UNDERSTANDING WATER TREATMENT

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Boiler Water Systems

WHAT KIND OF SYSTEM IS IT?

One of the very first problems you will face is how to properly identify a boiler water system. It will be one of two systems: a steam system or a closed loop (hot water) system. You can find the answer by asking the following questions.

What travels through the piping - steam or water?

In a steam system, the boiler heats the water to a temperature high enough to make it boil. The steam then flows through the piping under its own force; no circulating pumps are required to move the steam through the piping. When the steam reaches a radiator, it is condensed into water and gives off a great deal of heat. The hot condensate is piped back to a condensate receiver, where fresh make-up water is added to replace whatever water may have been lost during the trip through the piping. This mixture of condensate water and make-up water is then pumped into the boiler as required.

In closed loop (hot water) systems, the water is never boiled into steam. The water is simply heated to a preset temperature, then forced through the piping by circulating pumps. The boiler itself is often identical to those used in steam systems. Unlike most steam systems, a closed loop system requires very little or no fresh make-up water.

Where is the sight glass for checking the water level?

A steam boiler will have a sight glass mounted directly on the boiler near the top. Conversely, a hot water boiler will not have a sight glass on the boiler itself, because the boiler is completely filled with water. Sometimes a sight glass will be mounted on the expansion tank above the boiler. Do not confuse this expansion tank with a condensate receiver.

Does it have a condensate receiver or an expansion tank?

Both types of systems will have a “tank” in the system. The steam system will have a condensate receiver tank to collect condensate as it returns to the boiler. This condensate tank is usually located on the floor next to the boiler.
The hot water closed loop system will have an expansion tank to hold excess heated water. This expansion tank is almost always mounted above the boiler.

Are there circulating pumps?

As mentioned, pumps are not needed to move steam through the pipes of a steam system - the steam will travel under its own pressure. However, a steam system will have a pump to move the feedwater from the condensate receiver to the boiler, so do not get confused.

The hot water closed loop system must have pumps to move the heated water through the pipes. Usually, there are several pumps, and these are often quite large. They should be easy to see and identify.

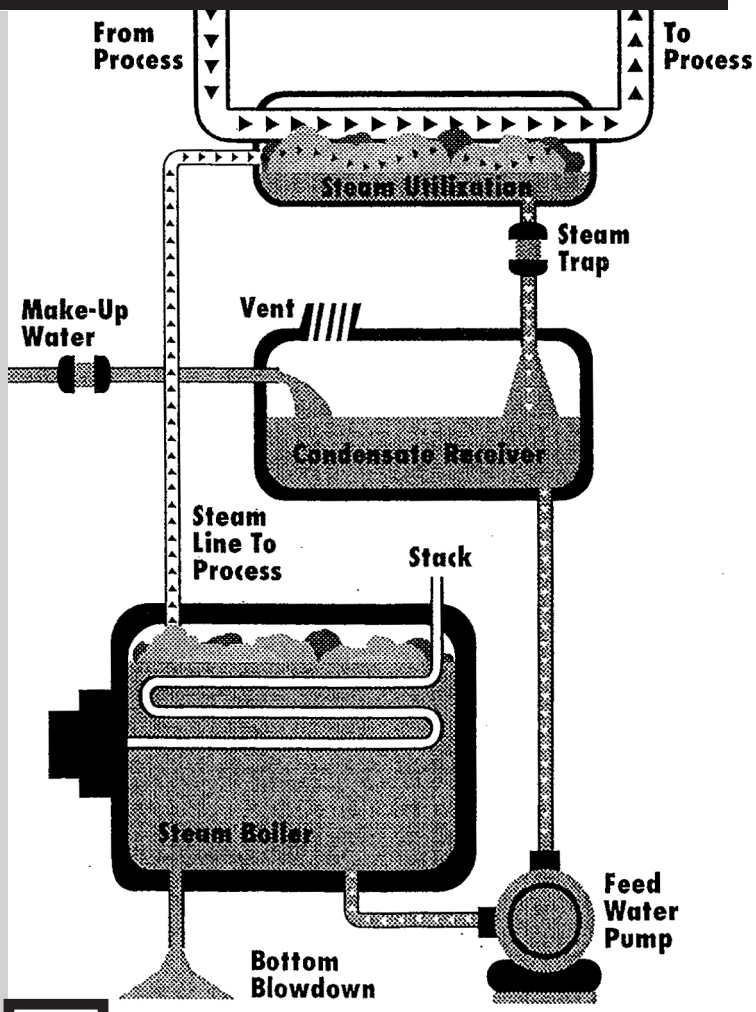
What does the operator say?

