Clayton WATER TECHNOLOGY

Feedwater Treatment Manual

Clayton Steam Generators & Fluid Heaters

CLAYTON INDUSTRIES
City Of Industry, California
USA

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WARRANTY

Clayton warrants its equipment to be free from defects in material and/or workmanship for a period of 1 year from date of original installation, or 15 months from date of shipment from the factory, whichever is shorter. Upon expiration of such warranty period, all liability of Clayton shall immediately cease. During the warranty period, if the Clayton product is subjected to improper installation, misuse, negligence, alteration, accident, improper repair, or operated contrary to Clayton's printed instructions, all liability of Clayton shall immediately cease. **THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXCEPT TITLE AND DESCRIPTION, WHETHER WRITTEN, ORAL OR IMPLIED, AND CLAYTON MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.** No representative of Clayton has any authority to waive, alter, vary, or add to the terms hereof without prior approval in writing executed by two officers of Clayton Industries.

If within the period of such warranty the purchaser promptly notifies Clayton's Service Department (Attention: Warranty Repairs, Cincinnati, OH) in writing of any claimed defect; and if requested by Clayton, promptly returns the part(s) claimed defective to Clayton's manufacturing facility with all transportation charges prepaid to Clayton, Clayton will consider said part(s) covered under this warranty. All parts returned must be shipped to Clayton's Cincinnati, OH facility (Attention: Warranty Repairs, Cincinnati, OH) except coils which must be shipped to Clayton's City of Industry, CA facility (Attention: Warranty Repairs, City of Industry, CA). Once reviewed by Clayton, if it appears to Clayton that such part(s) is defective in material and/or workmanship, Clayton will at its sole discretion & choice repair such defective part(s), or replace same with like or similar part(s), or provide a credit for the part(s). The purchaser shall be responsible for all transportation and labor charges relating to installation of any replacement part or removal of a defective part.

It is expressly understood that the repair or replacement of such defective part(s) by Clayton shall constitute the sole remedy of purchaser and sole liability of Clayton whether on warranty, contract, or negligence; and that Clayton shall not be liable for any other expense, injury, loss, or damage whether direct, incidental, or consequential.

With respect to any non-Clayton part(s) supplied hereunder; other than the duration of the warranty, the OEM manufacturer's warranty shall apply and be exclusive.

Goods sold or delivered may, at Clayton's discretion, consist in part of reconditioned or reassembled parts which have been inspected and checked by Clayton and which are fully covered by such warranty as if new. In performing its warranty as obligations hereunder, Clayton may in its discretion repair or replace any part with such a reconditioned or reassembled part.

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Feedwater Treatment Manual

Steam Generators
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STEAM GENERATOR WATER SYSTEM

Condition Control and Monitoring

Statement Of Operation

Water treatement is required with any boiler or steam generator to protect against corrosion and scaling. Due to the compact design of the Clayton steam generator, the water must be continuously treated and regularly monitored. Daily testing and logging is required to assure normal operation of all feedwater system components. The automatic operation of the total system makes the care and effort required minimal. Departure from specific Clayton guidelines may cause rapid and expensive damage. Such damage is NOT covered by warranty.

In case of any questions, contact a Clayton Factory Service representative

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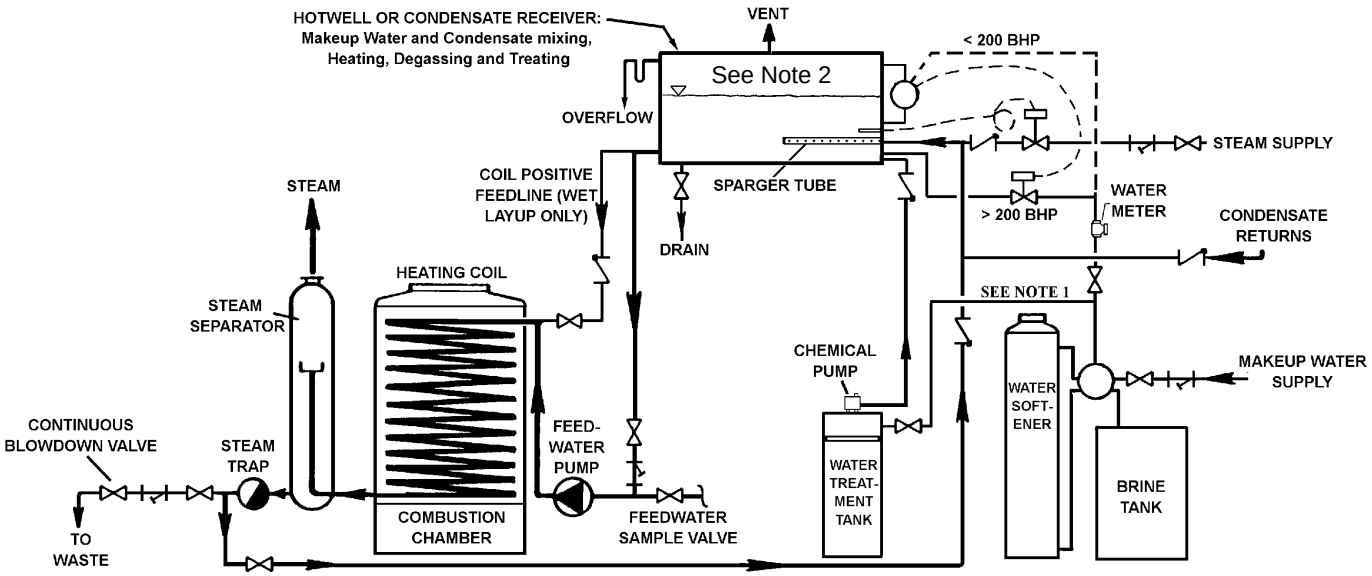

COIL FEEDWATER AT SAMPLE VALVE	
Limit Values:	Typical Values:
Hardness – 4 ppm maximum	0 ppm
pH	10.5 – 12.5
Residual Sulfite	50 – 100 ppm (during operation) >100 ppm (during wet lay-up)
Limit dissolved solids – 8,550 ppm maximum	*3,000 – 6,000 ppm
Free of suspended solids (mud, rust particles, etc.)	0

NOTES:

1. Used on dry chemical applications only.
2. Booster pump(s) required if hotwell cannot be elevated high enough to provide required NPSH to the feedwater pump.

* The Total Dissolved Solids (TDS) blowdown is to be adjusted to maintain the desired concentration range of dissolved solids.

NOTES

Table of Contents

SECTION I Introduction

This manual outlines the proper water treatment for Clayton steam generators and fluid heaters, as well as the proper operating procedures that would ensure many years of a problem-free machine operation.

Proper and adequate feedwater treatment must be used from the time your Clayton steam generator/fluid heater is commissioned. Daily treatment and care of the feedwater supply is the sole responsibility of the user. Since maintaining a properly treated feedwater supply is beyond the control of Clayton Industries, Clayton Industries will NOT be responsible for any equipment damage resulting from improper and inadequate water treatment.

Continuous feedwater treatment is required at all times, even during the periods of wet lay-up shutdowns. Water testing must be conducted daily, even during the periods of wet lay-up shutdowns.

Instituting a feedwater treatment program and maintaining proper and adequate care of Clayton equipment is the owner's responsibility. Arrangements for providing continuous feedwater treatment should be made when purchasing a steam generator/fluid heater. Suitable water treatment equipment should be installed before placing the steam generator/fluid heater into service.

Furthermore, pay particular attention to offline (lay-up) conditions, since these conditions may be more detrimental than online conditions. If a unit is laid up dry, it must be completely dry with no traces of water. If a unit is laid up wet, it must be completely wet with proper chemical treatment and the heating coil must be absent of all air/air pockets.

Also, pay particular attention to the water conditions during start-up and make sure that the proper water conditions are being maintained. During start-up, a substantial amount of cold water is normally added and it may take extra time for the hotwell to stabilize and reach its normal efficiency level.

NOTE

It may be necessary to temporarily increase the feed of water treatment chemicals to help recover from start-up conditions. This temporary increase will help bring feedwater parameters (i.e. sulfite level) back into specification quickly.

To ensure proper and adequate water treatment, you are encouraged to take advantage of Clayton's AWARE water treatement program, as well as its Coil Guard Technology. For customers who choose to forgo the AWARE water treatment program, Clayton strongly recommends recording feedwater conditions daily and maintaining long-term records using AWARE data log reports.

Finally, a complete understanding of the operation of a Clayton steam generator/fluid heater is very important in its successful operation. Therefore, you are encouraged to thoroughly review the contents of the manual.

Principle Causes Of Coil Damage or Coil Failure In A Clayton Steam Generator/Fluid Heater

Condition	Occurrence	Effect
Oxygen Corrosion	Occurs when the feedwater has not been properly treated mechanically and/or chemically to remove all dissolved oxygen.	Results in oxygen pitting of inner coil surface. Typically occurs in the upper portion of coil, although it can occur throughout the coil. Oxygen pitting corrosion can also be localized and occur rapidly when corrosive conditions exist.
Scaling	Occurs when the feedwater is not properly softened to remove calcium & magnesium from the make-up water. Can also occur when suspended iron exists and when the silica level exceeds certain levels.	Results in scale formation on the inner coil surface which reduces heat transfer. It can lead to plugging of the coil, loss of efficiency, and thermal stress cracking (usually in the lower waterwall).
Improper Shutdown	Occurs when the Steam Generator/ Fluid Heater is not left either completely dry or completely wet with properly treated water.	Results in accelerated oxygen corrosion at the water line on dry shutdowns and throughout the coil on wet layups.
Low pH	Occurs when the pH of the feedwater is not maintained between 10.5 and 12.5.	Results in generalized corrosion and thinning throughout the coil wall. **IMPORTANT:** If sodium bisulfite is used as the oxygen scavenger, extra precaution must be taken to maintain the correct pH since sodium bisulfite may lower the feedwater pH.

Note: Other inadequacies in water treatment or improper installation of the Steam Generator/ Fluid Heater or feedwater system can cause damage to the Steam Generator/Fluid Heater.

SECTION II The Basics

2.1 Water and Its Impurities

As water is formed in the atmosphere it is a relatively simple compound (H-O-H). However, as it falls through the atmosphere, it dissolves oxygen, nitrogen, carbon dioxide, as well as other gases.

Once on the ground, water will dissolve many minerals such as calcium, magnesium, etc. Thus, pure water in nature rarely exists. Depending on its "history" and where "it's traveled" (rivers, lakes, wells), water will contain many forms of impurities.

It is these impurities that cause most scale and corrosion problems. Nevertheless, even pure water (with a neutral pH of 7.0) can be very corrosive and aggressive on mild steel.

For practical purposes, the following impurities cause the majority of scale and corrosion problems:

Calcium and magnesium: these ions are called hardness and can form hard scales such as calcium carbonate, calcium sulfate, and magnesium carbonate. Such scale forms in boiler tubes because these compounds are less soluble as temperature and pressure rise. A water softener will remove these ions.

Iron (dissolved or suspended) is evidence of corrosion and may also lead to iron deposition and is another source of scale.

Silica, above certain limits and without the proper water chemistry, may lead to a very hard silicate scale.

The formation of any scale is undesirable because it will retard heat transfer, lower efficiency, and perhaps even lead to tube restriction and tube failure. Furthermore, even small amounts of scale can lead to another problem, “under deposit corrosion.”

Oxygen is the dissolved gas of greatest concern. Oxygen is required for most forms of corrosion—especially pitting. At higher temperatures oxygen corrosion is even more severe. For this reason, oxygen is normally expelled mechanically in a DA or hotwell system and residual oxygen is neutralized with sulfite.

Suspended solids pose a problem causing scale formation, as well as aggravating corrosion. Suspended solids can contribute to caustic gouging, which leads to tube wall erosion.

2.2 Principles Of Boiler Scale And Corrosion Control

Water concentrates in any boiler due to evaporation. That is, as steam is generated the ions in the bulk water concentrate until the solubilities of various compounds are exceeded. At this point scale forms at the points of highest heat transfer. Calcium and magnesium (hardness ions) can form carbonate, sulfate, and other types of scale. Silica and iron can also form various types of scale.

