UNIT 12 TYPES OF DETERGENTS AND SANITIZERS

Structure

12.0 OBJECTIVES

After reading this unit, we should be able to:

- state the meaning of cleaning and sanitization
- list the various types of cleaning and sanitizing agents used in the dairy industry
- describe the properties of common detergents and sanitizers.

12.1 INTRODUCTION

The cleaning and sanitizing of dairy plant equipment is essential for providing safe dairy products to the consumers as well as for ensuring the keeping quality of these products. Cleaning operations have been followed ever since processing food has been known. Only the scale of operation and the ingredients used have changed with alterations in the type of food, the quality expected and the kind of equipment used. Earlier, the traditional detergents and their methods of use were aimed at providing only satisfactory cleaning. As the function of specific chemicals and the contribution of other factors were made known along with improvements in plant design, detergent handling and control was also made an important research topic. As a result, detergents and sanitizers gradually improved, leading to the high standards expected and obtainable today.

Cleaning is the process of removing any extraneous matter (including dust, dirt, particles from the food handled) adhering to the equipment surface with the help of a suitable detergent and water. Thus, cleaning agents are materials that help to remove dirt from equipment surfaces and keep them visibly clean.

Sanitization is the process of reducing microorganisms to a level acceptable by public health authorities in terms of destruction of pathogens and minimizing other microflora. Therefore, sanitizers are agents that reduce microbiological contamination to levels conforming to public health requirements.

12.2 CHOOSING THE APPROPRIATE DETERGENT

The determination of the correct type of detergents for any cleaning process in a food processing factory is subject to a number of selection criteria. These include:

- the type of soil present
- the manner in which the soil is formed
- the chemical composition of water supplies
- the nature of the food processing steps
- plant design, construction and material used for the same
- the extent of cleanliness and sanitation required and
- the cleaning and sanitizing techniques available.

i. Milk Soil

Any equipment that stores, carries, contains, or contacts milk will accumulate particles of milk on its surface. This is the ‘milk soil’. These particles, if are not detected in time and removed, will act as nuclei onto which further clustering of milk particles occur. Eventually, these result in larger and dried particles of milk soil, commonly called ‘milk stones’. The accumulated dried soil consists largely of fat, protein (precipitated, coagulated and baked-on by heat), insoluble calcium salts from water and washing detergent and bacteria. These are stubborn and difficult to remove. They then cause problems of inefficient heat and material transfers during processing and also bacterial contamination that may eventually lead to food safety hazards.

The composition and concentration of cleaning compounds and the cleaning methods used are dependent upon the type of soil on the surface to be cleaned. The nature of soils from foods varies, based on the composition of the food and processing conditions. The chemical composition of typical milk soils is given in Table 12.1

Table 12.1: Chemical composition of a typical milk soil*

Constituent	Cold milk soil (%)	Hot milk soil (%)		Milk stone (%)	
		Scraped surface heater	Tubular heater	Min.	Max.
Lactose	38.11	Trace	Trace	None	Trace
Fat	29.9	48.0	23.1	3.6	17.66
Proteins	26.6	41.1	30.3	4.1	43.8
Ash	5.3	11.9	46.6	42.3	67.3

* Dry matter basis

The concentrations of water-soluble, alkali-soluble and acid-soluble soils will vary with the type of food and the processing it has received both before, and in, the equipment to be cleaned. The variation in some milk constituents with respect to their solubility and reaction to cleaning is shown in Tables 12.2.

