CLEANING AND SANITIZING OF MILK PROCESSING EQUIPMENT

"The product contact surfaces of all multi-use containers, utensils, and equipment used in the transportation, processing, handling, and storage of milk or milk products shall be effectively cleaned and shall be sanitized before each use. Provided, that piping, equipment and containers used to process, conduct or package aseptically processed milk and milk products beyond the final heat treatment process shall be sterilized before any aseptically processed milk or milk product is packaged and shall be re-sterilized whenever any unsterile product has contaminated it."

CLEANING OPERATIONS

This item requires that all milk contact surfaces be effectively cleaned and sanitized before each use. The only exception to this is the Ordinance provision that milk storage tanks be emptied and cleaned at least every 72 hours and raw milk and heat treated milk storage tanks use to store products longer than 24 hours and all raw milk silo tanks be equipped with a 7-day temperature recording device.

This recorder shall have a scale span of not less than 50 F, be accurate to plus or minus 2 F, include the normal storage temperatures plus and minus 5 F, with 2 F minimum scale divisions not less than 0.040 inch apart and time scale divisions of not more than 1 hour. The recording chart of these devices must be capable of recording temperatures up to 180 F.

Computer generated temperature recorders which provide a printout which is readily discernible and meets the intent of the Ordinance are acceptable as are devices equipped with multiple sensors or recording pens.

Records are a significant part of the cleaning and sanitizing process. All CIP charts are to be retained by the plant for a minimum of three (3) months. This includes records for cleaning and sanitizing of all plant product processing equipment.

It is also recommended that log records are maintained of manual cleaning operations. This will enable plant quality control staff and the regulatory agency to validate plant cleaning/sanitizing operations.

The Ordinance requires that the regulatory agency review and initial CIP charts during each inspection.

Milk tank trucks shall be tagged or log book records maintained to verify each time the tanker is cleaned and sanitized. The wash tags shall only be removed at the plant or receiving station where the tanker is next cleaned and sanitized. These records shall be retained for 15 days for regulatory review.

Note: Cultured product storage/processing vessels may not have to meet the 24 hour emptying and cleaning requirements if their process demands extended periods of storage, however, a plant should package cultured product within 24 hours of breaking the curd.

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Recent changes in the PMO permit the restricted use of condensing water from milk evaporators and water reclaimed from milk or milk products as follows:

1. Pre-rinsing of the product surfaces where pre-rinses will not be used in food products, and
    - Cleaning solution make-up water; provided that
    - There is no carry-over water from one day to the next OR,
    - The temperature of all water in the storage and distribution system is maintained at 63o C (145o F) or higher by automatic means, or
    - The water is treated with a suitable, approved chemical to suppress bacterial growth by automatic methods prior to entering the storage tank, AND
    - Distribution lines and hose stations are clearly identified as "limited use reclaimed water", AND
    - Water handling practices and guidelines are clearly described and prominently displayed at appropriate locations within the plant, AND
    - These water lines are not permanently connected to product vessels, without a break to the atmosphere and sufficient automatic controls, to prevent the inadvertent addition of this water to product streams. NOTE: Recovered water may be used as boiler feedwater for boilers not used for generating culinary steam or in a thick, double walled, enclosed heat exchanger.

CLEAN-IN-PLACE (CIP)
The recommended steps in a clean in place (CIP) operation may involve the following:

1. Remove those items that require manual cleaning such as fill tubes, manhole gaskets, plug valves, etc.
2. Provide physical breaks between any circuits or tanks containing product.
3. Pre-rinse or flush thoroughly with cool water not to exceed 80oF.
4. Discard pre-rinse water, flushing until relatively clear.
5. Circulate an effective detergent solution throughout the circuit for the period of time necessary to remove the residues in the circuit.
6. Circulate a rinsing water.
7. Circulate an acid detergent when needed followed by another rinse.
8. Sanitize immediately before use.

Most modern plants have installed clean-in-place systems throughout the plant. Prior to this, plants cleaned all their processing equipment, including tanks, vats, pumps and lines manually which involved complete disassembly, manually brushing with a cleaning solution, rinsing, reassembly and finally sanitizing. This was of course all highly labor intensive.

The basic components of any CIP system will include the following:

1. Permanently installed product piping and air operated valves

2. CIP solution make-up tanks
3. CIP pumps
4. CIP supply and return solution piping
5. Spray devices(either permanently mounted or drop- type)
6. Solution collection manifolds
7. Chemical feed systems and equipment
8. The CIP control/monitoring systems and necessary recorders. CIP temperature recorders must meet all requirements as listed in Appendix H, page 207 of the Ordinance.

