

IMPROVE PERFORMANCE OF COOLING TOWER BY PASSIVATION

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ABSTRACT

This in recent years, as air and water pollution has increased, the quality of the circulated water in evaporative condensers and cooling towers has declined. As regulations limit the use of many corrosion inhibitors for the hot dip galvanizing process, such as chromates, the passivation process for protection has become even more critical. Passivation is a treatment process that forms a very thin protective layer that reduces chemical activity with air and water or other material that comes into contact with a surface. The passivation process varies depending on the type of material to be protected and the substances with which they contact. The most common circumstance is passivation for coils and casings for evaporative condensers and cooling towers. Passivation provides maximum protection from corrosion on newly installed evaporative condensers and cooling towers that have hot dipped galvanized steel tube coil surfaces.

Keyword: -for evaporator, condenser and cooling towers

1. INTRODUCTION

A cooling tower is a heat rejection device that rejects waste heat to the atmosphere through the cooling of a water stream to a lower temperature. Cooling towers may either use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature or, in the case of closed circuit dry cooling towers, rely solely on air to cool the working fluid to near the dry-bulb air temperature.

Common applications include cooling the circulating water used in oil refineries, petrochemical and other chemical plants, thermal power stations and HVAC systems for cooling buildings. The classification is based on the type of air induction into the tower: the main types of cooling towers are natural draft and induced draft cooling towers.



Fig.1.1 cooling tower

2. PROBLEMS OCCUR IN COOLING TOWER:-

The cooling water for a condenser can be sea water, river water, or tank or pond water. As the cooling water is brackish water with lot of contaminants, and since the steam side is under vacuum, this water can find a way into the steam condensed water. The cooling water mixing with condenser water leads to many problems on the boiler side. The main problem when operating the boiler with one or more condenser tube leaks is tube failure. The conductivity

Of the boiler water shoots up immediately and the pH level goes down, indicating the boiler water is tending to become acidic.

Industry uses such vast quantities of water that its importance in the economies and performance of Plant should not be overlooked. Particular attention must be paid to match the water quality from available source to the requirements of any specific plant, i.e., a comprehensive cooling water treatment program.

Whatever the source, the water will contain impurities and these impurities will be varied both in character and amounts present, depending on the different sources. The most difficult characteristic of water to tame is its stability, that is, its corrosive or scaling forming tendency. Water, which may be quite stable in their specific environment, may become unstable once the environment is changed, and in whatever direction, either scaling or corrosive, the change will occur, these two tendencies are strictly inter-related and no net separation can be done.

2.1 Scale:

Scale will interfere with efficient heat transfer and serve as a matrix for foulants to accumulate resulting in noticeable loss in cooling efficiency. Scale build-up results when a compound precipitates from the water phase because its solubility has exceeded. It differs from sludge because it usually is a dense, very adherent deposit of minerals and is tightly bonded to itself and to metal surfaces. Sludge, on the other hand, is the result of precipitation of minerals in a form that is loosely adherent to metal surfaces and other sludge particles. Crystallization of a compound directly on surface requires four simultaneous factors. They are: 1.) Super saturation, 2.) Nucleation, 3.) Adequate Contact Time, 4.) Scale Formation.

Depending on the type of water used as makeup to the cooling system, deposits/scale of carbonate, sulphates, phosphates and silicates (as well as other salts of calcium, iron, manganese, magnesium and zinc) are also observed in cooling water deposits.

Most importantly the corrosion inhibitor used as a part of cooling water treatment contains phosphate based chemicals which tend to precipitate under specific condition that exist in cooling water system.