Table 12.2: Solubility and ease of cleaning of milk soil

Component on surface		Solubility characteristics	Ease of removal	Changes induced by heating soiled surface
Sugar		Water-soluble	Easy	Caramelization More difficult to clean
Fat		Water-insoluble Alkali-soluble	Difficult	Polymerization More difficult to clean
Protein		Water-insoluble Alkali-soluble Acid-soluble	Very difficult	Denaturation Much more difficult to clean
Salts	Monovalent	Water-soluble Acid-soluble	Easy	—
	Polyvalent (e.g., $CaPO_4$)	Water-insoluble Acid-soluble	Difficult	Interactions with other constituents More difficult to clean

ii. Quality of Water

Water is the major ingredient in all cleaning and sanitizing operations used in a dairy plant. Pure water presents no problem, but no water supply in a dairy plant is ideal. The cleaning compound, therefore, must be selected after carefully assessing the individual plant water supply. Water impurities that are significant with regard to cleaning operations are:

- Suspended matter - These must be kept to a minimum to avoid deposits on clean equipment surfaces.
- Water hardness - Salts of magnesium and calcium pose the major problem in the use of cleaners by reducing effectiveness and by forming surface deposits. Water hardness may be classified as shown in Table 12.3.

Suspended matter and soluble iron and manganese can be removed only by treatments such as filtration and deionization. Small amounts of water hardness can be taken care of by addition of seques-tering agents in the cleaning compounds. However, in case of hard or very hard water supplies, it is generally more economical to pretreat the water to remove or at least minimize water hardness.

Table 12.3: Classification of hardness of water

Class	Soft	Moderately hard	Hard	Very hard
ppm hardness	0-60	60-120	120-180	Over 180

The ingredients of modern commercial cleaning compounds modify the nature of water so that it may efficiently penetrate, dislodge and carry away surface contamination (soil). Although water alone will act as a good cleaning agent if enough external energy is put into the system (generally in the form of heat and applied force). Cleaning compounds decrease the external energy requirements by increasing the internal potential energy of the water.

Check Your Progress 1

1. Define a) cleaning and b) sanitization

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2. What are the factors that influence the choice of a detergent?

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3. What is ‘milk soil’? How does it differ from ‘milk stone’?

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4. How does hardness of water affect cleaning efficiency?

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12.3 CLEANING PROCESS

i. Steps Involved

The modern cleaning agents used in a food processing plant are complex combinations of chemicals mixed in order to achieve specific functions. Four fundamental steps involved in any cleaning process are:

- Bringing the detergent solution into close contact with the soil to be removed by means of good wetting and penetrating properties;
- Dislocating the solid and liquid soils from the surface to be cleaned by saponifying the fat, peptizing the proteins and dissolving the minerals;
- Scattering the soil in the solvent by dispersion, deflocculation or emulsification; and
- Preventing re-deposition of the dispersed soil back onto the clean surface by providing good rinsing properties.

ii. Qualities of a Good Detergent

In addition to achieving these essential steps, a good cleaner should:

- Soften the water adequately;
- Dissolve quickly and completely;
- Be non-corrosive;
- Be non-toxic;
- Be economical
- Remain stable upon storage and
- Be non-caking and non-dusting.

It is obvious that no single chemical can satisfy all these criteria. Therefore, a cleaning solution is generally made up of several ingredients, each one having one or more of these properties. The selection of the compounds to be blended into a good cleaner requires highly specialized knowledge. The different ingredients of cleaning compounds are combined in such a manner so as to assure the following functions:

Deflocculation: Breaking up of soil flocs on surfaces to improve removal of the soil.

Dispersion: The power to scatter and flocculate so that mineral films are not redeposited on the surface from which they are removed.

Dissolving: The ability to dissolve both inorganic and/or organic solids so as to speed their transfer into solution.

Emulsifying, suspending: The power to emulsify fat and suspend other solids in solutions.

Peptizing power: The ability to attack and disperse protein by hydrolyzing it.

Rinsing power: The ability to separate dirt/soil from the surface to which it has been adhering when fresh water is flushed over the surface.

Saponifying power: The capacity to turn fats into soaps.

Sequestering: The ability to prevent deposition of undesirable mineral salts on surfaces being cleaned.

Wetting: The capacity to lower the surface tension of the water medium so as to increase its ability to penetrate soil/dirt.

iii. Classification of Detergents

The chemicals used as cleaning compounds can be grouped into five basic classes: Alkalis, complex (or poly) phosphates, surfactants, chelating compounds and acids. Their general functions are listed in Table 12.4.

