Corrosion Under Insulation Monitoring using EMGR Technology

- Dr Prafull Sharma, Corrosion RADAR Ltd

28th April 2020
Corrosion Under Insulation Monitoring using EMGR Technology

Dr Prafull Sharma, CorrosionRADAR Ltd

www.corrosionradar.com
The Story of Rob, Bob and CUI

Rob, what is our biggest asset integrity issue?

Bob, it is Corrosion Under Insulation.

Dont we have coatings with 20 years of lifespan, water-tight insulations, reliable NDT and RBI practices?

Yes Bob, but still CUI management is very difficult with limited budget and resources.

Bob, unplanned shutdown!! We again found a leak due to CUI.

Oh no, Rob!! What better we can do? Inspection budget? NDT Technology? Processes? CUI Prevention?
Problem

HIDDEN CORROSION

Oil & Gas  Chemical Industry  Corrosion Under Insulation

Renewable Energy  LNG
Corrosion Under Insulation (CUI)
Among the biggest asset integrity threat

CUI is #1 asset integrity issue in O&G and Petrochemicals

60% of all pipeline failures are due to CUI

10% of the overall offshore platforms maintenance cost

How CUI happens

Water ingress into insulation

Unpredictable location

Suitable temperature

[Image of corrosion under insulation and pipeline failure]
Inspection 4.0 – Mega Trend

**Inspection 1.0**
Manual observation, Leaks

**Inspection 2.0**
Visualisation, NDT instruments

**Inspection 3.0**
Statistics, RBI

**Inspection 4.0**
Automated, Analytics, Prediction

- **Manual** ➔ Automated
- **Detection** ➔ Prediction
- **Reaction** ➔ Prevention
Predictive Corrosion Management - Opportunity

Enabled by IIOT and Predictive analytics

CURRENT PRACTICE
Reactive

HUMAN JUDGEMENT +
GUESSED RISK

PERIODIC
MANUAL
INSPECTION

FUTURE PRACTICE
Predictive

CONNECTIVITY

SENSORS

CONTINUOUS
MONITORING

AUTOMATED
RISK PROFILING

Knowledgebase

Analytics / ML

REACTIVE MAINTENANCE

• Labour Intensive
• Unscheduled Shutdowns
• Safety Risk
• High cost

PREDICTIVE MAINTENANCE

• Minimal labour effort
• Scheduled Maintenance
• Improved safety
• Reduced cost

SENSORS

Connectivity

Knowledgebase

Analytics / ML
Wave reflection time-of-flight locates the corrosion on sensor
Wave reflection time-of-flight locates the corrosion on sensor
Wave reflection time-of-flight locates the corrosion on sensor
CUI Monitoring Solution
PREDICTIVE CORROSION MANAGEMENT USING IIOT

**DETECT**
- CR Moisture
- CR Corrosion
- Distributed Corrosion & Moisture Sensors
- Long Range Coverage
- Cost Effective Installation
- Covering Complex Pipe works

**CONNECT**
- Transmitters
- Wireless Data
- Long-Life Battery Powered
- Remote Wireless Communications
- Continuous Monitoring
- Dashboard for Actionable Intelligence

**PREDICT**
- CR Cloud
- CR On-Premises
- CR Digital Twin
- Predictive Asset Management
- Asset life extension
- Effective Risk Management
- Historical Data & Analytics
Detect - Sensors

**Corrosion and Moisture Sensors for Predictive CUI Management**

- **Helical Configuration**
- **Line Configuration**
- **Mesh Configuration**

**Sensors**

<table>
<thead>
<tr>
<th>Sensors Type</th>
<th>1) Corrosion 2) Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Length</td>
<td>1) Up to 100m 2) 50m</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-50 to 1) +300 °C 2)+200 °C</td>
</tr>
</tbody>
</table>

**Embedded Sensors**

- **Long-range & Modular**
  (each sensor unit can cover up to 100 m)
- **Unaffected by Complex Geometries**
  (e.g. vessels, pipe bends, flanges...)
- **Cost Effective for Mass Deployment**

