SODIUM SULPHITE BASED

WATER TREATMENT PROGRAM

FOR

CLOSED CHILLED WATER SYSTEMS

Presented at

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by

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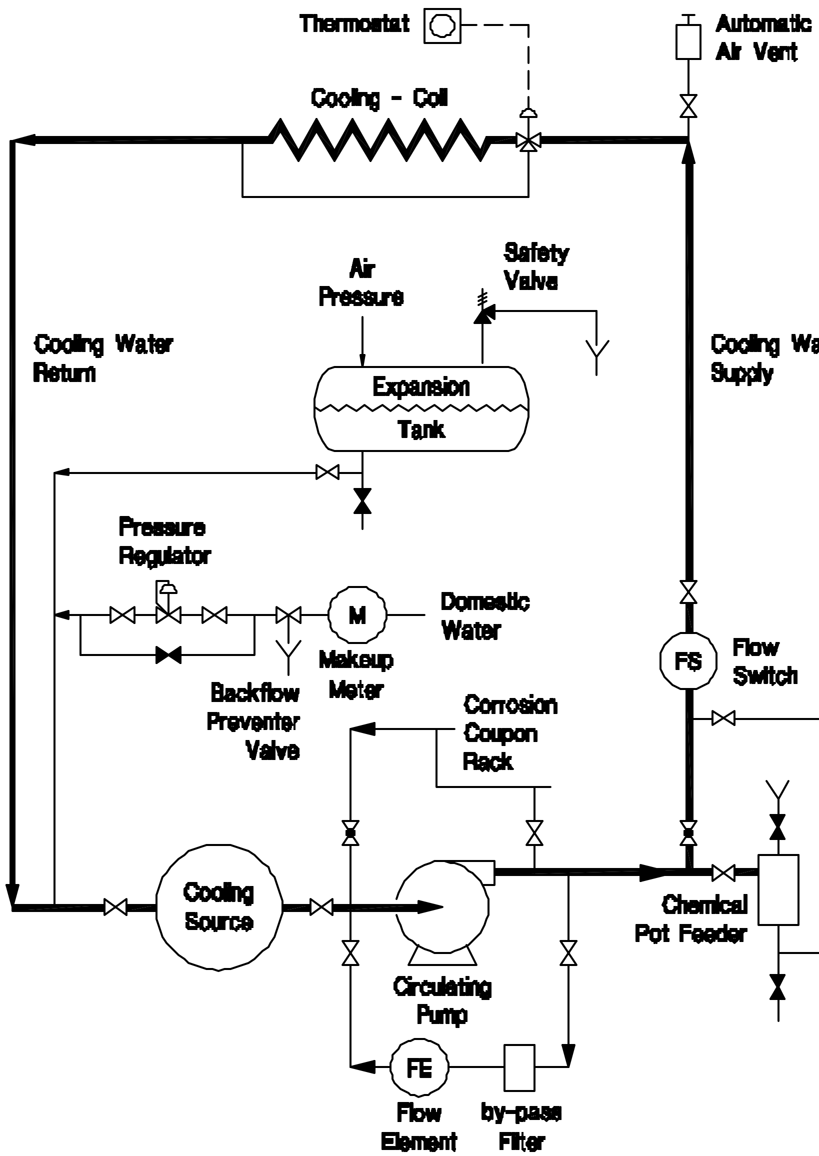
DESCRIPTION

A chilled water system (see schematic diagram overleaf) is a cooling system in which chilled water is circulated throughout the building or through cooling coils in an HVAC system in order to provide space cooling.

The principal components of these systems consist of a cooling source (ie., chiller), automatic air vents, circulating pumps, expansion tank, heat exchangers, chemical pot feeder, by-pass cartridge filter & flow indicator, water meter, backflow prevention device, pressure regulator, and interconnecting piping, valves & fittings of mixed iron, copper & bronze metallurgy.

The quantity of make-up water for a chilled water system generally averages less than 0.1% of the system volume per day (ie., for a 1,000 gallon system, the water make-up rate should be less than 30 gallons per month). Therefore, they are referred to as being closed systems.

SCHEMATIC DIAGRAM OF A TYPICAL CLOSED CHILLED WATER SYSTEM



OPERATION and MAINTENANCE

Closed chilled water systems are filled with untreated domestic water which contains hardness salts (ie., calcium, magnesium & iron) and dissolved oxygen, both of which are detrimental to the integrity of the system. That is, hardness salts are precipitated onto the metal surfaces to some extent, thus causing fouling, and dissolved oxygen reacts with iron in the system, thus causing corrosion & fouling.

