Flexible Riser Inspection with MEC-FIT™

Andreas Boenisch
Innospection Ltd.
Innospection – Company Information

Expertise: Advanced Electromagnetic Inspection Services & Application Solutions

Offices: Aberdeen (Head Office), Rugby, Abu Dhabi, Stutensee (R&D – Germany)

Main activities:
- HE & Boiler Tube Inspection
  - Pipeline Inspection
  - Storage Tank Inspection
  - Pressure Vessel Inspection
  - Subsea Inspection
    - Caissons
    - Risers
    - Structural Legs
- Flexible Riser Inspection
- Advanced crack detection

Established: 1998 (founder Andreas Boenisch)
SUBSEA INSPECTION

Flexible Riser Inspection
• External scanning, ROV adapted
• Fast scanning of the flexible riser general pipe
• Electromagnetic Eddy Current based Technology
• Defect detection like corrosion, cracks

Riser / Caisson / Structural Insp.
• External scanning, ROV adapted
• Combined systems SLOFEC & PEC & UT
• Fast scanning of the Caissons, Rig Legs
• Self crawling

Subsea Pipeline Scanning
• External scanning, diver or ROV adapted
• SLOFEC & PEC & UT
• Inspection through coatings of up to 200mm
• Electromagnetic Eddy Current based Technology
• Defect detection like erosion, corrosion, cracks

Video available on request
MEC-FIT™
Flexible Riser Inspection
Tool & Deployment

In cooperation with
MEC-FIT™ Flexible Riser Inspection System

MEC-FIT™
Magnetic Eddy Current – Flexible Riser Inspection Tool

a further development of the SLOFEC™ technique

Principle of the technique
Background of Eddy Current for Flexible Pipes

Experiences with Eddy Current based techniques:

- a wall penetration of up to 33mm was achieved
- through 15mm (liner) stand off was possible
- through cladded layers possible to penetrate
- Differential Mode sensitive detection of localised defects
- Absolute Mode to be used analysing Material changes

Feasibility Study

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Feasibility Test and further stages

Target of the feasibility tests at flexible risers with existing Pipe scanners

performing the tests with existing external pipe scanner.

Analysing:
- penetration depth with the existing scanners and sensors.
- detectability of various material dishomogenities
- distinction capabilities between defects and other caused signals
- capabilities of signal pattern distinction defects / armour layer edge effects.
- possible capabilities of fatigue detection & analysis
### Sample for Flex Pipe Inspection Test

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
<th>Material</th>
<th>T [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interlocked Carcass (72.0 x 1.5)</td>
<td>304 L (Fe 02)</td>
<td>8.7</td>
</tr>
<tr>
<td>2</td>
<td>Rislan P40 TL TP01 Pressure Sheet</td>
<td>Rislan</td>
<td>7.5</td>
</tr>
<tr>
<td>3</td>
<td>Zeta Wire</td>
<td>FM35 (Fl 11) (Carbon Steel)</td>
<td>8.0</td>
</tr>
<tr>
<td>4</td>
<td>First Armour layer</td>
<td>FM35 (Fl 11) (Carbon Steel)</td>
<td>3.0</td>
</tr>
<tr>
<td>5</td>
<td>Second Armour layer</td>
<td>FM35 (Fl 11) (Carbon Steel)</td>
<td>3.0</td>
</tr>
<tr>
<td>6</td>
<td>Fabric Tape</td>
<td>Type PVC</td>
<td>2.3</td>
</tr>
<tr>
<td>7</td>
<td>Polyethylene External Sheet</td>
<td>Polyethylene</td>
<td>10.0</td>
</tr>
</tbody>
</table>
MEC-FIT™ - Evolution Steps

Feasibility Test
at 10inch Coflexip Riser Sample with existing Pipe scanner

- penetration depth with the existing scanners and sensors.
- detectability of various material dishomogenities
- distinction between defects and other caused indications
- signal pattern distinction defects /armour layer edge effects.
- possible capabilities of fatigue detection & analysis
Feasibility Test - Conclusion

• Penetration into the different layers experienced so far: through 2 tensile wire into the zeta wire

• Localised defects detected in zeta wire & armoured wires
  conclusion: defects in armoured wire layers even easier detectable

• No significant influence of armoured layer arrangement versus filed line distribution: minor edge effect

