

Keep C/I customers free of white rust

A technical look at how water treatment and construction technologies combine to cause this tough problem.

By Mario C. Uy

Steels used for cooling towers are galvanized to protect them from premature corrosion. Galvanizing is the process of coating the base steel with a thin layer of zinc, to provide a barrier that acts as a sacrificial anode.

Zinc is anodic to steel and will preferentially corrode to protect the steel from rusting. As the galvanized surface is further exposed to the right environment, the zinc coating corrodes to form a dense, adherent, and protective basic zinc carbonate [$3Zn(OH)_2 \cdot ZnCO_3 \cdot H_2O$],

that resists further corrosion.

If the basic zinc carbonate is not formed, a porous, less tenacious, and non-protective zinc carbonate [$ZnCO_3$] is formed instead, which will corrode rapidly. This rapid corrosion of the zinc coating is the white rust phenomena. White rust has the appearance of a thick, white, waxy deposit.

How water treatment systems contribute

The appearance of white rust on a new cooling tower does not mean that the tower is falling apart, but the steel

can corrode very rapidly.

White rust has become common due to several technological changes made by the galvanizing and water treatment industries, to meet certain environmental laws.

The objectives of the environmental regulations are noble. Unfortunately, these environmental solutions have created additional problems for water treatment dealers and their C/I customers.

A main issue was that the galvanizing and water treatment industries made changes with each industry not accounting for what the other was doing. Eventually, this led to concurrent changes that promulgated the white rust phenomena.

The water treatment industry replaced acid and chrome treatment with high alkalinity and high pH programs.

Changes in the galvanizing industry

In the early days, cooling towers were galvanized by Hot Dipped Galvanizing method (HDG). HDG method produces a 1.5 oz/ft² zinc coating on each side.

Now, most cooling towers are being galvanized by the Heavy Mill Galvanizing method (HMG), under the industry coating class G-210. HMG produces a 2.1 oz/ft² zinc coating for both sides (or 1.05 oz/ft² per side), a reduction of about 30 percent of zinc coating, to reduce the zinc impact on the environment.

Galvanized steel can either be chemtreated or non-chemtreated. Chemtreatment is a chromate solution applied at the mill to passivate the zinc coating, to inhibit the formation of "white rust" or wet storage staining.

Most, if not all, of the galvanized tow-

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ers manufactured in the United States are now non-chemtreated, again due to environmental regulations.

With these changes, most new galvanized cooling towers are coming out of the factory unpassivated.

Changes in the water treatment industry

The water treatment industry also went through similar changes due to environmental regulations. The industry replaced the old acid and chrome treatment with more environmentally friendly high alkalinity and high pH water treatment programs.

The new alkaline programs have been found later to retard the formation of the basic zinc carbonate on unpassivated new galvanized cooling towers.

For example, as pH rises beyond 8.3, the level of free carbonate anions

Chart 1: Recommended chemical levels

Chemical	Level
pH	7 - 8
halogen	< 0.5 ppm
calcium	100 - 300 ppm
alkalinity	100 - 300 ppm
chloride	< 450 ppm
sulfate	< 1200 ppm

increases, which is believed to be the biggest contributing factor to white rust.

What can be done to prevent white rust on unpassivated new galvanized cooling towers?

The new cooling towers have to be pre-treated and passivated in the field, to form the protective basic zinc carbonate.

The Cooling Tower Institute (CTI) recommends the following guidelines for starting up new galvanized cooling towers.

- During cleaning, avoid harsh acid or caustic cleaners. Zinc is amphoteric and will corrode at either low pH or high pH.

- Pre-treat the towers with an inorganic phosphate at 400-450 ppm as PO₄.

- Thereafter, maintain the chemical levels in **Chart 1: Recommended chemical levels**, during operation for the first 30 to 60 days, in addition to the normal chemical treatment programs.

As a precautionary measure, continue to run the PO₄ at about 20 ppm during this passivation period. After the passivation period, the cooling towers can be operated under the normal alkaline programs without the risk of white rust formation. □

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