Autoclave Water Types and Usages

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Introduction

Autoclaves use steam. Steam requires liquid water, but how important is the purity of that liquid water? It all depends upon how important the longevity of your autoclave investment is to you.

Water is the working fluid of any autoclave, and it could be said to be its life-blood. The quality of the water supplied to your autoclave can affect the life-span of your autoclave's components such as the steam generator (for steam generating types of autoclaves) and even the curing / sterilizing chamber. The quality of water is often defined by its levels of hardness, chlorides, minerals and ph.

The types of water used in autoclaves vary depending upon the type of autoclave that is being used. This paper will focus on autoclaves used for the sterilization of instruments and plant matters, packaging and production equipment. The quality of water required for these applications distilled water or deionized water, which would ensure proper function and maintenance and longevity of the autoclave. Distillation removes impurities from the water and provides the cleanest water possible. But this is the short answer, let's delve into the issue of water quality a little deeper. First let's start by asking what kind of waters can be used for an autoclave:

Can I use Tap Water? No, because tap water contains too many impurities and may cause your autoclave to require frequent cleaning and maintenance, not to mention reducing the lifespan of outlet valves and door seals, steam generating elements and steam generation chamber.

Can I use Mineral Water? No, because the Impurities in mineral water have the same effect on an autoclave's maintenance requirements as tap water, so don't use Mineral Water.

Can I use Boiled Water? No, because boiling water only kills bacteria and biological contaminants and does not clean the water of minerals and other contaminants.

Which is better, Reverse Osmosis or Distilled Water? Reverse osmosis is better than any of the above solutions, because it filters out many impurities, however, it does not eliminate ionically charged organics, which can bond to the autoclave surfaces and lead to the requirement of frequent maintenance. Such organics can include sodium and other minerals. Distilled water is the processes of boiling tap water which kills the bacterial and other biological contaminants through a process of extended boiling in which the steam rises and is separated and is then cooled back down into liquid form. Contaminants in the boiling tank of a distiller are simply drained away. The result is boiled, sterilized and purified water. In other words, distilled water is de-ionized water that is pure up to 99.9% free of contaminants.

Levels of Damage that poor water quality can cause to an autoclave

It could be said that there are usually three levels of damage that can occur in an autoclave that uses impure water. The first level of damage is accumulation of minerals which could usually be dealt with by blow-down processes. The second level of

damage would force the use of reverse osmosis systems or a filtered water system that would be circulated through the autoclave to help remove minerals and deposits from the steam generation system by feeding the steam generator with this pure water during a maintenance cycle. The third level of damage is catastrophic damage where the mineral build up is so high that complete disassembly for cleaning is necessary, and possible replacement of the entire autoclave may be required.

Damage that can occur is shown by the following photos of a steam boiler.

The above image shows the material build-up in an electric steam generator that used impure water. This level of damage is the most severe and would have corroded the heating elements. Usually severe water hardness and silica present in the water causes this type of build up. Calcium (scale) is electrically conductive and when there is enough of a deposit between heating conductors flash arcs can occur causing short circuit and overheating.

How to know the water is good enough?

Municipal water quality reports are a good starting point to learning about the quality of your water. However, water quality for drinking is different from water quality for equipment and such reports are normally oriented around drinkability. You may consider that if the municipal report does not include hardness that an independent water quality test be performed. There are different solutions for different types of autoclaves.

For example, a carbon steel autoclave that uses an electric 'boiler' system can use RO (reverse osmosis) filtered water to remove most of the solid contaminants, except for bacteria and biological particles such as viruses. A water softener can also be used to reduce the hardness of the water but only if the water meets all water quality requirements but hardness.

Another example is a stainless steel sterilization autoclave that uses an electric 'boiler' system. For such a system deionization of the water would remove ions and produce a very high purity level. However deionization does not affect uncharged molecules, viruses or bacteria. Distillation, as discussed above, removes virtually all impurities from the water and dissolved minerals. Distilled water is also excellent to feed stainless steel autoclave boilers.

How Pure Does my water need to be?

Water that is between 2,000 to 26,000 ohms*cm can be achieved with an RO (reverse osmosis) filter and would be appropriate for the vast majority of stainless steel autoclaves and loads such as bio-hazardous waste, clothing, glassware, media or general production or labware. Autoclave load items that are sensitive to mineral content contamination, or are part of cGMP require a full stainless steel autoclave. cGMP (current good manufacturing practice), is a main regulatory standard for ensuring pharmaceutical quality for human pharmaceuticals in the USA, wheras Canada's version of cGMP is GMP. The reason behind the requirement of a stainless steel autoclave for sterilization of the afore mentioned loads this is that high purity water lacks ions or dissolved minerals and will leach impurities from every surface it touches, including carbon steel and copper, which will lead to continuous weakening and premature failure of plumbing components manufactured from these materials. High purity water is required also, and is typically at a purity of 1 megaohm*cm.

What are the types of water?

Tap water can be hard or soft depending upon the source (e.g. lake, river, ground well). Tap water has a purity of between 12,000 ohms*cm to about 500 ohms*cm.

Softened water is water that has been processed to exchange most of the dissolved calcium with either magnesium or sodium. Softened water has a purity that is

just a little better than tap water at between 25,000 ohms*cm to 400 ohms*cm.

Tap water varies in purity due to it's varied sources and has a purity around 500 ohm*cm to 12,000 ohms*cm.

Reverse Osmosis (RO) filtrates by forcing water through a thin permeable membrane whose holes are so small that they prevent most of the solid contaminants and dissolved minerals from passing through. Distillation and deionization are often preceded by RO because RO does not remove biological particles such as bacterial or viruses due to their small size. RO water purity is between 1.4 million ohms*cm to just over 100,000 ohms*cm.

Deionized water (DI) has its own ions removed and is considered high purity water with exception that molecules of uncharged viruses and bacteria are not removed. DI water has purity between 7,000,000 ohms to just under 2,000,000 ohms*cm.

Distilled water has nearly all of its impurities removed. Distillation, as mentioned earlier, involves boiling the water and collecting the steam into a clean container which cools to liquid, leaving the vast majority of the solid contaminants behind. Note that distillation apparatus has to be frequently cleaned as it leaves behind white or yellowish mineral scale. The purity of distilled water is upwards of 10,000,000 ohms*cm and between 5,000,000 and 2,000,000 ohms*cm.

CONCLUSION

In conclusion, water between 0.1 Megaohm*cm to 1.0 Megaohm*cm is likely appropriate for sterilizing biohazardous waste, clothing, cages, glassware, media or lab equipment.

High purity water greater than 2 Megaohm*cm could be is likely appropriate for sterilizing items sensitive to mineral contamination such as biological tissue samples or items used under cGMP or GMP. The use of DI or Distilled water is most appropriate for the afore mentioned applications, taking into account that the autoclave materials of construction should be stainless steel to prevent leaching.

A few References

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