

CHEMICAL INJECTION AND SAMPLING CONSIDERATIONS FOR KILN BOILERS

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Various chemicals can be fed to kiln boilers and related piping to prevent mineral deposits and system corrosion. This paper discusses methods for feeding the chemicals effectively, and sampling techniques to help ensure program success.

Corrosion Control

Two types of corrosion are common in boiler/kiln systems. Pitting corrosion is caused by oxygen gas (O_2), and is characterized by randomly-occurring pits that gouge into the pipe walls. The pits are sometimes covered by large caps of rust. In severe cases, these "tubercules" can grow large enough to obstruct the flow of steam or water.

Acidic corrosion is caused by carbon dioxide gas (CO_2), most of which evolves in the boiler from the breakdown of the make-up water's natural alkalinity. Acidic corrosion leads to a gradual thinning of pipe that carries steam or condensate.

Treatment to Prevent Oxygen Pitting

Prior to chemical addition, preheating of the boiler's feedwater should be done to mechanically remove as much oxygen as possible. The best preheaters are true "deaerators", that operate at temperatures above 212°F and positive gauge pressures. Atmospheric-pressure feedwater tanks are also used, with steam added to the feedwater through a perforated pipe.

Any oxygen that remains after preheating must be chemically scavenged. The chemical most commonly used is catalyzed sodium sulfite. It is best fed as far ahead of the boiler as possible (but just after any preheating), to give the sulfite maximum time to react with the oxygen. This usually dictates injecting the sulfite into the feedwater tank below its waterline.

Sulfite fed directly to the boiler may not capture all of the feedwater's oxygen, as the boiler's high temperature quickly purges the oxygen before it can react with the sulfite. A sulfite test of the boiler water will not detect this failure, but instead falsely lead the operator to think that oxygen removal is occurring successfully.

It is helpful to feed the sulfite continuously. Feed systems that cycle on and off (based on make-up meters or some other intermittent signal) may be off for an excessive period, allowing unscavenged oxygen to enter the boiler. Again, a sulfite test of the boiler water will not reveal this deficiency.

Oxygen pitting in steam coils can also be inhibited by using volatile filming amines, which are discussed in more detail in a later section.

Treatment for Acidic Corrosion

Carbon dioxide that evolves in the boiler can travel with the steam, ultimately dissolving in the condensate to form carbonic acid. This is the acid that causes the thinning of kiln coils and condensate lines.

Reducing the make-up water's natural alkalinity (carbonate and bicarbonate content) is a good pretreatment goal, but the methods used (dealkylizers, reverse osmosis, demineralization) are expensive and not commonly seen. This leads us to rely heavily on treatment chemicals.

The normal chemical combatant used against carbonic acid is a neutralizing amine. Several different kinds of neutralizing amine can be effective, including morpholine, diethylamino-ethanol, and cyclohexylamine. Being volatile at high temperatures, they travel with the steam to points of condensation, where they dissolve in the condensate to neutralize any acid that forms. A pH test of the condensate helps determine if the acid is being successfully neutralized, but this testing is vulnerable to innocent mistakes, discussed below.

Avoiding Amine "Gotchas"

Several warnings are appropriate here:

- Any amine fed to a heated feedwater tank will be partially lost to atmosphere via the tank's vent. To a lesser degree (but still noteworthy), amines fed to the boiler are diminished by blowdown losses. Therefore, it is desirable to feed amines directly to the steam header, ideally with a stainless injection quill.
- Earlier, we discussed the hazards of feeding sulfite on a cyclical (on-off-on-off) basis. To an even greater extent, lengthy interruptions of amine injection (during the chemical pump's off period) should be avoided. During these interruptions, steam travels down the pipe without being accompanied by amines. This unprotected steam will condense without the benefit of acid neutralization, leading to intermittent periods of acidic corrosion.
- Condensate sampling should take into consideration the possibility of contamination. Depending upon the location of drip legs and desuperheating nozzles, the condensate may get contaminated with boiler carryover and/or the water used for desuperheating. This leads to false test results and improper conclusions about the amine addition. Sample locations should be selected to reduce the likelihood of contamination. Also, the condensate testing protocol should include measurements such as conductivity, which help detect contamination.
- The tendency for condensate to absorb carbon dioxide (and become acidic) depends upon how far the condensate has sub-cooled below its condensing temperature. A substantial temperature drop leads to more CO₂ absorption, more acid formation, and a lower pH. Therefore, you can have two diverse pH readings in adjacent kilns depending upon their load at any given time. A composite sample from both kilns may not reveal that a corrosive condition exists in the kiln that's pulling the lower load.

