



Offshore Wind Farm

Corrosion and Cathodic Protection Services



Offshore wind farm - Integrity and durability

Offshore wind turbine substructures are exposed to severe corrosion conditions which, if not adequately controlled, can easily compromise structural integrity and durability of the asset.

Organic coatings are used for preventing marine atmosphere corrosion, while to prevent seawater corrosion, cathodic protection often in combination with coating, is the most effective choice (Fig.1).

For cathodic protection both galvanic anodes and impressed current systems are applicable, even if galvanic anodes seem to be most cost effective on a life-cycle basis.

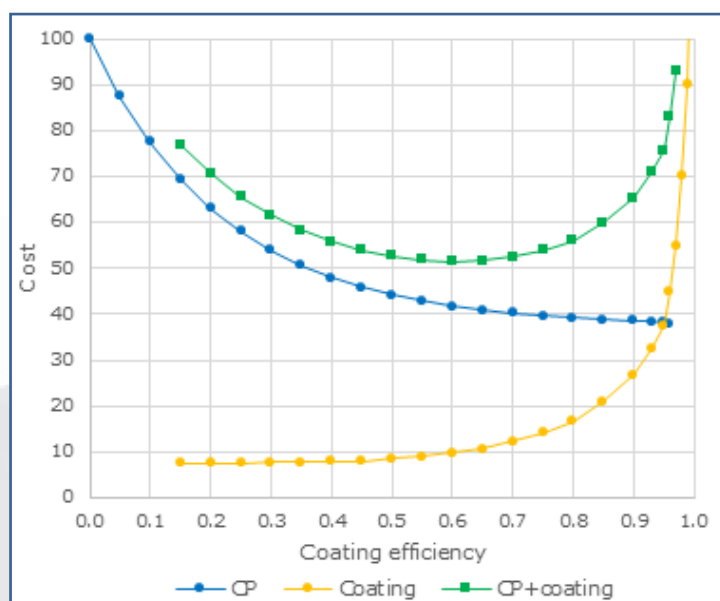


Fig. 1 - Cost vs. coating efficiency

Cathodic protection

For both cathodic protection by galvanic anodes (Fig. 2) and impressed current systems (Fig. 3), the installed systems and components shall guarantee adequate durability with low maintenance. Replacement costs, in a harsh environment as the offshore one, could be quite high.

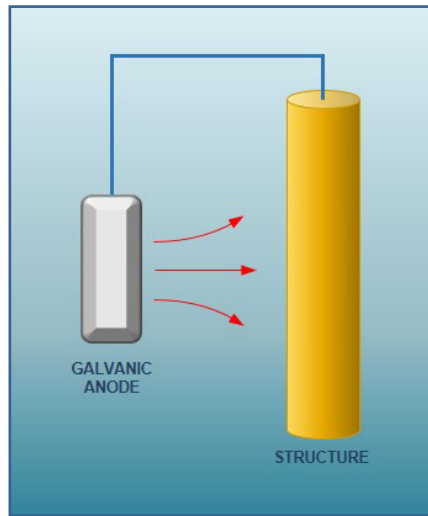


Fig. 2 - Cathodic protection by galvanic anodes

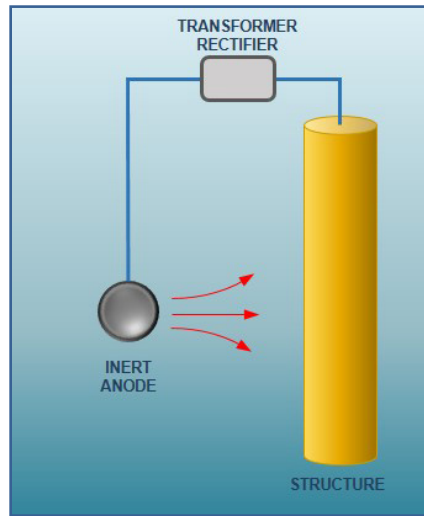


Fig. 3 - Cathodic protection by impressed current

CESCOR has specific competences for the design of all cathodic protection (CP) applications. Engineering services rely on robust knowledge of CP theory and principles. Computer modelling, by Finite Element Method (FEM) and Boundary Element Method (BEM), is routinely used by CESCOR for Advanced Cathodic Protection Design. CESCOR personnel are certified in accordance with the European Standard EN 15257 for the design of CP applications, by galvanic anodes or impressed currents, including:

- Offshore steel jackets, monopiles and other structures
- Piers and coastal facilities
- Onshore structures fully or partially buried in the ground
- Reinforced concrete structures.

Engineering capabilities for the CP competence include:

- Cathodic protection (CP) design packages, including monitoring, for all applications
- Advanced design by FEM (Finite Element Method) and BEM (Boundary Element Method) modelling (Fig. 4 and 5)
- Design of CP retrofitting systems for offshore jackets, monopiles, and other structures
- Offshore structures CP inspection specifications and integrity assessments
- Client Representative. Technical Advisor
- Inspections during PQT, manufacturing, installation
- Training.

