conarina

TECHNICAL CIRCULAR No. 327 of 05TH March 2016

To:	All Surveyors/Auditors
Applicable to flag:	All Flags
Subject:	**Cathodic Protection and Anode Backfills**
Reference:	**Corrosion**

Cathodic Protection and Anode Backfills

Anode backfills are an important component of Cathodic Protection (CP) that need to be evaluated on a case-by-case basis.

Cathodic protection, a technique to prevent corrosion, was employed before the science of electrochemistry had been developed. History tells us that this method was used in 1824 by Humphrey Davy to protect British naval ships. At first, it was primarily used to protect ordinary steel structures in soil and seawater, but now this technique is used for the protection of buried pipelines, bridges, ships, offshore platforms, the steel inside concrete structure and numerous other applications. Cathodic protection is generally applied alongside with coatings to protect the structure on holidays and damaged areas of coating.

The Key Principles of Cathodic Protection

The corrosion process occurs as a result of electrochemical reactions. It has four requisites:

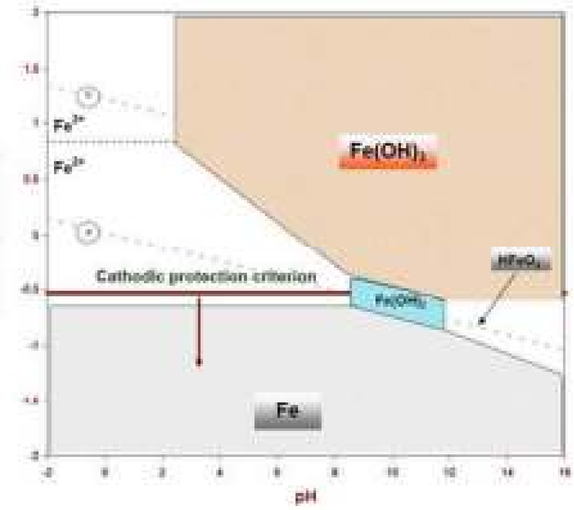
- Cathode
- Anode
- Electrolyte
- Path for the current flow

If we can eliminate any one of its requisites, we can prevent corrosion. The principle of cathodic protection is to provide external current to the material, which forces the electrode potential down into the region of immunity.

Customer Service Center
5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:
joel@conarinagroup.com

Technical Head Office
7111 Dekadine Ct.
Spring, Tx., 77379
Tel: 1 (832) 451 0185,
1 (713) 204 6380
E-Mail: cbozenovici@vcmaritime.com

Cathodic protection is achieved by supplying electrons to the structure to be protected, which in turn suppresses the dissolution of the metal, hence decreasing the rate of corrosion.



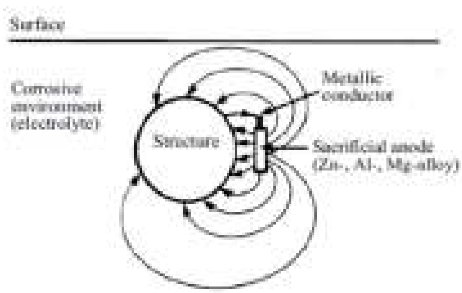
E-pH diagram of Fe

Types of Cathodic Protection

On the basis of supplying electrons to a structure, there are two types of cathodic protection:

1. Sacrificial Anode Cathodic Protection (SACP)

- A less noble material that acts as a sacrificial anode is connected by metallic conductors to the structure to be protected.
- The materials used for this purpose are magnesium, aluminum and zinc. They provide electrons to the structure to be protected and get consumed.

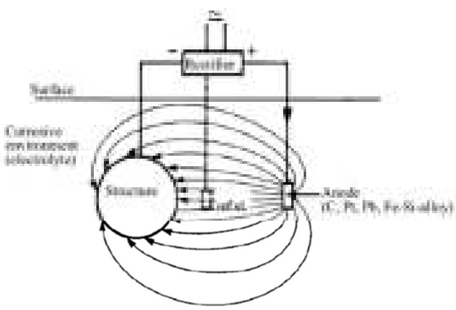


Customer Service Center
5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:
joel@conarinagroup.com

Technical Head Office
7111 Dekadine Ct.
Spring, Tx., 77379
Tel: 1 (832) 451 0185,
1 (713) 204 6380
E-Mail: cbozenovici@vcmaritime.com

2. Impressed Current Cathodic Protection (ICCP)

- An external current source and rectifier is used. The reference electrode might be used to control the rectifier potentiostatically.
- The anodes might be consumable, such as cast iron, iron and steel. Non-consumable anodes include platinized tantalum and niobium, and platinized titanium.
- A number of anodes might be used, which are electrically connected to each other and form an anode bed. This anode bed is buried in specific backfills to reduce the resistance of the soil.



