Problems with earthing, carbon steel tanks and piping

By: LOUIS KOSZEWSKI, President
U.S. Tank Protectors Inc.

NISTM
National Institute For Storage Tank Management

The common use of copper grounding (earthing) materials can create significant accelerated corrosion problems for carbon steel tanks and buried coated piping. "Earthing" is the electrode directly in contact with the soil. When carbon steel is electrically connected to bare copper earthing, corrosion of the carbon steel tanks and piping will occur. The corrosion problems occur due to natural differences in electrical potential between the carbon steel and copper earthing when they're installed in an electrolyte. A galvanic corrosion couple is created where the more active metal is an anode to the copper earthing. This is how galvanic cathodic protection works — electrically coupling two dissimilar metals together in an electrolyte.

Typically, magnesium or zinc are used in soil when coupled to carbon steel. The more active metal corrodes for carbon steel. Sir Humphry Davy figured this out back in the 1800s by attaching steel (anode) to his copper (cathode) navy ships. The steel corroded away from the copper ship. The same process of corrosion is occurring at our refineries, terminals and pipeline stations where copper earthing is used.

Electrical bonding of carbon steel tanks and piping to earthing electrodes is performed to reduce the effects of lighting, induced earth currents and fault currents. Electrical bonding and grounding are also used to reduce step and touch voltages for personnel safety. The typically bare steel tank bottoms are already in contact with the ground; however, the tank bottoms are typically installed on high-resistivity tank pads.

Cathodic protection (CP) is a regulatory requirement and often recommended to be utilized in industry-recommended practices for carbon steel tanks and piping to protect the soil side of the tanks and piping from external corrosion. When sacrificial or impressed current CP is installed to cathodically protect the tanks and piping, the dynamics change. If a magnesium anode is used for cathodic protection of a steel tank in electrical contact with copper earthing rods or bare copper cables, the magnesium anode — by the electrical laws of nature — has to protect the copper rods and/or bare cables before it protects the steel tanks and piping. The more bare copper rods and cables that are used, the more CP is needed to protect the copper before the CP will ever protect the steel. Where bare copper earthing rods and/or bare cables are utilized, the current required to provide effective levels of CP on the tanks and piping may increase by several orders of magnitude.

When CP is applied to the copper earthing rods and/or bare cables, the resistance-to-earth of the earthing rods and/or cables will increase significantly, so the earthing rods and/or cables may no longer meet the National Electrical Code (NEC) requirements for maximum resistance. What typically happens when your earthing rods are no longer in compliance with NEC? More copper earthing rods are installed. The more copper earthing rods and/or bare cables you add, the lower your levels of CP on your bare steel tank bottoms and coated piping.

The NEC does not require "copper" earthing but requires "permanent" earthing electrodes be used. Practical alternative earthing materials include the following:

1. Zinc anodes in rod, ribbon or bar form
2. Galvanized steel rods and cables (a steel rod/cable with zinc coating)
3. Carbon steel rods or cables

If zinc anodes, rods, ribbons or galvanized steel are used as an alternative earthing material per NEC and in combination with an impressed current CP system, a complete reversal of the effects described above will occur. There will be no increase in the resistance-to-earth of the zinc earthing rods due to CP current flowing to the zinc, if adherence to proper NACE criteria are followed.

A properly designed earthing system in accordance with the NEC can be provided economically, which will significantly reduce or eliminate the unfavorable effects of:

1. Galvanic corrosion of the carbon steel tanks and piping for the copper earthing.
2. Increasing the resistance-to-earth of the earthing rods.
3. Loss of CP current and protection to the tanks and piping.

For more information, contact Louis Koszewski at lou@ustankprotectors.com or call (630) 719-9754. ●