Therefore, once the system is filled with water, every effort must be made to minimize the entrance of additional hardness salts and dissolved oxygen into the system by the following operational type methods.

1. Limit the amount of make-up water as follows:
   - (a) ensure that a water meter is installed in the make-up line;
   - (b) locate & repair system leaks immediately;
   - (c) adjust pump seals with packing so that there is minimum leakage;
   - (d) ensure that pumps with mechanical seals have zero leakage;
   - (e) do not drain & fill the system seasonally (see procedure for winter freeze protection overleaf);
   - (f) minimize the amount of water lost from the system during maintenance, water sampling & filter cartridge replacement activities.

2. Ensure that there is a positive pressure at the top of the system at all times by maintaining a minimum static system pressure according to the following equation by the addition of air to the expansion tank:

$$P = (H/2.31) + 5$$

where P: pressure at the circulating pumps with the circulating pumps shut off, psig;

H: elevation of the system piping above the circulating pumps, feet

3. Ensure that the expansion tank is properly sized so that there is water in it at all times.

4. Replace faulty automatic vents as required.

5. Confirm the operation of the make-up water meter by noting the changes in its reading before & after such activities as maintenance, water sampling, filter cartridge replacement, etc.

In order to prevent freeze damage to the coils during the winter shutdown season, they must be drained & air blown to dryness. Note that flooding of the coils with glycol is optional, but if they are flooded, the glycol must be blown out prior to summer operation, rather than admitting the glycol to the system, in order to prevent the growth of corrosive bacteria. Similarly, the expansion tank must be flushed prior to summer operation in order to prevent the bulk of the bacteria population and corrosion products from entering the system.

CHEMICAL TREATMENT

When a new system is filled with domestic water, the hardness salts are precipitated evenly on the system piping, and the dissolved oxygen is consumed by local corrosion, thus leaving only inert nitrogen in the system. In this perfectly closed state, the water in the system will not cause further scale formation or corrosion.

However, since the system can not be a perfectly closed one in reality, sodium sulphite is added as an oxygen scavenger such that a residual concentration of 50-100 ppm SO_3 is maintained, and sodium hydroxide (e., caustic) is added as required in order to elevate the pH level to within its control range of 8.5-9.5 (**Note: corrosion of copper material is excessive at pH levels greater than 9.5; corrosion of iron material is excessive at pH levels less than 8.5**). A catalyst solution consisting of cobaltous chloride is also added at a rate of 20 ml per pound of sulphite in order to increase the reaction rate between the sulphite and the dissolved oxygen at the lower temperature of these systems.

In addition to being an oxygen scavenger, the sodium sulphite will react with iron & copper in the system to form black iron magnetite & cupric oxide, respectively. These two materials will offer moderate corrosion protection for the system, but if air is constantly entering the system, they will be sacrificed, the underlying metal will corrode, and the sulphite consumption will increase, thus causing the TDS concentration to increase, the pH level to increase, and the water in the system to become corrosive.

The addition of a dispersing agent such as sodium hexameta phosphate to the system is not recommended because although it is capable of maintaining hardness salts in solution in its poly phosphate form, the alkalinity in the water in the system will convert it either to the phosphoric acid form which will cause corrosion, or to the ortho phosphate form which will precipitate the hardness salts. Also, the phosphate will precipitate the cobalt in the catalyst, thus making it ineffective.

Chemical treatment can not correct the problems associated with continuous hardness & air ingression into the system. Chemical treatment can only provide a certain amount of temporary insurance against the effects of these contaminants should they temporarily gain entrance to the system. Therefore, under normal operation, if the operations & maintenance activities referred to previously are diligently carried out, only very small amounts of chemicals, or maybe none at all, are required in order to maintain their residual concentrations after the initial charge has been added.

Based on a generally acceptable maximum make-up water rate of 0.1% of the system capacity per day, the "rule-of-thumb" maximum acceptable sodium sulphite addition rate in grams/month is equivalent to 2% of the system capacity in imperial gallons. That is, if the system capacity is 1,000 imperial gallons, the maximum acceptable sodium sulphite addition rate would be 20 grams/month. If the sulphite consumption is greater than this amount, excessive air is entering the system.

