SELF-STUDY SERIES

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Learning Objectives

1. *Discuss three potential sources of surface stains on surgical instruments.*
2. *Describe steps to identify which source is the culprit in a particular situation.*

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Troubleshooting surface stains on instruments after steam sterilization

by Walt Deacon, Thermo Diagnostics

The purpose of this self-study article is to discuss instrument stains, specifically surface stains, not corrosion stains. The term "stainless steel" certainly doesn't mean that instruments won't get stained. The reader will understand the three typical sources of surface stains. The article then presents some troubleshooting steps to identify which of the three likely sources is the culprit, and possible next steps.

A careful reading of "AAMI ST-79: Comprehensive guide to steam sterilization and sterility assurance in health care facilities"[1] identifies three sources of surface stains after instruments have left the decontamination process. They are:

1. The steam system
2. The final rinse, whether after the instrument is washed manually or in a mechanical washer
3. The final rinse of the textile product or sterilization wrap.

Let's look at the sources individually. Then we'll suggest a path to determine which of the sources to "zero in" on.

Stains caused by the steam system

AAMI ST-79 Section 3.3.4.3 "Steam purity" has this to say:

"The boiler feedwater source, treatment chemicals used, and the design and maintenance of the steam supply system should minimize the presence of potential contaminants in the steam. The feedwater should be treated so that its condition and/or chemistry do not damage the boiler or the steam lines. Boiler additives and feedwater conditioners should be monitored. The use of such compounds on a batch basis is not recommended for sterile processing applications. Only additives and conditioners approved for use in the food and drug industries should be used (21 CFR 173.310 and 21 CFR 200.11). The addition of similar additives or conditioners to the steam in the steam distribution system is also not recommended, because it can cause pack and instrument staining and/or instrument damage."

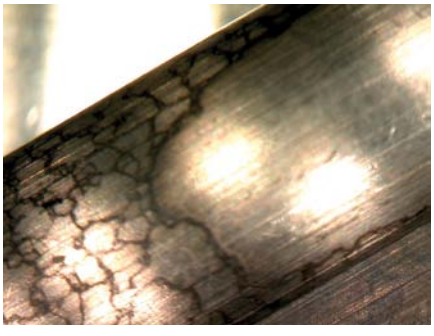
Note that the standard is saying the chemicals can be used, but they should not be injected INTO THE STEAM LINE, especially the ones supplying sterile processing. The type of chemicals most often injected into the steam lines are called amines. They are used to neutralize condensate that can become acidic. The acid forms when carbon dioxide meets cool condensate, and can corrode the piping. This will cause black rust stains from corroded steel or iron piping. So, the amines help prevent staining, but should be monitored as Section 3.3.4.3 goes on to say:

"Caution is advised in the use of amines for conditioning steam lines (as opposed to the use of amines in feedwater treatment) because amines can stain packaged items within the sterilizer.

Rationale: The hardness and pH of the water affect the purity of the steam generated in the boiler. It is important that boiler additives and feedwater conditioners be monitored to prevent carryover of excessive chemicals into the steam used for sterilization."

To prevent the rusting of older systems from reaching the sterilizer, Section 3.3.4.3 also suggests:

"In-line filters should be used to remove particulate matter, such as scaling that can

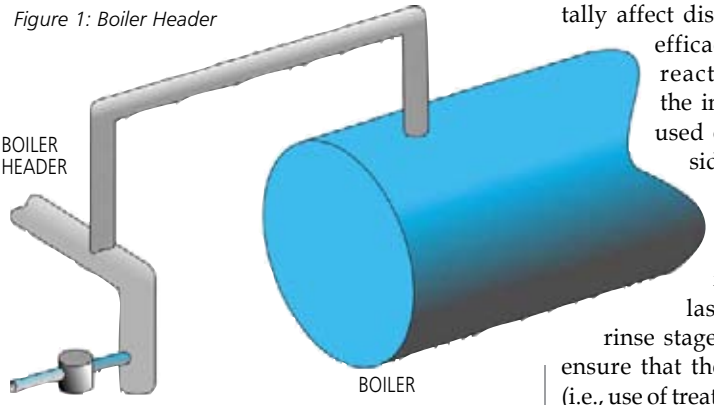


Stain on instrument viewed under microscope

occur as systems age. In-line filters should be installed as close to the sterilizer as possible, and they should include a drip leg or trap for condensate removal."

