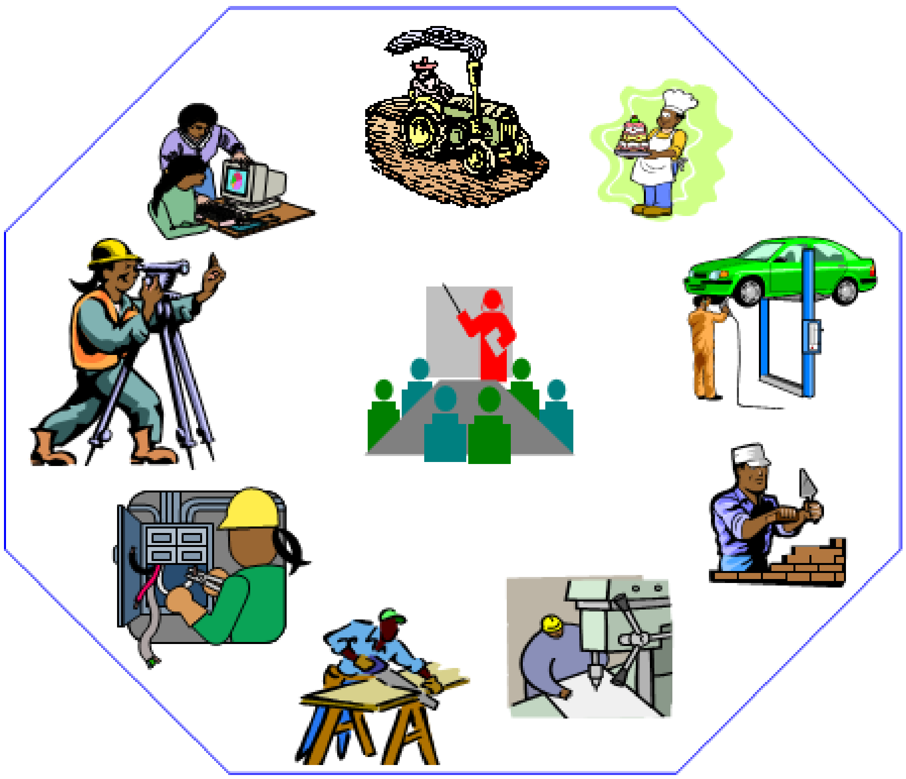
Dairy Products Processing
Level-III

Based on October 2019, Version 2 OS and March. 2021, V 1 Curriculum



Module Title: - Performing pasteurized milk production operation

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LG #29	LO #1- Apply sanitation procedures

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Keeping clean storage area of bulk milk and other inputs
- Cleaning and sanitizing all surface area
- Applying stringent personal hygiene procedures
- Maintaining separation of raw milk area from pasteurized milk operation
- Applying multi-phase cleaning system
- Recording food safety information

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Keep clean storage area of bulk milk and other inputs
- Clean and sanitize all surface area
- Apply stringent personal hygiene procedures
- Maintain separation of raw milk area from pasteurized milk operation
- Apply multi-phase cleaning system
- Record food safety information

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, ask your trainer for further instructions or go back to "Operation sheets".

Information Sheet 1- Keeping clean storage area of bulk milk and others inputs

1.1. Introduction

The handling of milk inside the plant is the key element in maintaining its quality. On arrival of milk is graded for acceptance/ ejection, weighed, sampled for testing, cooled and stored under refrigeration until next unit operation for preliminary processing in the dairy plant.

The first operation in a dairy plant is reception, chilling and storage of milk. Raw milk is pumped from the dump tank to the storage tank through a filter and chiller. The purpose of storage tank is to hold milk at low temperature so as to maintain continuity in milk processing operations and prevent any deterioration in quality during holding and processing period.

1.2. Bulk milk storage

Bulk milk tank" means a stationary storage tank used for the cooling and holding of raw milk on a dairy farm and includes the fixtures and equipment used in connection with it; Milk may be delivered to the dairy plant in cans or tankers.

Figure 1 Bulk milk storage tank

The milk received in these systems has to be sampled, graded, emptied, measured (weight or volume) and bulked to provide continuous supply of milk to the pasteurizer.

1.3. Storage tank

- Storage tanks enable milk to be stored for longer period of holding. They must be designed for easy cleaning and sanitization, preferably through CIP process.

- Storage tanks consist of a stainless steel inner shell, a layer of insulation, an outer jacket and necessary fittings for inspection control and cleaning.

In many storage tanks, chilled water circulation system is provided to maintain the temperature of milk. All closed type of tanks must be equipped with a manhole round or oval shaped to permit access to the interior for cleaning and inspection.

1.4. Types of Storage Tank

1.4.1. Insulated storage tanks

Figure 2 Insulated storage tank

These tanks merely stores the milk at a temperature at which it is filled. In most cases, depending upon the quality of insulating material, there is tendency of rise in the temperature of milk with long storage. These tanks are made up of a stainless steel inner shell, a layer of insulation and an outer jacket of stainless steel or mild steel.

1.4.2. Refrigerated tanks

It has built-in refrigerating facilities so that stored milk is chilled as and when required. This additional feature of maintaining the desired temperature is an added advantage in these tanks. In refrigerated tanks, the hollow space between the inner and outer shells is used for circulating the cooling medium.

1.4.3. Horizontal or vertical tanks

Horizontal tanks require more floor space than vertical ones, but need less headspace. For handling small volumes, horizontal tanks may be used. Now-a-days, milk is stored in vertical storage tanks commonly known as silos. These are vertical cylindrical tanks, installed outside the building. In these silos, milk feeding is from same discharge valve installed near the bottom.

1.5. Chilling Equipments

Figure 3 Chiller

1.5.1. Surface cooler-

It can be either an individual unit or cabinet type. The latter consists of two or more individual units, compactly assembled and enclosed in a cabinet. It is usually larger than those used on the farm/chilling centre.

1.5.2. Plate chiller

It is widely used for large scale cooling of milk of 5000 to 60,000 lit./day at the chilling centers. They are efficient, compact and easily cleanable. In chiller the gasket plates are tightly held between the plates. These plates are so arranged that milk flows on one side of plate and cooling medium on the other

Figure 4 Plate chiller

There is a counter current flow between the milk and the chilled water through alternate plates. It helps in efficient transfer of heat to the cooling medium resulting in quick chilling of milk. The chilled milk flows from the plate cooler to the insulated storage tank at 4°C.

1.5.3. Internal tubular cooler

It is a continuous cooling system consisting of a stainless steel tube about 2.5 – 5.0 cm in diameter surrounded by a similar tube, forming a concentric cylinder. Several such tubes may then be connected in series to obtain sufficient cooling. The cooling medium flows counter current to the milk flow.

1.5.4. Vat/tank cooling

It is suitable for batch cooling, especially of small quantity. It consists of a tank within the tank, with the space between the two being used for circulation of the cooling medium, by either pump or main pressure. An agitator is provided to agitate the milk for rapid cooling.

1.6. Cleaning procedure bulk milk storage

A. **Prewash:-** the removal of gross dirt particles before applying the clening solution.
B. **Soaking:-** immersing in the cleaning solution. The cleaning solution should be hot around 50^{o}C and the equipment permitted to soak for 15-30 minutes before manually or mechanically scrubbed.

C. Spray method:- Spraying cleaning solution on the surface. This method uses a fixed or portable spraying unit with either hot water or steam

Figure 5 Foaming equipment

Foaming:- Utilizes a concentration blend of surfactant developed to be added to highly concentrated solution of either alkaline or acid cleaners. Produces stable, copious foam when applied with a foam generator. The foam clings to the surface to be cleaned, which increases. **This may be accomplished flushing the equipment surface with cold or warm water under moderate pressure.**

D. Washing: - the application of cleaning compound.

- Contact time of the liquid with the soil,
- Prevents the rapid drying and runoff of the liquid cleaner,
- Thereby improving cleaning

E. Rinse:- to remove any detergent residue which can lease a sticky film, so rinse once more with hot water only

F. Disinfection/sanitization/:- A process either by using heat or a chemical concentration that will reduce the bacterial count including pathogens, to a safe level on utensils and equipment after cleaning

Self-check 1	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. Write the operation perform in milk reception plate form?(2pts)
2. List type of storage tank?(2pts)

Test II Write true if the statement is correct and false if statement is incorrect

1. Pasteuirzation is the first operation in a dairy processing plant (2pts)
2. Adulteration of milk with water is detecting by lactometer (2pts)
3. Milk may be held in chilled condition < 5°C in the tank for up to 72 hours between reception and processing. (2pts)

Note: **Satisfactory rating - 8 points Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information Sheet 2- Cleaning and sanitizing all surfaces

2.1. Introduction

The dairy industry is somewhat different from other industries so far as hygiene is concerned, and is comparable with medical practice. Every detail of equipment and building design must have medical rather than industrial approach. Every item of equipment which comes into contact with milk must be cleaned thoroughly and sterilized every day. In milk processing area that are not adequately cleaned and sanitized can be a source of microorganisms that cause spoilage and illness. When the environment is favorable bacteria, moulds and yeast multiply in food.

Milk spoilage microorganisms reduce shelf life by causing changes in texture, flavor and/or smell. These changes make the milk undesirable or unsuitable for human consumption. Unclean milk processing surfaces provide an ideal environment for the growth of microorganisms. When milk comes in contact with unclean surfaces, milk-spoilage or pathogenic microorganisms can be transferred to the milk being processed.

2.2. Cleaning and sanitation

Cleaning:- is the removal of unwanted material from production equipment and production areas. Removing leftover particles eliminates many microbes, their food source and other physical debris that can contaminate future batches of food.

Appropriate cleaning chemicals may be applied manually or mechanically to equipment that remains assembled (clean-in-place) or that is partially or fully disassembled (clean-out-of-place). Most often, a combination of methods is used.

Sanitizing:- is the treatment of a clean surface with a chemical or physical agent to reduce microorganisms that cause disease and/or spoilage to levels considered safe for public health.

The choice of cleaning chemicals is determined by:

- The type and/or combination of types of unwanted matter (soils)
- The composition and area of the surface to be cleaned
- The method of cleaner application
- Characteristics of the water used.

Chemical cleaners may be applied manually, in a soak solution, as a low-pressure wash or using an automated CIP system. Each application method has advantages and disadvantages. Most food processing facilities use a combination of these procedures.

2.3. Manual Cleaning

Advantages:

- Low-cost equipment required; affordable in small operations
- Adaptable to all types and sizes of facilities, equipment and tools
- Milder, generally safer, chemicals used
- Immediate observation of cleaning efficacy

Disadvantages:

- Effectiveness often depends on worker industriousness
- Cleaning can be inconsistent
- Labour intensive
- Mild chemicals required for safe human handling may be ineffective
- Greater opportunity for cross-contamination by workers and tools

2.4. Clean-out-of-Place (COP) System

Advantages:

- Minimal labour required

- Longer period of time for cleaner to act

Disadvantages:

- Requires disassembly
- Soak tank often requires agitation to be effective
- Incorrect cleaner can damage equipment because of extended contact time

2.5. Low-Pressure Wash

Advantages:

- Can be used for both rinsing and application of foam cleaners
- Fast application of cleaners on walls, floors and stationary equipment
- Easier to reach "hard-to-clean" areas

Disadvantages:

- Too high pressure may cause cross-contamination by aerosols and overspray
- Low-pressure systems generally require higher volumes of water
- Loss of water temperature during application

2.6. Cleaning and Sanitation Methodology

Because sanitizing requires direct contact between the sanitizer and the microorganisms to be killed, surfaces must be clean before a sanitizing solution is used. The presence of organic matter significantly reduces the killing power of sanitizing solutions.

Steps are required for cleaning and sanitizing:

1. Remove materials from the area to be cleaned.
2. Remove soil and other debris as possible
3. Rinse walls from the top down, equipment from the top down and in the direction of product flow, and floors.
4. Apply cleaning agents to loosen any remaining "invisible" soil and keep it in suspension.
5. Apply to walls, floors and equipment, in that order, at the correct concentration and temperature.

6. Before reassembling equipment, someone not involved in the actual cleaning should conduct a organoleptic (sight and smell) inspection.
7. Necessary to scrub areas that have been missed.
8. Allow cleaning agents to stand for an appropriate time, then rinse.
9. Be careful not to use excessive water pressure that may create equipment-contaminating aerosols.
10. Apply sanitizing solution at the correct concentration, the correct temperature, and for the appropriate contact time to floors first.
11. After the use of some sanitizers and certain concentrations of others, rinsing with potable water is necessary.
12. After rinsing, the surface should be air dried to eliminate chemical odours.
13. A record indicating completion of cleaning and sanitation activities should be kept.

2.7. Clean-in-Place (CIP) System

Advantages:

- Reduced labour required with automation
- More consistent, effective cleaning
- More powerful cleaners can be used
- Optimal use of water and cleaner
- Cleans difficult to access areas (e.g., inside pipes)

Disadvantages:

- Higher capital cost; higher maintenance costs
- Not all equipment can be cleaned in place
- Easy to ignore automated systems; routine monitoring is necessary to ensure that the system is working effectively

2.8. Dairy Soil

Dairy soil comprises largely of fat, protein, insoluble calcium salts from water and/or detergent and bacteria. Dairy soils are composed of 42.0 - 67.0% ash, 3.6 - 18.0% fat, 4.5 - 44.0% protein and 2.7-8.7% moisture. Continued deposition of the soil leads to accumulation of larger and harder particles that are known as milk stones.

Types of dairy soil

A. Those that dissolve in water:-

- Simple carbohydrates like sugars
- Some simple mineral salts (NaCl)
- Some starches

B. **Those that dissolve in alkali:-**

- Proteins
- Starches associated with proteins or fats
- Bacterial films(bio films)

C. Those that dissolve in Acids

- Hard water hardness salts (Ca and Mg salts)
- Complex mineral films ((Fe Mng deposits**)**

D. Those that dissolve with surfactants

- Fats ,oils and greases
- Many food residues
- Inert soils such as sand, clay or fine metals
- Some bio films

2.9. Detergents

- A good detergent should be highly penetrable,
- Be able to dissolve calcium salts deposited over the surface and keep them remain in solution to check re-deposition, possess moderate foam generation capacity, be non-corrosiveness and have a high bactericidal effect.
- It should also have the ability to soften water used for washing, good wetting power to assist the water to penetrate the greasy surface besides deflocculating and rinsing properties.
- It must also be non-corrosive and non-toxic.

2.10. Detergents use in the dairy industry

A. **Alkaline detergents-** Alkalis form the bulk of most dairy detergent compounds. The alkalis commonly used are soda ash, caustic soda, sodium bicarbonate, sodium metasilicate and trisodium phosphate

B. **Water softners-** Hard water is not suitable for cleaning operations as some ingredients of the cleaning material precipitate the hard salts that adhere to equipment surfaces or settle at the bottom on standing. Hard water also causes spotting and promotes water-stone and milk-stone formation besides possessing soap-destroying and scale-forming properties. Replacing 5-10 parts of soda ash in the detergent mixture with an equivalent proportion of calgon takes care of the hardness in water.

C. **Synthetic detergents-** They have good surface-active and emulsifying properties and improve wetting or penetrating power by lowering the surface tension of water.

D. **Acid cleaners-** Acid cleaning agents are used in combination with alkaline agents to remove milk stone deposited on metal surface exposed to heat. Phosphoric acid, diluted with water (140 g in 45.3 kg) is very commonly used.
   - Used on mineral deposits e.g. Scale
   - Used in ware-washing machines, steam tables
   - Used for rust stains and tarnish on copper and brass e.g. Nitric acid

2.11. Selection of Detergents

The selection of detergents in a dairy plant is very important. There is no 'universal detergent' that could be applied to all situations. For example,

- sodium hydroxide-(caustic-soda)-based detergents, when in contact with aluminium, galvanized and other soft metal surfaces leads not only to rapid corrosion, but also to the release of hydrogen gas, which can form an explosive mixture with air.
- Electrical installations and moisture sensitive processes require minimal use of water and therefore, detergents which contain non-toxic and non-tainting alcohols would be needed.
- The chemical composition of the local water supply will also affect the selection of detergents. With hard water, when alkaline detergents are used at elevated

temperatures, there is a chance of scale deposition on plant surfaces. The result is unattractive and, if it occurs on a direct or indirect food contact surface, it may become a source of physical and microbial contamination. Sequestering and dispersing materials are used in alkaline formulations to prevent scale deposition.

- Several factors specific to individual applications also affect detergent selection. Fermentative applications, for example, will generate carbon dioxide, which will rapidly break down sodium hydroxide to sodium carbonates. These will subsequently precipitate as process generated scale.

In response to these challenges, formulated detergents meant for specific use and based on acids, alkalis or neutral materials have come to the market.

- Acids are effective in dissolving mineral salts and in the hydrolysis of proteins, while
- Caustic alkalis will break down carbonized deposits and saponify fats and oils.
- Neutral materials such as sequestrants and surfactants are used to prevent precipitation of water hardness salts in hot or alkaline solutions, and for wetting of soil, soil penetration, soil suspension and surface tension reduction respectively.

2.12. Classification of sanitizers

A. Thermal Sanitizers- Thermal sanitizers are very effective, their efficacy depending on the extent of microbial contamination, humidity, pH, temperature and time.

i). Steam- Steam is effective as a sanitizer, its application is limited because of its high cost. By-products of steam condensation can cause hurdles in the cleaning operations. It is also difficult to regulate and monitor contact temperature and time.

ii). Hot water- Hot water as a sanitizer is relatively inexpensive, easy to apply and readily available. It is relatively non-corrosive and penetrates into cracks and crevices and can be effective over a broad range of microorganisms. However, the process requires come-up and cool-down time and is, therefore, slow. The energy costs are high. Safety aspects also need to be taken care of. The process also has the disadvantages of forming or contributing to film formations and shortening the life of certain equipment or parts such as gaskets.

B. Radiation- Radiation in the form of ultra violet, high-energy cathode or gamma rays destroys microorganisms rapidly. UV rays in the wavelength of 25 Angstrom units has been used extensively in the form of a sterilizing lamp to destroy undesirable organisms for foods on assembly lines, bakeries and other similar applications. UV radiations (contact time just more than 2 min) are very useful on surfaces that are heat sensitive such as flexible packing materials.

C. Chemical Sanitizers - Chemical sanitizers are also called low-temperature sanitizers. The ideal chemical sanitizer for food contact surface application should have a wide range of activity, destroy microorganisms rapidly,

- Be stable under all types of conditions,
- Be tolerant of a broad range of environmental conditions,
- Be readily soluble and possess some detergency and
- **B**e low in toxicity and corrosiveness, and be inexpensive.

