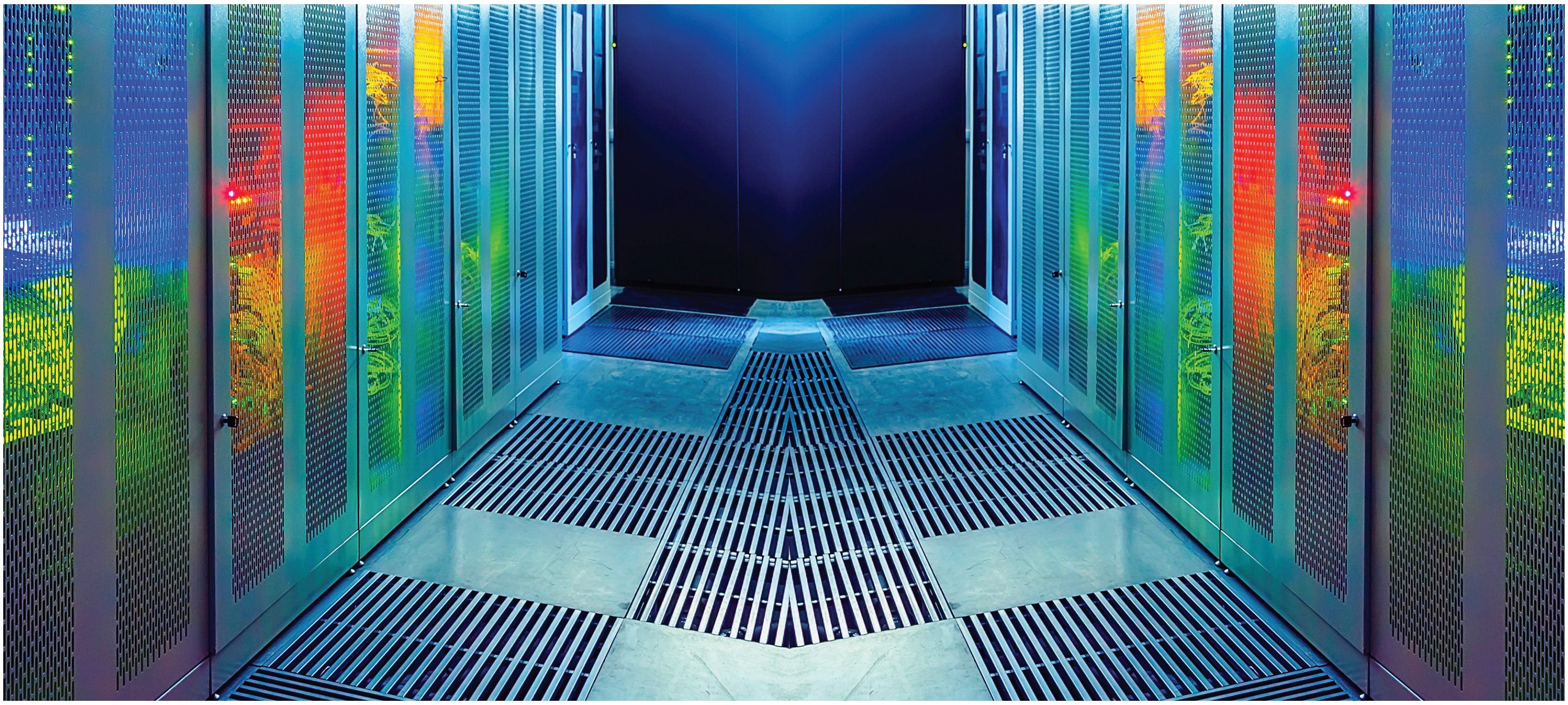
NALCO Water
An Ecolab Company



Data Center Condenser Protection

How to protect your data center condenser water system during idle operation

Keys to success:

- Select primary layup objective
- Implement safe practices

All condenser water systems are susceptible to corrosion during idle operation. Common corrosion inhibitors and biocides that protect systems during operation rely on water mixing and flow velocity to perform.

When water stagnates for any period of time, the chemicals that protect against corrosion, biofilms, and fouling can be diminished by up to 100%.

