GERNER ENERGY

MESA™
Quality Focused, *Service Driven.*
CATHODIC PROTECTION & INTEGRITY SOLUTIONS

Why Tanks Corrode

Underground steel tanks corrode due to an electrochemical reaction between the tank and the surrounding soil. The process of corrosion occurs due to small voltage differences on the steel surface that result in the flow of DC current from one location to another. Where current flows from the tank into the soil corrosion occurs. This location is called the anode in a corrosion circuit. Where current flows from the soil to the tank, no corrosion occurs. The progress of corrosion is determined by the amount of current flowing between the anode and the cathode and whether the locations of the anode/cathode remain constant over time. Corrosion rates are generally higher in wet soil environments since the conductivity of the soil promotes the flow of DC current in the corrosion circuit.

Corrosion generally exhibits itself on underground tanks in either a general overall rusting or more commonly, a pitting attack. Pit locations may result from metallurgical conditions of the steel suraface or soil variations such as rocks, salts, fertilizer, moisture concentration, oxygen concentration, etc.
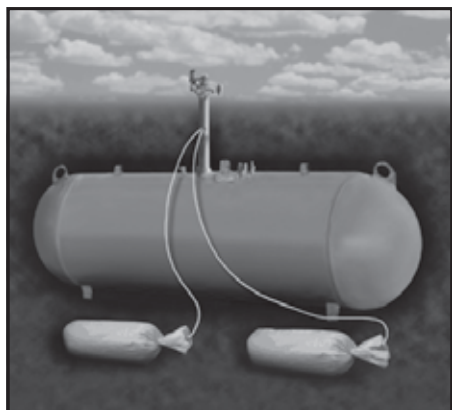
Preventing Corrosion

Protecting underground tanks from corrosion is easily achieved by the use of two commonly applied protection methods: external coating and cathodic protection. These two methods are complementary and should be used in conjunction with the other. An effective external protective coating insulates the steel from the soil environment, thus preventing the flow of corrosion current from the anode to the cathode. An effective external coating can protect over 99% of the tank surface area. However, no coating is perfect. Damage from construction or soil stresses create tiny defects, which may result in accelerated corrosion at the defect.

Cathodic protection prevents corrosion at those defects by applying DC current from an external source, forcing the tank to become cathode. Application of sufficient DC current to the tank will prevent any corrosion from occurring. The two general types of cathodic protection systems are sacrificial and impressed current. Sacrificial systems are used when the amount of current required for the protection is small, such as in underground propane tanks. Impressed current systems are more commonly used for large structures such as large diameter pipelines. Electrical isolation of the tank from metallic piping systems and electrical grounds is critical for the cathodic protection system's effectiveness.

How Sacrificial Cathodic Protection Works

Sacrificial systems work by creating a galvanic connection between two different metals. The most common anode material is magnesium, which when coupled to steel results in DC current flow from the magnesium to the steel. The open circuit potential of steel is about -0.50 volts referenced to a copper sulfate electrode. The open circuit potential of magnesium is about -1.55V to -1.80V. By connecting the two metals together, the difference of 1 to 1.25V volts results in current flow to the tank that overcomes the natural corrosion cells that exist on the tank. With this current available to the tank, no corrosion occurs.

Magnesium Anodes

There are a variety of anode sizes and alloys used for cathodic protection. The two primary alloys are designed as H-1 (or AZ63) and High Potential. The H-1 alloy is produced from recycled magnesium and has an open circuit potential of approximately – 1.55V. This alloy is well suited for protection of underground propane tanks. The High Potential alloy is 99% pure magnesium having an open circuit potential up to -1.8V. This alloy should be used for soil applications over 10,000 ohm-cm resistivity.

The two most common anode sizes used for underground propane tanks are 9 lb. and 17lb. The size designation relates to the metal weight. 10' of #12 TW insulated wire is attached to the anodes. Anodes are then backfilled in a mixture of gypsum, bentonite, and sodium sulfate to lower the electrical resistance of the anode to soil. The mixture is a low cost, nonhazardous, electrically conductive backfill. The anode and backfill is then packaged in a cotton bag and either a cardboard box or paper bag. Actual shipping weight of these anodes with backfill is 27 lb. and 45 lb.

Application Recommendations

Magnesium anodes can protect underground tanks in most soil conditions. The H-1 alloy is generally very effective. The following chart provides size and quantity recommendations for various size tanks based on conservative design assumptions. This chart covers soil conditions up to 10,000 ohm-centimeter resistivity. Resistivities higher than 10,000 ohm-centimeter generally represent very dry soils. Verification of soil resistivity can be performed through soil analysis. Contact us for design recommendations in locations where soil resistivities exceed 10,000 ohm-cm, or if there is no effective external coating on the tank.

The propane service line from the tank to the house also must be considered in the cathodic protection design, unless the service line is plastic. All underground steel pipe should be externally coated with a corrosion resistant material. The service line should be electrically isolated at the house with an insulating fitting or union. If service pipe is less than 50' in length, the tank anodes will provide sufficient current to protect both tank and pipe. For longer lengths of pipe, an additional anode may be required at the house connections.