As no available sanitizer meets all of these criteria, it is important to evaluate the properties, advantages and disadvantages of available sanitizer for each specific application. The most commonly used chemical sanitizers in dairy industry are chlorine, iodine and quaternary ammonium compounds (QACs).

A. Chlorine-based sanitizers- Chlorine compounds are broad-spectrum germicides, which act on microbial membranes, inhibit cellular enzymes involved in glucose metabolism, have a lethal effect on DNA and oxidize cellular protein.

Chlorine has activity at a low temperature, is relatively cheap, and leaves minimal residue or film on surfaces. It is non toxic, practically colourless, odourless and tasteless. Commonly used chlorine compounds include liquid chlorine, hypochlorites, inorganic chloramines and organic chloramines. The maximum allowable level for no-rinse applications 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, a recommended exposure time is doubled.

- For chloramines, the recommended combination is 200 ppm for one min. The activity of chlorine is severely affected by factors such as
  - ✓ pH, temperature and organic load
  - ✓ It is also relatively resistant to water hardness when compared to other sanitizers.

B. Iodine- Iodine sanitizers have been in use since the 1800s. The most active agent, but not too stable, is the dissociated free iodine most prevalent at low pH. Iodine sanitizers exist in many forms, usually with a surfactant as a carrier. These mixtures are called iodophors, which like chlorine compounds, have a very broad spectrum activity against bacteria, viruses, yeasts, molds and protozoans.

C. Quaternary ammonium compounds (QAC)- are neutral disinfectants. QACs are a class of compounds, which have the general structure as depicted. The properties of these compounds depend upon the covalently bound alkyl (R) groups, which can be highly varied. The length of the carbon chain of R-group is directly related with sanitizer activity in QACs. Since QACs are positively charged cations, their mode of action is related to their attraction to negatively charged materials such as bacterial proteins.

QACs are readily soluble and non-toxic, non-corrosive and surface active, very sensitive to organic matter (presence of milk solids improves their lethality) and do not affect sensory properties of the product. They are effective against bacteria, yeasts, mold and viruses. Some applications leave a residual antimicrobial film, though this is a disadvantage in the manufacture of cultured dairy products and cheese. QACs are more active against gram positive than gram-negative bacteria. They are not highly effective against bacteriophages. Their incompatibility with certain detergents makes thorough rinsing following cleaning operations essential. Many QAC formulations can cause foaming problems in CIP applications. QACs pose very little toxicity or safety risks under recommended usage and are commonly used as environmental fogs and as room deodorizers. These compounds are active and stable over a broad temperature range. Because they are surfactants, they possess some detergency and are, therefore, less affected by light soil than other sanitizers, though heavy soil decreases activity significantly. QACs are more active at alkaline pH. Most QACs are intolerant to hardness in water.

Surfaces and Cleaner Summary

- **Stainless steel-** Use non-abrasive acidic and alkaline cleaners; do not use hydrochloric acid or chlorides; corrosive properties vary with grade.
- **Plastic**- More corrosion resistant than stainless steel; resistant to chlorine; may crack or cloud from prolonged exposure to strong acidic or alkaline cleaners; easily scratched.
- **Nylon**- Do not use acidic cleaners
- **Rubber**- Deteriorates with constant use of chlorine; use alkaline cleaners
- **Brass, copper, mild steel**- All less corrosion resistant than stainless steel; acidic cleaners encourage steel rusting; use moderately alkaline cleaners with corrosion inhibitors
- **Aluminum-** Readily attacked by acidic and highly alkaline cleaners, use only soft metal-safe moderately alkaline cleaners
- **Wood**- Should not be used in food applications; where used, clean with detergents containing surfactants.
- **Iron Drains**- Acidic cleaners are corrosive; use moderately alkaline cleaners.
- **Painted surfaces**- Use moderately alkaline cleaners
- **Concrete**- Use alkaline cleaners

Self- check-2	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. What is cleaning and sanitaization?(2pts)

2. List types of dairy soil?(2pts)

Test II: Write true if the statement is correct and false if the statement is incorrect

1. Hard water is suitable for cleaning operations. (2pts)

2. Cleaning refers to the removal of soil from the surface of the equipment. (2pts)

***Note:* Satisfactory rating - 5 points Unsatisfactory - below 5 points**

Score = ___________

Rating: ____________

You can ask you teacher for the copy of the correct answers.

Information Sheet 3- Applying stringent personal hygiene procedures

3.1. Hygiene- Describe a system of sanitary principles to preserve health.

What is personal hygiene?

Good personal hygiene can benefit both physical and mental health. Good personal hygiene involves keeping all parts of the external body clean and healthy. It is important for maintaining both physical and mental health. In people with poor personal hygiene, the body provides an ideal environment for germs to grow, leaving it vulnerable to infection. Personal hygiene practices can help and the people around you prevent illnesses.

3.2. Types of personal hygiene

Each person's idea of personal hygiene differs. These main categories are a useful place to start for building good hygiene habits:

3.2.1. Toilet hygiene-

Wash hands after use the restroom. Scrub with soap for 20 to 30 seconds, and be sure to clean between your fingers, on the back of your hands, and under your nails. Rinse with warm water, and dry with a clean towel.

3.2.2. Shower hygiene-

If possible, everybody should have a shower or a bath every day. However, when people are out camping or there is a shortage of water. Personal preference may dictate how often you wish to shower, but most people will benefit from a rinse at least every other day. Showering with soap helps rinse away dead skin cells, bacteria, and oils. Shampooing your hair and scale helps remove skin buildup and protects against oily residues that can irritate your skin.

Figure 6 Shower hygiene

3.2.3. Nail hygiene –

Trim nails regularly to keep them short and clean. Brush under them with a nail brush or washcloth to rinse away buildup, dirt, and germs. Tidying nails helps prevent spreading germs into mouth and other body openings. Avoid biting nails.

Figure 7 Nail hygiene

3.2.4. Teeth hygiene-

Good dental hygiene is about more than just pearly white teeth. Caring for teeth and gums is a smart way to prevent gum diseases and cavities. Brush at least twice a day for 2 minutes.

Figure 8 Teeth hygiene

3.2.5. Sickness hygiene-

If not feeling well, take steps to keep from spreading germs to others. This includes covering mouth and nose when sneezing, wiping down shared surfaces with an antibacterial wipe, and not sharing any utensils or electronics. Also, immediately throw away any soiled tissues.

Hands hygiene- Germs on hands can easily enter body through mouth, nose, eyes, or ears. Wash hands when handle food, before eat, if handle garbage, when sneeze, any time touch an animal. washing hands with soap after going to the toilet

Figure 9 Hand washing

The five simple steps for effective hand washing:

- Wet the hands with clean, running water, then turn off the tap and apply soap.
- Lather the hands by rubbing them together with the soap, remembering to reach the backs of the hands, between the fingers, and under the nails.
- Scrub the hands for at least 20 seconds.
- Rinse the hands well under clean, running water.
- Dry the hands using a clean towel or air dry them.

The recommend washing the hands at certain times:

- Before, during, and after preparing processing
- Before eating food
- Before and after looking after toilet
- Before and after treating a cut or wound
- After going to the bathroom
- After changing cloth
- After blowing the nose, coughing, or sneezing

- After touching garbage or dirty surfaces or objects
- After handling pets or pet-related items, such as food

Negative effects of poor personal hygiene

- Poor hygiene is a sensitive topic, and talking to a person about it can be difficult. As a result, a person with poor personal hygiene could become isolated from other people.
- Poor personal hygiene may also have an effect on the workplace. Companies may be more likely to offer jobs and promotions to individuals who appear to take care of their health and presentation. Poor personal hygiene can be particularly problematic in the food industry.
- There are also many health implications of having poor personal hygiene, with the CDC listing the following as hygiene-related diseases:

3.3. Hygiene routine tips

Helpful tips for creating a hygiene routine include the following:

- Make it a habit: With daily practice, a new habit can become a regular part of life.
- Choose one area to focus on and practice until it becomes second nature.
- Set reminders: Using the notes app on a cell phone can be a great way to avoid forgetting any tasks.
- Use rewards: A sticker chart can be a brilliant incentive for children to maintain their personal hygiene.
- Invest in nice toiletries: Using products that smell good may encourage some people to stick to their personal hygiene routine

Self Check- 3	written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. Define personal hygiene? (1pts)

2. List types of personal hygiene (3 pts)

Test II:write true if the statement is correct and false if the statement is incorrect

1. Personal hygiene practices can help you and the people around you prevent illnesses. (2pts)
2. A person with poor personal hygiene could become isolated from other people.(2pts)

Note: **Satisfactory rating - 7 points** **Unsatisfactory - below 7 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information Sheet 4- Maintaining separation of raw milk area from pasteruized milk operation

4.1. The difference between raw milk and pasteurized milk

Milk is a white liquid formed by the mammary glands of mammals. It is the primary food source for the infants. It contains almost all major nutrients like fat, protein, carbohydrates, vitamins and minerals. Raw milk is the milk which we get when we milk a cow, buffalo etc. It is highly susceptible to microbial spoilage and may cause diseases as it contains a number of pathogenic microbes. In order to protect it from spoilage and to make it safe to drink, it is often pasteurized to kill the pathogenic microbes. After pasteurization raw milk becomes pasteurized milk. Let us see how raw milk differs from pasteurized milk.

4.2. Raw Milk:

Raw milk is also known as unpasteurized milk. It is the milk which get when milk a cow, buffalo, goat, sheep etc and has not been processed or pasteurized to kill the harmful pathogens. The harmful pathogens present in the raw milk tend to reduce the milk's shelf-life and may cause various diseases. Furthermore, raw milk is highly susceptible to microbial spoilage as it is rich nutrients which help microbes grow and reproduce. In some countries, selling raw milk is completely or partially banned. So, raw milk is unpasteurized milk which has not undergone pasteurization or allied process.

4.3. Pasteurized Milk:

Pasteurization is a process in which raw milk is heated to a specific temperature and held at that temperature for a specific duration in order to kill the harmful bacteria.These bacteria may expedite milk spoilage or cause diseases. So, the raw milk which undergoes pasteurization in order to kill the pathogenic microbes is known as pasteurized milk. Pasteurization was discovered by a French scientist Louis Pasteur in the 90th century. The heat-treated (pasteurized) milk is not only safe for human consumption but also has a longer shelf life, e.g. UHT pasteurized milk can be stored for about 6 months.The pasteurized milk should be stored under refrigerated conditions as the heat cannot kill the spores of pathogenic microbes. It is available as a whole, semi-skimmed or fully skimmed milk. The heat treatment may change the taste, colour and nutrients in the milk to some extent.

Based on the above information, some of the key differences between raw and pasteurized milk are as follows:

Raw Milk

- It is raw milk obtained from cow, buffalo etc which has not been processed or heated to kill the pathogenic microbes
- It may cause diseases.
- It has a shorter shelf life than pasteurized milk.
- It is generally consumed after homogenization.
- It contains phosphatase which is required for the absorption of calcium.
- It contains lipase which is required to digest the fat.
- Organoleptic properties of milk (taste, colour) do not change.
- Available only in liquid form
- It may contain pathogenic bacteria such as Salmonella, E. coli, Listeria etc.

Pasteurized Milk

- Milk is heated to a high temperature for a specific duration in order to kill pathogenic microbes.
- It is safe to drink.
- It has a longer shelf life than raw milk.
- It involves various steps.
- Phosphatase is destroyed due to heat during pasteurization.
- Lipase is destroyed due to heat during pasteurization.
- Organoleptic properties of the milk changes due to pasteurization.
- Available in whole, semi-skimmed and skimmed forms.
- It does not contain pathogenic bacteria but may contain their spores.

Requirments maintaining separation of raw milk from pasteurized milk

1. Pasteurized milk required heat treatment at specific temperature and time at 63^{o}C for 30 minutes in batch pasteurization or 72^{o}C for 15 seconds in contiunious pasteurizer.
2. Pasteurized milk is dairy milk that is heated and cooled using a simple, heating process that makes milk safe to drink before it is packaged and shipped to grocery stores.
3. The difference between raw milk versus pasteurized milk is that raw milk straight from the cow does not go through the pasteurization process. Unpasteurized milk is not widely available because federal law prohibits the distribution and sale of raw milk to grocery stores across state lines. In addition, many states also have passed laws to prohibit consumers from buying unpasteurized milk.

Self-Check-4	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. List the common tests carried out on milk supplies (3pts):

Test II: Write true if the statement is correct and false if the statement is incorrect

1. A temperature increase to slightly above +4°C is necessary during transportation. (2pts)
2. Milk of normal composition has a freezing point of -0.54 to -0.59 °C. (2pts)

Note: **Satisfactory rating - 7 points** **Unsatisfactory - below 7 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information Sheet 5- Applying multi-phase cleaning systems

5.1. Cleaning-In-Place (CIP) Systems

The manual cleaning of dairy equipment done by people equipped with brushes and cleaning solutions is a laborious and ineffective practice. Cleaning-in-place or CIP refers to cleaning of all sanitary pipelines by circulation. It may be defined as circulation of cleaning liquids through machines and other equipments in cleaning circuits without dismantling the equipment. The high velocity flow of liquid over equipment surface generates mechanical scrubbing effect that dislodges deposits from vessels and pipelines. The majority of cleaning and sterilizing liquids used in CIP systems are alkali or acid based. Automated CIP systems allow accurate dosing of the concentrated cleaning agent, normally into water, to give a low strength solution suitable for cleaning process plant. This solution is used within the plant to clean and sometimes, sterilize the system prior to the next production run. CIP can be carried out with automated or manual systems.

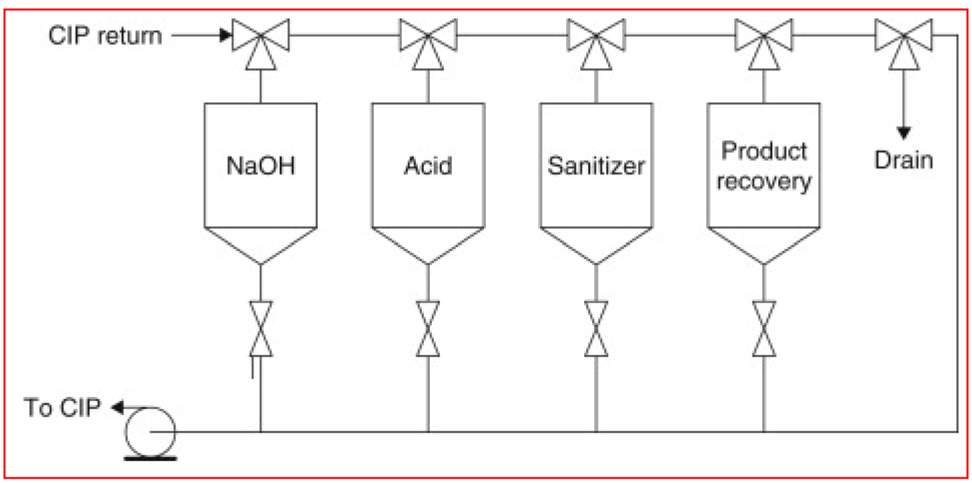

Figure 10 Diagram in CIP

5.1.1. **Single pass systems of CIP**

New cleaning solution is introduced to the plant to be cleaned for each cleaning cycle and then disposed to drain. It would start, in most cases, with a pre-rinse to remove as much soil as possible, followed by the detergent cleaning and a final rinse.

5.1.2. **Recirculation system of CIP**

The cleaning solutions are mixed in external tanks and introduced into the plant to be cleaned. They are recirculated and topped up as required until the cleaning cycle is complete. It is normal to carry out a final rinse after the detergent rinse. Recirculation systems need more initial investment, bur use less water and cleaning detergents.

Cleaning cycle- The sequence of events that are carried out in a dairy through CIP program for different circuits is as follows:

- Recovery of product residue by drainage
- Expulsion of non-retrievable residue with water or compressed air
- Warm water (50-60°C) rinse for 10 min
- Circulation of alkaline detergent (0.5-1.5% solution) at 75°C for 30 min
- Warm water (50°C) rinse for 5-8 min
- Circulation of acidic detergent (0.5-1.0% solution) at 75°C for 20 min
- Warm water (50°C) rinse for 5-8 min
- Thermal disinfection (90-95°C) and cooling for 10 min or chemical disinfection with a suitable sanitizer

Soda ash, caustic soda, sodium metasilicate or complex phosphates and a non-foaming surfactant may constitute an alkaline detergent for CIP cleaning. Sufficient hypochlorite solution to produce 25 to 50 ppm available chlorine may be added to help remove milk stones from metal surfaces. Acid solution may be used every 4 to 7 days in cold milk lines, while acid treatment should be a daily chore in cleaning hot milk lines.

Generally the CIP station consists of equipment for storage of different cleaning fluids and their distribution to various CIP circuits. Small dairy plants with short communication lines use centralized system by a network of pipes to all CIP circuits in the dairy. De-centralized CIP system (satellite system) is normally prevalent in large dairies where the distance between CIP stations and secondary CIP circuits are extremely large.

Figure 11 Clean in place /CIP/

Advantages of CIP

The major advantages of implementing CIP are:

1. Guaranteed and repeatable quality assurance
2. Provision of full data logging for quality assurance requirements.
3. Reduction in cleaning costs by recycling cleaning solutions
4. Possibility to clean inaccessible areas on equipment
5. Better safety to operators because hazardous cleaning materials are not handled
6. Reduction in time between two production runs. Safety-operators are not required to enter the plant to clean it.
7. Reduction in labour requirements
8. More effective use and control of cleaning materials
9. Reduction in water consumption

5.2. Sterilization-In-Place (SIP)

refers to a continuous commercial scale operation, where essential units can be sterilized. They are very sophisticated in terms of design, installation and operation and needs highly qualified manpower. In addition, the process equipment, pipe work and steam supply equipment must meet preset specifications for materials and for pressure and temperature resistance. The steam has to be extra pure and must pass through a micro-filter before use. The steam quality and cleanliness must be maintained by the use of pressure-grade stainless steel or Teflon®-lined tubing and appropriately constructed pressure control, shut-off valves and pressure gauges.