WATER CHARACTERISTICS AND AFFECTS ON MILK PLANT CLEANING OPERATIONS

Water hardness is the term applied to water supplies characterized by either a high mineral content, usually high in calcium or magnesium bicarbonates, or magnesium chlorides, and sulfates. Generally water hardness is precipitated by most alkaline materials but not by heat.

Some plants may need to condition their water by either selecting the proper detergents or in more severe hard water cases may need to install ion exchangers to remedy the problem.

Water over 100ppm hardness apply in the latter cases and usually softeners are required for boiler water or cooling tower feed water supplies.

Manual Cleaning Operations

Regardless of the automation and engineering built into a plants operation, there is usually a need to manually clean the contact surfaces of the many small parts used in a normal days operation.

This may include filler parts, valves, filler surfaces (mandrels, shields, guides, etc.), small vats, cultured product packaging equipment appurtenances, tanker pumps, fittings, and valves, culture room product handling utensils and equipment (processing vats, curd cutting knives, whey drainers, steam cookers, curd movers and stirrers, etc.).

Manually washed fillers require hand brush washing of the filler bowl, gaskets, the product supply line, ells, and bushings.

Since brushes are used in manual washing operations, they must be of the non-absorbent, nylon or plastic bristled type and designed to not retain soil (not recommended to use hollow body or handled type) and be quick to dry. Brush integrity must be maintained so that brushes used for floor drains or similar surfaces are not used on contact surfaces. This may be accomplished by color coding, marking, etc.

Utensils should be cleaned using a two compartment wash and rinse sink. Sanitizing with chemicals must be accomplished using a third treatment vat, unless heat is used for sanitizing.

The use of absorbent items, such as rags and sponges should be eliminated to reduce the potential of spreading microorganisms throughout the plant environment.

Separate brushes should be used for product and not-product surfaces and the use of wooden handled brushes, tools, paddles, etc. should not be used in production areas.

Particular attention must be given to cleaning underneath gaskets, "o-rings", and other small orifices in which residue and bacteria may accumulate.

Special emphasis should be given to the following when evaluating the effective cleaning of milk contact surfaces:

- AUP air blow devices/fittings;
- Storage tank agitator blades, shafts, fill inlets, vents, gaskets, shaft "O" rings;
- Filler valves, tanks, small parts (springs, screens, gaskets and "O" rings, vents, drain valve and lines, underside of shielding,);
- Plug valves, "butterfly valves";
- Fruit feed pumps, (varigators), fruit pumps;
- Homogenizer stand pipes;
- Reclaimed product surge tanks, milk cans, lines;
- Silo manhole doors (inside surfaces, sampling cocks, tank surface on inside below door opening);
- Silo vent caps (mold, slime);
- Liquefier (powder mixing tanks) outlet valve and connecting piping;
- Raw receiving lines and fittings;
- Product pumps ("O" rings, back plates, covers);
- Filter housings, springs, gaskets in raw receiving area;
- Air eliminators in receiving areas, air "burps" on product and CIP lines;
- Pasteurizer regenerator plates (points of greatest temperature differential);
- vacuum breakers, single stem flow diversion valves;
- Tank fill goose necks; and In-door sample valves.

CHEMICALS USED IN MILK PLANT CLEANING OPERATIONS ALKALINE DETERGENTS

Used to neutralize, break-up, and suspend soil in the cleaning solution. Alkalines have been termed the "guts" of the dairy cleaners and are usually termed generically as "caustics" and or alkaline chlorinated cleaners.. Chemically they are sodium hydroxide (NaOH, OR CAUSTIC SODA), potassium hydroxide (caustic potash), sodium carbonate (soda ash) or sodium hypochloride (NaOCL) and sodium silicates and have a pH higher than 7. They attack the fat and protein residues on all types of dairy processing equipment.

They are generally combined with a water conditioning additive such as liquid phosphate under hard water conditions and usually contain surfactants or wetting agents which enhances the cleaning action.

The water properties must be considered, since most cleaning solutions are made up of 99% water and the amount of neutralizers used should be customized to meet the individual demands. These detergents condition the water to prevent scum formation, and help to prevent saponification (the

chemical reaction which converts the actions of alkali and fats into soap and glycerin) during the cleaning cycle.

