Storage Tank Bottom Protection Using Volatile Corrosion Inhibitors

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Research and fieldwork show that volatile corrosion inhibitors can protect the bottoms of storage tanks used in the oil and petroleum industries. These systems can be used in conjunction with the traditional corrosion control method of cathodic protection.

Storage tank bottoms in the oil and petroleum industries are continuously threatened by corrosive species and moisture present in the environment. When located near the sea, the exposure to saline heightens this problem. Supports and tanks are exposed to exceptionally high loads. For safety and environmental reasons, it is imperative that these base supports and tank bottoms remain safe, secure, and intact, unimpaired by corrosion.

Storage tank bottoms have historically been protected from corrosion using cathodic protection (CP). However, problems arise when there is not complete contact with the base. This occurs as the bottom adjusts to the tank being filled and emptied, causing the bottom to buckle slightly and leave air gaps. Other times, a portion of the base may erode. In either case, electrical continuity is lost. Other means of protection such as protective coatings are not suitable because the coatings are destroyed when the bottom plates are welded together.

Research and field work show that protection can be achieved using volatile corrosion inhibitors (VCIs) under the tank. This works alone or in conjunction with CP.

Corrosion Problem

If general corrosion occurs in the tank bottom, a suitable corrosion allowance can be built in. However, pitting corrosion—where holes are literally drilled through thick steel plate—often occurs instead.

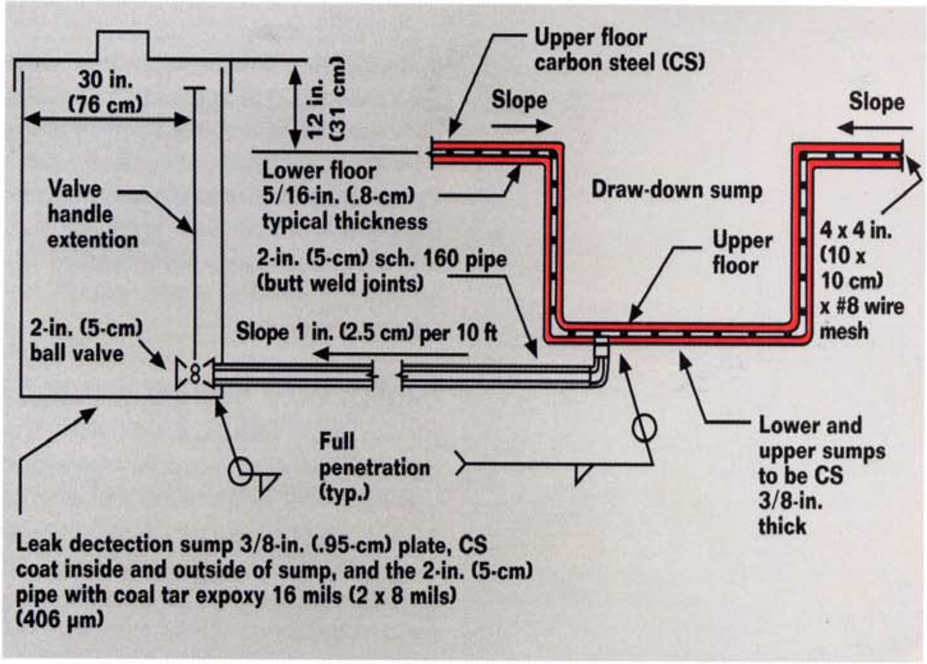
In the past, minor product leakage was acceptable. The cost of the product lost was not always great enough to be a major concern. With today's environmental regulations, however, leakage is a major concern. Vast amounts of groundwater can be contaminated, and cleanup costs can amount to millions of dollars. In extreme cases, the site is not salable on the open market. Also, leaking tanks jeopardize a company's positive public image.

Newer tanks are designed with secondary containment. Double bottoms detect leakage, and concrete or membrane containment limits product migration. Similar problems occur in older systems. VCIs are a suitable solution from both a technical and economic standpoint. These inhibitors have a long history of corrosion protection under wet conditions, corrosive environments, and void spaces.

