MGDUFF

Impressed Current Cathodic Protection

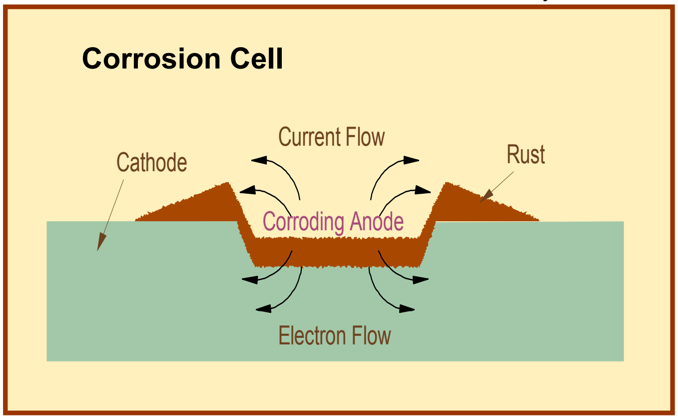
Automatic Systems for Ships Hulls

The Corrosion Process

Corrosion is a spontaneous electrochemical process in which a metal reacts with its environment to form an oxide or other compound, the commonest example being the pitting and rusting of steel. This undesirable process is initiated by the formation of a corrosion cell which has three essential components: an anode and a cathode coupled in an electrically conductive solution (electrolyte).

Corrosion Cell

Corrosion always develops at the anode, where current leaves the metal and enters the electrolyte, whilst a protective effect occurs at the cathode. Thus if the whole metal surface is made sufficiently cathodic, corrosion will not occur. This is the basic principle of Cathodic Protection.
In marine structures, such corrosion cells may result from the use of dissimilar metals. Usually, however, localised anodic and cathodic areas arise on the surface of the same metal through differences in the metal itself, variations in protective films or changes in the electrolyte. ie: aeration, temperature and salinity.



Corrosion may be prevented by removing one or more of these corrosive elements and for marine structures, the most practicable method is to apply a protective coating, thus introducing an electrical resistance between the metal and the electrolyte. Paint in various forms normally provides the first level of protection. However, even the most efficient coatings are subject to defects during application or service, with inevitable corrosion of the exposed metal.

It is therefore generally accepted that cathodic protection, in conjunction with a high performance paint system provides the most effective and economic safeguard against corrosion.

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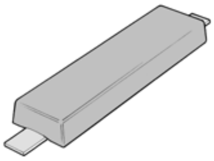
MG Duff International Ltd. 1 Timberlaine Estate, Gravel Lane, Quarry Lane, Chichester, West Sussex. PO19 8PP

Tel: 00 44 [0] 1243 533336 Fax: 00 44 [0] 1243 533422 Email: sales@mgduff.co.uk

Cathodic Protection

A technique for preventing corrosion which is the most important of all methods used to control corrosion of marine structures, including ships' hulls. The essential factor in cathodic protection is to ensure that the unwanted anodic reactions are suppressed by the application of an opposing current.
This opposing current can be achieved by either of two techniques:

