POCKET FIELD GUIDE

Cathodic Protection for Steel Water Storage Tanks

David H. Kroon

American Water Works Association

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Managing Editor: Melissa Valentine
Product Manager: Tony Petrites
Technical Editor: Jenifer Walker
Cover Art: Melanie Yamamoto
Production Editor: Megan McCarthy

ISBN: 978-1-625-76224-5

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Acknowledgments

Reviewed by the AWWA Steel Tank Committee whose membership include the following:

Joe W. Davis, Thomas M. Dawson Jr., Leslie D. Scott, and Gregory R. Stein.

And by the AWWA Corrosion Control Committee whose membership include the following:

Graham Bell, Sylvia Hall, Mike Horton, and Andy Romer.

With comments from:

Rajendra D. Vaidya and Al Fancher.

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Introduction

As early as 1943, an AWWA technical committee concluded it was necessary to control corrosion of submerged surfaces inside water tanks. At that time, cathodic protection was identified as an effective way to prevent leaks. It wasn't until the 1970s, however, when practical designs for water storage tanks were widely introduced, that cathodic protection began to gain widespread use to prevent corrosion.

Even the best protective coating systems cannot prevent corrosion indefinitely. When cathodic protection is added to a coated tank, however, the advantage achieved by combining the benefits of a protective coating with cathodic protection is significant for owners, doubling or even tripling the life of the coating. Consequently, tank owners view cathodic protection as a low-cost way to safeguard investments in their storage tanks and protective coating systems.

By pairing protective coatings and cathodic protection, it is possible to extend the life of a typical steel water storage tank's coating system for immersion service by as much as 20 years. Without cathodic protection, system failure is likely to occur within 10 years.

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Chapter 1

Water Tank Corrosion and Control

Steel water storage tanks are subject to corrosion on all of their external and internal surfaces. The primary focus of this pocket field guide is to provide guidance for cathodic protection of the internal wetted surfaces of steel tanks, but, for comprehensive asset protection, corrosion and corrosion control of all surfaces should be considered.

Most storage tanks are constructed of either steel or steel and reinforced concrete (composite tanks). For composite tanks, it is important that corrosive admixtures be avoided and that the depth of concrete cover over the rebar be sufficient to protect the steel reinforcements by providing a high pH environment over the life of the tank. For stainless steel tanks, a different set of corrosive conditions needs to be evaluated. These include sufficient oxygen in the water to form a protective oxide film and the presence of certain active ions, such as chlorides, that could lead to corrosion pitting of the stainless steel.

There are distinct zones associated with a water tank, each of which requires corrosion protection by a combination of material selection, protective coatings, and/or cathodic protection. The connection of the carbon steel tank shell to different metals should be avoided. This includes copper and

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stainless steel tubing, ladders, safety rails nozzles, noncompatible weld materials, and the like.

The exterior surfaces of the tank shell and roof exposed to the atmosphere are best protected from corrosion by the use of protective coatings. Many coating systems that have been successfully used include epoxies, polyurethanes, and alkyds, some of which incorporate zinc-rich primers. Section 4.3 of AWWA D102-14 "Coating Steel Water-Storage Tanks" describes seven outside coating systems. For the external surfaces of a flat bottom tank, consideration should be given to the application of cathodic protection to prevent corrosion of the soil side. Accelerated corrosion can occur because of corrosive soils or tank pad material, high moisture content, or connection to copper grounding. Applying a protective coating alone to the soil side of the bottom plates is not an effective alternative because the coating will be damaged during placement and welding. Information on tank bottom cathodic protection can be found in NACE International's RP 0193-2001, "External Cathodic protection of On-Grade Carbon Steel Storage Tank Bottoms."

Inside the tank, corrosion is even more challenging. Connection (metal-to-metal contact) to copper, brass, and stainless steel appurtenances must be avoided. Protective coatings and cathodic protection should both be used. Coating the inside of a tank is not an easy process. Proper surface

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preparation is essential. Humidity and temperature for proper cure must be closely monitored, recognizing that the side of the tank exposed to the sun can be quite a bit hotter from radiant heating. Surface preparation and quality application of coating the roof, support columns, and purlins is difficult because of impediments to inspection, including access, crevices, and sharp edges. Section 4.4 of AWWA D102-14 "Coating Steel Water-Storage Tanks" describes five inside coating systems consisting of epoxies, polyurethanes, or polyurea. The discussion that follows addresses corrosion and cathodic protection of the internal wetted steel surfaces of carbon steel water storage tanks.

CORROSION OF INTERNAL WETTED SURFACES

In fresh water tanks, corrosion activity on internal wetted surfaces usually results in concentrated pitting attack, which leads to quicker wall penetration than if the corrosion was more uniformly distributed on the metal surface. This is particularly true on tank interiors that are coated, where the corrosion attack is accelerated at holidays or voids in the coating. The attack is initiated by the development of anodic and cathodic areas on the submerged metal surfaces. The anodic areas (e.g., location of coating holiday) will suffer accelerated corrosion (metal loss), whereas the cathodic areas will not corrode (see Figure 1.1).

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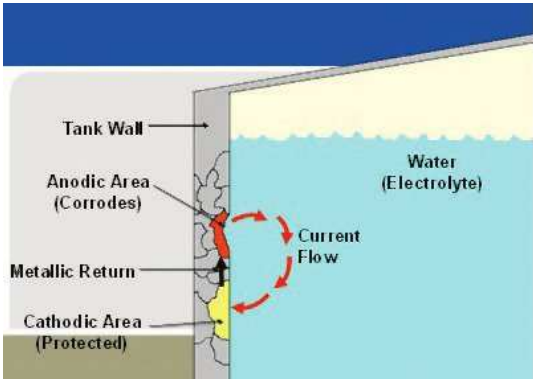


FIGURE 1-1 Anodic and Cathodic Areas on Tank Wall

The corrosion is often made even worse by the small anode-large cathode area effect (see Coating Pinhole Corrosion).

There are a number of mechanisms that can initiate and sustain corrosion of the submerged steel in water tanks.

Uniform Corrosion

Although steel visually appears to be homogenous, close inspection reveals that it is quite irregular, consisting of numerous grains of metal that are electrically different from each other. Thus, some will be anodes, whereas others will be cathodes.

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