The Application of Cathodic Protection to Vessels and Well Casings in the West Texas Area

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INTRODUCTION

The principles of cathodic protection, when applied to oil field vessels and well casings, have been more or less generally accepted within the last few years, and the application of cathodic protection to these structures has been the solution of many of the corrosion problems in the West Texas area.

It is the purpose of this discussion to outline the procedures for determining the need as well as the application of the equipment to vessels and casings in the West Texas area. A typical vessel will be discussed along with an outline of the procedures followed in the protection program in a field where corrosion of well casings has become a problem.

EMULSION TREATERS

First, I would like to discuss the protection of a typical emulsion treater. The average vertical treater will require the use of five 3 inch x 60 inch anodes. If no power is available, a rectifier-graphite anode type system would be used. A 4 inch 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 in the case of magnesium, and with a shunt and a lead wire to the rectifier positive connection. 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 approximately 10 ma. for each square foot of exposed steel surface. Although this current density of 10 ma. per square foot is more than adequate in most areas, under certain conditions it may not be high enough, in which case potential measurements would be required.

In the case of magnesium it should be remembered that the life of the anode is governed primarily by the amount of current it produces. The life may be figured at the rate of 17 pounds of magnesium per ampere-year. Graphite anodes should last from 3 to 5 years, depending on the temperature in the compartment where the anode is used.

When placing the anodes in the vessel, no anode should be placed closer than 8 inches from the metal of the tank. The anode to vessel resistance through the brine is very low and in every case a rectifier with a 6 volt D. C. rating is used. Most manufacturers of treaters have standard anode designs furnished by us and can supply the vessels with the mounts installed at the factory.

WELL CASINGS

Probably the most important phase of cathodic protection to the operator in the West Texas area at the present time is the protection of well casings from external corrosion. Although it is possible to estimate the cost of repairs and other remedial action on the wells involved, the damage to the producing strata by the influx of outside water is often very difficult to ascertain. In many instances this damage far exceeds the cost of any remedial action to the casing.

It is the purpose of this discussion to follow a typical West Texas field from the time it was first apparent that casing leaks were a serious problem, to the actual time of the installation of cathodic protection. The example we will use for discussion is a composite of several installations in the same area, all of which have shown the same problem and were protected by the same type of cathodic protection system. These 100 wells were of the 7500 foot to 8500 foot range and were approximately 12 years of age. A total of 8 leaks have occurred in this area in the 12 year period.

Location of the Leaks

An investigation of the records of the wells which had leaked reflected the location of the leaks. This information was obtained at the time the leaks were repaired. All of the leaks were found to be opposite the top section of the San Andres formation. The San Andres formation in this field is known to be saltwater bearing and sour. The attempts to repair the leaks were met with only limited success; all were stage cement jobs and 5 of the repairs were returned to partial production. 2 of the wells were never returned to production and 1 is listed as abandoned.

Water Analysis

It was found that a comparison of the analysis of the produced water and the water produced from leaking casings gave early indication of the failure of the casing. A program of water testing was instigated in order to prevent extensive damage to the producing strata by the influx of leak water. Early repair of the casing failures seems to be the only answer to the loss of productivity in these wells.

Leak Frequency Curves

The cumulative leaks were plotted by years on semi-log paper in order to establish a leak frequency and a prediction of the number of leaks for the remaining life of the field. It was found that the first leak occurred in 1952, 1 in 1954, 1 in 1956, 2 in 1957, and 2 in 1958. It was established from the leak frequency that some 50 wells would fail by 1965 and that all wells would fail by 1966 without some type of protection for the casings.

Internal Caliper Survey

Internal caliper surveys were run in 10 of the wells in question and some pitting was noted; however, pitting did appear in the area of the failures, and it was concluded that the corrosion was external in nature. This was confirmed by later investigation of recovered casing.

Current-Potential Break Surveys

Current-potential break surveys were run on 10 wells in the field to determine the current requirement for cathodic protection. This method consists of drainage of increasing amounts of current from the well for short periods of time. After each period of time the circuit is broken and the potential, as referred to a half cell located in remote earth, is read. The location of the temporary ground bed used to obtain the test current should be approximately the same as the proposed permanent ground bed location. The instrument for reading these potentials should be of high impedance type and accurate to three places.

Success in using this method requires very careful instrumentation, good technique and proper interpretation. The current is plotted versus casing potential to remote earth on semi-log paper, with current shown as the log function. The break formed in the curve is considered to indicate that current which is the minimum for starting polarization of the amount of casing which is being "seen" by the electrode. These surveys indicated the minimum current to protect the casings to be 5 amperes; however, 7 amperes was chosen as the design current.

Potential Profile Survey

This method consists of taking IR drops along the inside of the casing to determine the amount of current and direction of flow along the casing. Thus it is possible to locate the anodic and cathodic areas and evaluate their severity. The application of current from a temporary ground bed at the time of the second run of the instrument will ordinarily determine the amount of current required to eliminate the gross anodic areas. 2 of these surveys run in this field have shown little of no abnormalities in the native state current flow at the level of the leaks.

It was concluded that this type of survey was of little value in determining the type of corrosion occurring in these particular wells. Apparently the cell actions were complete within the span of the electrodes and the total overall IR drop in the casing was very small. It was determined, however, that when 7 amperes was drained from the well head that considerable current entered the casing in the area of the corrosion. Hence, it was felt that this current design figure, obtained primarily from the current-potential break surveys, was reasonable and valid.

Recovery of Casing

Due to the lack of information furnished by the down-the-hole potential profile survey, it was decided to pull one of the casings which had a leak. Investigation of approximately 700 feet of this casing showed that the top of the San Andres Section had severe pitting and general slab type corrosion. Hard iron sulfide scale covered most of the pitting, with bright metal underneath. None of the casing was serviceable, and all was scrapped.

Resistivity Surveys

In order to arrive at costs of the application of cathodic protection, it was necessary to design the system to be applied to each well. The ground bed design requires a knowledge of the resistivity of the soil. Resistivities of the pits was determined in 20 locations to arrive at an average figure of 300 ohms Cm^3. From this, it was determined that 2 anodes with 400 pounds of metallurgical coke breeze would give a ground bed resistance of 2 ohms or less.

However, since the design current was maximum current limit for 2 anodes, 3 anodes were used. The use of 3 anodes permitted lower current per anode with less heat generation and less drying out of the ground bed. The rectifiers were sized to provide not only the required 7 amperes but also additional driving potential for periods of drought. The units were actually 28 volt, 12 ampere units.

CONCLUSIONS

Since completion of these cathodic protection installations, an expected 6 leaks have not occurred and payout has been readily shown. This method of protection of well casings has become generally accepted. A great number of installations of this type are in progress.