Table 12.4: Classification of cleaning compounds and their major functions

S. No.	Class of compound	Major functions
1.	Alkalis	a. Soil displacement by emulsifying, saponifying & peptizing
2.	Complex (poly)phosphates	a. Soil displacement by emulsifying & peptizing

		b. Soil dispersion; water softening c. Prevention of soil redepositions
3.	Surfactants	a. Wetting and penetrating soils b. Soil dispersion c. Prevention of soil re-deposition
4.	Chelating compounds	a. Water softening b. Mineral deposit control c. Soil displacement by peptizing d. Prevention of re-deposition
5.	Acids	a. Mineral deposit control b. Water softening.

The different classes of cleaning compounds vary in the efficiency of their actions, as listed in Table 12.5.

Table 12.5: Relative efficiency of the different classes of cleaning compounds

Function	Alkali		Polyphosphate	Surfactant	Acids	
	Mild	Strong			Mild	Strong
Dispersion	+++	++	+	+++	+	N
Dissolving	+++	++++	++	+	+++	++++
Emulsifying	++	+	++	++++	N	N
Peptizing	+++	++++	+	N	++	+++
Rinsing	+++	+++	++	++++	+	N
Saponifying	+++	++++	N	+	N	N
Sequestering	+	N	++++	N	N	N
Suspending	++	+	++	++++	N	N
Wetting	++	+	+	++++	+	N
Corrosion	+++++	++++	N	N	++	++++

N D none; + D low; ++ D medium; +++ D high; ++++ D extreme

Check Your Progress 2

1. What are the four steps involved in an efficient cleaning process?

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2. What are the characteristics of a good detergent?

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3. What do you understand by the following terms? Deflocculation, dispersion dissolving, emulsifying, peptizing, rinsing, saponifying, sequestering and wetting.

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12.4 CLEANING AGENTS

The entire class of cleaning compounds may be divided into two groups: a) the alkaline cleaners and b) the acid cleaners in addition to wetting, sequestering agents and surfactants.

i. Alkaline Cleaners

This group comprises of the basic alkalis, polyphosphates and the wetting agents. As none of these groups alone can fulfill all the functions of a cleaning agent, blends of their mixtures are generally used.

Basic Alkalis : Basic alkalis, such as soda ash, caustic soda, tri-sodium phosphate and sodium metasilicate are the ingredients in most of the common dairy cleaners. Two or more of them are used in combination as a rule to give the needed properties to the blended product. In addition to providing alkalinity for the cleaning process, they have other properties that affect the cleaning process in various ways. Some of these are detailed below.

a) Caustic soda (Sodium hydroxide, NaOH)

- High germicidal action
- Dissolves milk proteins
- Lacks deflocculating & emulsifying power
- Most corrosive on hands & metals

b) Soda ash (Sodium carbonate, Na_2CO_3)

- Most inexpensive
- Good buffering capacity. The good buffering capacity of soda ash makes it useful in solutions that are used over extended periods, as in hand bottle washing.
- Poor water softener
- Only fair deflocculating & emulsifying action
- Not suitable for hard water. When soda ash is used in hard water, calcium carbonate is precipitated and this pre-cipitate causes hard water spotting and helps develop milk stone deposits on dairy equipment. This may be prevented by using along with soda ash, higher phosphates in quantities large enough to sequester or tie up the water hardness.

c) Trisodium phosphate (Na_3PO_4)

- High solubility, deflocculating & emulsifying powers
- Fairly expensive
- Fair water softening capacity owing to the flocculent character and insolubility of the calcium and magnesium phosphates formed.
- Relatively corrosive on tin. Corrosive action can be reduced by adding meta-silicate as a protective agent in the mixture.
- Limited levels permitted. Concentrations are limited to 0.5 – 1.5% today to minimize phosphate levels in wastewater.

d) Sodium metasilicate ($Na_2SiO_3.\ 5H_2O$)

- High active alkalinity
- Excellent deflocculating & emulsifying properties
- Relatively non-corrosive despite strong alkalinity, protects metals from other corroding alkalis
- Good suspending abilities. Very effective in holding the soil in suspension during the washing operation so that complete cleaning is possible.

