Cleaning, Sanitizing and Sterilizing

Cleaning

Cleaning is the physical or chemical removal of dirt, grime and other surface soils.
In food and beverage operations, residual constituents of the mix can be retained on surfaces at different rates and in varying amounts. Each soil and stain has unique characteristics and may require more than one method to remove.

Soils can be classified as either acid or alkaline. Acidic soils include most food soils such as fats, proteins and carbohydrates. Alkaline soils include scale and stone from mineral salts and water hardness constituents.

Removing soils by a rigorous cleaning must precede any sanitization or sterilization procedure.

Cleaning must be done thoroughly to fully remove any soils that can harbor active organisms under hard scale or in multiple unaffected layers insulated from the cleaning method.

Cleaning has two common terms: Clean In Place, known as CIP, and Clean Out of Place or COP.

Clean In Place (CIP) systems rely on velocity of flow and penetration of the soils for removal.
Clean Out of Place (COP) systems rely on complete disassembly and manual or partially automated vigorous brushing, scrubbing and cleaning of the disassembled parts.

COP systems typically have wash tanks where parts are placed and vigorous manual brushing, or high pressure jets where the disassembled parts are subjected to vigorous fluid movement.

CIP flows should be designed to have a minimum Reynolds Number of 4000 in all surface contact. The velocity of the fluid should be no less than 5 feet per second.

Sanitizing

Sanitizing is the deactivating of any residual exposed organisms left on surfaces after cleaning.
Sanitization is not effective without being preceded by an effective cleaning.

Sanitization is completed by using heat and or chemicals to kill a significant percentage of any organisms and render the surfaces under control from contamination by reducing the colonies of organisms. Sanitization is not sterilization. These terms describe different activities but are commonly confused in conversation.

Typically the effectiveness of the sanitization is measured by taking swab samples in strategic locations and growing the culture in a lab. The term “1 log” “2 log” etc. reduction indicates how much of the colony is reduced. For example, a “3 log” reduction translates to having reduced the colony by 99.9 wt%. Four log reduction is 99.99 wt% reduction of active organisms in the sample dish as compared to the same location first un-sanitized then sanitized.

Heat Sanitization

Heat can penetrate areas differently than chemicals as the soils themselves will heat to the temperature of the surrounding pipe, surface or liquid in which it is in contact. Heat is a time at temperature method that needs to be measured at the lowest temperature and shortest exposure time location.

Many times this is the Achilles heel in thermal sanitization systems.

Soils, especially stone and scale can be thermally self-insulating. If there is an active colony embedded in a thick soil, the heat sanitization may not be effective. If the time is not allowed for the heat to transfer into the center of the soil and if the center of the soil is not kept at that temperature for the needed time, then the colony will not be reduced. Even though the rest of the system may be assumed to have met the time and temperature requirement, problems can immediately surface due to this residual renegade colony not having felt the full sanitization procedure.

This exemplifies the critical need for rigorous cleaning procedures to remove any nook and cranny colonies prior to sanitization.

Time Temperature Requirements for Sanitization

Temperature	**Time**
200 F	20 minutes
180 F	30 minutes
160 F	40 minutes
140 F	60 minutes

The time at temperature does not start until the coldest part of the entire system reaches temperature. This is usually the single most significant source of error and problems with heat sanitization systems.

Chemical Sanitization

Chemical sanitation relies on a series of solutions to break the surfaces of the various soils and organisms and eventually contact and oxidize their cells.

Sanitization includes chemical cleaning steps.

Typically caustic is used to break organic or acidic soils. Acid is used to dissolve the alkaline soils like stone and scale. Common oxidizers are used to kill the organisms. The choice of oxidizer depends upon specific characteristics, conditions and sensitivities of the overall system. The most common oxidizers are hypochlorite, peracetic acid, quaternary ammonium compounds, iodine solutions and ozone.

In the chlorinated alkali and acid systems, heat is used in conjunction with the sanitizing chemicals. In the ozone system, heat may be used as a separate step, as the ozone system is more effective in cooler fluids.

Chemical sanitization systems usually follow a rotating sequence of flushes and chemical solution recirculation in the system. These sequences have a starting point, but are usually dependent upon the specific conditions of the system. The incoming water quality must be considered in the determination of the chemical sequences to be used.