CONTROL TESTS

In order to minimize fouling and/or corrosion of these systems, the following control tests must be performed:

1. Document the make-up water meter reading at least once per month (see record sheet overleaf).

2. Determine & document the sulphite concentration in the system at least once per month (see record sheet & test procedure overleaf).

3. Determine & document the pH level in the system at least once per month (see record sheet & test procedure overleaf).

4. Determine & document the TDS (or conductivity) level in the system at least once every 3 months (see record sheet & test procedure overleaf).

5. Determine & document the visual appearance of the water in the system at least once per month (see record sheet overleaf).

6. Document the system pressure at the circulating pumps with the circulating pumps shut off (see record sheet overleaf).

7. Replace the by-pass filter cartridge when the flow indicator shows a reduced flow and document this activity (see record sheet overleaf).

WATER TEST PROCEDURES

SAMPLE COLLECTION

The purpose of sampling is to obtain for analysis a portion of the main body of water that is truly representative. The most critical factors necessary to achieve this are:

- point(s) of sampling;
- time of sampling;
- frequency of sampling;
- maintenance of sample integrity prior to analysis.

The sample point must be remote from excessive amounts of particulate matter, incoming feed or make-up water, and chemical feed points.

Samples must be collected during normal operation prior to chemical dosing.

The frequency of sampling is determined by the amount of deviation of the control parameters from their control limits.

Before collecting a sample, establish a flow of not less than 500 ml/min for a minimum purge period of 10-15 seconds for every foot of sample line.

Fill the sample bottle completely, allowing no air space at the top of the bottle.

Samples must be analyzed as soon as possible after they have been collected.

DETERMINATION OF SULPHITE CONCENTRATION

1. Pour 50 ml of unfiltered sample into a clean casserole dish;
2. Add 1 ml of hydrochloric acid, 50% (SB-302) & stir gently;
3. Add 0.2 grams of starch indicator (S Ind-303) & stir gently;
4. Immediately titrate with potassium iodide-iodate, 0.0125N (ST-301), while gently stirring the sample, until the first appearance of a persistent blue colour appears in the sample;
5. calculate the sulphite concentration as follows:

   sulphite (as ppm SO_3) = 10 X ml of ST-301 used.

DETERMINATION OF pH LEVEL

1. Calibrate the pH meter by using buffer solutions of known pH values which are close to the expected sample pH level;
2. Rinse off the pH meter electrodes with a portion of the sample;
3. Immerse the pH meter electrodes into a fresh sample and read off the meter reading within 1 minute.

DETERMINATION OF TDS CONCENTRATION

1. Rinse off the TDS meter electrodes with a portion of the sample;
2. Immerse the TDS meter electrodes into a fresh sample and read off the meter reading.

RECORD OF CHEMICAL CONTROL FOR CLOSED WATER SYSTEMS

Building: ______________________________

System: ______________________________

Year: ______________________________

Date	**Sulphite (ppm SO_3)**	**PH**	**TDS**	**Make-up Meter**	**Filter Change**	**System Pressure**	**Comments**
Control Limits	50-100	8.5 to 9.5	2000 ppm max.				

TROUBLE SHOOTING GUIDE

Symptoms	Possible Cause	Remedy
Sulphite concentration is less than 50 ppm SO_3.	Insufficient sodium sulphite has been added. Excess air is entering the system.	Add sodium sulphite. Refer to O & M.
Sulphite concentration is greater than 100 ppm SO_3.	Too much sodium sulphite has been added.	Do not blow down the system.
pH level is less than 8.5.	Insufficient caustic has been added. Corrosive bacteria are present.	Add caustic in small amounts at a time. Contact Consultant.
pH level is greater than 9.5.	Too much caustic has been added.	Drain the system, fill with fresh treated water.
	Too much sodium sulphite has been added.	Eliminate air ingression into the system.
TDS concentration is greater than 2000 ppm.	Too much make-up water and too much sodium sulphite have been added.	Drain the system, fill with fresh treated water.
Black sediment is present in the system.	There is active corrosion in the system.	Replace filter cartridge. Refer to O & M.
Hardness deposits and/or corrosion products are present.	Too much make-up water has been added and there is active corrosion in the system.	Remove deposits by a chemical cleaning operation.
