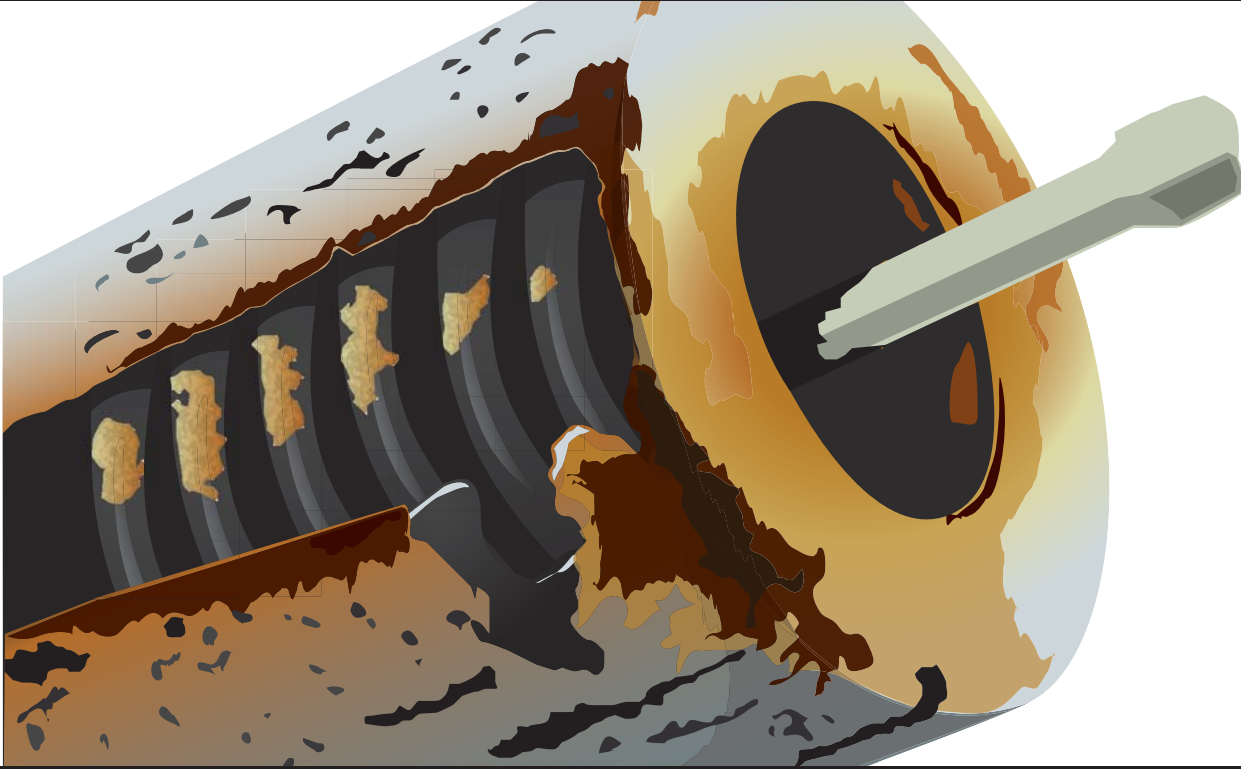
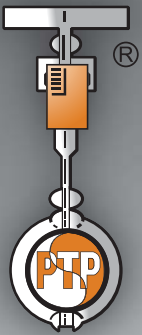


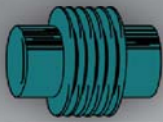
# TECHNICAL BULLETIN



## SERVICES CORROSION PROTECTION



### PIPING TECHNOLOGY & PRODUCTS, INC.



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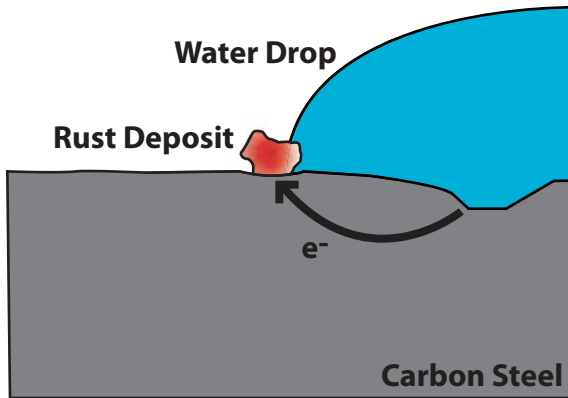
## Methods of Protecting against Corrosion

This technical bulletin will consider four methods of protecting carbon steel pipe supports components from corrosion; **painting, zinc coatings, hot dip galvanizing, and combinations of these**. Painting has an advantage when appearance and choice of color are important. Modern painting systems may be appropriate protection in certain environments. Paint provides “barrier” protection to a metal surface. The ability of zinc to provide cathodic protection for carbon steel in addition to barrier protection is a fundamental advantage. In most cases the reduction in life-cycle costs justifies the small additional cost of galvanizing. Indeed painting and galvanizing together can provide a synergistic benefit which may be justified in some cases.