To prevent hardness scaling, a water softener is used to remove hardness (calcium and magnesium). Iron levels must be kept to a minimum to avoid iron deposits (5 ppm iron in the make-up, condensate, and boiler water). Most raw water sources contain just a trace of iron; however, if it is too high it may have to be removed by another pre-treatment method. Iron in the condensate is evidence of return line corrosion and is controlled by the appropriate chemical treatment. While most boiler waters will have 1–3 ppm of iron (since the water is concentrated), a level above 5.0 ppm may indicate active corrosion in the boiler or iron contamination from the make-up or condensate.

The limit for silica (at steam pressures <300psi) is 120 ppm, provided the OH alkalinity is maintained at two-times the silica concentration. Above this limit, silica deposition may occur.

While pre-treatment systems will remove most of the undesirable ions, there are, nevertheless, some residual ions that can still form deposits. Even though these deposits may be small and will not retard heat transfer to any great extent, they may lead to under deposit corrosion. Therefore, a polymeric dispersant is required to control any deposition from these residual ions.

Most boiler corrosion is due to a low pH or the presence of oxygen. In a Clayton system, the pH is maintained at 10.5–12.5 to prevent corrosion (and to ensure sufficient alkalinity for the proper precipitation of any residual hardness). Oxygen is minimized by a properly functioning hotwell, deaerator (DA), or semi-closed receiver (SCR) system; the remaining oxygen must be neutralized by injecting an oxygen scavenger, such as a catalyzed sulfite.

Condensate line corrosion is typically caused by condensate with a low pH due to carbonic acid. Carbonic acid is a result of carbon dioxide in the steam, which comes from the decomposition of bicarbonate in the boiler water. To eliminate condensate line corrosion, a neutralizing amine must be fed into the boiler system. This amine will vaporize and be carried with the steam to neutralize the carbonic acid.

2.3 Understanding the Water Flow in a Clayton Steam Generator/ Fluid Heater

To understand the proper chemical treatment of a Clayton steam generator/fluid heater, it is best to follow the water flow (see **Fig. 2-1**). Softened water enters the feedwater tank where the majority of oxygen is removed. In the feedwater tank, the softened water is mixed with the customer's process condensate return (if any), steam, and generator trap returns from the steam separator. These returns raise the feedwater tank temperature and the feedwater to the proper operating temperature.

Furthermore, the appropriate chemicals are added and mixed to achieve proper chemical levels prior to delivery to the heating coil. A proper water system design must include adequate retention time to achieve the proper boiler feedwater quality.

The feedwater then enters the coil where the majority of water is evaporated—leaving a saturated steam-water mixture. From the coil, the saturated steam-water mixture discharges into the separator (or remote separator in a fluid heater) where the excess water is expelled from the steam. The expelled water collects at the bottom of the separator as a concentrated fluid. This fluid discharges from the bottom of the separator, passes through the steam trap, and returns to the feedwater tank.

Water impurities and chemicals concentrate (due to evaporation) in a Clayton system, as in any other boiler. However, because the trap fluid returns from the separator to the feedwater tank, the feedwater (in the feedwater tank) will be concentrated and "cycled up" as in normal boiler water. In other

words, the feedwater in the feedwater tank will have the same composition as the coil water. Thus, the Clayton feedwater consists of treated make-up water, process condensate, and trap fluid; therefore, the feedwater tank water is, in fact, boiler water.

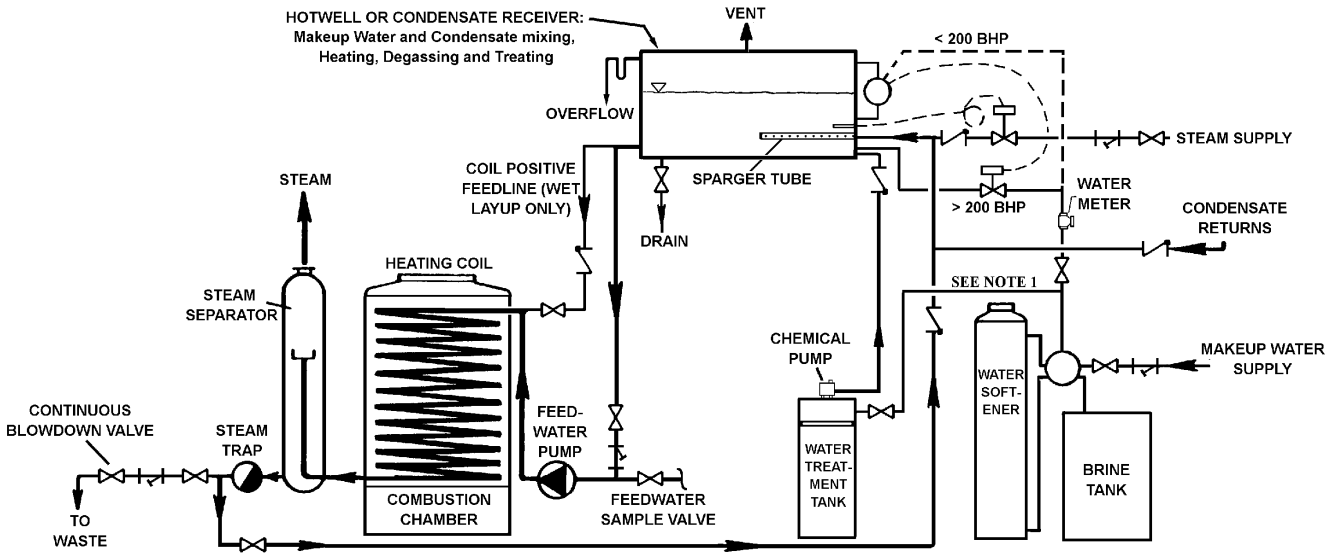

Fig. 2-1 Water flow diagram of a typical steam generating system

2.4 Optimum Water Conditions

The following water conditions must be maintained in the feedwater (boiler water) **at all times**.

- Hardness: 0 ppm (4 ppm maximum)
- pH 10.5–11.5 (normal range), maximum of 12.5
- Oxygen free with an excess sulfite residual of 50–100 ppm during operation (>100 ppm during wet lay-up)
- Maximum TDS of 8,550 ppm (normal range 3,000–6,000 ppm)
- Maximum dissolved iron of 5 ppm
- Free of suspended solids
- Maximum silica of 120 ppm with the proper OH alkalinity

2.5 Unit Operations

2.5.1 Softener

A typical Clayton steam generator/fluid heater system starts with the water softener system. Soft water must be used at all times. The water softener regeneration frequency is a function of water hardness, rate of water consumption, and softener size. See Sizing A Water Softener in Appendix B for sizing a water softener.

2.5.2 Feedwater Tank

The primary purpose of the feedwater tank is for expelling oxygen from the feedwater and blending sufficient anti-scaling and anti-corrosion chemicals with the feedwater (refer to Section III, Chemical Treatment). Soft water enters the feedwater tank where it mixes with customer's process condensate, if any, and the trap fluid. For optimum performance, the feedwater tank temperature should be maintained between 190^{o}–200^{o} F (88^{o}–93^{o} C). This will reduce the oxygen content to 1–2 ppm. Furthermore, the feedwater tank vent should always be vertical to facilitate oxygen escape.

The softened make-up water is introduced through a level control valve, which controls the rate of make-up in direct proportion to the system requirement. The make-up is introduced below the water surface in a manner that minimizes the entrainment of air. The feedwater tank is heated by steam injection and is controlled by a temperature control valve. The steam, process condensate, and trap fluid are introduced through a steam sparger inducer tube.

2.5.3 Clayton Steam Generator/ Fluid Heater

The feedwater tank water then enters the coil of the Clayton steam generator/fluid heater. The relatively high velocity in the heating coil assures the continual water displacement over all heating surfaces. It avoids stagnation zones and "steam blanketing," which can cause severe concentration of dissolved solids, localized overheating, and stress. Therefore, higher concentrations of dissolved solids can be tolerated in the forced circulation Clayton steam generator/fluid heater than is normally acceptable in natural circulation boilers. But, even Clayton's boiler design has limits on dissolved solids, and maintains a zero suspended solids requirement.

2.5.4 Steam Separator

The saturated steam-water mixture discharges from the heating coil and enters the steam separator. Forced circulation also makes possible a more effective steam separator design. The Clayton separator uses some of the pressure differential in the coil and separator circuit to achieve a strong centrifugal force. This force expels the excess water from the steam and the magnitude of the force impedes any influence by high dissolved solids, which normally cause foaming and carryover in conventional boilers.

Conventional drum-type boilers cannot achieve the same degree of mechanical separation because of the required differential pressure. Therefore, when the water surface in a drum reaches a certain critical rate, it will carry small droplets of water with it. This critical rate depends in part on the dissolved solids concentration and the tendency of these solids to cause foaming. Heavy foaming is called "priming" and can be compared to a coffee pot boiling over.

The Clayton system is not affected by this critical surface velocity condition and is, therefore, not limited to the conventional 3,500 ppm TDS limit formerly recommended by the ABMA. This limit was intended to prevent excessive moisture carryover. Because of these control features available with forced circulation design, the Clayton steam generator/fluid heater is capable of tolerating much higher TDS levels.

As steam discharges from the top of the Clayton separator, the concentrated fluid (with elevated levels of dissolved solids) discharges from the bottom of the separator, passes through a steam trap, and returns to the feedwater tank.

This completes the cycle.

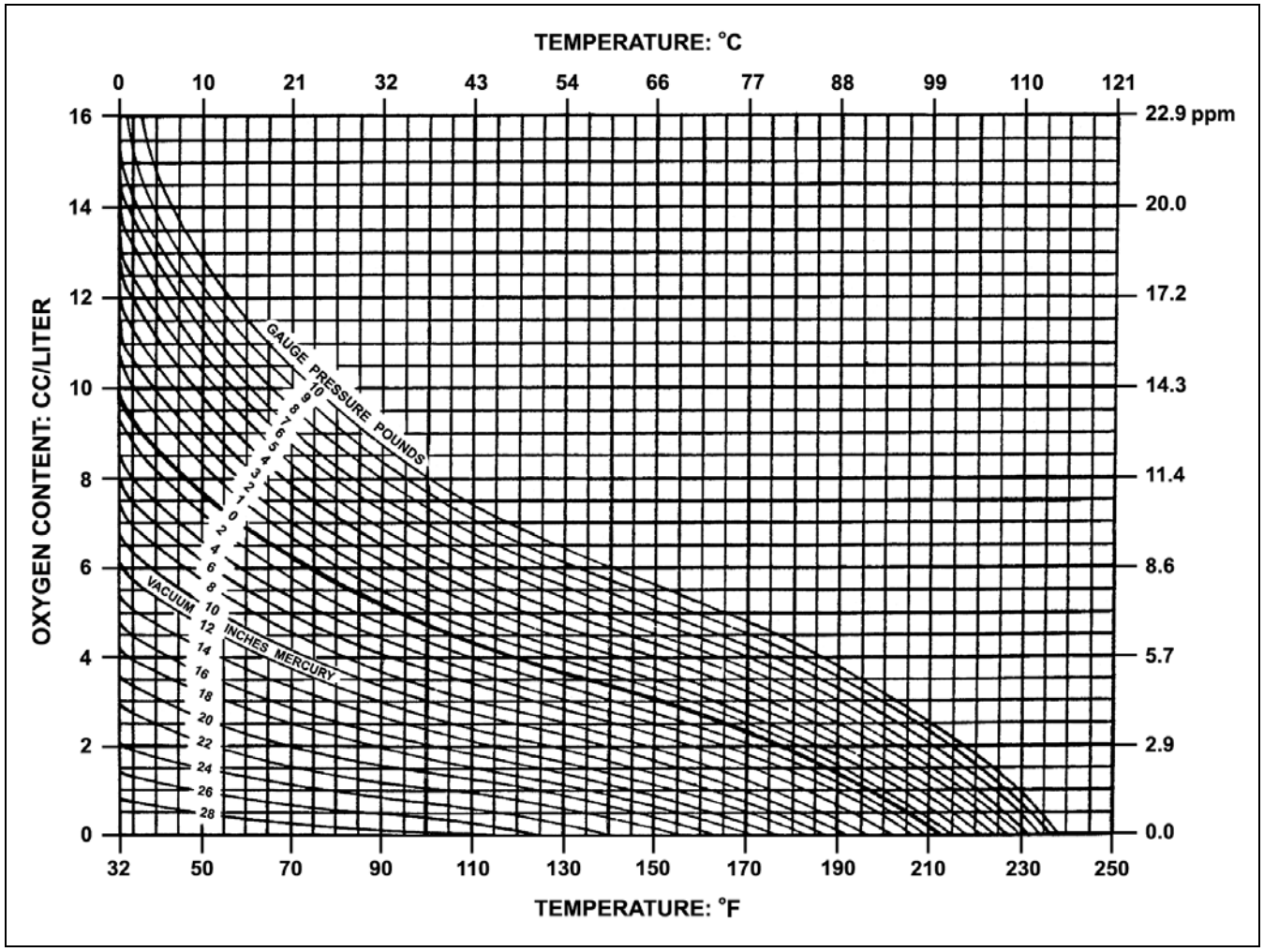

Fig. 2-2 Solubility of oxygen in water at various temperatures and pressures

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SECTION III Chemical Treatment

3.1 Water Quality Requirements

Proper water conditions for any boiler system are vital for maintaining efficient and problem-free operation. The optimum water conditions for treated make-up water, feedwater (boiler water), and condensate are outlined below.

