Corrosion monitoring and inspection

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Corrosion:
Importance of monitoring
CORROSION: importance of monitoring

- Corrosion evaluated at 3.1% of the GDP of developed country
- Corrosion happen in harsh environment (offshore, oil and gas industry) were the access and the maintenance cost are high (offshore) or where the consequence of failure have an high economical impact (oil and gas industry).

A proper corrosion monitoring system allows to:

- Schedule the inspection (only when it is necessary) and forecast the maintenance
- Decrease the maintenance and immobilization cost
- Having a fine control on the degradation status of the material
- In some case: improve the lifetime of the installation by optimizing operative parameters.
Corrosion monitoring: ER prototype

Remote corrosion monitoring system based on ER

Hardware, data acquisition and communication

ER reminder

Capabilities
Remote corrosion monitoring system based on ER

Probe
- Up to 6 ER probes (immersion, immersion under cathodic protection, splash zone)
- 2 temperature probes (immersion, splash zone)

Measurement
- Deal with cathodic protection
- Adjustable data acquisition frequency

Communication
- Scada simulation based on Mango
- Protocol using Modbus TCP
ER reminder

Electrical resistance (ER)

The ER technique consist in evaluating the section of the probe by measuring its resistivity. The probe is made in the same material than the structure of interest.

The resistivity of the probe is not only affected by the change of section, but also by the surrounding temperature.

\[ R = \frac{U}{I} \]
\[ R = \rho \frac{l}{s} \]

\[ \text{If } s \downarrow, R \uparrow \]

Temperature compensation

\[ \rho = \rho_0 (1 + \alpha \theta) \]
Hardware, data acquisition and communication

The prototype is based on industrial standards for both the hardware and software parts

Communication

- Scada simulation based on Mango
- Protocol using Modbus TCP
Capabilities

Test ongoing in the laboratory:
- Carbon steel probes
- Environment: synthetic sea water

Results
- Capabilities to measure a change of section of 0.3 ± 0.1 mm²
- Corrosion speed measured: 0.24 mm/year

Good accord with the values found in the literature
Corrosion inspection: Active thermography

Active thermography

Work ongoing
Active thermography

The inspection of the coating painted on surface is, as of now, implying the destruction of a small area painted in order to check its integrity.

The work ongoing here is to adapt the active thermography technique in order to be able to detect early degradation and corrosion initiation under the coating in a non-destructive way.

Active thermography consist in heating the system to inspect and observing the temperature evolution by using an IR camera.

The change of temperature is related to the properties of the materials (presence or not of water, corrosion products...)

Active thermography: work ongoing

Detail: IR camera

Setup: IR lamp, sample, IR camera

Evolution of the temperature (Area 3, 4, 6 on the blisters; 2 and 5 on the unaffected coating)

Sample: coated steel with blister

Thermal image of the sample