- Only a fair water softener. Fair water softening capacity because the calcium and magnesium silicates formed in hard water are floccu-lent and insoluble in solutions.

e) Modified sodas

- These are mixtures of soda ash and sodium bicarbonate. They are useful for manual washing operations, as they do not cause skin irritation.

ii. Acid Cleaners

Acid cleaners are used in dairy plants mostly to remove milk stones. They are also vastly employed in the cleaning of high-temperature processing machines. Equipment such as plate heat exchangers (pasteurizers), tubular heaters etc. are normally cleaned in two phases, the first phase with alkali and in the second phase, with acids. Acid type cleaners are also used in can washing.

The acids used in the dairy industry are blends of organic acids, inorganic acids, or acid salts usually with the addition of a suitable wetting agent. To be effective, an acid type detergent at the point of use should be at a pH of 2.5 or below. To be effective, it should work well in hard as well as soft water and should show a minimum of corrosion on dairy metals. The characteristics of acids normally used are listed below.

(i) Inorganic (mineral): muriatic acid, sulfuric acid, nitric acid, phosphoric acid)

- Corrosive, dangerous to metals
- High concentrations dangerous to handle
- Injurious to clothing
- Irritating to skin
- Low pH due to high degree of ionization
- Strong
- Under certain conditions some inorganic acids will precipitate insoluble salts

(a) Nitric acid (HNO_3): This inorganic acid is very good for removing milk stones and hard water scale. Although it attacks tin readily, it is suitable for aluminium and stainless steel (SS). Nitric acid is hazardous on the skin. It is widely used at strengths of 60% in automatic cleaning of plants (CIP – Cleaning-in-Place).

(b) Phosphoric acid (H_3PO_4): This is a mildly strong acid that replaces nitric acid in many dairy cleaning operations.

(ii) Organic (generally vegetable acids): acetic acid, lactic acid, hydroxyacetic acid, citric acid, levulinic acid, tartaric acid)

- Acid reaction tends to prevent and remove deposits of calcium and magnesium salts derived from either milk or water
- Can be combined with wetting agents, hence penetration
- Mild, stable, less corrosive
- Safe, gentle, harmless to hands in use-dilutions

iii. Wetting Agents

Water and most other aqueous solutions wet metal surfaces with difficulty unless these surfaces are free from fats and oils. Wetting or surface acting agents thus help to improve the wetting of surfaces. They also aid in penetration of the solution into capillary pores and minute spaces between the equipment surface and soil particles. The three groups of surfactant solutions are anionic (e.g. sulphosoaps, sulphated alcohols, alkyl aryl sulphonates), non-ionic (e.g. condensation products between ethylene oxide and an alkyl phenol) and cationic (e.g. quaternary ammonium compounds - QACs). Even at concentrations as low as 0.15% they reduce the surface tension of water to half. Increasing the concentration does not affect the degree of lowering of surface tension, and therefore, the amounts used in cleaners are usually small.

iv. Sequestering Agents

Sequestering and chelating agents prevent precipitation of salts formed due to hardness of water. There are three main classes of such agents.

a) Ethylene diamine tetra-acetic acid (EDTA) or its sodium salts
   - Heat stable
   - Compatible with Quarternary Ammonium Compounds (QACs)
   - Bacteriostatic property
   - Prevents redeposition

b) Sodium salts of gluconic and heptonic acids
   - Stronger than EDTA in chelating action of Ca and Mg
   - Requires high concentration of NaOH (~ 2.5%) for effectiveness

c) Polyphosphates (sodium tripolyphosphate, sodium pyrophosphate)
   - Not heat stable
   - Limited levels permitted. Environmental regulations limiting the levels of phosphates in waste waters, many cleaning compounds have removed or reduced phosphates, using chelating agents to eliminate the effects of water hardness. Concentrations may be limited to 0.5 to 1.5%.