If the stain is more brownish in color, it can be caused by boiler carryover. Steam specialists know that all boilers "throw" some liquid water out with the steam gas. The boiler piping is normally designed to remove this liquid water. The piping is called a "boiler header" and is an oversized piece of pipe equipped with drain valves called steam traps (see Figure 1). The header catches the liquid water, and the steam trap drains it out of the pressurized piping. However, there are two conditions in the boiler that can overwhelm the boiler header and let liquid water into the piping servicing sterile processing. These two conditions are priming and foaming. Priming is a bouncing water level in the boiler. Foaming is similar to what happens when you boil potatoes. By adding starch (that dissolves off the potato) the solids concentration in the water increases. The water is much more likely to "boil over" and make a dirty mess on the stovetop. The same exact thing can happen in the boiler, only now the dirty mess can end up in the sterilizer. Where do the solids come from in the boiler? Most healthcare facilities return about 85% of the boiler water as condensate (which is like clean distilled water) the rest has to come from fresh water. This fresh water has minerals dissolved in it, so the concentration of solids in the boiler is always increasing, making it likely to prime or foam.

Figure 1: Boiler Header



To keep this from happening, the boiler plant personnel monitor and control the total solids and the pH of the boiler water. They also monitor the performance of the steam traps, which are essential to removing any liquid water.

If you suspect staining is being caused by the steam system, here are some troubleshooting steps:

1. Identify the most likely instrument set. Is it a heavy orthopedic set, or is it showing up on peel packs too?
2. Make up two test loads with those likely instruments.
3. Sterilize one test load in-house and take the other across town or down the road to another facility with a sterilizer set-up close to that of your own facility. Check and see if the stains repeat after the test load is sterilized at the other facility. If they do, it could be:

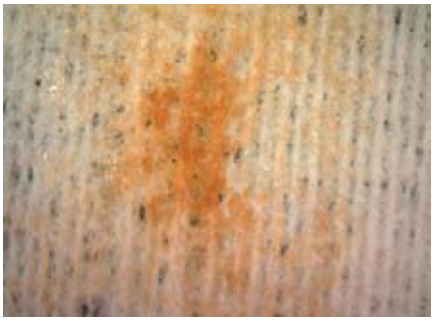
Stains caused by the rinse of the washer

AAMI ST-79 Section 7.5.4 "Rinsing" has this to say:

"Whether manual or mechanical cleaning has been performed, the device should be thoroughly rinsed to ensure that loosened debris and detergents are adequately removed. Tap water can be used for rinsing to ensure that copious volumes are used. However, the final rinse should be performed with treated water that is of a quality that does not contribute to staining or contamination of the instrument.

"Some automated washers can provide a final rinse with whatever grade of water is made available (e.g., deionized, distilled, or RO water). It should be recognized that deionized, distilled, or RO water might contain pyrogens, especially if the water treatment equipment is not properly maintained. Therefore, regular maintenance of the water treatment process is essential.

Rationale: The final rinse after cleaning is extremely important because any residuals after this stage will likely remain on the instrument and could therefore detrimentally affect disinfection and sterilization efficacy and/or cause adverse reactions in the patient that the instrument is subsequently used on. Tap water varies considerably, depending on the geographic location and season. However, it can still be used as part of the final rinse provided that the last water used in this final rinse stage is of adequate quality to ensure that there are no staining issues (i.e., use of treated water for the entire final rinse could be prohibitively costly, so users need guidance regarding rinse water options and when it is safe to use tap water)."



Stained disposable wrap

Note that the standard is calling for "treated" water. This does not mean softened. Softening only trades sodium for calcium and magnesium, and the same level of solids is in the water. Many facilities are able to get good final rinse without treated water, if the water source comes from rain, such as Chicago's, which comes from Lake Michigan. You may find that your water supplier switches between sources, i.e., if in dry summer conditions they switch from surface (rain) source to a well, which contains carbonates. The carbonates impact the steam system as well as final rinse (see article "Non-condensable Gases - Undesirable contaminants in your steam supply"[2]). Note the term deionized is often abbreviated as DI water, and used interchangeably with RO (which stands for reverse-osmosis). In either case, DI-RO systems need to have a monitor or test kit to be sure they are working. You need to find this equipment and be sure it is being used regularly.