The maintenance person will usually be quite knowledgeable about the heating system. This person should be able to tell you quickly whether steam or hot water is flowing through the pipes and heaters.

A Typical Steam Boiler

STEAM BOILER SYSTEM

Please take a look at the steam boiler diagram. A steam bolier is a pressurized vessel which heats water to the point at which it becomes steam. This steam is then used for various things, such as heating up an office building, cooking vegetables before they are canned or even cooking barbeque sauce.



SCALE AND CORROSION CONTROL

As water is boiled into steam, scale-forming impurities that were once dissolved or suspended in the water are now left behind. Since some steam is usually lost from leaks or through use in a kitchen or industrial process, fresh make-up water is added to replace the lost water. Fresh make-up water brings in more impurities, and as the concentration of these impurities builds up in the boiler, they start to precipitate out of the water. These solids then start to accumulate in low spots of a boiler, or places of low flow within a boiler. These deposits interfere with the heat exchange process and greatly reduce a boilers efficiency. Beneath these deposits are environments that can cause highly corrosive conditions, or under-deposit corrosion.

Scale and corrosion control is accomplished by both mechanical and chemical means. The mechanical method is through boiler blowdown. This is the deliberate release of both water and solids from the boiler. Keep in mind that when a boiler is blowndown, you are releasing solids at a higher concentration than they were brought into the boiler as make-up water.

Blowdown alone is neither sufficient, nor economical to prevent scale and corrosion. It must be accompanied by a chemical treatment program. The purpose of a chemical treatment program is to condition or solubilize solids so they do not adhere to a boiler's surface and may be removed from the boiler through blowdown.

STEAM CONDENSATE CORROSION CONTROL

This type of corrosion takes place in a boiler's steam piping system. It is caused by carbon dioxide (CO 2) which is usually present in the steam that is generated by the boiler. Carbon dioxide reacts with the condensation (water) in a steam pipe to form carbonic acid.

CO_2	+	H_2O	$\longrightarrow$	H_2CO_3
carbon dioxide		water		carbonic acid

This formation of carbonic acid can drop the pH of the condensate to below 4.0 which is extremely acidic. Condensate this acidic will start to attack metal steam pipes very aggressively.

A solution of neutralizing amines is the best way to combat this acid attack. Neutralizing amines actually boil off or travel out of the boiler with the steam and neutralize the carbonic acid. By neutralizing the carbonic acid, the pH of the condensate is raised to safer levels (above 8.0).

BOILER COMPLETE TREAT H and **BOILER COMPLETE TREAT S** are "all-in-one" steam boiler treatments which contain neutralizing amines that help keep the pH in the condensate at a safe level to prevent acid attack. Also available is **STEAM TREAT** which is strictly a blend of neutralizing amines to aid in the neutralizing of carbonic acid in steam lines. **STEAM TREAT** would be used in addition to the "all-in-one" treatments in difficult systems.

OXYGEN PITTING CORROSION CONTROL

This type of corrosion is caused by the presence of dissolved oxygen in the boiler water. Dissolved oxygen is found in all water. When heated, it creates carbon dioxide which contributes to the corrosion process.

Some boilers remove dissolved oxygen mechanically with a device called a deaerator. Another way to remove dissolved oxygen is chemically. Even if a deaerator is in operation, it is recommended that some form of chemical treatment be used to remove oxygen, as a deaerator is not 100% efficient. A solution of sodium sulfite is the most common chemical used to “scavenge” oxygen, as the formula below shows.

CO_2	+	H_2O	$\longrightarrow$	H_2CO_3
carbon dioxide		water		carbonic acid

BOILER COMPLETE TREAT Hand BOILER COMPLETE TREATS, “all-in-one” steam boiler treatments, have an oxygen scavenger already blended into them. Also available is OXY TREAT, a blend of sodium sulfite, for use in addition to the “all-in-one” treatments for difficult systems.

STEAM BOILER TREATMENT PRODUCTS

Hard water Scale and Corrosion Inhibitors

BOILER COMPLETE TREAT H - An “all-in-one” carbonate-based scale and corrosion inhibitor for hard water with a tendency for scaling. It also contains an oxygen scavenger and steam line treatment.

BOILER TREAT H - A carbonate-based scale and corrosion inhibitor for hard water with a tendency for scaling.

Soft Water Scale and Corrosion Inhibitors

BOILER COMPLETE TREAT S - An “all-in-one” phosphate-based scale and corrosion inhibitor for soft water that has a tendency for corrosion. It also contains an oxygen scavenger and steam line treatment.