5.2.1. SIP Process

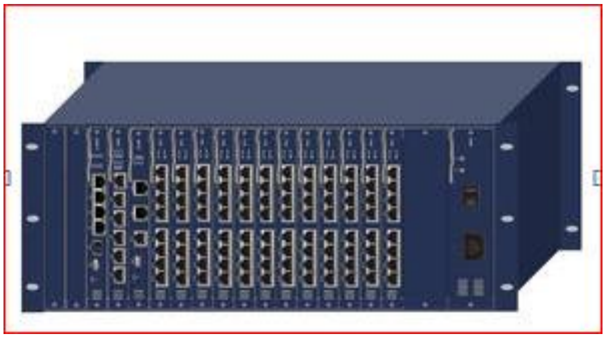

Figure 12 Sanitizing in place /SIP/

Steam under pressure is passed through the entire installation. Air is vented out through vents in the piping or on the equipment. The vents are protected by bacterial filters and remain closed after a suitable period of steaming to allow the steam pressure to build up to a predetermined level. Pressure is maintained for the length of the required period, after which the steam is released through a condenser. The recorded pressure is enough to and must result in achieving the desired time-temperature combination for destruction of all contaminants, as indicated by temperature sensors. The installation is inspected and revalidated at regular intervals to ensure efficiency of the system.

5.3. Cleaning Out of Place /COP/

No matter how advanced and automated the CIP system is, there is always a need to clean the parts of production equipment not exposed to the cleaning process. There are pieces of equipment that simply cannot be cleaned where they are used, including piping, fittings, gaskets, valves or valve parts, filler parts and surfaces such as guides or shields, tank vents, tray pack, grinders, pumps, and product handling utensils such as knives.

To properly clean and sanitize these units or parts, COP is employed to clean tear-down parts of processing and packaging equipment that require disassembly for proper cleaning. Because COP is essentially the systematic manual cleaning and sanitizing of production equipment that must be disassembled in many cases, specific attention must be paid to cleaning underneath and around gaskets, O-rings, small pipes and other small surface cavities, gaps or other niches and harborage points in which potentially harmful residue and bacteria may accumulate.

Cleaning knives or spoons that are used in a plant's dishwasher would be considered a COP operation. In dairy plants, a common use of the COP cleaning method involves pieces of equipment that are small, complex and otherwise hard to clean. They are dissembled, rinsed and then cleaned and sanitized.

COP may occur in a sink with a worker scrubbing to clean, or in tanks specially designed for COP. In these tanks, detergent and agitation are used to clean the equipment in question. Sanitizing may be done using hot water or chemical sanitizers. Small items, such as valves, sanitary fittings and such, can be placed in cages and cleaned with larger items. Options include doing a rinse, hot water wash with detergent, rinse and soak in sanitizer. Operators can also sanitize COP items by raising the second rinse temperature and holding for 15 minutes at >180F.

The basic steps in a COP operation:

Step 1 Dry cleaning to remove dust, soil and other debris from the equipment to be cleaned and the area in which COP tasks will take place.

Step 2 A pre-rinse of the equipment and area on racks or in COP tanks.

Step 3 Soap and scrub the equipment and equipment components in COP tanks or vessels.

Step 4 Post-rinse parts to remove residual detergent or cleaning chemicals.

Step 5 Conduct pre-operational procedures and sanitize any equipment components that are not accessible once reassembled. Reassemble the equipment.

Step 6 Sanitize the reassembled equipment with a sanitizing agent or heat treatment.

In general, the key to success in any endeavor can be summed up as follows: With regard to increasing the effectiveness of the plant's CIP and COP systems, the processor that understands the products being processed, the water chemistry involved, and the operating parameters will enhance the plant's ability to simplify the cleaning and sanitizing process.

Self-Check – 5	**Written test**

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. List the advantage of Clean In Place?(3pts)

Test II: Write true if the statement is correct and false if the statement is incorrect

1. The majority of cleaning and sterilizing liquids used in CIP systems are alkali or acid based. (2pts)
2. Caustic soda is an alkaline detergent used for CIP cleaning.(2pts)

Note: **Satisfactory rating - 7 points** **Unsatisfactory - below 7 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Information Sheet 6- Recording food safety information

6.1. Introduction

Food safety records form an important part of your HACCP food safety program. They are an essential record to support the implementation of food safety management system and the application of HACCP Principles. Information that needs to be recorded. Food safety records are evidence that a mandatory activity has been completed. However, many food businesses fail to include key components to ensure effective record keeping has been implemented.

At a minimum food safety forms, and subsequent food safety records, should include the following:

- **Document control information**- Including the name of the form and some type of document control is a basic requirement. The method you use for document control needs to align with the document management policies for your business. Examples of document control can include issue dates, version numbers, document dates.
- **Date and time-** Recording the date and time demonstrates when the event was undertaken. All records should be completed in real time. Information would be recorded at the time of undertaking the event, for example, GMP check or CCP monitoring.
- **Result of monitoring-** The main purpose of completing food safety records is to capture process information. When information is not captured on the record, it is very difficult to justify or evidence that the activity was completed. In a nutshell, make sure that all results are recorded as required (good or bad).
- **Name and signature of the person completing the record**- It is a requirement of the recognized standards to include the name of the person completing the monitoring and in the majority of cases the signature or initial of that person as well.
- **Product Name and lot code**- Recoding the product name and lot code not only assists with traceability it is also a legal requirement where appropriate.
- **Facility name and/or location**- Get into the habit of recording the facility name and/or facility location. This can be included in the initial form design to save having food

handlers complete this information. If you have forms that are used across multiple sites, record the site location as well.

- **Food Safety Record Verification**- Another person in authority should check all food safety records. This process aims to verify that there are no issues missed, process parameters have been met and the record has been completed effectively and correctly. Issues can be more quickly identified when a robust record verification system is in place.
- **Reviewing and verifying records-** Reviewing food safety and quality compliance records on a regular basis can provide an insight into the status of critical elements of your food safety system. Review provides the opportunity to identify trends in the monitoring data. Through identifying trends, one can ask many different questions like:
  - ✓ Are we still on track to produce a safe food product?
  - ✓ Is the system starting to get out of control?
  - ✓ Is this piece of equipment starting to fail?
  - ✓ Do my staffs require retraining?
  - ✓ Asking ourselves these questions can allow us to act before a deviation occurs and potentially save our customers from consuming an unsafe food product. To read more on how to complete record verification in your food business.

6.2. Record management system

The purpose of a document management system should be to manage all of the information that is collected by or generated by business. This also applies to food safety and quality compliance records. System should consider:

- Retention time
- Control of records
- Storage, both short term and long-term
- Retrieval, and,
- Disposal

6.3. Auditing food safety records

As part of internal audit procedures, should be auditing the food safety and quality compliance records generated within food business.The goal of this audit is to check that record keeping policies, procedures and practices are following both regulatory requirements and recognised standards (if relevant).

In recent audits seem to have had a run on identifying CCP monitoring records that do not actually record the critical limits actually identified. What the company have documented as a critical limit in their HACCP plans, is not reflected in their CCP monitoring records.

Self-Check – 6	**Written test**

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. List at a minimum food safety forms and subsequent food safety records?(3pt)

Test II: Write true if the statement is correct and false if the statement is incorrect

1. The goal of internal audit is to check the food safety and quality compliance record keeping policies, procedures and practices? (2 pt).
2. Food safety records are mandatory activity for dairy product processing plant? (2pt)

Note: Satisfactory rating - 7 points Unsatisfactory - below 7 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Operation Sheet 1- Carry out cleaning and sanitizing bulk milk storage area

Objectives of carrying out cleaning and sanitizing bulk milk storage area

- To identify the equipment needed for cleaning and sanitizing
- To identify tools, equipment and machine which needs for cleaning

List of Materials needed

-
-
-

Procedures to ensure the job gets done safely and without delay

Steps Carry out cleaning and sanitizing bulk milk storage area

1. Wear personal protective cloth
2. Prepare cleaning material
3. Prepare detergent used for sanitizing
4. Pre-rinse
5. Start cleaning (dry and wet)
6. Rinse
7. Acid rinse
8. Sanitize
9. Make sure all area cleaned

LAP TEST	**Performance Test**

Name……………………………….   ID………….. Date………………………………

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task

1. Perform successful cleaning and sanitizing bulk milk storage area

LG #30	LO #2- Implement procedures to prepare raw milk for pasteurization

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Carrying out clarification procedures for raw milk
- Implementing standardization procedures for pasteurized milk
- Carrying out pasteurization procedures
- Carrying out homogenization procedur

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Carry out clarification procedures for raw milk
- Implement standardization procedures for pasteurized milk
- Carry out pasteurization procedures
- Carry out homogenization procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to "Operation sheets".

Information Sheet 1- Carrying out clarification procedures for raw milk

1.1. Introduction

During handling of milk on farm and its transportation, certain visible particles and dirt may gain access into the milk which may be removed by either filtration or centrifugal clarification. Filtration/clarification equipment has been designed for both cold and warm milk. Since fluidity of warm milk is more, its separation process is more efficient. However, warming of milk for this purpose requires additional equipment. It also poses the risk of bacterial growth unless handled properly. Handling at higher temperatures may also affect creaming property of the milk besides dissolving some of the extraneous matter.

1.2. Pre-heating of milk

This term refers to heating of milk before the operation which follows immediately. The milk is pre-heated to about 35-40°C using plate or tubular heater for efficient filtration/clarification. Pre-heating becomes essential, if the incoming milk is cold. As the temperature of the milk increases, the viscosity of milk decreases resulting in more efficient filtration/clarification.

1.3. Straining

The practice of straining milk was introduced to remove some of the large particles of foreign material such as straw, hair, insects, grass, dirt, flies, etc., so that the visible sediment in milk might be reduced. The straining in the ordinary sense is accomplished on the dairy farm by means of pieces of cloth, cotton, wire gauge or specially prepared strainers/strainer pads.

1.4. Filtration

Filtration of milk is carried out to remove visible sediment (foreign matter) from the milk to improve the aesthetic quality of milk. This may be removed either by filtration or centrifugal clarification. While filtration removes suspended foreign particles by straining process, clarification removes the same by centrifugal force. There are two types of filters or clarifiers., those that operate with cold milk and those that operate with warm milk. The advantages of filtration are that preheating is not essential and there is less likelihood of soluble dirt going into the solution. However, the major disadvantage is the flow of milk is slow. Broadly there are two types of filters.

1.4.1. Tubular sieve

It removes dirt by sieving and is placed in the inlet pipe in the processing section. This permits the removal of coarser particles only.

1.4.2. Important features of a filter

- A filter cloth of the desired pore size is used to retain the smallest particle.
- A frame or support to compress and hold the margins of cloth or pad, so that milk can pass through pores
- A perforated metal or other support for the cloth or pad which will not tear or break under the pressure of milk
- An enclosure to confine both the filtered and unfiltered milk in closed system fitted suitably with inlet and outlet connections for sanitary piping
- A continuous operation is essential to handle large volumes of milk; 2 or more filters may be used without interruption.

For cold filtration, an in-line filter may be installed in the milk receiving line between the raw milk dump tank, unloading pump and chiller or raw milk storage tank. Warm milk filters may be installed in the pasteurization circuit.

In order to achieve the desired filtration effect, the filter material must have pores of 25 - 100 µ. The smaller the pores, the greater are the separation effect and filtration time. The filter consists of stainless steel body wherein a filter with a small pore nylon cloth is placed and closed with a tight fitting lid. Milk passes from the top to bottom. After 3 - 4 h of operation, the filter bag must be cleaned. For a continuous process, a double filter must be installed. This would enable cleaning of one filter while the other is being used.

1.5. Clarification

Clarification is more efficient than filtration for the removal of dirt and foreign matter from milk. Clarification removes leucocytes, udder tissues, other large cells and fine dirt. The objective of clarification is to improve the appearance and marketability of milk.

1.5.1. Milk clarifier

Figure 13 Clarifier

In general, the clarifiers are quite similar to cream separator. The difference between clarifier and cream separator are as follows:

- In clarifiers there is only one inlet and one outlet. In cream separator there is one inlet and two outlets (cream and skim milk).
- The discs in the clarifier are smaller in diameter to provide a large space for the accumulation of sludge than separators.
- The milk distribution holes are at the outer edge of the disk in the clarifier but near the axis of rotation in the separators.

1.5.2. Clarification process

In a clarifier, the ratio of bowl diameter to disc diameter is greater than in cream separator, resulting in a larger sludge space. In most clarifiers, 10 - 20 discs have no holes and on their surface are 6 - 12 baffles with a thickness of 1-3 mm which are evenly spaced. These baffles determine the disc distance and influence the flow pattern. Raw milk is pumped through central pipe through the rotating bowl via a distributor and passed through the small opening into the sludge area. The dirt separation takes place in the disc assembly where milk is enclosed by two adjacent baffles between discs. One baffle leads to rotation whereas the other baffle leads to the flow to the center. The dirt particles which have a higher specific gravity are separated by the centrifugal force. The clarified milk rises to the outer surface of the distributor and reaches the baffle and ejects out. The pressure is about 5.4 bars. The amount of sludge is influenced by:

- The amount of foreign matter

- Condition of the udder
- Stage of lactation
- The bacterial count and acidity of the milk
- The clarifying temperature
- The speed of the bowl
- Amount of milk run through the bowl

Figure 14 Clarifier

A clarifier may be operated depending on the size of the machine, for a period ranging from 2 - 8 h for cold milk (5 - 10°C) and 1-4 h for warm milk (57°C), without cleaning.

1.5.3. Location of clarifier

Clarifiers can be located in any one of the following ways:

1.5.3.1. Cold clarification

- Between the storage tank and the pasteurizer
- Between the receiving room and the storage tank. This arrangement is applicable only in those plants where a steady receiving operation is maintained.

1.5.3.2. Warm clarification

- Between the pre-heater and the pasteurizer.
- Between the regeneration section of high temperature short time (HTST) pasteurizer and heating section.
- Between the final heater and the holding tube of the HTST pasteurizer.

Difference between cold and warm milk clarification

a) Cold milk clarification

- Efficiency is lower since viscosity of milk is high.
- Operation time is more because less free casein particles are thrown out as slime.
- Quality of the processed milk is better as dirt is removed from the milk.

b) Warm milk clarification

- Efficiency is higher due to lower viscosity of milk.
- Running time is reduced because of rapid free slime build-up
- Operation of the entire system is more critical with a high pressure drop through the clarifier on one side of the pump and suction on the other side.

1.5.4. Factors affecting clarification

1.5.4.1. Viscosity

The viscosity of milk is an important factor to be considered in clarification, since the suspended foreign particles are removed by centrifugal sedimentation. Settling of particles by centrifuging depends upon their size, density and viscosity of the fluid in which they are suspended.

1.5.4.2. Temperature

The viscosity of liquid decreases as the temperature increases. Hence, milk is usually heated to a temperature of 32-35°C before it is subjected to clarification. A high temperature must be avoided as it adversely affects the creaming property of milk.

1.5.4.3. Bowl speed

The higher the speed, the better is the efficiency as the centrifugal force is directly influenced by the speed of the bowl.

1.5.5. Microbial load

The type and state of microbe influences the efficiency of clarification. The bacterial spores being denser are thrown into the slime more easily.

1.5.6. Effect of clarification on the bacterial quality

Since a large number of microbes are thrown into the clarifier 'slime', there will be fewer microbes in clarified milk. Due to the breaking up of the clumps of bacteria during the process, there may be an apparent increase in the plate count of clarified milk. Hence, it apparently seems that the plate count of milk is higher after clarification, while the actual number of organisms in the clarified milk is considerably lower.

Self-Check – 1	**Written test**

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. List the difference between cold and warm milk clarification? (3pts)
2. List the difference between clarifier and cream separator? (2pts)
3. List atleast three important features of a filter? (2pts)
4. List factors affecting clarification ? (2pts)

Test II: Write true if the statement is correct and false if the statement is incorrect

1. Filitration of milk is carried out to remove visible sediment to improve quality of milk (2pts)

Note: Satisfactory rating - 9 points Unsatisfactory - below 9 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer sheet

Test I

1.____

2. ____

3. ____

4. ____

Test II

1.____

Information Sheet 2- Implementing standardization procedures for pasteurization

2.1. Introduction

Many dairy processes require standardization of the chemical composition of milk meant for market purpose or milk products manufacture. Standardizing milk might require control of only one component (usually fat) while allowing the others to vary or control two or more components simultaneously.

2.2. Standardization

It may be defined as the adjustment of one or more of the milk constituents to a nominated level. In market milk industry, this normally involves reducing the butterfat content by addition of skim milk or through the removal of cream.

Objectives

- To comply with the legal requirements for particular milk/dairy products.
- To provide the consumer with a uniform product.
- To ensure economics in production.

Addition of skim milk increases the volume of milk available for sale and removal of cream allows the production of other value added dairy products such as table cream, butter or other high fat products.

2.3. Methods of Calculation

For standardization of milk or cream for product manufacture, usually the proportions of the various ingredients of known composition to be mixed, is required to be estimated. This can be done by:

- Pearson's Square method
- Algebraic equations

2.3.1. Pearson's square method

Draw a square and place in the centre of it the desired fat percentage. Place at the left hand corners of the square, the fat percentage of the materials to be mixed. Next, subtract the number in the centre from the larger number at the left hand side of the square and place the remainder at the diagonally opposite right hand corners. The number on the right hand side now represents the number of parts of each of the original materials that must be blended to have the desired fat content in resultant mix. The number at the upper right corner refers to the parts of material whose fat test was placed at the upper left corner and the number at the lower right corner refers to the parts of material whose fat test was placed at the lower left corner. If the numbers on the right are added, the sum obtained will represent the parts of the finished product.

Examples

600 kg of cow milk testing 4% fat is to be standardized to toned milk by removing 33% fat cream. Calculate the amount of toned milk.

Solution

A = Fat percentage of cow milk = 4%

B = Fat percentage of cream = 33%

E = Fat percentage of toned milk = 3%

Calculation

30 kg of cow milk requires removal of 1 kg of cream

So, 1 kg of milk requires removal of 1/30 kg of cream

Therefore, 600 kg milk will require removal of (1/30 x 600) = 20 kg cream

So, the amount of toned milk will be (600 – 20) = 580 kg.

Proof Sheet

In order to check the accuracy of calculations made, put the calculated values of various raw materials in the below given format and check:

In the product, fat required = 580 * (3/100) = 17.4 kg

2.3.2. Algebraic equations

In this method, we should know the composition of the products to be mixed, the final product and the quantity of any one product. Mass balance equations are formed and solved. The formula for determining the quantities of skim milk and raw milk on this basis is as follows:

- Skim milk (kg) = kg standard milk required x (% fat in raw milk - % fat in standard milk)
- Whole milk (kg) = kg standard milk required x (% fat in standard milk - % fat in skim milk)

Example

Prepare 500 kg milk testing 3.0% fat and 8.5% SNF. You are provided with whole milk having 5.0% fat and 9.0% SNF and skim milk powder having 0.5% fat and 96.0% SNF.

