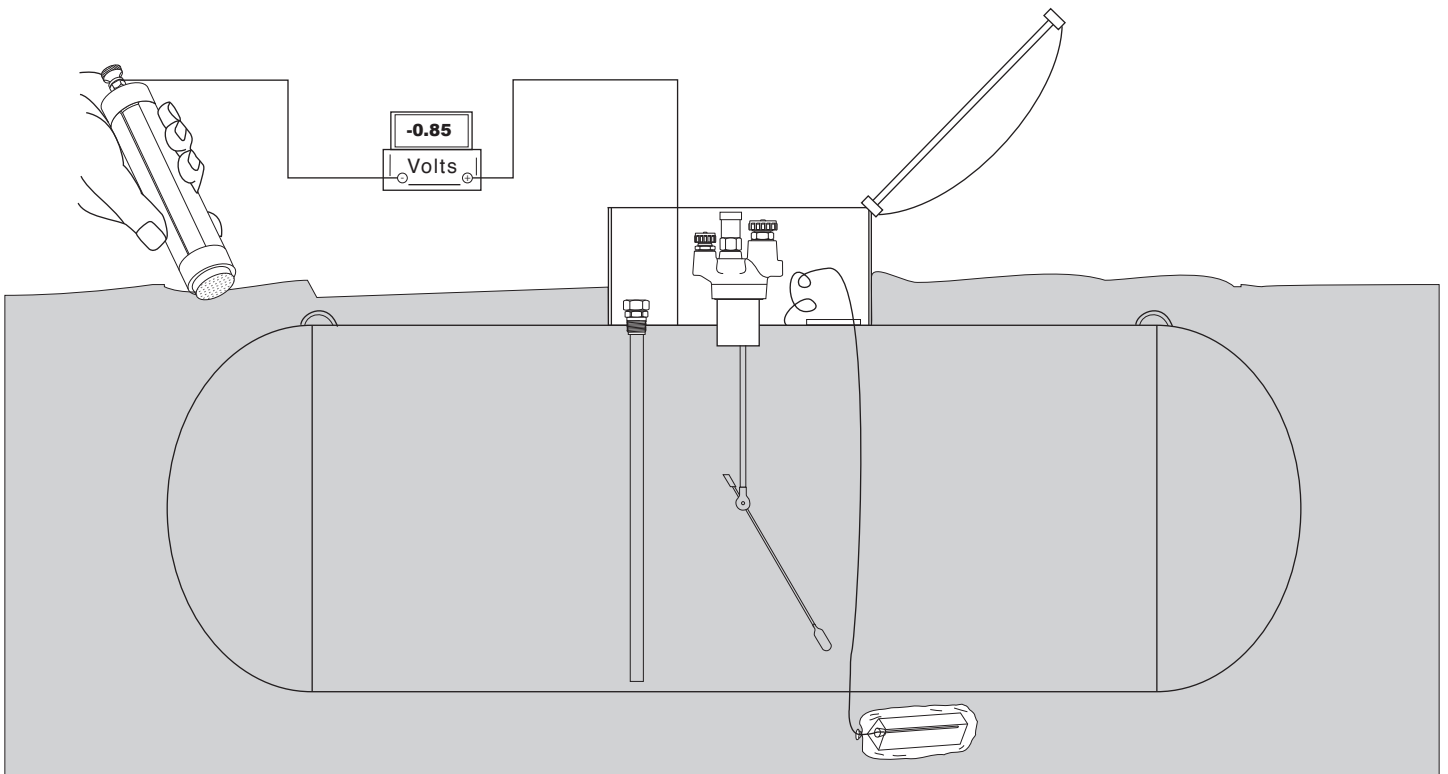


Cathodic Protection



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STEEL CORROSION

In its natural state iron ore is very stable. In the process of making steel, iron is transformed to an unstable state. Corrosion of steel is the process of iron returning back to its natural stable state with loss of bound iron on the exposed surface of the refined steel. The energy added to the steel during the refining process is the driving force in creating the corrosion. The iron ions will readily give up this excess energy to any material with a lower potential energy and the process will deteriorate the beneficial properties of the steel. Steel exposed to the oxygen contained in water will rust (iron becomes ferric oxide). The difference in potential between copper and steel will cause steel to corrode if they are connected.

The connection between the steel and the lower potential material is quite often indirect. It is made through a solution that is capable of carrying an electric current from the higher potential area to the lower potential area. Underground steel pipes and tanks connect to other materials through the solution of the moist earth. If the electrical path through the solution is not very resistive, current flow will be high and corrosion of the steel will be rapid. One ampere of direct current flow removes approximately twenty pounds of steel in one year.

STEEL PROTECTION

The two practical methods used in the protection of underground steel are coating and cathodic protection.

