Cleaning and Sanitizing Milk Utensils and Dairy Equipment

- The shelf life of the products depends upon effective programme to assure that all products-contact surfaces of equipment are properly cleaned and sanitized. Any milk solids not removed completely from dairy equipment serve as a culture media and in the presence of moisture permit bacteria to reproduce.
- **Cleaners:** They are complex mixtures of chemicals that achieve a specific purpose in washing equipment to remove all milk solids and other materials in order to leave a clean surface satisfactory for sanitization.

Characteristics of a good cleaner:

1- Economical.

2- Nontoxic.

3- Noncorrosive.

4- Noncaking and non dusting.

5- Easy to measure or meter.

6- Stable during storage.

7- Easily and completely dissolved.

When selecting a cleaning agent, the following major consideration is necessary:

1- Nature of the soil to be cleaned.

2- Water characteristics.

3- Application method i.e. for physical removal of residual soil.

4- You must know the chemistry of cleaning e.g. Do not try to mix acid cleaners with chlorinated alkaline cleaners because such mixture will liberate free chlorine gas which is poisonous.

5- Area and kind of equipment to be cleaned.

6-prevent residual microbial growth by allowing equipment to drain dry.

• **Soil:** It is considered to be not only dirt and dust materials but also organic materials that could be encountered in a food service or processing facility. Two kinds of deposit may be found on milking equipment. Organic deposits come from the fat, protein, and sugar found in milk. Mineral deposits come from inorganic salts (such as calicium, magnesium, and iron) that are in the water and milk.

Classification of soil according to the method of removal:

I-Soils soluble in water: Only include many inorganic salts, sugars, starches and minerals.

II-Soils soluble in a cleaning solution

A. Acid-soluble soils: e.g.

- **Water stone**: Whitish scale or deposits that adhere to metal surfaces of equipment or heat exchangers due to reaction between various alkaline cleaners and chemical constituents of water having non carbonate hardness. A portion of mineral found in water may be deposited when water is heated to 80°C or higher. Hard water scale: calcium and Magnesium carbonate.

• **Milk stone:** is a combination of the organic and inorganic materials. A hard coating of water stone and milk film interaction are precipitated by heat on a metal surface. An acid cleaning compound is the most appropriate for removal of inorganic deposits. When equipment is not properly cleaned, milk stone will build up to a point where it can be seen. Deposit on milking equipment provides a place for bacteria to grow and multiply.

- **B-Alkali- soluble soils:**

- Fatty acids, blood, proteins and other organic deposits are solubilized by an alkaline solution. An alkaline cleaner is more effective in removing organic deposits.

III- Soils insoluble in cleaning solution: They must be loosened from the surface on which they are attached and subsequently suspended in the cleaning media.

Soil deposited in cracks, crevices and other uneven areas are difficult to remove especially if deposition is in hard to reach areas of equipment as opposed to an easily accessible and smooth surface. Ease of soil removal from a surface depends on surface characteristics such as smoothness, hardness, porosity and wettability.

Soil removal from the surface consists of three sub processes as follows:

1-Separation of soil from the surface of equipment to be cleaned:

a. Through mechanical action of high-pressure water, steam, air and scrubbing, agitation.

b. Through alteration of the chemical nature of soil (e.g .reaction of an alkali with a fatty acid to form soap).

c. Without affecting the chemical nature of the soil. Surfactants that reduce surface tension of the cleaning medium i.e. water to allow more intimate contact with the soil. Increased temperature of the cleaning compound and water can increase soil separation from the surface.

2- Soil dispersion in the cleaning solution:

- Dispersion can be considered dilution of soil in a cleaning solution. Dispersion of insoluble soils is important to achieve disintegration of Soil into smaller particles or droplets with subsequent transport away from the cleaned surface.

3-Prevention of redeposition of dispersed soil.

