Cathodic Protection Retrofit

Life extension and CP retrofit

Thousands of permanent offshore structures for oil and gas production in the world, like steel jacket platforms, subsea pipelines, floating production and storage facilities (FPSO) are reaching or have exceeded their original design life. They require extension of life or requalification programs to prolong their operating life.

Cathodic protection (CP) is one of the issues to be managed as part of the life extension projects of existing structures. In case the original CP system cannot guarantee the planned residual life, a retrofit intervention shall be designed and executed.

CP retrofit is also a need for Offshore Wind Farm structures, such as monopiles and jackets.

The design of CP retrofit systems does not follow the criteria and approaches adopted for new facilities, as the intervention shall be executed with the structure in-place, and this has a strong impact on installation works. Accordingly, dedicated CP expertise has been developed for CP retrofit, aimed to select the most convenient system between impressed current and galvanic anodes. Actually, even if general rules exist, for CP retrofit projects, it is recommended to perform a dedicated technical and economic assessment study.

Method	Advantages	Disadvantages
IMPRESSED CURRENT	FEW ANODES REQUIRED WITH HIGH CURRENT OUTPUT	ELECTRICAL POWER AVAILABILITY NEEDED
	CURRENT OUTPUT EASILY ADJUSTABLE	MAINTENANCE AND INSPECTION OF FEEDING SYSTEM REQUIRED
	QUICK INSTALLATION	POSSIBLE MECHANICAL DAMAGES TO ANODES AND CABLES
	REDUCED INSTALLATION COSTS	RISKS OF UNEVEN POTENTIAL DISTRIBUTION
SACRIFICIAL ANODES	NO MAINTENANCE REQUIRED	HIGH NUMBER OF ANODES REQUIRED
	NO OVERPROTECTION	HIGH INSTALLATION COSTS, IN PARTICULAR IN DEEP WATERS

CP retrofit of shallow water platforms

Small size steel platforms in shallow water can be retrofitted using either galvanic anode or impressed current systems. Anode pods (Fig. 1) laid on sea floor and electrically connected to the jacket represent a quite competitive and cost effective option. If needed, it can be integrated with galvanic anodes directly clamped on structural elements. Impressed current systems can also be adopted based on the remote anodes concept. Both anode strings laid on sea floor or anode sleds can be used. Remote anodes can be integrated with impressed current anodes pile mounted type (Fig. 2).

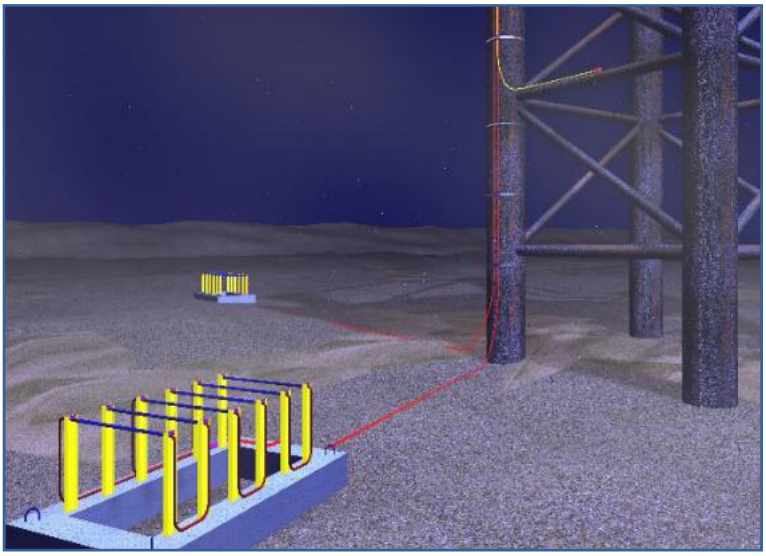
Fig. 1 - Anode pods with aluminium alloy – 300 kg anodes

