Water Categories and the Importance of pH

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Water quality is of utmost importance in Sterile Processing departments (SPDs), as it directly affects the cleanliness, disinfection and sterilization of surgical instruments. To ensure high-quality water for these processes, it is crucial to monitor and control key parameters. This article defines some of the parameters to be measured, with an emphasis on the pH (potential of hydrogen) balance for each category of water used in the department.

The technical information report, AAMI TIR34:2014/(R)2021, provides guidance for managing water in the SPD. The AAMI committee restructured that report and has provided a standard, AAMI ST108:2023 *Water for the processing of medical devices,* that not only provides guidance for identifying and resolving water quality issues but also establishes requirements to ensure that water contributes to the overall quality of sterile instruments.

Categories of water

Let's define the three categories of water and examine their respective requirements in managing water within the SPD, as outlined in AAMI ST108. The first is **utility water**, defined as water that comes directly from the tap. This water may require further treatment at the facility to meet the desired water quality measurement values. In the SPD, it is used for flushing, washing and intermediate rinsing between the cleaning and disinfection stages. The second, **critical water**, is that which meets the water quality measurement values. Critical water is used for the final rinse after high-level disinfection (HLD) and for the final rinse of critical devices before sterilization. The third category, **steam** refers to vaporized water produced by a centralized boiler or a generator or heat exchanger near the sterilizer.

Assessing water quality

As SP professionals, we rely on water as one of our primary tools for achieving the safest surgical instruments for our patients. Poor water quality can have detrimental effects on these processes. Contaminants, pH balance, alkalinity, total organic carbon (TOC), color and turbidity (lacking clarity or purity) are important factors to consider.

Contaminants, such as bacteria and endotoxins, can compromise the cleanliness and sterility of instruments, increasing the risk of patient infections. Residual organic carbon, measured as TOC, should be minimized to prevent adverse effects on patient tissue and mucosa. Visual inspection is also crucial to ensure that water used in the SPD is free from contaminants, as indicated by color, turbidity and residues. Monitoring and controlling these parameters is essential for ensuring water quality in the SPD.

Monitoring pH

When assessing water quality, pH measurement plays a significant role. The pH value indicates the acidity (1 to 6) or alkalinity (8 to 14) of a solution by measuring the concentration of hydrogen ions (H+). Maintaining pH levels near neutral (6 to 8) is recommended for all rinse stages to prevent corrosion, staining and interference with detergents and disinfectants. Levels that are too acidic or too alkaline can damage instrument surfaces and interfere with the effectiveness of cleaning agents and disinfectants. High alkalinity can lead to scale formation, reducing the efficacy of cleaning agents and potentially causing staining or corrosion during steam sterilization.

The specific pH range depends on the type of water being used. For utility water, a pH range of 6.5 to 9.5 is typically maintained; this is influenced by disinfection chemistry and water treatment methods. Critical water, used in processes like steam generation, has specific pH values based on its production method. For instance, steam generated by a boiler system with oxidizable materials requires a pH range of 7.5 to 9.2 to prevent corrosion and rust transfer.

To measure pH levels, colorimetric dipsticks or pH meters can be used.

Regular calibration of pH meters is essential to ensure accurate readings. Prompt testing, within 15 minutes of sample collection, is important to minimize interactions with air. Pure water, for example, can absorb carbon dioxide from the air, leading to increased acidity. Testing should be conducted at the entry point of the distribution loop or at the initial point of use (POU) along the distribution loop.

Regular and consistent monitoring of pH levels is vital to maintain optimal water quality in the SPD and ensure safe and effective sterilization processes. By adhering to recommended testing frequencies and calibration procedures, SP professionals contribute to the overall quality assurance of water used in the field.