v. Enzymes

Proteolytic enzymes are utilized, generally in combination with alkali and surfactants to increase the cleaning efficiency of equipment heavily soiled with protein. They have been especially useful in the cleaning of membrane processing plants. Lipases have been used also in a few cases to improve the removal of fat from surfaces.

vi. Chlorine

Chlorine increases the effectiveness of alkaline components tremendously (50-200/ ml chlorine increases the peptizing efficiency). As removal of protein films lessens the development of mineral milk stone deposits, it also reduces the build--up of mineral deposits. Chlorinated trisodium phosphate, hypochlorides and chloro-isocuranic are the commonly utilized chlorine compounds. The chlorine compound has to be compatible with the alkaline reagent, or else, it will result in the development of white deposits upon the equipment. Chlorinated alkalis do not function as bactericidal agents because of their high pH. The high pH also minimizes the corrosive activity of the chlorine component.

vii. Inhibitors and Antifoaming Agents

Inhibitors such as sodium sulphite are used to minimize the effect of acids and alkalis on metals. Sodium sulphite protects tinned surfaces, whereas sodium silicates protect aluminium and its alloys from mild alkalis. Antifoaming agents reduce the foam in detergent solutions. This, in turn, decreases the need for water.

Check Your Progress 3

1. List the properties of some acids used in dairy cleaning operations.

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2. Name some alkalis used for cleaning procedures in dairies. What are their characteristics?

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3. How do sequestering agents help a cleaning process?

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4. What is the role of enzymes in a cleaning process?

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12.5 SANITATION IN DAIRY PLANTS

Sanitizers are used as a part of the cleaning process, to reduce the load of microbial contaminants that may be present on milk/food contact surfaces. Most dairy sanitizers, when used appropriately, destroy a broad spectrum of microorganisms. Sanitation procedures should be performed after washing and immediately before processing. Most chemical sanitizers are inactivated by organic matter and are, therefore, ineffective on poorly cleaned surfaces. Dairy sanitizers should be non-toxic, non-corrosive, quick acting, be easily applied and economic. Sanitizers commonly used in the dairy industry may be classified as 1) thermal 2) radiation or 3) chemical Sanitizers.

i. Thermal Sanitizers

The effectiveness of thermal sanitizing depends on a number of factors including: microbial contamination load, humidity, pH, temperature and time.

Steam: The use of steam as sanitizer has limited application, as it is relatively expensive. It is also difficult to regulate and monitor contact temperature and time. Besides these, the by-products of steam condensation may hamper cleaning operations.

Hot Water: This is commonly used in many dairy plants. It involves circulating water of at least 77° C (determined at the outlet) for at least 5 minutes. Applying higher temperatures (>85° C) for longer times (10-15 minutes) are recommended to allow heat penetration into areas that are hard to reach. Hot water treatments should be followed by a cooling chemical sanitizer rinse. Hot water will often provide greater destruction and longer milk shelf-life than can be achieved with chemical sanitizers alone.

The main advantages of hot-water sanitization are as follow:

- easy to apply,
- penetrates into cracks and crevices,

- readily available,
- relatively inexpensive,
- relatively non-corrosive, and
- very effective over a broad range of microorganisms.

It also has a few limitations, namely:

- forms films or (or contributes to their formation), thereby shortening the life of equipment or their parts,
- high-energy costs,
- safety concerns for employees, and
- slow process which requires come-up and cool-down time.

12.6 RADIATION

Radiation is a non-conventional form of sanitizers used in the dairy where heat sensitive parts are to be sanitized. Radiation in the form of ultra violet (UV), high-energy cathode or gamma rays rapidly destroys microorganisms. UV radiations may be used on surfaces such as flexible packing materials for contact time in excess of 2 minutes to effectively destroy microbes.

Check Your Progress 4

1. Where in a dairy can radiation be used as a sanitizer and why?

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2. What are the advantages and disadvantages of hot water sanitizing?