In ICCP, the anode that is mounted to protect the structure is separated and surrounded by an insulating shield, whereas in SACP the sacrificial anode has an electrical connection with the structure to be protected.

The shield in ICCP protects the adjacent metal from large current densities in the vicinity of the anode. The anode bed is far from the structure to be protected. For example, in the case of offshore platforms, the anode bed is generally 100 meters away.

Both SACP and ICCP have different advantages over each other. The selection of which method to use depends on the application, efficiency, operational requirements and cost-analysis of a specific project. The table below shows the properties of both methods and anode materials, and compares sacrificial and impressed current anodes for cathodic protection.

Customer Service Center
5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:
joel@conarinagroup.com

Technical Head Office
7111 Dekadine Ct.
Spring, Tx., 77379
Tel: 1 (832) 451 0185,
1 (713) 204 6380
E-Mail: cbozenovici@vcmaritime.com

Comparisons of sacrificial and impressed-current anodes for CP:

	Sacrificial anodes		
	Magnesium	Zinc	Aluminum-tin
Theoretical consumption, lb/ampere-year	9	23	6.5
Actual consumption, lb/ampere-year	18	25	10–20
Potential vs. $Cu/CuSO_4$	−1.7	−1.15	−1.3

Impressed-current anodes		
Material	Typical applications	Typical loss, lb/ampere-year
Scrap steel	Soil, fresh- and seawater	20
Aluminum	Soil, fresh- and seawater	10–12
Graphite	Soil and fresh water	0.25–2.0
High-silicon iron and Si-Cr iron	Soil, fresh water, and seawater	0.25–1.0
Lead	Seawater	0.1–0.25
Platinized titanium	Seawater	nil

Anode Backfilling

The anode used for cathodic protection is not in direct contact with the soil in which it is buried. The reason is that the soil contains many minerals and other chemicals that might affect the anode and therefore decrease its effectiveness. One of the harmful effects that might be caused by minerals is the buildup of high-resistance films on the surface of the anode, thus hampering its conductivity.

In addition, we want the anode to get uniformly consumed and give its maximum efficiency. That's why special backfills are used depending on the particular environment, application and the anode's material. The prime purpose of using the backfill is to reduce electrical resistivity. This provides a lower anode-to-earth resistance and greater current outputs in cases where the surrounding soil is of high resistivity.

Some common backfill materials include:

- Coal coke breeze
- Petroleum coke breeze
- Betonite clay
- Gypsum
- Sodium sulfate

Based on these materials, anode backfills can be classified into two types:

1. Chemical Backfill

This type of backfill is generally used in the case of SACP. A typical mixture in the case of soil with high resistivity consists of 75% powdered and hydrated gypsum (calcium sulfate), 20%

Customer Service Center
5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:
joel@conarinagroup.com

Technical Head Office
7111 Dekadine Ct.
Spring, Tx., 77379
Tel: 1 (832) 451 0185,
1 (713) 204 6380
E-Mail: cbozenovici@vcmaritime.com

betonite clay and 5% sodium sulfate. Betonite absorbs water, expands and makes good contact between the soil and anode, reducing groundbed resistance.

In cases in which soil has low moisture content, 75% betonite and 25% gypsum is used. A mixture of 50% molding plaster and 50% betonite clay works well with the zinc anodes.

2. Carbonaceous Backfill
In ICCP, anodes are surrounded by carbonaceous backfill. The materials include coke breeze, natural graphite and calcined petroleum coke. The purpose of carbonaceous backfill is to reduce the groundbed resistance and surface for the oxidation reaction. This prolongs the life of the anode.

Tamping the backfill around the anode ensures good electrical contact between the anode and ground.

Cathodic protection and its types are very significant in the field of corrosion. Although its principles are easy to understand, designing CP for a system needs detailed and careful calculations and good practices for their implementation. For example, a structure that is protected using CP might be the reason for the stray current corrosion of another component in its vicinity. Overprotection has other disadvantages like hydrogen embrittlement. The anode's materials selection, the number of anodes required, the wastage rate, throwing power, efficiency and using particular backfills requires knowledge and experience.

REFERENCES:

- **Corrosion**

ATTACHMENTS: No.

Kindest Regards,
Cosmin Bozenovici
Naval Architect – Conarina Technical Head Office

Customer Service Center
5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:
joel@conarinagroup.com

Technical Head Office
7111 Dekadine Ct.
Spring, Tx., 77379
Tel: 1 (832) 451 0185,
1 (713) 204 6380
E-Mail: cbozenovici@vcmaritime.com