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# Cathodic Protection

CST often receives inquiries and recommendations about the use of cathodic protection to prevent tank corrosion. Cathodic protection is and can be a viable means of corrosion protection if applied correctly. But when misapplied it can cause issues that often outweigh the benefits.

**What is Cathodic Protection?** - Cathodic protection functions by creating a negative electric potential, either from an anode or rectified current on the steel, thereby reversing iron dissolution; the first step in the corrosion process.

Many specifications call for cathodic protection for water tank interiors. These are typically users who have had experience with field welded tanks. Since field welded tanks have uncoated floor bottoms, cathodic protection offers a way to address steel corrosion in this area that is essentially unprotected. It also addresses the shorter life of field applied coatings once the coating is compromised. If properly maintained, a cathodic protection system is the lesser of evils for a field welded tank and can prevent corrosion; buying time between recoats. This is lesser of an issue with factory coated bolted tanks which are coated on all sides in a controlled environment. Unlike steel floors on field welded tanks, factory coated tanks are installed with no exposed steel on the tank floor or any other part of the structure.

A common misconception is that cathodic protection is a supplement to protective linings (working in parallel). This is not the case since the CP system needs the conductivity between the bare steel and the liquid to complete the circuit. Until then, the CP system will remain idle, waiting until steel is exposed to the liquid. For this reason, CP works well on bare steel or protecting exposed steel after the coating is compromised. However, it can cause more harm than good on coated tanks if not properly sized, monitored and maintained. It is important to keep in mind the purpose of cathodic protection, which is to protect the steel substrate, not the coating. In fact, cathodic protection can actually lead to the attack of a coating in as little as two days by driving water through it where normally it would be resistant (electroendosmosis). The water is forced through the coating by an electrical potential, which occurs because the metal cathode surface has the same charge as the coating (negative).

Cathodic protection can also cause the formation of hydrogen bubbles at the metal surface that can lead to blistering and disbonding of the lining (referred to as “Cathodic Disbondment”).

These hydrogen bubbles are formed when an overvoltage (more than 1.2 V ref. Cu/CuSO4) is applied. This overvoltage is often required to achieve the voltage necessary for cathodic protection to function properly (-0.85 V ref. Cu/CuSO4 per NACE RP0575) across all of the areas of the tank. In addition, the pH of the areas where the hydrogen gas is formed will be very high (alkaline).

## Types of Cathodic Protection

**Impressed Current Systems** – CST does not provide Impressed Current CP systems and they are rarely used on CST tanks. In addition, CST's experience with third party Impressed Current systems has not been consistent due to cathodic disbondment of the protective coating. For this reason, CST does not warrant or recommend impressed current CP systems with any of our factory coated products. However, even though the CST warranty will become void if IC CP systems are used, some customers have supposedly applied these systems to CST tanks without issue. If you choose this path, CST recommends obtaining a corrosion and system warranty from a long time reputable CP provider. Lastly, error on the side of less voltage potential than more.

**Glass Coated Tanks and Passive CP Systems** – One of the advantages of porcelain enamel is its very strong adhesion and bonding to the steel substrate. Because of this, CST's Porcelain Enamel Glass Fused to Steel tanks are excellent candidates for passive CP systems. This is why CST markets, recommends and sells passive systems for all Glass Fused to Steel tanks storing water. This proprietary CP design has been developed and refined over 30 years to ensure maximum tank longevity and coating compatibility; resulting in the longest water tanks in the industry. Even though CST's glass coating is the primary barrier to corrosion, the CP system acts as added assurance if and when the coating becomes compromised.

**Figure 1: Example of CST Cathodic Protection System**

In addition, unlike third party CP systems, CST's is included in the tank warranty, providing a single point of accountability if issues arise. CST passive systems can also be applied to other applications besides water. For other applications, please consult with your CST channel partner if CP is right for your specific application. Keep in mind that cathodic systems must be designed for a specific liquid chemistry (or resistivity). If your process is one where the pH level and/or constituents change substantially during normal operation, then a passive cathodic system may not be right for you.

**Epoxy Coated Tanks and Passive CP Systems** – At this time, CST does not recommend any type of CP system for its Epoxy coated tanks due to the high potential for cathodic disbondment AND because CST's proprietary factory applied Optibond™ process and Tricobond™ coating will typically last 2 to 3 times longer than field applied coatings. So while a few customers have applied third party systems to CST epoxy tanks with mixed results, we feel it is not worth the risk to introduce something that may compromise the coating. For these reasons, CP systems are rarely used and are not recommended on CST Epoxy coated tanks. If a CP system must be used on a CST tank, consult CST on sizing a compatible custom solution.

**What is Cathodic Disbondment**? Cathodic Disbondment is a process by where the protective coating separates from the protected structure (cathode) due to the localized formation and flow of hydrogen ions over the surface. The degree of disbonding is reliant on the type of coating, with some coatings affected more than others (as in Glass vs Epoxy). Cathodic protection systems should be operated so that the structure does not become excessively polarized since this promotes disbonding due to high negative potentials.

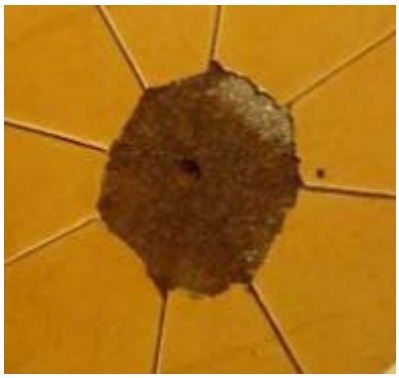

**Figure 2: Example of Cathodic Disbondment on an Epoxy Test Sample**

**Exterior Cathodic Protection for CST Tank Floors**

The intent of an exterior CP system for the floor is to prevent corrosion of the steel floor plates when set on grade. This requirement is common for field welded tanks which have no way to coat the bottom of the floor panels after welding. For field welded applications, this is a viable means of corrosion protection. However, for factory coated tanks external CP is not necessary since the floor panels are coated on both sides. For this reason (and the potential for disbondment) CST does not recommend exterior CP systems. Although CST does not recommend, sell, or warrant external floor CP systems for factory coated tanks, with some precautions, external cathodic protection of the tank floor is possible.

For those customers that must do this, there is a relevant NACE standard: NACE RP0193 - External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms. Both passive and impressed current CP systems can in theory be applied to tank floors depending on the site conditions. If the tank has not yet been constructed, there are several options for installation of a CP system under the floor. If the tank is already in place, distributed anodes can be installed around the perimeter. Although not recommended, if you must choose this path, CST recommends you obtain a corrosion warranty and system design from a long term reputable CP provider that follows NACE RP0193.