2.2 Fouling:

Fouling is distinguished from scaling in that fouling deposits are formed from material suspended in water. A fouling deposit, however, will contain substantial amounts of scaling and corrosion products along with microbiological growth. Materials that cause fouling can occur in cooling system in five forms:

- Biological growth.
- Transported colloidal material in the recirculating water, e.g., iron, calcium carbonate and corrosion products.
- Silt or suspended solids in the make-up water.
- Airborne dust and particles carried into the system by air/water contact.
- Substance such as oil leaking into the recirculating water from process

2.3 Microbiological Growth:

Experience has shown that uncontrolled microbiological growth will render the best stabilization treatment inefficient. Microbiological organisms may be responsible for scaling or slugging even though the deposits or sludge may not be principally microbiological in nature. The micro-organisms may serve as a binder for the minerals which are found in the deposit.

These are of great interest in any chemical cooling water systems where Ammonia, Methanol, chlorine etc. are present as contaminants.

Most problems encountered in cooling water systems involve bacteria, and to a lesser degree, algae and fungi. Bacteria, a major category of troublesome organisms, can be grouped into three classes:

- aerobic slime formers
- anaerobic corrosive
- Nitrifying bacteria

Aerobic slime formers produce sticky and gooey deposit generally resembles mucus and may be coloured. These deposits can occur throughout a water system because most cooling water usually has sufficient oxygen for aerobic bacterial growth. A number of mechanisms exist by which anaerobic sulphate reducing organisms accelerate corrosion under anaerobic conditions. They include:

- Direct depolarization
- Precipitation of ferrous sulphide at the anode
- Creation of highly corrosive pH (frequently less than 3.0) under deposit as a result of Nitrous/Nitric acid H₂ and H₂S metabolic by-products.

All of these accelerate severe pitting corrosion on practically any metal surfaces. Corrosion attributed to these anaerobic is always manifested as a highly localized pitting. Iron depositing bacteria are very abundant in natural waters. The two species of iron-depositing bacteria of major importance in cooling water are *Legionella* and *Sphaerostilus*. Both species can use soluble (ferrous) iron as an energy source and convert it to an insoluble oxide or hydroxide form. Fresh deposits that are formed by iron depositors are frequently white to reddish-brown and voluminous. These deposits create fouling and concentration cell corrosion, as well as conditions for anaerobic bacteria to flourish.

2.4 Corrosion:

Corrosion is the oxidation process by which metals are converted back into their native states. Iron, for example, is converted back into its oxide. The area over which metal is corroded (oxidized) is called the anode and that area over which the oxidizing agent is reduced is called the cathode. These areas are separated, but may actually be microscopically close together and as corrosion proceeds, electrons flow through the metal between these areas. For aqueous systems, cations migrate toward the cathode, while anions move toward the anode area. The flow of electrons through the metal is the corrosion current and is limited by the rate at which electrons are accepted by oxidizing agent (usually oxygen) at the cathode.

Conductivity of the electrolyte (water) completes the electrochemical (corrosion or reaction) cell and controls the rate at which corrosion half-cell reactants and products can be transported to and from the reaction (or corrosion) site. Conditions that increase the conductivity of the water, e.g., high dissolved solids, or high temperature, generally increases the rate of corrosion.

3. PASSIVATION:-

Passivation refers to the spontaneous formation of an ultrathin film of corrosion products, known as a passive film, on the metals' surface that act as a barrier to further oxidation. The chemical composition and microstructure of a passive film are different from the underlying metal. Typical passive film thickness on aluminum, stainless steels, and alloys is within 10 nanometers. The passive film is different from oxide layers that are formed upon heating and are in the micrometer thickness range – the passive film recovers if removed or damaged whereas the oxide layer does not. Passivation in natural environments such as air, water and soil at moderate pH is seen in such materials as aluminum, stainless steel, titanium, and silicon.

Passivation is primarily determined by metallurgical and environmental factors. The effect of pH is summarized using Pourbaix diagrams, but many other factors are influential. Some conditions that inhibit passivation include high pH for aluminum and zinc, low pH or the presence of chloride ions for stainless steel, high temperature for titanium (in which case the oxide dissolves into the metal, rather than the electrolyte) and fluoride ions for silicon. On the other hand, unusual conditions may result in passivation of materials that are normally unprotected, as the alkaline

environment of concrete does for steel rebar. Exposure to a liquid metal such as mercury or hot solder can often circumvent passivation mechanisms.

