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# CP Protiction on Piles

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**Abstract:** ***A new liquefied natural gas (LNG) receiving terminal was constructed on the site of a decommissioned facility; construction basis of the LNG receiving terminal project included an effort to extend the life of the existing jetty structure and associated berths. A comprehensive integrity evaluation of the existing jetty structure confirmed that it was feasible and economical to refurbish the jetty for future service as a loading dock for the LNG terminal. The design life of the new facility was 30 years. The primary means for extending the life of the jetty was select replacement of severely degraded components, concrete repair works, and application of cathodic protection (CP). Life extension of the jetty presented a number of significant design and execution challenges. These include the scope of the retrofit work and the constraints required to safely apply CP to pre - stressed concrete. The jetty included a mix of pre - stressed concrete piles, partially coated steel piles and concrete support structures located in and above the splashzone. In an effort to extend the life of the jetty, the piles and other support structures were retrofitted with an impressed current CP system. Use of impressed current system required addressing significant design challenges including avoidance of hydrogen effects on pre - stressed tendons, and the CP monitoring of hundreds of submerged piles and atmospheric zones. This paper will discuss the basic jetty design as well as concrete u rebar corrosion protection needs. The CP design basis which included dividing the jetty structure into several distinct zones to assist with CP design will also be covered.***

**Keywords:** LNG Jetty, Cathodic Protection and Corrosion

## 1. Background

Defined as degradation of substance, usually the metal is due to an interaction with its environment. Corrosion is a natural process. Minerals do not like to be metals, they prefer to stay with raw materials. Corrosion is also known as a chemical or electrochemical reaction between a substance, usually a metal or an alloy, and its environment, leading to deterioration of the material and its properties.

According to the characteristics of the environment, corrosion processes are classified as chemical or electrochemical. Corrosion is an expensive global problem. In addition to the huge economic cost, erosion is also responsible for many disasters that cause loss of life and destructive environmental pollution.

Corrosion is caused by significant damage to oil companies, and the relationship of the project to the cathode protection system of the liquid natural gas bridge in the company Sirte for the manufacture of oil and gas and for you to understand the principles of cathode protection systems is based upon understanding the nature of the corrosion process.

The corrosion of metals is an electrochemical process. That is, it is an electrical circuit where the exchange of electrons (electricity) is conducted by chemical reactions in part of the circuit. These chemical reactions occur at the surface of the metal exposed to the electrolyte.

Oxidation reactions (corrosion) occur at the surface of the anode, and reduction reactions occur at the surface of the cathode. Corrosion control systems that relocate these oxidation reactions, by making the protected structure a cathode in a larger corrosion cell are called "cathodic" protection systems. " The cathodic protection anodes are installed to become the anode in this larger corrosion cell and provide the location for all oxidation reactions in the cell. [IJS - 16]

### 1.1 Problem Statement

[LNG JETTY] located in the Sirte Company for production and manufacture of oil and gas, which is about 80 kilometers away from the city of Ajdabyia, is a portable pile that consists of concrete reinforced with carbon steel. This type of metal is reacting with the environment, which is the water of the sea, and results in a reaction phenomenon called corrosion Corroded metals lose efficiency over time, causing the [LNG Jetty] to collapse.

### 1.2 Objectives

Since the LNG JETTY is protected by a cathodic protection system (CP), it is protected from collapse. VICON The goal of the project is to conduct a detection of the applied system, read the B voltage meter to measure the voltage of the piles, indicate the cause of weakness in the effort, and, like you, design a cathodic protection system (CP). The [LNG JETTY] is a general ankle for the voltage difference between the piles.

### 1.3 Types of Corrosions

- Galvanic corrosion
- Pitting corrosion
- Crevice corrosion
- Intergranular corrosion
- Selective corrosion (dealloying)
- Stress corrosion cracking
- Corrosion fatigue

### 1.4 How to Control Corrosion

- Material selection.
- Cathodic protection
- Corrosion protection coatings
- Corrosion inhibitors

### 1.5 Application of CP for LNG Jetty

It is extremely important for the cathodic protection system at the LNG Jetty to maintain the integrity of the structure for both economic and environmental reasons. The proper design, installation, and maintenance of a cathodic protection (CP) system can help maintain the integrity and increase the useful service life of LNG jetty.

### 1.6 CP Construction design for LNG Jetty

There are also some LNG jetty locations in the shallow area, particularly along the shoreline. This was also a unique design for the anode installation. The CP work was only below the splash zone area, and we noticed the concrete jacket was cracked due to corrosion. The principal methods for mitigating corrosion are coatings and cathodic protection (CP). Although each will be treated in greater detail.

a) Coatings are normally intended to form a continuous film of an electrically insulating material over the metallic surface to be protected. The function of such a coating is to isolate the metal from direct contact with the surrounding electrolyte (preventing the electrolyte from contacting the metal) and to interpose such a high electrical resistance that the electrochemical reactions cannot readily occur. In reality, all coatings, regardless of their overall quality, contain holes, referred to as holidays, that are formed during application, or during transport or installation.
b) CP is a technique to reduce the corrosion rate of a metal surface by making it the cathode of an electrochemical cell. This is accomplished by shifting the potential of the metal in the negative direction by the use of an external power source (referred to as impressed current CP) or by utilizing a sacrificial anode.