Corrosion Protection

Even with detection and collection systems, corrosion protection still must

FIGURE 1



Double-steel-floor design with gravity drain—new tanks.

be addressed. Vapor corrosion inhibitors (VpCIs) have been used for many years to solve the basic problem of protecting metal surfaces in a confined space.

VpCIs are a subclass of corrosion inhibitors that have been used by the oil and chemical industries for more than 50 years to minimize difficult corrosion problems. They volatilize at ambient temperature (vapor pressure 0.0001 mm Hg) and redeposit on metallic and other surfaces at equilibrium in confined spaces. The inhibitor stops or retards the corrosion mechanism. It is adsorbed in a monomolecular layer. Some compounds are specific for ferrous metals while others are effective on both ferrous and non-ferrous metals.

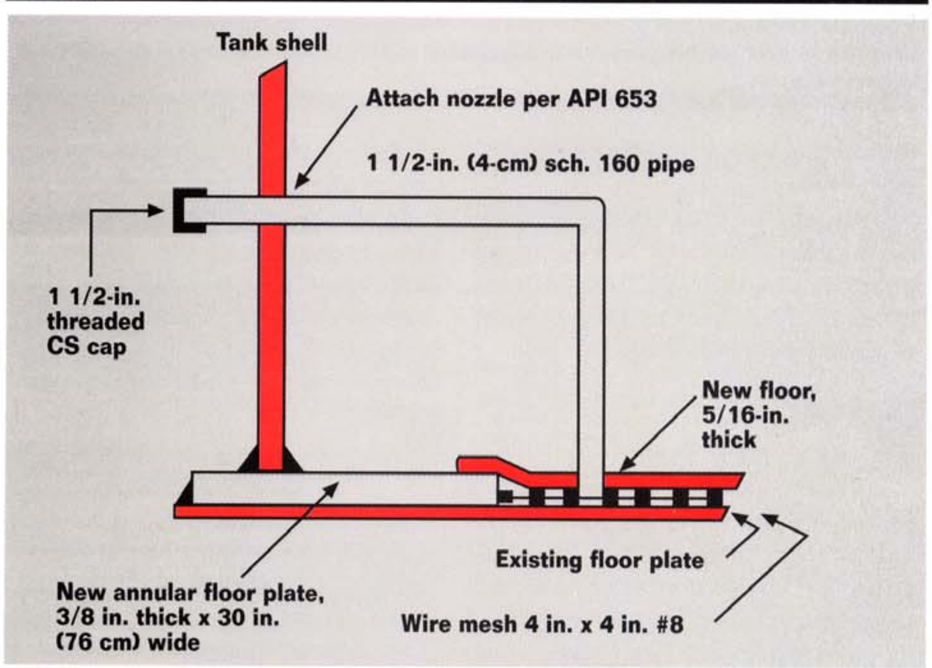
A series of low-toxicity compounds have been developed in the last 20 years,[1] many being in the toxicity range of table salt (2,000 to 3,000-mg/kg oral LD-50). A key characteristic of these materials is that they protect against corrosion in the presence of water vapor, chlorides, hydrogen sulfide (H_2S), sulfur dioxide (SO_2), nitrogen oxides, and other compounds found in a corrosive industrial environment.

These newer VpCIs are being used daily for successful protection. They are produced and used in many forms: pure powder, liquids, "emitters" used in electrical and electronic applications, plastic films and paper used in packaging, and lubricating oil/inhibitor combinations. They are also incorporated into standard solvent- and water-based paint formulations. Companies including DuPont, Conoco Oil, IBM, Motorola, General Motors, Exxon, Mobil, Phillips Petroleum, and others have incorporated these materials into their standard specifications. Organizations such as the U.S. Navy and the U.S. Air Force use this type of protection, reducing expenses significantly compared to conventional preservation methods.[2] The Navy even has an active program evaluating several VpCIs for use in void spaces in ships.