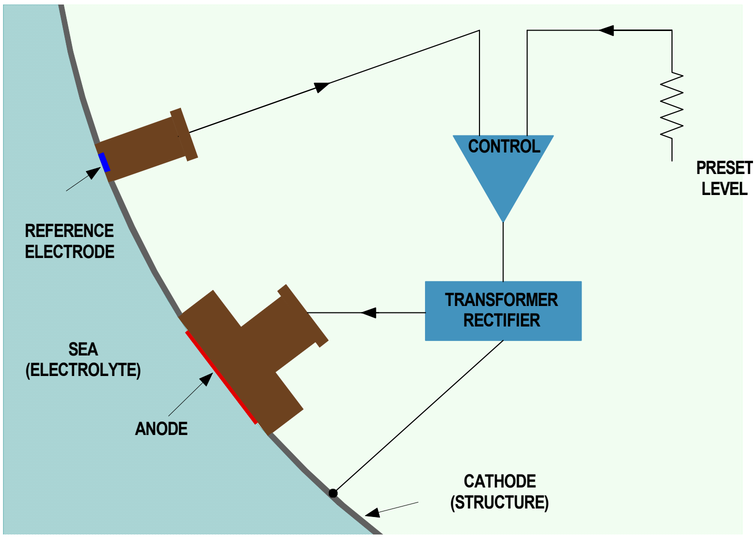


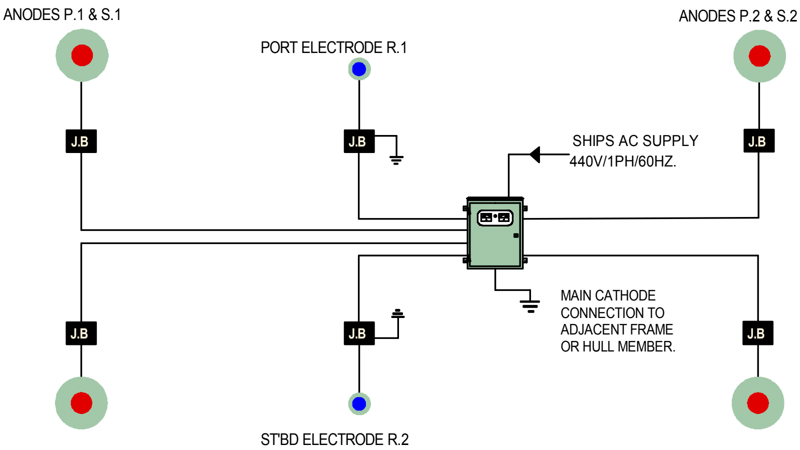
1. Sacrificial Anodes - By corroding away a more reactive (base) metal.

Anodes based on alloys of Zinc, Aluminium and occasionally Magnesium, are attached to the structure and corrode in preference to the protected metal. Consequently these anodes require renewal at routine intervals.

2. Impressed Current - A protective current is impressed on the structure through semi-inert anodes.

The **M G Duff** system converts the ship's a.c. supply into a controlled low voltage d.c. output, which is then delivered onto the metal surface by long life anodes attached to, but insulated from the hull structure. Various factors affect the amount of current required, therefore to ensure the correct level of protection is accurately controlled it is necessary to measure the potential of the steel against a known and reliable reference cell.
This potential is monitored by reference electrodes mounted on the underwater hull surface. The number of electrodes and their locations is carefully selected in conjunction with the anode configuration and hull geometry. Solid state circuitry within an automatic control unit compares the reference potential against a desired and pre-set optimum. Any difference between these will induce a resultant error signal, which is electronically conditioned to provide suitable regulation of the d.c. power supply to the anodes.





***MG Duff** Impressed Current Cathodic Protection systems are also available for protection of piled jetties, dolphins, sheet piling and similar harbour or offshore structures.*

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Automatic Power/Control Units

A comprehensive range of high specification units are available as wall mounted models or floor standing arrangements for large capacity systems.

The whole range features rugged, sheet steel enclosures with double door protection as standard.

Designed for ease of installation, these compact, functional units are fully rated for ambient/operating temperatures between 0-50 C and accept standard a.c. inputs; 380/440 volt; Single or three phase, 50/60Hz

Standard Features:

☑ Protection to IP.42
☑ Output ripple: 5% max
☑ Input circuit breaker: Magnetic trip & Thermal overload
☑ Fully automatic control with Manual override facility
☑ Automatic Reference Electrode Selection
☑ Automatic Current Limiting
☑ Reference Signal Buffering
☑ Calibration Feasibility
☑ Unit Spares Kit

Design Options:

☑ Alarm condition detector
☑ Shaft bonding condition meter
☑ R.F. Suppression (meets VDE.0875 Level 'K' & BS.800)
☑ Remote monitoring and alarm facilities

Underwater Components

The whole range of **M G Duff** anodes and electrodes is manufactured to high performance and low maintenance specifications. Innovative design combines proved cathodic protection materials with advanced plastics technology. High strength uPVC encapsulations resist chemical attack and take advantage of superior insulation characteristics to replace outmoded GRP based systems.
Watertight integrity at anode and electrode penetrations is maintained by heavy grade steel housings and cofferdams. Lighter grade assemblies are available for light hull vessels.

Anodes

A wide range of capacities and types achieves a high degree of flexibility.
Manufactured with active elements of Lead Silver alloy with platinised bi-electrodes or Mixed Metal Oxide on a titanium substrate, the whole range anticipates a normal service life in excess of 10 years.
To ensure effective current distribution and avoid coating damage adjacent to the anodes, all **M G Duff** anodes are complemented by a durable primary di-electric shield. This shield comprises a trowelled on mastic which completely eliminates the complicated and time consuming brackets and frames required for installation of pre-formed GRP shields.

Reference Electrodes

These flush mounted sensors are manufactured from high purity zinc alloy to provide a robust, non passivating reference source, with the distinct advantage of reliability under the variable conditions encountered in marine environments.

