

HOSPITAL STERILIZER PROBLEMS

SECTION 1: THE STERILIZATION PROCESS

Disease-causing bacteria can flourish in the medium of air and water, especially if additional nutrients are present. These microorganisms can cause infections and maladies, and their prevention is a major concern to the hospital's sterilization operation.

Sterilization employs heat in the destruction of microorganisms. At high temperatures the nucleic acid contained within the bacteria cells are destroyed. Bacteria die as a result of denaturation of proteins.

Since moist heat has better penetration and faster killing properties than dry heat, saturated steam is used to supply the heat source in the sterilization process. Typically, the steam to the hospital sterilizers is provided by the engineering department from the central steam generating and distribution system. The steam supply for sterilization should contain approximately 2% water and 98% dry steam. This balance is critical to maximize efficiencies.

Steam temperatures used in sterilization normally range between 270–274°F (35 psig) and the exposure and drying times to complete the process will vary depending on the type of cycle being employed (pre-vacuum or gravity) and the combined weight of the articles being sterilized.

The final process should result in providing the hospital with trays, instruments, and wrappers that are sterile, dry, and free of deposits and corrosion.

SECTION 2: STERILIZER PROBLEMS

Unfortunately, the operations of sterilizers within a hospital are not problem-free. Some of the problems commonly encountered are addressed separately below, but more often than not, the causation of the problem is a combination of various factors:

WET PACKS

Surgical instruments must be sterile. Wet materials transmit bacteria; therefore the sterility of the packs and instruments are compromised if they are wet. Wet packs typically require reprocessing which is time consuming and expensive.

Causes:

- Boiler water being entrained with the steam commonly referred to as carryover
- Improperly installed or no steam trap on steam supply line to sterilizer
- Pack preparation and sterilizer loading techniques
- Linen packs that are too large
- Types and sizes of wrappers
- Clogged drains and discharge lines on sterilizers
- Leaking valves
- Insufficient drying times

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SURGICAL INSTRUMENT CORROSION

This problem can cause instruments to become inoperative, which results in costly replacements.

Causes:

- The improper use of neutralizing amine resulting in steam condensate that has either a too low or too high pH
- Improper rinsing of laundered cloth wraps and laundering wraps with bed linens where "sour formulas" and/or quaternary ammonium fabric softeners are employed
- Mixed metal sterilization in the same basket can cause electrolytic corrosion to take place
- Integrity breaks in chrome-plated instruments
- Improper rinsing of highly acidic or alkaline cleaners before sterilization
- Saline solutions also cause corrosion problems for stainless steel
- Incomplete deposit removal, which causes under-deposit pitting to occur

SPOTTING AND STAINING OF SURGICAL INSTRUMENTS AND WRAPS

75% of the surgical instruments available today are made of stainless steel. But the term "stainless" is frequently taken too literally. Stainless steel does have weaknesses, including water spotting and staining. So, there really is not a "stainless" type of steel. Instruments containing spots typically have to be reprocessed which is time consuming and expensive. Badly stained instruments may require replacement. Both spotting and staining do not portray sterility.

Causes:

- Iron oxide corrosion products can break loose from the steam/condensate piping and enter the sterilizer with the steam, which can spot the wraps
- Rinsing instruments after washing with poor quality water can leave white mineral deposits on them
- Rusty colored spotting on the instruments can result from instruments being rinsed with water having a high iron content or result from instrument corrosion
- Purplish black staining can be caused by sulfides being present in paper wraps and by excessive amine chemical usage

BLACK SURFACE DEPOSITS ON STERILIZER INTERNALS

A fine black powder seems to form on the internal surfaces of most hospital sterilizers and instrument racks. Under this powder-like deposit, evidence of corrosion is normally absent. These black deposits have been analyzed on a number of occasions in the past and were found to consist of predominantly nickel, copper and sulfur. From these three deposits being present they are being formed by the reaction of nickel, iron and copper in the monel metal with sulfides. Metallic sulfides are black.

The investigation of the black deposits on cloth wraps and sterilizer washcloths have found high levels of sulfates present. Under the right conditions, sulfates will convert to sulfides. The same holds true for the sulfites that are commonly used as oxygen scavengers in many boiler plant water treatment programs.