Idling systems allow mud and silt to settle out, and promote the growth of biofilms including anaerobic acid producing bacteria (SRB), sometimes creating acute and devastating corrosion that can pit iron and copper pipes quickly.

Legionnaire's disease producing bacteria multiply and proliferate during idle water conditions and these harmful bacteria can diffuse into the cooling tower mist when the cooling tower is restarted. These bacteria can travel miles in the prevailing wind to infect and even kill susceptible hosts nearby.

Data center condenser water systems are particularly susceptible to sitting around idle because they are designed with redundant cooling capacity, often with N+1; N+2; or even 2N+1 philosophy of operation depending on Uptime Tier design requirements. With cooling seasonality, and the excess capacity often built in, it is not uncommon for data center water systems to be idle more than operational.

For this reason, it is critical to design a data center water treatment program with idle operation and lay-up in mind.

Determine Objectives of your Condenser System Water System Lay-up Program

It is extremely important that the plant's operating team and Nalco Water Sales Engineer undergo a process of discovery to determine what the most important objective of the lay-up protocol is prior to the selection and implementation of a lay-up program.

This part of the process, in selecting the lay-up option that is best for the plant's particular circumstance, is critical.

The lay-up program should be evaluated based on the equipment inspection results and corrosion coupons with a particular focus on coupon pit depth analysis with a goal of less than 5 mm measured in pit depth.

Examples of condenser water system lay-up program objectives are:

- Provide best asset protection
- Allow shortest time for the stored unit to come on-line
- Minimize chip scale risk
- Require the least amount of energy
- Require the least operator atten¬tion during the lay-up process
- Require the least capital investment in implementing the lay-up
- Meet the requirements of the water safety management program. (WSMP)

While it may be tempting to say "all of the above", this cannot be considered as a fair answer to the question of the lay-up objective. As an example, the best method for asset protection would be to recirculate the water through the condenser and evaporator side constantly to maintain passivation but this would be very energy intensive compared to other methods.

Therefore, lay-up objectives must be prioritized as the starting point for this discussion.

Here is additional information regarding the different objectives listed above, that can be used in the discovery process.

Asset Protection:
It is obvious that asset protection has a role in the selection of the lay-up process applied; otherwise the equipment would be allowed to rust away on its own. The question to be considered is how much effort and expense can be justified to maintain the chiller system to be stored in ready-to-operate condition. Units that would fall into the category of requiring the most sophisticated lay-up procedures would include those where there is limited redundancy in place, so protection must be maximized.

Short Time to Come On-line:
Data center uptime that would suffer as a result of an interrup-tion in chilled water supply may justify the greater demands and cost of a wet lay-up, which would allow the unit to be generating chilled water in a minimum time.

Minimize Chip Scale:
Dry layups can give better long-term protection but expose the system to a risk of chip scale, particularly for older systems. This is a particular concern if the system does not have good filtration and even with good filtration, extra maintenance/cleaning on startup may be required.

Least Energy Used:
Today's energy prices require a careful examination of the energy that would be used by various lay-up options. Long recirculation will provide the best passivation but require additional energy that may be perceived us as wasteful and expensive.

Least Operator Attention:
Many industrial plants operate with mini¬mal staffing, and selection of a lay-up procedure that calls for extensive operator attention might detract from the completion of other tasks. A lay-up practice such as a dry lay-up, where essentially no attention is required for weeks at a time, might be recommended in these cases.

Meet Requirement of Water Safety Management Program:
Most data centers today operate within the requirements of the local health standards and codes. In most parts of the world, frequent water circulation is codified and sometimes a legal requirement. NYC imposes daily fines and can even imprison company executives for failure to comply with water recirculation and chemical addition requirements during idle operation.

Importance of Proper Lay-up

The best corrosion-control program can be com¬pletely offset by neglect during outages.

Protection can be achieved by either:

1. Maintaining the chemical passivation/film on the piping

or

2.Keeping the surfaces completely dry

Because of wide variations in system design, there is no universal water system lay-up procedure. System shutdown and the mechanical aspects of lay-up are important, so the system P&ID's and the cooling tower manufacturers' recommendations should always be consulted before proceed¬ing into a specific lay-up protocol.