Make-up Water

- 0 ppm Hardness: accomplished by softening
- <0.5 ppm iron
- 0 Suspended solids

Feedwater (boiler water)

- 0 ppm Hardness (4 ppm maximum)
- <5.0 ppm iron
- 0 Suspended solids
- pH 10.5–11.5, 12.5 maximum
- Oxygen free with excess sulfite residual of 50–100 ppm during operation (>100 ppm during wet lay-up)
- Maximum TDS of 8500 ppm (preferred range of 3,000–6,000)
- Silica <120 ppm with sufficient OH alkalinity

Condensate (if returned)

- <0.5 ppm iron
- pH 8.0-8.5

Typical pre-treatment equipment for a Clayton unit consists of a softener to remove hardness and a feedwater tank to reduce oxygen. If the raw make-up water source is unusually high in total alkalinity, iron, or silica, other pre-treatment systems may be required.

The above conditions are maintained by the appropriate pre-treatment equipment and by a well managed water treatment program and daily water quality testing, regardless of operational status. See the section on Clayton's Coil Guard Technology.

These conditions must be maintained at all times for an efficient, problem-free operation. Furthermore, off-line conditions are just as important and the prescribed lay-up procedures must be maintained and tested daily.

3.1.1 Make-Up Water

Knowing the make-up water quality and monitoring it on a daily basis is the starting point for any good water management program. Changes in make-up quality or in the make-up source must be recognized daily since they may warrant changes in the pre-treatment or chemical programs or both.

Typically most water sources contain hardness which must be removed with a softener. Normally, (but not always), suspended solids, iron, and silica are not present to the level where they would cause a problem. Small amounts of iron and suspended solids will be removed by the softener.

It is also important to know the percent make-up and percent condensate return. This will obviously be a factor in designing a pre-treatment and chemical program. For example, if a unit is used solely for heating and the condensate return is near 100%, then make-up water impurities are much less critical.

Again, most systems incorporate a softener, which must be kept functional at all times. In fact, a softener should be regenerated with about 10% of it's capacity left in order to ensure soft water at all times.

3.1.2 Feedwater

As mentioned earlier, Clayton feedwater is, in fact, boiler water. Optimum water conditions are as follows:

1. **Hardness of zero (0):** If the make-up water is always soft and there is no hardness contamination in the return condensate, then the feedwater should always be soft. Nevertheless, there may be trace amounts of hardness (4 ppm or less) since this water is concentrated. This trace hardness is no problem provided adequate chemical (dispersant) is fed.
2. **Oxygen of zero (0) with an excess sulfite residual of 50–100 ppm:** As in any boiler system, oxygen will cause corrosion and pitting. Clayton recommends a slightly higher sulfite residual to ensure complete oxygen removal. Excess sulfite must also be maintained during periods of wet lay-up and have a minimum residual of 100 ppm. During these periods, the feedwater condition must be checked and logged daily.
3. **10.5-11.5 pH (12.5 maximum):** This pH range is recommended for optimum corrosion control and to provide sufficient alkalinity to avoid the precipitation of any residual scale forming compounds.

   (This pH range is higher than in feedwater for a conventional boiler. But again, Clayton feedwater is, in fact, boiler water.) Many water sources have sufficient alkalinity to achieve this pH in the feedwater naturally. However, in some cases additional alkalinity (chemical) must be added. This requirement is determined by the M (or total) alkalinity in the make-up and the percent make-up. (Clayton's Laboratory will help you assess this requirement.)
4. **Suspended solids of zero (0):** To control scaling and erosion, 0 solids must be maintained in the feedwater. Most municipal water sources do not contain suspended solids. If the make -up water does contain some suspended solids, the softener will filter them out. Rarely is this a problem.
5. **Maximum TDS limit of 8,500 ppm (preferred range of 3,000–6,000 ppm):** Because of the design of the Clayton System a much higher TDS limit can be maintained without carryover. This limit is maintained by blowdown, either automatic or manual, depending on load conditions.

6. **Iron of <5 ppm:** This limit is imposed to control iron deposition. If iron exceeds 5 ppm, it is necessary to determine the source (make-up, condensate, or feedwater). Iron in the make-up or condensate is covered under those sections. If iron is originating in the feedwater, it is a sign of active corrosion and must be addressed. Nevertheless, it is typical to find 1-2 ppm iron in the feedwater due to the concentration factor.
7. **Silica of <120 ppm with sufficient OH alkalinity:** Some water sources may have an appreciable silica content. If this is the case, the maximum silica limit in the feedwater is 120 ppm. In addition, the OH alkalinity must be maintained at 2 times the silica level in order to precipitate the silica in the "correct form" to prevent scaling. The OH alkalinity in adjusted (if necessary) with a caustic containing chemical.

3.1.3 Condensate

A complete and thorough water management program will also ensure optimum condensate conditions. These are as follows:

1. **8.0–8.5 pH:** To ensure minimum corrosion, the pH in the condensate should be maintained at 8.0–8.5 with the appropriate chemical treatment. Furthermore, complete condensate monitoring will include iron measurements. Iron should be controlled at <0.5 ppm as evidence of adequate corrosion control.
2. **Typical condensate TDS levels of <50 ppm:** While not specifically controlled, the TDS of the condensate should also be determined as a measure of carryover.
3. **Suspended solids of zero:** The entire steam and condensate return systems must be treated or filtered to maintain zero (0) suspended solids.

3.2 Coil Guard Technology

Clayton has developed a series of products called Coil Guard™. These products are designed specifically for the Clayton steam generator/fluid heater. All Coil Guard products incorporate a component to help passivate (make less reactive chemically) the metal surface, which aids in preventing corrosion. This component helps promote the formation of magnetite (Fe_3O_4). It is very important to start-up a new steam generator/fluid heater or new coil with a Coil Guard product to take full advantage of the benefits of these products.

The proper application and use of Coil Guard products along with the recommended operating procedures for the Clayton steam generator/fluid heater should result in many years of problem-free operation. Clayton's statistics have shown that installations that start-up and stay with Clayton Chemical Technology and recommended operating practices have fewer coil failures.

The Coil Guard family of products consists of:

Coil Guard 1 is a boil out product designed to remove residual mill scale, oil, and dirt which may remain after coil manufacture. It is designed to be used for new steam generators/fluid heaters as well as new coils.

Coil Guard 2 is a pre-start-up product designed to passivate the coil (promote the formation of a protective layer of magnetite) to minimize corrosion. The product is also an excellent wet lay-up corrosion inhibitor to be used when the steam generator/fluid heater is laid-up wet for brief periods.

Coil Guard 100 is a catalyzed sulfite based product used for oxygen scavenging which also includes a metal passivation agent. This product is used in conjunction with scale inhibitors and condensate treatment.

Coil Guard 200 contains catalyzed sulfite for oxygen scavenging, the metal passivation agent, and scale and iron dispersant. This product is used where additional pH elevation is not required and where either condensate treatment is not required or is fed separately.

Coil Guard 300 is the same as Coil Guard 200, but also includes condensate treatment. It can be the only chemical product required provided additional pH elevation in the feedwater is not required.

Coil Guard 350 is the same as Coil Guard 200, except it will raise the feedwater pH.

Coil Guard 400 is the same as Coil Guard 300, except it will also raise the feedwater pH.

All these products have USDA authorization for use in meat and poultry plants and every component has been FDA approved.

For proper product selection please consult your local Clayton Chemical Service representative or the Clayton Laboratory in Cincinnati, Ohio. Either can analyze the raw make-up water, evaluate your operating conditions, and make the appropriate chemical program recommendation.

3.2.1 Additional Chemical Products

COSD-15: Catalyzed, powdered sulfite for oxygen scavenging

COMD-1: A powdered product containing catalyzed sulfite, alkalinity builders for pH elevation, and scale inhibitor.

Coil Guard pHSC: A liquid iron and scale inhibitor to be used when additional pH elevation is required in the feedwater. To be used with Coil Guard 100.

Coil Guard CT-10: A neutralizing amine for the protection against corrosion in condensate lines.

Coil Guard CT-20: A neutralizing amine approved for use in dairies.

Coil Guard CT-25: A blend of two neutralizing amines for protection against corrosion in condensate lines.

Coil Guard CT-40: A blend of a filming amine and neutralizing amines.

All of the above chemical products can be used in FDA production plants and all but COSD-15 are USDA approved for use in meat and poultry plants.

3.2.2 Product Dosages

Product dosages are a function of steam load, percent make-up, make-up water analysis, oxygen content in the feedwater, and feedwater tank temperature (oxygen content in the make-up.)

For a typical system with a hotwell temperature of 190^{o} F (88^{o} C), the approximate dosage for Coil Guard 100, 200, 300, 350, and 400 is 12 lbs/day per 100 hp at 100% load and 24 hrs/day.

For Coil Guard CT-10, the condensate return line treatment, the dosage is based on the following:

Dosage in ppm = (1.76) (M alkalinity in make-up) (%make-up)

Coil Guard pHSC (if required) is used to adjust the pH in the feedwater to 10.5–12.5.

3.2.3 Chemical Feeding Methods

In the standard Clayton system, the chemicals are fed as follows:

1. Sulfite and scale inhibitor are fed to the feedwater tank.
2. Condensate treatment can be fed either to the feedwater tank, feedwater line prior to the feedwater pump, or to the steam header. If fed directly to the feedwater tank, the tank temperature must not exceed 200^{o} F (93^{o} C), lest some of the treatment be vaporized and lost up the vent.

Coil Guard 100, 200, 300, 350, and 400, as well as, Coil Guard pHSC, COSD-15, and COMD-1 are all fed to the feedwater tank in a standard system. Coil Guards CT-10, CT-20, CT-25, and CT-40 are condensate treatments and are to be fed according to the directions in item 2, above.

In a system having a SCR along with the Clayton steam generator/fluid heater, chemical treatment depends on a few parameters, the percent make-up (the frequency that the transfer pump is activated) and the alkalinity in the make-up.

1. Sulfite is fed to the feedwater tank. Additional sulfite may have to be fed to the SCR if the transfer pump is not activated frequently (very low make-up conditions).
2. Scale inhibitor is normally fed to the SCR.
3. Condensate treatment is fed to the SCR.
4. Additional alkalinity may have to be fed to the SCR if the make-up rate is very low (<25%), the alkalinity in the make-up is low (<40 ppm), or the unit is blown down dry daily.

The easiest way to chemically treat a Clayton steam generator/fluid heater with an SCR is to use Coil Guard 400. Feed it to the feedwater tank provided the transfer pump is activated on a regular basis. If it is not, feed the Coil Guard 400 to both the feedwater tank and the SCR.

If multiple chemicals are used, ensure that the feedwater tank and SCR both receive an adequate supply of oxygen scavenger for corrosion protection.

