White Rust

"White Rust" on Galvanized Steel Cooling Towers

For over 50 years, factory assembled cooling towers, evaporative condensers, closed circuit cooling towers and other evaporative cooling products have been manufactured from hot-dip galvanized steel. The life expectancy of these units, when properly installed and maintained has been excellent, often exceeding 20 years. In recent years, however, there have been reports of installations experiencing premature attack from "white rust". The critical fact that needs to be recognized is that white rust is preventable.

What is White Rust?

White rust is the accumulation of appreciable volumes of a white, waxy, non-protective zinc corrosion on galvanized surfaces. Typically, it will appear suddenly and progress rapidly over the wetted, galvanized steel components of the evaporative cooling equipment. If the condition is not corrected, it may lead to premature failure of the galvanized coating.

Causes of White Rust

Evaporative cooling equipment is subjected to a constantly wet and corrosive environment. In such situations, galvanizing serves both as a barrier coating and to provide cathodic protection to the steel. Historically, maximum service life was obtained by maintaining the chemistry of the circulating water at an essentially neutral state (pH of 6.5 to 9.0) and allowing the natural formation of a protective, light crystalline film on the zinc surface which retarded the formation of white rust. Alternatively, corrosion inhibitors such as chromates, and more recently phosphates, were used to develop such protective films.

In recent years, with more widespread air and water pollution, the quality of the recirculating water in evaporative cooling equipment has declined. Additionally, as federal and local regulations increasingly restrict or preclude the use of many corrosion inhibitors such as chromates, water treatment systems have come to rely increasingly on more alkaline (higher pH) chemistries. While there is still some disagreement on the actual cause of the recent increase in reported cases of "white rust", various water treatment experts are concluding that some of the newer, higher alkaline, treatment chemistries actually inhibit the formation of protective films on the galvanized surface and thus allow the development of white rust.

There are also indications that soft water (less than 30 ppm total hardness), when combined with these high pH conditions, can exacerbate the problem.

Prevention

Fortunately, “white rust” can be prevented, but it is important that the proper precautions are taken when a tower first becomes operational. In many cases, depending on water chemistry, the galvanized coating will be passivated by the untreated water. On other projects, a variety of treatment programs are available that are more or less suited to local water conditions. With other types of water treatment, a chemical pretreatment to

passivate the zinc may be needed, and this chemical passivation may need to be repeated periodically. In all cases, a competent water treatment specialist should be contacted and a proper water quality monitoring program should be initiated. It is important that this specialist is familiar with the formation of white rust, local water quality and the materials used to construct the unit. There are recommendations on how to passivate the equipment in the operations and maintenance manuals. The local BAC Representative can provide a contact for a local water treatment supplier.

In highly corrosive environments, where galvanized steel alone may not provide the required level of protection, alternative materials of construction may be more suitable. Stainless steel, galvanized steel coated with thermosetting hybrid polymer and TriArmor® Corrosion Protection System (link to brochure) are all options that would help prevent white rust. Contact your local BAC Representative for information on which of the alternative materials would best suit your specific application and site requirements.

Removal and Treatment

It is important to note that not all white deposits on galvanized steel are white rust. It is important for the owner/operator to, with the help of a competent water treatment specialist, properly determine if the deposits need to be removed or are better left alone. Deposit analysis may be necessary if, after physical inspection, no positive identification can be made.

Once the white rust has been identified, the following treatments are recommended by the Industrial Galvanizers Corp:

Light white rusting — This is characterised by the formation of a light film of white powdery residue and frequently occurs on freshly galvanized products during periods of heavy rain. It is particularly evident on areas that have been buffed or filed during quality assurance operations. These treatments remove the passivated surface from the galvanizing and expose unoxidised zinc to attack from rainwater. Provided the items are well ventilated and well drained, white rust rarely progresses past this superficial stage. It can be brushed off if required but will generally wash off in service with normal weather. No remedial treatment is generally required at this level.

Moderate white rusting — This is characterised by a noticeable darkening and apparent etching of the galvanized coating under the affected area, with the white rust formation appearing bulky. The galvanized coating thickness should be checked to determine the extent of attack on the coating. In the majority of cases, less than 5% of the galvanized coating will have been removed and thus no remedial work should be required, as long as the appearance of the affected area is not detrimental to the use of the product and the zinc hydroxide residues are removed by stiff bristle brush (not wire). If appearance is unacceptable, the white rust affected area can be treated as follows:

1 - Stiff bristle brush (not wire) the affected area to remove all white corrosion products

2 - Using a cloth pad wet with aluminium paint, rub the surface with the pad to apply a thin film of aluminium paint to the affected area to blend it with the adjacent unaffected galvanized surfaces.

Severe white rusting — This is characterized by very heavy oxide deposits. Items may be stuck together. Areas under the oxidised area may be almost black of show signs of red rust. A coating thickness check will determine the extent to which the galvanized coating has been damaged. Remedial treatment to reinstate the coating should be undertaken as follows:

1 - Stiff bristle brush (not wire) or buff the affected area to remove all oxidation products and rust if any.

2 - Apply one or two coats of approved epoxy zinc-rich paint (be sure to follow specific product instructions) to achieve required dry film thickness of 100 microns minimum.

The Association of Water Technologies also points out that in severe cases, multiple applications of a concentrated cleaning solution might be necessary along with brushing. Phosphoric acid, along with other acids such as acetic, glycolic or citric acid can also work, but when using any product, extreme care and caution should be taken since they can chelate the base zinc coating and overzealous cleaning can strip the zinc coating from the steel surface.

Repassivating

Any time the passivation film on galvanized zinc is damaged, by rust, abrasion or chemical attack, it is important that it is re-formed by again carefully controlling the recirculating water chemistry. To ensure proper passivation of the galvanized steel, keep the pH of the circulating water between 7.0 to 8.2 for four to eight weeks, or until new zinc surfaces turn dull gray in color.

It is important to note that stainless steel cold water basins and basins protected by BAC's own TriArmor® Corrosion Protection System and EVERTOUGH™ Construction do not require passivation. However, if the upper structure is galvanized steel, passivation is required.

It is important to contact your local water treatment specialist when treating white rust, and remember, stainless steel, galvanized steel coated with thermosetting hybrid polymer and TriArmor® Corrosion Protection System are all options that would help prevent white rust. Contact your local BAC Representative for information on which of BAC's many products would best suit your specific application and site requirements.

Johnson, Keith M. and Joseph B. Mihehc, "Update on White Rust Corrosion and Control", Technical Paper TP91-14, Cooling Tower Institute, Houston, TX (1991)