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EFFECTIVE CLEANING AND SANITIZATION OF DAIRY PLANTS: 2. COMMON PRACTICES

This bulletin includes technical and latest development on products, systems, techniques etc. reported in journals, companies' leaflets and books and based on studies and experience. The technical information on different issues is on different areas of plant operation. It is hoped that the information contained herein will be useful to readers.

The theme of information in this issue is **Effective Cleaning and Sanitization of Dairy Plants: 2. Common Practices**. It may be understood that the information given here is by no means complete.

In this issue:

1. INTRODUCTION

Technews Issue No.48 presented useful details of important dairy detergents and sanitizers. Cleaning methods and selection of detergents depend on the specific situation and equipment. Equipment where milk has been heated have different cleaning requirements than the equipment which handle only cold milk.

In modern dairy plants, most processing equipment are connected with cleaning-in-place (CIP) automatic system. Because the normal period of use for dairy processing plant equipment is less than 24 hours, this equipment and the area are cleaned daily. Longer and continued use of piping and storage systems can reduce the cleaning frequency to once every 3 days.

There could however be systems where mechanized (CIP) cleaning is not practical. These are cleaned manually. Then there are some equipment that need special cleaning procedures, such as can washing, cleaning dryers and butter making machine. This issue presents some dairy cleaning practices.

2. DETERGENT AND SANITIZER SOLUTIONS

To obtain desired characteristics, usually a blend of detergents is used depending on requirements. As informed in the last issue of Technews, this blend could be of a basic alkali (such as sodium hydroxide) or an acid, polyphosphates, a surfactant and a sequester. If water is very hard, trisodium phosphate at a rate of 0.3-0.5% or ethylene-diamine-tetra-acetic acid (EDTA) is used[1, 2].

If commercial detergent is not used, then the alkali and additives can be metered in the automatic CIP cleaning system at the same time.

Most cleaning solutions should be compounded with cold water only. A few need to be mixed with hot water to go into solutions. These should be limited to non-producer of heat of reaction. Cold water should be added during mixing such detergents to keep the solution below the boiling point. All cleaning compounds should be used in recommended concentrations. Detergents should be mixed and dispensed only by experienced, well trained personnel. An apron, goggles, rubber gloves and dust respirator must be worn during these activities.

Commonly used alkaline detergent is sodium hydroxide. It is normally available in liquid form (called soda lye) with 30-35% causticity or in dry form – flakes – with at least 95% strength[1, 3]. For preparing 1% NaOH solution, add slowly about 2.5 litre soda lye (density 1.33 kg/litre) per 100 kg water.

Alternatively, dissolve approximately 1 kg dry flakes in 10 litres cold water, and then add this solution to the balance tank. NaOH should always be mixed slowly in to cold water – never water into NaOH as it will boil up with explosive force.

Likewise, to prepare 0.5% nitric acid solution, add 0.6 litre commercial nitric acid (60% strength) per 100 litre water. The formula to be used is:

$$\text{Litre detergent} = \frac{100 \times \text{required \%}}{\text{\% detergent} \times \text{density of detergent}}$$

The sanitizer solution is made in the similar way. For example, to make 500 litre 200 ppm active chlorine solution, sodium hypochlorite

may be used. It is assumed that the hypochorite has 8.5% active chlorine. If the sodium hypochlorite required is m litres, then

$$8.5 \times m = \frac{200}{10^6} \times 500$$

or $m = 1.18$ litre

Thus the formula to be used is : $m = \frac{xw}{10000yd}$

Where, x = strength of solution required, ppm
y = strength of the sanitizer used, %
w = volume of the solution required, litre
d = density of the sanitizer, kg/litre.

The hypochlorites may also be added to cleaning compound solutions to provide a combination cleaner sanitizer. Organic chlorine-releasing agents, such as sodium dichlorisocyanurate and dichlorodimethydantoin, can be formulated with cleaning compounds. Cleaners containing active chlorine, such as sodium or potassium hypochlorite, are effective in the removal of carbohydrate and/or proteinaceous soils[(2)]. A small amount of hypochlorite will remove a relatively large quantity of protein. However, cleaners that contain hypochlorite should be applied soon after they are made up as they have poor stability during storage.

Similarly, iodophors can be complexed with surface-active agents and acids (like phosphoric acid) to qualify them as detergent – sanitizers. Quats can also be formulated with a specified detergent to function as a cleaner-sanitizer. However, these are not recommended for food plants as these have insufficient detergent properties. Its application is satisfactory for bathrooms, toilets and other non-food-contact surfaces. Its application requires rinsing.

For cleaner-sanitizer to be effective, the cleaning solution temperature should be 55ºC or lower, and the soil should be light[2].