System "dead legs" must first be mechanically eliminated for any lay-up program to work.

Cooling tower systems and sumps must be mechanically cleaned and pressure washed twice per year as per OSHA recommendations and all systems should be disinfected online at least once per year during the hottest part of the season.

Side stream sand filters (if present) must be disinfected annually and routine maintenance performed and validated with particle count analysis.

In the dry lay-up procedure, the system piping is fully drained and then dried either naturally or ideally with either nitrogen or warm air. Often the system is first passivated and/or filmed to help prevent corrosion. Dry lay-up is typically recommended for younger or well-maintained systems with longer downtime periods, meaning an expected dura¬tion of 30 days or longer and when the unit is not expected to be called into service on short notice.

Wet lay-up is recommended for shorter outages (usually 30 days or less) though it can be used for longer outages if the lay-up conditions are maintained and monitored. The wet method has the advantage of permitting the system to be returned to service on short notice.

Part 1 - Condenser Water and Cooling Tower
Wet Lay-up

The best lay-up practice would be to not take the system out of service. This would mean maintaining normal recirculation flow rates, load and chemical program. For many data centers this is not possible due to uptime Tier N+ requirements.

Systems must be circulated a minimum of 3 times per week for at least 30 minutes and operated at least 7 days per month at full load or a wet lay-up must be performed. Keep in mind that circulation should be coordinated around scheduled biocide feeds.

In climates with seasonality, data centers can sometimes take one of more systems out of rotation and perform a wet lay-up. This protects the system and enables it to be ready for service on short notice.

The first step in a wet lay-up is the passivation layer preparation before shut-down.

Preparing a good dense passivation layer is critical to success so short-cuts to this procedure are not recommended unless otherwise noted.

The first step in a wet lay-up is the passivation layer preparation before shut-down.

Preparing a good dense passivation layer is critical to success so short-cuts to this procedure are not recommended unless otherwise noted.

1. Blowdown the system to 1.5-2.0 cycles
2. Add a bio-dispersant like 73551 to the system to help remove biofilms before biocide addition
3. Add an oxidizing biocide like sodium hypochlorite, maintaining a 5 ppm free halogen residual for at least 4 hours.
4. Add 400 ppm of molybdate (as MoO4) or 1000 ppm of nitrite (as NO2). Add azole at 10 ppm. A preformulated product like TRAC104 is typically more convenient for lay-ups than adding separate chemistries.
5. Add a non-oxidizing biocide like isothiazolin, glutaraldehyde, or bronopol at the appropriate dosage based on the biocide label
6. Circulate chemistries 24 to 48 hours.

From this point we need to maintain passivation and monitor chemistry and bacteria. It is important to maintain zero SRB bacteria and aerobic bacteria plate counts below 100,000 cfu/ml using the swab method on the corrosion coupons inspected monthly for any evidence of pitting corrosion. Circulation at least once per week for at least 4 hours is recommended. Longer periods of circulation are better.

	Chilled Loop Side			Cooling Tower Side		
	Wet Lay-up without Circulation	Wet Lay-up with Circulation	Dry Lay-up	Wet Lay-up without Circulation	Wet Lay-up with Circulation	Dry Lay-up
Time to Start-up	Fast	Fast	Slow	Fast	Fast	Slow
Asset Protection	Poor	Moderate to good depending on the frequency of circulation	Good	Poor with conventional treatment, moderate with volatile corrosion inhibitors	Moderate to good depending on the frequency of circulation	Good
Ease of Operation	Easy	Complex, requires operator time to run	Moderate	Easy	Complex, requires operator time to run	Moderate
Time to Prepare System for Lay-up	Moderate: At least 24-48 hours	Moderate: At least 24-48 hours	Moderate to Long: 24-48 hours before shutdown; 24-48 hours after shutdown	Moderate: At least 24-48 hours	Moderate: At least 24-48 hours	Moderate to Long: 24-48 hours before shutdown; 24-48 hours after shutdown
Operational Issues	Stagnant conditions may support acid producing bacteria that are dispersed throughout the system on start-up	None	Risk of chip scale, particularly in older systems	Stagnant conditions may support acid producing bacteria that are dispersed throughout the system on start-up	None	Risk of chip scale, particularly in older systems
Safety Considerations	Microbio may present a *Legionella* risk when the system is started up	Microbio may present a *Legionella* risk when the system is started up	If nitrogen gas is used for drying out the system, there is a hazardous atmosphere risk	Microbio may present a *Legionella* risk when the system is started up	Microbio may present a *Legionella* risk when the system is started up	If nitrogen gas is used for drying out the system, there is a hazardous atmosphere risk

