White Rust

GALVANIZED COOLING TOWERS

Factory assembled cooling towers have been manufactured from "heavy mill galvanized" (HMG) steel for many years. HMG steel is continuously hot dip coated with protective zinc at the steel processing mill. The steel is treated subsequent to coating with a chromate rinse to initially passivate the zinc surface, providing for protection during storage, fabrication and transportation from "wet storage stain". Every year there are reports of steel cooling towers experiencing premature corrosion generally termed "white rust".

It is very important the cooling tower owner understands that white rust occurs in only a very small percentage of galvanized cooling towers, and it is preventable. Some possible combinations of water quality and treatment chemicals that might be experienced in the field could produce the following scenarios:

- Untreated water itself may passivate the galvanized surface and prevent white rust under the right water chemistry conditions (pH, hardness, alkalinity). However, untreated water may have a detrimental corrosive effect on other systems metallurgies, i.e. steel pipe and copper heat exchanger tubing. Consult a competent water treater as described in the following text.
- More traditional, neutral pH, water treatment programs for corrosion and scale control may passivate the galvanized surface. White rust should not occur in this situation.
- Commonly used, higher alkalinity water treatment programs may inhibit formation of a protective film on the galvanized surface, interfering with the passivation in a small number of cases. Initial and periodic passivation of metal surfaces may be required.

Even in the worst case situation, white rust is preventable. It is recommended that a competent water treatment specialist (familiar with local water quality and the materials of construction including zinc/galvanized steel) be consulted, and that a proper water monitoring program be initiated.

Definition of "White Rust"

"White rust is the accumulation of appreciable volumes of a soft, white, fluffy, non-protective zinc corrosion product on galvanized surfaces. With this non-protective *porous* reaction product in place, the surface is not passive to future zinc reaction and corrosion continues. Typically, white rust appears suddenly and progresses rapidly over the wetted, galvanized steel components in the cooling tower, condenser, or cooler."[1] If this condition is not corrected, it may lead to premature failure of the galvanized coating.

Possible causes of White Rust

HMG steel normally provides excellent corrosion resistance in cooling towers and many other applications. Zinc is a very reactive metal which acts both as a sacrificial anode protecting the steel and as a barrier to continuous ongoing reaction. Maximum service life for zinc is attained in a neutral pH environment (pH 6.5 - 8.0), which allows formation of the non-porous zinc carbonate/zinc hydroxide passivation barrier on the surface.

As federal and local regulations increasingly restrict the use of many corrosion inhibitors (such as chromates), water treatment systems have come to rely heavily on more alkaline (high pH) water chemistries to help control corrosion rates. While there is some disagreement about the actual cause of the corresponding increase in reported cases of white rust, various water treatment experts have concluded that some of these higher alkalinity treatment chemistries actually inhibit the formation of protective films on the galvanized surface and thus allow development of white rust.

There are also indications that soft water (less than 50 ppm total hardness), when combined with these high pH conditions, can make the problem worse.

Galvanized Steel Quality

One published study has unfortunately attributed the formation of white rust to changes in the zinc thickness or increases in the aluminum content of the HDG zinc or galvanized steel. In fact, all major suppliers of galvanized cooling towers use G235 coating, which has a zinc thickness of 2.0 mils per side or 2.35 oz per square foot of steel sheet. Due to the need to bend metal during fabrication, HMG materials do contain small amounts (less than .3%) of aluminum — this is not new. One major supplier of galvanized sheet steel stated they "have been producing continuous hot dip galvanized sheet with . . . aluminum . . . since 1960." [2] The aluminum is not a new factor in the white rust phenomenon. Current HMG materials used in cooling towers are identical if not superior to the HMG sheet steel produced in years past.

Conclusion

Fortunately, white rust can be prevented, but it is important that the proper precautions are taken when a cooling tower first becomes operational. It is now generally accepted that in order to get maximum service life from a galvanized cooling tower, the wet contact surfaces must be passivated. In some cases (depending on water chemistry), the galvanized coating will be passivated by untreated water. On other projects, a variety of treatment programs which passivate and subsequently protect zinc surfaces are available that are more or less suited to local water conditions. In some areas, traditional (phosphate type) treatment systems may actually help passivate the zinc surfaces and preclude white rust formation. Chemical pretreats to passivate may be effective, but may require repassivation periodically.

In any event, a competent water treatment specialist, familiar with local water conditions, the materials in your cooling tower and cooling system, and white rust, should be consulted. A proper water quality monitoring program for system metallurgies should be initiated. Ask for a program which will provide excellent zinc corrosion inhibition, and be aware that concentration levels of treatment chemicals within recommended limits is essential.

In highly corrosive environments where galvanized steel may not provide the desired corrosion resistance, alternate materials of construction may be more suitable. Contact your local Marley representative for information on which of the alternate materials of construction now available would best suit your application and site requirements.

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[1] Johnson, Keith M. and Michelic, "Update on White Rust Corrosion and Control", Technical Paper TP91-14, Cooling Technology Institute, Houston, Texas (1991).

[2] Private correspondence, Mr. David Hudok, Weirton Steel Corporation, December 12, 1991.

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