If you suspect staining is being caused by the final instrument rinse, here are some troubleshooting steps:

1. Identify the most likely stained set.
2. Make up two test loads with those likely instruments.
3. Run one set through your washer-decontaminator and take the other set across town (or down the road) to another facility with a washer-decontam set-up close to that of your own facility. Have the set washed and rinsed there. While you are there, identify what type of water treatment is used on their final rinse. Bring the instruments back, and sterilize both sets in your equipment. If the stains repeat on both sets, it's probably:

*See **SELF-STUDY SERIES** on page 38*

Self-Study Test Answers: 1. B, 2. B, 3. A, 4. B, 5. B, 6. B, 7. A, 8. B, 9. B, 10. B

CONTINUING EDUCATION TEST DECEMBER 2013

Troubleshooting surface stains on instruments after steam sterilization

Circle the one correct answer:

1. **Steam is always the source of stained instruments.**
   A. True B. False
2. **Liquid water always stays in the steam boiler.**
   A. True B. False
3. **Steam boiler water can be high enough in solids concentration to foam.**
   A. True B. False
4. **Treatment chemicals are seldom used in the boiler system.**
   A. True B. False
5. **RO is a term for untreated contaminated water.**
   A. True B. False
6. **DI is an abbreviation for distilled water.**
   A. True B. False
7. **Textiles can be contaminated by not being well rinsed.**
   A. True B. False
8. **Demineralized water is always required for final instrument rinse.**
   A. True B. False
9. **Sterile processing departments function best on their own, especially when troubleshooting stains.**
   A. True B. False
10. **Facilities engineers and equipment vendors are of no use when troubleshooting stains.**
    A. True B. False

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Stains caused by the rinse of the textiles

AAMI ST-79 Section 8.3.5 "Textile packs" has this to say:

"Wrappers made of woven textiles are reusable. The barrier qualities of new textile wraps are diminished by repeated laundering and sterilization cycles. Before each use, textile wraps should be laundered, delinted, and inspected (over illuminated tables) for holes, worn spots, breaks in or separation of the fabric, and stains. …The number of uses of textiles that have a defined use life should be monitored. See also ANSI/AAMI ST65."

Stained textile

The same concern with final rinse water during the washing of textiles exists as for washing the instruments. Remember that every sterilization cycle that involves steam, creates a hot, wet, saturated condition during the middle of the cycle. Impurities can "wash out" during this wet condition, and drain by gravity to the bottom of whatever is being sterilized.

If you suspect staining is being caused by the final textile rinse, here are some troubleshooting steps:

1. Acquire either disposable or brand new (preferably white) textiles.
2. Identify the most likely stained set.
3. Make up two test loads, one with normal textiles (pre-inspect for stains!), one with the new or disposable textiles.
4. Sterilize as normal in two separate cycles, and compare.
5. You can also call the textile laundry, and see what other sterile processing departments they service. Give those folks a call and see if their experience is similar.

Conclusion

Troubleshooting instrument surface stains can be done by the process of elimination. There are three potential sources of post decontamination stains. They are the steam system, and the final rinse of both the instruments and textiles. Having a good relationship with a nearby sterile processing department using equipment similar to yours is very helpful in the troubleshooting process. It allows you to zero in on the suspected source of the stain so you can focus on more detailed investigations with your equipment vendors and facilities engineers. HPN

References

1. Association for the Advancement of Medical Instrumentation. Comprehensive guide to steam sterilization and sterility assurance in health care facilities. ANSI/AAMI ST79:2010 & A1:2010 & A2:2011 & A3:2012. Arlington, VA: AAMI, 2012. American National Standard

2. *Healthcare Purchasing News*. Self Study Series - Noncondensible gases: Undesirable contaminants in your steam supply. August 2007.

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