Inspection of unusual Pipe Types with Eddy Current Technologies

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Innospection – Company Introduction

Expertise: Providing Advanced Electromagnetic Inspection Services & Application Solutions

Offices: Aberdeen (Head Office), Rugby, Abu Dhabi, Al-Khobar, Perth, Melbourne, Stutensee (R&D – Germany)

Activities: Tube Inspection (HE & Boiler) Pipeline Inspection Storage Tank Inspection Pressure Vessel Inspection Subsea Inspection
  • Caissons
  • Risers
  • Structural Legs
Flexible Riser Inspection
Advanced crack detection
R&D for Inspection Solutions
Inspection of “regular” pipe

- Regular pipe type is
  - Ferritic steel
  - No or thin coating
  - One type of steel material
  - Single layer

- Existing pigging inspection technologies
  - Ultrasonic Pulse Echo methods
  - Magnetic Flux leakage methods
What pipe is typical and what is unusual?

Examples of inspection tasks, for which regular inspection technologies fail:

- **Pipe with coating thickness in the range of 40 mm**
- **High steel wall thickness (MFL fails)**
- **Pipe cladded with a different metallic layer (internal or external)**
- **Non typical materials, such as Stainless Steel or Duplex**
- **Non-solid pipe material made from several layers of different material like flexible pipe**
- **Operational restricted : Riser Sections – particular Gas Risers**
What can eddy current do?

“Traditional” Eddy current

- Inspection of the near side only, i.e. for cracking or as a lift-off measure
- Traditional application in weld inspection, heat exchanger tube inspection, material sorting etc.
- Cannot inspect the volume of thick ferritic steel structures

Alterations of classic eddy current to circumvent these Problems

- Magnetically biased Eddy Current (SLOFEC™)
- Pulsed Eddy Current (PEC)
- Remote Field Eddy Current (RFET)
Magnetically Biased Eddy Current (SLOFEC™)

Magnetic Circuit

Eddy Current Sensors

Eddy Current Probe Field

Test Piece

Magnetic Field Lines

Defect

Increased Magnetic Flux Level

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Magnetically Biased Eddy Current (SLOFEC™) typical applications

**Storage Tank Scanning Capabilities**
- Wall Thickness range: up to 30mm
- Inspecting trough coating: up to 10mm

**Pipe & Vessel Scanning Capabilities**
- Wall Thickness range: up to 30mm
- Inspecting trough coating: up to 7mm

**Riser & Caisson Scanning Capabilities**
- Wall Thickness range: up to 30mm
- Inspecting trough coating: up to 15mm
The idea of pulsed eddy current

- **The higher the frequency the lower the penetration depth**
- **High frequency response probes the surface (sensitive to lift-off)**
- **Low frequency response probes the interior (wall thickness)**
- **A pulse contains a large frequency spectrum**
- **The response can be split up into different frequency content**
Pulsed Eddy Current Testing

Graph by: Paul CROUZEN and Ian MUNNS, Shell Global Solutions International, Amsterdam

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Diffusion of Eddy Currents in steel

PEC signal

Time [ms]

Wall loss
Remote Field Eddy Current

*Current Application mainly for Testing of small tubing like heat exchanger tubes*

- *Due to low frequency inspection not possible at high speeds*
- *Sensitive to wall thickness thinning*
- *Evaluation of the phase of the signal*
- *Rather insensitive to lift-off*
**Principle of Remote Field Eddy Current**

- **Exciter Coil generates magnetic field at low frequencies**
- **Pick-up coil is placed sufficiently far away**
- **Does not pick up directly coupled signal**
- **Signal is coupled through pipe wall and thus depends on wall thickness**
- **Phase shift directly converted to wall loss**
- **Sensitive to internal and external defects**
Coils – Tailor made solutions

- *The key to eddy current testing is the coil.*
- *The Variety of coil types is vast*
- *Every coil needs to be tailored to its application*

1. **Determine Coil size depending on defect size and lift-off**
2. **Determine the frequency for testing**
3. **Calculate Ampere-turns to get Impedance**
4. **Produce coil**
Example Solutions

Monel Cladded Riser Inspection

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Example Solutions

Monel Cladded Riser Inspection

Detecting Defects underneath Monel clad welds

Defect before cladding

axial weld

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Example Solutions
Cladded pipe in pipe

Test pipe with artificial defects

- 3 mm CRA cladding
- 15 mm wall thickness
- Pipe in pipe system

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Example Solutions

Cladded pipe in pipe
Example Solutions

Cladded pipe in pipe - Signals from test pipe (single pipe section)

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Flexible Riser Pipe

Flexible riser pipe is pipe made of several layer of steel armour. The armoured layers are wound in a helical form, with different layers wound in different directions.

The problem

• Inspect through a thick coating
• Inspect all layers, i.e. inspect layers beneath other ferritic conductive layers.

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Flexible Riser Pipe
The task - The solution

• Detect defects like snapped wires and metal loss in all layers of the flexible pipe

• Need a magnetisation unit that can adapt the magnetisation level
• The magnetisation direction needs to be made dependent on the direction of winding
• The tool needs to be light enough to be deployed sub-sea

First Step
• Verify the inspection solution
Flexible Riser Pipe Testing
Flexible Riser Pipe
Development of a suitable magnetisation unit & sensor array unit

Patented
Flexible Riser Pipe
Operational Arrangements

Full 360 coverage
• Axial movement only
• Higher weight—Requires a work-class ROV for deployment or lowered on steel rope
• Faster scanning. Suitable for long pipe

Partial coverage with circumferential scanning
• Movement in two directions
• Lower weight. Light ROV is sufficient
• Especially for defined areas
Flexible Riser Pipe
Lighter Option for ROV deployment

• Scanning up/down in several steps to achieve full coverage
• Light for ROV deployment

In cooperation with

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Eddy Current technique solutions have the potential to fill pipeline inspection gaps.