Technology Application Bulletin
Control of White Rust with "ZincGard"

Background

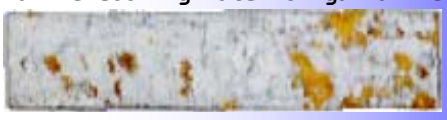
Shortages of fresh water, increasing costs for water and wastewater disposal, and stringent environmental requirements on discharges have created a desire to minimize both water usage and wastewater discharge. One common and very effective method to decrease both water usage and wastewater discharge is to **increase the cycles of concentration** at which cooling towers, one of the largest water users, are operated.

Increasing the cycles of concentration at which a cooling tower is operated increases the pH and alkalinity of the recirculated water. Operation of cooling towers at these higher pH and alkalinity values has resulted in the recognition of a new form of corrosion **"WHITE RUST".** White rust is the name applied to zinc corrosion, the products of which typically appears as a white to dirty gray voluminous deposit below the water line on galvanized steel surfaces exposed to the recirculated water. The white color is due to the formation of zinc carbonate, which does not form a corrosion limiting protective film on the base metal. Due to this lack of protective film formation, white rust corrosion will proceed until the protective zinc is entirely removed from the underlying steel, which is then subjected to accelerated corrosion and premature failure. White rust has been a substantial corrosion problem in some cooling towers, causing equipment failure in as little as three years.

White rust is not really a new phenomenon; it occurs anytime zinc, or galvanized steel, is exposed to water that has a pH value above 8.2 su. The **rate of corrosion**, however, is governed by the alkalinity of the water and presence of any accelerating agents, such as phosphates and phosphonates. Higher alkalinity, and the presence of accelerating agents, substantially increases the corrosion rate. In the past with pH control via acid feed, acidic chromium based water treatments, and lower cycles of concentration; white rust was rarely seen and thus not recognized as a specific problem. With the safety and control problems attendant with use of acid, the USEPA ban on chromium based water treatments, and general increase in cycles of concentration, many more cooling towers are now operated with **alkaline water chemistry**, putting them into the pH/alkalinity ranges that produce accelerated white rust.

To add to the problem, around 1989 the USEPA began to force zinc galvanizing plants to change the composition of the molten metal "bath" used to produce galvanized steel by reducing the level of lead in the bath to trace levels. The resultant reduction in lead content of galvanized steel produced by the new low lead baths is believed to render it even more susceptible to white rust corrosion in alkaline water.

Test run with soft alkaline cooling water on galvanized corrosion coupons.



This coupon was exposed to the cooling water treated with PCT 6221 at 200 mg/l. This product is a "standard" phosphonate/polymer material used in hard water service. This product is typical of those that are used by our competitors in situations similar to this.

This coupon was exposed to the cooling water treated with PCT 6420 at 300 mg/l. This product is a PCT formulation containing ZincGard™ and is designed for soft water use.

These coupons (above and below) demonstrate the effectiveness of ZincGard™ in combating white rust in both hard and soft water.

Problem

Once the problem presented by white rust was recognized, water treatment companies attempted to control it by using acid addition to lower the pH below the critical 8.2 su point, using higher levels of traditional corrosion inhibitors, pretreatment (passivation) of the cooling tower with various phosphate based products, and reducing cycles of concentration.

Unfortunately, none of these "cures" have been successful in providing a simple, reliable cure for this problem. Feeding acid to cooling towers still presents the safety and control problems it always has, with the additional problem that pH adjustment with the popular all-organic cooling water chemistries is critical, just a little too much acid and steel corrosion rates go through the roof. Laboratory examination of the traditional corrosion inhibitors, like phosphates and phosphonates, has shown that increased levels of these materials actually accelerate white rust corrosion, while pretreatment has shown limited success. Of course, reducing cycles of concentration is counterproductive as to reduction of water use and wastewater discharge. Another aspect of cycles reduction is that it also substantially increases the use of water treatment chemicals.

Test run with hard, alkaline cooling water on galvanized corrosion coupons.

This coupon was exposed to the cooling water treated with PCT 6200 at 150 mg/l. This product is a "standard" molybdate/phosphonate/polymer material used in hard water service.

This coupon was exposed to the cooling water treated with PCT 6203 at 150 mg/l. This product is a PCT formulation containing ZincGard™ and is designed for hard water use.

ZincGard™

- is a specific organic chemical compound found to directly inhibit corrosion of zinc (galvanized steel) in contact with alkaline waters
- is available **now**, incorporated into various blended products produced by ProChem-Tech for high cycle, all organic, softened makeup, and traditional water treatment chemistries
- protection against white rust is available at no increase in water management program costs
- eliminate the need to pretreat cooling towers for passivation
- eliminates the need to reduce cooling water pH below 8.2 su for control of white rust
- allows operation at economical higher cycles without fear of white rust damage to expensive cooling towers

Solution

Recognizing the need for a simple, reliable cure for the white rust problem, ProChemTech initiated research into new corrosion inhibitors. These efforts were successful in that a new inhibitor technology, **ZincGard™**, was discovered after two years of research. The technology is available in ProChemTech products offered directly to users and via other water management firms. ZincGard has also been formulated into an adjunct product for use with existing water management programs and is also available as a concentrate for use by product blenders.

ProChemTech International, Inc. is headquartered in Brockway, PA and maintains manufacturing facilities in Brockway and Apache Junction, AZ. The firm specializes in design, engineering, and manufacture of wastewater treatment and reuse systems; formulation and manufacture of specialty chemical products for boiler, cooling, process, and wastewater treatment; provision of complete water management programs; and supply of cooling tower systems.

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