Cathodic Protection Of Oil Lease Equipment

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Corrosion of steel in contact with the earth or brine results from the creation of anodic and cathodic areas by reason of differences in the electrolyte and/or differences in the surface of the metal caused in manufacture or fabrication.

In the anodic areas current leaves the surface of the structure and enters the electrolyte causing loss of metal or pitting action. In the cathodic areas current flows from the electrolyte onto the surface of the structure and no corrosion occurs.

The principal of cathodic protection is based on forcing direct current to flow from the electrolyte onto all exposed surfaces of the structure so that the structure becomes cathodic and in a non-corrosive state.

Another form of corrosion is caused by depolarization of areas along the surface of the metal by action of sulfate reducing anerobic bacteria. Under cathodic protection a highly alkaline film is built up on the cathodic surface which arrests the action of the bacteria.

The application of these principals to the protection of oil lease equipment has made possible considerable savings both in equipment and labor.

Current for applying protection to oil lease equipment is obtained by one of two methods.

1. First, the use af galvanic current furnished by magnesium anodes. In this system the anode is dissipated and must be replaced from time to time.

2. The second method is the use of graphite anodes and rectifiers. This is a more permanent system. However, it requires an external source of power.

Cathodic protection of tanks, treaters, gun barrels, filters and other vessels which contain brine, can offer complete protection of that portion of the vessel which is below the water level. Field tests have shown that protection even in bacterial environments is practical from both the economic and operating standpoint.

First I would like to discuss the protection of a typical emulsion treater. The average vertical treater will require the use of five 3"x60" anodes. If no power is available the magnesium type would be used. A 4" nipple is welded into each compartment which contains brine, except the burner compartment which requires an anode on each side of the fire tube. The anodes are self supporting and are placed through the nipples and clamped into position by the coupling. The lead is then connected to the vessel through a shunt and a length of resistance wire. The shunt is used to read the amount of current which is controlled by the length of resistance wire. The resistance wire is adjusted to give 10 ma. for each sq ft. of exposed steel surface. The anodes will last approximately 1 year, under average conditions.

For the graphite type the positive lead of the rectifier is connected to the anode and the negative lead to the vessel. The current to each anode is adjusted at the rectifier. For this type of installation the anode life should be 5 years.

Another vessel which gives considerable trouble is the filter. These vessels may be charged with graphitic ore, sand and in some cases with anthricite ore. Protection is attained by mounting anode nipples on the top of the tank and forcing the anode into the filter bed. Somewhat higher current densities may be required.

For protection of bolted and welded tanks many systems of getting anodes in the tanks, have been tried. One of the common methods has consisted of placing the anode on concrete blocks or other structures in the vessels. This requires draining the vessel and removing the cleanout hatch. In many cases the labor involved is more costly than the magnesium. The best method for mounting anodes in these tanks is the use of deck mounts. These mounts are nipples which are welded or flanged into the tanks, a cap with an insulator for hanging the anode and a compression fitting for bringing out the lead wire. The cap is held in position by a victaulic coupling. By this method anodes may be changed very quickly without having to drain the tank or get inside. These mounts are available in two sizes, one for the graphite anode and the large type for the round 51 lb. magnesium anode. In some cases two anodes may be hung from the same mount. By controlling the current output of the magnesium by its size rather than by external resistance gives considerably higher efficiencies. This mounting system is suitable for fresh water tanks also.

Current requirements for protection have been determined by tests run in the field. A typical test run in anerobic bacterial environment gave the following results:

Current Density	*Weight Loss In 7 Months*
No. Current Applied	30.5 grams
5 ma.sq. ft.	1.9 grams
10 ma. sq. ft.	0.0 grams

Further tests have shown that although most of the protection is attained at a 5 ma. density complete protection requires a 10 ma. sq. ft. current density.

External corrosion of buried injection and flow lines can be a trouble-some and expensive problem, especially when soils which may or may not be naturally corrosive, are contaminated by oilfield brine, acid, sludge, etc. Where these lines are bare, the most practical method of corrosion control is "hot spot" cathodic protection, using galvanic anodes such as magnesium. Where coated lines are used complete protection of the entire system is quite practical, using either magnesium or small rectifiers with graphite anode ground beds as a source of protective current. In either case a preliminary investigation by qualified personnel is indispensable to selection of the most practical and economical form of protection.

To illustrate what costs might be for such protection a 5" bare injection line in the King Ranch area of South Texas was surveyed and magnesium anodes installed at "hot spots" at a cost of approximately $965.00 per mile. On the other hand, a coated gas gathering system in the same field, consisting of 4" and 8" pipe, was surveyed and completely protected with magnesium anodes at a cost of $186.-00 per mile.

Of mounting concern to operators in all parts of the country is the problem of external well casing corrosion. Many down the hole casing surveys have been run to date and as a result it is pretty well agreed that 1.5 to 2.0 amperes current drain at each well head will provide reasonably good corrosion control down to some 3000 feet. For protection to greater depth somewhat higher currents are required. The 1.5 to 2.0 amperes of current can readily be supplied by magnesium anodes in higher mineral soils of good conductivity, but more often than not the soils are such that a very small rectifier with one or two graphite anodes is the best answer. Occasionally, a field will lend itself to a centralized cathodic protection rectifier installation which will provide protection for both well casings and flow lines, using the lines as connecting conductors to the wells.

We have an installation of this type currently in progress in East Texas, where some 50 wells and associated lines are being protected by 4 rectifiers at a cost of less than $400.00 per well. When individual units are installed, and power line extensions may be necessary costs will be somewhat higher, possibly $450 to $500 per well.

As to maintenance of cathodic protection systems a few general rules are indicated:

1. Regular checks of current outputs.

This is normally checked by measuring the current drop across a shunt mounted in the anode lead. With rectifier installations the current is measured by the ammeter on the rectifier.

2. Pipe to soil readings.

For line installations regular stations are made for checking the voltage of the line to a copper/copper sulfate halfcell. This measurement requires a high resistance voltmeter and a copper sulfate electrode. Regular checks are made to see that a pipe to soil potential of at least 0.85 volts is maintained. This measurement may be taken in a tank; however, a calomel halfcell is used to prevent dilution of the cell. A voltage of -0.78 volts to calomel is considered protective potential.

3. Inspection of Anodes.

In well designated tank installations it is possible to inspect the magnesium anodes from time to time to determine the remaining life.

4. Insulation check.

On lines which are under protection insulation of the protected portion and other lines should be checked annually or when current or pipe to soil readings fall below the protective levels.

As cathodic protection of oil lease equipment is relatively new, it is fast finding general acceptance. The industry has recognized the considerable savings to be made in this field.