Consult Clayton's Cincinnati Laboratory for help in product selection and application.

The chemicals are fed either "neat" from the drum or mixed and pumped from a day tank. Chemical feed lines from the drum, or day tank, to the entry point should be kept as short as possible. This will minimize any problems caused by loss of pump suction, air infiltration into the feed line, or feed line plugging when the unit is off line.

If the chemical feed lines are long (greater than 10 feet [3 m]) and booster pumps are included in the system, a 1/4 inch (7 mm) water line off the booster pump to the chemical injection assembly may be added to "sweep" the chemical quickly into the feedwater tank.

3.3 Automatic Chemical Feed Systems

3.3.1 Importance of Water Testing and Off-Line Lay-Up Conditions

For scale and corrosion prevention, the proper feedwater conditions must be maintained at all times, even when the steam generator is in lay-up status.

While chemical dosages can be proportioned to the make-up flow rate or even to the feedwater flow rate with automatic feed systems; the fact is, these automatic feed systems do not take into account all of the parameters that contribute to variations in oxygen, pH, and hardness levels.

Some of these parameters are:

1. Variations in the oxygen content of condensate returned.
2. Fluctuations in the feedwater tank temperature and the subsequent variation in the efficiency in which oxygen is expelled.
3. High chemical demand on start-up. Extra chemical is required to scavenge the additional oxygen present due to cold water on start-up. Many units are shut down and restarted on a regular basis, sometimes even daily.

Feedwater tanks can require high level chemical dosing prior to startup. Feedwater testing is required prior to startup at all times. Therefore, while an automatic chemical feed system may help control chemical residuals at times and may even work reasonably well in a continuous operation with constant variables; nevertheless, it may give a false sense of security and, even worse, may not be at all adequate when some of the above variables change constantly. This is why daily testing and logging is required.

Nothing replaces daily feedwater testing, logging, interpretation of the results, and adjustments in chemical feed rate to ensure proper feedwater, as necessary.

For best results, please be aware of the following and use Clayton's AWARE Program:

A. Maintain proper feedwater conditions at all times.
B. Maintain proper off-line or lay-up conditions at all times.
C. Pay particular attention to the water conditions during start-up and make sure the proper conditions are being maintained.

3.3.2 Chemical Product Selection

Product selection is a function of the following:

1. Make-up water analysis.
2. Pre-treatment system (Softener, Deaerator, or Hotwell).
3. Percent make-up.
4. Operating parameters:
   a. Continuous.
   b. Intermittent (daily shutdown and dry lay-up).
   c. TDS level normally maintained.
5. Economics.
6. Customer preference.
7. Any special technical requirements; for example, steam will make contact with milk in a dairy facility.

Table 3-1 shows the data required for proper product selection. Consult Clayton's laboratory in Cincinnati for water analyses and assistance in product selection.

Table 3-1: Product Selection Table

Product	Conditions
Coil Guard 200	High Make-up alkalinity with No Condensate Returns
Coil Guard 300	High Make-up alkalinity with Condensate Returns
Coil Guard 350	Low Make-up alkalinity with Condensate Return, where condensate treatment is not used
Coil Guard 400	Low Make-up alkalinity with Condensate Returns
Coil Guard 400	DI Water Make-up or SCR System

Data Required for Chemical Product Selection

Steam Generator/ Fluid Heater Model No. _____

Estimated Steam Load _____

% Make-up _____

Operation: Days/week _____ Hrs/day _____

Use of Steam _____

DA or Hotwell _____ Hotwell Temp. _____

Softener Model No. _____

SCR _____

Raw Water Make-up Analysis

Total Hardness _____

Total Alkalinity _____

pH _____

TDS _____

Iron _____

Silica _____

Water Source _____

3.3.3 Water Testing Procedures

Clayton offers a standard feedwater test kit for daily testing and logging. Clayton also offers various supplemental test kits, such as alkalinity, iron, silica, and color-metric pH test kit of various ranges, which broadens the scope of water testing. (See the addendum for descriptions and part numbers)

Daily tests to be performed are outlined in the Water Quality Requirements section.

Specific test procedures are in the addendum.

3.3.4 The Clayton AWARE Program

Clayton Industries has developed a monitoring and control program called AWARE specifically for its Chemical Customers.

Access

Water data to

Alert and

React for

Efficiency

The Clayton AWARE Program will help you do the following:

- Maintain equipment integrity
- Prevent scale and corrosion
- Conserve water, chemical, and energy resources
- Optimize the efficiency of your Clayton steam generator/fluid heater

In this program, Clayton forms a partnership with its chemical customers to achieve the above stated benefits. Consult your local Clayton Chemical Consultant or the Cincinnati Laboratory for details.

3.3.5 Steam Generator/ Fluid Heater Start-up Using Coil Guard 1 & 2

Prior to initial start-up of the Clayton steam generator/fluid heater, it is critical to ensure that all personnel are well trained in the proper operation of the unit and in its proper chemical treatment.

To initiate a quality water management program, Clayton Industries has developed Coil Guard 1 and Coil Guard 2 to ensure the generator and feedwater systems are properly cleaned and passivated.

Coil Guard 1 is designed for new Steam Generators/Fluid Heaters and new coils. It is used to conduct a boil out procedure to remove residual mill scale, oil, and dirt, which may remain after manufacture. Ensuring a clean metal surface will aid in minimizing problems from scale and corrosion after start-up.

Coil Guard 2 is added immediately after Coil Guard 1 and will promote the formation of magnetite, the passivate form of iron, thus reducing corrosion potential. This product may also be used as a wet lay-up corrosion inhibitor for off-line units.

Product bulletins and application procedures are in the addendum.

To reiterate, attention and care given to these start-up procedures will form the basis of a good chemical program and years of an efficient, problem free operation.

The Clayton AWARE Program
Data Log Report

Account Name: _____

Generator Model: _____

Generator S/N: _____

Fax report each week to fax number: _____

	Operating Conditions					Softener			Feedwater					Condensate		
Date	Hrs/ Day	Feed Press.	Op. Press.	Firing Rate	HW Temp.	Meter Read	TDS	H	TDS	H	pH	SO_3	Fe	TDS	pH	Fe
								< 2	< 8,500	< 4	10.5–12.5	50–100*	< 5	< 50	8.0–8.5	< 0.5

* Residual sulfite level in the feedwater must be between 50 ppm and 100 ppm during operation and >100 ppm during wet lay-up.

SECTION IV Steam Generator/ Fluid Heater Operation

4.1 System Blowdown

4.1.1 Manual

In most situations where the Clayton steam generator/fluid heater is shutdown dry on a daily basis, the dry shutdown procedure becomes a manual blowdown. High concentrations of TDS are removed from the system when the coil and separator are drained. Therefore, other blowdown methods are not normally necessary. (This may not always be the case if the TDS of the make-up water is unusually high, the percent make-up is high, and/or the load is very high.)

4.1.2 Continuous Bleed Blowdown

The Clayton steam generator/fluid heater can be equipped with a continuous bleed blowdown valve (see **Fig. 4-1**). For units that run for significant periods of time between dry shutdowns the continuous bleed valve can control TDS in direct proportion to steam production (firing rate). The continuous bleed valve removes a small amount of water with very high concentrations of solids from the steam separator trap returns prior to returning to the feedwater tank. This system is a manually adjusted valve that once set will proportionally discharge high TDS water to the blowdown tank or drain. **Table 4-1** lists the required flow rate for E-series steam generators/fluid heaters.

4.1.3 Automatic Blowdown

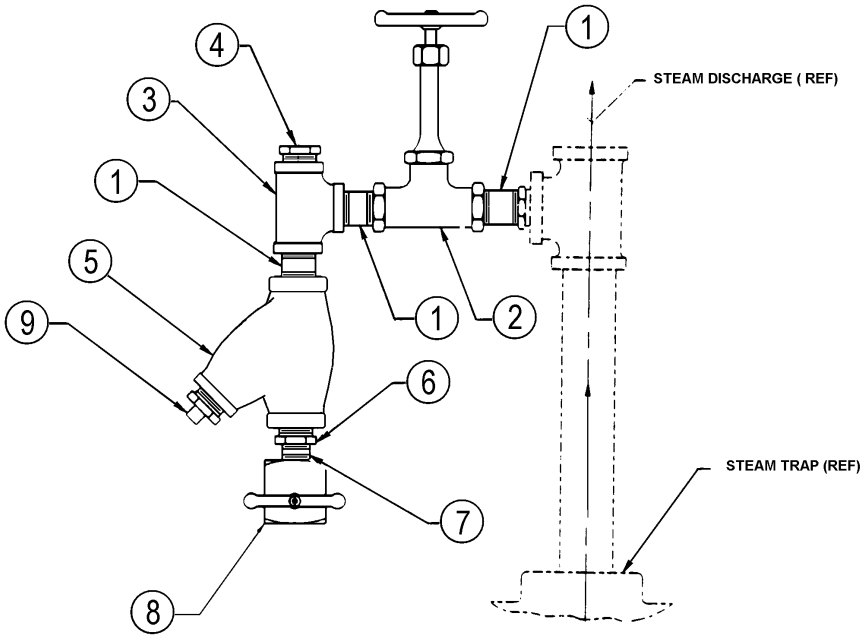
Where it is appropriate, the blowdown and control of TDS may be automated. A probe and TDS controller is used to monitor the TDS and activate a motorized dump valve to blowdown and maintain the TDS at a pre-set level. By automating this operation, water, chemical, and energy can be conserved by avoiding periods of excessive blowdown, while scaling conditions can be avoided due to lack of sufficient blowdown.

Nevertheless, some installations do not warrant an automatic blowdown system. Among these are:

1. Systems that operate for only part of a day and are shut down at night (and are drained).
2. Systems that use extremely little make-up water and require only occasional blowdown.

The appropriate application for an automatic blowdown controller is one that operates continuously and takes on make-up water on a regular basis.

Installation diagrams, equipment description, and part numbers are in the addendum.



1. Nipple
2. Valve
3. Tee
4. Bushing
5. Strainer
6. Bushing
7. Nipple
8. Valve
9. Plug

Fig. 4-1 Typical continuous blowdown kit hookup

Table 4-1: Continuous Blowdown Adjustment

Model	E-33	E-60	E-100	E-154	E-204	E-254	E-304	E-354	E-404	E-504	E-604	E-704
Rate (gph) (High Fire)	1.5	2.8	4.5	7.0	9.0	11.0	13.5	15.8	18.0	20.0	24.0	n/a

(The maximum adjustable rate is approximately 30 gallons per hour)

Flow must be increased proportionately for feedwater having higher concentrations. To adjust flow, simply open the valve a little to increase the flow. Make adjustments of approximately 1/4 turn at a time and check flow results.

For highly variable load conditions (large difference between maximum and minimum loads) the oxygen scavenger (sulfite) concentration should also be observed after the longest period of high make-up. If the sulfite concentration becomes too low, then the chemical dosage rate may have to be increased to suit. Therefore, a balance must be reached between the blowdown rate to control TDS and chemical dosage to control sulfite.

4.2 Wet and Dry Shutdown

4.2.1 General

At times, off-line conditions can cause more problems than on-line conditions if they are not properly addressed. Therefore, strict attention must be placed on the shutdown procedures to ensure a proper shutdown method is executed correctly.

There are a number of key aspects that dictate which shutdown method should be performed in each particular case. The primary consideration is the length of time that the unit(s) will be shutdown. It is Clayton's recommendation that if the unit will be shutdown for less than 14 days, then a wet shutdown is the preferred method, as long as the installation configuration allows for proper lay-up conditions. If the unit will be in a shutdown mode for more than 14 days, then a dry shutdown method is preferred.

NOTE

Refer to your Clayton steam generator/fluid heater instruction manual for specific instructions on how to properly execute a wet or a dry shutdown.

4.2.2 Wet Shutdown

The key to a successful wet shutdown is to keep the coil completely flooded with properly treated water **at all times**; a completely flooded coil helps prevent coil corrosion during the lay-up period. There are several ways of keeping the coil flooded at all times: having an elevated feedwater tank with proper head height, having a separate head tank, or having a feedwater tank with a booster pump set up for intermittent filling.