3. CLEANING CYCLE

The cleaning steps required in a cleaning-in-place (CIP) cycle would depend on the specific situation. The cleaning procedure will generally consist of the following seven sequential steps[2,3,4,5]:

i) **Pre-rinse with water.** Pre-rinsing with fresh or lukewarm water should always be done immediately after the end of production run, otherwise the milk residues will dry out and stick to the surfaces. Water temperature could be around 45ºC, but should never exceed 60ºC in order to avoid coagulating protein. Pre-rinse removes upto 90% of the materials, softens hard soils and facilitates penetration of the cleaning compound in the next step. This water should then be discarded.

ii) **Cleaning with detergent.** The processing equipment is cleaned by the circulation of a hot alkali solution. This removes all or bulk of the protein and fat soil. After cleaning the solution is collected and re-used after adjusting it for detergent concentration. Depending upon the type of soil, the concentration of the cleaning solution is kept at around 0.5 to 1% by weight, temperature at 71ºC to 85ºC for hot application and 57ºC to 71ºC for cold surfaces, and circulation time 15 to 30 minutes for hot application and 10 to 20 minutes for cold surfaces. Too high concentration may in fact impede cleaning.

iii) **Post rinse with hot water.** After the alkali wash the surfaces are rinsed with hot water to remove any residual soil, all traces of detergent and prevent redeposition of soils on the cleaned surfaces. Rinsing to a pH of 8.5 – 9.0 is usually considered enough. The rinse water is collected and used for pre-rinsing.

iv) **Acid rinse.** Equipment surfaces are then flushed with hot acid solution to remove milkstone and water scale. This also brightens stainless steel surfaces. The acid solution concentration is around 0.5% for nitric acid and around 2% for phosphoric acid, temperature around 65ºC and circulation duration 5 to 20 minutes depending upon the application. Table 1 provides these details for different equipment.

Table 1 : Cleaning Methods for Different Equipment

Equipment	Method	Detergent
Pipes	CIP	Lye : 0.5%, 75ºC, 10 minutes
		Acid : 0.3%, 65ºC, 5 minutes
Milk tanks	CIP	Lye : 0.5%, 75ºC, 10 minutes
		Acid : 0.3%, 65ºC, 5 minutes
Pasteurizers	CIP	Lye : 1%, 75ºC, 30 minutes
		Acid : 0.7%, 65ºC, 20 minutes
Continuous butter making machine	CIP special	
Evaporators	CIP	

v) **Post acid rinse.** The equipment is then rinsed with water to remove any residual acid. Rinsing to pH of 6 to 6.5 is usually considered enough.

After treatment with strong alkali and acid solutions at high temperatures, equipment and piping systems are practically sterile. However, to prevent overnight growth of bacteria in the residual rinsing water in the system, the rinse water may be acidified to a pH of less than 5 by adding, say, phosphoric or citric acid. This acid environment prevents the growth of most bacteria.

vi) **Sanitization.** A proper cleaning programme with alkaline and acid detergents renders the equipment not only physically and chemically, but also to a large extent bacteriologically, clean.

The bacteriological cleaning effect can be further improved by sanitization chemically or by heat. Sanitization can advantageously be done in the morning immediately before milk processing starts. Sanitization can be done, depending on the specific application, by hot water at 90ºC-95ºC (85ºC at outlet) for 15 minutes, chlorine solutions at 50-250 ppm at around 55ºC for 30 minutes, iodophor solution of 50-70 ppm available iodine at around 30ºC-40ºC or quats at 150-250 ppm at around 45º-50ºC for 5 minutes. Quats residues, if remained on surfaces, have an inhibiting influence on the growth of lactic acid bacteria. Therefore, the use of quats is limited.

vii) **Final rinse.** In case chemical sanitizers are used (except when chlorine solution of 200 ppm or less is used), the sanitizer solution should be flushed out with good water to remove residual sanitizer. This otherwise might attack the metal surfaces in case it is left on surfaces overnight.

In cleaning sequence, some times acid wash is done before the alkaline solution cleaning with post cleaning water rinse as mentioned. For light soiling, acid wash may not be required, such as in can washing and storage tank cleaning.

There are equipment that cannot be cleaned by CIP system, and are to be cleaned out-of-place by disassembly and/or removal from the normal location. The following guidelines are useful in such cases[(2)]:

i) A prerinse with water at 37-38ºC to remove gross soil.
ii) For manual cleaning, cleaning compound used should have a pH of less than 10 to minimize skin irritation (example milks alkalis). The solution should be at 45ºC, solution-fed brushes can be used effectively. Other parts of equipment should be cleaned through circulation of a chlorinated alkali solution for about 10-12 minutes at 30º-65ºC for loosening and eradicating remaining soil.
iii) A post rinse with water at 37º-38ºC to remove any residual soil or cleaning compound.

