Cooling Water Treatment for the ACR Serviceman

PROTECTS AND CONTROLS AGAINST . . .

- SCALE
- CORROSION
- SILT
- ALGAE AND SLIME GROWTH
- CLOSED SYSTEM CORROSION

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INTRODUCTION

Prior to the discussion of water treatment as it pertains to the air conditioning and refrigeration industry, let's make one observation: If you can understand why water treatment is necessary and what problems are caused by the lack of it, the task itself becomes, generally, quite simple.

There are basically three options for providing the proper water treatment. 1) Contract a water treatment service company to come in and do it, 2) Contract an air conditioning-refrigeration service company to come in and do it or, 3) Do it yourself. If the first option is chosen, the reliability of the equipment is at the mercy of the person doing the water treatment and not in the hands of the person responsible for the equipment. Obviously, it's best that the person responsible for the mechanical side of a system also be responsible for the water side as well.

This manual was written to assist you, the serviceman, in providing an approved and acceptable water treatment program that will assure that the equipment operates as well as possible.

Accordingly, there are some terms and relationships that you need to become familiar with. The following is a list of these terms and relationships and a definition of each.

TERMS

1. ppm—parts per million (how many pounds of a substance there are in a million pounds of water). May also be expressed as mg/1 (milligrams per liter).
2. gpg—grains per gallon (measurement of water hardness). May also be expressed in ppm (see below).
3. gpm—gallons per minute (measurement of water flow).
4. gph—gallons per hour (measurement of water flow).
5. BTU_h—British Thermal Units per hour (measurement of heat).
6. Ton—cooling effect of removing 12,000 btu's of heat.
7. TDS—total dissolved solids (the total amount of dissolved minerals present in the water).
8. µmhos—micromhos; unit of measure of conductivity (the opposite of ohm which is the unit of measure for resistance). Used as an indirect measure of total dissolved solids (TDS).
9. COC—cycles of concentration; refers to the number of times the TDS of the makeup (fresh) water has concentrated in the recirculating (tower) water.
10. Δt—chance in temperature; used to discuss the difference in temperature between water coming from the tower and water returning to the tower.

RELATIONSHIPS

1. 1 gpg = 17.1 ppm
2. 1 gallon of H_2O = 8.34 lbs.
3. 1 ppm ≈ 1 mg/1 (milligram per liter)
4. 1 ft^3 H_2O = 7.5 gallons
5. TDS = µmhos x .75
6. µmhos = TDS x 4/3
7. Btu/h = 500 x Recirc. Rate gpm x ΔT

AND ONE MORE—a ton of refrigeration will remove 12,000 Btu's of heat per hour but the cooling tower or evaporative condenser must remove 15,000 Btu's of heat per hour due to the extra heat picked up from the compressor, generally accepted to be 3,000 Btu's. This is very important to remember.

COOLING WATER TREATMENT

1. WATER FUNDAMENTALS

The hydrologic cycle is the ongoing process of evaporation and precipitation in the course of water movement. As water evaporates from the earth's surface, it does so in a pure state. As it falls back to earth in the form of precipitation, it picks up contaminates from the air. As it percolates down through the earth's layers and flows across the earth's surface, it dissolves and picks up many different types of minerals. In fact, water is generally regarded as a universal solvent and if given enough time will eventually dissolve practically anything.

These dissolved minerals are the cause of most of the problems associated with water-cooled equipment (ie. cooling towers and evaporative condensers). As the water containing all of these dissolved minerals (called Total Dissolved Solids or TDS) is circulated through a cooling tower or evaporative condenser (an Open Recirculating Cooling Water System, or ORCWS), a small portion of it is evaporated (approximately 1.8 gph per ton or 0.03 gpm per ton) to remove the heat that is absorbed from the refrigerant. In this way, the rest of the recirculating water is cooled and may be reused to pick up heat in the cooling application (commercial air conditioning, process cooling, etc.). The evaporated water is then replaced with fresh makeup water which contains more TDS, allowing the concentration of minerals to increase.

2. SCALE FORMATION AND CONTROL . . . CYCLES OF CONCENTRATION

If you will recall, water evaporates in a pure state. As water is evaporated from an ORCWS, its mineral content is left behind. As this evaporated water is replaced, it is done with fresh make-up that contains more naturally occurring minerals. If left unchecked, the mineral content will continue to grow and eventually exceed the water's saturation point and begin to "fall-out" (precipitate) as scale. The most common type of scale is calcium carbonate or "lime scale". Other types of scale are calcium sulfate, magnesium sulfate, silica, etc.

This build-up or concentration of minerals in the recirculating water is referred to as Cycles of Concentration (abbreviated COC or just C), and it represents the number of times the minerals present in the make-up water are concentrating in the recirculating water.

