# ASK DR. GALV...

MY CUSTOMERS OFTEN INQUIRE ABOUT THE USE OF HOT-DIP GALVANIZED STEEL SUBMERSED IN WATER. HOW WELL DOES ZINC STAND UP TO CORROSION IN THIS ENVIRONMENT?

The varieties of water throughout the world differ to the extent that predicting the corrosion rate is one of the more difficult aspects for hot-dip galvanizing applications. Many parameters affect corrosion of zinc in a water environment, such as pH level, oxygen content, water temperature, water climate and tide conditions to name a few. Therefore, when determining if your particular application will be suitable for a water setting, go step by step through the following corrosion parameters.

In what type of water is your application? Usually water is either pure water (e.g., distilled water or de-ionized water), natural fresh water or sea water. Hard water and soft water also cause corrosion to different degrees, as do hot and cold water.

Pure water, also known as de-ionized or distilled water, can have a low corrosion rate on zinc, provided it is free from oxygen and carbon dioxide. Upon exposure to pure water with uniform oxygen content, pure water's attack on zinc still isn't very pervasive. However, even though corrosion may be minimal in pure water, light to severe pitting may occur. Corrosion rates of zinc increase with aeration of pure water; oxygen is five to ten times more aggressive than carbonic acid.

Fresh water environments have two major constituents for categorizing corrosion potential: hard and soft water. Carbonates and bicarbonates, present in some concentration in fresh water, tend to deposit protective films on the zinc surface, which stifles corrosion. Carbonates subdue the corrosion effects of anions, the most corrosive to zinc being chloride in excess of 50 mg/L. The softer the water, the lower it is in carbonate, which means a more pronounced chloride content and a higher corrosion rate. Conversely, the harder the water the greater it is in carbonate, thus minimizing the corrosiveness of the chlorides. Therefore, what you have is a general rule that soft water severely corrodes hot-dip galvanized steel while hard water does not.

Sea water is high in salt content in the form of sodium chloride. Typical surface seawater has a pH of 8, due to excess amounts of carbonates. The pH may fall to 7 in stagnant waters. The depth of the water also plays a part in the pH level. The pH decreases with depth. Corrosion of zinc is best controlled in the pH range of 5.5 to 12.

Sea water temperature can vary widely from 28.4 F (-2 C) at the poles to 95 F (35 C) near the equator. The higher the temperature the greater the dissolution of zinc in water. Tropical seawater (higher temperatures) yields higher corrosion rates, especially in polluted waters.

Tidal zones and fluid agitation are also important considerations in determining the corrosion protection delivered by galvanized steel. Often, this motion of "washing" the carbonates off the zinc surface and not allowing them to form a protective film, along with zinc erosion, is the cause for base steel corrosion.

Determining the corrosion rate of zinc in water can be a daunting task. Let's summarize the basic elements that cause the corrosion of zinc. Soft water is a harsher environment to zinc than is hard water or even cold climate seawater. Temperate seawater deposits protective scales on zinc and is less corrosive than soft water. High oxygen content and warm waters can be detrimental to zinc as well. Corrosion of zinc is lowest in the pH range from about 5.5 to 12 and most natural potable waters have a pH range from 5 to 8.5. However, the corrosion of zinc in such waters is accelerated largely by the impurities present in the water and rarely is natural water pure. Even rainwater, which is distilled by nature, contains nitrogen, oxygen, carbon dioxide and other gases, as well as acquired airborne impurities such as dust or smoke. *(continued....)*

*(...continued)* Anything that disturbs the formation of a protective film on the zinc surface, such as carbonate deposits, will inhibit the hot-dip galvanized coating from delivering superior corrosion protection. In addition, other factors including pH, time of exposure, temperature and fluid agitation all influence the aqueous corrosion of zinc in water. Having identified the variables that adversely affect the galvanized coating, it is important to note that galvanized coatings on steel used in submersed applications is still one of the best methods of corrosion protection. It is common for hot-dip galvanized steel to perform flawlessly in seawater for eight to twelve years.