Underwater cathodic protection inspection services

Cathodic protection inspections

External corrosion of subsea pipelines is controlled by the combination of organic coating and cathodic protection (CP), mainly by galvanic anodes. Periodical underwater CP inspections are necessary to verify that correct protection levels are established and maintained along the pipeline, and to check the coating integrity as well as the status of anodic system.

CP inspection of subsea pipelines faces specific difficulties:

- Local inaccessibility for electrical contact
- Pipeline burial
- Water depth, ranging from very deep to shore approaches.

Extent of cathodic protection inspection includes all sections of a pipeline, from platform riser, to deep and shallow water, to shore approaches up to the on-land section of the subsea pipeline.

Underwater inspection methods

The protection conditions are normally verified by direct potential measurements of the steel structure with respect to a reference electrode in close proximity. However, because of the presence of the organic coating and concrete weighting as well as because of pipeline burial, direct potential measurements are actually unfeasible.

Subsea pipelines can be inspected adopting the following methods:

- The remote electrode potential profile
- The current density profile
- The trailing wire technique

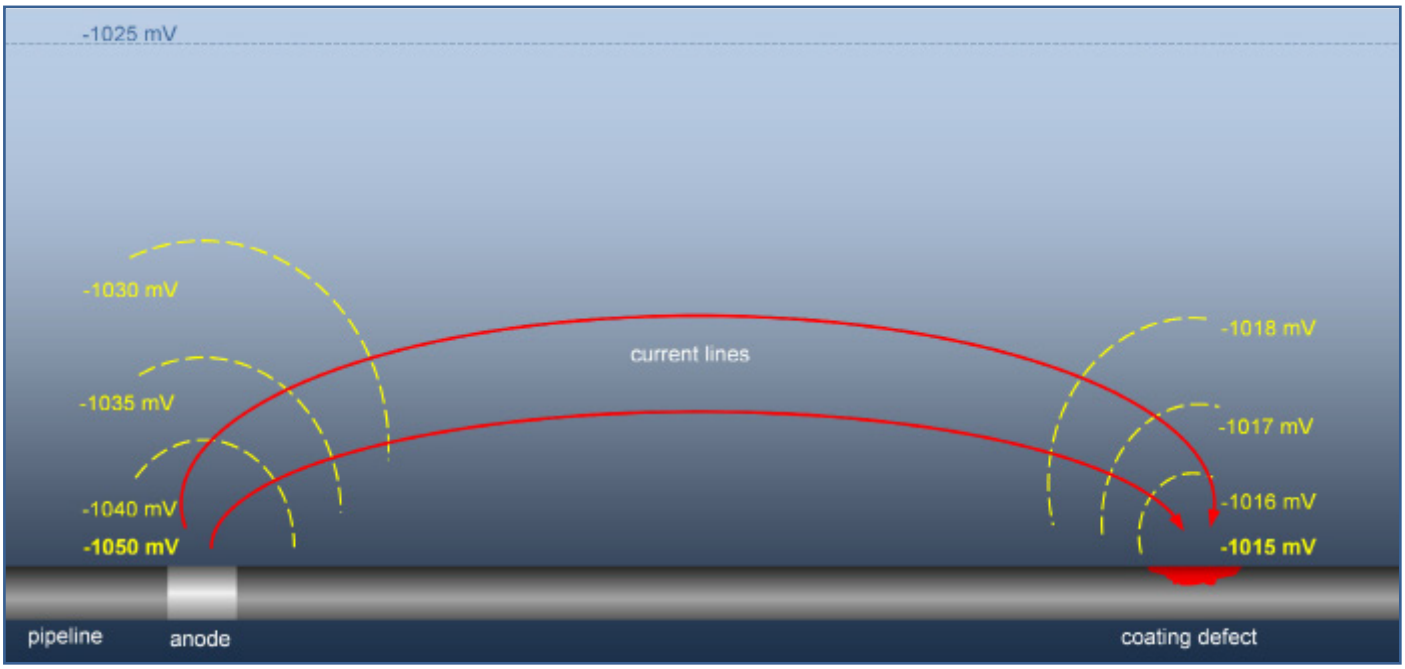

Fig. 1 - Electrical field surrounding a subsea pipeline.

The remote electrode potential profile

To overcome the inaccessibility for electrical contact, the remote electrode survey technique is used. Around a subsea pipeline with bracelet galvanic anodes, an electrical field is established (Fig. 1). In presence of coating defects, the protection current flows from the galvanic anodes to the steel exposed in correspondence of coating defects: the current flowing from anode to defect prevents steel corrosion to occur and this is verified by the cathode potential which shall be more negative than -0.80 V referred to silver-silver chloride reference electrode.

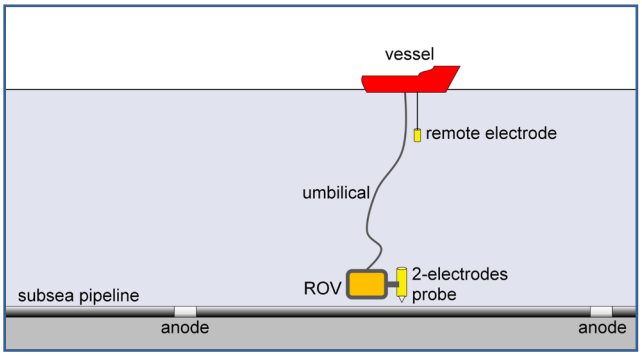

Fig. 2 - CP inspection of subsea pipeline with ROV

The remote electrode potential profile survey is performed using a remote reference electrode and a probe assembled on ROV and moving along the pipeline (Fig. 2). Direct potential readings are taken in correspondence of the anode, while along the pipeline the potential profile is reconstructed using the difference between close and remote reference electrodes.