Solution

Let the quantity of the whole milk = X kg

Quantity of SMP = Y kg

Quantity of water = Z kg

Fat equation:

X + Y + Z = 500

Now, solving equations (1) and (2) by 5, we get,

SNF required = 500 * (8.5/100) = 42.5 kg

Hence proved, because the required values are equal to the calculated values (in the table).

2.4. Methods of Standardization

There are three methods for standardization. These are batch, continuous and automatic standardization. They all involve the separation of whole milk into skim milk and cream and then proceeding for blending the required quantities only.

2.4.1. Batch standardization

It is a process most commonly used in the dairies. Raw milk is held in a silo and its fat content is evaluated. Some quantity of milk is removed and separated into skim milk and cream. The amount of skim milk or cream required is determined by the calculation and then added to the bulk milk under continuous agitation. The bulk milk is retested to check whether the fat content is as per the desired figure or not. If it is not, further adjustments are made until the batch is standardized correctly. The demerits of batch standardization are the time taken for agitation, testing and final mixing.

2.4.2. Continuous standardization

Continuous standardization employs an inline sampler in association with a testing device, which samples, measures and displays the fat content every 20 seconds. The operator observes the fat content displayed and adjusts the values to blend skim milk or cream into the milk line, before the sampling point, to alter the fat content to the required level.

2.4.3. Automatic standardization

It is an extension of the continuous process. The separator is replaced by a microprocessor/controller unit linked to the sampler/tester system. The microprocessor/ controller unit has information about the desired fat content and flow rates of the whole and skim milk. It receives signals from the sampler/tester system and responds by opening or closing a valve, which regulates the amount of skim milk added to the whole milk. The merits of this automatic process are time and labour savings and ensure more accurate standardization than other methods. Standardization depends on correct sampling, accurate testing of fat content, efficient separation and the correct amount of skim milk or cream needed.

2.4.4. Tri-process Machine

Tri-process machine is designed to clarify, separate, standardize milk in a single unit. The general construction is similar to that of standard cream separator. The tri-process separator has external valves in the discharge lines of cream and skim milk. A precise needle valve is fixed in the outlet for cream, which controls the cream flow rate. There is a bypass line connected from the cream discharge line to the skim milk discharge line. This bypass line has a needle valve which would control the flow of the cream coming in the bypass line. A cream meter is installed in the cream outlet line.

For standardization of milk to the desired fat content, the needle valve in the bypass line is adjusted to such a position that the bypass cream when mixed with the skim milk would result in the desired fat % in the standardized milk.

Self-Check – 2	**Written test**

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. List the method of calculation or standardized milk? (3pts)

2. List atleast the objective of standaidzation? (2pts)

Test II: Choose the best answer

1. A process that adjustment the milk constituents to a nominated level is called __________(2pts)

   A. Filitration B. Pasteruization C. Standardization D. Clarification

2. During standardization addition of skim milk______________ (2pts)

A. Increase volume of milk B. Increase protein percentage

C. Decrease lactose percentage D. Decrease volume of milk

Note: Satisfactory rating - 9 points Unsatisfactory - below 9 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer sheet

Test I

1.____

2. ____

Test II

1.____

2.____

Information Sheet 3- Carrying out pasteurization procedures

3.1. Introduction

The word pasteurization is derived from the name of an eminent French scientist Louis Pasteur (1860), who found that heating certain liquids specially wines to a high temperature improved their keeping quality. Pasteurization came into use on a commercial scale in the dairy industry shortly after 1880 in Germany and Denmark. This process is widely employed in all branches of dairy industry. Heat treatment destroys microorganisms present in milk. Further, a more or less complete inactivation of enzymes occurs, depending on temperature and treatment time. In order to retain as many sensory and nutritive properties of the raw materials as possible, different heating methods have been developed to destroy pathogenic organisms (pasteurization) or destroy all microorganisms and inactivate enzymes (sterilization).

3.2. Definition

According to International Dairy Federation (IDF), pasteurization can be defined as 'a process applied to a product with the object of minimizing possible health hazards arising from pathogenic microorganisms associated with milk by heat treatment, which is consistent with minimal chemical, physical and sensory changes in the product'. In general, the term pasteurization as applied to market milk refers to the process of heating every particle of milk to at least 63°C for 30 min or 72°C for 15 sec or to any temperature-time combination which is equally efficient, in properly operated equipment. After pasteurization, the milk is immediately cooled to 5°C or below.

3.3. Importance of Pasteurization

- The chief objective of milk pasteurization is to destroy pathogenic bacteria that could have a public health concern. By destroying these microorganisms, the product becomes safe for public consumption.
- Secondly, pasteurization eliminates destructive bacteria and enzymes that could cause spoilage of the product. This leads to a prolonged shelf life of the milk.

- There is need to ensure that the product can keep for longer periods without expensive storage equipment. Pasteurization will eliminate spoilage bacteria and enzymes and extend the shelf life of the product.

Disadvantages of Pasteurization

• It may encourage slackening of efforts for hygienic milk production and may mask low quality milk.

• It diminishes the cream line or cream volume.

• Pasteurized milk may increase the renneting time.

• It fails to destroy bacterial toxins

3.4. Time-Temperature Combination for Specific Requirements

All pathogenic organisms are destroyed by pasteurization, except spore forming organisms. The thermal death point of tuberculosis germs (Mycobacterium tuberculosis) is slightly higher than that for inactivation of phosphatase enzyme. Pasteurization is carried out at a heat treatment temperature above that for phosphatase inactivation and yet below that for cream line reduction. The pasteurization ensures complete destruction of pathogens, a negative alkaline phosphatase test and least damage to the cream line.

3.5. Methods of Pasteurization

- High-Temperature Short Time (HTST) pasteurization
- Low Temperature Long Time (LTLT) pasteurization
- Extended Shelf Life (ESL) pasteurization
- Ultra Heat Temperature (UHT) pasteurization

3.5.1. High-Temperature Short Time (HTST) Pasteurization

- This type of pasteurization is also known ‘continuous flow’ or ‘flash’ pasteurization
- Flash pasteurization involves heating milk to 72°C for 15 seconds to kill Coxiella burnetii, which is the most heat resistant pathogen in raw milk.
- Since it is technically impossible to bring the milk to that exact temperature, it is always safe to work with a range of temperatures. To be safe, you can heat the milk to between 72°C to 74°C for 15 to 20 seconds.
- This will ensure that the milk is heated uniformly to the required temperature.

- This method is most suitable in continuous pasteurization systems.
- Flash pasteurized milk will keep for between 16 and 21 days. For commercial reasons, some manufacturers intentionally reduce the number of days to push the products out of the shelves.

Figure 15 HTST Pasteurization

Advantages of HTST Pasteurization

i. Capacity to heat treat milk quickly and adequately, while maintaining rigid quality control over both the raw and finished product
ii. Less floor space required
iii. Lower initial cost
iv. Milk packaging can start as soon as milk is pasteurized
v. Easily cleaned and sanitized (system adapts itself to CIP)
vi. Lower operating cost (due to regeneration system)
vii. Reduced milk losses
viii. Development of thermophiles is not a problem
ix. Automatic precision controls ensure proper pasteurization

Disadvantages of HTST Pasteurization

i. The system is not well-adapted to handling small quantities of liquid milk products
ii. Gaskets require constant attention for possible damage and lack of sanitation
iii. Complete drainage is not possible

iv. Margin of safety in product sanitary control are so narrow that automatic control precision instruments are required in its operation

v. Lethal effect on high-thermoduric bacteria in raw milk is not as great as compared to LTLT system

vi. Accumulation of milk-stone in the heating section.

3.5.2. Low-temperature long-time (LTLT)/Batch pasteurization

Milk is heated, held and cooled in the inner vessel. The space between vessel and the outer casing forms a jacket, through which the heating or cooling medium is circulated. To heat the milk, hot water or low-pressure steam is circulated through the jacket and milk is continuously agitated for rapid and uniform heating. The heating process could be manually or automatically controlled. The milk is heated to a minimum of 63°C and held at this temperature for minimum 30 min. It is then cooled as rapidly as possible to 4°C. A cooling medium is circulated in the jacket for chilling the milk, but more often the heated milk is discharged to a surface cooler where a film of milk flows down the corrugated metal plates or series of interlocked tubes. A cooling medium such as brine or chilled water is circulated on the other side of the plates or through the tubes.

3.5.2.1. Type of LTLT pasteurizer

i. **Water – jacketed vat-** This is double-walled around the sides and bottom of the vat in which hot water or steam under partial vacuum circulates for heating, and cold water for cooling. The outer wall (lining) is usually insulated to reduce heat loss. The heat-exchange takes place through the wall of the inner lining. The difference between temperature of the hot water and the milk is kept to a minimum. The milk is agitated by slowly revolving paddles/propellers. When heating, the vat cover is left open for escape of off-flavors; and when holding, the cover is closed. During the holding period, an air space/foam heater (steam or electrically heated) prevents surface cooling of milk. Advantage: Flexibility in usage - multipurpose vat.

ii. **Water–spray type-** A film of water is sprayed from a perforated pipe over the surface of the tank holding the product which is continuously agitated. A rapidly moving continuous film of water provides rapid heat transfer.

iii. **Coil-vat type-** The heating/cooling medium is pumped through a coil placed in either a horizontal or vertical position, while the coil is turned through the product. The turning coil agitates the product (but additional agitation may be necessary). Disadvantage coils are difficult to clean.

3.5.3. Extended shelf-life (ESL) pasteurization

Extended shelf-life (ESL) pasteurization is a high heat treatment of the product (125–138ºC for 2–4 second) and sometimes even a microfiltration step, which provides normal pasteurized product sensory characteristics, combined with ultraclean packaging, which includes a controlled filling environment and container sterilization. ESL products must still be kept in a well refrigerated chain (<5ºC) during distribution and in retail stores, just like HTST pasteurized products, in order to be sold as a safe and good sensorial quality product for human consumption.

Extended shelf-life (ESL) milk has gained substantial market share in many countries. It has a refrigerated shelf-life of 21–45 days with some manufacturers claiming a shelf-life of up to 90 days. It is produced by two principal technologies:

(1) Thermal processing using more severe conditions than pasteurization but less severe than ultra-high-temperature (UHT) processing; and

(2) Non-thermal processes such as microfiltration and bactofugation, usually combined with a final thermal pasteurization treatment to meet regulatory requirements.

The heating systems used for ESL processing are of two major types, direct and indirect. In direct systems, heating occurs through direct contact between steam and the product and in indirect systems the heat is transferred to the product from steam or hot water through a stainless steel barrier in a heat exchanger.

Direct Heating

In direct heating processes, the milk is first heated indirectly in a plate or tubular heat exchanger to 70–80 °C and then heated to the required high temperature by direct contact with dry culinary steam. The milk is held at the required temperature for the required period of time while it passes through a holding tube. The heated milk then passes to a vacuum chamber, which removes the water from the condensed steam and cools the milk to approximately the same temperature to which it was pre-heated prior to the steam heating stage. The milk is then cooled indirectly to ~4 °C.

There are two modes of steam heating, steam injection and steam infusion. In milk processing, these are often described as steam-into-milk and milk-into-steam. They differ considerably in terms of equipment but ESL milk produced by the two methods is very similar, although some authors have reported advantages of steam infusion over steam injection. The major distinguishing feature of direct heating methods relevant to ESL milk processing is the high rate of heating and cooling, on the order of 0.5 s for a temperature change of 50–60 °C.

Indirect Heating

Indirect heating involves the use of plate or tubular heat exchangers for all heating and cooling stages. Of note in this regard is that a considerable amount of heat (up to ~90%) can be recovered by using the heat in the hot milk, after the holding tube, to heat the incoming cold milk. The heat recovery is greater than for direct systems, where it is ~50%. This is obviously an economic advantage of indirect systems.

The rates of heating and cooling in the high-temperature sections of indirect systems are much slower than in direct systems. This has an important consequence for ESL processing because, for the same bactericidal effect, the indirect systems cause more chemical change than do direct systems. Thus more cooked flavor is produced in indirect systems than in direct systems for the same bacterial, including spore, inactivation.

3.5.4. Ultra High Temperature (UHT) Pasteurization

- This is a completely closed pasteurization method.

Figure 16 Ultra high temperature /UHT/

- The product is never exposed even for a fraction of a second during the entire process.
- It involves heating milk or cream to between 135°C to 150°C for one to two seconds, then chilling it immediately and aseptically packaging it in a hermetic (air-tight) container for storage.
- Despite the risk of Millard browning, UHT pasteurization remains the most popular milk preservation method for safe and stable milk.

3.6. Operation of Pasteurizer

Initial preparation

i. The plant must be sterilized.

ii. All water remaining in the plant must be drained.

iii. Clean filter clothes/nylon filters should be fitted in the filter.

Steps of pasteurization

Step-1. Milk chilling

Chilling is not a pasteurization process but it is a necessary step when dealing with large volumes of milk. Milk leaves the cow's udder at temperatures above the ambient, which encourages rapid bacterial multiplication that speeds up spoilage. However, reducing the temperatures to between 2° C to 5° C arrests bacterial growth and metabolism. This provides a head start at keeping the quality before proper pasteurization commences.

Step-2. Pre-heating (regeneration)

After bulking, the chilled milk is heated to about 40°C to facilitate easy separation of butterfat during standardization. The system uses regenerative heating, i.e., it uses the heat of the already pasteurized milk to heat up the incoming chilled milk. The chilled milk, in a counter current flow, cools down the pasteurized milk. The purpose of standardization is to obtain a product with uniform content of butter fat.

Step-3 Clarification stage

Clarification is essential for removing all foreign matter from the product. Large solid particles are removed by straining the milk through tubular metallic filters. A centrifugal clarifier is used to remove all soil and sediments from milk. The filters usually fitted in parallel twins permits continuous processing as one can be cleaned while the other is running. Clean the filters regularly to avoid growth of bacteria.

Step-4. Standardization stage

It is important to standardize milk fat to ensure that you end up with a product of consistent quality in the market. Different consumers prefer different products. There are customers who will consume skim milk only while there are those who will take low fat milk. There are those who will take standardized milk while there are those who prefer high fat milk. Standardization is necessary to ensure that all the customers are catered for. Again, it is during the process of standardization that you get to separate the butterfat that is used for making cream and other fat based products such as butter and ghee.

Step-5. Homogenization stage

Homogenization is a physical process of breaking down the milk fat globules into tiny droplets to discourage cream separation. Tiny droplets of fat do not rise in a milk column since reducing their sizes also increases their density in the milk. A milk homogenizer working at between 100 to 170 bars splits all the fat globules into very tiny droplets that increase the level of integration of the fat in the milk. As a result, the milk fat remains uniformly distributed in the milk.

Step-6. Heating section

Utilizes heat from steam to raise the temperatures of the milk from about 60°C to the required 72°C that is effective to kill bacteria. The steam exchanges heat with the milk across the PHE plates in a counter current motion. At the end if this section, there is a temperature sensor, which controls the flow diversion valve. Any milk that does not attain the required temperature is diverted back to the heating section until it attains the required temperatures.

Step-7. Holding section

After heating, milk flows into the holding tubes whose lengths have been calibrated with the milk flow rate to ensure that milk takes at least 16 seconds in the tubes. All the milk must maintain the required pasteurization temperatures at the end of the tubes. In case of a breach, a sensor will trigger the flow diversion valve to take the milk back to the heating section to bring the milk to the required temperature. Once the milk has attained the required temperatures at the end of the holding tubes, milk flows back to the regeneration section to heat the incoming chilled milk while in itself being cooled down to about 30°C.

Step-8. Cooling/chilling section

After regenerative cooling of pasteurized milk to 4°C. The chilled milk is then pumped to the packaging machines for aseptic packaging and subsequent storage in the cold room

Figure 17 Chiller

3.6.1. Milk flow

The following steps or stages are involved as milk passes through the HTST pasteurizer:

1. Balance tank
2. Pump
3. Regenerative heating
4. Heating
5. Holding
6. Flow diversion valve (FDV)
7. Regenerative cooling
8. Cooling by chilled water or brine

An arrangement for incorporation of the filter/clarifier, homogenizer, etc., in the circuit is also made possible. There is some variation in the use or order of these steps in different milk processing plants.

3.7. Functions of specific parts

3.7.1. Float-controlled balance tank (FCBT)

Maintains a constant head of the milk for feeding the raw milk pump; also receives milk diverted by flow diversion valve.

3.7.2. Pump

Either a rotary positive pump between the regeneration and heating sections, or a centrifugal pump with a flow control device to ensure constant output, after float controlled balance tank is used.

Figure 18 Centirigual pump

Figure 19 Return pump

3.7.3. Plates- the Plate Heat Exchanger (PHE) is commonly used in the HTST system.

Figure 20 Plates

The PHE is a compact, easily cleaned unit. Its plates may be used for heating, cooling and regeneration. These plates are supported in a press between a terminal block in each heating and cooling sections. The heat moves from a hot to a cold medium through stainless steel plates. A space of approximately 3 mm is maintained between the plates by a non-absorbent rubber gasket or seal which can be vulcanized to them. The plates are numbered and must be properly assembled. They are tightened into place, and designed to provide a uniform, but somewhat turbulent flow for rapid heat transfer. Raised sections on the plates in the form of knobs, diamonds and channels, help provide the turbulent action. Greater capacity is secured by adding more plates. Ports are provided in appropriate places, both at the top and bottom of the plates, to permit both the product and the heating/cooling medium to flow without mixing.

3.7.4. Filter

Figure 21 Filter

Filter units are connected directly to the HTST system, placed after the pre-heater or regenerative (heating) section. These units, using 40-90 nylon mesh cloth are usually cylindrical in shape. Usually two filters are attached; when one is being used, other can be subjected to cleaning. This permits continuous operation.

3.7.5. Regeneration

The raw chilled incoming milk is partially and indirectly heated by the heated outgoing milk (milk-to-milk regeneration). This adds to the economy of the HTST process, as the incoming milk requires less heating by hot water to raise its temperature to pasteurization temperature in the heating section.

3.7.6. Heating

The preheated milk from regeneration section passes through heating section of HTST, where it is heated to 72°C or more with the help of hot water from hot well. Thereafter, the heated milk enters into the holding section (plates/tube).

3.7.7. Holding

The holding tube ensures that the milk is held for a specified time, not less than 15s, at the pasteurization temperature of 72°C or more.