BOILER TREAT S - A phosphate-based scale and corrosion inhibitor for soft water that has a tendency for corrosion.

Oxygen Scavenger

OXY TREAT - A catalyzed sodium sulfite and sodium bisulfite blend.

Steam Line Treatment

STEAM TREAT - A blend of cyclohexylamine and diethylethanolamine (neutralizing amines).

Supplemental Treatments

FUEL TREAT - A fuel oil additive to help improve combustion so that fuel oil burns cleaner and more completely.

SLUDGE TREAT - An on-line descaler, dispersant, and sludge conditioner designed to keep sludge and solids in suspension for easy removal through blowdown.

Closed Loop Systems

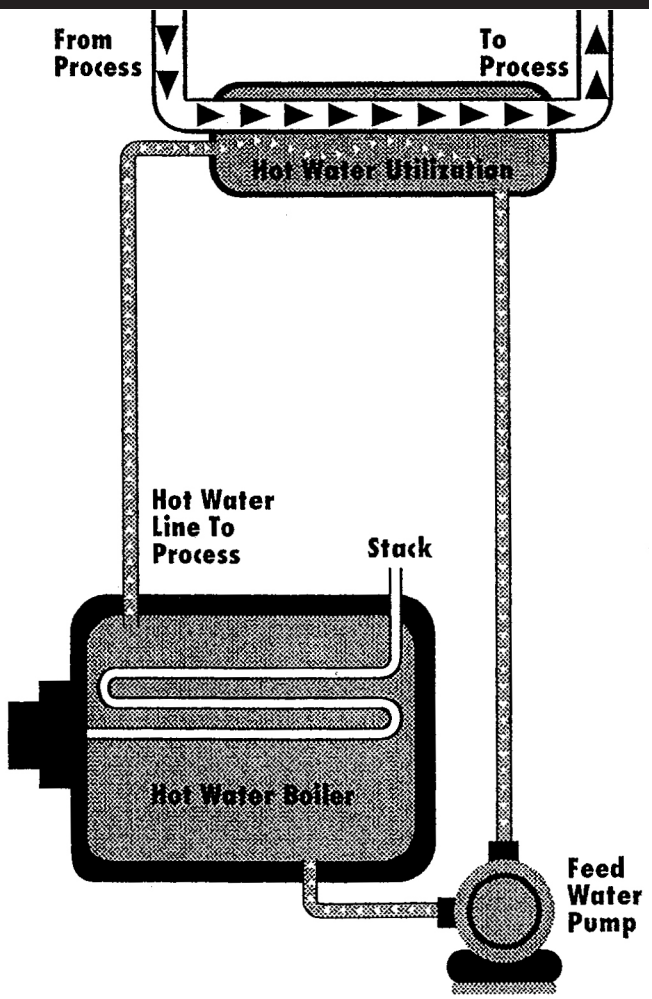
CLOSED LOOPS

A closed loop system is a recirculating water system where very little or no evaporation or exposure to the atmosphere takes place. Closed loops may use either chilled water for cooling, or hot water for heating. A diagram of a hot water closed loop is shown below, while a diagram of a chilled water closed loop is shown on the next page.

A Typical Hot Water Boiler

HOT WATER BOILER SYSTEM

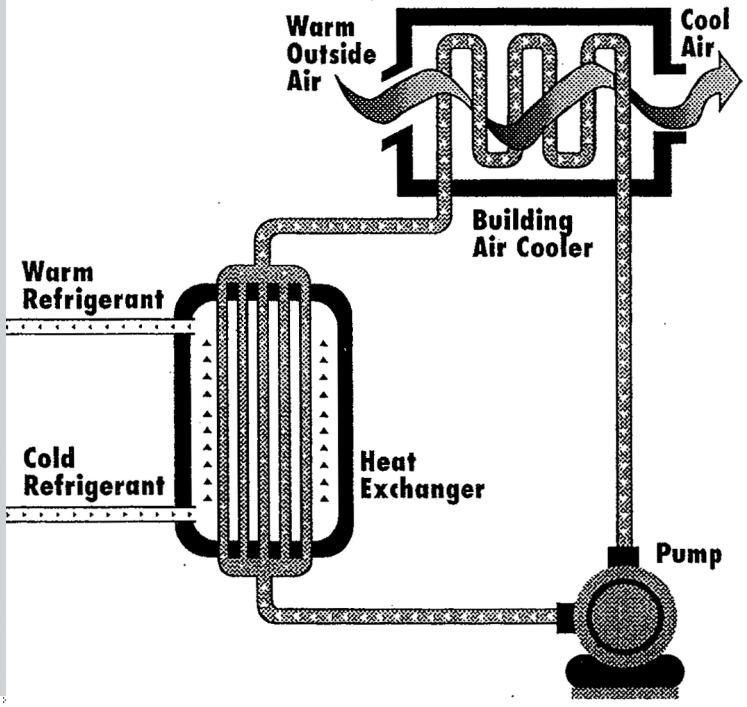
A hot water closed loop system is similar to a steam boiler - they both heat water - but a hot water boiler is filled completely with water and has a system of pipes containing hot water (a steam boiler has a system of pipes that contain steam). This hot water issued for various processes such as heating an office building, cooking vegetables before they are canned or even cooking barbeque sauce.



