

MILKING SYSTEM CLEANING AND SANITIZING: TROUBLESHOOTING MILK BACTERIA COUNTS

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The United States Public Health Service (USPHS) regulates the production and processing of raw milk. The requirement of milking system cleaning and sanitizing are documented in the Grade "A" Pasteurized Milk Ordinance (PMO). This document reflects the input of many sectors of the dairy industry. The requirements are designed to safeguard the milk supply so that consumers have access to milk and milk products that are safe and represent no human health or quality concerns.

Milking equipment use may range from 1-2 hours/milking on smaller dairies, to nearly around the clock use on very large dairies. Regardless of the use pattern, the equipment has to be cleaned and sanitized on a regular basis. Why, what is a regular basis and how?

The PMO states that after each milking the system shall be cleaned thoroughly and, immediately before the next use, the system shall be sanitized with an appropriate chemical sanitizer. A list of approved sanitizing compounds is included in the PMO. Chlorine and iodine solutions are the most commonly used of the approved sanitizers. The PMO does not describe what products are to be used for cleaning the system or how the system is to be cleaned. That is the responsibility of the owner with assistance from equipment and chemical suppliers.

Apart from regulatory requirements for cleaning and sanitizing milking equipment there is the basic issue of milk films, soil buildup and bacteria problems which occur if system cleaning and sanitizing is not done regularly and properly. These materials provide opportunities for unwanted bacterial growth and can result in regulatory, product quality and monetary issues for dairymen.

The PMO establishes a legal maximum number of bacteria in farm produced raw milk (100,000/ml); processors on the other hand expect their producers to achieve much lower bacteria counts. Monetary incentives in the form of bonuses are frequently associated with attaining these standards.

Based on these factors, programs must be in place that effectively clean and sanitize milking systems, comply with the PMO requirements, meet local requirements and enable dairy producers to qualify for any bonus payments associated with high quality raw milk.

Raw Milk Bacteria Counts

The number of bacteria present in the raw milk sample taken from the farm bulk tank represents contributions from several sources including:

1. Cows with mastitis but whose milk appears acceptable and is put into the tank.

2. Bacteria associated with soil and manure on the teats that is not thoroughly removed prior to unit attachment.
3. Bacteria sucked into the system when units fall off or are rinsed off with water that contains a high bacteria count.
4. Bacteria that accumulate and grow in various locations in the milking system during milking and between milkings and end up being transferred to the bulk tank.
5. Bacteria that grow in bulk tank milk even when well cooled.

Problems in any of these areas can influence bacteria counts. The objective of cleaning and sanitizing milking systems is to eliminate milk soils that may build up and provide opportunities for bacterial growth. Doing so minimizes system cleanliness as a risk factor contributing to high bacteria counts.

Milk Film Characteristics

Whole milk contains protein, fat, lactose sugar and small amounts of various minerals, all of which are dissolved or suspended in water. Milk adheres strongly to milking equipment surfaces if allowed to dry and such films can be difficult to remove. Understanding the characteristics of milk films is important when it comes to cleaning milking and cooling equipment surfaces.

Step 1-Rinsing Milking Equipment Surfaces

When milking is complete and all the milk has been pumped over to the cooling tank, the remaining milk in contact with equipment surfaces is still in a liquid form. It can be easily removed by rinsing all system components with appropriate amounts of warm water (100-110 degrees F) and dumping it down the drain after one pass through the system. The mechanical action of rinsing removes most of the milk residue from surfaces and carries it away. Remaining milk residues must be removed using appropriate cleaning compounds in hot water with proper physical cleaning action.

Step 2-Removing Raw Milk Film Components-Milk Fat

Milk contains 3.2-5% milk fat depending primarily on the breed and diet of the cow. Milk fat is a liquid above 100 degrees F but below this temperature it tends to solidify and form a film on surfaces. It is not soluble in plain, cold water but in hot water it will melt and form a liquid layer. Proper temperature is an important consideration when cleaning milk fat residues from milking equipment surfaces.

Milk fat residue in milk films is removed by contact with hot, concentrated chlorinated alkaline solutions. In most milking systems, vacuum is used to pull the hot cleaning solution from the wash vat through the system. Small diameter hoses etc. are flooded with cleaning solutions moving through at relatively high speeds and this provides a physical scouring action. The combination of chemical and physical cleaning action helps remove milk residues from these components.

In large diameter milk pipelines (3-4 inches) cleaning is done differently. Generally, cleaning solutions are pulled into the pipeline by vacuum until partially full. Then, by admitting timed bursts of air into the lines solid slugs of cleaning solution are repeatedly formed and pushed through the line into the receiver at a high rate of speed (20-30 feet/sec). The slug provides scouring action in the large pipeline and the chemical solution provides chemical cleaning. The cleaning solution is re-

circulated for 8-10 minutes and then dumped down the drain. Wash solution starting temperatures should be approximately 165 degrees F and the final temperature, before dumping, should be 105-110 degrees F. Lower than this and the milk fat may start to redeposit on components.