To maintain the Cycles of Concentration or C at a safe level in an ORCWS, a bleed-off is used. Bleed-off is the purposeful removal or draining, to an approved drain, of a small amount of the recirculating water. The bleed-off should be taken from a spot located after the condenser. This loss of recirculating water causes an equal amount of fresh make-up water to be introduced into the system which, in effect, dilutes the mineral content of the recirculating water, reducing the COC or TDS level. And in order to allow the water to maintain the highest amount of soluble TDS without scale formation, chemicals are added. Essentially, the use of selected chemicals gives the water a higher saturation point. The type of chemical used and the quality of the make-up water is what determines the level of COC that can be safely maintained in any given system.

3. DETERMINING MAXIMUM ALLOWABLE CYCLES

One of the most important steps in water treatment for ORCWS is determining the maximum level that the TDS will be allowed to concentrate, or the maximum allowable cycles or COC. This determination is directly controlled by the total alkalinity, hardness and silica of the make-up water (to a much lesser degree, chlorides can be an issue if they are unusually high in the make-up water). And, in the case of the alkalinity, the treatment product selected also plays a role.

One of the most important characteristics of water is its alkalinity. The minerals that belong to the alkalinity family are carbonates (CO_3), bicarbonates (HCO_3) and hydroxides (OH). These three, taken together, are referred to as total alkalinity, and the total alkalinity of the make-up water will determine what type of problem (scale or corrosion) to expect. Generally, the total alkalinity of the recirculating water cannot exceed 420-600 ppm depending upon the product selected.

With make-up water having low alkalinity levels (below 30 ppm), corrosion is the anticipated problem and a product called Cal-Treat 233 should be used. For make-up alkalinity levels between 30 ppm and 60 ppm, we would expect light scale to be the problem encountered. However, it is also possible to have a corrosion problem. Therefore, the product to use would again be Cal-Treat 233 as it is also a good scale inhibitor as well as a good corrosion inhibitor. When using Cal-Treat 233, the total alkalinity level cannot exceed 500 ppm in the recirculating water.

For make-up alkalinity levels above 60 ppm, scale is the expected problem and either No. 340 Liquid Scale Inhibitor or Ty-Ion C70 can be used. No. 340 LSI is strictly a scale inhibitor while Ty-Ion C70 inhibits both scale and corrosion, and it disperses silt. Once again, there are maximum allowable alkalinity levels for the recirculating water when using these products and they are 480 ppm and 600 ppm, respectively.

Regardless of which product is selected, the maximum allowable COC according to alkalinity is determined by dividing the alkalinity of the make-up water into the maximum allowable alkalinity level for the particular product being used. For example: if Ty-Ion C70 is being used and the total alkalinity of the make-up water (abbreviated mu / alk and measurable with a simple titration type test) is 180 ppm, then you would divide 600 by 180 and arrive at an answer of 3.3 allowed cycles (by alkalinity) for that system when using Ty-Ion C70.

But, another important characteristic of water is hardness. The minerals that belong to the hardness family are calcium (Ca) and magnesium (Mg). Both of these minerals, taken together, are referred to as total hardness, and total hardness also plays an important role in determining the maximum allowable cycles of concentration. The significance of the hardness is that they combine with the alkalinity and/or sulfate minerals to form most types of scale deposits found in ORCWS. The maximum level of hardness minerals that can be safely maintained in solution in the recirculating water is 1000 ppm, regardless of the product used. Maximum allowable COC according to hardness, then, is determined by dividing 1000 by the total hardness of the make-up water.

Silica is also very important. Silica is what glass is made from. Silica scale, caused by an excessive amount of silica in the recirculating water, *must be avoided* as it cannot be removed by acceptable acid descaling methods that are effective on the other types of scales (see application bulletin 3-106 for information about acid cleaning). The silica level in the recirculating water cannot exceed 150 ppm, once again regardless of the product being used. Maximum allowable COC according to silica, then, is determined by dividing 150 by the total silica of the make-up water.

Regardless of the make-up alkalinity, hardness or silica, the maximum cycles of concentration (COC) should never exceed 8.0.

SUMMARY

When using →	**Cal-Treat 233**	**No. 340 LSI**	**Ty-Ion C70**
Maximum allowable COC by alkalinity	$\frac{500}{\text{mu / alk}}$	$\frac{480}{\text{mu / alk}}$	$\frac{600}{\text{mu / alk}}$
Maximum allowable COC by silica	$\frac{150}{\text{mu / } SiO_2}$	$\frac{150}{\text{mu / } SiO_2}$	$\frac{150}{\text{mu / } SiO_2}$
Maximum allowable COC by hardness	$\frac{1000}{\text{mu / H}}$	$\frac{1000}{\text{mu / H}}$	$\frac{1000}{\text{mu / H}}$

Once you have selected the product to use, always use the smallest number obtained from the above calculations for that product. That smallest number must be the maximum level of allowable COC.