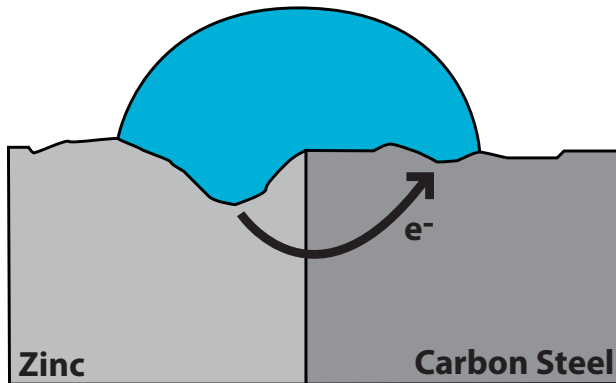
The use of zinc and galvanizing has a long history. The early patents for hot dip galvanizing were issued in France and England in 1836 and 1837. This technology was quickly adopted and was widely used in the late-1800s. In the United States we have bridges more than 100 years old which have galvanized structures. In addition, we have transmission towers and substation structures that are over 70 years old. A pipe rack at a petrochemical plant near Houston was studied after 28 years of service. Measurements of the zinc thickness remaining provided a forecast of another 60 years of service. Pulp and paper mills use galvanized materials in most of their critical environments. It is important to understand the fundamentals which make this “old” technology so cost effective in such a wide variety of applications.

## Electrochemistry of Zinc & Carbon Steel

Corrosion is an electrochemical process which occurs when four elements are present; an anode which gives up electrons, a cathode which receives electrons, an electrolyte (which is usually an aqueous solution of acids, bases, or salts) and a metallic current path. The rate at which corrosion occurs depends on the electric potential between the anodic and cathodic areas, the pH of the electrolyte, the temperature, and the water and oxygen available for chemical reactions.



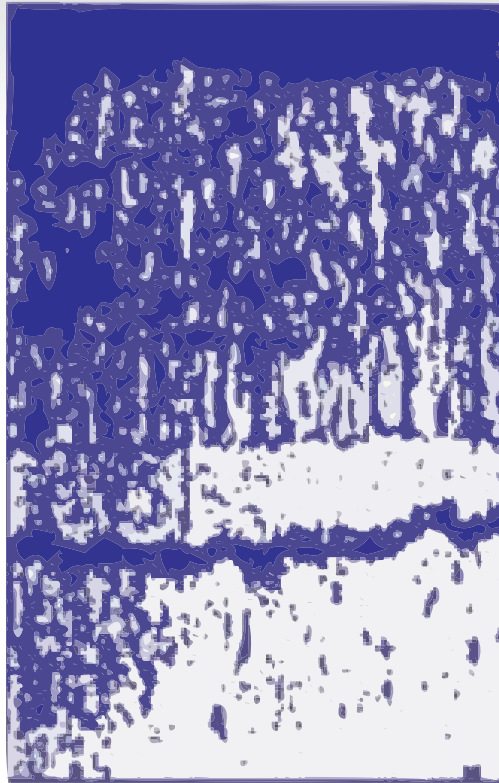
**Figure 1** indicates how corrosion damages carbon steel. Note that the pitted area to the right is anodic and gives up electrons while the cathodic area to the left (where water and oxygen from the air are present) is where rust appears. The pitted area where the carbon steel is weakened is not where the rust appears.



Zinc has a greater tendency to give up electrons than carbon steel, so when both are present, zinc becomes the anode and protects the carbon steel. **Figure 2** indicates corrosion with the zinc giving up the electrons and becoming pitted while the carbon steel remains undamaged. From this we see that a zinc coating will protect carbon steel by “sacrificing” itself until the zinc is depleted. The rate of zinc depletion is relatively slow when the pH of the electrolyte is between 4 and 13,

**Hot dip galvanizing** has two advantages over a zinc coating. During galvanizing, the molten zinc reacts with the carbon steel to form layers of zinc/iron alloys. **Figure 3** shows a galvanized surface with 5 layers, the top layer is 100% zinc and the bottom layer is carbon steel. The alloy layers between have increased hardness to provide mechanical (barrier) protection and because of their zinc content they are also anodic relative to carbon steel. The hardness of these alloy layers provides much more protection from scratches than paint can provide. This is important for most pipe supports applications.