The alkali in the cleaner specifically reacts with milk fat breaking it down into components that are suspended in the cleaning solution and dumped down the drain. This chemical action of alkali on milk fat is termed saponification and it is the backbone of milking system chemical cleaning programs.

The alkaline components are typically combined with surfactants, water hardness suspending agents and chlorine to produce a chlorinated alkaline cleaner. The surfactants assist the cleaning solution to penetrate and remove soils and milk film components from equipment surfaces. Water hardness control agents (phosphates and chelating compounds) keep minerals and soils in solution and prevent their re-deposition.

Milk Proteins

Raw milk contains approximately 3.2% protein. Chlorinated alkaline products are also used to remove protein. The chlorine component helps break proteins into smaller pieces, which can then be suspended in the wash solution and rinsed out. It is critical that residual milk is not allowed to dry or become cooked on by rinsing with hot water before it is cleaned. When this occurs the protein denatures or coagulates and sticks to surfaces with such force that it becomes very difficult to remove.

CAUTION! Chlorinated alkaline cleaners are based on the use of either sodium hydroxide (caustic soda) or potassium hydroxide (caustic potash) plus a chlorine component. Such materials are very aggressive if allowed to contact skin, eyes or mucous membranes. Treat them with caution and use all necessary safety precautions described on product labels. Never allow them to be mixed with acids because of the release of harmful chlorine gas. Accidental contact with these compounds can produce serious injury.

Acid Rinsing

After cleaning the system with hot chlorinated alkaline solutions, alkali residues are left along with some of the minerals that may be in the water. These need to be removed or neutralized to prevent film buildups. Removal is done by rinsing the system with an acid solution, which accomplishes three functions. It neutralizes alkali residues, solubilizes mineral deposits so they can be rinsed out and leaves an acid film on equipment surfaces, which helps suppress bacteria growth. Such products are not however considered sanitizers based on the EPA definition of sanitizers and are not labeled as such.

Phosphoric acid solutions are widely used for acid rinses. Nitric or sulfuric acids are also used, generally in a blend with phosphoric acid and are termed blended acids.

Once these three procedures are completed; rinsing, washing with a hot chloralkali solution and acid rinsing, the system should be clean. The interval between end of washing and the next milking may be several hours or only a few minutes. The PMO requires that just prior to each milking the

system shall be sanitized. This is done to eliminate bacteria that may grow on equipment surfaces between milkings even when well cleaned and acid rinsed. Flushing an EPA registered sanitizer through the system, so that all milk contact surfaces are contacted, minimizes bacteria counts at start up. Sanitizers are allowed to be used without a follow-up water rinse. Typically chlorine or iodine sanitizers are used.

Alternatives to acid rinse products are acid sanitizers. These are based on organic acids that provide acid for removing mineral deposits and they are also classified by EPA as sanitizing agents. They allow both steps to be accomplished in one operation.

The main task is effectively cleaning and sanitizing milking equipment at appropriate intervals so that raw milk bacteria counts are acceptable and meet whatever bonus standards may be in place. Cleaning programs must also be cost effective, non-damaging to system components and non-threatening to the environment within the framework of current and/or future regulations.

Future Farms

More dairy farms in the future will milk hundreds or thousands of cows daily so it will be critical that the cleaning systems are capable of cleaning these large facilities in the short intervals available between milkings. On some dairy farms robotic milking systems will be in use in the future. Even though they will milk cows automatically they will also have to be cleaned thoroughly and automatically after each cow has been milked. This will pose challenges because of the unpredictable pattern of use by the cows.

Trouble Shooting Cleaning Problems

Cleaning problems may occur on any farm. The end result often is an elevated bacteria count. Some of the problems are relatively easy to locate and remedy while others require more effort.

Did the water heater quit or partially fail? Is the water flow rate into the sink or cleaning vat adequate to minimize filling time and reduce heat loss? Sufficient hot water is critical for system cleaning and without it problems will arise. Checking the hot water supply for adequate temperature and volume is usually an early step in trouble shooting. Checking it with an accurately calibrated thermometer is the simplest way to determine the actual cleaning solution temperature.

Water hardness can vary a good deal and can limit cleaner effectiveness. Water hardness chemicals can link with cleaning chemicals and reduce their effectiveness. A water hardness evaluation is always a necessary first step in determining the proper cleaner to use and in what concentrations. The main water hardness chemicals are salts of calcium and magnesium. They can accumulate in water heating equipment and reduce the capacity to below adequate. Buildups in water pipes can restrict the flow of hot water to cleaning tanks or sinks. High levels of these minerals may leave dull gray films on cleaned surfaces. They are removed by treating with acid products.