4. DETERMINING AMOUNT OF BLEED-OFF REQUIRED TO CONTROL CYCLES

The amount of bleed-off required is determined by the cycles we are trying to maintain and the capacity (tonnage) of the system. Obviously, a system that can operate at 4.3 cycles would require less bleed-off than one that operates at 3.3 cycles, assuming equal capacity. With the desired cycles known, the amount of bleed-off can be calculated from the following formula:

$$B = \frac{E}{C-1}$$, where C = COC
E = evaporation rate
B = required bleed-off

> As a point of information, the evaporation rate is given to be 1.8 gph / ton or 0.03 gpm / ton. And for those most interested, this is derived from the facts that:
>
> a. 15,000 BTU_h must be dissipated
> b. there are 970 BTU_h dissipated for every pound of water evaporated, and
> c. water weighs 8.34 lbs. /gal.
>
> Therefore:
>
> $$\frac{15,000}{970} \div 8.34 = 1.8$$ gph / ton, or in gpm it is 0.03 pgm / ton.

In any event, factor in the evaporation and the tonnage, and the calculation for bleed becomes:

$$\text{Bleed in gpm (Bgpm)} = \frac{.03}{C-1}(\text{tonnage})$$

All that is needed, then, to calculate the amount of bleed-off required, is to know the maximum level of COC allowed and the tonnage of the system. And you will recall, in order to find COC you also must know which chemical is going to be used as well as the alkalinity, hardness and silica levels of the make-up water. Let's look at an example:

Example:

1. Chemical selected = Ty-Ion C70
2. Make-up alkalinity = 140 ppm
3. Make-up silica = 22 ppm
4. Make-up hardness = 200 ppm
5. Capacity = 120 tons

COC by alk.	**COC by Silica**	**COC by hardness**
$\frac{600}{140} = 4.3$	$\frac{150}{22} = 6.8$	$\frac{1000}{200} = 5.0$

therefore, COC = 4.3 (the smallest of the three).

To calculate bleed-off in gpm (abbreviated Bgpm):

$$\text{Bgpm} = \frac{.03}{4.3-1}(120) = \frac{.03}{3.3}(120) = 1.09 \text{ gpm, or } 1 \text{ gpm.}$$

Once it is determined, the bleed can be set to function, either (1) at all times the system is running or, and this is more preferrable, (2) it can be controlled with a conductivity monitor controller and solenoid valve, (automatic bleed & feed system), such as the CMS-IV Cooling Monitor System.

Cycles of concentration vs. bleed-off. We can see from the bleed-off formula that the COC and the bleed-off are inversely proportional. As the bleed-off is increased, the Cycles of Concentration will decrease, and vice versa. Looking at the following chart you can see that as the required COC is increased from 1.5 to 2 and from 2 to 3, the required bleed-off decreases each time by 50%. It decreases 33% from 3 to 4 and 25% from 4 to 5 and so on. The greatest water savings occur up to about 5 or 6 COC.

COC	Bleed gph / ton	Bleed gpm / ton	Change
10	.20	.0033	13%
9	.23	.0038	13%
8	.25	.0043	14%
7	.30	.0050	17%
6	.36	.0060	20%
5	.45	.0075	25%
4	.60	.0100	33%
3	.90	.0150	50%
2	1.8	.0300	50%
1.5	3.6	.0600	

5. DETERMINING THE AMOUNT OF CHEMICAL REQUIRED

There are two methods of determining the amount of chemical required: a specific, more exacting way that we will show you below and a simplified method.

The Specific Way

Doing it the specific way, we would look at the formula used to calculate the monthly chemical feed requirement:

$$\#\text{'s} = \frac{\text{ppm}}{(120)\,(C)}$$

Where:

1. #'s = lbs. of chemical / 1000 gal. of make-up / day
2. ppm = parts per million of chemical desired
3. C = maximum allowable cycles or COC

First, calculate gal / day of make-up:

make-up = (bleed over 24 hours) + (evaporation over 24 hours), or
make-up = (Bgpm x 60 x 24) + (1.8 x 24 x tonnage)

Therefore:

$$\#\text{'s/day} = \left(\frac{\text{ppm}}{(120)\,(C)}\right) \times \left(\frac{\text{daily make-up}}{1000}\right) \text{ or } \left(\frac{\text{ppm}}{(120)\,(C)}\right) \times \left(\frac{(\text{Bx60x24}) + (\text{1.8x24xtonnage})}{1000}\right)$$

Once you know pounds per day of required product, you need to change it to gallons per day and ultimately gallons per month:

$$\text{gallons / month} = \frac{(\#\text{'s / day})}{\text{product's wt. / gal.}}\,(30)$$

EXAMPLE:

1. System = 100 tons
2. Chemical = C70 @50 ppm
3. Product wt. / gal. = 9.6
4. mu / alk = 160 ppm
5. COC = 3.75
6. Bleed-off = 1 gpm

$$\text{C70} = \frac{\left(\frac{\text{ppm}}{(120)\,(C)}\right)\left(\frac{(\text{Bx60x24}) + (\text{1.8x24xtonnage})}{1000}\right)\left(30\right)}{9.6}$$

