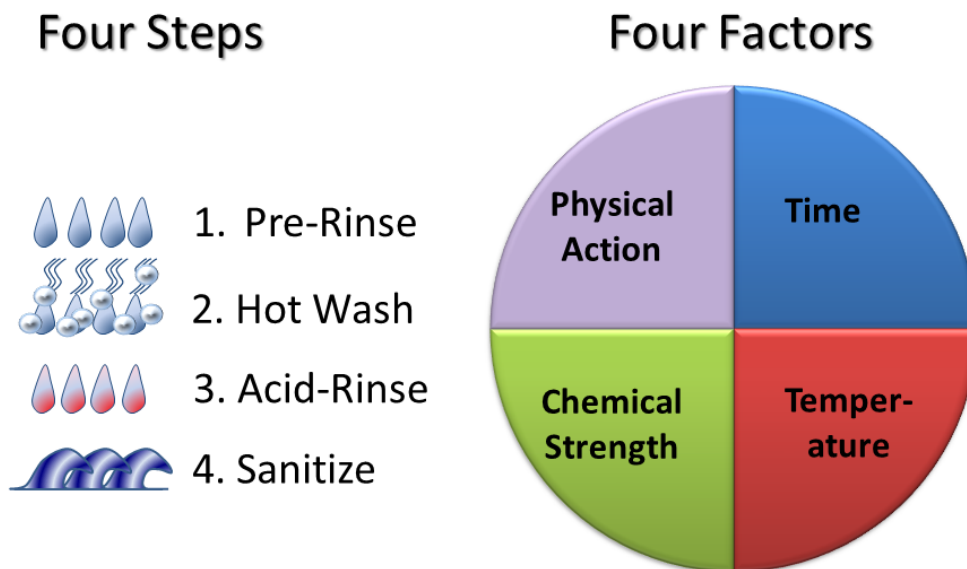


SECTION IV-2 THE BASICS OF CLEANING MILKING EQUIPMENT

2. THE BASICS OF CLEANING MILKING EQUIPMENT

In order to provide high quality milk to the market place, a pipeline milking system must clean up perfectly after each milking. The four basics of cleaning are **Time**, **Temperature**, **Chemical Concentration** and **Physical Action**. These factors are important in each cycle of a clean in place (CIP) system (Fig. 12).

Fig. 12. **SANITATION 4X4**. The key steps and factors involved in the cleaning process for hand-milking, bucket-milking or pipeline milking are basically the same.



2.1 STEP 1 – RINSING MILKING EQUIPMENT SURFACES

Milking equipment should be rinsed and washed immediately after milking to avoid milk residues from drying on equipment. If not cleaned promptly, these residues will be very difficult to remove later.

2.1.1 PURPOSE

This step removes 90-95% of milk solids. The high solids content of sheep milk make this step particularly important. It also removes residual milk and dirt and serves to warm up the milk line for Step 2.

2.1.2 TEMPERATURE RANGE

Water temperature should start at 43 °C to 49 °C (110 °F to 120 °F). If water temperature becomes too cool, i.e. drops below 38 °C (100 °F) milk fat will solidify back onto the milk line. The temperature can also be too hot. A rinse temperature above 60 °C (140 °F) may bake on milk protein.



2.1.3 MANAGEMENT TIPS

The first rinse should be an open cycle and not recirculate, i.e. open to the drain so only fresh water is used (Fig. 13). Otherwise a milk film may be redeposited in the system. Use of a pre rinse divert valve will eliminate recirculation of milk soil and reduce the load that must be removed during wash cycle.

To reduce the amount of milk in waste disposal systems, some producers save the first-rinse water-milk mixture and feed it to livestock. Note, it is not suitable to feed this water-milk mixture as a substitute for milk or milk replacer to nursing-age animals as the milk doesn't contain enough nutrients.

Fig. 13. First rinse should be discarded
Source: <http://www.progressivedairy.com/>



2.2 STEP 2 – HOT CHLORINATED ALKALINE DETERGENT WASH

2.2.1 PURPOSE

This cycle removes fat, protein and other organic materials including large number of bacteria.

WHY HOT WATER?

Dairy detergents require hot water to work effectively.

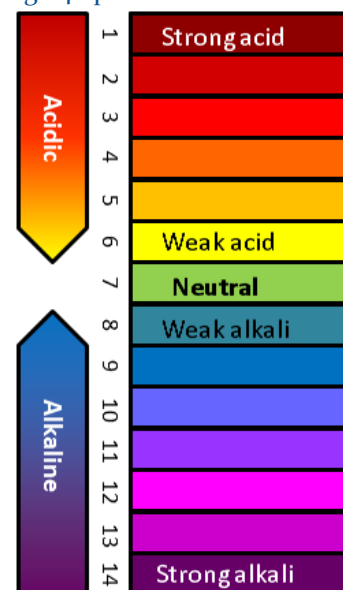
WHY A HIGH PH?