Fig. 2 - Pile mounted anode with Ti-MMO rod

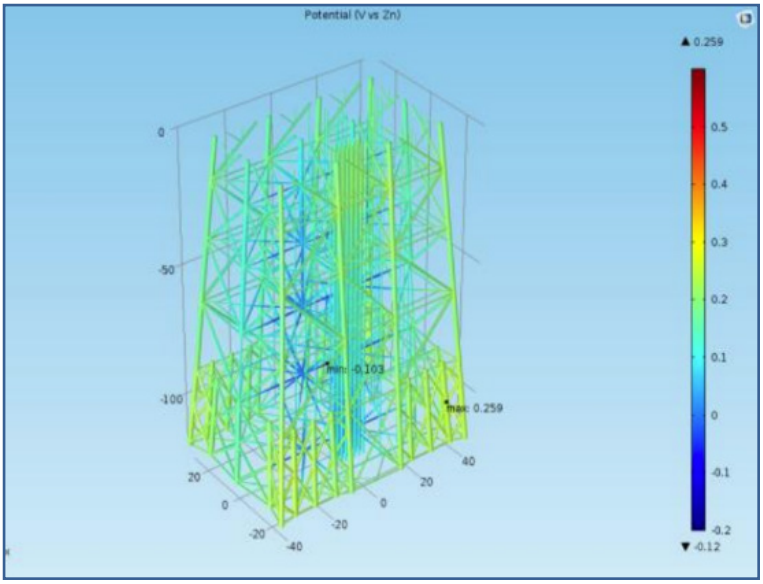
CP retrofit of subsea pipelines and other

Galvanic andoe sleds (retrofit of subsea pipelines)

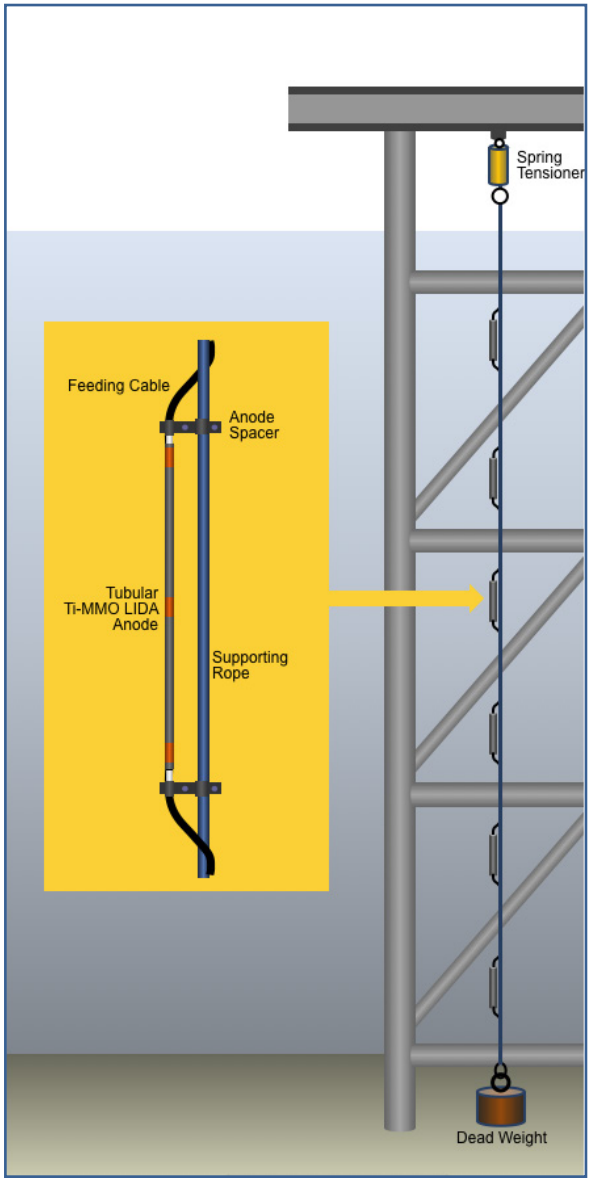
Segment of clamp with galvanic anodes (monopiles, single point moorings, etc)



Remote anode sleds



Boundary Element Method (BEM) modelling of jacket retrofitted by TSA's



TSA system and anode assembly detail.

CP retrofit in deep water

One of the most versatile and effective solution for deep water platforms retrofit is represented by the so called Tensioned String of Anodes – TSA1 system. The TSA system consists of mixed metal oxide activated titanium LIDA anodes assembled on a mechanical supporting rope. The TSA is tensioned between anchor points on sea floor (clamps or dead weights) and on lower deck of the platform, and can be installed inside or outside the jacket.