Controlling hardness in utility water

Utility water is typically considered hard water due to the presence of dissolved calcium or magnesium carbonate. When hard water is heated or evaporated, it can leave behind unsightly white and brown spots, and in water heaters, it can lead to the formation of mineral deposits. To address the issue of hard water, a softening process is recommended. Softened water is essentially hard water that has had calcium or magnesium replaced with sodium through the use of salt. When softened water is heated or evaporated, it forms a softer, mud-like substance that is easier to rinse compared to hard water, hence the term “soft.”

Controlling water hardness is crucial as it affects the residues left on medical devices. By minimizing excess hardness, the lifespan of washer-disinfectors can be prolonged, the risk of hard-water deposits on medical devices can be reduced, and the effectiveness of cleaning agents can be ensured.

Verifying the purity of critical water

Critical water undergoes extensive treatment to ensure the removal of microorganisms and inorganic and organic materials. The primary treatment process for critical water typically involves demineralization through either deionization (DI) or reverse osmosis (RO).

In the case of DI, the water has calcium or sodium chemically stripped from it. This process involves resin beads contained in fiberglass tanks, similar to a water softener. Over time, the resin beads become exhausted and require off-site regeneration. A sensor on the tanks indicates when regeneration is needed, and the water treatment company replaces the exhausted tanks with fresh ones.

An RO system mechanically removes the calcium or sodium from the water. It functions as a highly efficient filter, causing a significant drop in water pressure. Therefore, RO systems include a storage tank and a pump. The storage tank holds the processed water, and the pump delivers it under pressure to the SP area.

As previously stated, critical water plays a crucial role in the final rinse stage after HLD and the final rinse before sterilization of critical devices. It undergoes specialized treatment to ensure its purity and compatibility with the sterilization process, contributing to the overall effectiveness and safety of the sterile instruments.

Testing steam quality

Steam is produced through the process of distillation. Distillation is a method of purifying water by boiling it and condensing the pure water vapor. During this process, the impurities, including calcium and sodium, are left behind. Only the pure water forms the condensate. This is also how the steam equipment in a healthcare facility operates. The steam generated by boilers or steam generators leaves the solids behind, and the condensate is drained while fresh water, known as makeup water, is added to compensate for the loss. The makeup water, however, contains solids, necessitating the need for a blowdown (draining or intentional removal of water from the boiler) to prevent an accumulation of impurities.

Conductivity measurement is crucial for monitoring the quality of steam generation equipment in your facility. Facility engineers typically measure the conductivity of steam generation equipment on a daily basis, and water treatment companies conduct monthly verification of the equipment and readings. They can provide guidance on measurement techniques, demonstrating how and where to take measurements. In the boiler room, conductivity is measured in the hot, high-pressure water of the boiler. To facilitate testing, sample coolers are used to cool down the boiler water or steam, enabling quick and efficient measurements. Similar coolers can be installed behind sterilizers to measure steam in those areas.

When testing steam, it is examined as condensate, which is the liquid water formed when steam cools and condenses. Monitoring the quality of steam condensate is important as it may contain impurities or contaminants that can affect the performance and efficiency of equipment or processes where it is utilized. AAMI ST108 defines steam production through a boiler and recommends measuring and testing various parameters, including conductivity, pH, hardness, calcium, alkalinity, sulfites, chloride, chlorine, iron and temperature.

Conclusion

Maintaining high-quality water is crucial in SPDs to ensure the cleanliness, disinfection and sterilization of surgical instruments. Parameters, such as pH balance, contaminants, alkalinity, TOC, color and turbidity, play significant roles in water quality assessment. SP professionals must be vigilant in monitoring and controlling these parameters to prevent contamination and damage to instruments, while considering each category of water being tested. By adhering to recommended testing frequencies, calibration procedures and standards, SP professionals contribute to the overall quality assurance of water used in the field. Continuous monitoring and control of water parameters, particularly pH levels, are essential for safe and effective sterilization processes, ultimately ensuring the highest standards of patient safety. P

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Association for the Advancement of Medical Instrumentation (AAMI). AAMI TIR34:2014/(R)2021 *Water for the reprocessing of medical devices*. https://doi.org/10.2345/9781570205446.

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