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INDUSTRIAL
GALVANIZERS
CORPORATION

Tech Tips

What causes gray-coloured hot-dip galvanized coatings on steel?

WHY GALVANIZE?

Hot dip galvanized coatings are applied to steel to improve the anti-corrosion performance of the steel to ensure that it lasts as long as possible with a minimum of maintenance

COATINGS DIFFER

Only hot-dip galvanizing gives a coating that can reach the 50 year life required of structural building products.

THICKNESS COUNTS

Compared to other zinc-rich coatings, hot-dipped galvanizing is:-

- THICKER
- HARDER
- FULLER

HOT-DIP GALVANIZED PRODUCTS LAST LONGER...

Grey surface on large galvanized duct assembly. Steels with high silicon content typically develop uneven dull grey coatings after hot-dip galvanizing.

A common phenomenon with hot dip galvanized structural steel is the gray appearance of part or all of the coating after galvanizing, where the expectation of the customer is for the galvanized steel to be shiny.

Gray coatings are often a cause of contention between galvanizers and their customers as a result. This information has been produced to explain the phenomenon of gray coatings, their cause and effect on the performance of hot dip galvanized steel.

Why are some galvanized coatings gray.

Hot dip galvanized coatings are the result of a metallurgical reaction between the zinc and the steel. This reaction forms a series of zinc-iron alloys in the form of needle like crystals that grow from the steel's surface.

With conventional galvanized coatings, the alloy layer makes up about 80% of the coating and the upper 20% of the coating is zinc. This surface layer gives produced the shiny appearance. With conventional galvanized coatings, the alloy layer makes up about 80% of the coating and the upper 20% of the coating is zinc.

This surface layer gives the shiny appearance. Where this surface coating of free zinc is not present, the zinc-iron crystals are visible and it is the appearance of these that gives the coating matte silver or gray appearance.

When the steel emerges from the galvanizing bath, the coating is always shiny. The appearance of the coating changes to gray as the residual heat from the galvanizing process allows the reaction between the steel and the zinc to continue until all the fee zinc on the surface is consumed, leaving the coating with 100% alloy layers.

What causes some steels to produce gray coatings?

The reaction between zinc and steel in the galvanizing process is a function of a number of factors. The most significant of these with respect to gray coatings are:

- The chemical composition of the steel
- The steel section thickness
- The galvanizing bath temperature
- The cooling rate of the steel after galvanizing

Of these, the chemical composition of the steel is the most important. Two alloying elements in particular, silicon and phosphorus, will increase the reaction rate of the zinc with the steel. If the silicon content exceeds 0.20% or the combination of the percentage of silicon plus 2.5 x the phosphorus level exceeds 0.25%, then the likelihood of gray coatings forming is increased. Most Australian-made steels are 'galvanizer friendly' in this respect with silicon and phosphorus levels controlled within acceptable limits.

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What causes gray-coloured hot-dip galvanized coatings on steel?

TRIED & PROVEN

Over 40 years of field testing shows that galvanized coatings perform well even in harsh environments.

GRAY (OR MATT) FINISH ON GALVANIZING.

This is generally caused by the steel chemistry - with high silicon and/or phosphorus content causing the issue. Gray coatings are thicker than shiny galvanized coatings on equivalent steel sections. A significant increase in service life can be expected from these heavier coatings despite their dull look.

WHY GALVANIZE WITH INDUSTRIAL GALVANIZERS?

For steel users requiring fast, proven corrosion protection for local or national projects Industrial Galvanizers is the established hot dip galvanizer with nationwide coverage.

As about 35% of steel used in Australia is now imported, the variation in steel chemistry makes control of gray coatings a more difficult issue.

The steel section thickness is a factor with relatively thick sections (over 20 mm) because the greater mass of steel retains heat longer. The zinc-iron reaction will continue even when the zinc has solidified (at 420 degrees C) as a solid-state reaction until the temperature falls below about 390 degrees C. For this reason, heavy plate fabrications will produce thicker, gray coatings regardless of the steel chemistry.

The galvanizing bath temperature will only have an effect where it is possible to operate the galvanizing bath at above the normal 455°C. This can only be done in special ceramic lined galvanizing baths, as high operating temperatures will damage conventional steel galvanizing baths.

The cooling rate of the steel after galvanizing can affect the coating appearance. Galvanized items that are air-cooled are more likely to develop gray or partly gray coating than items that are quenched immediately after withdrawal from the galvanizing bath. This occurs because the quenching halts the solid-state zinc iron reaction before all the free-zinc on the coating's surface is consumed.

What effect do gray coatings have on coating performance?

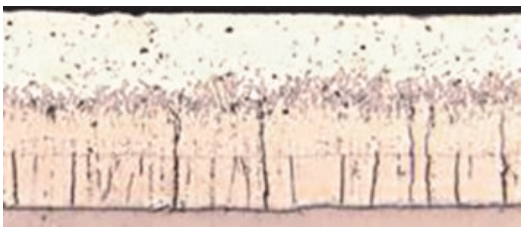
Without exception, gray coatings are thicker than shiny galvanized coatings on equivalent steel sections. Australian and International galvanizing standards require that on structural sections over 6 mm in thickness, the minimum galvanized coating thickness is specified at 85 microns.

Gray galvanized coatings are more typically almost double this thickness, and on heavier sections will frequently exceed 200 microns in thickness. As galvanized coating life is almost directly proportional to coating thickness, a significant increase in service life can be expected from these heavier coatings.

The main problems associated with gray coatings are their aesthetic acceptability and the fact that the zinc-iron alloy layers are hard and inflexible, and may be prone to mechanical damage if subjected to impacts during transport and erection, where conventional shiny coatings have excellent resistance to quite severe impacts.

One fringe benefit of gray coatings on galvanized steel is that they provide a good substrate for painting, because of the matte surface. This characteristic has been used by some steel producers to produce a galvanized sheet which is then heat treated to improve the paintability of the product for whitegood manufacture.

Gray coating micrograph: zinc-iron alloy crystals form all of the galvanized coating, producing a non-shiny gray surface appearance.



Standard galvanized coating micrograph: the zinc-iron alloy layer is coated with smooth layer of zinc, producing a shiny surface.

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