Emerging Role of Digital Tools in Coating Condition Assessment and Corrosion Management in LNG and Oil & Gas

By PCN Editor

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This article examines the digital transformation in the integrity assessment of protective coatings and corrosion management, the impact of these advancements, and the advantages that digitization brings to corrosion management in the LNG and Oil & Gas Industry. These digital tools are ideal for the detection and monitoring of CUI. Many LNG assets face an elevated risk for corrosion under insulation (CUI) to develop and proliferate.

The hidden dangers of corrosion under insulation (CUI) span the oil and gas industry from upstream operations to midstream infrastructure to downstream applications, including the production of liquified natural gas (LNG). CUI is a severe form of localized corrosion that occurs when water, inorganic salts and other contaminants become trapped beneath insulation covering pipes, valves, tanks and other assets, leading to the formation of corrosion cells that are hidden from view and can spread unnoticed.

In LNG operations, cold/cryogenic temperatures can contribute to increased CUI risks. Moisture from condensation can be especially prevalent under insulation in cryogenic LNG operations due to the extreme temperature differentials with ambient air.

Digital transformation in corrosion management

Corrosion, the gradual deterioration of materials (primarily metallic) due to chemical or electrochemical reactions in their environment, poses a significant challenge in terms of safety, economic costs, and environmental sustainability. Traditionally, corrosion management has relied on physical inspections, periodic testing, and a reactive approach to problems. However, digital transformation and advancements in corrosion management are enabling a shift towards more proactive and predictive strategies, thanks to the incorporation of advanced technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), data-driven corrosion management, and cloud computing.

Internet of Things (IoT)

The IoT has enabled the implementation of sensors in structures and equipment susceptible to corrosion, collecting real-time data on conditions that can accelerate corrosion, such as humidity, salinity, temperature, and the presence of corrosive agents. This information allows engineers to monitor corrosion and environmental conditions to adjust protection strategies more effectively, even remotely. Electrochemical Impedance Spectroscopy (EIS) sensors can detect coating breakdown *in situ* in real time and give early warning indications of coating breakdown and early incipient corrosion. See https://sensorlink.no/non-intrusive-corrosion-monitoring/

Artificial Intelligence (AI) and Machine Learning (ML)

AI and ML are transforming corrosion management through advanced analysis of large volumes of data collected by IoT EIS sensors. These technologies can identify patterns in coating breakdown and predict areas of corrosion risk before a failure occurs. Machine learning algorithms can also optimize the selection of materials and protective coatings based on specific operating conditions, thereby improving corrosion prevention.
Data-driven corrosion management: Predictive analysis uses historical and real-time data to predict when and where corrosion is most likely to occur. This approach helps to plan preventive maintenance more effectively, reducing costs associated with unplanned shutdowns and extending the lifespan of assets.

Augmented Reality (AR) and Virtual Reality (VR): These technologies offer new possibilities for personnel training and corrosion inspection by overlaying CAD drawings with coating inspection maps and actual plant views. By using these technologies, engineers, and technicians can visualize corrosion on virtual or augmented assets without being physically

present, improving the efficiency and safety of inspections. Additionally, training in virtual environments allows professionals to experiment with different corrosion scenarios and learn mitigation techniques without risks.

What is the impact of digitalization on coatings inspection and corrosion management?

Digitalization has had a significant impact on coating condition assessment and corrosion management, enhancing the methodologies and strategies employed in the industry. Here are some of the most notable effects of digitalization in this area:
• Improved data collection: Digitalization has enabled the use of sensors and IoT (Internet of Things) devices to monitor real-time conditions affecting corrosion, such as humidity, temperature, and the presence of corrosive agents. This allows for precise and continuous data collection, which is crucial for corrosion analysis and prevention.
• Advanced data analysis: With the advent of big data and advanced analytics tools, it is possible to process and analyse large volumes of corrosion-related data. This leads to the identification of trends and patterns that were previously difficult to detect, allowing for better corrosion prediction and prevention.
• Modelling and simulation: Digital tools enable the creation of complex models and simulations that can predict how corrosion will behave under different conditions. This is particularly useful for designing new materials and structures, as well as planning preventive measures.
• Asset management and predictive maintenance: Integrating asset management systems with corrosion data allows companies to implement predictive maintenance strategies. Instead of performing maintenance based on fixed intervals, companies proactively invest when data indicates a risk of corrosion, thus optimizing resources and extending the lifespan of assets.
• Collaboration and information sharing: Digitalization facilitates the exchange of information and knowledge about corrosion among different stakeholders, including companies, researchers, and regulators. This promotes a better understanding and management of corrosion on a global scale.

About ExcelPlas

ExcelPlas Coating Chemists and Engineers have positioned themselves at the forefront of the coating monitoring and condition assessment industry, particularly by leveraging the transformative power of digitalization. Here's how their expertise aligns with the advancements in the field:

Improved Data Collection - The integration of digital technologies like Electrochemical Impedance Spectroscopy (EIS) and Dry Film Thickness (DFT) sensors, combined with Internet of Things (IoT) devices, has revolutionized the way ExcelPlas monitors corrosion. These technologies enable the continuous and real-time tracking of environmental factors that contribute to corrosion, such as humidity, temperature, and corrosive agents, leading to more precise and timely data collection.

Advanced Data Analysis - Utilizing big data and advanced analytics, ExcelPlas processes extensive volumes of data that inform the condition of coatings and the extent of corrosion. The company’s engineers are skilled in detecting complex trends and patterns, enhancing their ability to predict and prevent corrosion, rather than just react to it.

Modelling and Simulation - The expertise of ExcelPlas also extends to the creation of sophisticated models and simulations that predict corrosion behavior under varying conditions. This capability is essential not only in the design and development of new materials and structures but also in establishing proactive measures to combat corrosion before it becomes problematic.

Asset Management and Predictive Maintenance - ExcelPlas has harnessed the synergy between asset management systems and corrosion data, which has enabled them to implement predictive maintenance strategies effectively. By maintaining assets based on the risk of corrosion indicated by real-time data, rather than on a fixed schedule, the company can optimize resources and prolong the life of these assets.

Through these cutting-edge practices, ExcelPlas not only ensures the integrity and longevity of coatings and structures but also offers a more cost-effective and resource-efficient approach to managing corrosion, thus providing significant value to their clients in the industry.