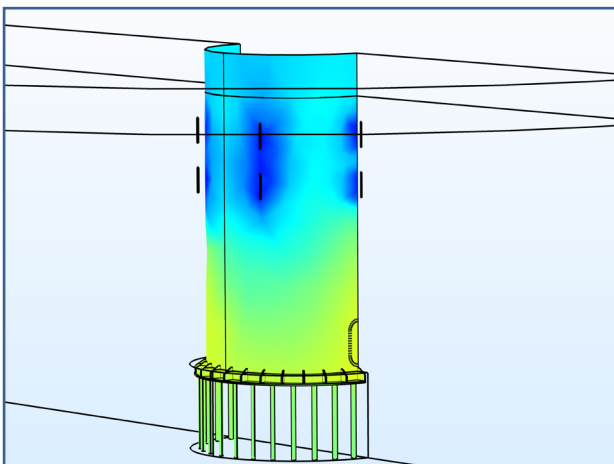


Fig. 4 - Monopile protected by galvanic anodes – potential distribution

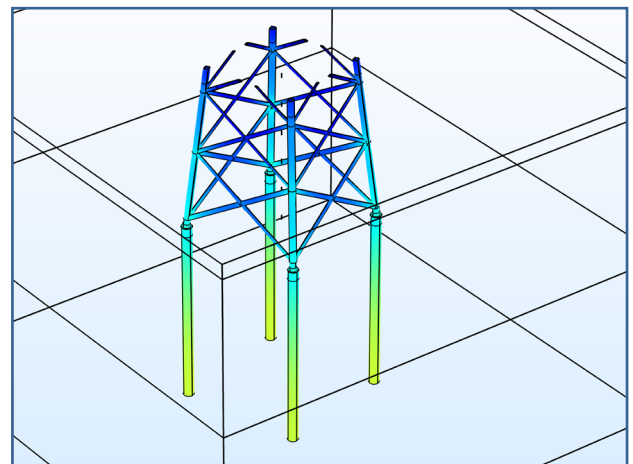


Fig. 5 - Steel jacket protected by tensioned anode string – potential distribution

■ ■ ■ ■ ■ Cathodic protection – Retrofit systems

CESCOR provides supply of turnkey CP retrofit systems for all applications, including:

- Site survey
- Detail design (design data and calculations, drawings)
- Materials Procurement Service
- Installation supervision
- Start up and commissioning
- Periodical controls and maintenance
- Training for field operator
- Cathodic protection data management.

■ ■ ■ ■ ■ Cathodic protection – Inspections and surveys

CESCOR provides inspection services such as:

- Corrosion and CP inspection of offshore structures:
 - probes to be assembled on ROV's, or handled by divers (Fig. 6 and 7)
 - field CP technicians
 - reporting at office
- CP inspection of marine and offshore structures: drop cell measurements
- Inspection of above water components of CP/monitoring systems.



Fig. 6 – Subsea CP inspection system mounted on ROV



Fig. 7 - Water and seabottom resistivity probe

■ ■ ■ ■ ■ Corrosion and materials

■ ■ ■ ■ ■ Material selection

CESCOR provides Engineering Services for the materials selection in several industrial sectors. The material selection specialist identifies, for every component, the most suitable materials from the point of view of their resistance to aggressive environments – on the inside and on the outside - and their cost effectiveness. All related aspects are then reviewed, including metallurgy, welding, coating, and cathodic protection. The material selection process is supported by a detailed corrosion engineering analysis, and completed by the identification of adequate corrosion control systems. Corrosivity assessments are performed by considering different exposure zones for wind farm substructures which can include:

- Atmospheric corrosion zone
- Splash zone
- Submerged portion of the pile
- Pile internal surface
- Rebar of reinforced concrete caisson
- Anchor bars.

Metallurgy and welding

CESCOR has the in-house expertise to support engineering activities related to metallurgy and welding. CESCOR personnel are qualified in accordance with the International and European Institute of welding (IWE/EWE) for welding engineering. In addition, CESCOR personnel hold welding inspection qualifications such as PCN Level 2, CSWIP 3.1 or equivalent. CESCOR engineering capabilities include but are not limited to:

- Preparation of specification with technical requirements of various components manufactured from different metallic and non-metallic materials
- Material requisitions
- Technical bid evaluations
- Review of mechanical, chemical and corrosion test procedures and test reports
- Coordination and review of welding Procedure Specifications (WPS) and Welding Procedure Qualification Records (WPQR)
- Fabrication site supervision and QA/QC.

Painting and coating

In-house expertise of CESCOR also includes engineering activities related to painting and coating. Engineering capabilities include but are not limited to:

- Preparation and review of technical requirements for painting and coating systems
- Technical Data Sheets (TDS)
- Technical bid evaluations
- Review and validation of documentation and analysis of data submitted by suppliers
- Fabrication site supervision and QA/QC.

Asset integrity

Corrosion is known to represent the main threat to the integrity of metallic structures throughout their operating life. Accordingly, corrosion and material expertise are essential for asset integrity management, and to ensure safe and sustainable operations. CESCOR provides expert services for asset integrity management of existing / operational assets focused on customised approach for corrosion management and the definition of the most appropriate plan of inspection.



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