

**WATER TREATMENT PROGRAM**

**OPERATING MANUAL**



**Prepared For: W.S.U.**

**Prepared By: Lance Lange & Phil Curran**

**District Representatives**

**GE Betz**

**Edited by Carol Dargin, WSU - Facilities Operations**

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# Feedwater and Boiler Oxygen Control

# CORTROL IS100

A powdered, catalyzed 100% sodium sulfite oxygen scavenger. This product is granulated to minimize dusting.

A Sulfite test is done on the boiler water to determine the amount of IS100 that is in the boiler water. Presence of a significant sulfite residual ensures that dissolved oxygen is not present in the boiler water. This is very critical since dissolved oxygen can result in pitting corrosion and failure of boiler tubes and is preventable by always maintaining 80 ppm sulfite in boiler water. Off-line boilers are especially susceptible to oxygen attack and should be tested daily and drained if off line for over 2 weeks.

The control range is 80 ppm to 150 ppm.

* If boiler water test results are lower than 80 ppm ………..increase the dosage of IS100 in the day tank
* If boiler test results are higher than 150 ppm, …….decrease the dosage of IS100 in the day tank.

***Oxygen scavenging.***

*A properly functioning deaerator, or feedwater heater, is capable of removing most, but not all, of the corrosion-causing oxygen from the feedwater. The remainder must be removed by chemically binding the oxygen into a harmless state.*

*The standard practice for low-pressure systems is to inject sodium sulfite solutio, often combined with a catalyst to speed up the reaction time. The sodium sulfite reacts with the oxygen to form sodium sulfate, which remains as a more or less inert compound in the boiler water. At the point where all of the oxygen has been bound up, a residual of “leftover” sulfite will begin to accumulate in the boiler water. A reserve of 20-50 parts per million (ppm) is typically desired. Too much residual is wasteful of chemical and will reduce the boiler water pH.*

*Sulfite is replaced in high pressure systems by hydrazine and other proprietary blends.*

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***Scale & Corrision control.***

*Protection of internal boiler parts is a complex and painstaking part of chemistry. Blends of selected chemicals are injected into the feedwater line or the boiler itself to prevent the formation of scale, deposits and corrision.*

*Control of alkalinity is an important part, and other additives suspend contaminants, keep sludge from sticking, and act to remove old deposits. For instance, phosphates react with calcium that might get through the softener and chelants scavenge existing scale, dissolving it to be drained out through the blowdown. Polymers prevent contaminants from sticking to metal internal parts, and act to keep particulates dispersed in the water, rather than settling out.*

*These chemical formulations must be constructed based on the individual needs of the particular system. This is definitely not a one-size-fits-all proposition.*

# Boiler Scale/Deposit Prevention

# OPTISPERSE AP302

The first line of defense against scale and deposits in steam boilers is prevention of hardness from entering the boiler and maintaining consistently soft (<1 ppm hardness) makeup and condensate water. Hardness can enter the boiler due to a poorly operating softener or via condensate if a leak in steam heat exchange equipment exists. Either situation can result in deposition throughout the boiler. Maintaining recommended AP302 levels in boilers further protects against deposits. AP302 is a liquid concentrated all polymer internal boiler treatment based on advanced polymer technology. It provides superior control of both hardness and iron oxide deposition in boilers

A Molybdenum test is done on and easy to use digital colorimeter. The control range for AP302 is 1.0 ppm to 2.0 ppm.

* If boiler test results are lower than 1.0 ppm and the boiler water conductivity is in the control range…….increase the dosage of AP302 in the day tank.
* If boiler test results are higher than 2.0 ppm and the boiler water conductivity is in the control range…….decrease the dosage of AP302 in the day tank.
* Molybdenum (Mo) levels will fluctuate with conductivity, so low boiler water conductivity will typically have low Mo, and high boiler water conductivity will have high Mo when feed rates of AP302 are correct. Adjust blowdown rates as needed to maintain conductivity between 2500-4000 and consider this effect when checking Mo levels.

