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TECHNICAL ARTICLE

Cooling Tower Systems - Stagnant Conditions

What Are You Going To Do?

The Challenge

Routine system shutdowns, plant closings, and equipment "mothballing" are a sign of the times. These are all examples of situations where the cooling water may be in a non-flowing condition (stagnant) for long periods of time. These stagnant times will result in corrosion and fouling problems that are difficult to overcome once the system resumes operations.

If a cooling system, or even parts of a cooling system, is going to be idle for more than a few weeks, then proper contingencies should be considered. After extended-time shut downs the cooling systems rarely return to service without major problems unless precautions are instituted.

Why Are Stagnant Conditions Dangerous?

In the world of cooling the transport of water treatment to the metal surfaces and the transport of deposition away from surfaces is critical to success. Corrosion potentials increase and microorganisms more easily flourish and attach to surfaces. The net result is increased fouling and corrosion. The flow of water is essential in bringing corrosion inhibitors and deposit control agents to the metal surfaces.

What Will You Tell Your Customer?

Remind your customers that stagnant conditions and improper storage of equipment & systems will lead to severe consequences. It is extremely important that you document to the customer these dangers and what will happen if they don't follow proper recommendations.

Lay-Up of Equipment in Cooling Water Systems

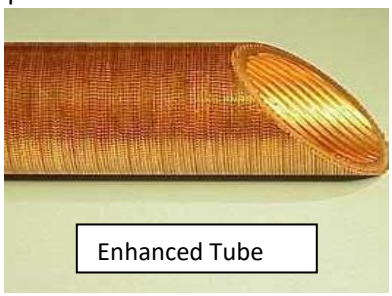
Best Practices for Cooling System and Equipment Lay-Up

Introduction

Protection of cooling systems and related equipment should always be considered regardless of it being in service, coming out of service, idle, or in storage. Improperly treated systems during intermittent operation or shutdowns will create corrosion and/or fouling problems which are difficult to overcome once the system is brought back on-line. By following some basic best practices during intermittent operation or down time better protection will be ensured. Lay-up or storage of cooling systems or equipment can be classified as a "Dry" or "Wet" lay-up. Each has its advantages and disadvantages. Remember to conduct the proper system shutdown and startup procedures before and after every lay-up or turn-a-round. Avoid having idle heat exchanger bundles unprotected and don't let improperly treated equipment sit stagnant.

A special note for Enhanced Tube design, it is well known that enhanced surface tubes have inherent stresses from the manufacturing process. These areas of stress are potential candidates for localized corrosion attack. This design, with its many ridges and crevices, also acts as a strainer for debris and tends to collect suspended matter. It is important to avoid low flow or stagnant conditions and also to minimize suspended matter and high iron levels in the circulating water especially if this type equipment is being stored. Suspended materials in the circulating water will tend to settle on idle heat exchange surfaces. Especially with enhanced surface exchangers, this creates a situation where under deposit attack and microbiologically influenced corrosion (MIC) can oc-

cur. These materials (organic and inorganic) will also impact on the inhibitors ability to protect the surfaces. It is imperative that proper pre-cleaning, lay-up, and passivation procedures be implemented to minimize corrosion caused by improper storage or lay-up. This document offers some storage Best Practices accepted in all industries.


Enhanced Tube

SHUTDOWN

Intermittent operation and system turn-around/down time are very common occurrences in all industries. The cooling system and related equipment should be managed properly prior to shutdown. The equipment or systems should be shutdown properly to minimize the potential long-term detrimental effects from lay-up. Certain types of systems/equipment may require more frequent management. Equipment such as chillers may experience shutdown more frequently than industrial equipment. In the southern climates, chilled-water cooling systems will generally remain operational year round, with only a very short period of intermittent operation. In the northern climates intermittent operation may extend over a period of one to two months before total system shutdown procedures take place. In areas of the country where total shutdown occurs, proper shutdown procedures should be followed before the system is laid up for the season. The following shutdown guidelines will help prepare the system for lay-up.