(calculation continued on Page 8)

$$C70 = \frac{\left(\frac{50}{450}\right)\left(\frac{(1x60x24) + (1.8x24x100}{1000}\right)\left(30\right)}{9.6}$$

$$\frac{.1x5.76x30}{9.6} = \frac{17.25}{9.6} = 1.8 \text{ gals / month}$$

The Simplified Way

There is an easier way! While this previous method is correct, it is most exacting. As a result, we have a more simplified method that results in a similar answer without all the arithmetic. It is as simple as this: **The amount of monthly chemical feed for a particular Nu-Calgon product is calculated by multiplying the Bleed-off in gpm times that product's special factor!** Nu-Calgon No. 340 Liquid Scale Inhibitor must be fed at 10-15 ppm, Cal-Treat 233 must be fed at 200-300 ppm and Ty-Ion C70 must be fed at 45-50 ppm for scale and silt control and at 120-150 ppm for scale, silt and corrosion control. To obtain the proper amount of monthly chemical feed, use the following chart:

Chemical	ppm desired	Factor
No. 340 L.S.I.	15	.5
Ty-Ion C70	50	2
Ty-Ion C70	150	6
Cal-Treat 233	250	10

EXAMPLE: using Ty-Ion C70 and the previous example,

a) 1 gpm of bleed-off is required.
b) Therefore, for scale and silt control, you multiply the bleed in gpm times C70's factor, or 1 x 2 = 2 gallons. of C70 needed to treat the system at 100% load conditions for the whole month.
c) For corrosion and silt control, you have 1 x 6, or 6 gallons of C70 needed to treat the system at 100% load conditions for a whole month.

Chemical treatment can be fed with Nu-Calgon calibrated drip feeders or with a conductivity monitor controller and a chemical feed pump such as the CMS-IV Cooling Monitor System. And, in order to check the amount of chemical present in the recirculating water, use the Nu-Calgon Organic Phosphorus Test Kit (4804-0) or the No. 89A Test Kit (4798-2).

6. COOLING TOWER OPERATION

The proper operation of the cooling tower itself is of great importance in the overall task of water treatment. The water distribution holes, spray nozzles, fill and basin must be kept in good condition to insure proper water movement and system operation. A very important part of the proper operation of a cooling tower or evaporative condenser is the make-up water float assembly. Unless this is set properly, it is impossible to provide proper water treatment for the system.

In order to set the float so as to operate properly, please follow these guidelines:

1. With the system not running, adjust the water level so that it is approximately 1”-2” below the overflow.

2. Adjust the float so that no make-up water is allowed to enter into the sump when the circulating pump first comes on and the water level drops.

3. Insure that after setting the float to accomplish this, any further drop in the water level will result in the addition of make up water into the sump.

The above guidelines are presented to insure that water removed from the sump at system start-up is not replaced by make-up water. The only time make-up water needs to be added to the sump is when water is lost due to evaporation or bleed-off. If water is allowed to refill the sump due to the initial drop in water level at start-up, when the system is shut down there will be an excess amount of water in the sump, resulting in water loss via the overflow. When this occurs an unknown amount of chemical is lost and is not replaced. Also, TDS is lost causing a drop in COC and conductivity. If this is allowed to occur repeatedly the fine balance of TDS and chemical residual will be lost and it will be impossible to maintian a proper water treatment program.

It is very important to realize the fact that the only water that should be allowed to leave the system is from bleed-off and / or evaporation. Any water that is allowed to go out the overflow will throw off the balance of chemical that must be maintained at all times.

DO NOT FORGET THAT THE AMOUNT OF WATER LEAVING THE SYSTEM MUST BE KNOWN IN ORDER TO BE ABLE TO ACCURATELY MAINTAIN THE PROPER AMOUNT OF CHEMICAL IN THE WATER!!

If this fact is overlooked, the task of water treatment becomes pure guesswork. On page 15, there is a sample report that may be used in the field to keep a record of water treatment test results. It can be personalized by copying it onto your letterhead.

CONTROLLING BIOLOGICAL GROWTHS—ALGAE AND SLIME

All water cooled equipment is susceptible to algae and / or slime bacteria infestation since bacteria is present in the water supplies and the atmosphere. If a cooling tower or evaporative condenser is infected with either algae (a vegetable growth) or slime (an animal growth), it must be treated with an algaecide (biocide). The algaecide or biocide kills the problem-causing microbials and prevents the infestation from causing any major problems. Normally if a system is treated with an approved and effective biocide, the algae and slime growths are controlled. Sometimes, however, a particular strain of bacteria is able to develop an immunity to the biocide being used. If this happens, all that needs to be done is to temporarily switch biocides. Sometimes (though rarely) it may even require two different biocides being used at the same time to control an extremely hardy strain.

