WET USA Inc.
316 Roma Jean Pkwy, Streamwood, IL 60107
tel 630-540-2113 • fax 630-540-2117
www.wet-usa.com • info@wet-usa.com

TECHNICAL PUBLICATION

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Prevention of White Rust on New Galvanized Cooling Towers

by: Mario C. Uy

Introduction

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. It protects the base metal by providing a barrier and by acting 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 [$3Zn(OH)_2 \bullet ZnCO_3 \bullet H_2O$], 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.

White Rust, therefore, is the premature and rapid corrosion of this protective zinc coating. Obviously, as the protective barrier is stripped, the base steel becomes vulnerable to corrosion. The appearance of White Rust on a new cooling tower does not mean that the tower is falling apart, at least not yet. However, if the base steel is not protected immediately via other means, then it can corrode very rapidly, shortening the life of the tower.

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 sometimes, solutions can create new problems. Such is the case in the White Rust occurrences in new galvanized cooling towers. Both industries made changes without factoring in the concurrent changes that were also being made in the other industry. Even if they knew this, no one could have ever predicted the results of the combined changes. There was simply not enough time to have studied the long term effects these changes have on each other. Eventually, this resulted in a gap between the 2 industries, leading to premature failures of new galvanized cooling towers, due to the White Rust phenomena.

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/ft^2 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/ft^2 zinc coating for <u>both</u> sides (or 1.05 oz/ft^2 per side), a reduction of about 30% of zinc coating, to reduce the zinc impact on the environment.

Galvanized steel can either be chemtreated or non-chemtreated. Chem treatment 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 towers manufactured in the USA are now non-chemtreated, again due to environmental reasons.

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 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 or high pH. Pre-treat the towers with an inorganic phosphate at 400-450 ppm as PO_4.

Thereafter, maintain the following chemical levels, during operation for the first 30-60 days, in addition to the normal chemical treatment programs.

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

As a precautionary measure, continue to run PO_4 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.