If equipment has become fouled during operation, then a cleaning should be completed first prior to laying up the equipment and as part of the shutdown procedure. Depending on the nature of the deposit and the metallurgy, chemical cleaning and passivation may be appropriate. Also, complete any regularly scheduled condenser/evaporator tube brushing and/or power lancing using the recommended reversing machine for the surfaces being maintenance (i.e. enhanced surface tubes) along with the proper tube brushes. The surfaces should be clean prior to laying the equipment up. This type of maintenance could ideally be used on all equipment before storage.

Shutdown Procedure

Pre-shutdown:

Five days before shutdown, gradually lower the specific conductivity to a point below the minimum of the control range.

48 hours prior to shutdown, add a surfactant. Wait 2 to 3 hours and add a heavy dosage (2 times normal feed rate) of non-oxidizing biocide.

Maintain the corrosion inhibitor concentration at the upper control range. Since you are removing water to bring the conductivity down, this will require an increase in the feed rate of the corrosion inhibitor.

The water systems should be flushed and purged of any miscellaneous materials and reduce the TDS to minimize deposition during lay-up. The biocide program should also be fortified prior to lay-up to minimize the chance of microbial growth during lay-up. For the last ten days of operation (or some period of time prior to shutdown or storage), reduce the cycles of concentration to reduce the level of suspended and dissolved solids. Several days prior to shutdown, blow the system down to lowest feasible cycles of concentration. For closed systems, it may not be necessary to flush the system unless the circulating water is contaminated with high levels of metals (>2 ppm iron and >0.2 ppm copper) or other contaminates. For closed systems, the system can be purged with fresh makeup, or a side stream filtration can be use.

After the system has been purged and fresh water added, several operational considerations should be performed. Part of this system shutdown procedure is to make sure that all of the equipment in the cooling loop sees the fresh water and the proper levels of inhibitors and biocides.

The system should be disinfected prior to shutdown. There are several approaches that can be utilized with a target of high dosages of surfactants and biocides (either oxidizers and/or non-oxidizing biocides). Non-oxidizers are preferred because of their persistent residuals and minor effect on a system's metallurgy. Once the system water is flushed, replenished, and treated with biocides and surfactants, charge the system with a high dose of a broad-spectrum biocide. This approach helps minimize microbial growth in areas of outstanding water.

Higher than normal inhibitor levels (consider doubling or tripling) should be maintained during shutdown to overcome for the lower cycles and attempt to passivate prior to shutdown. The specific levels depend on the system and its make-up water.

Test for chemical residual, microbiological activity, and monitor corrosion coupons prior to shutting down. Maintain corrosion inhibitor concentration at the upper control limit (or compensated for lower cycles) during the pre-shutdown procedures.

Shutdown Summary

Shut the system down, drain, and inspect. Clean and flush the tower. Inspect and clean the tower decks for deposits and debris. Bond's Tower Turbo Kits help to expedite this process - https://www.bondwater.com/tower-turbo-cooling-tower-cleaning-kits/

Refill with fresh water.

Dry Lay-up using ***Vaprotex 2000***: Add lay-up chemical at a rate of 4 - 2.2 lb bags for every 1,000 gallons of system volume, and a heavy dosage of non-oxidizing biocide (2 times normal feed rate) and circulate 12 to 24 hours. Allow 1 hour between adding layup chemical and biocide. Drain the system completely. Be sure to close all valves to seal system piping to external atmosphere and cover all major openings such as fan stacks and open expansion tanks in the system.

Wet Lay-up using ***Bond 8080:*** Add lay-up chemical at a rate of 1.5 – 3.0 gallons for every 1,000 gallons of system volume, and a heavy dosage of non-oxidizing biocide (2 times normal feed rate) and circulate for 12 to 24 hours. Allow 1 hour between adding layup chemical and biocide. Drain lines to below roof level to protect against freezing, if applicable.

Remove, clean, and store pH and conductivity probes per manufacturer's recommendations.

