

Milk quality – A look outside the cow

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Abstract

Milking system cleaning is an extremely important aspect of modern dairying. Many veterinarians are not involved in milk-quality programs, particularly those involving system cleaning. Veterinarians have the basic observational skills to make a difference on dairies by simply being in the parlor during wash-up and observing the process. Several simple basic tests can be performed when counts are elevated to determine the issues on the dairy. Veterinarians should be monitoring milk-quality records to bring added value to their producers by improving the overall quality of milk shipped from the dairies with which they work on a regular basis.

Key words: dairy, milk quality, system cleaning, SPC, LPC, coliform

Résumé

Le nettoyage du système de traite est une facette extrêmement importante de la production laitière de nos jours. Bien des vétérinaires ne sont pas impliqués dans les programmes de qualité du lait surtout au niveau du nettoyage du système de traite. Les vétérinaires ont un sens de l'observation naturel et peuvent faire une différence dans les fermes laitières par le simple fait d'être présent dans les salles de traite durant le nettoyage et d'observer le processus. Plusieurs analyses de base peuvent être faites lorsque les comptages sont élevés afin d'identifier les problèmes de la ferme laitière. Les vétérinaires devraient surveiller les relevés de qualité du lait pour apporter une valeur ajoutée aux producteurs en améliorant la qualité du lait expédié des fermes laitières pour lesquelles ils travaillent sur une base régulière.

Introduction

Traditionally veterinarians have focused on clinical rates of mastitis and the somatic cell count of shipped bulk-tank milk as the prime indicators of a dairy's milk-quality program. Few veterinarians are involved with their client's bacterial counts in shipped milk, which adds another area where practitioners can bring value to their dairy clients. Analysis of the dairy's milk-quality reports, including Dairy Herd Improvement (DHI) somatic cell count records, if available, on a regular basis along with simple observations of the washing cycle

while making some basic measurements will contribute to improved milk quality in shipped milk.

Bacterial tests performed on milk will vary somewhat depending on geographical location within the United States. However, all farms are required to submit samples on a periodic basis for regulatory compliance. When investigating milk-quality bacterial issues, the following tests offer the most value:

- Standard Plate Count (SPC). The SPC is the number of colony-forming units in 1 mL of milk that is plated and incubated for 48 hours at 90°F (32°C). Many dairies routinely maintain SPCs of 1000 or less, and counts under 5000 should be easily maintained when teats are appropriately cleaned and milk is cooled quickly. Many milk processes have implemented penalty levels at 50,000/mL. The legal limit in the US is 100,000/mL.
- Lab Pasteurized Count (LPC). This test shows the number of bacteria present per milliliter after laboratory pasteurization at 143°F (62.8°C) for 30 minutes. An SPC analysis is then run on the pasteurized sample to arrive at the LPC level. Bacteria that commonly come from the mammary gland are removed, leaving bacteria which may come from the environment or from incubation in the milking system. There is some discussion about significant levels, but an LPC above 200 is a clear indication of a system that is improperly cleaned. Some dairies have maintained LPC counts below 50 on a year-to-year basis.
- Coliform (coli). Coliform counts are run on specific media. Results will depend on cleanliness of the cows, and will be highly elevated if incubation is occurring during milking. Generally, counts below 100 per mL are considered acceptable. Very good herds can have counts less than 10/mL. Coliform counts between 100 and 1000 per mL generally indicate poor milking hygiene. Counts above 1000/mL indicate incubation is occurring in the milking equipment, and is an indicator of overall poor system cleaning.

Bacterial counts in raw milk are becoming more important. A significant amount of US dairy production is currently being exported, approximately 16% in 2013. Several new whole-milk powder plants have either been built or are under construction, which will be focusing

on the export market. Some countries, such as China, are now testing powdered milk supplies to determine the presence of spore-forming bacteria and are rejecting some shipments. Another compounding issue is the tendency of dairies to only wash systems twice daily rather than 3 times a day to increase dairy capacity. As the soil load increases on the milking equipment and the time between wash cycles increases, the likelihood of higher bacterial counts typically increases.

