

Abstract

The use of galvanized treated steel in enclosures increases the life expectancy of the product by over 100 years when compared to the use of standard untreated carbon steel. Additionally, galvanized treated steel has certain properties that allow it to be more resistant to superficial damage when compared to standard carbon steel, further improving its life expectancy in harsh environments.

Enclosures manufactured with galvanized steel have exceptional corrosion resistance to harsh environments.

Galvanized Steel and the Galvanization Process

Galvanized steel is steel that has a zinc coating on its outer layer meant to protect the steel from corrosion.

In the galvanizing process, standard carbon steel is dipped into hot molten zinc resulting in combined steel and zinc protective layers. During the “hot-dip” galvanization process, zinc is melted in a large tank, and steel is submerged in the molten zinc, the iron from the steel and the zinc combine to form tightly bonded alloy layers on the surface of the steel. These bonds become a fundamental property of the steel itself, as opposed to, the zinc just being an additional outer surface coating. The total thickness of the zinc-iron layer depends on many factors such as the steel’s chemical properties, immersion time, or cooling rate.

Benefits

The galvanization process gives steel many notable benefits.

The layer of zinc-iron alloy that is closest to the raw steel center tends to be even harder than the raw steel itself. This adds an additional protective and higher tensile layer on top of the already sturdy properties of steel. This added protection is extremely important for the extra layers to be able to provide long term benefits such as corrosion resistance. The additional combined layers of zinc and iron can withstand substantially more physical damage than standard carbon steel.

Additionally, zinc coating has another important property. In the event of a physical abrasion, the surrounding zinc coating will sacrificially spread itself out over a small radius and cover the newly exposed steel. The zinc actively seeks to reinforce and protect the exposed raw steel, which corrodes significantly faster than the zinc-iron layers that make up galvanized steel.



Corrosion Resistance

One of the most important benefits of the galvanization process is the significant increase in corrosion resistance. The corrosion rate of galvanized steel is immensely lower than that of regular steel. While the corrosion rate depends on many factors such as the conditions of the enclosures surrounding environment or the thickness of the zinc coating, the corrosion rate of galvanized steel typically varies anywhere from 1/10 to 1/30 of the corrosion rate of raw steel.

Example, if a standard carbon steel enclosure lasts 4 years in an industrial environment before 5% of the steel's surface is corroded, it would take galvanized steel anywhere from 40 to 120 years to corrode the same amount under the same environmental conditions, depending on the thickness of the zinc-iron layer.

Additional Protection and Longevity via Powder Coating

The addition of powder coating on top of the zinc-iron layer can significantly improve the longevity of galvanized steel. While the powder coating does not have corrosive properties, it does have properties that resist environmental conditions and has a quantifiable degradation over time, especially when exposed to UV rays. Powder coating finishes typically last upwards of 20 years before they are fully degraded, but many factors can accelerate this process such as frequent use, consistent long-term exposure to UV rays, or external conditions introduced by the environment.

Considering all factors, a powder coating layer added to galvanized steel can result in a lifespan of up to 60 or even 140 years, depending on the thickness of the zinc coating.

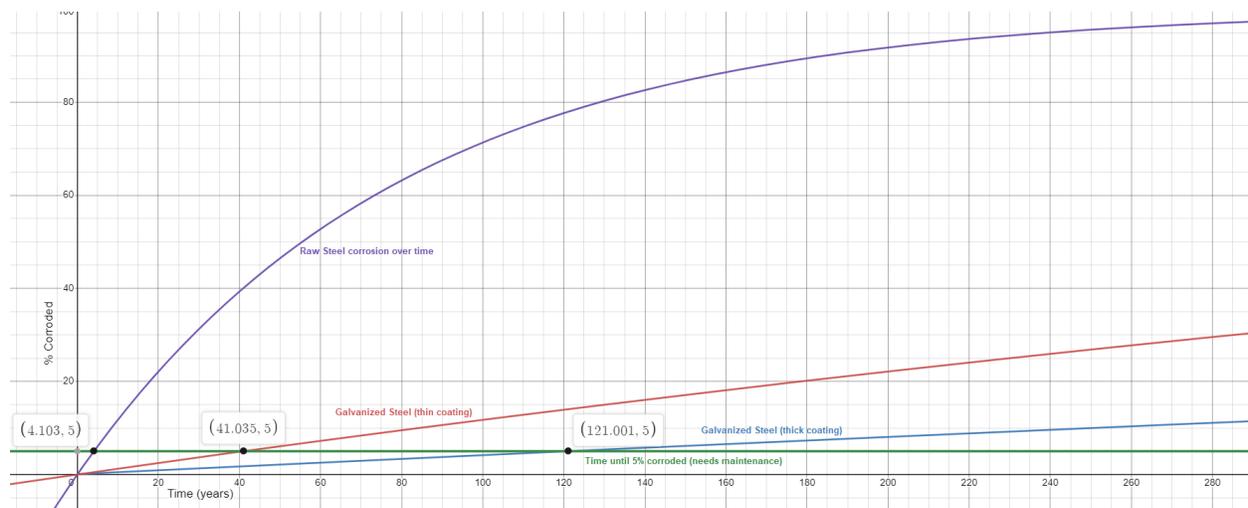
Powder Coated Galvanized Steel -vs- Galvanize Steel -vs- Raw Carbon Steel Analysis

The chart shows the corrosion rate of powder coated galvanized steel, galvanized steel, and raw carbon steel. The analysis displays the corrosion rate in an environment with the enclosure exposed to 24-hour continuous corrosion and UV exposure.

Results: Time for 5% corrosion on the surface of the enclosure (Figure 1)

- Raw Steel = 5 years to reach 5% corrosion continuously exposed to environmental and UV conditions.
- Galvanized Steel = 40 years to reach 5% corrosion continuously exposed to environmental and UV conditions.
- Powder Coated Galvanized Steel = 120 years to reach 5% corrosion continuously exposed to environmental and UV conditions.

Figure 1



Additional Information

White papers and information on galvanized steel process and corrosion resistance properties can be viewed at: <https://galvanizeit.org/>

A galvanizing video produced by the American Galvanizers Association is available showing the process and benefits of galvanizing:

<https://www.youtube.com/watch?v=3r8CZ6B5ID8>

Example of Raw Steel Tubing



Example of Galvanized Steel Tubing