Coating the bare steel interrupts the electrical path of the current carrying ions. If the steel could be completely isolated, no corrosion current would flow. However, no coating can be considered a perfect coating. Handling, installation, thermal stresses and soil stresses will eventually create defects that exposes the underlying steel to the environment.

Cathodic protection involves applying an electrical current to the steel surface from an external source. By forcing the steel surface to accept current from the environment, the bound iron in the steel cannot give up its excess energy and corrosion cannot take place.

CATHODIC PROTECTION

Cathodic protection of underground steel is most often accomplished by direct wire attachment of a magnesium anode to the steel structure. Magnesium is very reactive in relation to other metals and readily gives up its ions to the environment. The resultant electrical current through the attachment wire to the steel structure protects the steel from corrosion. The bound iron in the steel cannot give up its excess energy and corrosion cannot take place.

It is important to realize that the magnesium anode is being consumed while protecting the steel structure. The structure should be electrically isolated from any ancillary piping. The anode will try to protect any attached metal which could adversely shorten its effective life. In all cases the protection system needs to be monitored regularly to ensure the steel structure is still being protected.

PROTECTION MONITORING

Determining the effectiveness of a cathodic protection system is accomplished by measurement of the voltage difference between the protected steel (meaning the anode is in place and connected) and a copper-copper sulfate electrode placed near the structure. A base potential of -0.850 volts is considered neutral. If the measurement is more negative than -0.850 volts, then the structure is considered protected. If the measurement is more positive than -0.850 volts, the structure is unprotected.

UNPROTECTED STEEL

The steel underground storage tank in Fig 1 is buried in a soil environment that contains an excess amount of negative ions. The soil is moist allowing these negative charges to migrate into the vicinity of the steel tank.

The iron (Fe) contained in the steel, which is relatively positive, "feels" the attraction of the negative charges and begins to combine with them. Left unchecked, the process will deteriorate the beneficial properties of the steel.

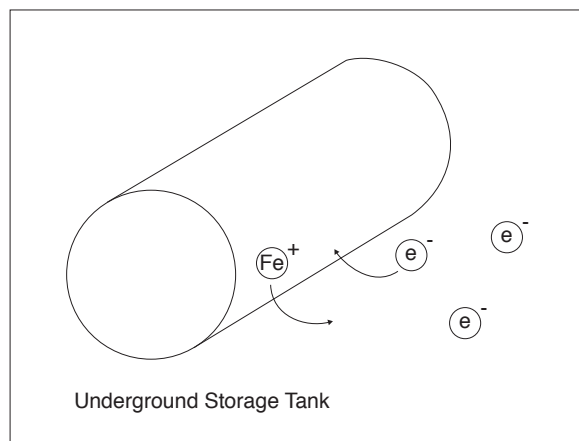


Fig 1

The conditions that allow the corrosion process to occur can be created by a number of different environmental factors. Trace amounts of reactive elements in the soil, stray currents from a variety of sources, or simply the presence of oxygen contained in the water will all create an environment contributing to corrosion of the steel structure.

Elimination of all these factors in the soil is virtually impossible. Protective coating of the steel goes a long way toward isolating the steel from the process. But any coating, no matter how carefully installed or handled, will eventually develop defects that will allow corrosion to occur.

CATHODICALLY PROTECTED STEEL

The steel underground storage tank in Fig 2 is buried in the same soil environment as in the first example. A magnesium anode, shown oversized for clarity, is attached to the tank. The magnesium is much more reactive than the iron in the storage tank. The magnesium (Mg), which is relatively positive, "feels" the attraction of the negative charges and begins to combine with them. As the positive magnesium leaves the anode, an electrical current flows in the attached wire to the tank creating an excess of negative charge on the steel. The tank no longer has an attraction for the negative ions in the soil thus "hiding" the iron from corrosive effects.