3.1.9. Flow diversion valve (FDV)

This routes the milk after holding section. If the milk is properly pasteurized, it flows forward through the unit. In case the milk is not heated to the set heating temperature, it is automatically diverted by the flow diversion valve back to the Float Controlled Balance

Tank (FCBT) for reprocessing. It is usually operated by air pressure working against a strong spring. If the temperature of heated milk falls below set temperature, air pressure is released and the valve snaps shut immediately. When the temperature is regained, air pressure builds up and the valve opens up for the forward flow to occur. The system is so arranged that any failure of electricity moves the valve in the diverted position.

3.1.10. Regeneration (cooling)

The pasteurized hot outgoing milk is partially and indirectly cooled by the incoming cold milk. This again adds to the economy of the HTST process. In fact, when pre-cooled (raw) milk is received, regeneration efficiency is 90% and above which obviates cooling using well water altogether.

3.1.11. Control panel

Contains instruments, controls, FDV-mechanism and holding system, all centralized in one moisture-proof panel. The lower half of the panel forms an air-insulated chamber which carries the holding tube.

3.9. Automatic control devices: - These include

3.9.1. Steam pressure controller

Figure 22 Steam pressure

Maintains a constant hot water temperature for heating milk accurately to the required pasteurization temperature. It acts as a reducing valve in the steam supply line to give a constant steam pressure.

3.9.2. Water temperature controller

Figure 23 Water temperature control

Regulates the amount of steam entering the hot water circulating system.

3.9.3. Milk temperature recorder

Records the temperature of milk leaving the holding tube/plate. This is an electric contact instrument that operates either a FDV or a milk pump, automatically preventing milk from leaving the holding section at temperatures below the one set in the control panel. Both the frequency and duration of the flow diversion (if at all) and the temperature of milk leaving the heating section are recorded in the thermograph (recording chart) by means of two different colored pens.

3.7.8. Hot water

Circulates hot water through the heating section of the machine to maintain the correct milk heating temperature within very fine limits.

3.7.9. Pressure in the system

The normal pressures maintained in the HTST system are:

3.7.10. Testing of Holding Time

The holding time is calculated between the points at which the heated milk leaves the heating section and reaches the FDV. The efficiency of pasteurization in the HTST system depends on attaining the requisite temperature along with the desired holding time. Hence, the latter should be checked periodically. Several methods are used for determining the holding time, viz. the electrical conductivity method (of a salt solution); the dye injection method; the electronic timer method; etc. The requirements for heat treatment and modifications which can occur in milk, time-temperature profiles have been established for heat treatment processes.

3.7.11. Devices for Controlling the Heat Treatment Process

- Automatic temperature control and recording devices.
- Automatic safety device to avoid insufficient heating of the milk (bypass installation) with recording device for time/temperature and valve position for the flow, as well as passage and recirculation of the milk or cleaning.
- Safety device with automatic recording against unplanned blending of pasteurized or sterilized milk with non-heated milk based on pressure increase after the heating or holding section of the heat exchanger. The most widely used installation for the heat treatment of milk is plate heat exchanger. For reason related to the flow conditions, tubular heat exchangers are used when operating at temperature level >100°C.

3.7.12. Maintenance of Milk Pasteurizers

i. The pasteurizer should be inspected every day for any leakage and for ensuring cleanliness.
ii. The filter cloth or filter bag must be changed at regular intervals.
iii. Periodical inspection of individual plate surface and gaskets must be done when the pasteurizer is dismantled for manual cleaning.
iv. Any loose or broken gasket must be replaced, using proper adhesive.
v. The face of the plate bar and the tightening spindle should be kept lightly coated with grease.
vi. All air-operated equipment should be supplied with clean dry air.

vii. All recording instruments, thermometers etc. must be checked for accuracy, periodically.

Self- Check-3	Written test

Name…………………………………………… ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Choose the best answer for the following Questions

1. Which of the following is correct for pasteurization? (3pts)
   A. 63°C for 30 second C. 72°C for 30 minutes
   B. 72°C for 15 seconds D. 63°C for 15 minutes
2. Which one of the following is not the advantage of pasteruization? (2pts)
   A. Kill pathogen microorganisum C. Multiple spore form bacteria
   B. Safe milk for consumer D. Extend shelife life of milk

Test II: Write true if the statement is correct and false if the statement is incorrect

1. The prolonged holding period of pasteurization alters the structure of the milk protein making it bette (2pts)
2. Chilling is not a pasteurization process but it is a necessary step when dealing with large volumes of milk.(2pts)

Note: Satisfactory rating - 8 points Unsatisfactory - below 8 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer sheet

Test I

1.____

2. ____

Test II

1.____

2.____

Information Sheet 4- Carrying out homogenization procedures

4.1. Introduction

Homogenization implies mechanical treatment to break fat globules into smaller size of and uniformly disperse them in milk. Homogenization in the dairy industry is used principally to prevent or delay the formation of a cream layer in full cream milk by reducing the diameter of the fat globules. After homogenization, size of fat globules becomes less than 2µm. The average size of milk fat globule in milk is 2-12µm. The number of fat globules is 3-4 billion in a milliliter of milk.

In the past, pasteurized milk usually was not homogenized, although the flavor of the milk becomes fuller by homogenization. A certain amount of cream was permitted to form to show the consumer clearly the full cream character of milk. Sterilized milk, evaporated or condensed milk and cream are generally homogenized.

4.2. Definition

Homogenization can be defined as the process in which fat globules in milk are broken down to a size small enough to prevent the formation of a cream layer. Homogenizer is a machine, which disintegrates the fat globules of milk.

According to the United States Public Health Services (USPHS), 'homogenized milk is one that has been treated in such a manner as to ensure the break-up of the globules to such an extent that after 48 hours of quiescent storage, no visible cream separation occurs in milk and the fat percentage of the milk in the upper 10% portion, i.e., in the top 100 ml of milk in a quart bottle or of proportionate volumes in containers of other sizes, does not differ by > 10% of itself from the fat percentage of the remaining milk, as determined after thorough mixing'.

The number of fat globules in homogenized milk is about 10,000 times greater than those in unhomogenized milk. The size of fat globule is reduced to < 1 micron, while normal fat globule size averages 2 – 12µm in milk. The number of fat globules will be increased, but total volume of fat globules will remain almost same. The surface area of newly formed smaller fast globules is increased by 4-6 folds.

Merits of Homogenization

- No formation of cream layer/plug
- Fat will not churn
- Thick body and rich appearance
- Produces soft curd, easily digestible
- Less susceptibility to oxidation

Demerits of Homogenization

- Increased cost of production
- Fat from returned homogenized milk is difficult to salvage.
- Sediment is greater
- May produce rancidity if temperature is not kept adequately high.

4.3. Principles of Homogenization

In raw milk, the diameter of the fat particles varies from 2 to 12µ, while a diameter of about 2µ or less is required to keep the fat from rising in stored condition. The milk is forced at high pressure through a narrow slit (spring loaded valve), which is only slightly larger than the diameter of the globules. The velocity of milk in the narrow slit can be 100 - 200 m/s. This can cause high shearing stresses, cavitations and micro-turbulence. The globules becomes deformed, wavy and then breakup.

4.3.1. Homogenizer

Figure 24 Homogenizer

The homogenizer consists of a high pressure, reciprocating pump driven by a powerful motor, and a back pressure device i.e. homogenizer head. It is equipped with a set of valves and valve pressure screws that enable the exposure of liquid products to very high pressures. To withstand the high pressure and velocity and to prevent the wearing of the head, a special metal alloy 'stellite', which is noted for its hardness, is used for making the homogenizer valve. The power source is an electric motor built into the unit. The motor drives the crank and piston assembly either by a pulley or by a set of gears, both of which greatly reduce rpm to provide a suitable speed for the pistons. The gears, cranks, and drive shafts run in an oil bath. The pistons (commonly three sometimes five or seven in number) are usually straight rods giving a small displacement. The pistons extend from the crank shaft in the crank housing, into the pressure chamber in the homogenizer head. Each piston passes through a packing gland especially designed both to prevent product leakage, despite high operating pressures and to facilitate sanitation. The parts of homogenizer head are precisely ground and made to fit together in correct position in order to avoid any leak. The wear and tear of homogenizer head is also frequently checked because if there is any shell gap the fat globules may escape through it and lower the efficiency of homogenization.

4.3.2. Process homogenizer

The high velocity of milk confers high kinetic energy. The energy is dissipated into heat and since the passage time through the slit is small (< 0.1 m/s), the average energy density is very high. Such high energy densities lead to very intense turbulence. The pressure fluctuations are not desirable. When the flow velocity in the valve slit is at its maximum, local pressure is less than zero. A negative pressure may cause cavitations. The collapsing process creates huge shock waves, which may disrupt particles. The degree to which this happens in homogenizers varies. In most cases, globule disruption primarily is caused by turbulent eddies. The small globules do not rise to the top of milk but remains suspended in the milk or rise very slowly. Immediately after the globules are broken down, they show a tendency to cluster and rise to the top of the milk. Two-stage homogenization prevents this. The second stage breaks up any clusters, thus ensuring better dispersion on the fat throughout the milk.

4.3.3. Types of Homogenizer

4.3.3.1. High pressure homogenizer

This type of homogenizer consists of single acting triplex pump with each cylinder having suction and discharges valves. The discharge valve of each pump empties into a common discharge pipe, in which a special valve is placed. The pressure ranges between 35– 350 bar (500-5000 psi) depending on the type of construction of the valve.

4.3.3.2. Low pressure-rotary type homogenizers

Usual operating pressures are below 35 bar (500 psi). The construction is so designed that milk is subjected to grinding and shearing action.

4.3.3.3. Sonic vibrators

The milk is subjected to high frequency vibration in a device called sonic vibrator or oscillator. The milk is subjected to high frequency vibration in a device called sonic vibrator or oscillator

Figure 25 Sonic Vibrator

The machine consists of a flat disc actuated by an electric magnet located over an anvil containing a hole, through which milk enters. The milk passes through the space between the disk and an anvil, and the vibrating action of the disk against the film of milk hammers the fluid at high frequency.

4.4. Details of Homogenization

Homogenizers can be single-stage, double-stage or even multi-stage type. Single-stage homogenizers are equipped with only one homogenizing valve. A homogenizing valve usually consists of a valve, valve seat and an impact ring. These are held within a valve body. On the other hand, double-stage homogenizers are equipped with an additional homogenizing valve.

Commercial milk homogenizers are high pressure reciprocating pumps, each having a sanitary head upon which is mounted a homogenizing valve or valves. Homogenizers have 3, 5 or 7 pistons driven by an eccentric shaft through connecting rods and cross heads. The pump head contains a section manifold with passages connecting to the individual cylinders. Each cylinder has suction and a discharge valves, either poppet or ball type. The valves are spring loaded in some models.

The homogenizing valve accomplishes its intended function by restructuring the product flow area which results in the pressure commonly known as "the homogenizing pressure." The degree of homogenizing effect can be controlled by regulating this pressure, or corrected by the restriction to flow. A pressure gauge is used to indicate the pressure. Generally, double-stage homogenizers are used and pressure of 140 bar and 35 bar in the first and second stages respectively are maintained.

4.4.1. Factors Affecting Homogenization

4.4.1.1. Homogenization pressure

In a single-stage homogenizer, usually 140 – 175 bar pressure is sufficient for milk having up to 6.0% fat. Higher pressure may increase the tendency of the milk to curdle when cooked, due to the increased destabilizing effect on milk proteins. For milk on milk products with > 6 % milk fat, two-stage homogenization is needed to prevent fat clustering pressure of 140 bar and 35 bar in the first and second stage respectively are applied in two-stage homogenization.

4.4.1.2. Stage of Homogenization

For milk with more than 6% fat, two stage homogenization is better. If the broken up fat globules have a tendency to agglomerate after the first homogenizing stage (150-200 bar), they can be re-dispersed employing 20-40 bar in the second stage.

4.4.1.3. Temperature of homogenization

The enzyme lipase should be inactivated prior to homogenization by pre-heating milk to a temperature of 60°C or above. At this temperature fat is already in molten condition. In routine practice, the milk is heated to 65-70°C (149-158°F) for homogenization.

4.4.1.4. Fat content

Homogenization becomes less effective with increasing fat content. When the fat content is high, raising the temperature improves homogenization efficiency. When the fat content is high, the newly created total fat globule surface is so large that the material (plasma protein) becomes insufficient to form new membranes on fat.

4.4.2. Efficiency of Homogenization

4.4.2.1. Degree of homogenization- The degree of homogenization is defined as the ratio of the volume of fat with fat globules diameter of < 0.7 µ to the total fat content of milk or cream. The value of 0.7 µ was based on the fact that fat globules with smaller diameter do not form clumps because they break up again due to Brownian movements.

4.4.2.2. Farrall index- It is a widely accepted microscopic method for determining the homogenization efficiency. This index may be defined as the number of fat globules having < 2 µ in diameter. The efficiency of homogenization is apparently based on the number of fat globules larger than 2µ, as measured under specified conditions.

4.5. Operation of the Homogenizer

Before starting the homogenizer, the following points should be checked

- Water is turned on to lubricate and cool the pistons.
- Pressure controls are checked to see that they are in idling position.
- Check availability of the product to the machine.
- Check during starting of the machine whether the oil pressure records > 1 kg/cm2; otherwise the starter will trip.

4.5. Starting of homogenizer machine

- The motor is started.
- The homogenizer is run on water for about 5 min., then it is stopped and the water drained off by slackening the inlet union, which is tightened subsequently.
- The machine is checked for any leaks.

• The homogenizer is provided with milk supply by adjusting the 3-¬way valve accordingly.

• As soon as the machine starts pumping at full capacity, the pressure adjusting handle of the second stage valve is adjusted to the desired pressure, followed by adjusting the first stage pressure. This can be observed in the single pressure gauge provided.

• The product discharge from the machine is diverted back till the desired homogenizing pressure is obtained.

• When normal operation is attained, the bypass valve is turned to direct the product flow into the processing system. In some homogenizers, there might be provision to release the air from the machine.

4.5.1. Closing down the homogenizing operation

• At the end of the run, the product flow is diverted.

• As soon as the product to be homogenized is emptying out, the water is filled into the hopper for flushing.

• The first stage valve pressure and subsequently the second stage valve pressure are released in that sequence.

• The homogenizer can now be cleaned by switching over to the cleaning sequence.

• After the cleaning is over, the homogenizer is stopped.

Precautionary measures

• The homogenizer should never be run dry. Adequate feed must be maintained at all times to prevent starving of the machine.

• Before the homogenizer is put to use again, the strainer from the inlet chamber should be removed, cleaned and refitted.

• The homogenizer should always be started with both homogenizing valve handles in released position.

• The pressure should be built up gradually.

• While the homogenizer is running, the 3-way valve on the product delivery line should never be closed; otherwise it may result in severe damage to the machine.

4.5.2. Maintenance of Homogenizers

i. The oil level should be inspected daily for maintaining desired level.

ii. Periodic check-up of the lubricating system must be done.
iii. Change the lubricating oil before 500 operating hours or 6 months or sooner, when it becomes emulsified.
iv. Inspect oil seals for preventing any chance of mixing of water with oil.
v. Leakage can be prevented by tightening the nuts or couplings, inserting or replacing gaskets or replacing the pistons.
vi. The homogenizer gauges should be checked periodically for accuracy against a standard gauge.
vii. The homogenizer valves must be regularly inspected and if required, they should be lapped with a fine abrasive for perfect sealing.
viii. While dismantling the valves, care must be taken to avoid scratches. They must be kept on a rubber mat.

4.5.3. Homogenization- Effect on milk properties.

Homogenization prevents phase separation of fat into cream layer during storage and enhances the richness of mouth feel as well as due to an increased surface area. It involves physical changes in milk protein, resulting in lower curd tension and possibly increased digestibility due to faster coagulation in the stomach.

4.5.3.1. Effect of Homogenization on Physico-Chemical Properties of Milk

i. Reduction of fat globules size

Reduction of fat globule size to < 2 µ prevents formation of cream layer and increases the surface area of the fat above 6 times.

ii. Whiter milk

Homogenization of milk increases its whitening power due to an increase in the number and surface area of the fat globules. Adsorption of casein miscelles and serum proteins on newly created fat globules surface increases scattering of light thereby causing whiter appearance.

iii. Physiology of nutrition

Homogenization has been reported to improve the digestibility of milk due to increase in the number and surface area of the fat globules.

iv. Flavor of milk

Homogenized milk has a uniform flavour throughout. It tastes richer, smoother and creamier than unhomogenized milk due to an increase in the surface area of the fat globules which are uniformly distributed in milk.

v. Sensitivity to lipase

Homogenized milk is more susceptible to enzymic activities, especially lipase action, than unhomogenized milk. Lipase can cause rancidity rapidly in homogenized raw milk.

vi. Susceptibility to oxidation

Homogenized milk is more susceptible to oxidized flavours caused by natural or artificial light than unhomogenized milk. To prevent development of off-flavours, homogenized milk must be packaged in opaque containers, such as cartons, plastic containers or coloured bottles.

vii. Sediment on storage

Homogenized milk may develop dark sediment at the bottom of the container after standing for 24 h. This is due to settling of cells, foreign matter and casein particles. In unhomogenized milk, these particles are usually held by the fat globules. To prevent the sediment formation, homogenized milk must be filtered or clarified, preferably before homogenization.

viii. Bacterial count

There will be an apparent increase in bacterial count after homogenization due to the break-up of clumps and colonies of organisms. The aerobic spore-forming bacteriabelonging to the genus Bacillus and allied genera that have caused specificproblems for the production of pasteurised fluid milk specifically. This is due to extended refrigerated storage of raw milk before processing on the farm and in the dairy, higher pasteurisation temperatures, reduction of post-pasteurisation contamination by principally Gram-negative organisms such as Pseudomonas spp., and prolonged shelf-life requirements of the consumer product.