Water borne minerals can combine with milk components to form a buildup of material called milkstone. This can build up in successive layers and form a tough deposit that provides a good location for bacteria to grow and possibly cause problems. Milkstone can be removed by repeated cleaning with alternating caustic and acid solutions.

Fat deposits or combinations of fat and other materials may accumulate in locations where cleaning action is insufficient. Frequently a hot, double-strength solution of alkaline cleaner is used to “shock” the system and remove the material. Eventually however changes have to be made to prevent this from re-occurring.

Cleaning solution distribution throughout the system must provide adequate volume to components and be properly distributed so that all surfaces are thoroughly contacted. In large diameter pipes, such as the milk line, mechanical cleaning action is primarily controlled by the air injector. It is an air inlet valve that can be adjusted several ways to control how much air enters each time it opens, how long each opening is and how frequently each opening occurs and the interval between openings. It must be adjusted to open when enough solution has filled the pipeline so that it pushes the solution into a slug that completely fills the diameter of the pipe. Once a slug is formed it then needs to be forced intact through the milk line at about 20-30 feet/second and into the receiver group. Solution slugs need to be formed repeatedly during washing. This is critical in large diameter pipelines so that the upper portion is completely cleaned.

Milk meters and takeoff sensors often are tough to clean because of the resistance to fluid flow through them as well as numerous small components that are tough to reach. Water distribution to these components must be adequate and properly balanced or else certain units may be starved of cleaning solutions and become dirty as they develop buildups.

Other Problems

In addition to these issues other cleaning problems are often less obvious. Worn rubber tubing and short milk tubes develop cracks in the surface that hold milk residues, which promote bacterial growth. Once in this condition they cannot be properly cleaned or sanitized. Tubing, liners, gaskets should be inspected regularly and changed when they appear worn.

Bacteria that attach to milk deposits in these cracks and crevices have the ability to firmly anchor themselves in place. Over time, bacterial film buildup can become significant and they are then very tough to remove. A smooth surface, well cleaned and sanitized is the best way of limiting bacterial bio-film problems.

Check for split liners. When this occurs, milk can pass into the pulsation chamber and create problems. It can also be sucked up the pulsation hose into the header tank and occasionally this will have some drainage back to the trap near the receiver.

Long milking times can lead to bacterial growth and buildup in milk filters. The warm conditions and fresh milk promote rapid bacterial growth and this can cause problems. Changing filters every 4 hours will help reduce this problem.

Look closely at large receiver vessels that may have milk levels that occasionally rise high up on the walls producing a milk film that remains for hours before it is cleaned. This can promote bacterial growth. Make certain with large capacity receivers that during operation the maximum height of the liquid level is consistent.

Cleaning Problems And Bacteria Count Issues

The result of ineffective cleaning often is bacteria count problems. A typical well-cleaned and sanitized system should be able to produce milk with less than 10,000 bacteria/ml. When the count is greater cleanliness of the system needs to be inspected.

Soiled and dirty milking systems provide food and shelter for bacteria. The milk films protect the bacteria from cleaning and sanitizing solutions allowing them to build in numbers. It may not happen immediately but in time the number of bacteria present will increase if system cleaning is not effective.

A major increase in the standard plate count may be first indication of problems simply because that is the most commonly used test. It measures bacteria that grow in warm conditions in a 48-hour period. If a system is dirty it will allow more bacteria to grow and end up in the bulk milk. This means the starting number of bacteria for the SPC test is increased so the final count will be higher as well.

The PI count is another measure of bacteria in raw milk and is an attempt to identify the presence of bacteria that may grow preferentially in cold milk.

Another test sometimes used for evaluating milking system cleanliness is the Lab Pasteurized Count or LPC. It only measures bacteria that survive pasteurization conditions. This excludes mastitis causing bacteria and most of the normal soil organisms. There are certain soil bacteria however that can survive in the system and cause problems later on. These are frequently associated with a dirty system.

Finally don't forget the bulk tank. It represents a very large surface area that can be difficult to clean. Typically the cleaning system for tanks involves a spray ball(s), which distributes rinse water and cleaning solutions to all areas of the interior surface when working properly. The same basic program and chemicals are used as are used to clean and sanitize the pipeline and milking equipment.

Typical problems include failure of the spray ball system. They may become partially plugged and fail to apply cleaners to all interior surfaces. Mixing paddles may not be well cleaned and outlet valves can occasionally be a problem. Lack of hot water, failure to provide adequate strength cleaning solutions can be issues. Mineral buildup in certain areas can be an issue that can lead to surface films such as protein films and these can hold milk soils and promote bacterial growth.

All system-cleaning programs rely heavily on time, temperature, chemicals at the proper concentration and physical cleaning action. Problems usually can be traced back to deficiencies in one or more of these areas. Taking time routinely to make certain these are acceptable is the best way to eliminate cleaning issues that may contribute to bacteria problems in raw milk.