To control algae and slime growths on a continuous basis; (a) feed Nu-Calgon No. 85 Algaecide into the system at the rate of 1/6 gal/month for every 50 gph of bleed-off using one of Nu-Calgon Drip Feeders or (b) feed No. 90 Algaecide at the rate of 1-1.5 lbs./month for every 1.0 gpm of bleed-off using one of our Bromine feeders, a mesh feed bag or a biocide floater. These two products may be used independently or together, being alternated as required. The best results are obtained by using No. 90 Algaecide.

CORROSION CONTROL

Corrosion is the "eating away" of the system metals and can occur in one of two ways.

1. "General Attack" type corrosion is uniform in its appearance as it attacks all metals exposed to the water in a fairly uniform manner. This type of corrosion is the least aggressive of the two and is generally caused by the water having a low pH or a large amount of dissolved carbon dioxide present in it. In the latter case, carbonic acid is formed resulting in a low pH condition and corrosion.
2. "Pitting" type corrosion appears as scattered or localized pits. This is caused by oxygen molecules being trapped under something that is adhering to the metal such as scale, silt or biological growths. As oxygen is a very corrosive element, this results in holes being "eaten" clear through the metal. This type of corrosion is much more aggressive and therefore much faster than the general attack type discussed above.

To help prevent corrosion from occurring, corrosion inhibitors are used to coat the system metals with a protective film to prevent the metal from being attacked. This is most effective when the inhibitor is used from the "first day" of the system's operation. If the system is allowed to operate without any corrosion inhibitors in the water, corrosion will start. It is very difficult to correct this problem as all of the existing corrosion by-products must be removed prior to the start of any treatment by an inhibitor. If the corrosion by-products are not removed and the inhibitors are deposited on top, the corrosion will continue underneath the inhibitors and they will not be effective. Inhibitors however, will help corrosion from starting in any new areas.

A very cost effective way of removing existing corrosion products is by using a good hydrochloric acid such as Nu-Calgon's **Liquid Scale Dissolver**. To use this product, follow the directions found in product bulletin No. 3-106.

Nu-Calgon has several very good products available for use as a corrosion inhibitor. Each has its own special application and area where it is a little better than the others.

1. Cal-Treat 233 is a zinc, molybdate and organic phosphonate based product used primarily in very low alkaline waters. It also contains a copper corrosion inhibitor.
2. Ty-Ion C70 is an organic phosphonate and polymer based product that also includes a copper corrosion inhibitor.
3. Micromet, which comes in both a plate (Season Treat) and crystal form, is an inorganic polyphosphate product with over 50 years of success in controlling corrosion. It is used in moderately alkaline waters where the water can be either corrosive or scale forming.

WATER TESTING

The No.89A Test Kit has all of the materials necessary to run the tests that are appropriate for cooling water applications: alkalinity, hardness, chlorides and pH as well as product residual tests for organic phosphorous and sodium nitrite (silica is not included).. We have already discussed alkalinity and hardness and the important role they play both in predicting the problem to expect and in setting up a proper preventative maintenance program. Now, let's discuss chlorides and pH.

1. CHLORIDES

Chlorides (CI) are one of the many minerals present in water. They are very soluble in water, meaning they can concentrate many, many times without precipitating. For this reason they are used as a comparison or barometer against the other mineral concentrations to make some decisions as to what is going on inside the recirculating water regarding the concentrations of minerals (COC).

The normal procedure is to measure the alkalinity, hardness, chlorides and pH and silica of the make-up water and also of the recirculating water. Divide make-up alkalinity into recirculating alkalinity and you'll arrive at a COC for the alkalinity minerals. Do the same for the hardness, silica and chloride minerals. If the system is operating as it should (in balance), the alkalinity, hardness, silica and chloride minerals should all be concentrating at about the same rate. As has already been discussed, scale is formed by minerals precipitating and forming deposits. If the alkalinity, hardness and silica minerals have precipitated and formed scale deposits within the system (condenser, piping, tower, etc.), then they no longer will be present in the recirculating water to be measured with the test kit. If that is the case, there will be a lower COC for them, particularly hardness, than for chlorides. We will then have a clue that something is not as it should be and the problem should be looked into. If a higher COC for alkalinity, hardness and silica than for chlorides is present, then minerals that had been deposited previously are being removed from somewhere in the system and placed in solution in the water, and that is good . . . . descaling is taking place.

EXAMPLE

	Make-up	Recirc	COC
		IN BALANCE	
alkalinity	120	530	4.4
hardness	225	990	4.4
pH	8.1	8.8	
chlorides	55	240	4.4
conductivity	550	2400	4.4
		SCALING	
alkalinity	120	430	3.6
hardness	225	810	3.6
pH	8.1	8.7	
chlorides	55	240	4.4
conductivity	550	2150	3.9
		DESCALING	
alkalinity	120	625	5.2
hardness	225	1170	5.2
pH	8.1	9.0	
chlorides	55	240	4.4
conductivity	550	2750	5.0

As you can see, in a properly balanced system, the alkalinity and hardness minerals must concentrate at a value equal to or greater than that of the chlorides. If this is not the case then scale is being formed and the operating parameters must be recalculated and rechecked. This testing and analyzing must be done monthly to ensure proper operation.