Redeposition of dispersed soil can be reduced by:

a. Removal of the dispersed solution from association with the surface being cleaned.
b. Continued agitation of the dispersed solution while still in association with the surface to stop settling of the dispersed soil.
c. Prevention of any reaction of the cleaning compound with water on the soil.
d. Maintenance of the soil in a finely dispersed condition to avoid further entrapment on the cleaned surface.
e. Elimination of the residual solution and dispersed soil which may have collected on the surface by flushing or rinsing the cleaned surface.

Necessity for cleaning:

- Dairy food particles and other debris provide the required nutrients needed for microorganisms such as bacteria, yeasts and moulds to proliferate. Therefore, thorough removal of existing soil through use of cleaning compounds is necessary for physical cleaning to proceed in sanitizing to provide a microbiologically clean environment. Water used for cleaning should be free of microorganisms, clear, colorless, noncorrosive and free of minerals (soft water).

Selection of cleaning compounds:

Functions required of cleaner ingredients:

The cleaner ingredients should have the following properties:

1-Suspension:

Processes by which a cleaning compound loosen, lifts and hold soil particles in solution.

2-Saponification:

A chemical reaction between an alkaline cleaning material and the animal fat or vegetable oil to produce a soluble soap and will act as solubilizer and dispersant for remaining soils.

3-Emulsification:

Physical breakdown of fats and oils into smaller particles which are dispersed or distributed throughout the solution i.e. uniformly mixed with water used.

4-Surfactant:

This is a complex molecule which when added to water reduces the surface tension of water to permit a more intimate contact between the soil deposit and the cleaning solution .This additive is responsible for emulsification action.

5-Wetting (penetration):

This is caused by the resultant action of a surfactant which is capable of wetting or penetrating the soil deposit to start the loosening process from the surface (affect rapid removal of the soil).

6-Rinsibility:

This is the ability of a cleaning compound to be easily removed from a surface with a minimum amount of residue.

7-Peptizing (Hydrolysis of protein):

This process involves formation of a colloidal solution from a material which is partially soluble, that is by the action of alkaline materials on protein soils.

8-Chelating agent:

Removal of water hardness constituents are formed by the formation of a soluble complex or chelate (prevent hardness constituents and salt of calcium and magnesium from depositing on equipment surfaces by binding these salts to their molecular structure).

Most organic agents are EDTA salts of Ethylene diamine tetra- acetic acid.

9-Sequestrant agent (consist of polyphosphates):

A chemical agent which ties up calcium and Magnesium Ions in a solution to prevent the Ions from forming insoluble curds with the cleaning detergent which result in precipitation deposits e.g. Polyphosphates. Both chelating and sequestrant agents have the ability to make water soft by tying up metallic Ions in a manner to prevent their precipitation.

10- Corrosive action: Low corrosive action on the surface for which they are used.

11- Dissolving action: Good dissolving action or the ability to dissolve proteins (peptonize).

12-Deflocculation or Dispersion: The ability to break up dirt or aggregates or flocs into individual particles (by wetting agent).

13-Germicidal power: Effective in killing microrganisms.

Classification of cleaning compounds:

I-Alkaline cleaning compounds:

The principal activity is the dissolving of the milk protein and saponification of the milk fat ,so that the deposits can be removed from all surfaces.

A-Strongly alkaline cleaners:

These compounds have strong dissolving powers and are very corrosive and can burn, ulcerate and scar skin .Inhalation of the fumes or mist may cause respiratory tract damage.

Sodium hydroxide (NaOH) or called **caustic soda**. The addition of silicates (SiO_2) to Sodium hydroxide tends to reduce the corrosiveness and improve penetrating and rinsing properties of Sodium hydroxide Stainless steel is resistant to its corrosive action .Aluminum is corroded by it.

B-Heavy Duty Alkaline cleaners:

a-Sodium Metasilicate ($Na_2SiO_3 .10H_2O$).

b- Sodium Hexametaphosphate.

c-Sodium pyrophosphate.

d-Trisodium phosphate.

e-Sodium tripolyphosphate (STPP).

These cleaners are frequently used with cleaning -In- place (CIP) and have excellent capabilities for removing fat.