4. COMMON CLEANING PRACTICES

The choice of cleaning method depends on the specific application. Accordingly, the cleaning compound would be selected, temperatures would be used. In manual cleaning, mild alkalies and acids would be used, whereas in CIP cleaning strong acids and alkalies are used. Table 2 provides a guide to the most appropriate cleaning compound, cleaning procedure and cleaning equipment for major cleaning applications[2]:

Table 2 : Optimal Cleaning Guides for Dairy Processing Equipment and Area

Cleaning Applications	Cleaning Compound	Cleaning Medium	Cleaning Equipment
Plant floor	Most types of self-foaming, or foam boosters added to most moderate to heavy-duty cleaners. (Teepol, Alkyl sulphates, sulphated alcohols, quats).	Foam (high-pressure, low-volume should be used with heavy fat or protein deposits).	Portable or centralized foam cleaning equipment with foam guns for air injection into the cleaning solution.
Plant walls and ceilings	Same as above	Foam	Same as above
Processing equipment and conveyors*	Moderate to heavy-duty alkalies that may be chorinated or non-alkaline.	High-pressure, low-volume spray	Portable or centralized high-pressure, low-volume equipment; sprays should be rotary hydraulic.
Closed equipment	Low-foam, moderate to heavy-duty chlorinated alkalies with periodic use of acid cleaners as follow-up brighteners and neutralizers.	CIP	Pumps, fan or ball sprays, and CIP tanks
* Packaging equipment can be effectively cleaned with gel cleaning equipment.			

Likewise, a specific requirement of sanitization would dictate the selection of a sanitizer. Table 3 provides the area of application[6]:

Table 3: Specific Areas or Conditions where Particular Sanitizers are Recommended

Specific Area or Condition	Recommended Sanitizer in Order of Preference	Concentration (ppm)
Aluminium equipment	Iodophor	25
Bacteriostatic film	Quat	200
Film formation prevention	Acid sanitizer	130
	Iodophor	
Fogging, atmosphere	Hypochlorite	800-1000
Hand sanitizer	Iodophor	25
Hard water	Acid sanitizer	130
	Iodophor	25
High iron water	Iodophor	25
Non-corrosive	Iodophor, quat	
Odour control	Quat	
Plastic crates	Iodophor	25
Porous surface	Active chlorine	200
	Quat	200
Process equipment, stainless steel	Acid sanitizer	130
	Active chlorine	200
	Iodophor	25
Psychrophilic bacteria	Hypochlorite	
Rubber belts	Iodophor	25
Sanitization of equipment to be stored	Quat	
Sanitization of equipment just before use	Iodophor, hypochlorite	
Tile walls	Iodophor	25
Visual control	Iodophor	25
Walls	Hypochlorite	200
	Quat	200
Water treatment	Hypochlorite	20
Wood crates	Active chlorine	1000

Pasteurizing Plant

CIP cleaning of pasteurizer plant is as follows[1-5, 7].

i) Pre-rinse. At the end of the production run, the pasteurizer, including pumps, valves and pipes, is flushed out with cold or lukewarm water (38º-45ºC) until the water is clear at the outlet. This takes around 8-10 minutes. Discard this water. Then switch to closed circulation.
ii) Alkaline cleaning. Circulate alkaline detergent solution of 0.5-1% (sodium hydroxide) strength at 70º-75ºC for 20-30 minutes.
iii) Water rinse. Flush it out with water for about 5 minutes.
iv) Acid wash. Circulate nitric acid solution of 0.5% concentration at 60º-70ºC for around 20 minutes.
v) Post acid rinse. Rinse acid out with water for about 10 minutes. This would also cool the plant gradually. This water then can be used for pre-rinse next time.
vi) Sanitization. Before start-up of the next production run, the pasteurization system is sanitized by circulating hot water at 90ºC for about 10 minutes.

If the plant is very dirty, such as when milk of bad quality has been pasteurized, it may be necessary to use higher concentrated cleaning solutions, or alkaline solutions should be used first.

Cold Milk Equipment

CIP cleaning of cold equipment and other components, such as tanks, piping and fittings is as follows[4, 5, 8]:

i) Rinse with cold or lukewarm water (40º-45ºC) for about 3 minutes to remove milk residues. Discard the water.
ii) Remove blank caps, valve plugs and other similar fittings, clean with a brush and replace.
iii) Circulate caustic solution of about 0.5% at 50º-55ºC for around 20-30 minutes or at 75ºC for about 10 minutes.
iv) Rinse with hot water (90ºC) for about 3 minutes.
v) Gradual cooling with water for about 7 minutes.

vi) Just before use sanitize by recirculating hot water at 85º-95ºC for 10 minutes, or a chemical sanitizer solution (100 ppm active chlorine-hypochlorite at 50º-55ºC for 10 minutes or isodphor-nonionic-surfactant adjusted to pH 3, at 50 ppm at around 50ºC for 10 minutes or quats solutions at 150-200 ppm at 50ºC for 5-10 minutes).