• Newer scanner generation versus systems used in first phase provide stronger field
Test – at Real Flex Stress Test Sample

Permission for testing between stress tests of a real flexible pipe sample with an existing adapted pipe scanner (200mm circumferential coverage)

Advantage:  - Real materials
            - Real flaws without damaging upper layer

Result:  
Scanned through polyethylene layer
Detected cracks
Completed Studies

- Hand-held device on artificial defects in flexible pipe sample
- Examination on different layer configuration on flat test sample
- Electromagnetic Simulation
- Design Studies, Deployment and Scanning Principle
Capability Test – at simulated flat flex-plates

Flat plates prepared with comparable Flex-pipe wire layer configuration, scanned with flat scanner

Advantage: flaws produceable without damaging upper layer

Limitation: scanner loss of field lines at side versus a 360° tool coverage

Result: e.g. simulated stand off to outer a. layer 17mm

Detection 1.0mm perpendicular crack in armoured layer
Internal Tests

Tests performed at flat Flexible Riser layer simulation for Crack and general wall loss detection

Detection of wall loss defects in single wire and cracks in single wire
MEC-FIT™ - Flexible Riser Pipe Inspection Tool

Comparison of different magnetization levels on the wire magnetization
Magnetisation Level within the layers

- Carcass
- Pressure Sheath
- Pressure Armour
- Armoured Layer
- Outer Sheath

Magnetisation Unit

B, Tesla

k7

k8
MEC-FIT™ Flexible Riser Inspection System

Scanner Mk1 MEC-FIT™

External 360° coverage inspection tool for pipes (flex pipes) on basis DC magnetic field & ET (system patented)

Video available on request
MEC-FIT™ Flexible Riser Inspection System

Operations and Defect Display

Video available on request
MEC-FIT™ - Flexible Riser Pipe Inspection Tool

ROV Subsea operation of the Flexible Riser Inspection tool,
Right picture shows the inspection tool at a 10” Flexible Riser
of an FPSO
MEC-FIT™ - Evolution Steps

Internal Tests - Flexible Riser test sample

Signal Display Test Defects

- FBH
- Dia 10mm
- 3.0mm
- Transverse
- Crack type
- 2 wires

With wire direction
Crack type
1 wire

FBH
Dia 10mm
5.0mm
MEC-FIT™ Flexible Riser Inspection System

Sample Report

MEC-FIT Analysis Legend:
- Green = Normal
- Yellow = Small
- Red = Large
- Black = Non-Detected
- Gray = Unknown
- 1x - 6x

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### 4” Gas Lift Riser Segments

<table>
<thead>
<tr>
<th>Segment ID</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL1</td>
<td>30m below sea level</td>
</tr>
<tr>
<td>GL2</td>
<td>80m below sea level</td>
</tr>
<tr>
<td>GL3</td>
<td>Entry into mid water arch</td>
</tr>
<tr>
<td>GL4</td>
<td>Exit from mid water arch</td>
</tr>
<tr>
<td>Control pipe</td>
<td>‘unused’</td>
</tr>
</tbody>
</table>

### 8” Oil Export Riser Segments

<table>
<thead>
<tr>
<th>Segment ID</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>OE1</td>
<td>30m below sea level</td>
</tr>
<tr>
<td>OE2</td>
<td>80m below sea level</td>
</tr>
<tr>
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<td>Entry into mid water arch</td>
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MEC-FIT™ - Flexible Riser Pipe Inspection Tool
Flexlife End of Life JIP

JIP – workshop test set up

Scan Result of OE Segment 3
MEC-FIT Conclusion - inspection tool for flexible risers

- Fast external scanning
- No couplant required
- Penetration in Tensile armoured layers, depending on configuration towards Zeta wire
- Detection sensitivity for localised defect detection like
  - Cracks
  - Corrosion (single wire or area)
- Material property change analysis (fatigue)
- With variation of settings deciding layer of indication
- Visual overview Polyethylene Layer

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THANK YOU FOR YOUR ATTENTION

Andreas Boenisch

Innospection Limited
Howemoss Avenue
Kirkhill Industrial Estate
Dyce - Aberdeen - AB21 0GP
United Kingdom

P +44 (0) 1224 724 744
F +44 (0) 1224 774 087
Web: www.innospection.com
info@innospection.com