Most alkaline detergents contain chlorine which also breaks down the fats and proteins.

ACID CLEANERS

Acid detergents are those with a pH of lower than 7 and react with mineral deposits which have accumulated on milk contact surfaces. These acid cleaners may contain either nitric, phosphoric or a mixture of both acids; however phosphoric acid based cleaners are the most widely used in the U.S.

Milk and water mineral deposits (termed milk stone) become hardened and layered on the equipment surfaces and provide excellent surfaces on which "biofilms", which are adherent macro-colonies of bacteria, may thrive. Milk stone may consist of milk solids, calcium, magnesium, iron, sulfates, etc.

Acid based detergents (or rinses) do not saponify. They do, however, tend to neutralize any alkalinity and react with the milk minerals which are then carried away in the rinse cycles. Acid rinses will usually provide a bacteriostatic condition, however the equipment must be effectively cleaned with an chlorinated alkaline based detergent prior to using the acid rinse.

Using an acid detergent without first removing the fats and proteins with a chlorinated alkaline detergent will result in fixing the protein soil to the surface. Acid rinses may also tend to protect against corrosion and when used in proper strengths will not attack rubber parts.

MILKSTONE White to yellow Minerals from milk Acid wash Regular and proper cleaning procedures coupled w/ acidified rinse FAT/ GREASE Hanging water droplets Greasy (white) appearance 1. Low water temperatures 2. Improper detergent concentration 3. Regular use of acids in place of alkaline detergent 1. Proper water temperature 2. Correct concentration of alkaline detergent Regular and proper cleaning procedures coupled w/ acidified rinse MINERAL (Calcium, Magnesium) White (water- stone) chalky to gray 1. Rinse too hot, drop-out of minerals from water supply 2. Failure to use acid detergents 3. No acidified rinse 4. Alkaline detergent used cannot handle hard water at present concentration Acid wash 1. Acid wash 2. Alkaline detergent used has good water conditioning 3. Water softener or treatment

NOTE: NEVER MIX CHLORINE AND ACID BASED DETERGENTS TOGETHER

The following is a list of terms commonly used when referring to the properties of detergents used in the food industry.

1. Emulsification - The spontaneous dispersion of substances (proteins, gross soil particles, etc.) when brought in contact with water.
2. Peptize - The mechanical action combined with a surfactant which results in two immiscible liquids to form a stabilized colloid.
3. Saponification - The combination of fatty acids and oils with alkali to produce soap.

4. Sequestering and Chelating - The prevention of precipitation of hard water constituents by keeping them in suspension as stable and solid compounds.
5. Wetting - Lowering of surface tension which permits cleaners to break the bond between the soil and surfaces.

IT MUST BE STRESSED THAT CHEMICAL SANITIZERS ARE NOT EFFECTIVE UNLESS ALL PRODUCT SURFACES ARE EFFECTIVELY CLEANED PRIOR TO THEIR APPLICATION.

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Chemical Sanitizers: General Information

1. **CHLORINE**

Chlorine is the most common chemical sanitizing agent used in the milk industry. One of the more common forms of chlorine is sodium hypochlorite which is the soluble salt of hypochlorous acid combined with sodium chloride. This is the stable form of a liquid chlorine solution however has a limited shelf life.

Granular chlorine sanitizers are based upon the salts of an organic carrier which contains releasable chlorine ions. When blended with water, sodium hypochlorite is released and the hypochlorous acid is the active antimicrobial for all chlorine sanitizers.

The killing rate of chlorine is greatly influenced by the pH of the solution. For instance at a solution of 25 ppm chlorine will deactivate organisms at pH 4 in 15 seconds, while a pH level of 10 would take up to 10 minutes. Temperatures of the solution also play an important role in chlorine effectiveness rates. Optimum temperatures of chlorine range from 75o F - 100o F.

Chlorine solutions deactivate the microorganisms by affecting the cell wall transport mechanisms, causing the formation of chloramines with the amino acids of proteins. This denatures the proteins within the enzymes causing intracellular damage and destroys the microbe.

Chlorine sanitizers are generally used in recirculated cleaning systems for cleaning small parts, milk tank trucks and environmental surfaces.

2. **IODINE**

Iodine sanitizers used in milk plants are usually in the form of iodophors. Iodophors are simply iodine which are combined with non-ionic wetting agents (surfactants). Iodophors, when diluted for use in the proper concentrations, have a low pH value (pH 2.6 - 5.0) which enhances their germicidal qualities. This along with increased temperatures (up to 120o F) makes them a popular sanitizer for use in milk plants.