# Steam Condensate Corrosion Control

# STEAMATE NA2260 or NA2040

***Condensate corrosion control.*** *Unless boiler feedwater is dealkalized, a significant quantity of carbon dioxide gas is generated along with the steam. This does not create a problem until the steam condenses back into water at the far end of the process. At that point, the CO2 redissolves and, without the buffering agents left behind in the boiler water, forms carbonic acid. This can quickly corrode through the full length of the return piping system.*

*Low pH and high iron levels in the condensate are quick clues that a steam system is not adequately protected. The most common means of treating condensate return plumbing involves the injection of one or more ammonia-derived compounds that evaporate with the steam and recondense with the CO2, raising the pH out of the corrosive range.*

# *The selection of the volatile amines used is determined by system temperature, pressure, and the length of the piping run between boiler and the farthest point of the system. Morpholine, cyclohexlamine, and diethylaminoethanol (DEAE) are three of the most common amines used for return line treatment. The amine feed is titrated to maintain the pH between 8.0 and 8.8 at all sampling points.*

Concentrated FDA approved amines, travels out of boiler with steam and condenses with steam to elevate condensate pH.

**Steamate NA2260 should be used for boilers operating at 20 psi steam or greater, and Steamate NA2040 should be used for boilers operating at <20 psi steam.**

###### STEAMATE NA2260 or NA2040

Neutralizing amines, protect condensate systems of steam boilers from corrosion due to acidic steam condensate. Works by condensing with steam into condensate and elevating condensate pH to slightly alkaline pH of 8.0 – 8.8.

Carbon Dioxide is naturally produced in the boiler when heat and pressure break down alkalinity. Carbon Dioxide flashes with the steam and travels throughout the steam system. When steam turns to condensate some of the carbon dioxide dissolves in the condensate and forms carbonic acid. This action reduces the pH in the condensate and increases the corrosion potential. NA2260/NA2040 neutralizes the carbonic acid and raises the pH. NA2260/NA2040 is controlled by the pH of the condensate. The control range is condensate pH 8.0 to 8.8.

* If condensate test results are lower than 8.0 pH ………..increase the dosage of NA2260/NA2040 in the day tank
* If condensate test results are higher than 8.8 pH…….decrease the dosage of NA2260/NA2040 in the day tank.
* Boiler water carrover and/or condensate leaks that allow condensate contamination may affect condensate pH. If condensate conductivity is high (>100) action should be taken to stop carryover or contamination from continuing.



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**BOILER WATER TESTING AND TREATMENT**

Water tests are recommended to be performed daily on the day shift. Record results in the water test log. Following are the test procedures to follow:

**TEST SAMPLE POINT LIMITS AFFECTED BY**

Hardness Softener effluent 0-1 ppm Softener Regeneration

Conductivity Softener effluent <250 μmhos Check Softener Final Rinse

Conductivity Boiler Water 2500-3500 μmhos Skimmer Blowdown

Sulfite Boiler Water 80-150 ppm IS 100 (Sulfite) feed

AP302 (Mo) Boiler Water 1.0-2.0 ppm AP302 feed

Conductivity DA Feed Water record % condensate returned

Hardness DA Feed Water 0-1 ppm Check Condensate/ Softeners

pH Condensate 8-8.5 pH NA 700 (Amine)

Conductivity Condensate < 100 Carryover or condensate

contamination

Hardness Condensate 0-1 ppm Contamination or carryover



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# TEST PREPARATION

Testing Equipment

* All equipment that is to be used for a particular test procedure should first be **rinsed 3 times** with the water to be tested.
* Testing done with dirty or contaminated equipment may give you false test results.
* Batteries should be replaced when they are low on the Mo tester and conductivity meters.

Recording Results

Chemical Treatment

When your testing shows a reading that is above or below the control limits you can either add more chemical to the day tank or change the pump settings. This provides two variables which can lead to confusion from shift to shift. It is better to add more chemicals than to change the pump setting. If any of these adjustments are made during a shift, it is important to log the changes on the log sheets and/or in the operator’s diary.

