Sensorlink
Corrosion monitoring on welds

Subsea Controls Down Under 2018

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Outline

• Sensorlink
• Motivations and applications for corrosion monitoring systems
• Monitoring versus manual UT inspection
• Pulse-echo ultrasonic measurements
• Monitoring on weld
• Installation configuration
• Results from installation
• Conclusions
Company Facts

• Established in 1997
• We were a spinoff from SINTEF (one of Europe’s largest R&D foundation)
• Head office in Trondheim, Norway
• Sensorlink specializes in innovative solutions for pipeline integrity management based on ultrasound technology
Sensorlink value proposition:

We enhance our customers pipeline integrity management capability through:

- easy to install, non intrusive, high precision direct wall thickness monitoring
- resulting in reliable erosion and corrosion rate estimates

This knowledge is applied for:

- remaining service life estimates
- determining maintenance actions
- optimising chemical inhibition

Resulting in:

- reduced inspection/pigging cost
- reduced operational down time
- reduced risk for system failure and unplanned S/D
Motivations and applications – corrosion monitoring system

Reduced Opex:
- Reduce cost for inspection programs
- Optimise chemical injection program

Reduced HSE risks:
- Substitute for intrusive coupons and probes
- Reduce work in H2S area
- Difficult access area

Improved integrity management:
- Rapid detection of corrosion/erosion rates
- Monitor on welds and HAZ
Inspection

**Scanning**
- Gives a picture of the situation now
- Labour and equipment intensive (man hours, scaffolding, vessel, ROV)
- Need to be repeated to give corrosion/erosion rate
- Repeatability not on the level of monitoring

**Pigging**
- Scan of pipe through it’s length
- Gives a picture of the situation now
- Need pig launcher
- Have effect on the production (need’s to be shut down)
- Need to be repeated to give corrosion/erosion development
Monitoring from Sensorlink

Permanent UT Monitoring:

- **Used to monitor change in fixed locations**
- Real-time and online follow up of known defects
- Repeatability <0.1 mils/2.5 µm
- Rapid determination of erosion/corrosion rate
- Selective weld and HAZ corrosion
Permanent installation of sensors enables:

**High quality wall thickness measurements:**
- eliminate the multiple sources of error associated with manual inspection, such as
  - variability from one measurement to the next in time of measurement location
  - equipment used
  - operator expertise

**Frequent wall thickness measurements:**
- measurement frequency of the sensors can be programmed and corrosion/erosion rate can be determined quickly and accurately (within 2.5 um)
Monitoring using Single Element Pulse/Echo Transducers

- Non-Intrusive
- Direct wall thickness measurement of pipe wall, weld, HAZ zone, elbow, t-piece
- Not sensitive to pipe wall thickness
- Works through solid coatings (FBE, 3LPP, PE, etc.)
- Possible to separate pipe wall front and back wall echo’s when used on coating.
- Does not discriminate between erosion and corrosion
- Embedded temperature transducers enables temperature compensation
- Fixed sensors combined with advanced signal processing detects wall loss of less than .1 mills (2.5 micrometres)
Typical wall thickness graph

CR = 3.15 mils/year (0.08 mm/year)

RMS = 0.05 mils (1.3 µm)
Monitoring on weld
Monitoring on weld

Corrosion monitoring made easy
## Installation configuration

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of installations</strong></td>
<td><strong>4</strong></td>
</tr>
<tr>
<td><strong>Installation date</strong></td>
<td>October 2014</td>
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<tr>
<td><strong>Pipe</strong></td>
<td>Wet gas piping system</td>
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<tr>
<td><strong>Monitoring</strong></td>
<td>On weld</td>
</tr>
<tr>
<td><strong>Motivation</strong></td>
<td>Monitor selective weld seam corrosion</td>
</tr>
<tr>
<td><strong>Pipe Material</strong></td>
<td>Carbon steel</td>
</tr>
<tr>
<td><strong>Paint</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>EX requirement</strong></td>
<td>Atex zone 1</td>
</tr>
<tr>
<td><strong>Measurements per day</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>
Installation configuration

<table>
<thead>
<tr>
<th>Instr ID</th>
<th>Pipe ID</th>
<th>Wall Thickness (Approximately)</th>
<th>Location</th>
<th>Pipe material</th>
<th>Pipe temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24&quot;</td>
<td>19-22 mm</td>
<td>on weld</td>
<td>Carbon steel</td>
<td>~50 degC</td>
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<tr>
<td>2</td>
<td>30&quot;</td>
<td>21-22 mm</td>
<td>on weld</td>
<td>Carbon steel</td>
<td>~20 degC</td>
</tr>
<tr>
<td>3</td>
<td>36&quot;</td>
<td>21-26 mm</td>
<td>on weld</td>
<td>Carbon steel</td>
<td>~20 degC</td>
</tr>
<tr>
<td>4</td>
<td>36&quot;</td>
<td>22-26 mm</td>
<td>on weld</td>
<td>Carbon steel</td>
<td>~20 degC</td>
</tr>
</tbody>
</table>
Sensor interfaces

FULLY AUTOMATED

SAFE ZONE

OPC/SCADA
Modbus TCP
4-20 mA
Modbus RTU (Optional)

HAZ ZONE

Sensors

Datalogger

SEMI AUTOMATED

SAFE ZONE

PC

HAZ ZONE

PipeMonit® PDL Ex

Sensors

Datalogger
Results

Wall thickness

Date

0.029 mm/year

0.44 mm/year

0.0027 mm/year
Results

Wall thickness

Date

Corrosion monitoring made easy
Results

Corrosion monitoring made easy
Conclusions

- Corrosion monitoring demonstrated on weld
- Corrosion monitoring system demonstrated that corrosion was low after inhibitor system was set in place
- Measurements from corrosion monitoring systems are important input to the corrosion management program
Current product line

PipeMonit® Swarm®
Topside/onshore wall thickness monitoring

World wide distribution agreement with Cosasco

UltraMonit® SEC
Subsea Erosion Corrosion monitoring
UltraMonit® SEC subsea instruments for pipelines

Fixed installations/new pipelines (InSitu):
- Preinstalled sensor arrays
- 30 year life time
- Sensors installed inside insulation
- Can be installed to monitor a weld

Retrofittable installations:
- Installed on existing subsea pipelines without production interference
- Fully ROV or diver installable, removable and movable
- 15 years lifetime
UltraMonit® SEC Erosion Monitoring

Concept:
- Array of Ultrasound transducers
- Subsea clamp with sealing
- Pressure compensated
- Retrieveable datalogger
- Self contained unit with batteries or connected to subsea control system
With Sensorlink up and above!