly near field joints
Crude Line in North Sea

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CONCLUSIONS

Use of Wide Band Ultrasound for In Line Inspection
Conclusion

Use of ART for In Line Inspections
Thank you for your time

Willem Vos
willem.vos@halfwave.com
+31 615 663 754
www.halfwave.com
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