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CORRUSION A MAJOR FAILURE MECHANISM IN OFFSHORE WIND
HOW TO PREDICT, DETECT AND MANAGE (BIO-)CORROSION?

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Aspects of interest with offshore wind farms

Corrosion is a top three failure mechanism for offshore wind farms.
The mechanisms that must be taken into account include degradation of organic coatings and local corrosion mechanisms like Microbiologically Influenced Corrosion (MIC). Zones affected by corrosion include the coated tower, transition piece and internal/external surface of the mono pile. MIC plays a larger role in enclosed and inaccessible areas.

How can maintenance and operational cost be reduced?

A major reduction can be achieved by
- tailor made corrosion prevention in wind farm design phase and
- continuous monitoring combined with usage based degradation models.

This would optimize the integrity management of wind farm assets.

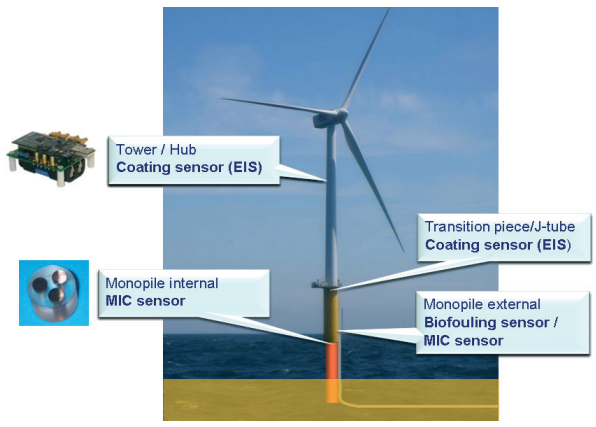


Figure 1: Typical setup for EIS measurements.

Approach

Applicable electrochemical measurement techniques are

- Electrochemical Impedance Spectroscopy (EIS) for early detection of coating degradation and remaining lifetime prediction.

- Electrochemical Noise Measurement (ENM) for detection of localized corrosion mechanisms such as MIC.

Determination of the protective properties of organic coatings

EIS has proven to be a sensitive measurement technique that can detect relevant decrease of protection properties in an early stage. This benefits end-users as they can perform appropriate action before unexpected damage occurs.

Fig 2. Example coating damage

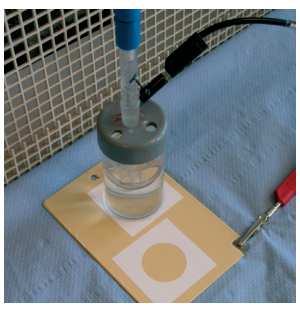


Fig 3. Laboratory setup EIS

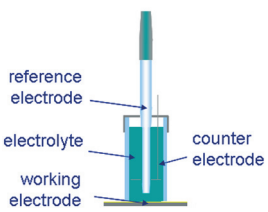


Fig 4. On site EIS

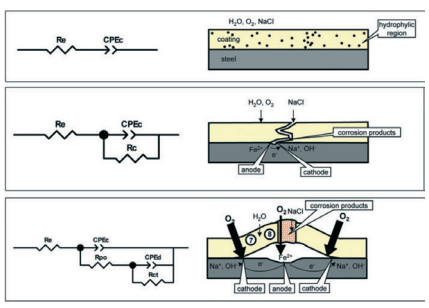
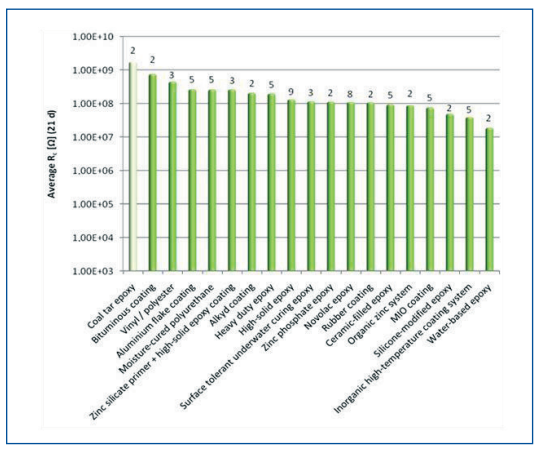