**TEST PROCEDURES**

**TOTAL HARDNESS**

1. Measure 10 ml of sample and add to sample vial.
2. Add 3 drops **Hardness Buffer Reagent** (Code L1566) and mix.
3. Add 1 dipper **Hardness Indicator** (Code L290) and stir to dissolve.
4. If sample turns sky-blue, water is zero hardness.
5. If sample turns red or purple, add **Hardness Titrating Solution** (Code L834) from dropper bottle 1 drop at a time until sample turns sky-blue.
6. Record # drops reading x 1 as ppm. (Each drop = 1 ppm)

##### CONDUCTANCE CORRECTIONS FOR AMMONIA AND CARBON DIOXIDE

The purpose of the conductivity determination is to obtain a measure of the solids present in the condensed steam sample as an indication of the degree of carryover of boiler water solids. To interpret the conductivity of a condensed steam or condensate sample, it is necessary to correct for the effect of any gases present. After the concentration of ammonia or carbon dioxide has been determined, the correction factor applying to that concentration is subtracted from the observed conductance.

##### CONDUCTANCE OF HIGH-PURITY WATER

Samples such as makeup water, feedwater, condensed steam, and return condensate should not be neutralized prior to determining conductivity.

High-purity waters are easily contaminated and should be measured immediately. Never test a sample that has been standing. The average value for converting micromhos of conductance to dissolved solids in condensate is approximately 0.5-0.6 mg/L. In calculating the approximate solids content, gases such as ammonia and carbon dioxide must not be present because they will affect conductance.

The specific conductance of water is a measure of its ability to conduct an electrical current. This property is of no consequence in itself with respect to water treatment. However, from a control standpoint, the conductivity test is important as a direct measure of the total ionizable (dissolved) solids in the water. The conductivity test provides a measurement of steam purity as well as a simple control for boiler water solids. Conductivity may also be used for blowdown control in recirculating cooling water systems.

Specific conductance is inversely proportional to electrical resistance. Pure water is highly resistant to the passage of an electric current; therefore, it has a low specific conductance. If the water contains ions, it becomes a better conductor of electricity and the specific conductance is increased. Inorganic compounds, such as sodium chloride and sodium sulfate, dissociate into positive and negative ions, which conduct electricity in proportion to the number of ions present. The conductivity test, therefore, is not specific for any ion, but is a measure of the total ionic concentration.

The basic unit of electrical resistance is the ohm; because electrical conductivity is the reciprocal of resistance, the term "mho" (ohm spelled backwards) was chosen as the basic unit of conductivity. The conductivity test measures small amounts of electrical conductance, so the instrument is usually calibrated in micromhos (1 micromho = 1 millionth of a mho). Often, a conductivity meter is calibrated to read directly in milligrams per liter dissolved solids (or some specific ion or compound). This is not recommended for control testing because the conversion factor from micromhos of specific conductance to milligrams per liter varies slightly with different waters. The conductivity test provides an accurate, simple method of blowdown control. However, in alkaline samples the hydroxide ion has a disproportionately high conductance.

**CONDUCTIVITY**

1. Pour boiler water or feedwater or condensate into hand held conductivity tester.
2. Push the button marked COND and read the digital conductivity.

Ionizable solids give water the ability to conduct electrical current. A multirange conductivity meter measures this electrical conductance. Scales are calibrated in micromhos (µmho) or the equivalent SI system microsiemens (µS). In the case of boiler water, hydroxide ions may be neutralized with a boric acid solution prior to measurement of neutralized conductivity.

**SULFITE**

1. SAMPLE POINT(s): **Boiler Water**
2. CONTROL LIMITS: **80 - 150 ppm**
3. TESTING EQUIPMENT:

GE BETZ REAGENTS:

**L219** - Sulfite Indicator Powder

**L6105** - Potassium Iodide-Iodate N/44

1. Measure 10 ml of boiler water and add to sample vial.
2. Using the plastic dipper, add 1 dipper of **Sulfite Indicator Plus** (Code L219**)** and stir/mix the solution.
3. Add **Potassium Iodide-Iodate** (Code L6105) dropwise from dropper bottle until a faint permanent blue color develops.
4. Count # drops used, subtract 1, then multiply by 3 to determine parts per million sulfite as SO3.

