Application Note

Corrosion Monitoring of Soil-Side Bottoms of Aboveground Storage Tanks Using Electrical Resistance (ER) Method

THE PROBLEM

Aboveground Storage Tanks (ASTs) are used to contain a variety of fluids that may pose minor or very serious threats to the environment and public safety, in case of leakage. Leaks due to external corrosion of single and double-bottom aboveground storage tank bottoms are a serious industrial challenge from both an operational and regulatory perspective. Different protective methods have been utilized to provide corrosion protection to the underside of a tank floor, such as cathodic protection. However, air gaps between the bottom plates and construction pad may render a CP system ineffective in those areas and result in accelerated reduction in metal thickness, pit holes, and eventual leaks[1]. This happens due to the fact that air gaps break the essential electro-chemical circuits formed by direct contact between the soil (electrolyte) and the metal tank bottoms. This problem may be further enhanced by the use of bituminous beds or oily sand below the tank bottoms.

The ingress of water, moisture present in the atmosphere, as well as airborne chlorides through the unsealed gap between the tank annular plate and the foundation is another important factor for accelerating the soil-side corrosion on the perimeter of the tank.

Due to such corrosion issues and possible leaks, operators have to put the tank out of service for inspection, patchwork repairs, and sometimes replace bottom plates, within the first few years of the tank's life or at the scheduled inspection intervals. Therefore, adequate and effective corrosion protection and monitoring methods should be implemented to ensure the bottom plates' integrity for continuous, safe and economical operation of the storage tank.

CORROSION MONITORING OF SOIL-SIDE BOTTOM PLATES OF ASTs USING ER METHOD

Implementing one or more reliable online corrosion monitoring systems under the tank is as important as selecting an effective corrosion control method for soil-side corrosion.

A growing industrial practice to mitigate soil-side corrosion of tank bottoms is to introduce amine carboxylate based volatile corrosion inhibitor (VCI) materials under the tank bottom and monitor the impact on corrosion rates using Electrical Resistance (ER) corrosion probes. When amine carboxylate VCI material is delivered and released under the tank, protective vapors disseminate, adsorb onto the metal surface and form a monomolecular protective layer throughout the soil-side surface of the tank bottom plates. This solution is applicable for cathodically protected and unprotected tanks during scheduled maintenance outage, while in service or during construction.

Unlike other indirect corrosion monitoring systems, ER probes are designed to evaluate and continuously monitor the corrosiveness of the surrounding environment on the AST bottom plate metal surface. The ER probes are positioned close to the tank floor and exposed to the same environmental conditions as the tank floor, hence, there is a direct relationship between the corrosion rate of the ER probe and the tank floor corrosion rate (Figures 1, 2 and 3).

In most cases ER probes are used as the primary corrosion rate monitoring technique to evaluate the effectiveness of the volatile corrosion inhibitors (VCI).

Generally, multiple ER probes are installed and uniformly distributed to cover the tank bottom plate area. They are usually installed away from the inhibitor injection point to confirm inhibitor diffusion and evaluate the overall effectiveness of VCI materials.

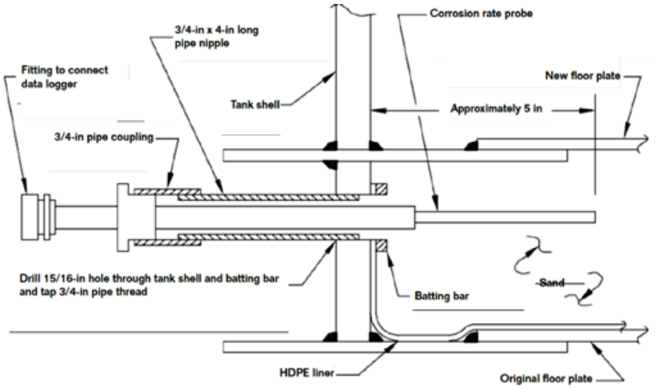

Figure 1: Typical ER probe installation through the tank wall in a double-bottom tank[2]

