Boiler water treatment

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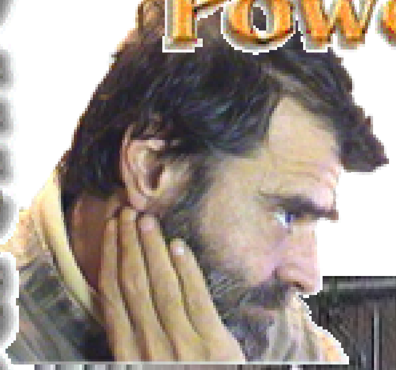

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Boiler water treatment

There are two approaches to removing impurities in steam generating systems: external and internal water treatment.

External treatment (also called pretreatment) refers to any process used to improve water quality before it enters the boiler.

A sound approach to boiler operation is to use pretreatment in conjunction with a well planned internal chemical treatment program.

That's because boiler feedwater, regardless of the type and extent of external treatment, may still contain impurities. Other contaminants may originate from pretreatment system upsets or process contamination in returned condensate.

Even a small amount of impurities in boiler feedwater can eventually accumulate in the boiler to dangerously high levels, due to the effect of *"cycling".* Therefore, the accepted practice is to use some type of internal chemical treatment.

As in most water-handling systems, the problems associated with deposit formation and corrosion are so closely related that both must be effectively controlled in order to achieve satisfactory results.

In deciding on the treatment to be used, the entire system must be considered since all parts of the steam/water system are interrelated.

In this unit we will cover several approaches to chemical treatment, but as treatment of very high pressure boiler systems is substantially different, it is left out.

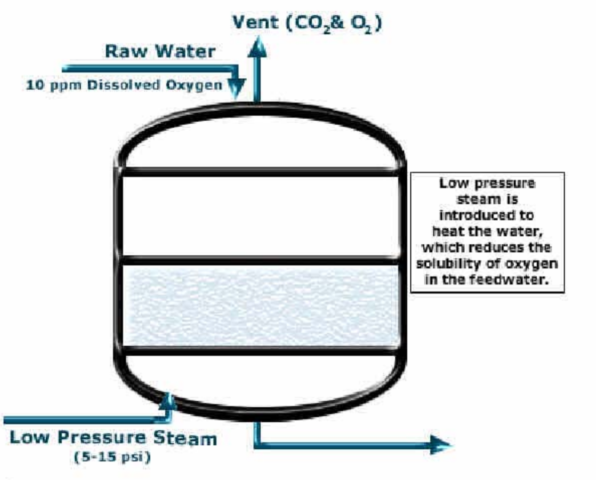
Corrosion

In our efforts to control corrosion in a boiler water system, remember that dissolved oxygen in the boiler water plays a key role in the corrosion process.

Oxygen can cause corrosion in the preboiler, boiler and afterboiler sections with metal destruction occurring rapidly. Therefore, it is essential that dissolved oxygen be kept at the lowest possible level throughout the system.

This requirement grows more critical in larger systems with high operating pressures because the cost and danger of equipment failure increase proportionately. Primary removal of dissolved oxygen, or deaeration as it is commonly termed, is carried out in the preboiler section by means of a deaerator preheating the feedwater.

This equipment utilizes steam to heat water, and in effect, drive off oxygen and other dissolved gases. The solubility of gases in a liquid decreases as the temperature of the liquid is increased.



While modern mechanical deaerators can reduce the dissolved oxygen level to seven thousandths of a ppm, any malfunction of the equipment will permit much higher levels of oxygen to enter the boiler.

It is a common practice to add a chemical oxygen scavenger to remove the last traces of oxygen in the feedwater prior to its entry into the boiler. Historically, sodium sulphite and hydrazine have been the most commonly used scavengers.

Recently, the use of hydrazine has decreased. Substitutes such as Di-Ethyl-Hydroxyl-Amine (DEHA) are now commonly used to scavenge oxygen.

In addition to removing oxygen, most of the current scavengers with the exception of sulphite are also metal passivators. The scavengers react with various metal surfaces such as iron oxide and promote the formation of the protective magnetite and copper oxide layers.

Oxygen scavengers can be added to either the preboiler or boiler sections, and as some of them are volatile, and easily vaporise into gases, they can also be carried into the after boiler section along with the steam.

Pure steam, as produced by the boiler, should have a neutral pH of 7. However, in an untreated system, it often has a pH of around 5 or 6. This is because of the breakdown of alkalinity in the boiler. Alkalinity is made up of dissolved carbon dioxide gas, bicarbonate ions, carbonate ions, and hydroxide ions.