Self-Check-4	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions

1. List the important of homogenization operation? (3pts)

Test II: Choose the best answer

I. The average size of fat globules in milk is__________µm. (2pts)

A. 2-12 µm B. 20-40 µm C. 0.5-1 µm D. 0.01-0.02 µm

II. The process in which fat globules in milk are broken down to small size is called______________. (2 pts)

A. Separation B. Maintenace C. Homogenization D. Cream separation

III. Which of one the following is not merits of homogenizer (2 pts)

A. Fat will not churn C. Less susceptible to oxidation

B. No formation of cream layer D. Separation of skim milk

Note: Satisfactory rating - 9 points Unsatisfactory - below 9 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: _____________

Answer sheet

Test I

1.____

Test II

1.____

2.____

3.____

Operation Sheet-1 Raw milk clarification

Objectives of the raw milk clarification

- To separate physical object that enter raw milk during production and transportation
- To identify tools, equipment and machine which needs for operation

List of Materials needed

-
-
-

Procedures to ensure the job gets done safely and without delay

Steps for clarifying raw milk

1. Preheating of raw milk before operation 35-40^{o}C
2. Straining the milk received or holding container by cheese cloth
3. Start filitration by draining the raw milk on cheese cloth
4. Remove dirt by sieving
5. Wash cheese cloth

Operation Sheet 2– Maintainace of homogenizer machine

Objectives of maintaining homogenizer machine

- To identify parts of homogenizer
- To identify parts must inspect and regular of inspection

List of Materials needed

-
-
-

Procedures to ensure the job gets done safely and without delay

Point to be consider during maintenance of homogenizer

1. Insepect the oil level daily for maintaining desired level.
2. Check-up of the lubricating system must be done.
3. Change the lubricating oil before 500 operating hours or 6 months or sooner, when it becomes emulsified.
4. Inspect oil seals for preventing any chance of mixing of water with oil.
5. Leakage can be prevented by tightening the nuts or couplings
6. Inspect gaskets
7. Inspect the pistons.
8. Check the homogenizer gauges
9. Inspect the homogenizer valves must be regularly inspected and if required, they should be lapped with a fine abrasive for perfect sealing.
10. Take care for dismantling the valves to avoid scratches and must be kept on a rubber mat.

Operation Sheet 3– Operate Homogenizer

Objectives of operating homogenizer machine

- To identify parts of homogenizer use for start up
- To identify parts must inspect and regular of inspection

List of Materials needed

-

Procedures to ensure the job gets done safely and without delay

Before starting the homogenizer, the following points should be checked

- Water is turned on to lubricate and cool the pistons.
- Pressure controls are checked to see that they are in idling position.
- Check availability of the product to the machine.
- Check during starting of the machine whether the oil pressure records > 1 kg/cm2; otherwise the starter will trip.

Starting of homogenizer machine

- The motor is started.
- The homogenizer is run on water for about 5 min., then it is stopped and the water drained off by slackening the inlet union, which is tightened subsequently.
- The machine is checked for any leaks.
- The homogenizer is provided with milk supply by adjusting the 3-¬way valve accordingly.
- As soon as the machine starts pumping at full capacity, the pressure adjusting handle of the second stage valve is adjusted to the desired pressure, followed by adjusting the first stage pressure. This can be observed in the single pressure gauge provided.
- The product discharge from the machine is diverted back till the desired homogenizing pressure is obtained.
- When normal operation is attained, the bypass valve is turned to direct the product flow into the processing system.

Operation Sheet 4– Closing down/shut down the homogenizing operation

Objectives of maintaining homogenizer machine

- To identify parts of homogenizer able to shut down
- To identify parts must inspect and regular of inspection

List of Materials needed

-
-
-

Procedures to ensure the job gets done safely and without delay

Point to be consider during shut down of homogenizer operation

- At the end of the run, the product flow is diverted.
- As soon as the product to be homogenized is emptying out, the water is filled into the hopper for flushing.
- The first stage valve pressure and subsequently the second stage valve pressure are released in that sequence.
- The homogenizer can now be cleaned by switching over to the cleaning sequence.
- After the cleaning is over, the homogenizer is stopped

Operation Sheet-5 Start up pasteurization machine

Objectives of carrying out pasteurization machine

- To identify all the tools, equipment and machine functional and sufficient enough
- To identify tools, equipment and machine which needs

List of Materials needed

-
-
-

Procedures to ensure the job gets done safely and without delay

Steps for starting the pasteurizer

1. Start the air compressor.
2. Switch on the control panel mains.
3. Fill the hot water tank, start the hot water pump and inspect the tank after 2-3 min for the level.
4. Open the air vents.
5. Start flow of the milk to the float controlled balance tank by starting milk pump.
6. Close the air vents when the milk comes out from them.
7. Set the temperature controller at pasteurization temperature (minimum 72°C) and adjust the air reducing valve so that the supply gauge registers 1.76 kg/cm2 pressure.
8. Turn on the steam to the hot water system via 'solenoid valve' for controlling steam passage into the heater.
9. Turn on the chilled water/brine as soon as forward flow takes place. Once the chilling temperature is reached, the plant will set itself to forward flow

Operation Sheet-6 Shut down pasteurization machine

Objectives of carrying out pasteurization machine

- To identify all the tools, equipment and machine functional and sufficient enough
- To identify tools, equipment and machine which needs

List of Materials needed

-
-
-

Procedures to ensure the job gets done safely and without delay

Steps for shut down the pasteurizer

Step 1. Start the air compressor.

Step 2. Switch on the control panel mains.

Step 3. Fill the hot water tank, start the hot water pump and inspect the tank after 2-3 min for the level.

Step 4. Open the air vents.

Step 5. Start flow of the milk to the float controlled balance tank by starting milk pump.

Step 6. Close the air vents when the milk comes out from them.

Step 7. Set the temperature controller at pasteurization temperature (minimum 71.7°C) and adjust the air reducing valve so that the supply gauge registers 1.76 kg/cm2 pressure.

Step 8. Turn on the steam to the hot water system via 'solenoid valve' for controlling steam passage into the heater.

Step 9. Turn on the chilled water/brine as soon as forward flow takes place. Once the chilling temperature is reached, the plant will set itself to forward flow

LAP TEST	Performance Test

Name………………………………. ID………….. Date………………………………

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour for each. The project is expected from each student to do it.

Task

1. Perform successful clarification of raw milk
2. Perform successful maintainace of homogenizer
3. Perform successful Operate Homogenizer
4. Perform successful shut down homogenizer
5. Perform successful Start up pasteurization machine
6. Perform successful shut down pasteurization machine

LG # 31	LO #3- Assess the organoleptic properties of product and relate to specifications

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Identifying desirable and undesirable flovors in the product
- Recornizing different organoleptic qualities
- Assessing the products for evenness of color and finsh
- Identifying possible causal factors and addressing products quality

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, **upon completion of this learning guide, you will be able to**:

- Identify desirable and undesirable flovors in the product
- Recornize different organoleptic qualities
- Assesse the products for evenness of color and finsh
- Identify possible causal factors and addressing products quality

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Identifying desirable and undesirable flavors in the product

1.1. Introduction

Flavor perception is highly complex. Traditionally, two chemical senses are distinguished: taste and odor, which are sensitive to specific water-soluble and volatile compounds, respectively. Such compounds can be identified and characterized. It has long been known that a combination of taste and odor leads to the perceived flavor. Actually, flavor perception involves other stimuli as well, in a manner only partly understood. Mouth feel and physical structure of the food can have significant effects. The minimum concentration, at which a flavor compound can be perceived, generally called the *threshold value*, varies widely among compounds, for the most part ranging between 10^3 and 10^{-4} mg per kg. This means that some compounds give a perceptible flavor even if present in minute quantities. The threshold value of a compound can also depend on the material in which it is present.

- Most volatile flavor compounds are hydrophobic and readily associate with proteins, substantially decreasing flavor perception.
- It is also clear that substances that cause a strong flavor mask the perception of weak flavors.
- Moreover, a substance giving a pleasant flavor when present at low concentration often causes a quite unpleasant sensation if the food contains much larger amounts. However, all this depends on the individual observer because perception is, by its nature, purely subjective.
- The main nonvolatile flavor compounds in fresh milk are lactose and dissolved salts, which cause a sweet or salty taste, respectively. The sweetness caused by lactose is decreased by the dissolved salts and by the micellar casein in milk. The salty taste is prevalent if the Chlorine lactose ratio is high, as in mastitic or late-lactation milk.
- Some volatile compounds, especially dimethyl sulfide, and also diacetyl, 2 methylbutanol, and some aldehydes are responsible for the characteristic flavor of

fresh raw milk. However, skim milk and whole milk differ considerably in flavor. The fat globules are largely responsible for the 'creamy' or 'rich' flavor.

- It is quite likely that the physical presence of the fat globules plays an important part because creaminess can also be enhanced by other small spherical particles.
- Naturally, cream tastes much creamier than milk. All in all, the flavor of milk is generally considered mild, especially when cold, which implies that few people dislike it. On the other hand, the mildness means that flavor defects are readily noticed.
- Fresh milk may have off-flavors originating from the cow's feed. The compounds responsible for this enter the milk through the cow or from the air, and sometimes via both pathways. Examples are clover and garlic flavors. If the cow suffers from ketosis, for instance because it's feed is deficient in protein, increased concentrations of ketones (especially acetone) are found in the milk. Consequently, the milk exhibits a typical 'cowy' flavor. Vacuum heating may remove part of such volatile flavor compounds if they are hydrophilic. Removal of the many fat-soluble compounds is more difficult.
- Microbial spoilage of milk may produce flavor defects; the various defects are referred to as acid, 'unclean,' fruity or ester, malty or burnt, phenolic, bitter, rancid, etc. The resulting free fatty acids of 4 to 12 C atoms are responsible for a soapy-rancid flavor.
- Several proteolytic enzymes can attack casein, giving rise to bitter peptides. Autoxidation of fat, as caused by catalytic action of Cu, can lead to 'oxidative rancidity'.
- Several carbonyl compounds contribute to the off flavor, especially some polyunsaturated aldehydes. The resulting flavor in milk is generally called 'tallowy'; in butter one speaks of 'oily' or, if the flavor is quite pronounced, 'fishy.'
- In milk a 'cardboard' flavor may also occur, which results from autoxidation of phospholipids; it can also be observed in skim milk.
- The phospholipids in the plasma appear to be oxidized readily. In sour-cream buttermilk, which is rich in phospholipids, this may lead to a 'metallic' flavor if the defect is weak and to a sharp (pungent) flavor if it is strong.

- Flavor defects in milk can also be induced by light. Like Cu, light may catalyze fat autoxidation. Direct sunlight applied for 10 min or diffused natural light for a somewhat longer time often suffices. A tallowy flavor develops, not immediately, but only after some time. Light from fluorescent lamps especially can induce the cardboard flavor. Exposure of milk to light can also lead to the development of a 'sunlight flavor.'
- Moderate heat treatment of milk (say, 75°C for 20 s) causes the characteristic raw milk flavor to weaken so that a fairly flat flavor results.
- More intense heat treatment, e.g., 80 to 100°C for 20 s, results in a 'cooked' flavor, caused mainlyby H2S. This compound primarily derives from a protein of the fat globule membrane, which is the reason why cream is much more sensitive to the development of a cooked flavor than milk.
- More intense heat treatment, e.g., 115°C for 10 to 15 min, leads to a 'sterilization' flavor, which can be especially strong in concentrated milk.
- Several flavor compounds result from the degradation of lactose, partly via the Maillard reaction; the main compounds causing off-flavor are maltol, isomaltol, and certain furanones. Other components that can be responsible are formed by the breakdown of fatty acids.
- The typical flavor of UHT milk is mainly due to H2S as well as the mentioned ketones and lactones.

1.2. Sensory evaluation of milk and dairy products

Good quality milk should have a pleasantly sweet and clean flavor with no distinct aftertaste. Because of the perishability of milk and the nature of milk production and handling procedures, the development of off-flavors/odors is common. To prevent flavor/odor defects in milk, proper milk handling procedures from the farm to the consumer are essential.

The common flavor and odor defects found in milk may be classified according to the ABC's of off-flavors:

A= Absorbed/Transmitted

B= Bacterial/Microbial

C= Chemical/Enzymatic/Processing

Absorbed- feedy,barny,cowy,weedy, unclean, lacks freshness, stale, refrigerator/cooler odors.

Raw or pasteurized milk products can absorb flavors during production, storage and distribution. On the farm, off-flavors can be absorbed, or more correctly transmitted, through the bloodstream of the cow from the lungs and/or rumen into the milk in the udder. Similar off-flavors may be absorbed into the milk during farm storage if ventilation is poor and the milk is not protected. Pasteurized milk can absorb flavors during refrigeration storage, especially in paperboard or low barrier cartons. Examples of off-flavors that might be absorbed include volatile compounds of fruits or vegetables or unclean odors associated with poorly cleaned milk coolers. Absorption of flavors by packaged milk can occur at the plant, in the supermarket or in the consumers' home refrigerators.

Bacterial- acid,bitter,malty,lacks freshness, unclean, fruity/fermented, putrid and rancid.

Bacterial and other microbial off-flavors result from the growth of microorganisms that are present in milk due to poor sanitation and/or milk handling practices. Bacteria that are able to grow at refrigeration temperatures (≤45°F/7.2°C), or psychrotrophic bacteria, are most often responsible for spoiling refrigerated milks. The type of spoilage (e.g., fruity, rancid, acid) depends on the predominant type(s) of bacteria present and generally occurs when bacterial numbers exceed one to ten million per milliliter. The time it takes for bacteria counts to reach spoilage levels depends on the initial numbers of bacteria and the temperature of storage; the warmer the storage temperature, the quicker bacteria grow and produce off-flavors and the shorter the shelf-life. If the raw milk quality is good and post-pasteurization contamination is prevented during processing, the numbers of microorganisms should not reach spoilage levels before 14-21 days when milk is held under proper refrigeration. Bacterial and other microbial defects can occur in raw or pasteurized milk and in other dairy products.

Chemical- cowy (ketosis), salty, rancid, bitter, oxidized, sunlight, foreign, astringent, medicinal, flat, cooked.

Chemical and enzymatic defects can occur in both raw and pasteurized milk. The cows may be suffering from ketosis (rare) or mastitis, which can affect milk flavor. Abusive handling of raw milk may result in a rancid flavor from the action of the naturally occurring lipase enzyme, which breaks down butterfat to free fatty acids (i.e., butyric acid is perceived as "rancid"). Oxidized flavors can be induced by heavy metals, particularly copper, or by exposure to sunlight and fluorescent lights. Chemical or foreign off-flavors can also occur due to contamination with cleaning chemicals, sanitizers, medicines, or other substances during production or processing. Processing parameters, if not managed properly, can result in off-flavors including cooked (from high heat) or flat (from added water). A complete description of the characteristics of milk defects and guidelines for milk judging and scoring follows.

3.2. Characteristics of undesirable flavors of milk

i. Typical milk flavor- No criticism. Very little distinct odor, pleasantly sweet and clean with no aftertaste.

ii. Acid- Basic taste sensation- Sour, tart, may cause tingling sensation on tongue. "Cultured milk" or "sour" odor may be present.

Cause- Growth of lactic acid producing organisms such as Lactococcus lactis, due to poor refrigeration, especially when temperatures exceed 70°F (21°C)."Malty" milks may be acid also.

iii. Astringent flavor- Peculiar mouth-feel, tongue and mouth lining feel shriveled, puckered, chalky (e.g., cranberry juice).

Cause- Associated with denatured proteins due to high heat treatments or with staleness (e.g., milk powder). May be more pronounced in skim milks and in Ultra High Temperature (UHT) or Ultra-Pasteurized (UP) products. Occasionally occurs with slight rancid, bitter or acid milk.

iv. Barny flavor- Unpleasant odor and taste of a poorly maintained barn or unpleasant feed. May be perceived as "unclean." "Cowy" or "cow's-breath" may present a similar defect but generally with an unpleasant medicinal or chemical (i.e., acetone) aftertaste.

Cause- absorbed, transmitted odor/flavor due to cow inhaling barn odors associated with poor ventilation and unclean barn conditions. Similar defect may be due to ketosis in cows, but with more of a medicinal or chemical after taste (see cowy).

v. **Bitter flavor**- Basic taste sensation. Pure bitter has no odor. Taste sensation is detected on the tongue after expectoration (delayed) and tends to persist. (e.g., hops in beer, coffee may be bitter).

   Cause- enzymatic breakdown (microbial or milk enzymes) of milk proteins to short bitter peptides. Certain weeds ingested by cows may also cause bitterness although this is rare.

vi. **Cooked flavor**- Note odor and flavor. Varies in intensity from sweet, pleasant, with slight sulfurous or custard notes, to caramelized or cabbage-like, which may be objectionable. Flavor usually becomes less intense over time but may persist depending on packaging material.

   Cause- Higher pasteurization temperatures and/or longer holding times. Intensity depends on the severity of heat treatment. Cooked flavors tend to be more pronounced in batch-pasteurized than HTST milk; most pronounced in Ultra High Temperature (UHT) or Ultra Pasteurized (UP) products.

vii. **Cowy flavor**- Unpleasant odor & flavor; “acetone” or “cow's-breath”; unpleasant medicinal or chemical aftertaste.

   Cause– metabolic disorder in cows such as acetonemia or ketosis. Rare in commingled bulk supplies. Similar defect may be transmitted/absorbed odors of poor barn conditions (i.e., barny).

viii. **Feed flavor**- Odor & flavor is characteristic of associated feed; silage, hay, grassy, etc. Can be slightly sweet, generally not unpleasant, although could be unclean when strong o rfeed quality is poor. Most feed flavors clear up readily after milk is discharged from mouth. Common, though most often slight.

   Cause- cows consume particular feed or inhale feedy odors prior to milking; transmitted to the milk. Feeding should be done after milking when practical, barns should be well ventilated.

ix. **Flat flavor**- No odor. Lacks mouth-feel, flavor fullness, and/or sweetness of fresh milk. Watery characteristic.

Cause- adulteration with water or low milk solids content. Older milk may be "flat."

x. **Foreign flavor**- May have odor and/or flavor that is not commonly associated with milk. Often "chemical" in nature. Depends on causative agent; sanitizers, detergents, exhaust fumes, cow medications, citrus fruits, etc. Chloro-phenol compounds may give "medicinal" or "bandage-like" flavor.

Cause- Contamination of milk with foreign substance. May be direct contamination of the milk (e.g., udder ointment/chemical sanitizers, phenols/chlorine);may be transmitted through the cow or absorbed during raw storage or through retail packages in plant, store or home refrigerators.

xi. **Fruity/Fermented flavor**- Odor and flavor is usually pronounced, similar (not exact) to pineapple, apple, strawberry or other fruit (fruity); may have more of asauerkraut or vinegar-like odor or flavor(fermented).

Cause- growth of psychrotrophic spoilage bacteria, especially certain psychrotrophic Pseudomonas species or some of the spore-forming organisms (e.g., Bacillus, Paenibacillus).

xii. **Garlic/Onion flavor**- Characteristic pungent odor and flavor. Highly objectionable. **Cause-** Animals ingesting wild onion or garlic weed; may also be absorbed through packaging during refrigeration storage with onion or garlic containing foods.

xiii. **Lacks-Freshness flavor**- Lacks fine, pleasing flavor. Mild off-flavor that lacks specific characteristic to make identification easy. May be "stale" or less sweet (e.g., "flat"). Generally not intense enough to fail product.

