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Cathodic Protection (CP) is a technique to control the corrosion of a metal surface by making that surface the cathode of an electrochemical cell. In practical terms, CP is a method used to protect metal structures from corrosion. Cathodic protection systems are most commonly used to protect steel water and fuel pipelines and tanks, steel pier piles, ships, and offshore oil platforms.

Impressed Current cathodic Protection (ICCP)

For large structures and extenuating circumstances, galvanic anodes, usually made from zinc, aluminium or magnesium, cannot economically deliver enough current to provide complete protection. ICCP systems use anodes connected to a direct current power source (AC powered rectifier). Anodes for ICCP systems are usually tubular or solid rod shapes of various specialized materials, including, but not limited to: high silicon cast iron, graphite, mixed metal oxides, and platinum and niobium coated wires.

A typical ICCP system for a pipeline would include an AC powered DC rectifier with a maximum rated DC output of between 10 and 50 amperes and 50 volts. The positive DC output terminal is connected by (positive) cables rated for the conditions of burial, to an array of anodes buried in the ground (the anode groundbed). Some groundbeds are near the surface, whereas others may be in deeply drilled wells. A typical deep well might be 250 mm (10 inch) diameter by 100m (330 feet) deep, backfilled with conductive graphite fines (coke breeze). The primary purpose of the backfill is to reduce the electrical resistance to earth, and to prevent the hole from collapsing. Electric cable rated for the expected current output connects the negative terminal of the rectifier to the pipeline. Current output from the rectifier is adjusted by a CP specialist, after various potential measurements are made. Often CP specialists are part of a larger organization dealing in Design, Material Supply, Contracting and Monitoring of Cathodic Protection. Leading CP Houses can be located by referring to [NACE](#) Corrosion Engineering Directory in [Materials Performance](#) magazine.

Historical and Technical Background

The first use of CP was in 1824, when Sir Humphry Davy, of the British Navy, attached chunks of iron to the external, below water line, hull of a copper clad ship. Iron has a stronger tendency to corrode than copper and when iron was connected to the hull, the corrosion rate of the copper was dramatically reduced.

Today, galvanic or sacrificial anodes are made in various shapes using alloys of zinc, magnesium and aluminium. The electrochemical potential, current capacity, and consumption rate of these alloys is superior to iron for CP.

Galvanic anodes are designed and selected to have a more "active" voltage (technically a more negative electrochemical potential) than the metal of the structure (typically steel). When galvanic anodes are connected to steel structures, by (a) an insulated "negative" wire, and (b) through earth or water (electrolyte) surrounding the structure, the potential of the steel surface becomes polarized (negatively) relative to the earth or water. For effective CP, the potential of the steel surface must be polarized negatively until it has achieved a sufficient and uniform potential; at which stage the driving force for corrosion reactions is halted. The polarization is caused by the current flow from the anode to the cathode. The driving force for the CP current flow is the difference in electrochemical potential between the anode and the cathode.

With the passage of time and current, the anode is consumed. According to Faraday's Law of Electrolysis: The mass of a substance involved in reaction at the electrodes is directly proportional to the quantity of electricity passed through the solution. In actuality, in the practical world of cathodic protection, the consumption rate of an anode material (mass per ampere-year) varies between materials according to their chemistry, their metallurgical structure and their environment. For this reason, published consumption rates for anodes should be interpreted as representative, not absolute.

Electrochemical potential is measured with reference electrodes (usually copper copper-sulphate for structures in soil or fresh water).

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