"Above Ground Storage Tank Bottom Protection and Application Using Vapor Corrosion Inhibitors (VpCIs)"

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Unique AST Corrosion Control Challenges.

Fluctuating Contact of the Floor with the Tank Pad.

The soil-side of storage tank bottoms is typically protected from corrosion using cathodic protection (CP). Corrosion control becomes difficult to maintain when contact between the floor and the tank pad vary during fill / empty cycles. This is particularly true of "drain-dry" tanks that are designed to be totally emptied of product. The floors of these tanks are sloped into sumps so that 100% of the product drains from the tank. Thus, during the "empty" portion of the cycle, the tank floor has no weight on it. The floor sheets will ripple causing a large percentage of the steel to loose contact with the tank pad material. During this time period, cathodic protection produces ineffective corrosion control for the portions of the floor that are not in contact with the tank pad soils. It is possible to utilize **Vapor Corrosion Inhibitors (VpCI's)** for corrosion control during the "empty" cycle or in any other instance of loss of contact between the tank pad and the tank floor.

Double Bottoms and Tanks with Containment Liners.

Double bottom tank installations, and tanks with HDPE liner containment, often also create unique corrosion control challenges. CP current will not flow through the lower floor of a double bottom tank or through HDPE liners. Therefore, all CP system anodes need to be installed between the upper floor and lower floor, or containment liner. Control of corrosion by cathodic protection is difficult to implement once this type of tank is in service. It is also problematical to maintain or repair.

Research and fieldwork indicates that corrosion control can be achieved using **Vapor Corrosion Inhibitors** within double bottom or lined containment environments. Rials & Kiefer of Conoco Oil published a technical paper presenting results from testing a variety of corrosion control options for double bottom tanks (3). One of the tests included a vapor corrosion inhibitor mixed with a typical tank pad material. Corrosion was monitored and measured over an extended time period. Almost no corrosion developed in the presence of the VpCI.

Real world experience utilizing VpCI's in void space protection over a 15-year time span has confirmed the longevity of this approach. Corrosion inhibitors are effective alone, or in combination with CP. Inhibitors have a long history of corrosion protection under numerous types of conditions (wet, corrosive environments and void spaces).

Corrosion Protection with Corrosion Inhibitors.

Corrosion Inhibitor Basics

Vapor corrosion inhibitors have been used for many years to solve the basic corrosion control problem for metal surfaces in a confined space.

VpCI's are a sub-class of metal inhibitors. Inhibitors have been used by the oil and chemical industry for over 50 years, minimizing difficult corrosion problems. Numerous technical literature papers on corrosion inhibitors are available. A unique characteristic of VpCI is its relatively high vapor pressure (.0001 mm Hg). These inhibitors volatilize at room temperature, re-depositing on metallic (as well as other) surfaces in an equilibrium condition in confined spaces. The inhibitor then works as any other inhibitor, stopping or retarding the corrosion mechanism. They are chem-adsorbed in a monomolecular thick layer. Some compounds are specific for ferrous metals while others are effective on both ferrous and non-ferrous metals.

In the last 20 years Cortec Corporation has investigated these compounds and developed a series of low toxicity inhibitors (1), many being in the range of table salt, 2000 to 3000-mg/Kg oral LD-50. A key characteristic of these materials is that they protect against corrosion in the presence of water vapor, chlorides, hydrogen sulfide, sulfur dioxide, nitrogen oxides, and other compounds found in a corrosive industrial environment.

The newer VpCI's are being used daily for successful corrosion control. They are produced and used in many forms: pure VpCI powder, VpCI liquids, "emitters" used in electrical and electronic applications, VpCI plastic films and paper used in packaging, lubricating oil/VpCI combinations, and incorporated into standard solvent and water based paint formulations. Companies such as DuPont, Conoco Oil, IBM, Motorola, General Motors, Ford, Chrysler, and Volkswagen have incorporated these materials into their standard specifications. Organizations such as the United States Navy & Air Force use this type of protection, saving vast amounts of money compared to conventional preservation methods. The US Navy has an active program evaluating several VCI's for use in void spaces in ships. (2).

Techniques for Measuring VpCI Effectiveness

There are two primary methods to measure and confirm the effectiveness of corrosion inhibitors. (7)

1. Corrosion Rate Probes.
   A corrosion rate probe provides a real-time calculated corrosion rate measurement described in mils per year metal loss. These probes can be installed at numerous locations under a tank floor to evaluate the corrosion rate of the environment, and thus the effectiveness of corrosion inhibitors.
2. Metal Loss Coupons.
   These special coupons should be placed under a tank floor within the tank pad material in such a way that retrieval is possible. After a period of time, the coupon is removed and weighed. Corrosion control is then evaluated in terms of mils per year metal loss.

Applications for Aboveground Tank Floors.

New Tanks & Floor Replacement.

Corrosion inhibitors are easily applied during the construction of new tanks or the replacement of floor plates. After tank pad construction is completed, VpCI powder should be applied at the rate of 1-2 Kg/100 m^2 (2-4 pounds/100 ft^2). It should be spread evenly onto the tank pad. The floor plates can then be fabricated as normal. The VpCI slowly distributes itself uniformly throughout the base. At welds a small amount vaporizes, but condenses after cooling of the metal.

In the case of a concrete tank pad, VpCI is applied to the surface, or a modified form is mixed into the wet concrete. Migration of the inhibitor in concrete has been extensively evaluated by several organizations (5,6).

Existing Tanks

Refinement of methods for applying VpCI's under existing tank bottoms is currently under development and will be commercially available. These methods include:

1. Application of VpCI's in a powder form at the tank floor – tank pad interface.
2. Pumping liquid VpCI slurry in the area between a tank floor and a lower floor or containment liner.

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