Monitoring Pipelines

Monitoring Storage tanks

Monitoring Vessels

CorrosionRADAR Ltd.
## Corrosion & Moisture Monitoring System - Electronics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATEX/IECEx Certification</td>
<td>II 2 GD</td>
</tr>
<tr>
<td></td>
<td>Ex db IIB+H2 T3-T6 Gb</td>
</tr>
<tr>
<td></td>
<td>Ex tb IIIC T85°C - T150°C Db</td>
</tr>
<tr>
<td>Ingress Protection</td>
<td>IP66</td>
</tr>
<tr>
<td>Power Source</td>
<td>Mains</td>
</tr>
<tr>
<td>Temperature Range (°C)</td>
<td>-20 to +60</td>
</tr>
<tr>
<td>Communications</td>
<td>Wireless: Wifi/Cellular/WirelessHART/LoRa</td>
</tr>
<tr>
<td></td>
<td>Other options: USB</td>
</tr>
<tr>
<td>Approx. Dimensions (mm)</td>
<td>284H X 245W X 169D (Without Antenna)</td>
</tr>
<tr>
<td>Approx. Weight</td>
<td>11.2 Kg</td>
</tr>
</tbody>
</table>
Predict - Analytics Platforms

CR Predict IIOT Cloud platform

CR Predict On-Prem Software platform

CR Predict Digital Twin platform

CR Predict Add-on Algorithm Products

CR Analytics Module

CUI Prediction Module enabled by new improved models

CR Automated Defect Recognition Module using Machine Learning
CR Predict - CUI Prediction Module

**ADD-ON ALGORITHM PRODUCT**

Continued laboratory testing for predictive models

Validated to match industry standards

API 581 is industry guideline for CUI rate estimation. CorrosionRADAR moisture sensors provides critical factor $F_{INF}$ for accurate estimation of CUI rate.

The above plot is an experimental demonstration of CR prediction module.

$$C_r = C_{TB} \times F_{INS} \times F_{CM} \times F_{IC} \times \max[F_{PS}, F_{IP}] \times F_{INF}$$
Corrosion Monitoring (ATEX)

Case Study A

PRODUCT COLUMN CORROSION MONITORING (ATEX)
Case Study B

MOISTURE MONITORING SYSTEM

Figure (A)
Installation of CR corrosion sensors on a 3 inch pipe using cable ties

Figure (B)
Installation of the prefabricated insulation around the pipe and the corrosion sensor

Figure (C)
Installed CR Nodes (electronic) driving CR Moisture and Corrosion sensors

Figure (D)
Moisture sensor is placed inside the prefabricated insulations and installed at a fixed distance from the pipe
Case Study B
MOISTURE MONITORING SYSTEM

Moisture sensor data analysis and correlation with historical weather data

Detected water ingress points at 22 metres location
Case Study C

Installation of CR Systems

Installed layout of both CR Corrosion and Moisture monitoring systems
Data after 6 months
CORROSION AND MOISTURE MONITORING SYSTEMS

No corrosion signal observed

Water detected 07:14 GMT on 11.06.2019

Sensor start
Sensor end

Sensor start
Sensor end
Data after 7 months
CORROSION AND MOISTURE MONITORING SYSTEMS

Sensor start
Sensor end

Minor anomaly 05.07.19
Reduced reflection from sensor end 05.07.19

Water detected 08:00 GMT on 05.07.2019
Shift in sensor end indicates water presence along the sensor

Sensor start
Sensor end

Corrosion Sensor
Moisture Sensor

Corrosion sensor (10m)
Moisture sensor (15m)
Corrosion Bridge Cable (15m)
Moisture Bridge Cable (25m)
Benefits of CUI Monitoring System

ESTIMATED MAINTENANCE COST SAVINGS: 30-45%

COST

RISK
Benefits of CUI Monitoring System

- CUI Monitoring (Corrosion & Moisture)
- Data Driven RBI
- Early Detection
- Optimised Maintenance
- Less human intervention
- Reduced assets Risk
- Reduced unplanned Shutdowns
- Leak Prevention
- Reduced maintenance cost

PREDICTIVE MAINTENANCE

CUI PREVENTION
Enabling Smarter Assets

CorrosionRADAR Ltd
Future Business Centre
King’s Hedges Road
Cambridge, CB4 2HY
info@corrosionradar.com
www.corrosionradar.com
THANK YOU FOR ATTENDING

This Webinar was brought to you by MCF working in partnership with ICorr and Corrosion RADAR Ltd