Throughout a wet lay-up, the internal coil surface must be in contact with properly treated water. Therefore, the water must be tested and recorded daily to ensure the proper parameters are met during the entire lay-up period. The treated water should have a residual sulfite greater than 100 ppm with a minimum pH of 10.

There are other scenerios that drastically improve the effectiveness of the wet shutdown method; such as, circulating treated water through the coil to help ensure flooding and keeping the internal coil surface in contact with freshly treated water. Also, keeping the treated feedwater tank water heated will ensure that oxygen is continuously expelled.

NOTE

If wet shutdowns will be performed on units installed in climate zones where freezing winter conditions exists, then these installations will require down draft dampers. Down draft dampers prevent cold freezing air from being drawn down the stack, which will cause a wet coil to rupture. If a down draft damper is **not** installed or **not** functioning, then a dry shutdown is recommended.

4.2.3 Dry Shutdown

The key to a successful dry shutdown is to keep the coil **completely dry at all times;** a completely dry coil prevents coil corrosion during the lay-up period. Once the dry shutdown is properly executed, the goal is to keep the coil tightly sealed to prevent any moisture from entering. It is important that all feedwater inlet valves, feedwater and steam discharge valves, coil and separator blowdown valves, and any other valve where the moisture can enter be closed.

NOTE

If a dry shutdown is intended to exceed 30 days, then a positive-pressure nitrogen blanket is preferred.

Appendix A Chemical Products Information & Water System Diagrams

Clayton
INNOVATIVE STEAM SOLUTIONS

EFC WATER SOFTENERS

ELECTRONIC FLOW CONTROL AUTOMATIC TWIN MODELS

CLAYTON WATER SOFTENERS PROVIDE CONSISTENT WATER QUALITY

EFC MODELS OFFER:

- *Programmable electronic control with twin alternating softener tanks*
- *Self-Diagnostic: Memory can be accessed via telephone for troubleshooting*
- *Non-volatile EPROM memory retains configuration and historical data so there is no need to reprogram after a power loss (up to 12 hours)*
- *Softener's controller emits a distinctive tone to alert personnel for corrective action*
- *Controller reduces salt and water usage*
- *"Look-ahead" feature schedules reconditioning when needed and automatically adjusts to high and low water demand*
- *Twin tank design allows for a continuous supply of softened water without interruption.*

Available in 12" to 48" mineral tanks and capacities from 30,000 to 1,200,000 grains.

SPECIFICATIONS

CLAYTON EFC WATER SOFTENERS

TWIN ELECTRONIC FLOW CONTROL MODELS

Soft make-up water is the first step toward satisfactory feedwater treatment for a Clayton Steam Generator. CLAYTON WATER SOFTENERS provide a state-of-the-art method for achieving a consistent and reliable soft water source. Softener size is determined by flow rate required, the raw water hardness and the volume to be softened between convenient regeneration periods. Mineral tanks are available in fiberglass or steel. Consult your Clayton representative for assistance in sizing and selection.

MODEL	Max Grain Cap. (each tank)	Service Flow (GPM)	Press Drop (PSI)	Peak Flow (GPM)	Peak Press Drop (PSI)	Back Wash Rate (GPM)	Softener Dia. TWO TANK (IN.)	Brine Tank Dia. (IN.)	Weight Dry (LBS)	Weight Operating (LBS)	Overall Dimensions L	W	H
EFC-30-1-F	30,000	10	15	12	25	2	12" x 52"	18" x 40"	230	650	38	18	49
EFC-60-1-F	60,000	18	15	21	25	3.5	12" x 52"	18" x 40"	350	825	48	18	59
EFC-90-1-F	90,000	18	15	21	25	5	14" x 65"	18" x 40"	500	1100	56	18	76
EFC-90-1.5-F	90,000	37	15	48	25	5	14" x 65"	24" x 40"	545	1250	56	24	74
EFC-120-1.5-F	120,000	37	15	48	25	7	16" x 65"	24" x 40"	695	1500	60	24	73
EFC-120-2-F	120,000	50	15	60	25	7	14" x 65"	24" x 40"	620	1300	60	24	80
EFC-150-2-F	150,000	84	15	105	25	9	18" x 65"	24" x 40"	820	1600	72	24	80
EFC-180-1.5-F	180,000	37	15	48	25	8	18" x 65"	24" x 40"	775	1600	60	24	73
EFC-180-2-F	180,000	84	15	105	25	9	18" x 65"	24" x 40"	920	1700	64	24	80
EFC-210-2-F	210,000	84	15	105	25	10	21" x 62"	24" x 54"	1310	2000	72	24	80
EFC-240-2-F	240,000	84	15	105	25	12	24" x 65"	24" x 40"	1500	2250	84	24	80
EFC-300-2-F	300,000	84	15	105	25	15	24" x 72"	24" x 50"	1920	2800	80	24	88
EFC-450-2-F	450,000	84	15	105	25	25	30" x 72"	30" x 50"	2400	4000	96	30	80
EFC-660-2-F	660,000	84	15	105	25	35	36" x 72"	30" x 50"	3320	5000	120	35	95
EFC-600-3-F	600,000	210	15	271	25	35	36" x 72"	39" x 48"	3520	5000	120	39	110
EFC-900-3-F	900,000	225	15	250	25	45	42" x 72"	50" x 60"	5650	10000	140	50	90
EFC-1200-3-F	1,200,000	210	15	251	25	60	48" x 72"	50" x 60"	6760	11000	180	50	110

CLAYTON WATER SOFTENERS PROVIDE CONSISTENT WATER QUALITY

Soft make-up water is the first step toward satisfactory feedwater treatment for a Clayton Steam Generator. CLAYTON WATER SOFTENERS provide a state-of-the-art method for achieving a reliable soft water source. Softener size is determined by flow rate required, the raw water hardness and the volume to be softened between convenient regeneration periods. Mineral tanks are available in fiberglass or steel. For continuous duty applications, Clayton Model EFC twin softeners are recommended. Consult your Clayton representative for assistance in sizing and selection.

MODEL	Max Grain Cap. (GRAINS)	Service Flow (GPM)	Press Drop (PSI)	Peak Flow (GPM)	Peak Press Drop (PSI)	BW Rate (GPM)	Softener Dim. Dia. (IN.)	Brine Tank Dia. (IN.)	Weight Dry (LBS)	Weight Operating (LBS)	Overall Dimensions (in.) L	W	H
STC-30-1-F	30,000	18	15	21	25	2	9" x 48"	18" x 33"	115	450	30	18	56
STC-60-1-F	60,000	18	15	21	25	3.5	12" x 52"	18" x 40"	185	550	56	18	80
STC-90-1-F	90,000	18	15	21	25	3.5	14" x 65"	18" x 40	265	750	56	18	80
STC-90-1.5-F	90,000	37	15	48	25	7	14" x 65"	24" x 40"	275	760	56	18	80
STC-120-2-F	120,000	40	15	50	25	7	16" x 65"	24" x 40"	370	900	50	24	80
STC-150-2-F	150,000	50	15	70	25	8	18" x 65"	24" x 40"	475	1150	55	24	85
STC-180-2-F	180,000	60	15	80	25	10	21" x 62"	24" x 40"	550	1350	55	24	85
STC-210-2-F	210,000	60	15	80	25	10	21" x 62"	24" x 40"	600	1350	55	24	85
STC-240-2-F	240,000	80	15	90	25	15	24" x 65"	24" x 40"	700	1450	55	24	85
STC-300-2-F	300,000	100	15	105	25	15	24" x 72"	24" x 54"	930	1850	55	24	85
STC-450-2-F	450,000	100	15	105	25	25	30" x 72"	30" x 50"	1270	2000	55	30	85
STC-600-2-F	660,000	100	15	105	25	35	36" x 72"	30" x 50"	1780	2600	55	30	85
STC-600-3-F	600,000	180	15	220	25	35	36" x 72"	30" x 60"	1880	2600	72	36	90
STC-900-3-F	900,000	210	15	250	25	50	42" x 72"	50" x 60"	2875	4000	100	50	100
STC-1200-3-F	1,200,000	210	15	250	25	70	48" x 72"	50" x 60"	3480	5000	120	50	100

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Clayton Scandinavia A.S.
Clayton Nederland B.V.
Clayton de France S.A.R.L.
Clayton Sales & Service Canada

World Leaders in Precision Steam Generators, Fluid Heaters, Heat Recovery Systems and Customer Service

Introducing Coil Guard™

A full line of advanced water treatment products designed specifically for the Clayton Steam Generator. These multi-functional products also incorporate a new metal passivating agent to further protect against corrosion.

Proper application of Clayton's Coil Guard technology will ensure the highest efficiency and longevity of your Clayton Steam Generator.

Whether you use a simple one drum treatment or a combination of products to meet your needs, Clayton Coil Guard technology can provide a quality, scientifically advanced and easy-to-use program to protect your steam generator for years of efficient performance.

Simply put, Coil Guard is the best technology available for a Clayton Steam Generator.

Coil Guard Products

Coil Guard 1 An alkaline boil-out product for new generators and coils to remove mill scale, oil, and dirt

Coil Guard 2 To be used following Coil Guard 1 to passivate the metal surface and minimize corrosion after start-up. May also be used as a wet lay-up inhibitor.

Coil Guard 100 A catalyzed oxygen scavenger product incorporating a metal passivating agent.

Coil Guard 200 A combination product that includes catalyzed oxygen scavenger, metal passivating agent, and scale and iron deposit control agent.

Coil Guard 300 A total system product that includes all the components of Coil Guard 200 plus a neutralizing amine for protection against corrosion in the condensate lines.

Coil Guard 350 This product provides all the same benefits as Coil Guard 200; plus, it will raise the pH of the feedwater.

Coil Guard 400 This product provides all the same benefits as Coil Guard 300; plus, it will raise the pH of the feedwater.

Existing Products And Services

A comprehensive program using these Coil Guard products and Clayton's traditional product line can be designed by your Clayton Water Treatment Consultant. Furthermore, the Clayton Chemical Division can provide the following services:

Evaluation of water source and quality

Evaluation of current and proposed pre-treatment equipment

Prestart-up coil cleaning and passivation

System start-up using Coil Guard technology

Program monitoring by A.W.A.R.E.: **A**ccess **W**ater data to **A**lert and **R**eact for **E**fficiency

Coil Guard 1

Coil Guard 1 is a boil-out product designed to remove residual mill scale, oil, and dirt that may remain after coil manufacture. It is to be used prior to the start-up of new generators, as well as, new coils.

Directions for use

1. Using soft water, flush out the feedwater tank and generator system.
2. Refill feedwater tank with soft water and add the appropriate amount of Coil Guard 1 to the tank. Refer to "Dosage Instructions," below, for dosages. The product may be added through any opening in the feedwater tank with a funnel or be pumped in with a transfer pump, or chemical feed pump. Note: using the chemical feed pump may take four to eight hours to add the product.
3. Short fire the generator to raise the water temperature to about 180^{o} F (82^{o} C).
4. Recirculate the water for two hours. Keep the steam header closed, but the atmospheric vent open.
5. Shut down the generator and drain the feedwater tank and generator.
6. Fill feedwater tank with soft water and rinse. Continue this rinsing process until the water is clean with no visible sediment.
7. With the generator filled with soft water, add the appropriate amount of Coil Guard 2 to the system.
8. Recirculate the Coil Guard 2 solution for 2 hours and short fire the generator to raise the water temperature to around 180^{o} F (82^{o} C).
9. Drain the Coil Guard 2 solution from the system followed by a rinse with fresh soft water.
10. Fill the feedwater tank with soft water and add the appropriate Coil Guard product; then, start the generator for normal operation.

Dosage Instructions

0.5–1.0% of system capacity (capacity = water in coil + water in feedwater tank)

Benefits of Coil Guard 1

Removes mill scale, oil, and dirt.

Prepares metal surface for proper corrosion protection with Coil Guard Products.

Product Data

Appearance: dark brown

Density: 9.25 lbs/gal.

pH: 12.0

Flash point: none

Coil Guard 2

Coil Guard 2 is a prestart-up product designed to passivate the coil tube to minimize corrosion. The product is also an excellent wet lay-up corrosion inhibitor to be used when the Clayton generator is laid-up wet for brief periods.