C-Mild Alkaline cleaners:

Mild alkaline cleaners are frequently in solution and are used for hand cleaning lightly soiled areas.

a-Sodium carbonate (Soda ash) 0.25%.

b- Tetrasodium pyrophosphate.

C-Alkyl Aryl Sulfonates.

1-Organic acid such as:

A- Citric acid.

B- Tartaric acid.

C- Sulfamic acid.

D- Gluconic acid.

All the organic acids are excellent water softeners that rinse easily and are not corrosive or irritating to the skin.

2-Inorganic acids such as:

A- Hydrochloric acid.

B- Hydrofluoric acid.

C- Sulfuric acid.

D- Phosphoric acid.

E- Nitric acid.

- Although inorganic acids are excellent for removing and controlling mineral deposits, they are extremely corrosive and irritating to the skin. Some of these cleaners, on heating produce corrosive toxic gases which can ulcerate lungs. Strongly acid cleaners are used to remove encrusted surface matter and mineral scale.

- Corrosion inhibitors such as potassium chromate for nitric acid solution or butylamine for hydrochloric acid detergents may be added. Phosphoric acid and hydrofluoric acid both clean and brighten certain metals.

Sanitizers:

- The major purpose of sanitizers is to reduce the pathogenic and spoilage microorganisms of food processing and food preparation facilities and equipment. Control of these organisms is essential to ensure a safe and wholesome product with an adequate shelf life.

Chemical sanitizers:

The ideal chemical sanitizers should have the following properties:

I-Microbial destruction properties:

The effective sanitizer should have uniform, broad –spectrum activity against vegetative bacteria, yeasts and molds also produce rapid kill.

2-Environmental resistance:

An ideal sanitizer should be effective in the presence of:

a. Organic matter (soil load).

b. Detergent and soap residues.

c. Water hardness and pH.

3- Good cleaning properties.

4- Nontoxic and nonirritating.

5- Water soluble in all proportions.

6- Acceptable odor (No odor).

7- Stable in concentrate and use dilution.

8- Easy to use.

9- Readily available.

10- Inexpensive.

11- Easily measured in use solution.

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Sanitizer efficiency:

- Sanitizers should produced 99.99% kill of 75 to 125 million *E. coli* and *Staph aureus* within 30 seconds after application at 20°C. The effectiveness of chemical sanitizers can be influenced by a number of factors such as:

1. Concentration.
2. pH.
3. Cleanliness of equipment.
4. Temperature.
5. Presence of interfering substances.

- In the water in which they are used, chemical sanitizers should be used before processing starts again, generally the next day or in the next shift.

- **Chlorine compounds**: Can be classified as

a. Liquid chlorine.

b. Hypochlorites.

c. Inorganic chloramine.

d. Organic chloramines and chlorine dioxide.

Antimicrobial activity:

- When liquid chlorine and Hypochlorites are mixed with water, Hypochlorous acid will be formed. Hypochorous acid (HOCl) is the most active of the chlorine compounds to kill the microbial cells through inhibition of Glucose oxidation by chlorine-oxidizing sulfhydryl groups of certain enzymes important in carbohydrate metabolism i.e. through enzyme inactivation and protein denaturation.

Other modes of chlorine action that have been proposed are:

Disruption of protein synthesis.

B- Oxidative decarboxylation of amino acids to Nitriles and aldehydes.

C- Reactions with nucleic acid, purines and pyrimidines.

D- Unbalanced metabolism after the destruction of key enzymes.

E-Induction of deoxyribonucleic acid (DNA) lesions with the accompany loss of DNA- transforming ability.

F- Inhibition of oxygen uptake and oxidative phosphorylation coupled with leakage of some macro molecules.

G-Formation of toxic N-chlorderivatives of cytosine and certain of chromosomal aberrations. The chemical properties of chlorine are such that when liquid chlorine (Cl_2) and hypochlorites are mixed with water, they hydrolyze to form hypochlorous acid Hypochlorous acid will dissociate in water to form a hydrogen Ion (H^+) and a hypochlorite Ion (OCl^-).