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Bacteria Control Troubleshooting Guide for Automated Watering Systems

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On rare occasions, we receive calls from facilities that may be experiencing problems with high bacteria levels in their automated watering systems. In trouble-shooting, we first ask questions to define the problem:

- *Where and how are samples taken?*
- *What was the water tested for?*
- *What is the bacterial quality of the supply water?*

We ask these questions to try to pinpoint the source of contamination. Is the bacteria level high in the supply water or in just one portion of the automated watering system? Knowing the source or extent of high bacterial contamination helps correct the problem.

What bacterial level is considered too high? There is no specific standard for laboratory animal drinking water, but many facilities have set their own limits for total bacteria counts. These counts can range from 500 cfu / mL to 1 cfu / mL (cfu=colony forming units). For more information about drinking water standards, read the Edstrom Industries document, "Standard for Animal Drinking Water Quality (MI4171)".

To improve the bacterial quality of drinking water in an automated watering system, we recommend regular flushing, elimination of dead-legs, periodic sanitization, and treatment of the supply water. This troubleshooting guide gives a more detailed checklist of design and maintenance practices, practices that can improve bacterial water quality. If you need further help in identifying the cause of bacterial quality problems in your automated watering system, contact Edstrom Industries at 800-558-5913.

Flushing

In an automated watering system, laboratory animals drink very little water and the water exchange rate is very low. This creates a condition where bacteria can grow and attach to the inside of pipe surfaces. By periodically flushing fresh water through the piping at a higher flow velocity, stagnant water is exchanged with fresh water and biofilm (the bacteria attached to inside pipe surfaces) is limited.

Flush frequency

A typical flush schedule is once or twice per day. Each facility should monitor its water quality to establish flushing frequency.

Flush length

The typical flush length is 2 minutes. When flushing at 15 psi, this will provide 2-3 water exchanges in a 100-foot length of room distribution piping. For longer piping runs, longer flushing times should be used.

Flush velocity

High-velocity, turbulent flow is most effective for limiting biofilm on pipe surfaces. The higher the water pressure, the higher the flow velocity. Pressure Reducing Stations from Edstrom Industries can provide up to 15-17 psi water pressure for flushing.

Flush consistency

Manual flushing systems are only effective when performed regularly and consistently. Automated systems ensure that flushing will be done the same way every time and without the associated personnel costs.

Pipe size

Oversized pipes make flushing procedures less effective because flushing velocities are lower. Replace oversized piping or consider treated water.

Manifold flushing

Just like room distribution flushing, on-line rack manifold flushing replaces the water in the mobile rack manifolds with fresh water. Automated systems ensure daily flushing at elevated flushing pressure and velocity. Manifold piping can also be flushed with special flush stations in the cage wash area.

Manifold configuration

Serpentine manifolds ("S" manifolds) make on-line flushing more effective. "Reverse S" manifolds accomplish this without air entrapment. "H" configuration manifolds can be updated to serpentine configurations to improve flushing effectiveness.

Recoil hose flush

Recoil hoses can be flushed on-line along with manifolds as part of an on-line flushing system or they can be flushed periodically with Recoil Hose Flush Stations in the cage wash area.

Eliminate Dead Legs

A deadleg is any area in a piping system where water can become stagnant and where water is not exchanged during flushing. Bacteria in dead-end pipe lengths and crevices are protected from flushing and sanitization procedures and can recontaminate the piping system. Modern piping design limits the length of any dead-end pipe to 6 times the pipe=s diameter (even shorter deadlegs are preferred). This is known as the six-diameter rule.

Dead-ended piping

If high bacteria counts are found in the pressure station supply water, look for deadlegs Aupstream@ in the building piping, such as piping to a seldom-used sink. If an animal room is not being used and is not being flushed, close the water supply to the room and drain the piping. Replumbing may be necessary to eliminate dead ended pipe runs.

PRS tubing

Pressure Reducing Stations made prior to 1988 have flexible tubing connections to the pressure gauge and pressure switch. Newer Pressure Reducing Station designs shorten these deadlegs by mounting the pressure gauge and switch directly to the flushed piping in the station.

Dual-pressure flushing

Automatic flush systems built after 1988 flush each pressure station at both 15 psi and 3 psi. Earlier systems, which only flushed at 15 psi, did not flush the low pressure regulator, so this became a stagnant pocket. The controllers for older flush systems can be updated to support dual-pressure flushing.