2. pH

pH is the term used to express the acidity or alkalinity level, or strength, of a substance, and it is represented by a number. The pH scale is a logarithmic scale from zero to fourteen with seven being neutral. A substance, such as water, having a pH below seven is acidic. If its value were above seven it would be alkaline. Water with a low pH (say, 6.8 or lower) or an alkalinity level below 30 ppm should be considered as potentially corrosive and treated with a corrosion inhibitor. As the alkalinity of the recirculating water increases or becomes more alkaline, the pH will also increase. The pH of the recirculating water will usually be greater than the make-up water pH because, as alkalinity increases, so should the pH.

ACID CLEANING

Acid cleaning is performed to remove scale deposits and corrosion deposits from water cooled equipment. There are many different acids that can be used to accomplish this task, however, the two most common ones are hydrochloric and sulfamic because of there efficiency and relative safety.

When corrosion takes place within the system, the integrity of the system metal is compromised, which results in drastically reduced equipment life and the formation of corrosion deposits occurs. The presence of scale or corrosion deposits will **reduce water flow and heat transfer** within the system which results in loss of system efficiency and higher operating costs. When this occurs in air conditioning or refrigeration systems it causes the system operating pressures and temperatures to increase. These increases result in more rapid breakdown of the compressor lubricant causing loss of lubrication and compressor failure.

To learn about these two acids and the proper procedures for using them, refer to our Application Bulletin Number 3-106 “Removing Scale From Cooling Tower Systems”.

EQUIPMENT FOR COOLING WATER TREATMENT

1. Conductivity Meters

The conductivity meter is a hand held instrument that is used to measure the conductivity or TDS of water. Conductivity meters are usually calibrated in µmhos but sometimes they are calibrated in ppm. The conductivity meter is one of the tools of the water treatment specialist. It provides a very fast way of determining the COC of a system. It is also used to calibrate conductivity monitor controllers like the CMS-IV by first calibrating the meter with Calibration Solution and then using it to calibrate the controller.

2. Conductivity Controllers

There are many makes and models of conductivity controllers or monitors in use today. However, they are all designed to do the same thing: continuously monitor the conductivity (TDS) of the recirculating water and to turn on a bleed-off solenoid valve and a chemical feed pump when the conductivity reaches a predetermined set point.

The controller utilizes a sensor that is installed in the recirculating loop as the means of monitoring the water conductivity. When the input from the sensor reaches the set point of the controller, two relays are energized. One of the relays supplies power to the bleed-off solenoid valve and the other one supplies power to the chemical feed pump. The normally closed bleed-off solenoid valve opens and allows a preset rate of recirculating water to be discharged (bled off) into an approved drain, causing an equal amount of fresh make-up water to be introduced into the recirculating water; since the make-up coming in has a lower TDS than the bleed-off that it is replacing, the system's TDS is essentially diluted or reduced and COC is thus controlled. The chemical feed pump is preset to pump a set amount of chemical into the system during the same period of time that the system is bleeding-off; essentially, this replaces chemical that is lost through bleed. With a predetermined and preset amount of "bleed-off" and chemical feed, the COC and the proper amount of chemical residuals are constantly and automatically controlled.

Some controllers utilize a "set knob" to allow for setting of the "set point". The more sophisticated and better ones utilize an analog meter or a digital read-out which allows for a continuous, visual indication of the water conductivity. And the top-of-the line units, like the CMS-IV, are digital.

The controllers should be equipped with means of calibrating them for proper operation. The proper procedure is to use a pre-calibrated, hand held conductivity meter to measure the conductivity of the recirculating water and then to calibrate the controller to read the same as the hand held meter.

The better controllers also have a "safety lock-out timer" to automatically turn off the chemical feed pump if the operating or running time of the pump exceeds the time set on the "lock-out timer". This is done to protect against accidentally pumping out the entire container of chemical in the event of a failure within the system that allows the controller to stay in a continuous "run" mode for an extended period of time. Whenever a controller is equipped with a "lock-out timer", it should be set at 60-90 minutes. And if the system ever runs at close to or at full load for most of the operating time, it is a good idea to increase the bleed rate, perhaps 25% above the normally calculated rate. This will provide for a quicker reduction in system TDS and prevent the system from "floating" near the "setpoint". It will also prevent the "lock-out timer" from prematurely turning off the chemical feed pump. If this is done, increase the calculated monthly rate of chemical feed by 25% as well. **Conductivity Controllers should be calibrated and have their sensors cleaned monthly.**

3. Chemical Feed pumps

There are many types and styles of feed pumps available and in use. However, the most accurate and reliable ones have two controls on them. One of them is to adjust the "stroke" or actual distance of the diaphragm movement and the other one is to adjust the "speed" or frequency of this movement. Most pumps are rated in gpd (gallons per day) output, and this information is usually printed on the pump nameplate. To properly set up a pump, the amount of chemical feed required per month must be known and this figure is then converted to a percentage of the pump's total monthly output capacity. The percentage of speed operation multiplied by the percentage of stroke operation must then equal this percentage of the pump's total capacity.