Evaporators[4]

i) Flush with cold or warm water (upto 40ºC).
ii) Reduce steam pressure to approximately 75% of normal running conditions.
iii) Open product valve, mix caustic soda in the balance tank for a period of 5 minutes to an approximate 2% solution at 80ºC.
iv) Circulate cleaning solution for 20-30 minutes.
v) Flush with condensate for 10-15 minutes and lead to a collecting tank.
vi) Circulate 0.3-0.5% nitric acid solution (70ºC) for 10-15 minutes and lead to a collecting tank.
vii) Flush with condensate until the plant is free from chemical residues.
viii) Cleaning of external surfaces with a cleaning solution, if necessary with brushing. Final rinse with slightly chlorinated water.

Immediately before start-up sanitization is necessary. A rinse with water containing 75 ppm available chlorine for 5 minutes or a brief fogging with a chlorine solution containing 500 ppm of available chlorine is preferable. This solution must immediately be rinsed off to avoid the danger of corrosion. Start-up should follow soon afterwards.

Manual Cleaning

Guidelines for manual cleaning of different dairy equipment are presented in Table 4[2].

Table 4 : Special Considerations for Hand Cleaning Dairy Plant Equipment

Equipment	Recommended Cleaning Procedures
Weigh tanks (can receiving and/or in-plant can transfer)	Rinse immediately after milk has been received; disconnect and disassemble all valves and other fittings; wash weigh tank, rinse tank, and fittings; sanitize prior to next use.
Tank trucks, storage tanks, processing tanks	Remove outlet valve, drain, rinse several times with small volumes of tempered (38ºC) water, remove other fittings and agitator; brush or pressure-clean vats, tanks, and fittings; rinse and reassemble after sanitizing fittings just before reuse. Thoroughly clean manhole covers, valve outlets, slight glass recesses, and any air lines. High-pressure sprays are preferable to keep the cleanup personnel out of the tanks or vats and to minimize damage to surface and contamination of cleaned surfaces.
Batch pasteurizers and heated produce surfaces	Lower temperature to below 49ºC immediately after emptying product; immediately rinse, with brushing to loosen burned-on products. If the vat cannot be rinsed, fill with warm (32º-38ºC) water until cleaning. Clean the same as to other processing vats.
Homogenizers	Pre-rinse while the unit is assembled; dismantle and clean each piece; place clean parts on a parts cart to dry. Sanitize and reassemble prior to use.
Sanitary pumps	After use, remove head of pump and flush thoroughly with tempered (38ºC) water; remove impellers and place them in the bucket containing a cleaning solution of 49ºC-50ºC. Wash intake and discharge parts and chamber. Brush impellers and place them in a basket on a parts table to dry.
Centrifugal machines	Non-CIP types must be cleaned by hand. Rinse with 38ºC water until discharge is clear. Dismantle, remove bowel and discs, and rinse each part before placing in the wash vat. A separate wash vat is desirable for separator and clarifier parts to avoid damaging the discs and other close-tolerance parts. Each disc should be washed separately, rinsed, and drained thoroughly. If a separator is used intermittently during the day, it should be rinsed after each use, with at least 100 L of tempered water. Use of a milk alkaline wetting agent can improve rinsing efficiency.

5. SOME USEFUL TIPS

i) Do not mix chemicals unless specifically instructed in writing by the manufacturer.
ii) Never mix an acid cleaner with a chlorinated cleaner. Mixing acid with chlorine or chlorine-bearing compounds will produce dangerous chlorine gas.
iii) Chlorine in an alkaline cleaner is for soil removal, not sanitizing.
iv) Elastomers (e.g., rubber gaskets) can be attacked by chlorine and oxidizing agents, and hence should be cleaned and sanitized with compatible chemicals.
v) Temperatures of under 80ºC should be used with nitric acid to prevent attack on gaskets.
vi) For contact with aluminum, the active chlorine concentration should be less than 200 ppm.
vii) Sodium silicate (water glass) in a concentration of 0.1-0.3% of an alkaline solution prevents attack on metal, even at high temperatures (80ºC).
viii) Quats are used most frequently on floors, walls, furnishing and equipment.
ix) It is best to follow manufacturer's instructions.

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