3.1 How to passive?

The term 'passivation' refers to treating metal with chemical baths in order to make them permanently resistant to corrosion. In some cases, passivation is the name given to the application of anti-corrosives (instead of a bath) to various metals. The process that is used to passive copper, however, is a little different, as there is no way to truly alter this metal through chemical baths.

Passivation requires a neutral to slightly alkaline pH. Circulating passivation chemicals with inhibitor should be circulated to have proper passive film.

Nevertheless, in order to change the metal surface from an active state to passive state. The electrode potential must be raised to a level above that of the passivation potential. Typically this is achieved by the use of PO4/polymers in the presence of oxygen. Obviously the cooling water must be circulated over the tower to the necessary oxygen and heat load should be provided and chemical should be add accordingly. During the process fans should be switched off. The process for proper and effective passivation will need 3-4 days. Before the regular treatment is employed pH should be not more than 7.0 – 7.5 for the efficient use of chlorine or biocides. The easiest way to passive is to have min pressure of 2-3 kg /cm 2 of circulation water for primary wash and then pass the coating by reducing it thickness by 100 ppm to 25 ppm, by this it take 4 day for each layer.

3.2 Procedure of passivation:

Pre-cleaning

Systems hold up : 100 M3

Circulation rate : min pressure of circulation water is 2-3 Kg/CM2

Product : Ist Day Katside 6423 100 ppm on hold up : 10 Kg.
IInd Day Katside 6565 100 ppm on hold up : 10 Kg.

Keep pH valued of circulating water 6.5-7.0 during Pre-cleaning

Base of material : Non Oxidizing Biocide with dispersant

Temp required (heat Load) : min 3-50C delta T of cooling tower

Give 10 Blow Down after Completion of Pre-cleaning and before starting Passivation

Passivation:-

System hold up : 100 M3

Circulation rate : min pressure of circulation water is 2-3 Kg/CM2

Product : 3rd Day Sofaid 4170 100 ppm on hold up : 10 Kg.
4rt Day Sofaid 4170 50 ppm on hold up : 05 Kg.
5th Day Sofaid 4170 35 ppm on hold up : 3.5 Kg.

6th Day Sofaid 4170 25 ppm on hold up : 2.5Kg.

Keep pH valued of circulating water 7.0-7.5 and No Blow down during Passivation

Base of material : Phosphate Base Scale and Corrosion Inhibitor.

Temp required (heat Load) : min 2-40C delta T of cooling tower

Required time for Pre-cleaning and Passivation is 7 days.

3.3 Advantage of passivation:

- Passivation is a process that helps to prevent corrosion and pitting on surface.
- The passivation process applies a thin transparent passive chemically inter film to stainless steel that reduce the reactivity of the metal.
- This film detects corrosion and oxidation.
- For this plant since the load is decreased due to ageing it is not necessary to increase the number of tube.
- Due to this process tube life is increase so that change of new tube is delay so productivity will increase.
- Maintenance work will reduce.

4. CONCLUSION:

When the galvanized coating on carbon steel is maintained on cooling tower or other evaporative cooler surfaces, it functions to essentially slow down the rate of corrosion of the underlying steel. This promotes acceptable performance of the steel and maximizes the life span of the equipment while minimizing the overall cost of the material. However, the steel must remain wholly covered with the galvanized zinc coating to maintain this corrosion inhibition. White rust formation on these galvanized surfaces may eventually lead to the coating being compromised, resulting in rapid, local corrosion at the site of the exposed carbon steel beneath. Properly passivating the zinc coating on these surfaces can greatly improve the corrosion resistance of the coating, extending its protection of the steel structure. This process can be repeated on cooling evaporative systems that have already been in service to re-passivate the surface, restoring the passive zinc oxide layer. All galvanized surfaces should be regularly inspected for white rust formation, and the process repeated as needed. Talk to your water treatment specialist for any specific questions you may have.

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