



Closing the Gap⁸

Water to steam

July 1998

Failure to understand the relationship between water chemistry and different foodservice equipment applications can be a source of great expense and aggravation. Problems attributable to local water chemistry vary with location, time and application. Since water quality varies so much, a filtration or treatment strategy that is effective in one area in a given application may not be effective in another. Self contained steam generators and boilers that are connected to local water sources are particularly problematic and are the focus of this month's article.

Water chemistry

Most of the worlds fresh water supplies contain impurities. Since different minerals are found in different places, it follows that underground water sources or aquifers have different compositions. Water is natures perfect solvent and will (given time and degree of purity) dissolve everything. Water "leeches" minerals by dissolving them on contact and holds them in solution. High pressure and heat accelerate the rate at which minerals are brought into solution and the water will continue to hold them in solution as long as pressure and temperature remain constant. When water that is saturated with impurities is placed under pressure it is able to assimilate additional impurities and hold them in suspension. When the pressure is relieved, these latent impurities are dropped. When water is heated the molecules on the surface that are in contact with air make a phase change from liquid to a gas (or vapor). With fewer water molecules to suspend the dissolved solids, some minerals will precipitate out of solution and take solid form as calcium carbonate scale. Heating water is said to make it reactive, which is to say that it has greater energy and reacts more aggressively with any non-water molecules it contacts. Many owners of steam equipment have learned lessons about water chemistry through their wallets the hard way. Mineral salts accumulate in steam generators by coating water level probes and heat exchanger surfaces. Scale accumulates on probes because of the small electrical charge used to sense the waters level. This small current is enough to attract the ferrous metal minerals floating around in the water. Eventually the accumulation of scale on probes disables the water level sensor to the point that it either senses water when their is none, which leads to a dry fire condition, or the probes cannot sense the presence of water which means that the heaters will not engage. So you can see that the process of boiling water or evaporation as the case may be, causes dissolved solids to form as scale coating heated surfaces and water level probes.

Warranties

Water hardness is usually measured in units of parts per million (ppm) of total dissolved solids ie., ppm TDS (for the record, 1ppm=1mg/l). Manufacturers of steam equipment commonly mention in their specification pages that their equipment is designed to be connected to water with 30 ppm TDS or less. Standard warranties for steamers range anywhere from 90 days to (1) year though some offer extended warranties of up to seven years if you order their water treatment system and agree to maintain it. Standard warranties against defect in materials and workmanship do not include wearable parts, adjustments or damages due to abuse or neglect. Connecting to your municipal water supply constitutes neglect as it will never be as pure as 30ppm TDS or less. There are areas in NW Iowa where the water has 1600ppm TDS. In some parts of west Texas, they have 1800-2500 ppm TDS. Aberdeen SD is built on a limestone bed and many parts of the Midwest have waters between 200-400ppm TDS. To complicate matters, water chemistry changes from season to season, and day to day depending upon which wells your city brings on-line. Water pH is also important and ought to be as close to 7.0 (neutral) as possible. Lower pH values indicate corrosivity and higher values lend themselves to scale formation. Many steamer owners have been surprised when they have had to pay for the installation of a



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new boiler shell or steam generator even though the piece of equipment is still within the original warranty period.

Chlorine

The municipal water treatment plant adds chlorine to the water to help combat microorganisms and algae. Chlorine is an oxidant and (depending upon its concentration) is effective in killing organisms that would otherwise pose health risks. Furthermore, since chlorine also works to inhibit (kill) algae, its presence in the water helps to keep the cities water tower and all of their water mains free and clear of growths that may otherwise plug things up.

Chlorine imparts a bad taste in water however, and it is bad news for stainless steel (SS) surfaces. Chlorine combines with H₂O to form hydrochloric acid, which will eat SS in no time. If the chlorine concentration is high enough and the steamer compartment is not wiped clean after use, it will begin to oxidize (eg., rust, pit and corrode). Bleach too has this effect on SS. That's why you never want to use bleach or chlorinated cleaners in high concentration to clean floors if your table legs are SS. If you do, you will notice that pretty soon the table legs begin to rot away, beginning where ever the mop wrapped around the base of the leg. Pressure washers too need to have water that is filtered and run through a carbon cell. Otherwise its spray with its load of chlorine and water will become an acid sprayer, contributing to the corrosion of SS surfaces it contacts. This effect is magnified if the SS surface is already heated. Owners of self contained steamers may want to consider placing an activated carbon block upstream the unit to protect the SS steamer compartment from attack.

Scale and steam generator design

Some steam equipment manufacturers use steam generation methods that spray water on a heated surface. The impurities within the water do not disappear with the steam. Rather, they accumulate on the heat exchange surface as scale. There is no such thing as magic and regardless of manufacturers claims, water chemistry will effect the performance of your self contained steam generating equipment. Steel surfaces do expand and contract as they are heated and then cooled, but this movement is not going to be enough to break up scale as some claim. Some manufacturers have introduced steamers designed to be filled with distilled water. One of those manufacturers has a design that steams in a vacuum. This distilled water based equipment is not subject to problems associated with water impurities, though there are other costs and differences to be considered. The cost of distilled water along with the additional labor required to constantly fill a reservoir are costs that need to be evaluated. Furthermore, if high production and speed are the need, you won't be using these smaller distilled water type units. The vacuum chamber units are slow in comparison to the atmospheric steamers, and the vacuum affects food cell structure in much the same way that pressure steamers do (see June's article). The two most common designs for self contained steam generators today are pressurized boiler shells (pressures up to 15PSI max.) which are formed from ASME rated materials (1/4"thick or greater), and atmospheric steam generators which are made from different types of Stainless Steel.