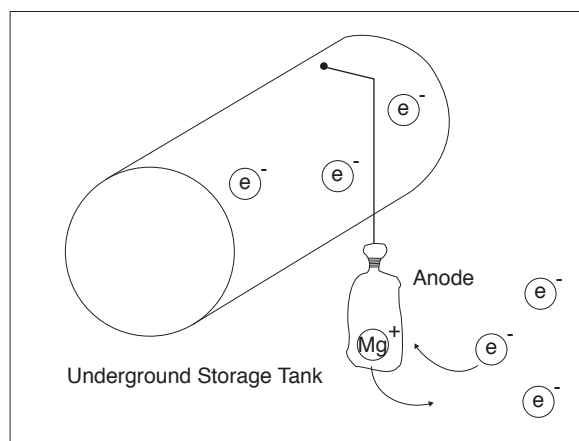


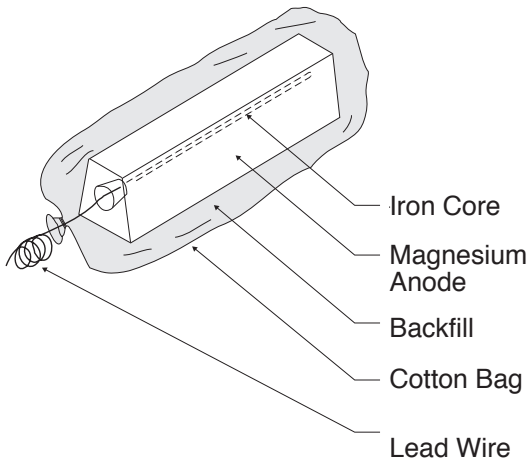
Fig 2

This example is called Sacrificial Cathodic Protection. The magnesium in the anode is sacrificed to protect the steel of the storage tank. The protection is sustained as long as enough magnesium remains to charge the steel tank.

The amount of current flow and the rate of magnesium loss from the anode will depend on the size of the structure being protected, the size of the anode and the electrical nature of the soil. Periodic testing is required to determine whether the protection system is still working.

An ample sized anode or multiple anodes must be employed to ensure an adequate service life. A properly designed system will give a service life of 10 to 20 years.

ANATOMY OF THE ANODE



PART NO	MAGNESIUM WEIGHT	SHIPPING WEIGHT
TG-1	17 lbs	42 lbs

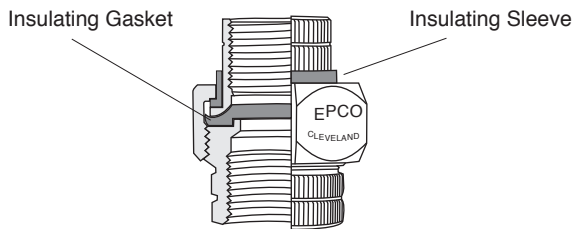
The TG-1 anode will produce between 1.4v to 1.5v potential in most environments. Higher potential anodes are available for very reactive soils.

Service life will vary with the resistivity of the environment and the surface area protected. On an average installation the 17# size has a median life of ten years.

ELECTRICAL ISOLATION COMPONENTS

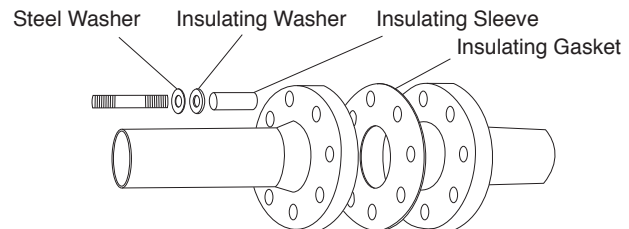
DIELECTRIC UNIONS

1/2" - 2" Pipe Sizes



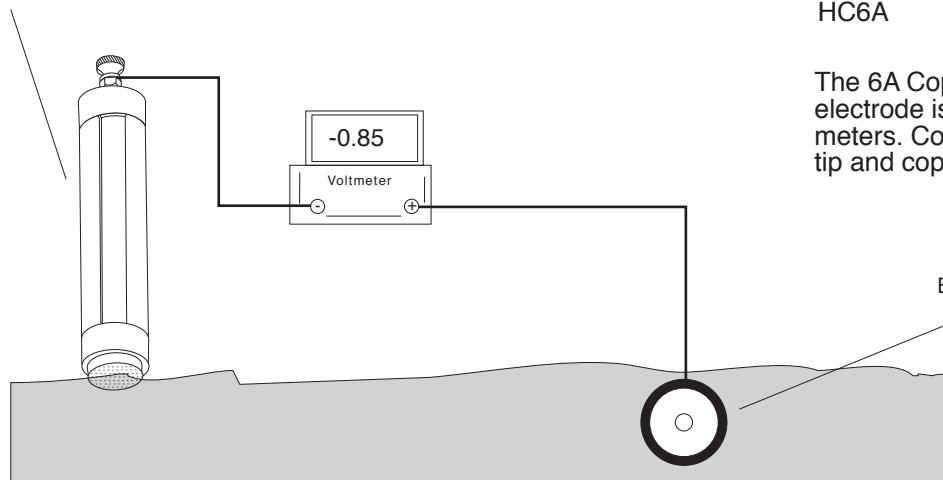
FLANGE INSULATION KITS

1 1/2" - 12" Flange Sizes



COPPER - COPPER SULFATE REFERENCE ELECTRODE

Reference Electrode



PART NO	SIZE	WEIGHT
HC6A	1 1/4" X 6"	69Z

The 6A Copper - Copper Sulfate reference electrode is readily fitted to popular millivolt meters. Comes with pre-saturated ceramic tip and copper sulfate crystals.