Cause- Usually due to age, staleness, residual milk enzymes or initial stage of microbial spoilage (e.g., psychrotrophic bacterial off-flavors such as unclean, bitter and rancid).

xiv. **Malty flavor**- Malt-like aroma or taste (like malted milk or Grape-Nuts). May be similar to feed or cooked odors, but is considered a severe defect as microbial spoilage. Milk often is acid as well.

Cause- Growth of Lactococcus lactis var. maltigenes (or possibly other organisms) due to poor refrigeration. May be followed by "acid" or "unclean" flavors.

xv. **Oxidized/Light-Induced**- Odor and taste of burnt-protein, burnt-feathers, or medicinal or plastic-like taste. May progress to metallic or lipid oxidized type flavor due to fat oxidation.

Cause- exposure of milk to sunlight or fluorescent lights resulting in protein degradation and/or lipid oxidation. Milk in unprotected or transparent milk jugs/bottles is more susceptible although this defect may occur in paper packaging if the light is intense and exposure time is sufficient.

xvi. **Metallic-Oxidized**- Wet cardboard, oily, tallowy, chalky, or fishy flavor. Odor (old veg. oil) is pronounced when defect is intense. May have a lingering greasy or puckery mouth-feel. Sensation comes quickly.

Cause- milk fat oxidation catalyzed by copper or certain other metals contacting milk (e.g., copper pipe, white metal, metallic water supply). May be associated with raw milk of cows fed high fat feeds (e.g., soybeans) and/or lack of antioxidants (e.g., vitamin E). Sometimes occurs spontaneously. Raw or cream-line milk is more susceptible than pasteurized homogenized.

xvii. **Carton/Paperboard**- Plastic-like or wet paper flavor. Subtle, rarely pronounced unless there is evidence of carton burning during the sealing process.

Cause– associated with paper-board packaging with heat used to seal HDPE polymer coating. Generally more apparent in half-pints due to increased package surface area to volume ratio.

xviii. **Rancid flavor**- Pungent odor when extreme. Taste soapy, unclean, bitter, blue cheese-like or "baby vomit." Provolone cheese has a rancid flavor profile. Pronounced lingering aftertaste. Sensitivity varies.

Cause- free fatty acids (e.g., butyric acid) released from milk fat by natural or microbial enzymes (lipase). In raw milk it's associated with excessive agitation, temperature abuse or cow factors (e.g., poor health and/or nutrition).Pasteurization destroys natural enzyme (lipase), but spoilage microorganism may have similar enzymes that cause rancidity.

xix. **Salty flavor**- Basic taste sensation. No odor. Generally easily detected. Clean mouth-feel.

Cause- associated with late lactation or mastitic cows. Would be rare in bulk supplies

xx. **Unclean**- Unpleasant odor and taste. Mouth fails to clean up after expectorated. Suggestive of mustiness, putrid, "dirty dish-rag" or other "unclean" flavors.

Cause - generally due to growth of spoilage microorganisms in milk or on excessively dirty equipment. Can occur due to milk absorbing odors from dirty coolers or environment.

Self- Check- 1	Written test

Name…………………………………………… ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. List the characterstics and cause of undesirable flovor for acid milk?(3)

Test II Write true if the statement is correct and false if the statement is incorrect

1. Good quality milk should have a pleasantly sweet and clean flavor.(2pts)
2. To prevent flavor/odor defects in milk, proper milk handling procedures from the farm to the consumer are essential. (2pts)
3. off-flavors result from the growth of microorganisms that are present in milk due to poor sanitation and/or milk handling practices (2pts)

Note: Satisfactory rating - 9 points Unsatisfactory - below 9 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

1. ____
____

Test II

1. ______________________________
2. ________________________________
3. ____________________________________

Information Sheet 2- Recognizing different organoleptic qualities

2.1. Introduction

Milk being a product of biological origin, is extremely vulnerable to attack by microbes. It is also a good vehicle for additives and adulterants without any apparent changes in its appearance. Thus, milk is prone to several post-secretion changes, some natural and some man-made. Most dairy plants usually follow chemical quality control with the intention of payments to contractors/producers, processing of milk and meeting mandatory requirements for end products.

2.2. Quality Assessment of Raw Milk

The quality of dairy products depends upon quality of raw milk used in their manufacture, processing and handling. The poor socio-economic conditions of the rural producers pose serious problems in producing raw milk of good quality, which is further deteriorated during subsequent handling and transportation. The quality of the incoming raw milk is assessed to check its suitability for processing through various quick tests called ‘platform tests’. Samples are drawn from the milk supplied by each producer and certain tests performed to assess its acceptability.

2.3. Organoleptic milk quality tests

To conduct a preliminary examination of a milk sample, first look at the container and assess its overall cleanliness. Examine seals or lids to see if they are working properly. Next, open the container and immediately smell the milk. The milk should not contain any off odors. Off odors can be produced by the animal’s diet, chemical adulteration, natural hormones in the milk, the milk collection environment, and, most commonly, bacterial growth. Milk with high bacterial counts will have a characteristic sour odor.

Fresh milk should appear white. Chemical adulteration and colostrum can produce off colors. If a small amount of milk is allowed to run down a polished surface, it should leave a streak of milk.

Finally, the milk should be free of clumping. Milk that is spoiled or otherwise unusable due to microbial growth is often easy to identify based on simply on appearance and odor.

2.3.1. Appearance

In order to judge the appearance of the milk, remove the lid of the milk container and note the appearance of the surface of the milk and the lid, note any abnormal colour of the milk, visible dirt and particles, changes in viscosity etc. The tester smells the milk, observes the appearance, checks the can for cleanliness, looks for sediment, flies, etc. and tastes if necessary. After milk has tempered swirl the cup and observe for signs of coagulation and film formation. If coagulated or otherwise visually unacceptable, check the appropriate criticism box and put not tasted in the sample score box.

2.3.2. Colour of the milk

Colour is one of the attributes that affect consumer perception of quality. Color changes particularly during milk storage time are vital quality. During tasting, whitesh milk color is acceptable while milk have bloody, pause are rejected.

2.3.3. Odor of the milk

Swirling leaves a thin film, which allows volatile compounds to evaporate. Immediately after swirling milk, hold the cup up to your nose and remove the lid while inhaling. Milks with objectionable odors do not need to be tasted. Note the perceived odor in the appropriate criticism box and put not tasted in the sample score box.

2.3.4. Taste the Milk.

Take a generous sip of milk roll it in mouth note the flavor sensation and expectorate. Do not swallow the milk. Flavors can be enhanced by drawing in a breath of fresh air through the mouth followed by a slow exhale through the nose.

Self-Check – 2	**Written test**

Name………………………………………… ID……………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Choose the best answer

1. The milk sample taste having 6.4 – 6.6 pH value categorized as?(2pts)
   A. Normal B. Sliglthly acidic C. Acid D. Alkaline
2. The milk sample taken from collection center temperature is 17^{o}C and lactometer reading is 30.6. What is the true lactometer reading of the milk? (2pts)
   A. 30.0 B. 30.3 C. 31.2 D. 30.6

Test II Write true if the statement is correct and false if the statement is incorrect

1. Milk that is acidic or milk that contains colostrum often cannot withstand boiling (2pts).
2. Milk taste result having lactometer reading range of 26.0 -32.0 ^{o}L is accepted (2pts).

Note: Satisfactory rating - 8 points Unsatisfactory - below 8 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

1. ____
2. ____

Test II

1. ________________________________
2. __________________________________

Information Sheet 3- Assessing the products for evenness of color and finsh

3.1. Introduction

Colour is one of the attributes that affect consumer perception of quality. As well as flavour and texture, they are considered to be major attributes that contribute to the overall quality products. Hence, in the food industry, the assessment of the colour has become an important part of quality product and process management. In some foods, colour is the first criterion to be perceived by the consumer.

The color of the milk product can be indicator of physico-chemical changes. In this context, color changes particularly during storage time are vital quality measures and, thus, instrumental color analysis has been widely used in identifying color variations in dairy products over the storage. Furthermore, color of the foods must be analyzed with utmost accuracy.

Due to the subjective perception of color and its variety from observer to observer, color measuring devices are mostly used in order to have a reliable and objective color determination. Instrumentally, color measurement can be carried out using conventional instruments and computer vision systems. Commonly used colorimeters are Chromameter and colorimeter.

When color is fully saturated, the color is considered to be in its purest version. Each color can be represented by numerous color spaces. A color space is a model that can be used to characterize as many colors as our vision system can possibly distinguish. Typically, there are many types of color spaces, but instrumental spaces are used for color devices, such as the colorimeters and spectrophotometers.

3.2. Important pigments in milk and dairy products

Several dietary factors have been identified as being responsible for the obtained raw milk characteristics. These factors include those associated with the diet fed to animals. Among these, the nature and stage of maturity of forage, the pasture system in use, the supplements given, the adaptation periods and the energy balance have special significance.

Carotenoids are a family of more than 600 molecules that are synthesized by higher plants and algae. They form the main group of natural pigments and are natural pigment precursors of the yellow to red colour range in vegetal and animal tissues. Plant carotenoids are transferred into animal products. Carotenoids are involved in the nutritional and sensory characteristics of dairy products, either indirectly through their antioxidant properties or directly through their yellowing properties.

The colour of dairy products highly depends on their carotenoid concentration. Forages represent the main source of carotenoids for ruminants, where they develop several functions including provitamin A function, antioxidant function, cell communication, enhancement of immune function, and UV skin and macula protection.

Nearly 10 carotenoids have been identified in forages: lutein, epilutein, antheraxanthin, zeaxanthin, neoxanthin and violaxanthin for xanthophylls, all-trans ß-carotene, 13-cis ß-carotene and α-carotene, being the most quantitatively important ß-carotene and lutein.

In cows' milk, carotenoids principally consist of all-trans- ß-carotene and, to a lesser extent, lutein, zeaxanthin, ß-cryptoxanthin. Since the amount of ß-carotene deposited in adipose tissue and/or secreted in milk fat varies widely according to the carotenoid content in the feed, it plays a key role in the sensorial and nutritional value and dairy products.

Carotenoids are found in higher concentrations in milk produced through grass-based diets, specially pasture. In grazing systems, a change in carotenoids in milk in the course of time may depend on both the amount of carotenoid intake and milk yield. Diets based on grass, mainly pastures, lead to a higher concentration of β-carotene in milk as compared to diets rich in corn silage or concentrates, since processing greatly reduces their concentration.

3.3. Milk colour

Milk colour characterization is mainly applied to identify technological parameters such as homogenization, thermal treatment, fat concentration, photo-degradation, storage conditions or additives. The white appearance of milk is the result of its physical structure. The casein micelles and fat globules disperse the incident light.

3.4. Dairy products colour

Milk carotenoids are transferred to butter and cheese with minimal losses and hence contribute to their yellow colour. Since carotenoids and retinol are soluble in fat, they mainly behave as milk fat. Nevertheless, a small proportion of retinol and carotenoids are related with whey protein and / or concentrated in the membrane of fat globules in milk. As a result, a certain amount of these micronutrients may be lost to whey during cheese and butter processing.

3.5. Color stability during milk and milk products processing

3.5.1. Conventional treatments

Thermal treatments of milk have been successfully applied in industrial practice, ranging from mild to severe ones. As expected, the more severe the heat treatment, the more extensive the damage. Dairy powders are sensitive to the Maillard reaction as they contain high concentration of lactose and proteins with high lysine level. In addition, relatively high temperature and water content during processing and prolonged storage are the major factors involved in the high susceptibility of dehydrated dairy products, as they are favorable conditions for the Maillard reaction.

Milk color is known to be affected by many factors including animal genetic merit and breed, stage of lactation and parity, time of milking, udder health status, as well as herd-level factors such as pasture grazing and seasonal calving.

Self- Check -3	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Write true if the statement is correct and false if the statement is incorrect

1. Among carotenoid pigments, the β-carotene and lutein provide the yellow colour for milk (2pts)
2. The colour of dairy products highly depends on their carotenoid concentration.(2pts)
3. Colour is one of the attributes that affect consumer perception of quality. (2pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

1. ______________________________
2. ________________________________
3. ____________________________________
4.

Information Sheet 4- Identifying possible causal factors and addressing products quality.

4.1. Introduction

The amount and quality of milk a cow produces depends largely on the environment. It's all about comfort: The more comfortable the cow, the more milk it will produce. The less comfortable the cow, the less productive.

4.2. Factors affecting milk production

4.2.1. Environmental factors

Temperate climates with milder seasons put less stress on cows than climates with more extreme weather. Geography is closely tied to weather and climate. For example, cows in Wisconsin and Michigan tend to be more productive than cows in New Mexico due to heat in the latter region. Heat and humidity are the factors with largest impact. If nighttime temperatures cool, cows get a chance for cover even in hot seasons. However, if they don't have a chance to cool down, they will eat less feed and produce less milk.

4.2.2. Feed

Weather and climate can also affect the abundance and quality of feed, which translates to quantity and quality of milk produced. Feed prices and availability can have a large impact on what farmers can use.

4.2.3. Accommodations

When cows have comfortable places to rest, space to graze and farmers who work to keep everything clean, they're more productive.

4.2.4. Species

Different cow breeds naturally produce different quantities of milk.

4.2.5. Age

Younger cows generally produce more milk than older ones. Farmers constantly face the decision of letting a cow give milk versus when it's economically better to slaughter for beef and let a younger cow replace it.

4.2.6. Milking frequency

Farmers are very precise about how frequently cows are milked. The amount of milkings per day adds to labor and equipment costs. But waiting too long between milkings means quantity and quality will suffer.

4.2.7. Health

Sick cows produce less milk and poorer quality milk than healthy ones.

4.2.8. Dry period

How long a cow is allowed to be "dry" in between calvings impacts how much milk it will give during lactation.The quality of milk a cow gives directly affects how much a farmer is paid for it. That's why farmers go to such great lengths to assure quality of milk.

4.3. Factors affecting milk quality

4.3.1. Cow health

A cow's health has the biggest impact on the quality of the milk it produces. Just like humans, cows can catch illnesses such as a cold or flu. They're also susceptible to irritation or inflammation of their udders if stall conditions are poor. Exposure to mud, manure and runoff can expose the herd to more pathogens, increasing incidents of infection. Rainy seasons can predictably lead to higher somatic cell counts.

4.3.2. Somatic cell counts

Figure 26 High performance somatic cell count analyzer

These are the best markers of cow health. High somatic cell counts in milk indicate an increased presence of white blood cells a signal that the cow is fighting an illness. Other types of somatic cells can degrade the fat and protein content in milk.

4.3.3. Diet-

Just as a cow's diet impacts the quantity of the milk it produces, it also affects the quality composition. In times of food scarcity, both will suffer. When feed is plentiful, farmers have more room to adjust feed to enhance the components of milk. Better composition means a better paycheck.

4.3.4. Milk handling

Another factor affecting milk quality is how it's treated once it leaves the cow. Because milk is a naturally good place for bacteria to thrive, bacteria counts taken during processing can show whether milk was taken with clean equipment and cooled quickly.

Operation sheet-1 Perform milk quality taste by organoleptic test

Objectives of carrying organoleptic test of raw milk

•To identify all the tools, and equipment functional and sufficient enough

•To identify tools, equipment and machine which needs

List of Materials needed

-
-
-

Procedures to ensure the job gets done safely and without delay

Procedure:

1. Mix the milk sample gently and pour it gently into a measuring cylinder (300-500).
2. Let the Lactometer sink slowly into the milk.
3. Read and record the last Lactometer degree (ºL) just above the surface of the milk.
4. If the temperature of the milk is different from the calibration temperature (Calibration temperature may be=20 ^{0}C) of the lactometer, calculate the temperature correction.
5. For each ºC above the calibration temperature add 0.2ºL;
6. For each ºC below calibration temperature subtract 0.2 ºL from the recorded lactometer reading.

LAP TEST	Performance

Name………………………………. ID………….. Date………………………………

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task

1. Perform successful clot on boiling test of raw milk
2. Perform successful alcohol taste of raw milk
3. Perform successful milk quality taste by Lactometer test

LG #32	LO #4- Meet workplace requirements for food safety, quality and environmental management

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- keeping records of product manufacture
- Implementing health and safety and environmental protection procedure
- Disposing waste and reviewing environmental impacts

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, **upon completion of this learning guide, you will be able to**:

- keeping records of product manufacture
- Implementing health and safety and environmental protection procedure
- Disposing waste and reviewing environmental impacts

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to "Operation sheets".

Information Sheet 1- Keeping records of product manufacture

1.1. Definition of a record

Records are “information created, received, and maintained as evidence and information by an organization or person, in undertaking of legal obligations or in the transaction of business final reports, emails confirming an action or decision, spreadsheets showing budget decisions, photographs or maps of field missions, which need to be kept as evidence. If you created or received the document in the course of your work and it provides evidence of an activity, decision, or transaction, you need to keep it as evidence, according to established schedules that document becomes a record and must be stored safely.

1.2. Important of records

The key difference between information, documents, and records is their level of accountability. If information is useful but does not provide evidence of actual official work, or actions or decisions, treat that information as a “non-record”: it is informative but cannot be used to prove that we did or did not take a certain action. Documents become records when we use them to inform our organization and ourselves of what has been done or decided or when they provide examples of or background to previous work or evidence of our actions or decisions.

When a document provides evidence, it to be a record. That is, store the record in an official records system so that can find and use it again easily. If the document is superseded or obsolete an email confirming a lunch appointment is no longer needed when lunch is over do not need to declare that document as a record.

A record should have one of the following uses

- Provide evidence of a transaction
- Be used as reference material

- Ensure compliance with statutory or other regulations

1.3. Important of records management

Managing records effectively does not happen by accident. You have to follow internationally accepted records management requirements. The main purpose of records management is to support the organizational business, to make sure that official records are easily accessed as evidence and that redundant and superseded information is not kept any longer than necessary.

1.3.1. Benefits of effective records management.

- Accurate, reliable records allow personnel to make decisions and perform duties effectively and efficiently.
- Well-managed records provide evidence of organization policies, decisions, actions, and transactions, demonstrating accountability and supporting transparency and openness.
- Time is saved because filing systems are easy to use and well-structured.
- Records storage costs are reduced because redundant records are removed systematically.
- Duplicates and up to date versions of records are easily identified.
- Saving time and space and reducing the risk of confusion.
- Outdated documents are securely destroyed, with destruction decisions documented.
- Vital records are identified and protected, supporting business continuity and disaster recovery efforts.
- The small volume of records with enduring value as archives are identified and managed appropriately.