Application to Tank Bottom Protection

Several years ago, Conoco Oil published a paper on tank bottom protection presenting laboratory testing procedures with positive results.[3] A given quantity of VpCI was mixed with a given volume of sand/gravel mix. Corrosion was monitored over a 2-year period. Real-world experience in void space protection over 15 years has con-

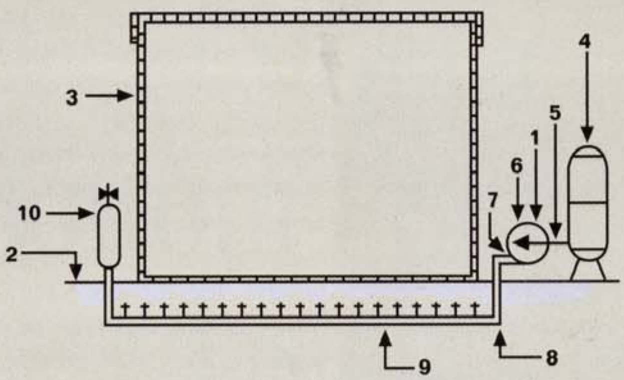
FIGURE 2



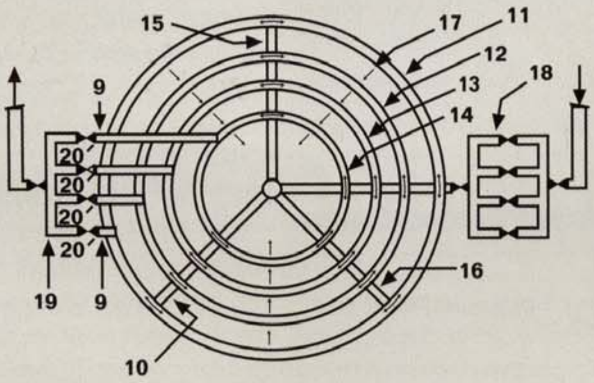
Retrofit of existing tank, joint detail for tank shell to floor with double-steel bottom.

FIGURE 3

Corrosion inhibitor dispensing system



Top view of the configuration of the dispensing system



1. Corrosion inhibitor dispensing system, 2. Concrete support pad, 3. Petroleum type reservoir, 4. Reservoir or chamber enclosure, 5. & 7. Conduit or transfer line, 6. Pump, 8. Dispensing array, 9. Conduit or transfer line, 10. Expansion vessel, 11., 12., 13., & 14. Perforated tubing, 15., 16., & 17. Individual radial extending feed lines, 18. Inlet manifold, 19. Outlet manifold, 20. Relief valves.

Corrosion inhibitor dispensing system in combination with a petroleum reservoir and support pad (patents pending).

firmed the long-term effectiveness of this approach.

This type of protection is incorporated into standards for corrosion control of new and existing tank bottoms. It has also been used in the void space of double tank bottoms.

Tank Bottoms

NEW TANKS

After the subbase of sand/gravel is spread, VpCI powder is applied at the rate of 10 to 20 kg/100 m² (2 to 4 lb/100 ft²). It is mixed into the base with simple hand tools. The tank bottom is then laid out and fabricated as normal. The VpCI slowly distributes itself uniformly throughout the base. At welds, a small amount vaporizes but condenses after the metal cools.

In the case of a concrete base, a VpCI is applied to the surface or a modified form is mixed into the wet concrete. Several organizations have evaluated the migration of this inhibitor extensively and found positive results.[4-7]

EXISTING TANKS

When tanks are being refurbished and new bottom plates are welded in, VpCIs are spread under the plate. When possible, VpCIs are distributed in the adjacent areas. They may also be air lanced from the perimeter under existing tanks, with the powder blown in during the withdrawal process. Ashland Oil evaluated this application process in Pittsburgh, Pennsylvania by analyzing the base for distribution after floor plate removal. Citgo Corp. has adopted another approach that select-injects a 5% solution of VCI-609 in the underbottom sections of fuel oil storage tanks at its Fort Lauderdale, Florida, terminal.

Double Tank Bottom Protection

NEW INSTALLATIONS

After the first bottom is installed, VpCI powder is spread at the rate of 1 to 2 kg/10 m² (2 to 4 lb/100 ft²). Figure 1 shows typical construction. The spacer and second bottom are then welded in place.

EXISTING INSTALLATIONS

VpCI powder is carefully blown into the void to provide uniform distribution (Figures 2 and 3). Alternately, a VpCI solution may be pumped into the void and either left or drained. Either method provides corrosion protection.

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