Another alternative that may be useful in systems where molybdate or nitrite cannot be used, is the azole-based program. In this program, an azole residual of 30 ppm as azole is targeted. pH is maintained between 7.0-9.0. This will protect both mild steel and yellow metal components well. It is a more expensive option and, in some locations, this level of azole may present aquatic toxicity issues.

Chemical and biological testing should be performed at least once per month (during the circulating period; ideally at the end of the period) and chemistry should be added as required.

Residuals should be maintained at the original passivation levels. Planktonic total aerobic count should be less than 104.

There is also a mechanical component to a wet lay-up. To lessen corrosion in the chillers themselves, sacrificial anodes in the end bells are recommended or epoxy coatings on the chiller tube sheets and bell caps.

Side stream filtration is also highly recommended for systems that will be circulating. Filtration should remove particles down to .5 micron.

Dry Lay-up

The first four steps of a dry lay-up procedure are the same as the wet lay-up procedure. They are repeated here in addition to the three options for dry lay-up.

1. Blowdown the system to 1.5-2.0 cycles
2. Add a bio-dispersant like 7348 to the system to help remove biofilms before biocide addition
3. Add an oxidizing biocide like sodium hypochlorite, maintaining a 5 ppm free halogen residual for at least 4 hours.

Dry Lay-up Option 1 – Oil Based Filmer

4. Add 400 ppm of molybdate (as MoO_4) or 1000 ppm of nitrite (as NO_2). Add azole at 10 ppm.
5. Add 0.6-1.2 fl oz/gal of Nalco 41. (Note that Nalco 41 is not compatible with EPDM or other rubber roof membranes. Do not allow these products to come into contact with these materials. Also Nalco 41 is not compatible with oxidizing biocides.)
6. Circulate for 24 hours.
7. Shut-off pumps and drain system. (Note that Nalco 41 contains high levels of oil. Special precautions may be needed to be taken before this product, can be discharged to the sanitary sewer. When in doubt consult with the local authorities. Never discharge any product to non-sanitary sewer outlets unless it is identified and complies with local requirements and the facility permit.)
8. Dry system with either nitrogen or hot air if possible, then seal in the internal surfaces to keep out moisture.

Dry Lay-up Option 2 – Non-Oil Based Passivation

4. Add 400 ppm of molybdate (as MoO_4) or 1000 ppm of nitrite (as NO_2). Add azole at 10 ppm.
5. Circulate for 24 hours.
6. Shut-off pumps and drain system
7. Dry system with either nitrogen or hot air if possible, then seal in the internal surfaces to keep out moisture.

Part 2 – Chilled Water Systems

Wet Lay-up

1. Increase inhibitor level to 2-3 times normal residual level
2. Add a non-oxidizing biocide such as isothiazolin, glutaraldehyde, or bronopol.
3. Circulate for 24-48 hours.
4. Check micro-bio level with Dip Slides.
5. If micro-bio is present at unacceptable levels (greater than 103), repeat biocide addition and circulation steps.
6. Circulate the system weekly for 4-6 hours.
7. Check the inhibitor level monthly. If the inhibitor level is low, add product and recirculate for 6-12 hours.

Dry Lay-up

1. Increase inhibitor level to 2-3 times normal residual level.
2. Add a non-oxidizing biocide such as isothiazolin, glutaraldehyde, or bronopol.
3. Circulate for 24-48 hours.
4. Shut-off pumps and drain system to desired level.

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