A Typical Chilled Water Closed Loop

CHILLED WATER CLOSED LOOP

Chilled water closed loop systems use cold refrigerant (usually from a cooling tower system) to cool the water in the loop. This chilled water is then pumped through insulated pipes to the building air cooler (also called the air handler). Large fans blow warm room air over the coils containing the chilled water. As the air is cooled, the chilled water becomes warmer. This warm water returns to the chiller to be cooled by the refrigerant once again.



CLOSED LOOP SCALE AND CORROSION CONTROL

Some operators may feel that “closed” systems do not require treatment. This would be true under ideal circumstances where the closed loop did not have any leaks and used pure distilled water. In real life, however, closed loop systems may have a lot of leaks and use make-up water containing corrosive and scale-forming minerals. Therefore, closed loops do require treatment to prevent scale from decreasing boiler efficiency and, since many closed loops use soft copper plumbing, prevent damaging corrosion. Below is a list of some problems that may affect a closed loop system and why they need to be treated.

Scaling

Theoretically, this should be a very minor problem in a closed system since no evaporation is taking place like in a steam boiler. This usually is a problem because there are leaks, evaporation form vents, and hard, scaling waters present.

Corrosion

This is the largest potential for closed recirculating system failure. Closed systems may contain a combination of different metals causing an electrical current or “battery” effect to occur. When this electrical potential develops, corrosion begins.

Oxygen Pitting Corrosion

Theoretically, this should be a very minor problem in a closed system since little make-up water is introduced. This may be a problem, because a normal closed loop system will use some make-up water due to leaks. This make-up water contains dissolved oxygen which can cause localized corrosive pitting.

Fouling

Again, since closed systems are not exposed to the atmosphere, this may not be a problem. Systems with leaks or high make-up water systems can experience fouling from sludge, rust and suspended solids. Bacterial fouling may also occur in chilled water closed loops.

CLOSED LOOP TREATMENT PRODUCTS

Scale and Corrosion Inhibitors

LOOP TREAT NITRO

An inorganic borate/nitrite scale and corrosion inhibitor for use in both hot and cold water closed loops.

LOOP TREAT POLY

An organic polymer/phosphate scale and corrosion inhibitor for use in both hot and cold water closed loops.

Oxygen Scavenger

OXY TREAT

A catalyzed sodium sulfite and sodium bisulfite blend.

Fuel Oil Treatment

FUEL TREAT

A fuel oil additive to help improve combustion so that fuel oil burns cleaner and more completely.

Cooling Water Systems

A cooling tower is an open recirculating water system in which the water comes in direct contact with the air that is used to cool the water. A certain amount of water is evaporated when it comes in contact with the air, and this evaporation process cools the remaining water. A good example of this cooling process is the human body. When you perspire, moisture forms on your body and when this moisture is exposed to the air it evaporates. This evaporating perspiration helps to cool the human body.
Most industrial air conditioning systems operate via a combination of both an open recirculating water system and a closed loop recirculating water system. The information below along with the diagram on the following page should help you understand what is happening in a typical water cooled air conditioning system.

COOLING TOWER SCALE AND CORROSION CONTROL

There are two measures to help stop scaling and corrosion.

The first control measure is the bleed-off valve. The bleed-off valve is usually located at the bottom of the cooling tower sump and is set to bleed-off (release) high solids water. The make-up water which replaces the bleed-off water is low in solids content.

Bleed-off alone is neither sufficient, nor economical to prevent scale and corrosion. It should be accompanied by a chemical treatment program with a good cooling tower scale and corrosion inhibitor. TOWER TREAT H and TOWER TREATS contain the latest technology in deposit and corrosion prevention.

COOLING TOWER FOULING CONTROL

The tower water (condenser water) is always relatively warm and usually high in solids and pH. Since the cooling tower is also a warm moist environment with sufficient oxygen and sunlight, this area is a good breeding and growing area for algae and slime.

TOWER-CIDE interrupts the algae growth process of photosynthesis.