The system provides significant advantages in terms of easy distribution of the impressed current anodes based on the local current demand. The design of the system shall be accomplished by using modelling of the current and potential distribution using computer modelling. For such applications, CESCOR developed specific capabilities using finite elements or boundary elements methods to optimize positioning of the TSA.

The Tensioned String of Anodes and the relevant mechanical connections (pad-eye, spring tensioner, turnbuckle, and adjustment chain) are verified with respect to wind, waves and marine current solicitations by performing a structural analysis based on the actual TSA characteristics and on the 100-year return period extreme environmental conditions.

1 TSA and LIDA are trademarks of Industrie De Nora SpA.

Monitoring

Retrofit projects include installation of permanent reference electrodes, distributed in critical positions convenient to detect under-protection as well as over-protection conditions. Modelling is used to optimize the number of permanent reference electrodes and to interpret potential readings. High purity zinc is the preferred reference electrode type. Zinc electrodes are available in different shapes and assembly configurations (Fig. 3, 4).

Fig. 3 - Zinc reference electrodes for tensioned anode string.

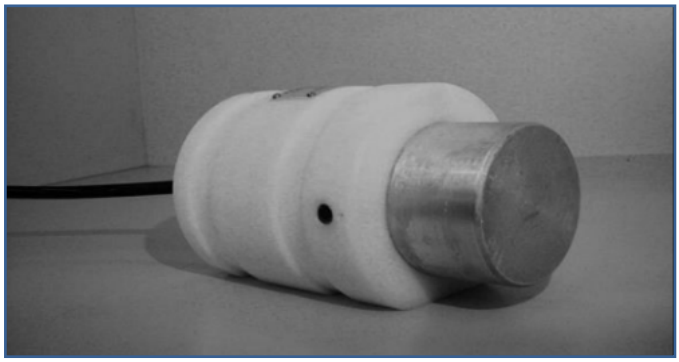


Fig. 4 - Zinc reference electrode for jackets and other subsea structures.

Cescor Services

For CP retrofit, CESCOR provides:

- CP retrofit design
- Material supply
- Monitoring systems design and supply
- Supervision to commissioning and installation works

Selected papers

- B.Bazzoni, G.L.Mussinelli, "*New Design of Anodic Structures for Impressed Current Cathodic Protection in Sea Water*", 4th Middle East Corrosion Conference, Bahrain, 11 - 13 January 1988.
- R.L. Cabe, G.L. Mussinelli, M. Tettamanti, B. Bazzoni, G.P. Franzoso, "*Impressed Current Cathodic Protection Systems of Offshore Structures*", NACE Corrosion 1989, New Orleans LA, Paper n. 285, 17 - 21 April 1989.
- Guo Jin Wen, L.Patterson, A.Amorelli, D.Condanni, B.Bazzoni, "*C.A.C.T. Op. Gr. Experience on Offshore Cathodic Protection Retrofitting*", AGIP Maintenance Conference, 1998.
- O.Nieto, J.Almestar, T.Caglioni, B.Bazzoni, M.Mori, "*Cathodic protection retrofitting of offshore steel platforms. Anode system concepts and applications*", AIM - Giornate Nazionali sulla Corrosione e Protezione, 5a Edizione, 2005.
- B.Bazzoni, M.Tettamanti, S.Tremolada, M.Manghi, T.Turk, "*20 years of impressed current cathodic protection retrofit of offshore platforms using MMO Tensioned Anode Strings*", NACE International, paper n. 07049, Corrosion Conference 2007.
- P. Marcassoli, M. Ginocchio, B. Bazzoni, A. Msallem, A. Ibrahim "*Design of Cathodic Protection retrofitting of subsea pipelines assisted by Finite Element Method (FEM) Modelling*", Eurocorr 2014, Pisa, September 2014.
- P. Marcassoli, M. Ginocchio, B. Bazzoni, "*Modeling in selection, design and optimization of cathodic protection retrofit systems of offshore facilities*", Eurocorr 2017, Prague, Czech republic, September 2017.

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