### 1.7 Selection of type of a cathodic protection system

Some of the questions to be resolved when planning a CP system include the following:

1) Should galvanic anodes be used, or would an impressed current system be a better choice?
2) How much total current will be required to attain adequate CP?
3) What should be the spacing between installations, and what will be the current output required from each installation?
4) What provisions should be made to permit testing the completed installation?
5) Are there special conditions at certain locations that will require modifications in the general plan for CP?

These questions cannot be answered using only material covered up to this point. The needed information that will influence the decision includes such items as:

- The corrosivity of the environment;
- The soil structure and resistivity;
- Whether the structure is bare or coated;
- If coated, the quality and electrical strength of the coating and the presence of environmental conditions that may cause the coating to deteriorate;
- The metal or alloy used in the structure;
- The size of the structure and its ability to conduct CP current;
- The presence of metallic structures from other resources (usually termed foreign structures) crossing or close to the pipeline to be protected;
- The presence of stray current from man - made or natural sources

### 1.8 Determining type and design of cathodic protection system

When all preliminary data have been gathered and the protective current has been estimated, the design sequence can begin. The first question to ask is: which type (galvanic or impressed current) of cathodic protection system is needed? Conditions at the site sometimes dictate the choice. However, when this is not clear, the criterion most widely used is based on the current density required and resistivity. If the resistivity is low (less than 5000 ohm - centimeters) and the current density requirement is low (less than 1 milliampere per square foot), a galvanic system can be used. However, if the soil resistivity and/or current density requirements exceed the above values, an impressed current system should be used. According to the data gathered and the most practical for the structure, the CP specialist decided to use a galvanic system for the LNG jetty.

### 1.9 Monitoring and data

**Review of Monitoring Data**

A comprehensive review of historical CP monitoring data was made to evaluate the protection levels reported on the LNG Jetty, shown on the actual data report (Please see the Picture) The reading was summarized from 2013 to 2019. This was conducted as part of the annual CP survey. In each survey, the potential was recorded at the CP test station along the LNG Jetty i. e., the platform, the breasting dolphin, and the pile.

### 1.10 Design

Sea - Bottom Anodes can be designed and manufactured with almost any current output and life required. Contact MATCOR with specific current and life requirements, and our expert corrosion engineers will design the right anode for virtually any marine cathodic protection application anywhere in the world. .

## 2. Result

Record the measurement on the appropriate data sheet. Measurements taken in this manner have negative potential. Repeat the procedure at each representative location along the structure, making sure to accurately describe each location on the data sheet. We concluded that the potential reading was decreasing at a specific test point, and we will begin further investigation (as shown on the data sheet below for the most recent 2019 survey).

**Table 4.1:** Measurements taken in this manner are negative potential

| | | |
|---|---|---|
| 1 | - 894 | Pile |
| 2 | - 910 | Pile |
| 3 | - 913 | Pile |
| 4 | - 909 | Md5 |
| 5 | - 912 | Pile |
| 6 | - 912 | Pile |
| 7 | - 912 | Msgs |
| 8 | - 876 | Bd5 |
| 9 | - 918 | Bd3 |
| 10 | - 992 | Pile |
| 11 | - 897 | Pile |
| 12 | - 790 | Pile |
| 13 | - 763 | Pile |
| 14 | - 754 | Md1 |
| 15 | - 679 | Pile |

## 3. Discussion

A review of annual CP survey data (shown below) indicates the majority of potential measurement readings met the acceptable criteria adopted by SOC as representing the minimum acceptable level of protection, i. e., 850 mV with respect to a saturated copper/copper sulfate [CSE] reference electrode placed near the structure. This suggests an adequate level of protection was being measured at the majority of the test point locations. However, in years 2019 through 2013, the year 2013 The test station located in the end portion (TP 49 to TP 60) is getting lower in potential measurement. It is suspected that these low potential measurements are related to anode consumption that is faster than usual. Because the LNG Jetty is connected electrically to the ACID Jetty by the catwalk,

Since there is no cathodic protection on the ACID jetty and this could be draining current from the LNG Jetty, this would account for the low potential at pile TP 56 to TP 60.

It is important to note that the interpretation of potential reading and the annual CP survey data has its limitations. For example, a potential reading measured at a test station during the annual survey represents an average reading for the area of pile immediately adjacent to the test station, and it does not necessarily represent the level of protection of the entire LNG jetty.

### 3.1 Status of Protection

The report presents the cathodic protection survey which was carried out on March 2019, in LNG Jetty. The minimum protection criteria are - 800 mV and - 850 mV with respect to Ag/AgCl and Cu/Cu SO4 Reference Electrodes for sea and landside, respectively. The protective status was adequately protected. Except at several points that showed low protection, the end portion of the LNG Jetty linked to the ACID jet

## 4. Conclusion

- Cathodic protection has successfully prevented corrosion in a variety of applications for many years.
- Continued the scheduled monitoring to determine any lake may recorded.
- Cathodic protection is recognized by rehabilitation technique that has proven to stop corrosion under seawater structures.
- The performance of the sacrificial anode system has been satisfactory. This has resulted in monitoring dates
- The aluminum anode provided stable operation and protection for the LNG Jetty.
- The anode's performance began to worsen after 10 years of operation, as noted by the decrease in potential readings. Our researcher reported performance fluctuations in the existing system.
- Remote monitoring of cathodic protection systems is a convenient method of data collection.
- compatibility with the CP systems of other items in the field;
- Galvanic anodes (other than magnesium) do not disband coatings and do not require dielectric shield installation.

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