MOLYBDENUM

1. SAMPLE POINT(s): **Boiler Water**
2. CONTROL LIMITS: **1.0-2.0 ppm**
3. TESTING EQUIPMENT:

1. TEST PROCEDURE
2. Measure 20 ml of boiler water.
3. Add One Mo powder pillow L2358 to the 20 ml sample.
4. Split sample into into 2 glass vials, 10 mils each.
5. Add 0.5 mil (1/2 mil) of liquid L2359 to one of the vials – this is the “reacted sample”, the other is the “blank”.
6. Put the blank vial into the Mo colorimeter and press zero. “0.00” should appear.
7. After 1-2 mins, put the reacted vial into the colorimeter and press read. Record result.
8. CHEMICAL TREATMENT ADJUSTMENTS:
9. If boiler test results are lower than 1.0 ppm and the boiler water conductivity is in the control range…….increase the dosage of AP302 in the day tank.
10. If boiler test results are higher than 2.0 ppm and the boiler water conductivity is in the control range…….decrease the dosage of AP302 in the day tank.
11. Molybdenum (Mo) levels will fluctuate with conductivity, so low boiler water conductivity will typically have low Mo, and high boiler water conductivity will have high Mo when feed rates of AP302 are correct. Adjust blowdown rates as needed to maintain conductivity between 2500-4000 and consider this effect when checking Mo levels.



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# The Chemical Day Tank

The chemical dilution tanks used for boiler chemical feed should last between 24 to 72 hours before it is refilled.

Pump setting should be adjusted so that the tank is nearly empty after 24-72 hours of operation. The tank should be filled to the 30-inch line with condensate or softened water…..NOT CITY WATER.

1. The chemicals should be kept sealed/pails capped or covered. Sulfite and return-line treatment lose their effectiveness with prolonged exposure to air.
2. Dosage adjustments are simplified. You do your tests daily so that you can make chemical adjustments daily so that the treatment program is consistent and damage to operating equipment is kept to a minimum.
3. Control over the treatment program is simplified.

When your testing shows a reading that is above or below the control limits you can either add more chemical to the day tank or change the pump settings. This provides two variables which can lead to confusion from shift to shift. It is better to add more chemicals than to change the pump setting. If any of these adjustments are made during a shift, it is important to log the changes on the log sheets and provide comments in th e boiler rm log book.

Chemical Drums and Containers

All containers used to apply dosage to the day tank should be marked in increments such as pints, quarts, cups, & pounds e.t.c. Try to use a labeled, separated pitcher, or measuring cup for each specific treatment product. This activity leads to consistent treatment and improved communication between operators on different sh

**Alkalinity.** For best steel protection and scale prevention, boiler water is maintained in a fairly alkaline (high pH) state. Low alkalinity can lead to magnesium phosphate deposits, acid corrosion, and calcium carbonate deposits. High alkalinity can cause steel to become brittle and crack, and cause foaming of the water as it boils, contaminating the steam.

Alkalinities may be present as free hydroxide (OH-), carbonate (CO3), or bicarbonate (HCO3). Heating of the water causes the bicarbonate alkalinity form to convert to carbonate alkalinity, releasing carbon dioxide gas. Much of this reaction can and should take place in the deaerator. The relationship between the types of alkalinity is determined by two chemical tests and a calculation. The phenolphthalein alkalinity test (P-Alkalinity) and mixed methyl orange and brom cresol green (M-Alkalinity) tests measure how much of a calibrated concentration of sulfuric acid is necessary to lower the pH of the boiler water sample from its normal 10 or 11 down to about 8.3 for “P” (pink-to-clear), and 5.4 for “M” (green-to-orange).

Ordinarily, the P-Alkalinity of boiler water will be somewhat over half of the M-Alkalinity, and the equation 2P-M=OH is used to determine the free hydroxide alkalinity. The water has been heated enough to convert all the bicarbonate to carbonate. Maximum M-Alkalinity for low-pressure boilers is about 700-750 ppm. Maximum hydroxide alkalinity is about 400 ppm. Inability to keep alkalinities down to these ranges can be a sign that dealkalization is required.

Sodium hydroxide (caustic soda) can be fed to raise alkalinities, but is most commonly combined with the scale and corrosion control chemicals, ideally custom-blended to the particular needs of the particular installation.