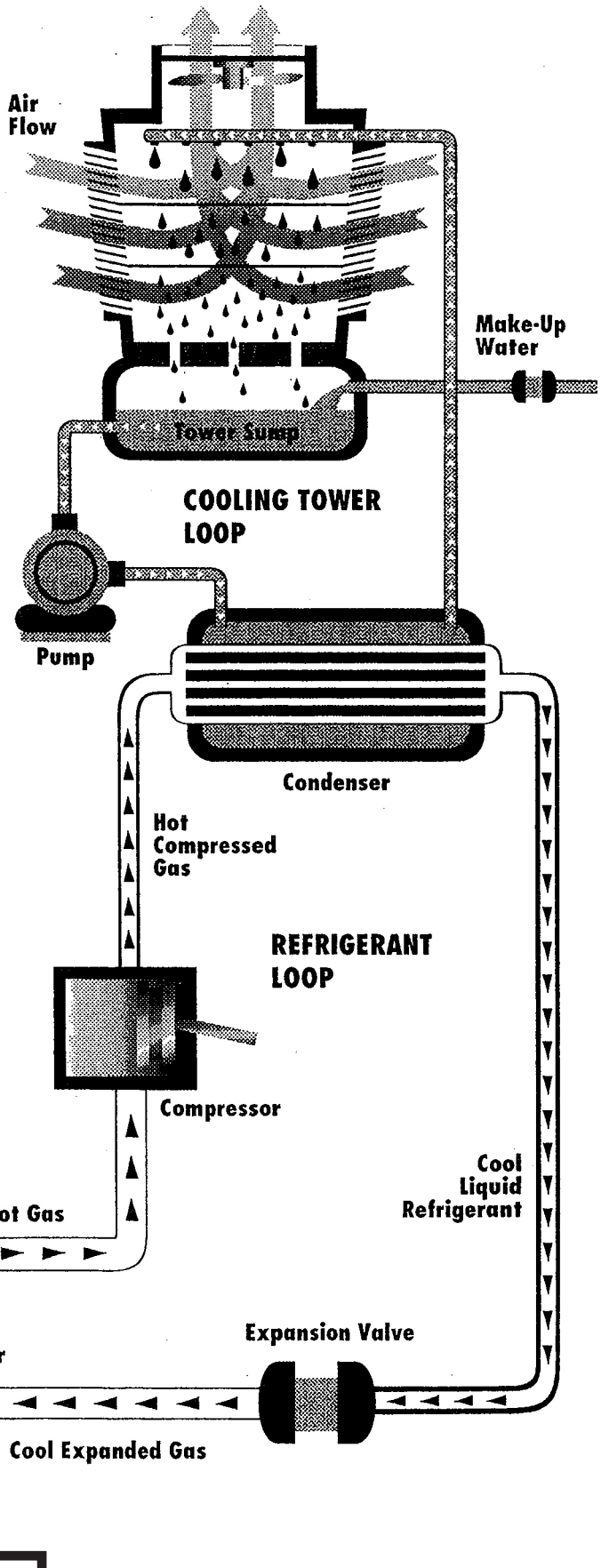
A Typical Cooling Tower and Air Conditioning Loop

GUIDE TO THE WATER COOLED AIR CONDITIONING SYSTEM DIAGRAM

Please find the piece of equipment marked condenser. This is the sectionwhere the air conditioner is cooled. Cooling tower water (also called condenser water) is pumped through the condenser in order to cool the hot refrigerant. This, in turn, warms the cool tower water.

This warm tower water (condenser water) returns to the cooling tower. Chemicals are usually added to this section of pipe. Chemical metering pumps or “bleed and feed” systems can be used to deliver the chemical to the tower water.

When warm tower water (condenser water) reaches the cooling tower, it is sprayed or showered evenly into the air stream in the tower. Powerfil fans move the air through these water droplets. Not shown on this diagram is the fill material or packing that is in the tower. This may be metal or plastic sheets that help to keep the water droplets small for better contact with the air. The air evaporates a portion of the water droplet, thus cooling it (remember our example of the human body?). The evaporation of some water leaves minerals and impurities behind. That need to be controlled through a good chemical treatment program.



COOLING TOWER TREATMENT PRODUCTS

Scale and Corrosion Inhibitors

TOWER TREAT H

A phosphate-based scale and corrosion inhibitor for high hardness, high scaling type water.

TOWER TREAT S

A phosphate-based scale and corrosion inhibitor for low hardness, highly corrosive type water.

Algaecides

TOWER-CIDE

A non-volatile formula that interrupts the algae growth process of photosynthesis.