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USE OF COATINGS AND POLYETHYLENE FOR CORROSION PROTECTION

INTRODUCTION

Galvanic corrosion has been a major concern in the water works industry for many years. Many tests and studies have been completed to find ways to prevent or at least control galvanic corrosion. As mentioned in Connections™ bulletin GI-1, three conditions must be met in order for galvanic corrosion to occur: (1) two dissimilar metals, an anode and a cathode, (2) in electrical contact with each other and (3) a common electrolyte. Because most useful metals, including pipeline materials, are alloys created by combining elements with different galvanic potentials, most metals will corrode in the presence of an electrolyte. This bulletin will discuss ways to prevent the electrolyte from coming in contact with the pipeline and its components.

COATINGS

One way to separate metal from an electrolyte is to coat the metal with a tightly adherent coating. There are several coatings available such as coal tar epoxy, fusion bonded epoxy, ceramic based, and fluorocarbon resins. There are also a variety of polymer and organic based coating available. Each one performs essentially the same function: prevent the metal from contacting the electrolyte. In addition to insulating a particular part from the electrolyte, the coatings also insulate the parts from each other.

In a study conducted by the Cast Iron Pipe Research Association (CIPRA), several mechanical joints were buried with various kinds of T-bolts and several types of coatings. The bolts that continuously suffered the least amount of weight loss due to corrosion were the coated or taped bolts. The bolts were made from 0.5% Cu. gray-iron and with various coatings, some applied at the factory and some field applied. Even bolts that were individually taped prior to installation were more stable than either uncoated bolts or bolts in joints wrapped in polyethylene.

POLYETHYLENE WRAP

The "quality" of the electrolyte is influenced by the presence of oxygen in the electrolyte. The use of loose polyethylene wrap limits the effectiveness of the electrolyte even when small amounts of water are present between the wrap and the metal. As long as the water is stagnant and not replenished, the amount of electrolyte and the amount of oxygen is limited. In this situation, corrosion will be depleted from the water and corrosion will cease. In addition, the stagnated water will become saturated with Fe^{++} ions. Corrosion will be stopped once the electrolyte becomes saturated. Thus, due to the polyethylene wrap, the stagnated water actually helps protect the pipeline from further corrosion.

TESTING

In the early 1950's, E.F. Wagner conducted a test of polyethylene wrap in which a six inch mechanical joint was encased in polyethylene and buried in highly corrosive cinder fill. Two years later, the test section was uncovered and the mechanical joint, the gland, nuts, bolts, and pipe inside the polyethylene wrap, were in excellent condition. The unprotected section of the pipe outside the wrap was pitted with corrosion. During a test conducted in the late 1950's and early 1960's, the Cast Iron Pipeline Research Association (CIPRA) buried several polyethylene wrapped mechanical joints in various locations. In the highly corrosive soils of Casper, Wyoming and Lombard, Arizona, the polyethylene performed in an exceptional manner. The bolts that were protected by the poly wrap lost an average of only 3 grams per year. It should be noted, the soil in each location was not continuously saturated. Bolts from the polyethylene wrapped joints that were buried in the Atlantic City tidal marsh lost an average of 28.9 and 33.1 grams per year. This was probably due to the replenishing of the electrolyte by the tidal action. In each case, the polyethylene was described as "loose". However, in the test conducted at the Atlantic City site, the tidal action "forced" new water between the polyethylene and the pipe. The bolts in each case were made from 0.5% Cu cast iron.

A paper, "Corrosion Prevention With Loose Polyethylene Encasement" by W.H. Smith in Water and sewage Works (May 1972), reports "After almost 20 years of experience, including research and application in the field, there has been no failure of pipe so protected." Since that time, there have been failures of polyethylene wrapped pipe reported. The failures were probably situations similar to the test in Atlantic City in which the electrolyte was replenished. Mr. Smith's paper also noted a test conducted by CIPRA in 1968 to evaluate "the performance of polyethylene encasement when protecting gray and ductile iron pipe." The test sections were installed in high corrosive soils near strong level stray direct current. The results of the test were as follows:

1) Loose polyethylene film wrap not only protects against severely corrosive soil but shields the encased pipe from stray direct current.
2) The dielectric capabilities of polyethylene encasement prevent development of local corrosion cells.
3) Polyethylene-encased gray and ductile cast iron pipe can be cathodically-protected with a required current density of about 25 X 10^-6 amps per square foot.

Also the study concluded:

1) Electrical resistance normally available in rubber-gasketed, push-on joints is retained at a higher level in pipelines which have been encased in polyethylene film.
2) Loose polyethylene film encasement is not affected by high voltage protection currents as would be adherent coatings. (A pipe-to-soil potential of -14.8 volts was maintained for six months with no effect on polyethylene.)

DISADVANTAGES/ ADVANTAGES

As mentioned previously, the polyethylene wrap may not provide enough protection in continuously saturated soils, but it may be used in conjunction with cathodic protection systems. Although care should be taken during installation and the backfill process to prevent rips and tears, polyethylene may be repaired easily in the field. Polyethylene may be used to protect against stray direct currents. Also, polyethylene wrap reduces soil to pipe friction and must be taken in to account during the design of a restrained pipeline system.

Coatings can provide total electrical insulation between the different pipeline materials. However, if holdays, small holes, develop in the coating, the area near the holiday is susceptible to corrosion due to a concentration cell developing. It is possible to test for holidays and to "fix" any such inconsistencies in the coatings. Coatings may be applied in a number of ways depending on the type of coating used. Coatings also provide protection from stray direct currents.

SUMMARY

Polyethylene wrap has been tested and has performed exceptionally well. It is the subject of several national standards as well as an international standard. Polyethylene wrap is the most popular method of corrosion protection in the water works industry. Coatings not only provide an excellent insulation between the pipeline parts and the electrolyte but they also provide electrical insulation between the pipeline components. Both loose polyethylene wrap and tightly adherent coatings should be considered whenever the pipeline surroundings present a possible corrosion problem.

REFERENCE LIST

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