Strategic Milk Sampling

The best way to determine the source of bacterial contamination is to sample milk at several locations in the milk system and the bulk tank during the same milking. It is best to start with an empty bulk tank and sample the receiver jar (after 2 to 3 sides of cows have been milked) by closing a gate valve above the moisture trap, bleeding air into the system, and then removing the receiver cover to sample milk in the receiver jar with a sterile syringe. Additional receiver jar sampling should be done at the midpoint of milking, and just before milking is completed. The second area to sample would be at the exit of the plate cooler. A sample can be obtained by inserting a needle through a tri-clover gasket and adjusting the sample flow tube so some milk is placed into a sterile plastic bag each time the transfer pump is activated. The sample bag should be placed in a cooler containing ice to limit bacterial multiplication during the sampling. The bulk tank is then sampled after milking to allow comparison of the results from all 3 strategic sites.

The Normal Cleaning Cycle

The major components of milk are water, lactose, butterfat, protein, and minerals. Lactose is soluble in warm water, and is one of the primary reasons for rinsing a system as the first step of washing with a warm-water rinse of between 100 and 140°F (37.7 to 60°C). The first rinse cycle should never be recirculated, and should be dumped on its return to the wash vat or sink. Butterfat is soluble in alkaline detergent, and protein is soluble in a chlorine solution. In most conventional wash systems both butterfat and protein are removed with the normal chlorinated alkali wash or soap cycle. The chlorinated alkali cleaner should start with a temperature of 160°F (71.1°C) and should be dropped from the system at 120° (48.8°C). The wash cycle should last a minimum of 5 minutes for adequate cleaning. The third step in conventional wash systems is an acid rinse to remove salt and minerals. The acid rinse cycle temperature is determined for the product recommendation of the chemical company. Acid rinse cycles typically are set for 3 minutes, but some systems

are designed so the solution is only 1 surround and then dumped. All parts of the milking system, including the non-sanitary side, should drain completely between each of the normal wash cycles.

Movement of the cleaning solutions through the pipeline and the milking equipment is controlled by an air injector designed to slug the milk line to create turbulence and the amount of time the air injector is closed, which allows cleaning solutions to be drawn into the system through any of the components of the normal milk path. These would include the liners, claws, milk hoses, milk meters, milk flow sensors, and any other device in the milk path. Turbulence is generated by admitting air into the system to cause a wash solution slug to form and move completely around the milk pipeline. To calculate the open phase of the air injector, first measure the distance from the air injector to the milk line, and then around the milk line to the receiver jar. The goal is to have a slug move between 23 to 33 ft per second. Dividing the total distance from the air injector to the receiver by 25 will give a rough calculation of the open phase necessary for an adequate slug to form in the pipeline.

Observations Before or After System Cleaning

Many observations can only be carried out when the system is not milking or washing. Always begin an investigation by drawing a diagram of the system including the most important components, such as location of the air injector, diverter valves, wash lines, receivers, and milk lines. Check the insides of units, milk meters, and any other plastic components of the system to determine if there are buildups or improper cleaning. Remove the receiver jar lids and use a flashlight to examine the interior. A small digital camera or cell phone camera can be used to photograph the milk lines where they enter the receiver jar; always try to look at the diverter valve from the inside of the receiver to determine its cleanliness. Many wash lines are dead-ended and these should be examined, especially if there is not an inlet within several feet of the end of the line.

Remove moisture trap lids and examine the inside of the moisture trap, the diverter ball, and then run your fingers as far as possible into the main supply line to the moisture trap. All of these areas should be clean and have a squeaky feel when rubbed with the hand. If possible, examine the inside of any distribution tank or tanks along with the interior of any filters located close to vacuum pumps. Remove clean-out plugs on pulsator lines to allow inspection of the lines. Inspect all drains in receiver jars, moisture traps, pulsation lines, distribution tanks, and filter tanks to be sure they are functional and performing properly. It is common to find significant buildups in the non-sanitary side of the

system, which can result in bacterial contamination, in particular in systems that have some down time from the end of wash to the beginning of the next milking. If this is occurring on a dairy, the first samples taken in the receiver jar early in the milking during strategic sampling may have the highest bacterial levels.

