Protective Chemistry for Steam Boiler Wet Layup

posted to DPS client area on:

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Richard Kunz, DPS Consulting Chemist's treatment recommendation:

sulfite = 100 ppm	0.2 lbs. (3.2 oz.) of **sodium sulfite** / 100 gal.
P alkalinity = 400 ppm	0.3 lbs. (4.8 oz.) of **lye** (sodium hydroxide / 100 gal. (this amount will yield a pH of about 10.5)

References:
(summary of recommended protective water chemistries from seven professional sources)
… full wet chemistry procedures are attached (8 pages).

Compiled by Richard Kunz, consulting chemist

For Steve Wells, Supervisor
Preventive Maintenance Shop
DPS Maintenance Department

sulfite - 100 ppm	pH ~ 10.5	P alkalinity - 400 ppm

americanwatertreatment.com

sulfite > 100 ppm	pH ~ 10.5	P alkalinity ~ 400 ppm

Facilities Management Magazine

sulfite - 200 ppm	P alkalinity - 400 ppm

sellersengineering.com

Treat boiler water per the recommendations of the water treatment consultant.

Rentech Boiler Systems

sulfite - 200 ppm	P alkalinity - 1000 ppm

boilerchemicals.com

sulfite - 100 ppm	pH - 9.5 to 11

constructionmanuals.tpub.com

sulfite > 100 ppm	P alkalinity > 400 ppm

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BOILER STORAGE - WET

http://www.americanwatertreatment.com/page21/assets/Boiler%20Storage%20West.pdf

Internal and external surfaces of boilers out of service for any length of time are particularly susceptible to corrosive attack. To minimize attack, units should be stored with the following procedure.

WET STORAGE
This method is not practical if the ambient air temperature may drop below freezing.
The boiler should be first thoroughly cleaned and inspected.

The boiler should be filled to the normal water level with deaerated feedwater.
With vents open, heat should be applied to boil the water for one (1) hour.

100 ppm sulfite	pH ~ 10.5	400 ppm P alkalinity

After the boiler has cooled somewhat, but before a vacuum is created, the boiler should be filled with deaerated water. Filling should be sufficient to complete the superheater elements and headers with treated water. This can be determined by testing the overflow water from the superheater outlet for sulfite and alkalinity. After filling, all connections should be tightly closed. It is desirable to leave a small positive pressure in the boiler to prevent a vacuum from developing as the unit cools to room temperature.

After filling the boiler completely a nitrogen tank at five (5) pounds per square inch (psig) pressure is to be connected to steam drum vent. This supply will compensate for volumetric changes due to temperature variations.

The drain between the non-return and the main steam stop valve should be left open wide. All other drains and vents are to be closed tight.

The boiler water should be tested regularly every other week, with additional treatment being added whenever necessary to maintain treatment levels. When chemicals are added, the boiler water is to be circulated by means of an external pump or by reducing the water level to the normal operating level and steaming the boiler for a short time. If steaming is necessary, the boiler should be filled completely in keeping with the above recommendations.

Facilities Engineering JOURNAL
Facilities Management Magazine

Corrosion Control in Off-Line Steam Boilers

Corrosion control in off-line steam boilers can be particularly difficult. n fact, as many cases of tube failure due to corrosion occur in idle steam boilers as in operating ones.

Oxygen Corrosion

Dissolved oxygen can cause serious corrosion damage to the carbon steel metallurgy used for boiler construction and is the primary cause of corrosion in out-of-service steam boilers. Oxygen corrosion is characterized by intense localized corrosion areas referred to as "pits," which may be covered by a cap called a "tubercle." Because oxygen attack is concentrated in a small area of the total surface, tube perforation and failure can quickly occur although only a small amount of metal has been lost.

Oxygen pitting on a boiler tube.

Operational Considerations

Some facilities only use the steam boiler seasonally, when the weather is cool enough to warrant operation for heating. The vacuum created as the boiler cools causes dissolved oxygen intrusion that can result in severe oxygen corrosion unless proper steps are taken.

Sulfite is commonly added to the boiler feedwater as an oxygen scavenger to help prevent oxygen corrosion. Clean boiler tubes are more susceptible to oxygen corrosion than scaled tubes. With modern boiler water treatment technology and the emphasis on energy efficiency, clean tubes are now standard and proper off-line boiler storage procedures are more important than ever.

Wet storage

There must be no danger of freezing which would damage a boiler during wet storage.

