SODIUM SULPHITE BASED

WATER TREATMENT PROGRAM

FOR

HOT WATER HEATING SYSTEMS

Presented at

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by

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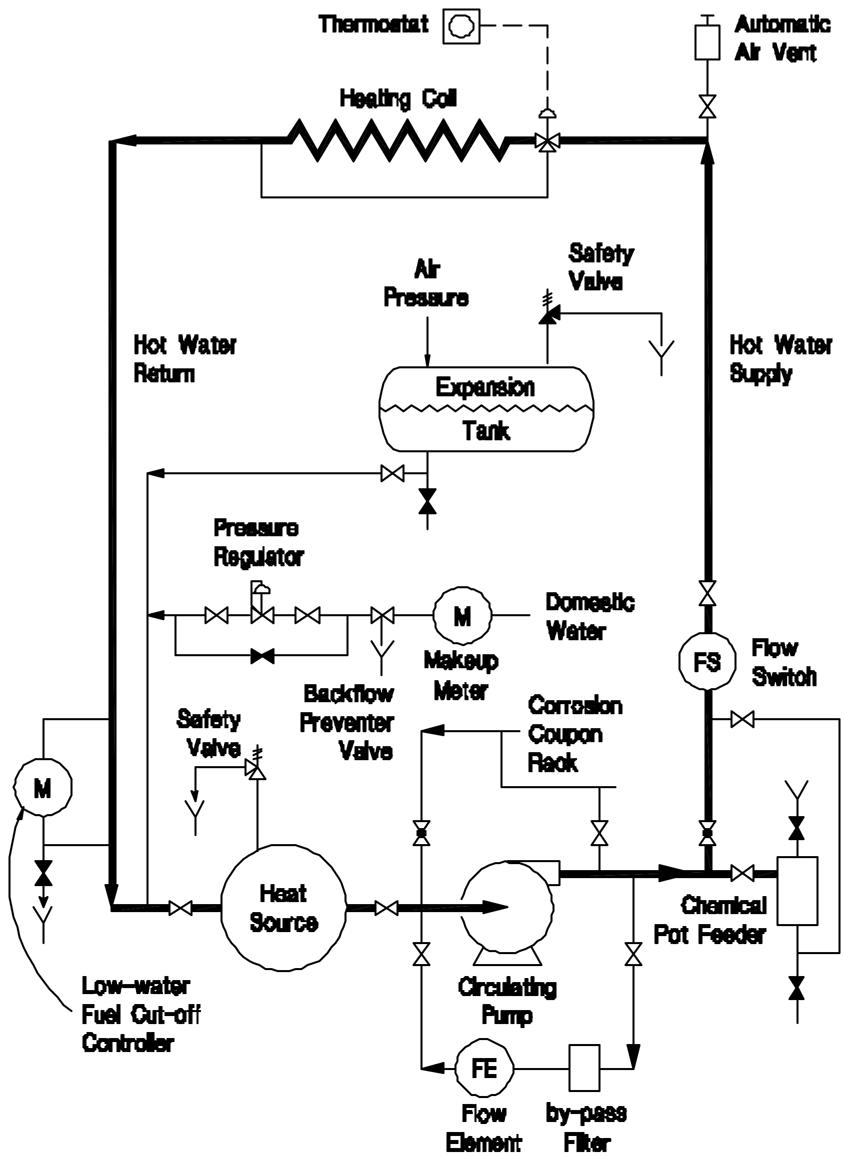
DESCRIPTION

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

The principal components of these systems consist of a heat source (ie., boiler or convertor), 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, low- water fuel cut-off controller, and interconnecting piping, valves & fittings of mixed iron, copper & bronze metallurgy.

The quantity of make-up water for a hot water heating 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 HOT WATER HEATING SYSTEM



OPERATION and MAINTENANCE

Closed hot water heating 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 and baked onto the metal surfaces as the temperature of the water is increased, thus causing overheating & possible failure, and dissolved oxygen reacts with iron in the system, thus causing corrosion & possible failure.

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) ensure that the safety valve has zero leakage;
   - (f) do not drain & fill the system seasonally;
   - (g) minimize the amount of water lost from the system during water sampling, low-water fuel cut-off controller blow down, safety valve testing & 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 water sampling, low-water fuel cut-off controller blow down, safety valve testing, filter cartridge replacement, etc.

CHEMICAL TREATMENT

When a new system is filled with domestic water and heated for the first time, the hardness salts are precipitated evenly in the boiler & 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 corrosion or scale formation.

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**).

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 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 & the elevated temperature 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.

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 a 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 scaling 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. 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 cooled to room temperature.

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**	**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.	Add sodium sulphite.
Repeated sodium sulphite additions are required.	Excess air is entering the system.	Refer to Operation & Maintenance Activities.
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.	Add caustic in small amounts at a time.
pH level is greater than 9.5.	Too much caustic has been added.	Blow down the system, fill with fresh water and treat with sulphite.
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 water and treat with sulphite.
Black sediment is present in the system.	There is active corrosion in the system.	Replace filter cartridge. Refer To Operations & Maintenance.
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.