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Bonding Systems

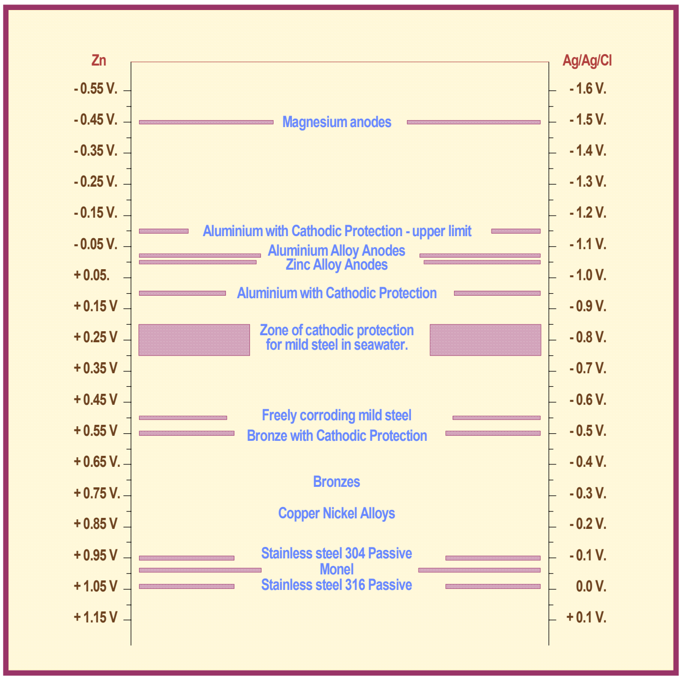
M G Duff Shaft Earthing Systems meet the requirements of BS Code of Practice CP.1021 as well as major engine manufacturers recommendations. High efficiency silver tracked Sliprings and silver graphite brushes effectively extend cathodic protection to exposed propeller and shaft surfaces whist at the same time reducing spark erosion damage to shaft bearings. (A more economic, but less efficient copper based version is available).

The effectiveness of the shaft bonding may be monitored by an optional Shaft Condition Monitor.

Rudder and stabiliser bonding cables are provided as standard

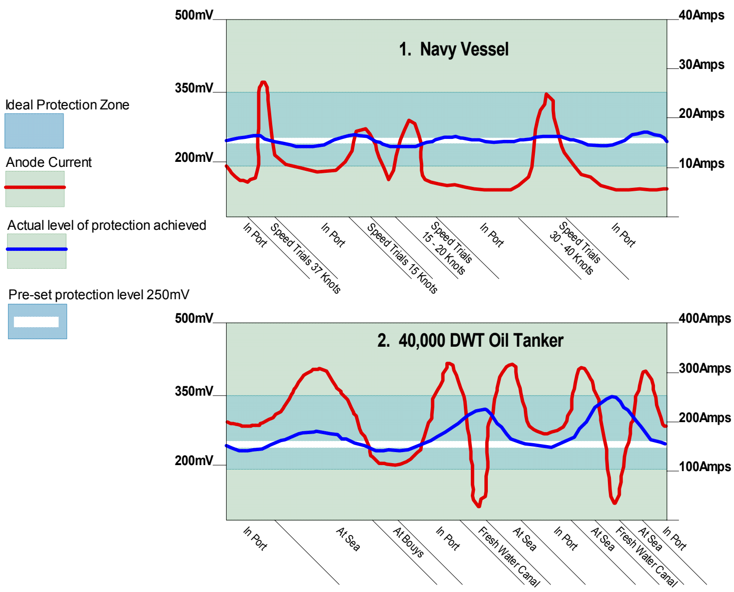
System Control and Performance

All metals immersed in an electrolyte have a potential relative to the electrolyte and the reference half cell (electrode). The table lists the natural potentials in a sea water electrolyte of the various metals used in ship construction, relative to both a silver/silver chloride (Ag/AgCl) reference electrode, which is used for test purposes by corrosion engineers, or a zinc reference electrode used as part of an impressed current system.



The installation of a cathodic protection system, whether by means of sacrificial anodes or an impressed current system, alters the potential of the protected metals. It is this change in potential which can be detected by the reference electrode (sensing electrode) which allows an impressed current system to be automatically controlled. Much work has been done by many authorities on determining the correct potential required for complete protection from corrosion. Based on this information and our own experience, we have produced the Potential Table, from which it can be seen that freely corroding steel displays a natural potential of +0.45 to +0.55 volts, with respect to a zinc reference electrode. However, the application of cathodic protection will depress this potential into the range +.0.30 to +0.20 volts when all corrosion is suppressed.

The **M G Duff** Automatic Impressed Current System of cathodic protection is supplied with zinc reference electrodes which monitor the potential of the steel hull and adjust the automatic controller to maintain the hull at the correct pre-set protected potential. This is indicated on the Performance Graphs which show two examples of automatic controls.



(1) Navy Vessel. Wide variation in anode current output (5-28 amps) as vessel's speed alters, but only slight variation of potential. Well within the protective zone.

(2) Tanker. Again wide variation in anode current output
(0-300 amps) as vessel goes to sea or returns to port. Variation of potential is greater than with the navy vessel due to the vessel entering a fresh water river, when the system is virtually shut off automatically by the high resistivity of the fresh water electrolyte.

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