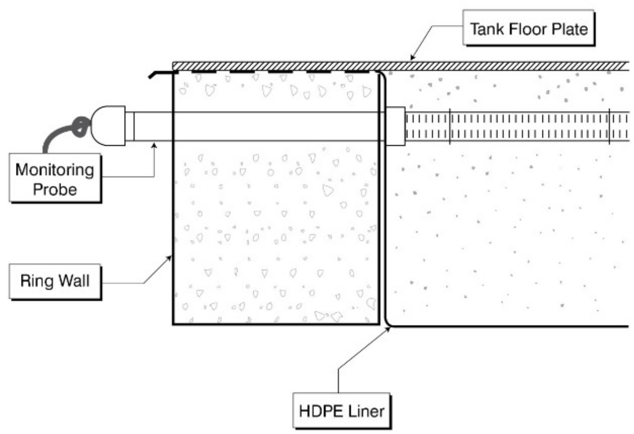

Figure 2 Typical ER probe installation thorough concrete ring wall in a single bottom tank setting on sweet sand pad

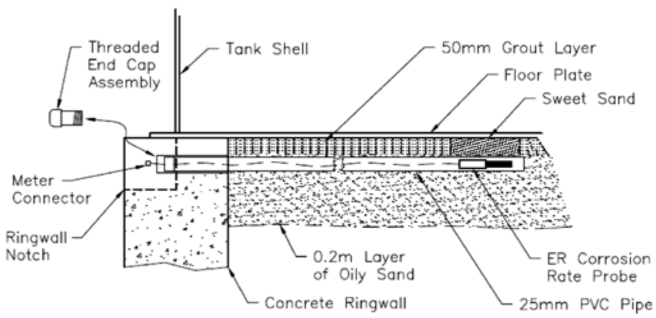

Figure 3: Typical ER probe installation with grout removed above probe location[2]

Metal loss measurements using ER probes are usually acquired over a two to three month period prior to the introduction of the vapor phase corrosion inhibitors and for several months to many years after the inhibitor injection. There are different methods of interpreting ER data and generally a linear trend or moving point average method is used to check the performance of the inhibitor. Figure 4 shows the typical trend of metal loss of an ER probe for the inhibitor pre-injection and post-injection period obtained from a field installed probe. Such trend of metal loss also determines the timing of reinjection of inhibitors if the reduction of its efficiency is observed.

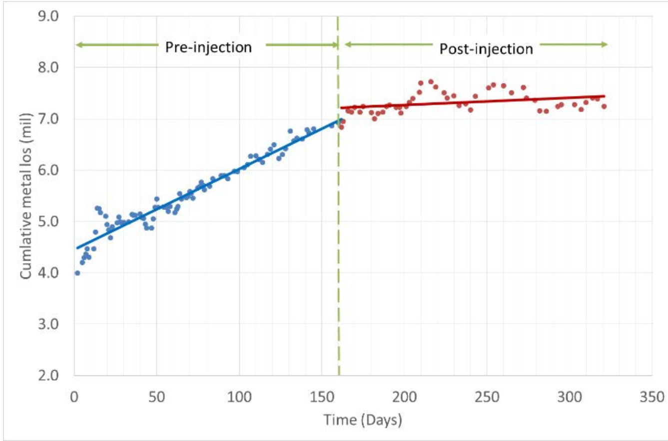

Figure 4: Typical metal loss trend observed from ER data for pre-injection and post-injection period

Metal Samples ER0500 corrosion probes are designed for heavy duty service conditions. The surface strip element assembly is suited to the "construction site" environment. The cylindrical element with its slim profile is convenient for locations with restricted access such as AST soil-side bottom plate structures and other infrastructure applications. Both probes provide good sealing of the reference element and the check element provides confidence in the continued performance of the corrosion sensor. Either probe may be connected to a cathodically protected structure using the attached grounding lead. This allows the probe to measure the effectiveness of the Cathodic Protection (C.P.) System under operating conditions. If left unconnected from the structure, the probe monitors the direct corrosivity of the soil or environment. The high resolution MS4500E hand held data logger is used to measure metal loss from ER0500 ER probes. The MS3500E/MS3600E can be used as a remote data logger for continuous metal loss measurement at predetermined intervals.

References:
1. Xianming (Andy) Yu, Saudi Arabian Oil Company "Evaluation of the Tank Bottom Corrosion and CP Effectiveness at a Saudi Aramco Crude Oil Tank Farm", Paper 10043, 13th Middle East Corrosion Conference and Exhibition
2. Tim Whited, Cortec Corporation; Xianming (Andy) Yu and Robin Tems, Saudi Aramco "Mitigating Soil-Side Corrosion on Crude Oil Tank Bottoms Using Volatile Corrosion Inhibitors", Paper 2242, NACE 2013