Directions for use (when used following Coil Guard 1)

1. Drain the feedwater tank and coil containing Coil Guard 1.
2. Fill feedwater tank with soft water and rinse. Continue this rinsing process until the water is clean with no visible sediment.
3. With the generator filled with soft water, add the appropriate amount of Coil Guard 2 to the system.
4. Recirculate the Coil Guard 2 solution for 2 hours and short fire the generator to raise the water temperature to around 180^{o} F (82^{o} C).
5. Drain the Coil Guard 2 solution from the system followed by a rinse with fresh soft water.
6. Fill the feedwater tank with soft water and add the appropriate Coil Guard product; then, start the generator for normal operation.

Directions for use (when used as a wet lay-up inhibitor)

1. Add one gallon of Coil Guard 2 per 100 gallons of system capacity.
2. Recirculate for 15 minutes before shutting down the generator in wet lay-up mode.
3. Maintain feedwater residual sulfite above 100 ppm and feedwater pH above 10.0 at all times

Dosage Instructions

1% of system capacity (capacity = water in coil + water in feedwater tank)

Benefits of Coil Guard 2

Passivates metal to minimize corrosion.

Ensures optimum start-up conditions.

An excellent wet lay-up inhibitor.

Product Data

Appearance: light-yellow liquid

Density: 8.8 lbs/gal.

pH: 12.0

Flash Point: none

Fuel Savings Calculation

$$\text{Savings in \$} = \frac{B(r) \times H(b)}{H(f) \times \%E(f)} \times C$$

Where:

B(r) = Blowdown reduction, lbs/day (from one TDS limit to another)

H(b) = Heat content of blowdown, from saturated steam table

H(f) = Heating value of fuel, BTU/unit

%E(f) = Boiler efficiency

C = Cost of fuel, $/unit

Clayton Water Quality Limits

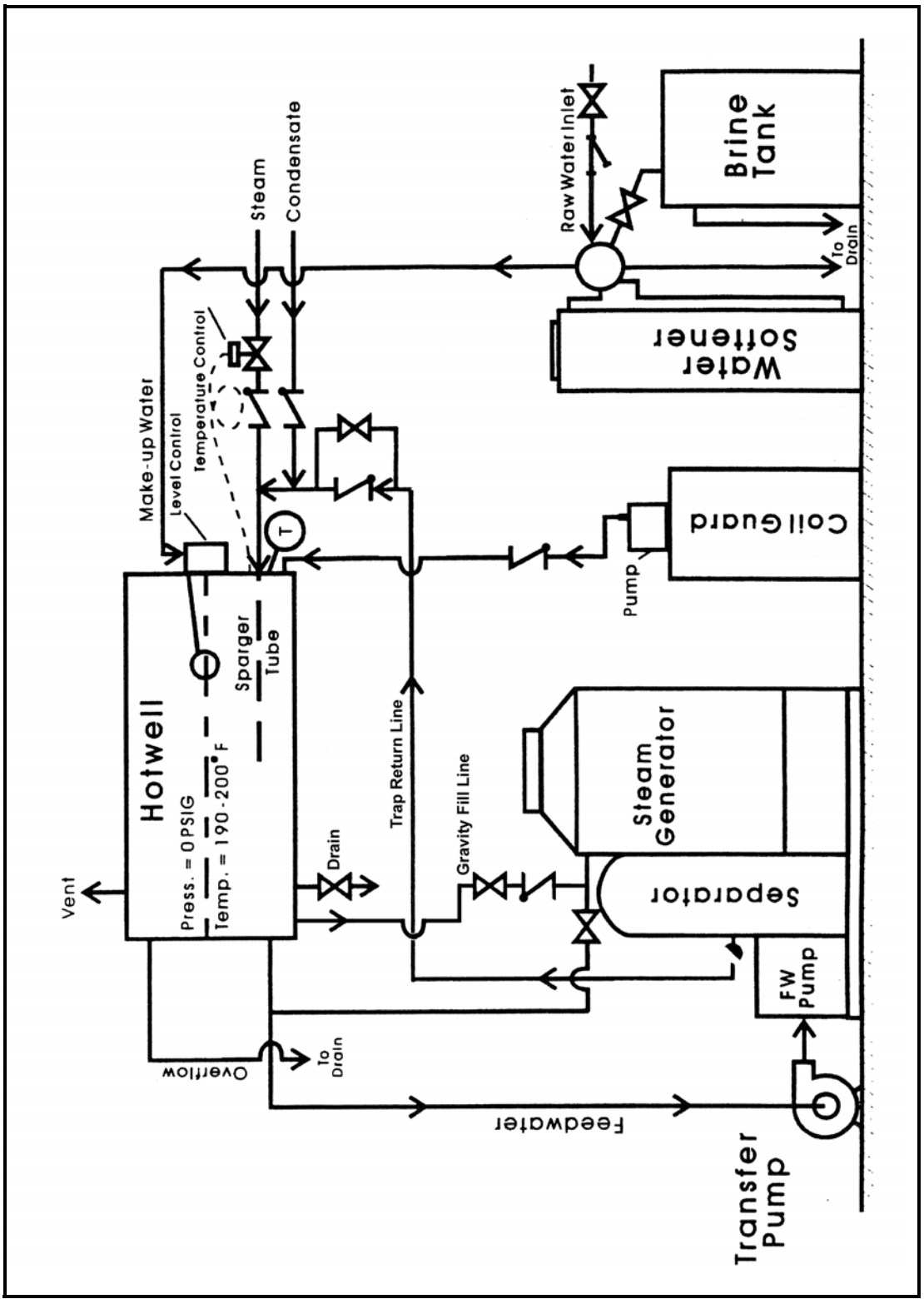
Sample	Test	Control Limits	Adjustments
Soft Make-up	Hardness	2 ppm	Regenerate softener
Feedwater	Hardness	4 ppm	Regenerate softener; blowdown
	TDS	<8,500 ppm	Blowdown
	Residual Sulfite	50–100 ppm	Sulfite product
	pH	10.5–12.5	Alkaline product or blowdown
	Iron	<5 ppm	Blowdown or sulfite product
Condensate	pH	8.0–8.5	Condensate treatment
	Iron	<0.5 ppm	Condensate treatment
	TDS	<50 ppm	Investigate for carry-over or process contamination

Steam Table

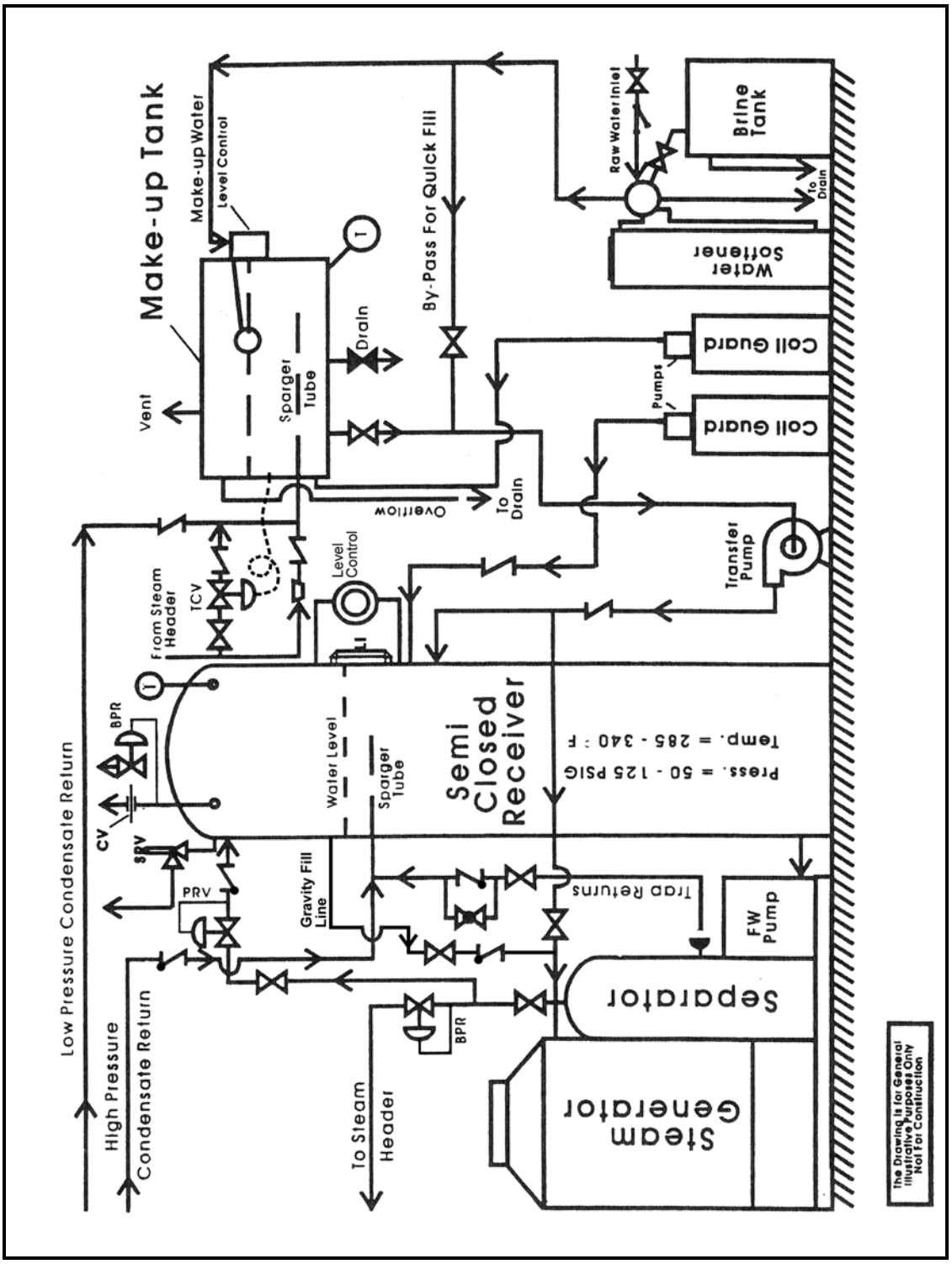
PSIG	TEMP °F	ENTHALPY (BTU/LB.) WATER	ENTHALPY (BTU/LB.) VAPOR Hfg	ENTHALPY (BTU/LB.) STEAM Hg	VOLUME (CU.FT/LB.) WATER Vf	VOLUME (CU.FT/LB.) STEAM Vg
.	40.0	8.0	1071.0	1079.0	.01602	2445.8
.	60.0	28.0	1059.7	1087.7	.01603	1207.6
.	80.0	48.0	1048.4	1096.4	.01607	633.30
.	100.0	68.0	1037.1	1105.1	.01613	350.40
.	120.0	88.0	1025.6	1113.6	.01620	203.26
.	140.0	108.0	1014.0	1122.0	.01629	123.00
.	160.0	128.0	1002.0	1130.2	.01640	77.290
.	180.0	148.0	990.2	1138.2	.01651	50.220
.	200.0	168.1	977.9	1146.0	.01664	33.639
0	212.0	180.2	970.3	1150.5	.01672	26.799
5	227.1	195.4	960.6	1156.0	.01683	20.830
10	239.4	207.8	952.5	1160.4	.01692	16.491
15	249.7	218.3	945.6	1163.9	.01700	13.878
20	258.8	227.5	939.5	1167.0	.01708	11.996
30	274.0	243.1	928.9	1171.9	.01721	9.4597
40	286.7	256.1	919.8	1175.6	.01733	7.8261
50	297.7	267.3	911.8	1179.1	.01743	6.6830
60	307.3	277.3	904.5	1181.1	.01753	5.8369
65	311.8	281.9	901.1	1183.0	.01757	5.4910
70	316.0	286.3	897.9	1184.1	.01761	5.1845
80	323.9	294.5	891.7	1186.1	.01770	4.6656
90	331.2	302.0	886.0	1188.0	.01778	4.2426
100	337.9	309.1	880.6	1189.6	.01785	3.8911
110	344.2	315.6	875.4	1191.0	.01792	3.5941
120	350.1	321.8	870.5	1192.3	.01799	3.3397
130	355.6	327.6	865.9	1193.5	.01806	3.1193
140	360.9	333.2	861.3	1194.6	.01812	2.9266
150	365.9	338.5	857.0	1195.6	.01818	2.7563
160	370.6	343.5	852.8	1196.4	.01824	2.6050
170	375.2	348.4	848.8	1197.2	.01830	2.4694
180	379.6	353.1	844.9	1198.0	.01835	2.3473
185	381.7	355.4	842.9	1198.3	.01839	2.2907
190	383.8	357.6	841.0	1198.7	.01841	2.2368
200	387.8	362.0	837.3	1199.3	.01847	2.1361
210	391.7	366.1	833.7	1199.8	.01852	2.0442
220	395.4	370.2	830.2	1200.4	.01857	1.9598
230	399.1	374.1	826.7	1200.9	.01863	1.8820
240	402.6	377.9	823.4	1201.3	.01868	1.8102
250	406.0	381.6	820.1	1201.7	.01873	1.7436
260	409.4	385.3	816.8	1202.1	.01878	1.6816
270	412.6	388.8	813.7	1202.4	.01882	1.6239
275	414.2	390.5	812.1	1202.6	.01885	1.5965
280	415.7	392.2	810.5	1202.7	.01887	1.5700
290	418.8	395.6	807.5	1203.0	.01892	1.5194
300	421.8	398.8	804.5	1203.0	.01896	1.4720
310	424.7	402.0	801.5	1203.5	.01901	1.4274
320	427.5	405.2	798.6	1203.7	.01905	1.3854
330	430.3	408.2	795.7	1203.9	.01910	1.3457
340	433.0	411.2	792.8	1204.0	.01914	1.3084
350	435.6	414.2	790.0	1204.2	.01919	1.2729
360	438.2	417.1	787.3	1204.4	.01923	1.2392
370	440.8	419.9	784.5	1204.5	.01927	1.2071
380	443.3	422.7	781.8	1204.6	.01931	1.1767
390	445.7	425.5	779.2	1204.7	.01936	1.1477
400	448.1	428.2	776.6	1204.7	.01940	1.1200
410	450.5	430.8	774.0	1204.8	.01944	1.0936
420	452.8	433.4	771.4	1204.8	.01948	1.0684
430	455.1	436.0	768.8	1204.8	.01952	1.0443
440	457.3	438.5	766.3	1204.8	.01956	1.0212
450	459.5	441.0	763.8	1204.8	.01961	0.9990
500	467.0	449.4	755.0	1204.4	0.0198	0.9278
600	486.2	471.6	731.6	1203.2	0.0201	0.7698
700	503.1	491.5	709.7	1201.2	0.0205	0.6554
800	518.2	509.7	688.9	1198.6	0.0209	0.5687
900	532.0	526.6	668.8	1195.4	0.0212	0.5006
1000	544.6	542.4	649.8	1191.8	0.0216	0.4456