Additional Considerations

Any system shutdown should depend on the type of lay-up approach that is most appropriate for your customer's systems or equipment. The system and equipment to be shutdown should first be identified. Determine whether one piece of equipment is being taken out of service, if 2 out of 4 chillers are being taken out of service or determine if the entire system is coming down. The expected lay-up method will define the steps required for shutting the system down. For individual pieces of equipment, there are a lot of options because of the typically small volumes of lay-up solution involved. As for system lay-ups, the volumes of water typically warrant certain types of reasonable storage and shutdown procedures. If the system is extremely large (volume) then protecting all the equipment and piping can be difficult and potentially costly.

Most systems should be shutdown, drained and inspected. The cooling tower should be cleaned and flushed. Remember to remove accumulated organic and inorganic material and debris that may have accumulated in the system. Clean built-up salts from drift eliminators and remove deposits from deck, fill, louvers and spray heads. Mechanically clean all components in the tower area that can be accessed.

When mechanically cleaning cooling towers there is a potential for significant exposure to various pathogens such as Legionella and special personal protective equipment should be worn during the cleaning.

Cooling Tower

Float and ball cock valves on the cooling tower makeup should be taken apart, cleaned, and rewashed.

The interior of the cooling tower and the tower boards or packing should be washed down.

Distribution decks/ pans and spray nozzles should be thoroughly cleaned.

Tower pans/distribution decks&sumps, pipelines, and pumps should be drained and flushed and, if exposed to freezing temperatures, these components should have all water safely removed.

Automatic "fill" valves should be locked closed.

Strainers, filters, and screens should be removed and cleaned or serviced.

Tower fans and fan drives should be carefully inspected for wear, cracking, corrosion, and other conditions that may cause service interruptions.

If possible, fan and louver openings should be covered or screened to minimize the amount of airborne dirt carried into the tower or evaporative condenser during the idle period.

Pumps should be winterized by using foamed lubricant, and pump motor bearings should be checked and lubricated.

All metal parts subject to alternate wetting and drying should be painted to prevent corrosion.

If the tower is of wood construction the surfaces should be continuously wetted to prevent structural shrinkage at the fittings and also to minimize the fire hazard.

Air Handling Coils

Chilled water coils in air handling units subject to freezing conditions should be drained and air-blown to remove water, or flushed with an anti-freeze solution.

The coil face should be cleaned and the condensate traps and pans cleaned and drained.

Freeze protection controls in the air ducts should be checked for proper operation to prevent subfreezing air temperatures from passing through the undrained chilled water coils or hot water heating coils.

Suitable freeze alarms should be installed in ducts where damper mechanism failures, pump outages, or control failures can cause coils to be exposed to freezing conditions.

START UP PROCEDURES

Even with a good lay-up and storage practice on cooling systems and equipment, it is always recommended that some type of Start Up Procedure be implemented to optimize cleanliness and good system passivation. Prior to start-up, follow proper "Pre-Cleaning" and "Pre-Filming" guidelines. If equipment inspection reveals good system cleanliness, it is still recommended that the system be properly started because they may be areas in the system or individual piece of equipment that may require additional treatment. Basins should be thoroughly cleaned if not already done. Be aware of issue concerning galvanized towers and white rust.

As already defined, a goal of following these Best Practices is incorporating some type of system or equipment management during down time that helps minimize the potential problems associated with improper storage. We should remind our customers that improper storage of equipment and systems can lead to very severe corrosion attack and difficult system and heat transfer surfaces re-passivation.

A general guideline for system start up is as follows (a complete and thorough pre-treatment and pre-filming procedures should be implemented during a system wide start up or the commissioning of an individual exchanger):

Refill with fresh water and begin circulating. Initiate a pre-treatment procedure to passivate the system. This involves high levels of inhibitors and dispersants to ensure system wide passivation and compensates for the softer low cycle water.

Shot feed with dispersant and biocide 2 X the normal dosage.

Once TSS and metal levels are within normal levels, the cycles can increase and the normal corrosion inhibitor program can be initiated.

For the first one to two weeks, maintain higher than normal blowdown to remove the lay-up inhibitor, if the wet method was used.