A typical cleaning sequence can combine certain steps. Uniformly some sort of cleaning step or water flush step is first. A caustic step is next followed by a water flush and neutralization. These three steps could be considered part of the cleaning sequence or the sanitization sequence since there is microbial efficacy from both the acidic and basic chemicals. The true sanitization step is the oxidation step. This is usually done in conjunction with the caustic step due to the need to keep the release of gaseous products from occurring. The activity of the acidified oxidizers are much higher than the basic oxidizers, but dangerous by products can also be created. There is a balance between efficacy and safety.

The sequence and specific details must be determined for each application. The typical chemical sanitization sequence is: water, caustic/oxidizer, water, acid, water. Heat is most commonly used in conjunction with the chemical sequence.

1. A thorough and rigorous cleaning – Without cleaning, no sanitization process is effective
2. Acid flush – To dissolve any stone and scale not fully removed by cleaning
    a. Note that if stone and scale is allowed to build up over time and if the sanitization procedure has not been rigorous in the time period preceding its implementation, the acid flush could remove stone and scale that could have been harboring colonies under a protective cover and may release new contamination from those now exposed colonies.
    b. The acid flush dissolves the inorganic scale and stone
3. Water flush – To remove the now dissolved stone and scale and to remove the acid
4. Caustic flush – The caustic flush dissolves and removes organic film and scum versus the inorganic stone and scale that is removed by the acid
5. Water flush – To remove the organic scum and films
6. Oxidizer flush – To kill any colonies on the surfaces and to insure all surface sanitization
    a. The choice of oxidizer is critical as the efficacy of the sanitization process will depend upon this step
    b. **Sodium Hypochlorite (bleach)** is cheap and effective, but it corrodes most metals and it creates residual organic species in wood and some plastics that may then leach into the products
        i. NOTE: If the product has a sensitivity to wood, cork or other soft material components, bleach is not the best answer as the part per billion

residuals may affect the product. The best example of this is in the wine industry where cork and wood barrels impart flavor effects on the wine
   ii. Bleach, however, has been traditionally the most effective sanitization chemical and has significant history of successful service in a wide range of applications

c. **Peracetic Acid** – A mixture of hydrogen peroxide and acetic acid is the traditional alternative to bleach where bleach cannot be used. It too will corrode certain metals and elastomers, so materials of construction must be reviewed.
d. **Ozone** – Ozone is generated in situ and has a short half-life so it cannot be stored. Usually a corona type ozonation system is installed on the flush water system. Ozone has been very effective if properly applied. Contrary to the other flushes ozone appears to be more effective when cooler, so hot flushes are separate steps from the ozonation step.
e. **Quaternary Ammonium Compounds** – Quats are effective and are usually used in sanitization procedures prior to the longer term storage of seasonal parts. Quats are affected by water quality and detergents that may be used in the preceding cleaning process. Quats also tend to foam. Their film forming characteristic is one reason they are used as the sanitization step prior to storage of the part or idling of the system.
f. **Iodine Solutions** – Iodine is effective as it has good penetration functionality. It is not as strong nor consistent as other oxidizers listed. It is frequently used on systems with hard to reach nooks and crannies in the design. Iodine does leave residuals than can be promulgated throughout the system and add off odors to food stuffs.

Note that for all chemical sequences the order, concentration, temperature and contact time all make a difference. In many cases components are combined in certain steps to improve efficiency and reduce he complexity of the system. Whether CIP or COP, the sanitization steps are usually the same, however implemented in different ways.

Sterilization

Sterilizing surfaces requires the removal and kill of all contaminants on the surface. Usually sterilization is a heat step following a cleaning and sanitization.

The COP sterilization procedure usually includes placing all parts in an autoclave to insure time and temperature exposure of all parts.

A CIP sterilization procedure usually has a sanitary steam flush of all wetted surfaces using time and temperature requirements. This is not the plant utility steam, but steam produced specifically for sterilization. Sterilization procedures include the autoclaving of connection pieces so that all surfaces are insured to have been exposed to the sterilization procedure. It is important that no nook or cranny is left unexposed to the various steps in the cleaning, sanitization and sterilization sequences.