EXAMPLE:
4 gpd pump = 120 gal/month
2.5 gal/month chemical needed

Therefore, we need:
2.5 gal/month chemical feed rate, which is 0.02 or 2% of the pump's maximum capacity.

To obtain 2% of the pump output, multiply a decimal stroke setting by a decimal speed setting to obtain .02. For example, 10% speed (.10) x 20% stroke (.20) = .1 x .2 = .02. Set the speed control at 10% and the stroke control at 20%. This will give you 2% of the pump output, or 2.5 gal/month. **The stroke setting should always be as large as possible as it is a mechanical movement.**

When the gpd output of the pump is so large that the desired settings cannot be obtained, a percentage timer such as the C-1120 may be used.

4. Nu-Calgon Equipment

Nu-Calgon provides two pieces of feed equipment. The first is the CMS Feed Pump. It can feed up to 15.1 gallons per day and as low as 0.02 gallons per day. It has both frequency and stroke adjustments. The other is the CMS-IV Pump/ Monitor, a digital unit that combines both the pump and the TDS Monitor into one unit. It is a very advanced piece of equipment, combining a pump output of 0.02 – 15.1 gallons per day and various feed timer arrangements.

CLOSED SYSTEM TREATMENT

Experience has taught us that closed systems (ie. chilled water loops, hot water loops and process water loops) must be treated for the prevention of corrosion. It is generally accepted that the best treatment to use in closed systems is a borax-nitrite type product, and Nu-Calgon has such a product available. It is a red-colored liquid called Ty-Ion B20 and it offers the ease of treatment level detection by a simple color comparison, by the ability to administer the chemical through almost any available opening and by a polymer dispersant for mud and sludge dispersing.

If the system to be treated is noticeably fouled, thoroughly flush the system as much as possible and add fresh water. If a pot feeder is not already in place for introducing treatment, install a No. 44 Pot Feeder on a by-pass arrangement. If you have chosen to use the liquid, any plugged opening can be used for this purpose. If there is a hose bib available, a T775-0 Silver King Pump may be used. The real benefit of this pump is that it can be used continually on all jobs.

If the system was flushed due to fouling, as an initial charge, add 3 gallons of Ty-Ion B20 liquid for every 100 gallons of water in the system. This will provide an excess of treatment to react with any existing corrosion products (iron oxide) in the system. If the system's water turns murky or dirty within 4-6 weeks due to the treatment's reaction wtih the iron oxide deposits in the system, the water should be drained and flushed to prevent any problems that could be caused by loosened deposits. If you flush the system after 4-6 weeks, be sure to add fresh water and 1 gallon of Ty-Ion B20 for every 100 gallons of water in the system. This will provide the required treatment level of 1000-1200 parts per million (ppm) of sodium nitrite. This treatment level is also the required dosage for a new system or one that is not noticeably fouled.

Note that the 1000-1200 ppm treatment level must be maintained at all times if proper protection is to be assured. And if the system is a hot water boiler where the temperature is above 180°F, it may be necessary to use up to 1800 ppm as nitrite.

Nu-Calgon's W003-0 Test Kit (or the the No. 89A Test Kit) is an ideal way to measure the amount of sodium nitrite in the water. The test should be used to check the treatment level every month as well as during the initial treatment of the system. A hand held Conductivity Meter (Part #4812-0) may be used in lieu of the test kit, in case of an emergency, by first measuring the conductivity of the recirculating water and then adding chemical until the conductivity of the system's water increases by approximately 1400-1600 µmhos.

Once the system is cleaned up, or if it is a new system, and a drop in treatment level in noticed, it is highly probable that a leak exists where water is leaving the system. The system should be inspected thoroughly in order to maintain the 1000-1200 ppm treatment level at all times.

EVAPORATIVE COOLERS

Evaporative coolers, or "swamp coolers" as they are often referred to, are devices that are used for air conditioning or cooling in drier climates (southwest, desert areas, etc.)…where dry-bulb temperatures of 90°F or more occur simultaneously with wet-bulb temperatures of 75°F and below. The wider this gap, the greater the opportunity for efficient evaporative cooler applications. They accomplish cooling by adding moisture or humidity to the ambient air.