The alkali in the cleaner reacts with milk fat breaking it down and suspending it in the cleaning solution. The chlorine chemical breaks up the milk proteins which are then also suspended in the wash solution. See Fig. 14 for range of pH numbers.

WHY DAIRY DETERGENTS?

Dairy detergents contain sequestering agents or chelating agents which tie up hard water minerals such as calcium and magnesium. Chelating agents prevent minerals from precipitating out of solution and forming films on the milk contact surfaces (milk stone). Dairy detergents also contain surfactants which decrease the surface tension of the solution and assist in penetrating the milk soils. Use only approved dairy cleaners. Non-dairy cleaners are less effective and over time will lead to the development of films and residues, which leads to high bacterial counts in the milk.

Fig. 14. pH scale.



2.2.2 TEMPERATURE RANGE

Start temperature should be 74 °C (165 °F). Water temperature at the end of the cycle must be **absolutely no less than 49 °C (120 °F)** (Fig. 15). Circulation time is usually 6 – 10 min. Adequate end temperature is more important than precise wash solution contact time.

2.2.3 MANAGEMENT TIPS

WATER QUALITY

The wash solution is mostly water - 99% or higher. The amount of detergent used depends on volume of water and water hardness. Hard water can reduce the effectiveness of dairy cleaning products. A water softener is recommended for hardness over 20 grains.

Most labels will specify amounts to use per quantity of water, according grains of water hardness. Your chemical supplier should provide a wash procedure chart, which reflects the types and amounts of cleaners required for each cycle. Follow the recommendations!

ALKALINITY OF THE CLEANING SOLUTION

The pH of the caustic cleaning solution should be between 12 and 13 (Fig. 14). Handle using gloves and goggles to reduce risk from splashing. The active alkalinity needs to be in the 600 - 900 ppm range, in the higher range for bulk tank and milk meter cleaning.

INVESTIGATE WATER TEMPERATURE IF CLEANING AND BACTERIAL PROBLEMS

The water heater needs to be adequately sized for your requirements. The actual amount of hot water available from a tank is about 70% of its capacity. So a 40 gallon tank only provides (40 X 0.7) 28 gallons of hot water!

Using hot water for other uses e.g. mixing milk replacer, can reduce the availability of hot water for pipeline washing. Recovery rates will vary depending on your specific heater. The time between a pipeline wash and a bulk tank wash needs to be long enough to allow the water heater to recover.

Water heater problems can go undetected for a long time if you do not monitor wash temperatures. Calcium and magnesium salts can accumulate in water heaters and reduce heating capacity to below adequate. A burnt out bottom element is a frequent problem. Buildup of mineral in water pipes and screens can restrict the flow of water to the wash control box causing improper temperatures at the wash sink.

Unplanned admissions of air into the milking system cools wash water very rapidly and may cause poor slugging. Maintain water level in wash sink so that suction lines never draw air (Fig. 17). The pipeline must be free of air leaks at joints and milk inlets.

Fig. 15. Hot enough at the end of the cycle?



Fig. 16. Hot water tank in good repair



PHYSICAL ACTION / SLUGGING OF CLEANING SOLUTION

Most modern pipeline systems rely on slugs of cleaning solution to provide scrubbing action. If your system has an air injector, proper adjustment is essential.

Keep filters clean; a blocked air injector results in a poor slug. The air injector open time determines slug travel distance. The open time should be just long enough to cause the slug to travel to the receiver jar before it breaks up. The air injector closed time determines the amount of water drawn in and initial slug length.

- Slug volume should be about $\frac{1}{3}$ rd the volume of the receiver.
- Slug velocity needs to be 7-10 m/sec (23 to 33 ft per sec).
- Minimum of 15 slugs per wash.

The following indicates there may be an issue with air injector location or timing:

- The water level in the receiver does not change during the cleaning cycle
- The milk pump never shuts off during the cleaning cycle
- The system “traps out” (the ball valve in the sanitary trap shuts off system vacuum during one or more wash cycles)
- A large volume of water drains from the distribution tank when the vacuum pump is shut off after cleaning
- Air is drawn into the system at the wash sink.

Douglas J. Reinemann Trouble Shooting High Bacteria Counts in Farm Milk 1997

Automatic wash bulk tanks are more difficult to clean because the spray may only hit a small surface area. Cleaning is achieved by a sheeting action. The entire surface of the tank needs contact with the cleaning chemicals. You may need to manually clean your tank to be sure all surfaces are adequately scrubbed (Fig. 19).