Hotwell Water Treatment System

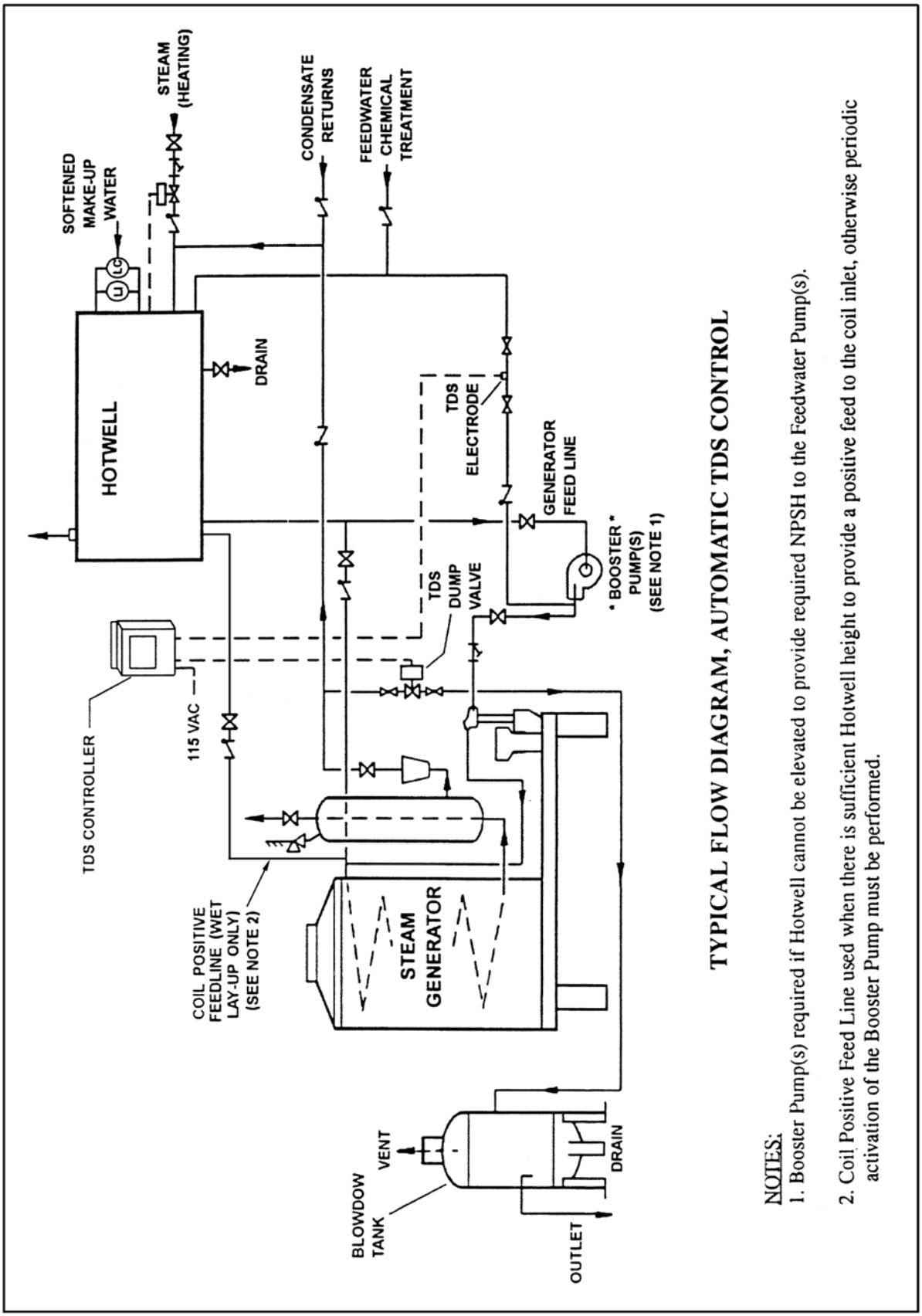
Chemical Treatment with a Single Multipurpose Treatment (Coil Guard)



Semi-Closed Receiver Water Treatment System



Automatic TDS Control System



TYPICAL FLOW DIAGRAM, AUTOMATIC TDS CONTROL

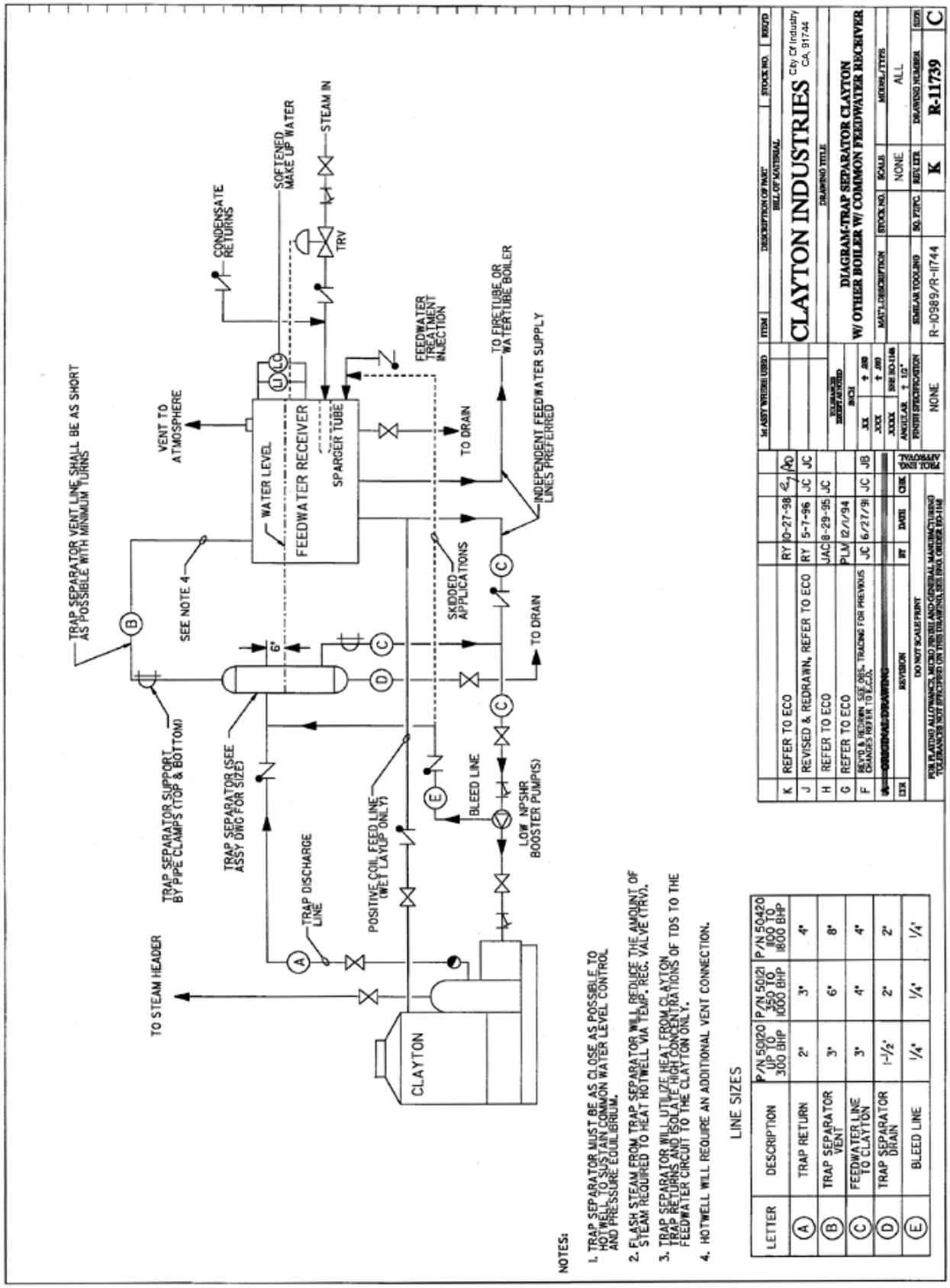
NOTES:

1. Booster Pump(s) required if Hotwell cannot be elevated to provide required NPSH to the Feedwater Pump(s).
2. Coil Positive Feed Line used when there is sufficient Hotwell height to provide a positive feed to the coil inlet, otherwise periodic activation of the Booster Pump must be performed.

May 1996

R-15618

Trap Separator System For Operation With Traditional Boilers



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Appendix B Clayton Part Ordering Information

Sizing A Water Softener

Three facts are required to size a water softener:

1. Water hardness in grains per gallon or ppm (one grain = 17.1 ppm)
2. Maximum water flow rate (make-up rate)
3. Desired frequency of regeneration (for continuous duty, twin softeners must be used)

The water softener selected must have sufficient capacity to remove hardness and sufficient service flow.

Calculation:

Water required at full output:	_____ gallons/hour (See machine specification sheet.)
Percent make-up (estimated maximum):	x _____ % = _____ gal./hr max. flow*
Water hardness:	x _____ grains per gallon = _____ grains/hour
Hours between regeneration:	x _____ hour
(for each tank, use 12 hours unless other frequency is desired; each softener will then regenerate every 24 hours)	
Softener size (capacity):	_____ grains removed between regeneration
Maximum flow (gal./hour) _____ / 60 = _____ service flow in gal./minute	

* NOTE: Service flow from softener specification sheet as compared to maximum flow required (Softener service flow rate must be higher than maximum flow required.)