If another metallic material such as copper is used for service piping, the pipe should be electrically isolated from the tank at the fill pipe connection. Copper and steel create a galvanic couple that will accelerate corrosion of the steel tank when directly connected to copper piping. Generally, copper piping does not require cathodic protection.

Soil Type	Fertile Soils, Clay, Sandy Loam			Sand, Gravel, Rocky Areas		
Tank Cap. (gal.)	5 to 5000 ohm-cm			5000 to 10000 ohm-cm		
	Size	Qty.	Alloy	Size	Qty.	Alloy
120	9#	1	H-1	9#	1	H-1
150	9#	1	H-1	9#	1	H-1
250	9#	1	H-1	9#	2	H-1
325	9#	1	H-1	9#	2	H-1
500	17#	1	H-1	9#	2	H-1
1000	17#	2	H-1	9#	4	H-1
1500	17#	2	H-1	9#	4	H-1
2000	17#	3	H-1	9#	6	H-1

*Based on 90% effective external coating, 2 ma/ft2 current density, and 30-year Anode life.

Anode Installation
1. Determine size and quantity of anodes from application chart.
2. When a single anode is installed, it should be located near the tank center on either side of tank.
3. When multiple anodes are installed, space them evenly around the tank. See examples below.
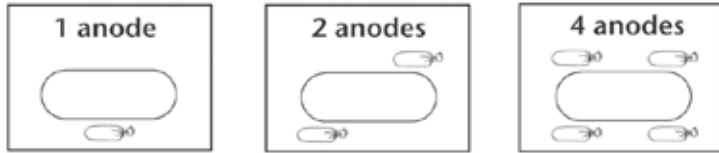
4. Anodes are shipped in either cardboard boxes or multi-wall paper sacks. Remove outer container and bury the cloth bagged anode. If anode is supplied in plastic bag, remove plastic bag before installing.
5. Install anodes approximately two to three feet from the tank and at least as deep as the center line of the tank. Anodes work best in locations with permanent moisture, so generally the deeper the better.
6. After placing the anode, stretch out the anode connection wire and extend over to a connection point on the tank fill pipe.
7. Cover the anode with approximately six inches of backfill and pour 5 gallons of water on the anode to saturate the prepared backfill. Water is necessary to activate the anode.
8. Connect the anode wire to the tank with a low electrical resistance connection. Examples are threaded stud on the tank fill pipe or any accessible metallic connection point to the tank. All connections should be coated with a moisture-proof material.
9. Ideally, the tank connection is made in the area of the tank fill pipe within the covered dome. With access to the anode wire, subsequent testing of the tank can include measurement of anode output and verification of performance.
10. Verify performance of the anode using an appropriate test procedure.

Mechanical Connection Under Dome
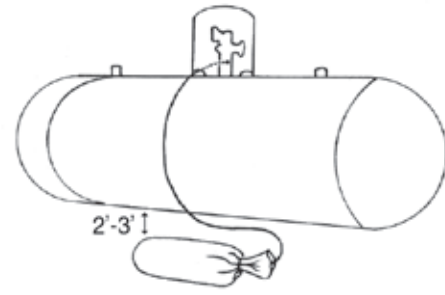
Cathodic Protection Testing Procedure

Equipment Needed Digital Voltmeter, Red Test Lead Min. 12' Long & Black Lead Min. 2' Long, Reference Electrode (Copper/Copper Sulphate Half-Cell)

STEP 1: Using a digital voltmeter insert the red test lead into the Volt jack of the meter and select the 2 or 20 volt DC scale. Clip red test lead connector to an uncoated metallic area of the tank, preferably to the fill pipe multivalve. A good solid connection is very important. (DO NOT connect to shroud).
STEP 2: Insert the black test lead into the Common jack on the meter, and connect the opposite end of the lead to a charged reference electrode (½ cell).
STEP 3: Remove protective cap from the porous plug at bottom end of electrode. Place porous plug end into native soil (remove grass if necessary) at four locations around the tank (one on each side of the tank, and one at each end of the tank). If difficulty is encountered obtaining readings, moisten soil with water or dig ½ cell deeper into the soil.
STEP 4: Record all four meter readings on an appropriate form. The least of all four readings should be a minimum of -0.850v or more negative. {Note: If any of the four readings are below (less negative) -0.850v then the tank is not fully protected}.

Charging Reference Electrode

STEP 1: Unscrew and remove porous plug end of new reference electrode. Add deionized or distilled water to the copper sulfate crystals, filling electrode completely. The solution will turn blue in color and there should always be excess crystals at the bottom of the tube. DO NOT USE TAP WATER.
STEP 2: Replace porous plug end of electrode and place in an upright position so that the porous plug end is facing in the down position and let stand for 1 hour before use. This will allow the porous plug to become completely saturated before use.
Caution: Do not allow electrode to contact oil, road salts, or other substances that may contaminate the solution by absorption through porous plug. Do not allow electrode to freeze.