DRAINAGE IS IMPORTANT

Wash temperatures as well as chemical concentrations can be adversely affected by residual water from previous cycles. All secondary drains, especially from the receiver must be large enough to drain completely before the next cycle. All milk lines and wash lines need adequate and continuous slope to allow for complete drainage between cycles. Inadequate drainage in the system results in mixing / neutralizing of cleaning chemicals. This can affect solution temperatures and strength. Poorly drained equipment allows bacteria growth between milkings.

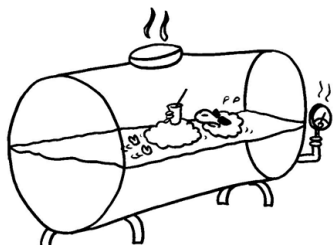


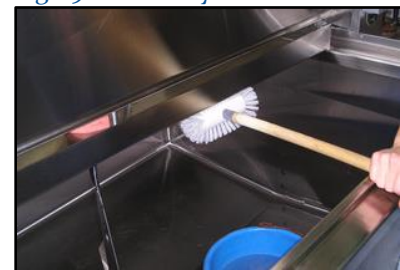
Fig. 17. Maintain water level



Fig. 18. Receiver jar wash-up



Fig. 19. Manually clean bulk tank



2.3 STEP 3 - ACID RINSE

2.3.1 PURPOSE

This cycle removes detergent residues, neutralizes alkali residues and prevents mineral deposits. The acid rinse leaves the pipeline with an acid pH, (pH 4.0 or less, see Fig. 14) which suppresses bacteria growth. An acid rinse also increases the life of inflations and gaskets. If an acid rinse is not completed rubber ware starts to ink quickly indicating that the rubber is deteriorating and not doing its job of providing a water-tight seal.



2.3.2 TEMPERATURE RANGE

Water temperature is not critical in this cycle but should comply with label recommendation as posted on wash chart.

2.3.3 MANAGEMENT TIPS

The acid rinse pH should be between 2.5 and 3.5. Handle using gloves and goggles to prevent injury from splashing. **NEVER mix an acid detergent with a chlorine-based product.** This produces a highly lethal chlorine gas which, when inhaled can destroy the lungs of animals and people, in a very short period of time.

2.4 STEP 4 – SANITIZE

2.4.1 PURPOSE

This cycle is completed to eliminate bacteria that may grow on equipment surfaces between milkings even when well cleaned and acid rinsed.

2.4.2 TEMPERATURE RANGE

Use warm water 43 °C – 60 °C (110 °F – 140 °F)

2.4.3 MANAGEMENT TIPS

Use a solution containing 100-200 ppm chlorine. The sanitize cycle should be completed just prior to milking – no more than 30 min prior to milking and should circulate for 3 to 4 min. It should be run before installation of an inline milk filter.

2.4.4 TYPES OF SANITIZERS

CHLORINE

Chlorine is the most popular dairy sanitizer. It has activity at low temperatures, is relatively inexpensive, and leaves minimal residue or film. It is a broad spectrum bacteriocidal chemical (kills many forms of bacteria). It is minimally affected by hard water but is corrosive if present in too high

concentration. Chlorine is minimally affected by hard water. A maximum of 200 ppm chlorine should be used just prior to milking.

The major disadvantage to chlorine is corrosiveness (especially at high temperatures). Avoid using hot water in the sanitize cycle, cold or tepid is acceptable. The activity of chlorine is reduced by organic load and by alkaline pH. Chlorine sanitizers must not be mixed with acid cleaners because at low pH deadly chlorine gas can be formed.

IODINE

Iodine also has broad spectrum microbial activity. Iodine sanitizers mixed with a surfactant are termed iodophores. Organic matter has less effect on iodophores than on chlorine. Iodophores have more residual activity than chlorine. A concentration of 12.5 to 25 ppm is recommended for iodophore sanitizers.

The major disadvantage is that iodine can cause staining, particularly on plastics. Iodine vaporizes at temperatures above 120°F / 49°C. Loss of activity occurs at a high pH.

PEROXYACETIC ACID

Peroxyacetic acid (PAA) is stable at use strengths of 100 to 200 ppm. These sanitizers are non-corrosive and tolerate hard water. PAA solutions have been shown to be useful in removing biofilms – important when troubleshooting high bacterial counts in the milk. PPA solutions have a pungent odour.

2.5 CLEANING MILK CONTAINERS

2.5.1 CLEANING THE BULK TANK

Bulk tank cleaning involves the same cycles and temperatures as pipeline cleaning. Often bulk tanks are a more difficult vessel to clean than a pipeline. Achieving a 120 °F / 49 °C end temperature of the hot wash can be challenging. Automatic bulk tank washers deliver a spray of cleaning solution which sheets over the surface. There is much less shear force or physical action as compared to pipeline slugging. The spray-ball or jet tube must deliver cleaning solutions to all interior parts of the bulk tank. Watch for plugged spray heads and incomplete drainage between cycles.

Listed below are areas where cleaning problems frequently occur in bulk tanks.

