Vapor Corrosion Inhibitors for Storage Tanks

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Introduction

This document provides details on using vapor corrosion inhibitors (VCIs) for protection of the soil-side of tank bottoms from corrosion.

VCIs are chemical compounds that are typically available as crystalline powders. They may be available as loose powder or in prepackaged tubes. The crystalline powders may be mixed into a liquid (commonly with potable water) to deliver the VCIs beneath the tank bottom. Whether delivered by either powder or liquid, the VCIs volatize into a gas molecule and use their vapor pressure to permeate through air space until a steady-state concentration is reached. The VCI chemistry allows it to maintain a dynamic steady-state equilibrium, providing ongoing corrosion protection to the tank bottom plates.

Vapor pressures of different VCI compounds will vary. The vapor pressure will determine the carrying distance of the molecule within the enclosure and will also affect the concentration of the vapor molecules within that space. VCIs are compounds that vaporize or sublimate and condense on the tank bottom surface, forming a molecular layer that mitigates the naturally occurring active corrosion mechanisms. The molecular size is such that the VCI propagates through the voids between the sand particles in a sand pad or airspaces between the steel plate and a foundation pad.

VCIs prevents corrosion by the following actions:

— Vapor transport: VCI molecules volatize from a source and diffuse through the airspace as a vapor molecule. This enables the VCI molecules to move to a metallic surface without direct surface contact of the source chemistry.

— Adsorption: Molecules adsorb onto the surface by a physical and chemical process. When a molecule adsorbs on a steel surface, it effectively blocks other molecules from interacting with the surface of the steel. Under a tank bottom, VCI molecules take precedence on the surface and block oxygen and water molecules, thus reducing the corrosion potential at the interface.

— pH balancing: Some VCI formulations are designed with components that can modify the pH of an environment, typically resulting in a more alkaline condition. Testing of the soil from beneath the steel bottom will provide information about the pH. A low pH may be an indication of bacteria or other causes of acidic conditions.

— Chemical passivation: Some VCIs act to shift the electrical potential of metal toward a more electro-positive state. The interaction can be direct, whereby VCI reacts with the metal surface and becomes part of the passive film, or it can be indirect, whereby VCI improves the adsorption of oxygen on the metal surface to passivate the metal surface.

— Contaminant neutralization: Acidic species are known to cause corrosion of ferrous metals. Some VCI molecules can neutralize the acidic species.

Vapor Corrosion Inhibitors for Storage Tanks

1 Scope

1.1 General

1.1.1 The purpose of this technical report (TR) is to provide information to owner/operators regarding the use of vapor corrosion inhibitors (VCI) and to provide guidance for their use in corrosion protection of aboveground storage tank (AST) bottoms, specifically from soil-side corrosion of carbon steel. The VCI chemistries discussed in this document are from the amine-carboxylate group.

1.1.2 Certain practices recommended herein may also be applicable to metallic tanks in services other than hydrocarbon under special circumstances.

1.1.3 VCI manufacturers should be able to assist in determining the suitability of VCI use for each situation, along with proper concentration and application method for their products. VCI professionals working for the manufacturers or working in conjunction with the owner/operators will need information about the tank to make valid recommendations. Annex A provides a list of relevant information that may be required to make an informed decision.

1.1.4 The potential for corrosion can occur in void spaces where cathodic protection (CP) will not be effective because of oxygen concentration cells, from contaminants in the foundation pad, or contaminants that may ingress, such as water and oxygen. VCIs may be beneficial in these situations.

1.1.5 VCI molecules disperse through the foundation materials from their source based on their vapor pressure. Because these molecules are lighter than air, they will adsorb to the surface of materials in the foundation. Also, they have a higher attraction to steel than to the sand, gravel, concrete, or asphalt and other surfaces. Uniform distribution of the VCI source material is not required since the vapor pressure of the VCI molecules will eventually complete the distribution under the tank bottom.

1.2 Limitations

1.2.1 For VCIs to protect the tank bottom from soil-side corrosion, the tank foundation design shall provide a means to contain the VCI beneath the bottom.

1.2.2 While most manufacturers' VCI chemistries for use in tank bottom applications have similarities, each has unique characteristics and chemistries. Owner/operators should review the characteristics of the chemistries to determine which product best suits their needs.

1.2.3 In cases where API 651 identifies several foundation designs or details where CP may not be effective or may offer limited protection, VCIs may be an effective alternative or may work in conjunction with CP to improve protection.

1.2.4 VCIs volatize into vapors that may be inhaled. VCIs, in powder form, may create dust when handled. If engineering or administrative controls are not effective in reducing exposures, proper PPE should be worn when handling the VCI during installation. At very large concentrations, the dust may be combustible. Concentrations in air from mixing or applying VCI powder are considerably below the concentrations susceptible to combustion. Consult the Safety Data Sheet for additional information.

1.2.5 Since VCIs may be discharged to the ground at any time during installation and service, it is imperative that all federal, state, and local discharge permit requirements be followed. This may preclude the use of VCIs, depending on the jurisdiction’s discharge permit requirements.

1.2.6 When using VCI powder near welding operations, VCI powder shall not be in the weld zone. The powder is not combustible, but may affect the quality of the weld, as would other contaminants.