Fig 5. equivalent circuits and their physical interpretations

Results

TNO determined the barrier properties of over 100 commercial coating systems using EIS and created a database of the initial performance of protective coatings.
One of the values that can be derived from EIS is the coating resistance (Rc). The Rc value represents the resistance that charge carriers (ions) encounter as they migrate through the coating.
An overview of the obtained Rc values is shown in figure 6. Generally, a good barrier coating has a high Rc value.



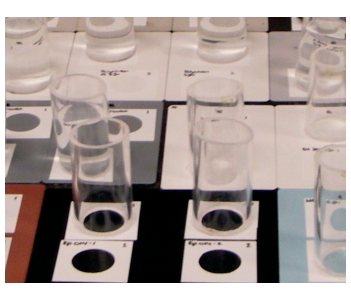


Fig 6. Average Rc-values for each coating type after 21 days of immersion.

Determination of MIC

MIC is corrosion initiated or accelerated by a few specific genea of microorganisms attached as biofilms.

Fig 7. Monopile installation

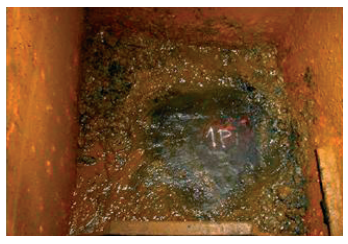


Fig 8. MIC damage

MIC can be determined with ENM which is suitable to distinguish for bio corrosion processes of general corrosion.
Bacterial attachment on the electrodes surface changes the frequency of noise pattern as a contrast, no oscillation pattern features are observed for the blank solution.

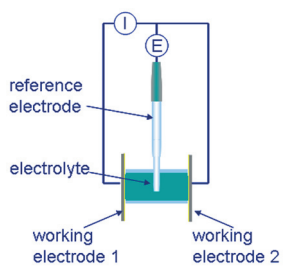


Fig 9. Experimental setup ENM

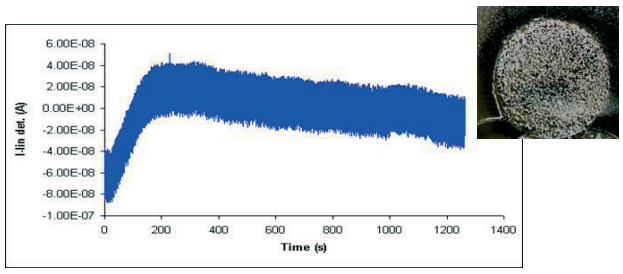


Fig 10. Uniform corrosion carbon steel

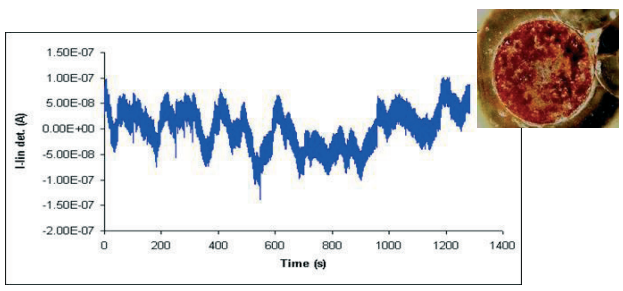


Fig 11. Local corrosion MIC (thiooxidans)

References

- Corrbase 1, S.J. Buter, W.M. Bos, TNO, 2007
- Microbiologically Influenced Corrosion (MIC) in Ship Tank Environments, A. Heyer, F. D'Souza, G. Ferrari, J.M.C. Mol and J.H.W. de Wit, M2I, 2008