The current density profile

The CP probe on ROV moving along the pipeline route also records the local ohmic drop, i.e. the electrical field gradient, in close proximity to the pipeline, by means of two reference electrodes mounted on the CP probe. The recorded ohmic drop profile is then converted to current density profile allowing to detect:

- Coating defects, if any
- Bracelet anode locations, even in case of burial.

The trailing wire technique

The trailing wire technique is generally adopted for CP inspections of shallow water pipeline shore-approaches, where vessels and work class ROV cannot operate. Pipeline potential is measured using a trailing wire directly connected to the structure at a contact point on land. The CP probe with reference electrodes is handled by a diver or operated by a rubber dinghy or a small vessel.

Instrumentation.

CESCOR developed different sets of probes for subsea CP inspections, suitable for every environment, from very shallow waters, up to very deep waters, rated for 2,000 m or more. Main features are:

- Highly resistant and low weight CP probe (Fig. 3, 4)
- High accuracy
- High stability and robust reference electrodes
- Conductivity probe

CESCOR instrumentation is positioned in the inspection area with ROV or divers, provided by Marine Contractors according to Clients requirements. Probes are connected to Data Acquisition System, which performs the recording of all measurements.

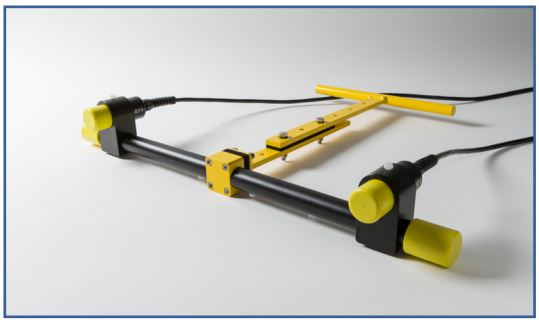

Fig. 3 - CP Probe

Fig. 4 - Contact tip with resistivity probe

Software

Proprietary software have been developed to manage and control the acquisition processes and to process the recorded raw data.

TWICE

Trailing WIre CEscor

CESCOR software for trailing wire data acquisition.

R CLOSE

CLOSE-to-Remote potential survey

CESCOR software for close-to-remote potential and gradient data acquisition.

PRO CESS

PROcessing CEScor Software

CESCOR software for inspection data processing.

On-land techniques

CESCOR provides integrated CP services for the on-land portion of subsea pipelines, when present. The following techniques are used (see Fig 5):

- DCVG - Direct Current Voltage Gradient
- CIPS - Close Interval Potential Survey
- TGM - Transverse Gradient Method

To localize coating defects and to measure the protection level. Stray currents and DC/AC interference surveys complete the CP inspection where required.

Fig. 5 - Combined CIPS and TGM methods

Finite Elements Modelling

Finite Element Modelling (FEM) allows to represent the electrical field around the pipeline and for correctly interpreting the inspection results, particularly in presence of coating holidays (Fig. 6). In case of buried pipelines, the electrical field can be modelled considering burial depth and the sea bottom resistivity, predicting the minimum detectable defect size (Fig 7).

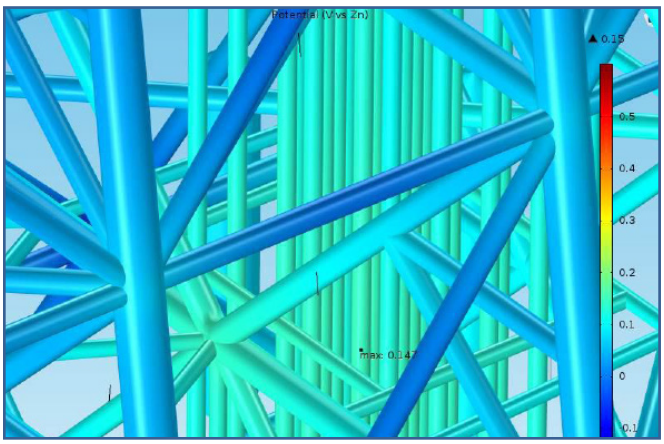

Fig. 6 - Simulation of protection potential on platform jacket.

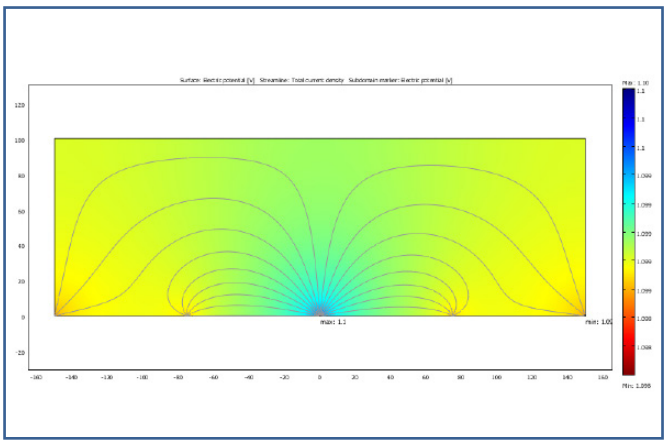

Fig. 7 - Simulation of coating defects on a pipeline protected by bracelet anode.

Expert reporting

Field activities are completed by data analysis and interpretation performed at office under the responsibility of CP experts certified as per EN ISO 15257. Inspection reports typically include:

- Protection conditions assessment certification
- Anode residual life
- Recommendations for CP retrofit if needed.

Services

For subsea Cathodic Protection inspection services, CESCOR provides:

- Instrumentation – CP probes and electronics
- Data Acquisition Systems and Software
- Certified CP personnel at field
- Data interpretation and , also assisted by Finite Element Modelling (FEM)

Applications

- Subsea pipelines
- Subsea power cables
- Pipeline shore-approches
- Offshore platform

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