Filming amines

Filming amines are similar to neutralizing amines, in that they're designed to travel with the steam to the point of condensation. Filmers, however, leave a very thin residue on the inside of the coils and condensate lines. This residue repels water and, therefore, is called hydrophobic. Just like a coat of wax on the hood of your car, the film protects the underlying steel from corrosive attack.

It is crucial to note that, in some kiln installations, it's virtually impossible to feed enough neutralizing amine to keep the condensate from becoming acidic. This is particularly true when the kiln sees long, leisurely schedules (causing substantial subcooling) and the make-up water has lots of natural alkalinity. In these instances, the filmers are an excellent way to prevent acidic corrosion. The filmers also inhibit attack by any oxygen that travels with the steam.

An insidious source of corrosive acid and oxygen is the air within the kiln. If there are leaks of any kind in the coils and related piping, they can pull a vacuum when the steam is withdrawn. Oxygen in the air, as well as the gaseous organic acids that are liberated from the lumber during the drying process, will then readily enter the coil and contribute to the corrosion process. Again, filming amines are invaluable in prevention of this corrosion.

One downside to using filmers is the potential for plugging steam traps, especially if the filmer is overfed or if the kiln piping contains lots of rust deposits. This problem is usually overcome by thorough testing of the condensate and conservative adjustments to the filmer feed rate.

Controlling Mineral Deposits ("Scale")

The chemicals used for scale prevention usually don't have the direct impact on kiln operation as do the chemicals used for corrosion control. We will review them briefly, paying special attention to possible effects to the kiln.

Caustics

Most boiler treatment programs include some type of caustic compound such as sodium hydroxide (caustic soda) or potassium hydroxide (caustic potash). These products make the boiler water quite alkaline, which is the desired environment to prevent scale formation in the boiler.

Caustics should be fed to the feedwater line (downstream of the feedwater pump) or directly to the boiler. Otherwise, the caustic may attack the copper alloys (brass and bronze) used in the pump impeller and mechanical seals. Unlike the sulfite and amines, it's acceptable to feed the scale inhibitors on a cyclical basis, as the volume of the boiler provides a dampening effect on the intermittent chemical additions.

Overfeeding caustic can definitely affect your life at the kiln. High boiler alkalinities are the most common chemical cause of boiler carryover. This unwanted water can lead to pipe hammer and waterlogging of coils and related piping.

Softening Agents

Some treatment programs use chemicals to reduce the scaling tendencies of calcium and magnesium, which are the traditional forms of "hardness" in water. Various types of phosphates are most commonly used. They should be fed to the feedwater line or directly to the boiler, as was indicated for the caustics. Cyclical feeding is acceptable.

When hardness enters a boiler containing phosphates, the boiler water typically becomes turbid, with the appearance of diluted milk. This is of interest in the event of carryover, if the drip legs fail to remove the boiler water from the steam line. Depending upon the piping configuration in the kiln, you may see "milky" boiler water blow out of the spray nozzles, leaving a chalky light beige residue in the kiln and on the top few courses of lumber.

Dispersants

Various polymers and sequestrants are used in the treatment of steam boilers. Their primary purpose is to keep the mineral particles from joining together to form a solid scale layer on the boiler surfaces. Feeding guidelines are similar to caustics and phosphates.

General Sampling Recommendations

When a sample is being drawn from the boiler for testing, it is important to ensure that the sample is representative of what's in the boiler. Sampling from level controls or other stagnant pipes will require that you purge the piping for an extended period before capturing the sample. Similarly, any condensate sample must be allowed to flow freely until the water is representative of what's inside the operating piping.

Clean glassware or other containers should be used to prevent contamination of the sample. This is very important with condensate sampling, as the condensate is usually quite pure. It takes only a small amount of contaminant to ruin a condensate sample.

Ideally, your sample points will include cooling coils to permit safe handling of the otherwise hot samples. If you have sample coolers, be wary of leaks in the cooling coils that permit cooling water to contaminate the sample. If no coolers are used, you should cap the sample bottle tightly and allow it to cool to a safe handling temperature (below 90 F) before analysis. Boiler water samples should fill the sample bottle completely prior to capping, to prevent air from consuming the sulfite.

Summary

The careful addition and monitoring of your boiler treatment chemicals plays a large part in the successful operation of the dry kiln. The reader is encouraged to work closely with their treatment vendor to establish appropriate chemical feed points and sampling locations.