- Outlet and valve
- Plug and plunger rod
- Under the bridge and lid
- Dipstick and dipstick socket
- The corners of a square tank
- Agitator paddles

Fig. 20. Buckets for milk need to be cleaned between uses



2.5.2 CLEANING MILK CONTAINERS USED FOR FREEZING MILK

The cleaning procedure is labour intensive: first warm rinse, followed by brush cleaning each bucket with a hot chlorinated alkaline dairy detergent. Then rinse with dairy acid. Let thoroughly dry before stacking or nesting together. If they are stacked wet, molds and bacteria may grow causing later milk

contamination and off-flavours. The lids and pails should be stored on the farm where they don't get dirty or dusty. Check with the processor to determine cleaning procedures at the plant. Ideally the processor will thoroughly clean and sanitize the pail and lid with chlorine after removing the milk.

2.6 RESIDUAL FILMS ON MILKING EQUIPMENT

Cleaning failures usually result in a visual buildup or residual film in some part of the milking equipment. Films can often be diagnosed by scrubbing a small area with concentrated acid or detergent solutions. There are two categories of residual films:

2.6.1 ORGANIC FILMS

Organic films are usually composed of fat or protein. Protein films can appear as a blue rainbow colour (Fig. 21) or a brownish slime (applesauce). Beads of water hanging on the top side of the pipeline or receiver jar may indicate a fat film. Fat films are alkaline soluble. Protein films are soluble in chlorine.

BIOFILMS

Microbiological films, a type of organic film, can form under certain conditions. These films are called biofilms and can be very difficult to remove. Often there is no obvious residue but the stainless lacks the sheen of a clean surface and may appear a dull grey colour. A group of bacteria known as pseudomonads are often linked to biofilms. These biofilms shed billions of bacteria and cause a significant increase in standard plate counts (see Section V.3). Cleaners and sanitizers with strong oxidizing properties have proven to be effective in biofilm removal. Peroxyacetic acid sanitizers are effective in biofilm removal.

2.6.2 INORGANIC FILMS

Inorganic films are typically hard water minerals such as calcium, magnesium and iron (Fig. 22). Mineral films have a rough porous texture and are invisible when wet. Inorganic films are usually acid soluble.

2.7 TROUBLESHOOTING CLEANING

If a cleaning problem is suspected, begin troubleshooting the simplest things first. Observe one complete cleaning cycle (pipeline and bulk tank). Make sure that the manufacturer's cleaning instructions are being properly followed (Fig. 23). Note times and temperatures of each cycle. Verify amounts of cleaners used (Fig. 24 - left) and if possible chemical concentration (e.g. pH, Fig. 14).

A hand held thermometer is essential (Fig. 24 - right). A visual inspection of the milk contact surfaces requires a strong

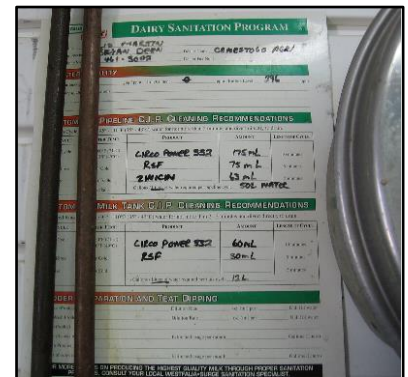
Fig. 21. Protein film in tank



Fig. 22. Mineral deposit



Fig. 23. Posted cleaning instructions



flashlight (Fig. 24 - right). This is particularly important for bulk tank examination. Mineral deposits and biofilms are difficult to detect when stainless steel is wet. Allow surfaces to dry prior to visual inspection. For more information, see Section V.3.5.

EXAMPLES OF PROBLEMS EASILY DETECTED

- Low end temperature of wash water
- Improper temperature at beginning, middle of cycle
- Wash draw line in the sink is sucking air
- The system “traps out” or sanitary trap floods causing shut-down of the wash system
- The hot wash circulates only once and then drains
- The sink drain is leaking and losing cleaner down the drain
- Poor washing action is one or more claws or hoses due to a plugged jetter
- Incomplete drainage from pipes etc. between the cycles

Fig. 24. Left - verify cleaners used correctly; Middle - pH paper to check acidity / alkalinity; Right - thermometer and strong flashlight



2.8 PLANNING A PARLOUR FOR CLEANING

2.8.1 KEEP IT COMPACT

Parlour design should minimize milking line, wash-line and airline lengths. Every extra foot of pipeline adds complication for cleaning. The length of pipeline from the milk-house to the parlour needs to be minimized. This will reduce heat loss during cleaning and reduce water volume requirements.

2.8.2 KEEP IT SIMPLE

Additional components such as milk meters can be difficult to clean. If you use these components as a management tool, be prepared to do some extra cleaning!

Fig. 25. Milk meters need extra cleaning