Inspect the interior of the wash-line hoses, jetter cups, and duckbills to assess the overall quality of these critical rubber goods. Worn or torn jetter cups frequently result in significant air admission over and above the air injector, which will cause diminished turbulence in the milk line and result in improper cleaning. When systems are set up properly, they will contain flow restrictors at most, if not all, units in the parlor. Check to be sure they are present and whether they are properly sized. If no meters are present in the parlor, the typical opening will be 3/16 inch. When meters are present, the typical opening will be ¼ inch. These will supply 0.8 gallon or 1.5 gallons per minute of flow through the units.

Observations During System Cleaning

Several observations should be made during system cleaning:

- Record the open and closed times of the air injector.
- Evaluate the slug action in the receiver jar. Is there enough velocity to send some water into the moisture trap during washing? Does the moisture trap have 2 to 4 inches (5.08 to 10.16 cm) of cleaning solution in it at the conclusion of each wash cycle?
- Does the receiver jar completely drain between each cycle?
- Are all valves properly aligned for the wash cycle?
- Are filter socks used during all wash cycles, especially in systems utilizing plate coolers or chillers? Are milk-harvest technicians careful when removing filters at the end of milking to minimize contaminants getting to plate coolers or chillers? Are the technicians carefully rinsing out the filter chambers prior to installing a clean filter for wash?
- Observe all units in the parlor to ensure there is water flow and turbulence in the claw from either liner vents or claw vents. Some systems have been installed with vented mouthpiece liners with no vents into the claw. These systems will not have adequate agitation in the claw without an additional vent being supplied typically at the jetter cup assembly or washed tray.
- The system should not trap out during normal washing.

- Observe the sink or wash vat when transfer pumps are moving water back to the vat or sink. Does the water level increase when the transfer pump is operating? If not, then the system will eventually trap out.
- Signs of improper air injector settings:
 - Milk pump never shuts off.
 - Large amounts of water drain from distribution and filter tanks after each cycle.
 - System traps out.
 - Do the main wash lines suck air?

Other Testing Procedures

Monitor and record the water temperature available in the milk house and at the start and end of each cycle. A critical mistake made on many dairies is that as the parlor size was expanded the hot water supply was not increased.

All dairies should have a digital vacuum gauge that is not attached to the milking system unless a reading is being made. A nipple can be installed above the moisture trap so that on a daily basis the vacuum level can be measured during the wash cycle when the air injector is not open. If the vacuum level changes on the system, then further evaluation should be made to determine why the vacuum has dropped. The most common issue is that jetter cups are not firmly seated on all teat cup assemblies in a parlor. Other common causes are loose hoses, hoses off either units or jetter cup assemblies, or vacuum-sensing issues on the system such as a dirty regulator or sensor for a variable speed drive (VSD).

Regular evaluation of the chemical levels in the wash cycles should be made using a measuring container to accurately determine the amount of chemical placed in the wash vat or sink for each cycle. One of the most neglected pieces of equipment on many dairies is the tubing used in peristaltic pumps to deliver chemicals. As the tubing ages, the volume of chemical delivered will change and can result in either under- or over-use of chemicals, which can impact the life of rubber goods in the case of too-high concentration of chemicals or inadequate cleaning with lower levels than needed. Use 1 to 14 pH paper strips to test the chlorinated alkali wash cycle, which should have a pH of 11+, and the acid rinse cycle, which should have a pH of 3.

If significant issues are observed on the dairy during system washing, then a qualified service person with appropriate testing equipment should perform a full wash-flow evaluation. This will include slug analysis and monitoring water flow through individual units. During this evaluation, slug velocity and vacuum drop will be calculated. The following table shows recommended vacuum drop during slug formation at the first inlet being tested.

Milkline diameter	Vacuum drop inches	Vacuum drop kPa
2.5" (60 mm)	4.4 to 9.5	15 to 32
3" (73 mm)	4 to 8.6	13 to 28
4" (98 mm)	3.2 to 7.1	11 to 24

Conclusion

Basic observations and testing of milk system wash cycles can bring added value to dairy producers. Veterinarians should be obtaining milk-quality records

from their client's milk plants on a regular basis and analyzing this data as a second set of eyes for their producers. Milk-quality programs will be implemented on your dairies. Will you be a part of the team or sit on the sidelines? Milk-quality work can be both fun and profitable for the veterinarian, and better milk quality will always benefit your clients.