These black deposits, if allowed to accumulate on the sterilizer surfaces and instrument racks, can slough off periodically and will cause black spots on the wraps and instruments. The presence of sulfides in the sterilization process can originate from:

Causes:

- Disposable, non-woven wraps
- Laundry residuals
- Improper removal of cleaning agents
- Boiler water carryover
- Color change indicator tape

SECTION 3: IMPURITIES IN STEAM

This problem is being addressed in this fact finder as a major topic for two reasons:

1. For a chemical supplier and consultant to hospitals, the goal is to design a water treatment program that limits impurities in steam.
2. Most problems that occur in a hospital's sterilization process are first blamed on poor quality or dirty steam. But that's rarely the case unless the hospital is experiencing severe boiler water carryover problems or has not implemented a sound steam/condensate corrosion control program.

STEAM GENERATING AND DISTRIBUTION SYSTEM

To understand what is in the steam and why it is there, it is useful to examine the hospital steam generating and distribution system from the viewpoint of the facilities engineer, who is responsible for operating and maintaining the system.

The main requirements for hospital steam are space heat, absorption refrigeration (if used), humidification, laundry (if any), kitchen and finally sterilizers. Steam to the sterilizers represents a very small fraction of the total steam produced, probably in the range of 3 to 5%. Obviously the boilers must be operated to ensure a reliable supply of steam to the entire system, and specific sterilizer steam purity requirements can be considered only after the health of the steam system is ensured.

The components of a hospital steam generating facility would typically include the following:

- Boilers—Firtube and/or Watertube
- Steam Distribution Lines
- Steam Utilization System
- Condensate Return System
- Feedwater Holding Tank, Heater, Deaerator, etc
- Pretreatment Equipment—Softeners, Dealkalizers, Reverse Osmosis, etc.

Is it the goal of the facilities engineer to reclaim as much of the condensate steam as possible since this saves energy, water and chemicals. Most hospitals recover 70% to 85% of their condensate with most of the losses resulting from humidification requirements.

Most hospital boilers are not fitted with sophisticated steam separating devices like those used in central utility stations where steam turbine blade deposits must be avoided. This means that the steam quality from the hospital boilers will contain some water that is actually beneficial to the sterilization process.

HOSPITAL WATER TREATMENT PROGRAM

A hospital's water treatment program should be designed to accomplish the following:

- Prevent deposits from forming on the boiler exchange surfaces
- Prevent oxygen pitting on the boiler metals
- Ensure a steam as clean as possible for end-use
- Reduce corrosion rates in the condensate return systems to acceptable values

To prevent scale deposits from forming on the heat exchange surface, the following chemicals are normally utilized.

- Crystal Modifiers—Phosphonates
- Dispersants—Synthetic Polymers
- Precipitants—Phosphates
- Chelants—EDTA

Oxygen pitting corrosion is controlled by the use of:

- Chemical Oxygen Scavengers
 - Sulfites
 - Erythorbate



The management of all the steam generating components in the facility should result in recovering of 70% - 85% of the condensate return.



The goal of your water treatment provider is to accomplish the following:

- Prevent deposits
- Prevent oxygen pitting
- Ensure clean steam
- Reduce corrosion rates

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Clean steam is controlled by limiting the total alkalinity and dissolved solids via continuous blowdown regulation in conjunction with:

- Antifoams
 - Polyglycols
 - Polyamides

Condensate corrosion control is obtained by the application of various volatile amines:

- Neutralizing Amines
 - Morpholine
 - Cyclohexylamine
 - Diethylaminoethanol
- Film Forming Technology

These materials are typically controlled so that the active ingredient in the steam does not exceed what is permitted by the FDA for steam that comes in direct contact with food.

STEAM IMPURITIES

One of the best ways to measure steam quality is to monitor the condensate at various locations throughout the hospital. Since steam quality to the sterilizers is often questioned, one of the monitoring sites should be from the steam supply line to the sterilizers. A cooling coil should be installed at this location so that the representative sample can be controlled for analysis.

A good quality steam condensate should have values with the following control parameters:

- Total Hardness (as CaCO₃)- 0 ppm
- pH - 7.8 to 8.8
- Conductivity- < 50 Mmhos
- Iron (as Fe) - < .1 ppm
- Copper (as Cu) - < .05 ppm
- Corrosion Rates - < 1 MPY (mild steel)

Steam Filters have been installed at many hospitals where steam quality is questionable with very good success.

CONCLUSIONS

A well-controlled and operated water treatment program designed to prevent the problems throughout the hospital's entire steam should also minimize steam-related sterilizer problems. It should also be recognized that corrosion in a steam/condensate system can never be totally stopped, only controlled.



The chemistries that are used should be controlled so the steam that comes in direct contact with food does not exceed what is permitted by the FDA.



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