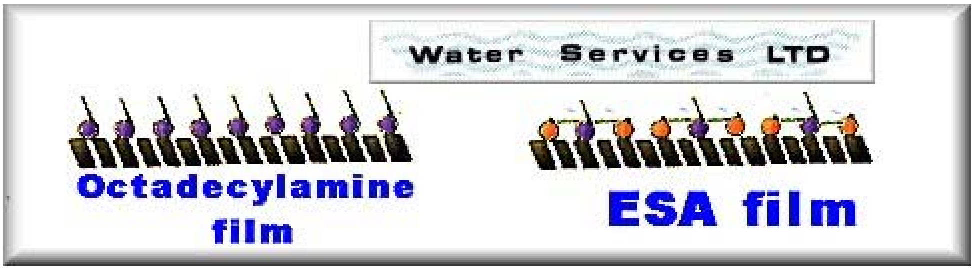
At operating pressures of 10 bar or more, about 80% of all the bicarbonate and carbonate ions will break down and form carbon dioxide gas. This gas flashes off, leaving the boiler with the steam and eventually re-dissolves in the condensate to form carbonic acid. When the carbonic acid is formed, the pH of the condensate is lowered. To prevent this, neutralizing compounds are added to react with the carbonic acid.

Because they must also travel with the steam, they are typically volatile *"canine"* chemicals such as rnorpholine and cyclo-hexyl-amine.

Usually a combination of several amines provides the best protection, depending upon the design of the after boiler section, the consumption rate of the amine, and cost.

Another type of amine, known as filming amine, is sometimes used to provide protection against corrosion in the afterboiler section.

These types of amines are much larger molecules than the volatile amines just discussed. When used correctly, filming amines form a thin wax-like, non-wettable film on the metal surfaces of the steam and condensate lines, and prevent contact between the metal surface and the corrosive condensate. Therefore, attack by both carbon dioxide and oxygen are minimized. Octadecylamine has been the most widely used filming amine. In recent years, soya-based amines have gained popularity.



Deposits

The problem of deposit formation is the next area for discussion. Boiler deposits are controlled and prevented chemically through one of two approaches, a precipitating program or a solubilizing program.

Precipitating programs result in the formation (or precipitation) of sludge instead of scale.

The sludge is relatively non-adherent and can be removed from the boiler through bottom blowdown.

Phosphate-based treatments are the most common precipitating programs. With this approach, desirable hydroxyapatite and serpentine sludge are formed and removed. Phosphate dosage levels must be carefully monitored and controlled. If not, scales such as calcium silicate, magnesium hydroxide and magnesium phosphate may form instead.

Dispersants are sometimes added to the program to condition the sludge and prevent excessive sludge build-up.

Solubilizing programmes

The other approach, the solubilizing chemical treatment, is not subject to most of the problems associated with precipitating chemical treatment.

In a solubilizing program, hardness ions are kept in a soluble form rather than being precipitated to form sludge. Solubilizing programs can be divided into two types.

One type utilizes chemicals which react on a one-to-one basis with impurities to keep them solubilized. In other words, one part of chemical is necessary to react with each part of hardness to keep it solubilized.

This type of programme relies on precise proportions and is called stoichiometric treatment. Chelants such ad EDTA and NTA are the two most common chemicals used in these types of programs.

Chelants are chemicals that tie up dissolved impurities and prevent them from precipitating. For example, calcium ions in the feedwater are bound by the chelant, preventing their reaction with carbonate, sulphate, or silicate ions to form scale.

A major disadvantage in the use of chelants is that they require very careful control to be effective. A low residual of free chelant must be maintained in the boiler for two reasons:

1. chelants are relatively expensive, and
2. high excess chelant concentrations are corrosive.

On the other hand, keeping this low residual chelant level, makes such programmes highly sensitive to upsets in the feedwater quality.

Excessive hardness levels entering the boiler will consume the free chelant residual resulting in the excess hardness precipitating as scale.

The other type of solubilizing approach employs polymers, dispersants, and organic sludge conditioners to prevent scale formation.

These chemicals function by absorbing onto the surface of precipitates, effectively blocking their growth into larger particles, and simultaneously keeping the particles relatively soft and non-adherent.

Additionally, these chemicals serve to disperse any scale fragments, minimizing their build-up. Since one polymer molecule can react with more than one molecule of scale, these types of programs are referred to as substoichiometric.

Because the chemicals function by distorting the scale structure, precise control in these programmes is not as critical as with the chelant programs.

However, gross overfeed should be avoided as this can cause particles to bind and settle out on metal surfaces.

We have now covered the basic treatment of boiler water systems. It is a complex science, combining knowledge of chemistry, boiler design and equipment operation.

Our local representative is the best source for further information of the program recommended for your system. He is a professional water treatment Technologist -ready to provide his expertise and assistance to help with any problems in your plant.

By working together, your system is in good hands!