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12.7 CHEMICAL SANITIZERS

The chemical sanitizer, as the name suggests is a chemical substance used at specific conditions to achieve the desired sanitizing effect. An ideal chemical sanitizer should have following characteristics:

- approved for food contact surface application,
- inexpensive,
- low in toxicity and corrosiveness,
- readily solubilized and possess some detergency,
- stable under all types of conditions,
- tolerant of a broad range of environmental conditions,
- destroy microorganisms rapidly, and
- have a wide range or scope of activity.

As no available sanitizer meets all of the above criteria, it is important to evaluate the properties, advantages, and disadvantages of available sanitizer for each specific application.

The chemical sanitizers used in a dairy are normally used as rinses, sprayed on to surfaces or circulated through equipment in CIP operations. Their major groups are discussed below.

i. Chlorine and its compounds

Chlorine, in its various forms, is the most commonly used sanitizer in any food processing plant. Chlorine compounds that are employed include liquid chlorine, hypochlorites, inorganic and organic chloramines. These are broad-spectrum germicides, which destroy microbes by the following means:

- acting on microbial membranes
- having a lethal effect on DNA
- inhibiting cellular enzymes involved in glucose metabolism and
- oxidizing cellular protein.

The maximum level of application is 200 ppm available chlorine, but recommended usage levels vary. For hypochlorites, an exposure time of 1 min at a minimum concentration of 50 ppm and a temperature of 24° C are recommended. For each 10° C drop in temperature, double the exposure time is suggested. For chloramines, 200 ppm for 1 min is recommended.

Chlorine has activity at a low temperature, is relatively cheap and leaves minimal residue or film on surfaces. The activity of chlorine is affected by pH, temperature and organic load. However, chlorine is less affected by water hardness when compared to other sanitizers (especially the quaternary ammonium compounds). The major disadvantage to chlorine compound is corrosiveness to many metal surfaces (especially at higher temperature). Health and safety concerns can occur due to skin irritation and mucous membrane damage in confined areas. At low pH (below 4.0), deadly Cl_2 (mustard gas) can form. In recent years, concerns have also been raised about the role of chlorine in the formation of potential carcinogens and therefore, its use as a disinfectant in drinking water.

Chlorine dioxide (ClO_2), being more environmental-friendly is currently being considered as a replacement for chlorine. ClO_2 has 2.5 times the oxidizing power of chlorine and thus, less chemical (1 to 10 ppm typically) is required. It has the disadvantage of being toxic and hazardous. Its highly concentrated gases can be explosive at risks higher than that for chlorine. As ClO_2 decomposes readily in the presence of light or at temperatures greater than 50°C, making it on the factory premises rather than procuring it from outside is recommended.

The methods of application of chlorine compounds include

- circulation with 200 ppm for 5 min through pumps and pipelines,
- immersion in a 200 ppm solution for 5 min,
- spraying large open vats with 300 ppm solutions for 5min contact time,
- fogging closed vats and tankers with 500 ppm solutions with atomizing devices, and
- brushing cheese vat surfaces, agitators, weighing vats and similar open vessels with 400 ppm solution.

ii. Iodine and its derivatives

Iodine has been used as an antimicrobial agent since the 1800s. It is normally marketed in combination with a surfactant as a carrier. These mixtures are termed as iodophors. Generally recommended usage for iodophors is 12.5 to 25 ppm for 1 min. The antibacterial activity of iodine is dependent on

It is generally thought that the bactericidal activity of iodine is due to

- cell wall damage,
- destruction of microbial enzyme activity, and
- direct halogenation of proteins.