Clayton Feedwater Treatment Chemicals

Liquid Products

Part Number	Name & Description
CH98005	Coil Guard 1 - 5 gallons
CH99005	Coil Guard 2 - 5 gallons
CH94005	Coil Guard 100 - 5 gallons
CH94030	Coil Guard 100 - 30 gallons
CH94055	Coil Guard 100 - 55 gallons
CH94275	Coil Guard 100 - 275 gallons
CH96005	Coil Guard 200 - 5 gallons
CH96030	Coil Guard 200 - 30 gallons
CH96055	Coil Guard 200 - 55 gallons
CH96275	Coil Guard 200 - 275 gallons
CH66005	Coil Guard 220 - 5 gallons
CH66030	Coil Guard 220 - 30 gallons
CH66055	Coil Guard 220 - 55 gallons
CH66275	Coil Guard 220 - 275 gallons
CH00001	Coil Guard 240 - 5 gallons
CH00002	Coil Guard 240 - 30 gallons
CH00003	Coil Guard 240 - 55 gallons
CH00004	Coil Guard 240 - 275 gallons
CH97005	Coil Guard 300 - 5 gallons
CH97030	Coil Guard 300 - 30 gallons
CH97055	Coil Guard 300 - 55 gallons
CH97275	Coil Guard 300 - 275 gallons
CH86005	Coil Guard 350 - 5 gallons
CH86030	Coil Guard 350 - 30 gallons
CH86055	Coil Guard 350 - 55 gallons
CH86275	Coil Guard 350 - 275 gallons
CH89005	Coil Guard 400 - 5 gallons
CH89030	Coil Guard 400 - 30 gallons
CH89055	Coil Guard 400 - 55 gallons
CH89275	Coil Guard 400 - 275 gallons

Part Number	Name & Description
CH72005	Coil Guard 720 - 5 gallons
CH72030	Coil Guard 720 - 30 gallons
CH72055	Coil Guard 720 - 55 gallons
CH90005	Coil Guard pHSC - 5 gallons
CH90030	Coil Guard pHSC - 30 gallons
CH90055	Coil Guard pHSC - 55 gallons
CH90275	Coil Guard pHSC - 275 gallons
CH93005	Coil Guard SC - 5 gallons
CH93030	Coil Guard SC - 30 gallons
CH93055	Coil Guard SC - 55 gallons
CH92005	Coil Guard CT-10 - 5 gallons
CH92030	Coil Guard CT-10 - 30 gallons
CH92055	Coil Guard CT-10 - 55 gallons
CH92175	Coil Guard CT-10 - 275 gallons
CH92105	Coil Guard CT-25 - 5 gallons
CH92130	Coil Guard CT-25 - 30 gallons
CH92155	Coil Guard CT-25 - 55 gallons
CH92275	Coil Guard CT-25 - 275 gallons
CH85005	Coil Guard CT-40 - 5 gallons
CH85030	Coil Guard CT-40 - 30 gallons
CH85055	Coil Guard CT-40 - 55 gallons
CH85275	Coil Guard CT-40 - 275 gallons
0039460	Coil Guard CT-20 - 55 gallons
CH90105	Resin Guard - 5 gallons
CH90130	Resin Guard - 30 gallons
CH90155	Resin Guard - 55 gallons

Powder Products

Part Number	Name & Description
CH61100	COMD-1 - 100 lb
CH61400	COMD-1 - 400 lb

Part Number	Name & Description
CH91100	COSD-15 - 100 lb
CH91400	COSD-15 - 400 lb

Clayton Feedwater Treatment Equipment Accessories

Part Number	Name & Description
0038172	Chemical Pump - 14 gpd at 150 psi, 360:1 turn down, manual
0038535	Chemical Pump - 55 gpd at 105 psi, 1,800:1 turn down, manual
0038538	Chemical Pump, Tank, & Agitator - 55 gallon, 14 gpd pump, automatic
0038536	Chemical Pump - Pulsed, 14 gpd at 150 psi, 1,800:1 turn down, automatic
0038568	Chemical Pump - 55 gpd at 105 psi, 1,800:1 turn down, 4–20 mA input, automatic
0038557	Flowmeter - Pulsed Output, 2 pulse / gal., 0.44 – 52 gpm, 1 in.
0038829	Flowmeter - Pulsed Output, 2 pulse / gal., 0.88 – 88 gpm, 1 1/2 in.

Part Number	Name & Description
0039123	Flowmeter - Pulsed Output, 2 pulse / gal., 0.198 – 132 gpm, 2 in.
0037444	Controller - TDS, with probe
0037445	Electrode - TDS Controller
UH29616	Dump Valve Kit - TDS Controller
0059349	Sample Cooler - Water
0032784	Indicator - Flow, 3/8 in.
0059369	Indicator - Flow, 1/4 in.

Clayton Feedwater Test Kits

Standard Kit (Part No.: 0052500)

Part Number	Name & Description	Part Number	Name & Description
0052927	Hardness Indicator Liquid - Buffer Solution, 30 ml	0052304	Bottle - polypropylene, w/ cap, 4 oz.
0052446	Hardness Titrant (Low) - 1 drop = 2 ppm as $CaCO_3$/25 ml, 60 ml	0052368	Beaker - polypropylene, 150 ml
0052925	Hardness Buffer - 30 ml	0052467	Tongs - metal
0052441	Phenolphthalein Indicator - 30 ml	0052450	Vial - Test, 10–50 ml, w/ cap
0052443	Starch Acid Powder - 10 g	0052355	pH Pen - pH Tester
0052439	Sulfite Titrant - 1 drop = 5 ppm as SO_3/ 25 ml, 60 ml	0052356	TDS Pen - TDS Tester
0052453	TDS Solution Standard - 3,000 ppm, 60 ml (2 bottles)		
0052455	Buffer Solution - pH 10.0, 60 ml (2 bottles)		

Upsized Replacement Reagents for Standard Kit

0052440	Sulfite Titrant - 500 ml, 1 drop = 5 ppm as SO_3/25 ml	0052926	Hardness Buffer - 500 ml
0052442	Phenolphthalein Indicator - 500 ml	0052928	Hardness Indicator Liquid - Buffer Solution, 500 ml
0052444	Starch Acid Powder - 100 g	0052454	TDS Solution Standard - 3,000 ppm, 500 ml
0052447	Hardness Titrant (Low) - 500 ml, 1 drop = 2 ppm as $CaCO_3$/25 ml	0052456	Buffer Solution - pH 10.0, 500 ml

Supplemental Kit To Standard Kit

0052460	LaMotte Iron Test Kit (0.5 to 10 ppm)	0052910	Cresol Red pH Test Kit (7.2–8.6)
0052494	LaMotte Silica Test Kit (0.5 to 100 ppm)	0052912	Wide-range pH Test Kit (5.0–10.0)

Appendix C Periodic Maintenance

PERIODIC MAINTENANCE

DETAILED INSTRUCTIONS CAN BE FOUND IN THE STEAM GENERATOR / FLUID HEATER INSTRUCTION MANUAL.

DAILY

1. RECORD STEAM PRESSURE AND COIL FEED PRESSURE.
2. OBSERVE TRAP GAUGE OPERATION – APPROXIMATED TIME VERSUS LOAD
3. TEST FEEDWATER AND RECORD DATA. PREPARE CHEMICAL TREATMENT SOLUTION, SOFTENER. (GREEN SHEETS.) RECORD BOTH BOILER AND CONDENSATE CHEMICAL ADDED.
4. MANUAL BLOWDOWN (UNLESS EQUIPPED WITH AUTOMATIC BLOWDOWN).
5. SOOT BLOW (TWICE PER DAY OR AS REQUIRED – OIL FIRED ONLY).
6. GENERAL WALK-AROUND INSPECTION FOR LEAKS (INCLUDING HOT LINES ON MANUAL BLOWDOWN DISCHARGE), STACK SMOKE, STRANGE NOISE, OIL LEVEL, ETC.

WEEKLY

1. ROTATE FUEL (OIL) FILTER HANDLE ONE TURN.
2. PARTIALLY DRAIN HOTWELL (OPEN DRAIN VALVE FULLY FOR ABOUT ONE MINUTE. MAY BE DONE WHILE IN OPERATION, BUT DO NOT ALLOW WATER TO DROP OUT OF SIGHT IN GAUGE GLASS).
3. TEST (FEEL) MOTOR FOR ABNORMAL VIBRATION (COUPLING ALIGNMENT).
4. CHECK BELT CONDITION AND TENSION (IF APPLICABLE).
5. CHECK AUTOMATIC BLOWDOWN VALVE RATE. (MAY BE OMITTED IF TDS READINGS ARE STILL STABLE AND WITHIN DESIRED RANGE.)
6. RECORD WATER METER READING AND ESTIMATE OPERATING HOURS FOR PREVIOUS WEEK.

MONTHLY

WHILE OPERATING CHECK:

1. COIL FEED PRESSURE AT HIGH-FIRE RATE. RECORD AND COMPARE WITH ORIGINAL READING FOR INDICATION OF INTERNAL SCALING.
2. VOLUTE PRESSURE AT HIGH-FIRE RATE (BLOWER CLEANLINESS). RECORD AND COMPARE. (OPTIONAL) (SEE REVERSE SIDE.)
3. WATER BY-PASS PRESSURE (WHERE APPLICABLE).
4. STACK TEMPERATURE AT HIGH FIRE.
5. AUXILIARY THERMOSTAT SWITCH. REDUCE SETTING UNTIL IT INTERRUPTS BURNER. RETURN TO ORIGINAL SETTING.
6. BURNER SAFETY CONTROL (SIMULATE BY PULLING BANANA PLUG AT BURNER OR REMOVING DETECTOR FROM BURNER MOMENTARILY).

WITH UNIT SHUT DOWN:

7. CLEAN STRAINERS: WATER FLOAT VALVE, FEEDWATER, FUEL (DRAIN WATER).
8. DRAIN AND FLUSH HOTWELL.
9. OPEN DRAIN COCKS TO CHECK OR FLUSH SLUDGE FROM PUMP HEADS, AUTOMATIC BLOWDOWN VALVE (EXCEPT E-500).
10. CLEAN BLOWER ROTOR BLADES IF NECESSARY (SEE ITEM 2). LUBRICATE BEARINGS.
11. BURNER: REMOVE FOR INSPECTION AND:
    A. WIPE ELECTRODE INSULATORS WITH CLEAN SOFT CLOTH.
    B. CHECK ELECTRODE GAP (1/8 TO 5/32 INCHES).
    C. CLEAN PHOTOCELL GLASS (OIL BURNER).
    D. CLEAN OIL BURNER NOZZLE SCREENS (DO NOT DISASSEMBLE NOZZLE UNLESS SMOKE PERSISTS).
12. CHECK PUMP LEVEL SWITCH RESPONSE. HIGH_____ LOW_____
13. COIL WASH

ANNUAL OR SEMI-ANNUAL – FREQUENCY DEPENDING ON USAGE AND NECESSITY OF UNINTERRUPTED OPERATION (PREVENTIVE MAINTENANCE)

1. REPLACE BURNER NOZZLES (EXCEPT AIR ATOMIZING TYPE).
2. INSPECT CHECK VALVES (PUMP). REPLACE IF WORN.
3. PUMP DIAPHRAGMS – REPLACE AT ABOUT 7000 HOURS OPERATION FOR E154 THRU E604-2 AND 2000 HOURS OPERATION FOR E604-2.5 THRU E754.
4. REPLACE OIL IN PUMP CRANKCASE.
5. INSPECT ALL AIR, FUEL AND WATER CONTROL LINKAGES (WHERE APPLICABLE) FOR WEAR, SCREWS TIGHT, FREE MOVEMENT, ETC.
6. BURNER PHOTOCELL – CHECK FOR SIGNAL STRENGTH, OR REPLACE.
7. STEAM SAFETY VALVE TEST. AS REQUIRED BY LOCAL INSPECTOR.

CLAYTON INDUSTRIES
CITY OF INDUSTRY, CA

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