Cleaning

As scale deposits accumulate, the efficiency of the exchanger drops requiring proportionately more energy to provide the same amount of heat. Eventually thick scale formations will choke off steam production entirely. Scale leeches minerals from the metal surfaces it forms on. Lighter accumulations of scale can be removed with gentle acids like vinegar. Heavier accumulations are removed with more dangerous acids like sulfamic and muriatic acid, both of which are hazardous to people and to the environment. You really don't want to mess with either of these acids as both of which are major pollutants and are considered hazardous waste.



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When scale is removed from a metal surface the pits created by scale leeching are exposed and available for the next layer of scale to adhere to. Eventually these pits will become holes which cannot be repaired. The American Society of Mechanical Engineers (ASME) is the certification authority for pressure vessels. Once a hole has formed in a certified pressure vessel, the unit is condemned. The reason for this is that metal becomes embrittled and will structurally fail after sufficient minerals are lost to calcium carbonate scale leeching. The process of welding further weakens the bond between minerals in a metal and, consequently, is of no use in repairing a leaky steam vessel. For these reasons, it is critically important that water used to generate steam is softened and/or treated or purified before it is connected to a steamer.

Filtration

Filtration does little if anything in a steam application yet that is what you most frequently see attached to a steamer. These scale causing minerals are in solution and trying to “filter” them out is like trying to filter out the salt in salt water using a coffee filter. To make matters worse, it is estimated that 80% of the filters installed in the foodservice industry are not properly maintained. A filter may be helpful in areas with high turbidity and sediment assuming clogged drains are the concern. Few operators have the discipline to routinely change their filters or replace their water treatment cartridges even though to do so (assuming they are using an effective treatment product) is critical to the long term viability and performance of their steam generating equipment. There are many reasons for the lack of proper maintenance in food service equipment. Among these are 1) Lack of proper maintenance guidelines within the establishment. Managers don’t know the frequency and importance of proper maintenance. 2) Managers purposefully refuse to purchase replacement filter cartridges as it effects their bottom line, especially if the costs are high depending on the treatment system. The truth is steam generators simply do not fail due to accumulations of sediment or flakes of rust. Furthermore, though water softeners mitigate the impact of hard water on steam equipment, they are not a solution. To the contrary, they may tend to increase corrosive characteristics of the water in certain applications and it is not a viable solution for single point of use applications. There are however some effective treatment choices one can make.

Water Treatment

Before any solution can be recommended, your water needs to be analyzed and then compared to your specific application. If hot water and hard scale are the issue and the application is commercial foodservice equipment, then there are some compounds that can help. There are a number of polyphosphate based products on the market that really help reduce or eliminate scale in foodservice equipment where water temperatures do not exceed 90 degrees F. However, in hot water applications, the ability for polyphosphates to effectively inhibit scale formation is drastically reduced. Unlike standard polyphosphates, HydroBlend™ is a proprietary compound that retains its integrity right up to the boil point. It acts as a sequesterant to scale causing minerals like iron and manganese. It also changes the shape of the scale molecule, making it irregular enough that they are not attracted to one another through surface tension. It is available in a low cost, convenient new form known as ScaleStick™, which fits into anybody's 10" clear pre-filter housing. When feed water has been treated with this compound, the mineral salts that precipitate from solution fall to the bottom of the steam generator with a loose, oatmeal like consistency rather than the usual hard tenacious scale. When the tank is allowed to drain the impurities flow away with the water. But, like filters, someone needs to be disciplined enough to change the cartridges when spent.

The most complete (and expensive) protection is to purify the water before it gets to your equipment. R/O systems (reverse osmosis) have dropped in price in recent years, though they are still



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considerably more expensive than any of the other strategies. They work on the principal of a pressure drop across a membrane with tiny little pores that are less than a micron in size. Water molecules can pass, but the larger molecules of impurities tumble along the surface of the membrane until they reach the drain. In really horrendous water areas, R/O is the way to go. Every market in Phoenix sells R/O water and almost every home has its own system. They work exceptionally well, though they do require a bit a maintenance. Another consideration is that R/O can purify the water so much that the electric probes on your steamer won't be able to sense the presence of water. Totally pure water cannot carry an electrical current...it is the mineral impurities that enable water to carry a charge. Consequently, R/O systems connected to steamers using electric water level probes need to be adjusted so that they allow some minerals to seep through. For the record, the HydroBlendTM compound dramatically extends the life expectancy of R/O membranes. It acts as a hyper-wetting agent and also as an anti-corrosive.

In summary,

your local water chemistry will have a profound affect on the performance of your steam equipment. There are effective strategies but they require that the owner assume responsibility and employ a bit of discipline to assure that treatment cartridges, membranes or filters be replaced before they are spent. Some servicer's, like General Parts and Supply in the Midwest offer preventative maintenance (PM) programs specifically designed around the need to first analyze, and then support a particular water treatment strategy. If your equipment planning includes effective analysis, treatment and maintenance of your water treatment system, you can expect many years of productive steamer performance free of water related disappointments.

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