Iodophors, like chlorine compounds have a very broad spectrum of activity, being active against bacteria, viruses, yeasts, molds, fungi and protozoa. As iodine is highly temperature-dependent (vaporizes at 49° C), it is suitable for lower temperature applications. The most active, but less stable form is the dissociated free iodine, prevalent at low pH. The amount of dissociation from the surfactant depends on the type of surfactant. The degree to which iodophors are effective depends on properties of the surfactant used in the formulation. Iodine has limited solubility in water. Organic matter and water hardness generally affect iodophors less than chlorine. Although iodine has been used since long in treating wounds, ingestion of iodine gas involves the risk of toxicity in closed environments. Iodine also leads to staining on some surfaces (especially plastics).

iii. Quaternary Ammonium Compounds (QACs)

Quaternary ammonium compounds (QACs) are a class of compounds, which are used widely in dairy and food sanitation operations. Since QACs are positively charged cations, their mode of action is related to their attraction to negatively charged materials such as bacterial proteins. It is generally accepted that the mode of action is at the membrane function.

These are non-irritant to skin and possess antibacterial and surfactant properties. They should be used with soft water. They are active and stable over a broad temperature range. QACs generally have higher activity at alkaline pH. QACs form deposits that are hard to remove on rinsing glass surfaces. An advantage of QACs in some applications is that they leave a residual antimicrobial film. However, this would be a disadvantage in operations such as cultured dairy products and cheeses, where microbial starter cultures are used.

Many QAC formulations can cause foaming problems in CIP applications. Under recommended usage and precautions, QACs pose little toxicity or safety risks. Thus, they are in common use as environmental fogs and as room deodorizers. However care should be exercised in handling concentrated solutions or use as environmental fogging agents.

iv. Acid Anionic Sanitizers

These formulations include an inorganic acid plus a surfactant, and are often used for the dual function of acid rinse and sanitization. Unlike QACs, they are negatively charged. Their activity is moderately affected by water hardness. Their low use pH, detergency, stability, low odor potential, and non-corrosiveness make them highly desirable in some applications. Disadvantages include relatively high cost, a closely defined pH range of activity (pH 2 to 3), low activity on molds and yeasts, excessive foaming in CIP systems and incompatibility with cationic surfactant detergents.

v. Fatty Acid Sanitizers

Fatty acid or carboxylic acid sanitizers have been in use since the 1980s. Typical formulations include fatty acids plus other acids such as phosphoric or organic acids. These agents also have the dual function of acid rinse and sanitization. The major advantage these offer over anionic-acid sanitizers is lower foaming potential. Fatty acid sanitizers have a broad range of activity, are highly stable in dilute form, are stable to organic matter and also to high temperature applications. They have low activity above pH 3.5-4.0, are not very effective against yeasts and molds and some formulations lose activity at temperatures below 10° C. They are corrosive to soft metals and can degrade certain plastics and rubber.

Check Your Progress 5

1. What is the mode of action of iodophor in bacterial destruction?

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2. What are the different ways of using chlorine as a sanitizer in a dairy?

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12.8 FACTORS AFFECTING EFFICACY OF SANITIZERS

i. Physical Factors

Surface Characteristics : All equipment surfaces must be thoroughly clean prior to sanitization. Since the effectiveness of sanitization requires direct contact with the microorganisms, the surface should be free of cracks, pits, or services, which can harbor microorganisms. Surfaces which contain biofilms (films formed by the ability of microorganisms to attach and grow on food and food-contact surfaces under favorable conditions) cannot be effectively sanitized.

Exposure Time : In general, the longer time a sanitizer chemical is in contact with the equipment surface, the more effective the sanitization effect; intimate contact is as important as prolonged contact.

Temperature : Temperature is positively related to microbial destruction by a chemical sanitizer. Owing to the corrosive nature of most chemical sanitizers, high temperatures (about 55° C) should be avoided.

Concentration : Although the activity of a sanitizer increases with the increased concentration in general, it is always best to study the properties of the chemical before using it. Employing sanitizer concentrations above recommendations can be corrosive to equipment and in the long run lead to less cleanliness.

Soil : The presence of organic matter dramatically reduces the activity of sanitizers and may, in fact, totally inactivate them.

ii. Chemical Factors

pH : Sanitizers are affected by the pH of the solution. Many chlorine sanitizers, for example, are almost ineffective at pH values above 7.5.