In most equipment designs, water is allowed to flow over a media or evaporative pad while warm, dry ambient air is forced or blown across the wet media. Evaporation is induced, and the dry ambient air is cooled. Evaporative coolers can be used to directly cool ambient air for comfort air conditioning, or used as "precoolers" on mechanical air conditioning (air cooled) condensers.

Nearly all water supplies, particularly those in the dry arid regions, are scale-forming due to the presence of hardness, alkalinity and silica minerals. As this water is brought into an evaporative cooler and evaporated, these scale-forming minerals remain behind in the recirculating water. Eventually, the dissolved minerals become so concentrated in the water that they begin to "fall out" or precipitate as scale. The most effective way to control this problem is to use an inorganic polyphosphate like Micromet, and the recommended product is a special polyphosphate called 6R Micromet.

Today, 6R Micromet can be easily applied to evaporative coolers through the use of the NP Series. The NP Series consists of two housings that will each hold their own cartridge of 6R Micromet. The NP24DD will hold the NP246R cartridge and can treat a system up to 5500 cfm while the NP48DD will hold the NP486R cartridge and can treat a system up to 10,000 cfm. Multiples of these housings, used in conjunction with one or more of the custom brackets, can provide treatment on units up to 20,000 cfm. In all cases, treatment will last for six months.

Capacity of Cooler	NP Housing(s)	NP Bracket	Bleed Rate
5500 cfm	NP24DD	———	9.0 fl. oz. per min.
10,000 cfm	NP48DD	———	16.0 fl. oz. per min.
15,000 cfm	NP24DD (x3)	NP3BR	24.0 fl. oz. per min.
20,000 cfm	NP48DD (x2)	NP2BR	32.0 fl. oz. per min.

SAMPLE FIELD REPORT

Name: ____

Address: ____

Phone Number: ____________________ City: ____________________ State: __________ Zip Code: ___________

Date:	Make-up Water	Recirculating Water
alkalinity	__________ ppm	__________ ppm
hardness	__________ ppm	__________ ppm
silica	__________ ppm	__________ ppm
pH	__________	__________
chlorides	__________ ppm	__________ ppm
conductivity	__________ µmhos	__________ µmhos

Date:	Make-up Water	Recirculating Water
alkalinity	__________ ppm	__________ ppm
hardness	__________ ppm	__________ ppm
silica	__________ ppm	__________ ppm
pH	__________	__________
chlorides	__________ ppm	__________ ppm
conductivity	__________ µmhos	__________ µmhos

Date:	Make-up Water	Recirculating Water
alkalinity	__________ ppm	__________ ppm
hardness	__________ ppm	__________ ppm
silica	__________ ppm	__________ ppm
pH	__________	__________
chlorides	__________ ppm	__________ ppm
conductivity	__________ µmhos	__________ µmhos

Bgpm = $\frac{.03}{C-1}$ (tonnage) COC = C = $\frac{600}{mu/alk}$ (for C70)

Ty-Ion C70/month = 2 x Bgpm COC = C = $\frac{480}{mu/alk}$ (for 340)

No. 340 L.S.I/Month = Bgpm x .05 COC = C = $\frac{500}{mu/alk}$ (for 233)

Comments: ____

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Nu-Calgon Wholesaler, Inc. is committed to help provide you with a successful and efficient water treatment program. If we can be of any assistance to you in any way, please do not hesitate to contact us. A representative can be contacted by calling 1-800-554-5499 and asking to be put in touch with your local representative. We can also be contacted through any of the major air-conditioning refrigeration wholesalers in your area.

PRODUCT LISTING

CHEMICALS

No. 340 Liquid Scale Inhibiter, 1-gallon....4340-08
No. 340 Liquid Scale Inhibiter, 5-gallon....4340-05
No. 340 Liquid Scale Inhibiter, 55-gallon....4340-01
Ty-Ion® C70, 5-gallon....7597-05
Ty-Ion C70, 15-gallon....7597-P3
Ty-Ion® B20, 5-gallon....7537-05
Cal-Treat® 233, 5-gallon....4149-05
Micromet® Crystals, 4 lb....4243-97
Micromet Crystals, 50 lb....4243-84
Season Treat®, 5 lb canister....4364-88
Micromet® Plates, 50 lb....4275-84
No. 85 Algaecide, 1-gallon....4108-08
No. 85 Algaecide, 15-gallon....4108-P3
No. 90 Algaecide, 4 lb....4109-M5
No. 90 Algaecide, 50 lb....4109-M9

EQUIPMENT

No. 215 Drip Feeder....4669-W3
No. 1075 Drip Feeder....4670-W3
1-Gallon Bracket....4606-0
5-Gallon Bracket....4607-0
CMS Feed Pump....4609-1
CMS-IV Monitor System....4608-4
No. 90 Algaecide Floater....4695-0
Micromet® Plate Feeding Bags....4673-W3
No. 89A Test Kit....4798-2
Organic Phosphorus Test Kit....4804-0
Nitrite Test Kit....4797-0