Regulator design

Since 1988, the "Total Water Exchange" design has been standard on all pressure regulators. A unique Flow Valve Diffuser was developed to create a high-velocity flow across the entire surface of the regulator diaphragm. With this improved design, water in the regulator is completely exchanged and bacterial growth is limited by the higher flushing velocity. Older regulators can be updated with a rebuild kit.

Detach recoil hoses

Unused recoil hoses left hanging from room piping are deadlegs. Upgrade to detachable hoses and remove them when not in use.

Interconnect design

Older CPVC automated watering systems used a T-J assembly for connecting recoil hoses to the room distribution piping. Newer automated watering systems use only a T fitting, which shortens the pipe length to the quick disconnect fitting. This shortens the deadleg to the unused interconnect points.

Minimize crevices

O-ring and threaded pipe connections are two examples of small crevices in a piping system that can harbor bacteria. The newest automated watering system designs use sanitary type pipe connections and smooth surfaces to minimize crevices.

Periodic Sanitization

Unless water contains a constant residual of disinfectant like chlorine, a biofilm will develop on wetted piping surfaces. Regular flushing will limit bacterial accumulation in an automated watering system, but no amount of flushing alone will totally eliminate biofilm. Periodic sanitization with a chemical biocide may be necessary to remove and destroy biofilm. Effective oxidizing biocides include chlorine, chlorine dioxide, and ozone. Since sanitizing chemicals are corrosive, contact Edstrom Industries for recommended concentrations and procedures.

Sanitizing manifolds

The manifold piping on mobile animal racks can be chlorine-sanitized following the wash cycle in the cage wash area using the Edstrom Industries Chlori-Flush Station. Sanitization frequency is typically once every 1-2 weeks (the same as the rack wash frequency).

Sanitizing hoses

Recoil hoses can be chlorine-sanitized in the cage wash area using the Edstrom Industries Chlorine Injector Station and Recoil Hoses Flush Station. Sanitization frequency is typically every 1-2 weeks.

Room piping

Automated watering systems should contain injection ports where a sanitizing solution can be introduced. These are typically located at the inlet to each pressure reducing station. The Edstrom Industries Portable Sanitizer is designed for injecting a chlorine or chlorine dioxide sanitizing solution into the room distribution piping. Usually, animal racks are disconnected from the room piping during sanitization. While monthly sanitization is typical, the frequency for your particular system will depend on its design, the frequency of flushes and filter changes, the supply water quality, and your goals for bacterial quality.

Water Quality and Treatment

The quality of the incoming water supply will affect the bacterial quality in an automated watering system.

Change filters

Filter cartridges offer a lot of surface area for biofilm attachment and growth. They should be replaced at least every 30 days.

Residual chlorine

Is there any residual chlorine measured in the automated watering system? A low level of chlorine in the supply water will help to maintain low bacteria counts, especially when the system is flushed regularly. The Edstrom Industries Central Proportioner can be used to inject chlorine if tap water chlorine has dissipated.

Acidification

As an alternative to chlorination, the water supply can be acidified to pH 2.5 – 3, which will kill gram-negative bacteria (such as Pseudomonas aeruginosa) commonly found in water. Note that some yeasts, molds, and filamentous bacteria (actinomycetes) can multiply in acidic conditions.

Ultraviolet irradiation

UV radiation kills bacteria and virus in water flowing through the unit. It does not alter water chemically and the killed microorganisms are not removed from the water. UV is most effective for treating high-clarity purified RO or distilled water. UV units only kill bacteria at one point in a watering system and do not provide any residual germicidal effect downstream. You will still need to use flushing and sanitization to control bacterial regrowth downstream of the UV unit.

Submicron filtration

Reverse osmosis water purification and 0.2-micron filters will remove bacteria from the incoming water supply. You will still need to use flushing and sanitization to control bacterial regrowth downstream of the filter.

Water purification

Reverse osmosis treatment removes most inorganic and organic chemical contaminants from the supply water. RO produces purified, nutrient-poor water that supports less bacteria than tap water. NOTE: Deionized (DI) water treatment removes only dissolved ionized chemicals, not organic chemicals, bacteria, or other microorganisms. Bacteria can grow on the nutrient-rich surfaces of DI resin and add bacteria to drinking water.

Reference

Dreeszen, P.H., *Biofilms: Key to understanding and controlling bacterial growth in Automated Drinking Water Systems*, Edstrom Industries Inc. Technical Report (January 1997)