Water properties : Certain detergent residues contain inactivators that react chemically with sanitizers giving rise to non-germicidal products. Thus, it is important that surfaces be rinsed prior to sanitization.

iii. Biological Factors

The microbiological load can affect sanitizer activity. The type of microorganisms present can also influence the effectiveness of sanitizer. Sanitizers also vary in their effectiveness against yeasts, mold, fungi and viruses. Certain sanitizers are more active against gram positive than gram-negative microorganisms and vice versa. Spores are more resistant than vegetative cells.

Check Your Progress 6

1. What are the physical factors that influence the efficiency of a sanitizer?

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2. List and explain the chemical factors that affect sanitizer efficiency.

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12.9 LET US SUM UP

Cleaning and sanitization are essential operations followed in dairy and food processing plants. They ensure cleanliness and hygiene of the equipments and surroundings and also ensure that the products meet the safety standards. Several agents are used for efficient cleaning. They vary in their efficacy and mode of action and hence, it may be necessary to choose and blend different types of such agents. Cleaning agents include alkaline cleaners, acid cleaners, wetting agents, sequestering agents, enzymes, chlorine, inhibitors and antifoaming agents. Sanitization may be carried out by thermal sanitizers (steam, hot water), radiation and chemical sanitizers such as chlorine compounds, iodine derivatives, quaternary ammonium compounds (QACs). Several physical, chemical and biological factors influence the efficiency of the sanitizers.

12.10 KEY WORDS

Cleaning : Process of removing dirt and soil from a surface.

Sanitization : Process by which equipment or a material is made safe for human beings.

Surfactant : An agent that helps to improve the wetting of surfaces and aids in penetration of detergent into crevices and pores of the equipment being cleaned.

Sequestering agent : Also known as chelating agents, these prevent precipitation of salts formed due to hardness of water.

Long-life milk : Milk, which has been given such processing and packaging as to reduce the bacterial load of the milk. The keeping quality of the milk is thus increased.

12.11 SOME USEFUL BOOKS

De, S. (1980). Outlines of Dairy Technology. Oxford University Press. Delhi.

NDDB. (1990). Milk Products Manual. A practical guide for dairy plant personnel.

Robinson, R.K. (1994). Modern Dairy Technology. Vol. 1 and 2. Chapman and Hall. London, Glasgow, New York.

Sabikhi, L. (2004). Advances in Cleaning and Sanitation in Food Industry. Compendium of the 17th Short Course conducted by the Centre of Advanced Studies in Dairy Technology. National Dairy Research Institute, Karnal. March 3-24.

12.12 ANSWERS TO CHECK YOUR PROGRESS

Your answer should include the following points:

Check Your Progress 1

1) i. The meaning cleaning and sanitization besides their importance in dairy processing.

2) i. List the criteria that are kept in mind while choosing a detergent.

3) i. Explain milk stone and milk soil and compare the two.

4) i. Explain in brief the effect of water hardness on the cleaning process.

Check Your Progress 2

1) i. List the major stages in the cleaning process.

2) i. Include the characteristic requirement of a detergent.

3) i. Define and explain all the terms mentioned.

Check Your Progress 3

1) i. Some important acids used in dairy cleaning and describe briefly, their properties.

2) i. Include the names of a few alkalis used in dairy cleaning processes and briefly explain their characteristics.

3) i. How sequestering agents work along with detergents in a cleaning process.

4) i. Why enzymes are used in the cleaning process.

Check Your Progress 4

1) i. Reflect the meaning of radiation, how it helps in sanitization and where it is employed.

2) i. List the pros and cons of hot water sanitizing.

Check Your Progress 5

1) i. How iodophors kill microbial organisms.

2) i. The process of using chlorine as a sanitizer and also the different strengths recommended for different sanitizing operations.

Check Your Progress 6

1) i. Explain the physical factors that affect the performance of a sanitizer.

2) i. Describe the chemical factors that influence the include action of a sanitizer.