Effective corrosion control in wet stored boilers is directly dependent on maintaining alkalinity and sulfite levels in the boiler water, and not allowing any intrusions of oxygenated makeup, feedwater, steam or condensate. As a general rule, a minimum of 100 ppm of Sulfite and 400 ppm of P-Alkalinity should be maintained.

Sulfite > 100 ppm	pH ~ 10.5	P alkalinity ~ 400 ppm

The following procedure is generally recommended for wet storage. If the boiler has been drained, add sufficient treatment chemicals while refilling to achieve the desired treatment levels. To ensure the chemicals are well mixed and to expel any excess oxygen, the boiler should be fired temporarily. If the boiler was not drained prior to placing in storage, add additional chemicals to raise treatment levels into the desired range shortly before taking offline. Be sure to add enough chemicals to achieve the required levels after the boiler has been flooded. Allow the boiler to cool to less than 200°F, then flood with feedwater to the top of the drum. If "quick fill" is used to flood the boiler with cold makeup, be especially careful that the sulfite level does not drop below minimum. Make sure all connections are closed so the steam line or superheaters are not flooded.

Oxygen corrosion covered by tubercle.

Test the boiler water weekly. If the levels drop below the minimums, additional treatment chemicals should be added and the boiler water circulated by means of an external pump or by lowering the water level and steaming for a short time. If the water level was lowered to steam the boiler, it should be completely flooded as outlined above before placing back in storage.

TECHNICAL BULLETIN 1003

http://www.sellersengineering.com/Engineering%20Data/techbull1003.pdf

Wet layup is recommended for short downtimes (30 days or less) and has the advantage of allowing the boiler to be returned to service on short notice. This method can be a problem if the boiler will be exposed to freezing conditions..

In the wet procedure, the boiler is completely filled with chemically treated water and sealed to prevent any air in-leakage. Nitrogen gas under slight pressure can also be used to displace air and "blanket" the boiler surfaces from corrosion. (See safety precaution)

The following steps should be taken to wet lay-up a boiler:
1A. At least 30 minutes before the boiler comes off line, add the following chemicals:

per 1000 gal:	3 lb. Sulfite	3 lb. Caustic Soda
	200 ppm Sulfite	400 ppm P alkalinity

If the boiler has been out of service for cleaning or has never been online, use the following procedure: Select the highest quality water available to lay-up the boiler. Steam condensate, softened water, filtered fresh water and boiler feedwater are generally acceptable for lay-up. Raw city water should not be used.

Laid-up boiler must be tested weekly to make sure that the proper levels of sulfite and alkalinity are being maintained. To do this, take a sample of the boiler water from the surface blowdown line or other high point.

Safety Precaution
The use of nitrogen for blanketing is recommended in many of the lay-up procedures. Nitrogen will not support life, therefore, it is essential that proper precautions be taken before such equipment is entered for inspection or other purposes. These precautions shall include disconnecting the nitrogen supply line, thorough purging and venting of the equipment with air and testing for oxygen levels inside the equipment. Appropriate caution signs shall be posted around the equipment to alert all personnel that nitrogen blanketing is in use.

Boiler Shutdown, Standby and Storage

Courtesy of Rentech Boiler Systems

Suggested Shut-Down

When the unit is taken out of service, good care of the boiler during the idle periods is mandatory to prevent unnecessary corrosion damage.

When removing a boiler from service for storage, inspection or cleaning, the circulation of water ceases. This causes suspended solids in the water to settle out on the boiler surfaces, then cake and dry to an adherent sludge, which can be mistaken for scale during normal operation.

Standby Protection

Many boilers used for heating or seasonal loads or for standby service may have extended periods of non-use. Special attention must be given to these, so that neither waterside or fireside surfaces are allowed to deteriorate from corrosion.

Corrosion can be more serious during this down time than when the boiler is actually in service. The key factors responsible for corrosion are water, oxygen, and pH. Elimination of dissolved oxygen will prevent appreciable corrosion.

Wet Storage

Units should not be wet-stored when the temperature could drop below freezing.

Treat water per the recommendations of the water treatment consultant.

As the boiler is being shut down and as the pressure subsides, but before steaming stops, add chemicals to the boiler to scavenge oxygen and to control pH, per the recommendations of the Owner's water treatment consultant.

Frequent water samples should be taken and analyzed by the water treatment consultant. If the analysis indicates a need for additional chemicals, the level in the boiler steam drum should be lowered to normal level and chemicals added. The boiler should be then be steamed to circulate the solution, and the process of wet storage repeated as previously described.