Iodine interferes with the intracellular protein in a similar manner to that of chlorine, with the sulfhydryl, amino or carbonyl protein groups being affected.

Iodine sanitizers are used extensively in filling/packaging machines and areas, culture processing equipment, drop hoses and hand dipping stations.

3. **QUATERNARY AMMONIUM COMPOUNDS (Cationics)**

These sanitizer agents are commonly known as "Quats" and are highly effective in the denaturing of cell (bacteria) proteins which leads to their destruction.

Bacterial cells walls are electrically charged and can possess a net positive or negative charge largely depending on the acidity of the solution in which they are found. Moreover, each type of bacteria have a different cell wall composition. Generally bacteria grow in the optimum pH range of 6.0 to 8.0, and are generally negatively charged at this growth range. The cationic sanitizer, having a positive charge, attracting their opposite charge (negative). This interaction between the opposite charges tends to produce drastic effects upon the cell wall and will cause fluid leakage and eventually cellular rupture. In concentrations of 50 -100 ppm cationic surfactants will not only denature the cells proteins, but also totally inactivate the enzyme and actually alter the cell wall permeability.

Quats are generally used in case washing areas and other environmental surfaces, but are rarely used in CIP and plant equipment sanitization where culture processes may be damaged.

4. **CHLORINE DIOXIDE**

This chemical sanitizer has become more widely used in the dairy industry, predominately in the sanitizing of environmental surfaces of equipment, floor drains, and other areas to greatly reduce the microbial load in these area. Recommended (CFR) effective uses of this sanitizer for contact surfaces must not exceed 200ppm and a recommended strength of 100-200ppm has been established. The CFR describes the formulation for this sanitizer by either metering a concentrated chlorine dioxide solution into potable water or by acidification of an aqueous alkaline solution of the oxychloro species.

5. **ACID SANITIZERS**

Aqueous solutions containing one or several of the acceptable acid sanitizers has been effective in the deactivation of microbes. The active acid ingredient may be sulfonic, phosphoric, de-cationic, cyanuric or a blend of the above to provide not more than 100ppm of available halogen.

Note: Trichoromelamine based sanitizers are not approved for use on milk contact surfaces.

Acid sanitizers are used primarily for large (silo) milk storage tanks, milk tankers and other large milk storage vessels within the plant.

PROS AND CONS OF CHEMICAL SANITIZERS

CHLORINE ADVANTAGES

1. Economical
2. Effective against most bacteria, spores, phages
3. Readily available in liquid or granular form
4. Not affected by hard water salts
5. Test kits available

CHLORINE DISADVANTAGES

1. Corrosive
2. Effectiveness is pH dependent
3. Strength dissipates under storage, heat or light
4. Skin irritant, objectionable odor
5. Hard on rubber parts

IODINE ADVANTAGES

1. Color indicative of strength
2. Activity less affected by organics
3. Effective against wide variety of non-sporeformers
4. Solution not affected by hard water salts
5. Not a skin irritant
6. Stable, long shelf life
7. Non-corrosive
8. Test kit available

IODINE DISADVANTAGES

1. Effectiveness decreases with increased pH
2. May discolor equipment
3. Less effective against spores
4. Should be used above 120o F.
5. May cause product off flavors

QUATERNARY AMMONIUM COMPOUNDS (Cationics) ADVANTAGES

1. Active against wide range of organisms, especially gram positive slime-formers, thermodurics
2. Low toxicity, odorless, colorless
3. Non-corrosive
4. Stability excellent

5. Heat stable, long lasting
6. Less affected by pH
7. Non-irritant to skin

QUATERNARY AMMONIUM COMPOUNDS (Cationics) DISADVANTAGES

1. Undesirable in cultured dairy product applications
2. Low activity against gram negative and coliform organisms
3. Loses effectiveness with anionic detergent contamination.

ANIONIC ACIDS ADVANTAGES

1. Non-corrosive
2. Unaffected by hard water, temperature, or organic contaminants
3. Rapid activity
4. Effective on wide range of microbes(thermodurics, phages, and yeasts)
5. Controls milk-stone

ANIONIC ACIDS DISADVANTAGES

1. Increase in pH level decreases effectiveness
2. Cannot be used with alkaline detergents
3. Is less effective against thermo- durics, spores, psychrophils
4. Relatively expensive
5. Leaves foam residual in CIP applications