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**Eta layer 100: Zn  
70 DPN hardness**

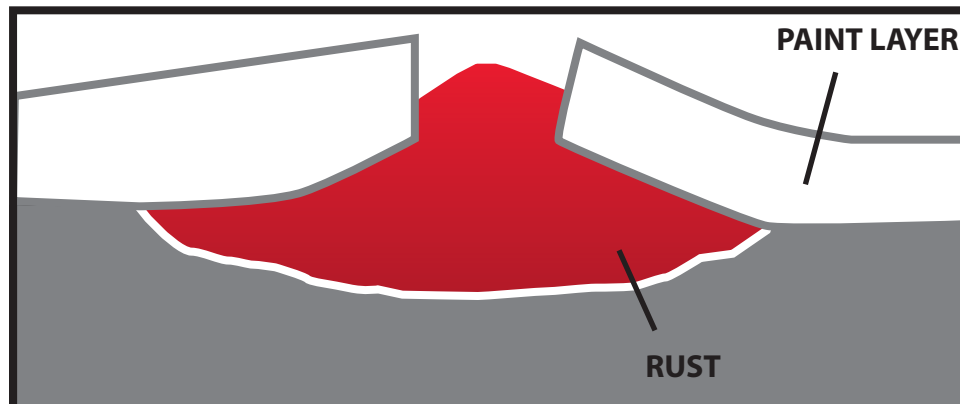
**Zeta layer 94% Zn 6% Fe  
179 DPN hardness**

**Delta layer 90% Zn 10% Fe  
224 DPN hardness**

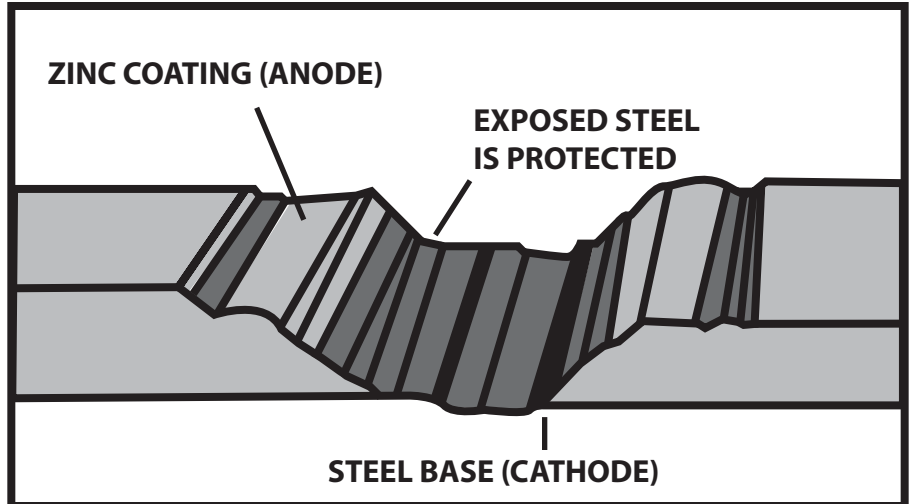
**Gamma layer 75 Zn 25% Fe**

**Carbon Steel  
159 DPN hardness**

Any coating which provides a barrier to the moisture and oxygen in the air will help protect carbon steel from corrosion. A properly painted surface will provide a barrier, but it is subject to scratching from contact with hard objects. **Figure 4** illustrates how rust can grow and damage a painted surface when corrosion begins because the paint barrier is broken by a scratch.



**Figure 5** illustrates the cathodic protection provided when a galvanized surface is scratched.



Duplex Systems usually require painting over galvanizing. Some of our customers have specified a duplex system. This is more expensive but it can be justified for certain corrosive environments or for appearance. The American Galvanizing Association suggests the following “rule of thumb” to estimate the service life of a duplex system.

***(Duplex System Service Life) = 1.5\* (Service Life: HDG Only) + (Service Life: Paint Only)***

\*The synergistic multiplier of 1.5 is based on the barrier protection the paint provides for the galvanized surface.

At Piping Technology and Products Inc., many customers have returned painted variable and constant spring supports which could no longer function due to corrosion. Costs must be considered during the specification of coatings for pipe supports. The owner and operator of a facility should consider life-cycle costs. Pipe supports are usually a relatively small percentage of the total cost of installing and operating a power plant, petrochemical plant, paper mill or other major facility. The small additional cost of hot dip galvanizing the carbon steel components of pipe supports is most always a wise investment.

For more information you may want to contact the following organization:

**American Galvanizing Association-AGA**  
12200 E. Illif #204 Aurora, CO 80014  
ph 800-468-7732

**National Association of Corrosion Engineers-NACE**  
1440 S. Creek Dr. Houston, Tx 77084  
ph 713-492-0535

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