Boiler Storage

http://www.boilerchemicals.com/Boiler-Storage-Procedure-s/125.htm

Proper Boiler Storage is important to prolong your boiler life.

wet lay-up

Boiler Storage the wet method is done after the boiler has been removed from service, according to the procedure described in the Technical Data Sheet, "Removing Boilers from Service", it should be refilled with water. The water temperature should be raised to approximately 200F, leaving the top drum vents open so air present will be driven off.

sodium sulfite - 200 ppm P alkalinity - 1000 ppm

With sufficient firing to keep the water circulating, add a sufficient amount of a sodium sulfite containing product to develop a residual sulfite . In addition, add sufficient caustic soda or alkalinity builder to increase the 'P' alkalinity to 1000 ppm. As the water cools, an air space will develop at the top of the boiler. The water level must be checked daily and the boiler kept completely full. A sample should be taken once a week and tested for proper chemical content. Make sure the top tubes in a firetube always remain submerged.

Using Nitrogen gas to lay-up a boiler?

Boiler Storage with Nitrogen is common for boilers where immediate return to service may be required. This method is a modification of the wet storage method in that the water in the boiler is maintained at the normal operating level and this water is treated as recommended under the wet method. In addition, nitrogen is pressurized into the unit when it is sealed to prevent oxygen intrusion.

LAYING UP IDLE BOILERS

http://constructionmanuals.tpub.com/14259/css/14259_255.htm

Many operators faithfully and carefully follow all the procedures and regulations concerning boiler water treatment only to find that the watersides experience corrosion and pitting. It should come as no great surprise that the fault is not with the treatment methods, but the manner in which the boiler is permitted to stand idle. After the pressure drops within an idle boiler, air gradually seeps into the boiler, carrying oxygen with it. The air also contains carbon dioxide that combines with the boiler water to form carbonic acid, which, in turn, lowers the pH of the boiler water. Gradual in- leakage of feedwater can dilute and lower the causticity of the boiler water even further. In addition, condensation within the boiler, on both waterside and firesides, can produce water droplets that are saturated with oxygen. Conditions within the boiler are now ideal for active and rapid corrosion. The need for protecting boilers that are left idle for any length of time should be obvious.

Wet Method

A wet lay-up is done after a thorough cleaning of both firesides and watersides. The feedwater used to fill the boiler is deaerated as much as possible.

sodium sulfite - 100 ppm	pH - 9.5 to 11

While the boiler is being filled, add caustic soda (Sodium Hydroxide) (Lye) in sufficient quantities to maintain a pH reading of 9.5 to 11. Additionally, add approximately 2 ounces of sodium sulfite per 1,000 gallons of boiler to maintain 100 ppm.

To ensure the boiler is filled completely, you should add water until it overflows at the top of the boiler through any convenient outlet, and then close the outlet. When there is a superheater on the boiler, add water to fill it completely. If appreciable air is dissolved in the water, you should boil the water to vent out any air after the boiler is nearly filled.

Slug feed the chemical while the boiler is being filled. Of course the boiler water must be mixed to obtain uniform distribution of the chemical throughout the boiler. Mixing can be accomplished by heating the boiler just enough under low fire to set up natural circulation.

After a boiler has been filled for standby, it must be kept filled as long as it is idle with no water flowing in or out. Leakage out, as through a leaky blowdown valve, can admit air and form a corroded waterline in the boiler.

Water in an idle boiler should be sampled and analyzed weekly. When the pH or concentration of sulfite drops considerably, ensure additional chemical is fed and the boiler water circulated to distribute chemical uniformly.

BOILER STORAGE PROCEDURES

Hydro Logic, Inc.

Choosing the best way to properly protect equipment from oxygen pitting and/or general corrosion can be quite a challenge.

WET STORAGE

The boiler should be filled to its normal level using deaerated feedwater when possible. Add **3 pounds of caustic soda** and **1.5 pounds of sodium sulfite** per 1000 gallons of water capacity. Open boiler vents, apply heat for one to two hours, and allow the unit to cool for an hour after firing. Completely fill the unit with deaerated feedwater. All boiler vents and drains should now be closed and the drain between the non-return and the main steam stop valve should be left fully opened.

sulfite > 100 ppm	P alkalinity > 400 ppm

The boiler water should be tested periodically and additional chemical added as needed to maintain sulfite at a minimum of 100 ppm and p-alkalinity at a minimum of 400 ppm.