1.3.2. In Dairy and dairy products manufacturing record:

1. **Raw milk received at plate form shall be recorded**

Date	Name of supplier	Amount of milk supplied	Time

2. **Raw milk physicochemical and microbial load shall be tested and recorded**

2.1. Physicochemical taste

Date	Name of supplier	Protein	Fat	Lactose	Total solid	Moisture	Density

2.2. Microbial load taste

Date	Name of supplier	Total bacteria count	Total coliform count	Yeast and mould	Density

3. **Raw milk amount accepted for processing shall be recorded**

Date	Amount of milk receive	Amount of milk accepted	Amount of milk rejected

4. **Daily amount of milk allowed for different products processing**

Date	Products type	Amount of milk	Responsible person

5. **Final product delivered for market shall be recorded**

Date	Type of product	Amount	Market area	Batch number	Name of distributor

6. Products returned and reason of return shall be recorded

Date	Type of product	Amount of product return from market	Reason for return	Batch number

7. Final products Quality analytical tests for raw milk.

Quality tests	Acceptable limits	Standards	Reference number
Acidity (Titratable)	≤0.18%		
Antibiotic residues	Absent/0.1 g		
Freezing point (added water)	−0.54°C		
Fat	0.8%		
Protein	34%		
Lactose	>4.2%		

8. Incoming Materials Test Book

Product Name__________________________ Batch Number____________

Raw material*	Supplier	Results of inspection for**		
		A	B	C
Write in either ‘pass/Failorobservations on quality				

Self-Check-1	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. List the importance of records?(2)

Note: Satisfactory rating - 3 points Unsatisfactory - below 3 points

You can ask you teacher for the copy of the correct answers.

Score = ____________

Rating: _____________

Answer Sheet

Name: ___________________________ Date: ________________

Test I

1. ____
____
____

Information Sheet 2- Implementing health and safety and environmental protection procedures

2.1. Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP). These EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons.

2.2. Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with dairy processing facilities that occur during the operational phase, along with recommendations for their management. Recommendations for the management of EHS issues common to most large industrial facilities during the construction and decommissioning phases are provided in the General EHS Guidelines.

2.3. Environment

Environmental issues specifically associated with dairy processing facilities include the following:

- Wastewater
- Solid waste
- Emissions to air
- Energy consumption

2.3.1. Wastewater

Industrial Process Wastewater

Due to the presence of milk solids (e.g. protein, fat, carbohydrates, and lactose), untreated wastewater from dairy processing facilities may have a significant organic content, biochemical oxygen demand (BOD), and chemical oxygen demand (COD). Whey may also contribute to high organic loads in wastewater. Wastewater may also contain acids, alkali, and detergents with a number of active ingredients, and disinfectants, including chlorine compounds, hydrogen peroxide, and quaternary ammonia compounds. Wastewater may have a significant microbiological load and may also contain pathogenic viruses and bacteria.

The following recommended techniques can be used to prevent the contamination of the wastewater stream:

- Avoid milk, product, and by-product losses through the adoption of good manufacturing procedures and facility maintenance;
- Separate and collect product waste, including rinse waters and by-products, to facilitate recycling or further processing for subsequent use, sale, or disposal.
- Install grids to reduce or avoid the introduction of solid materials into the wastewater drainage system;
- Process and foul drains should be separate in process areas and should discharge directly to a treatment plant and / or municipal sewerage system;
- Pipes and tanks should be self–draining, with appropriate procedures for product discharge prior to, or integral with, cleaning procedures;
- Subject to sanitary requirements, recycle process water, including condensate from evaporation processes, for preheating and heat-recovery systems for heating and cooling processes, to minimize water and energy consumption;
- Adopt best-practice methods for facility cleaning, which may involve manual or automated Clean In Place (CIP) systems, using approved chemicals and / or detergents with minimal environmental impact and compatibility with subsequent wastewater treatment processes.

2.3.2. Solid Waste

Solid organic waste in dairy processing facilities mainly originates from production processes and includes nonconforming products and product losses, grid and filter residues, sludge from centrifugal separators and wastewater treatment, and packaging waste arising from incoming raw materials and production line damage.

Recommended measures to reduce and manage solid waste include the following:

- Where possible and subject to sanitary requirements, segregate solid process waste and non-conforming products for reprocessing into commercial products and byproducts;
- Optimize product filling and packaging equipment to avoid product- and packaging-material waste;
- Optimize the design of packaging material to reduce the volume of waste. If PET bottles are blown on site, plastic waste cuttings can be reused, or should be sorted as plastic waste for off-site recycling or disposal;
- Use uncontaminated sludge from on-site wastewater treatment for agricultural fertilizer or production of biogas.
- Remaining waste should be managed and disposed of according to the recommendations for industrial waste in the General EHS Guidelines.

2.3.3. Air Emissions

2.3.3.1. Exhaust Gases- Exhaust gas emissions (carbon dioxide [CO2], nitrogen oxides [NOX] and carbon monoxide [CO]) in the dairy processing sector result from the combustion of gas and fuel oil or diesel in turbines, boilers, compressors and other engines for power and heat generation. Guidance for the management of small combustion source emissions with a capacity of up to 50 megawatt thermal (MWth), including air emission standards for exhaust emissions, is provided in the General EHS Guidelines. For combustion source emissions with a capacity of greater than 50 MWth refer to the EHS Guidelines for Thermal Power.

2.3.3.2. Dust- Emissions of dust during dairy processing activities include fine milk powder residues in the exhaust air from the spray drying systems and bagging of product. Recommended measures to prevent and control dust emissions mainly consist of the installation of exhaust ventilation equipped with dry powderm retention systems. Bag filters are generally favored over wet scrubbing methods, as they use significantly less energy, generate less or no wastewater, and produce less noise. The presence of hot air and fine dust creates fire and explosion impacts. All modern spray dryers should be equipped with explosion release mechanisms and fire prevention systems.

2.3.3.3. Odor- the major sources of odor emissions in dairy processing facilities are related to on-site wastewater treatment facilities, in addition to fugitive odor emissions from filling / emptying milk tankers and storage silos.

Recommended management techniques to prevent and control odor emissions include the following:

- Ensure wastewater treatment facilities are properly designed and maintained for the anticipated wastewater load;
- Keep all working and storage areas clean;
- Empty and clean the fat trap frequently
- Minimize stock of waste and by-products and store for short periods in cold, closed, and well-ventilated rooms;
- Enclose production activities that cause odor and operate under vacuum

2.4. Occupational Health and Safety

Occupational health and safety hazards for dairy processing facilities are similar to those of other industrial facilities and recommendations for the management of these issues can be found in the General EHS Guidelines. In addition, occupational health and safety issues that may be specifically associated with dairy processing operations include the following:

- Physical hazards
- Biological hazards
- Chemical hazards
- Exposure to heat, cold, and radiation

2.4.1. Physical Hazards

Physical hazards include exposure to same-level fall hazards due to slippery conditions, the use of machines and tools, and collisions with internal transport equipment (e.g. forklift trucks and containers). Guidance on general workplace conditions, including design and maintenance of working and walking surfaces to prevent slips and falls, is presented in the General EHS Guidelines. Additional, industry-specific recommendations are presented below.

- Maintain walking and working surfaces clean and dry and provide workers with antislip footwear;
- Provide workers with training in the proper use of equipment (including the proper use of machine safety devices) and personal protective equipment (PPE), such as hearing protection;
- Ensure that the process layout reduces opportunities for process activities to cross paths, thus avoiding collisions and falls;
- Demarcate transport corridors and working areas and ensure the proper placement of handrails on platforms, ladders, and stairs;
- Ground all electrical equipment and installations in wet rooms.

2.4.2. Biological Hazards

Exposure to biological and microbiological agents may be associated with inhalation and ingestion of dust and aerosols, particularly in milk powder operations.

The General EHS Guidelines, recommendations for the prevention and control of exposures to biological hazards specific to dairy processing include the following:

- Avoid dust- and aerosol-generating activities (e.g. use of compressed air or high-pressure water for cleaning) and, where they cannot be avoided, provide proper ventilation of enclosed or semi-enclosed areas to reduce or eliminate exposure to dust and aerosols;
- Install exhaust ventilation equipped with filters and / or cyclones, at sources of dust;
- Provide workers with PPE that is appropriate for the process activity;
- Ensure physical segregation of work and welfare facilities to maintain worker personal hygiene;

- Avoid direct contact with non-conforming dairy products.

2.4.3. Chemical Hazards

Exposure to chemicals typically involves chemical-handling activities related to cleaning operations and disinfection of process areas, in addition to the maintenance of heating and cooling systems. Recommended measures to prevent and control exposure to chemicals are discussed in the General EHS Guidelines.

2.5. Community Health and Safety

Community health and safety impacts during the operation phase that are common to most industry sectors, including those related to traffic safety during transport of raw materials and finished product, are discussed in the General EHS Guidelines. Industry-specific issues with the potential to impact the community or the public at large are those associated with pathogens or microbial contaminants, as well as other chemical or physical impacts, associated with processed dairy products.

2.5.1. Food Safety Impacts and Management

Dairy processing should be undertaken according to internationally recognized food safety standards consistent with the principles and practice of HACCP.

Recommended food safety principles include the following:

- Respect "clean" and "dirty" zoning, designed in accordance with HACCP prerequisites.
- Ensure the cooling chain is unbroken for sensitive products requiring refrigeration;
- Ensure full traceability of all materials and products throughout the supply chain;
- Ensure adequate veterinary inspection,
- Comply with veterinary regulations and precautions for management of waste, sludge, and by-products;
- Institutionalize all HACCP prerequisites

2.6. Performance Indicators and Monitoring

2.6.1. Environment

2.6.1.1. Effluent Guidelines

Guideline values for process emissions and effluents in this sector are indicative of good international industry practice as reflected in relevant standards of countries with recognized regulatory frameworks.

Guidance on ambient considerations based on the total load of emissions is provided in the General EHS Guidelines

Table 1 Effluent levels dairy processing

Pollutants	Units	Guideline Value
pH	pH	6-9
BODs	mg/l	50
COD	Mg/l	250
Total nitrogen	Mg/l	10
Total phosphorus	Mg/l	2
Oil and grease	Mg/l	10
Total suspended solids	Mg/l	50
Temperature increase	oC	<3b
Total coliform bacteria	MPN/100 ml	400
Active ingredients/ Antibiotics	To be determined on case specific basis	
Notes: [a]MPN= Most Probable Number [b]At the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity		

2.7. Occupational Health and Safety

2.7.1. Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines

2.7.2. Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources.

2.7.3. Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents.

Self- Check- 2	Written test

Name…………………………………………… ID……………………….. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. List environmental issues specifically associated with dairy processing facilities?(2)
2. List occupational health and safety issues that may be specifically associated with dairy processing operations (2pts)

Test II Write true if the statement is correct and false if the statement is incorrect

1. Controlling emissions and effluents in dairy processing industries are indicative of good industry practice.(2pts)
2. The major sources of odor emissions in dairy processing facilities are related to on-site wastewater treatment facilities. (2pts)

Note: Satisfactory rating - 8 points Unsatisfactory - below 8 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

1. ____

2. ____

Test II

1. ______________________________

2. ________________________________

Information Sheet 3- Disposing waste and reviewing environmental impacts

1.1. Introduction

Dairies are centers where raw milk is processed, either for immediate consumption or converted into dairy products. Dairies handling milk are classified as receiving, bottling, condensing, dry milk powder manufacturing, ice cream manufacturing, cheese making and butter making.

Waste water generated in a dairy contains highly organic constituents. This necessitates prompt and adequate treatment of the waste water before its disposal to the environment. Almost all the organic constituents of dairy waste are easily biodegradable. Hence, the waste water is amenable to biological treatment either aerobic or anaerobic or a combination of the two.

Operation in a dairy include receiving of raw milk, pasteurizing milk, bottling milk, condensing milk, dry milk manufacture, cheese making, butter making and Casein making consist dry soil**.** Milk solids consist essentially of carbohydrates, fats, and proteins. Roughly the BOD/Biochemical oxygen demand/ of l kg of milk fat is 0.89 kg, 1 kg of milk proteins is 1.03 kg, and 1 kg of milk sugar is 0.69 kg. Dairy wastes are made of dilutions of whole milk and by-products. The BOD values of the products of milk are:

- Whole milk: 90,000 – 105,000 mg/l
- Skim milk: 65,000 – 75,000 mg/l
- Buttermilk: 55,000 – 65,000 mg/l
- Whey: 25,000 – 35, 000 mg/l

The manufacturing activities in a dairy are of the batch type; i.e. one batch of milk is processed, the equipment is drained, thoroughly cleaned and the next batchis taken for processing. As the result, the flow of waste water from a dairy comes in slugs, This fact should be taken into account in designing a waste water treatment plant to handle dairy waste water.

1.2. Biological methods of treatment

(i). Non-mechanized methods such as anaerobic ponds, aerobic oxidation ponds and combination of the two, and

(ii). Mechanical methods such as trickling filters, aerated lagoons and activated sludge process based on extended aeration.

1.3. Essential steps in reducing the pollution load in the dairy include:

i. Allowing the cans and tankers to be emptied completely by keeping them in inverted position till almost all the milk is drained out.
ii. Minimizing spillage and leakages in the bottling section.
iii. Attending to leaks in pipes, valves and equipment promptly.
iv. Observing good housekeeping practices.
v. Using minimum amount of water for cleaning

1.4. Water pollution

Domestic and industrial uses of water add a number of contaminants and pollutants to it. Contaminants are capable of causing diseases and rendering water unfit for human consumption, while pollutants are substances which impair the usefulness of water, or render it offensive to the senses of sight, taste and smell. Domestic waste water contains contaminants, while industrial waste water may contain both contaminants and pollutants.

1.5. Categories of pollutants

Industrial wastes contain a large variety of pollutants which are categorized as follows:

i. **Inorganic pollutants**. These include alkalis, mineral acids, inorganic salts, free chlorine, ammonia, hydrogen sulphide, salts of chromium, nickel, zinc, cadmium, copper, silver, etc., anions such as phosphates, sulphates, chlorides, nitrites and nitrates, cyanides; Cations such as calcium, magnesium, sodium, potassium, iron, manganese, mercury, arsenic, etc.

ii. **Organic pollutants**. These include high molecular weight compounds such as sugars, oils and fats, proteins, hydrocarbons, phenols, detergents, and organic acid. Some of these pollutants are resistant to biodegradation and/or others are toxic to aquatic life in the receiving water. Their removal or at least reduction to a low concentration becomes necessary in order to be able to treat such waste water by biological means.

1.6. Treatment and disposal of industrial wastes

Method of treating waste water can be classified as follows

i. **Physical methods:** These include screening, sedimentation, flotation, filtration, mixing, drying, incineration, freezing, dialysis, osmosis, adsorption, gas transfer, elutriation, etc.

ii. **Chemical methods:** These include pH correction, coagulation, softening, ion exchange, oxidation, reduction, disinfection.

iii. **Biological methods:** These employ aerobic, facultative and anaerobic microorganisms to destroy organic matter and reduce the oxygen demand of the waste water

iv. **A combination** of the above three methods is also used to treat waste water.

1.7. Selection and sizing of the proper unit(s) is done by

(a) Flow measurement, sample collection and characterization of the wastewater flows,

(b) subjecting the waste water samples to treatability studies by employing laboratory-scale models, which may be run on a batch feed basis, semi-continuous feed basis, or continuous basis,

(c) deciding which combination of unit operations and unit processes will be appropriate for the waste water under study and

(d) If necessary, running a pilot plant, this will simulate the working conditions in a full-scale plant.

1.8. Quality of the industrial effluents must be

(i) They will not endanger the lives of the drainage maintenance crew, who may be required to enter the sewers for maintenance and repairs,

(ii) The material of the sewers will not be damaged and

(iii) The effluent treatment plant, if one is provided at the end of the drainage system.

Industries wishing to follow this mode of disposal will almost always be required to give **some pretreatment to the waste water, its extent depending on**

(i). The volume and strength of the waste water and

(ii). The degree of dilution offered by the sewage flowing in the drainage system.

1. Chemical Waste

All chemical waste must be stored and disposed of in compliance with applicable regulatory requirements. Waste containers should be properly labeled and should be the minimum size that is required.

Good housekeeping practices in the laboratory have a number of benefits. For example, in terms of safety, it can reduce the number of chemical hazards in the laboratory and help control the risks from hazards that cannot be eliminated. Practices that encourage the appropriate labeling and storage of chemicals can reduce the risks of mixing of incompatible chemicals and assist with regulatory compliance.

Self-Check-3	Written test

Name…………………………………………… ID………………………… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I short answer

1. List the method of industrial waste water tratment?(2)
2. List the categories of pollutants (2 pts)
3. List the essential steps in reducing the pollution load in the dairy industry?

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

1. ____
2. ____
3. ________________________________

Reference Materials

Book:

1. Anon. 1992. Advances in detergent and cleaning-in-place system.
2. Anon. 1994. Revolutionary Cleaning Technology. Dairy Foods 95 (9) 110-111
3. Britz, T.J. and Robinson, R.K. 2008. Advanced Dairy Science and Technology.
4. Blackwell Publishing Ltd., UK.
5. Dairy Processing Handbook. 2000. Alfa-Laval AB, Dairy and Food Egg. Division, Sweden. Chapter 21.
6. Hall, H.S. Tuszynski, W.B. 1984. Maintenance Systems for the Dairy Plant.
7. FAO Animal Production and Health Paper 45. FAO Animal Production and Health Division. Food and Agriculture Organization of the United Nations. Rome.
8. Marriott, N.G. and Gravani, R.B. 2006. Principles of Food Sanitation. Fifth Edn. Food Science Text Series. Springer Publications. USA.
9. FAO. 1998. Milk Testing and Quality Control. Milk Processing Guide Series. Volume 2. FAO/TCP/KEN/6611 Project. Training Programme for Small Scale Dairy Sector and Dairy Training Institute – Naivasha. Kenya.
10. IS: SP : 18 (Part XI), 1981. Handbook of Food Analysis. Part XI., Dairy Products. Bureau of Indian Standards, New Delhi.
11. Marshall, R.T. 1993. Ed. Standard Methods for the Examination of Dairy Products. 16th ed. American Public Health Association, Washington, DC.
12. MIF. 2005. Analysis of Milk and Its Products: A Laboratory Manual. Milk Industry Foundation (U.S.). Daya Books, India.
13. Claeys, W.L., Cardoen, S., Daube, G.et al. (2013) Raw or heated cow milk consumption:Review of risks and benefits,Food Control,31: 251–262.
14. Lindmark-Månsson, H. and Åkesson, B. (2000) Antioxidative factors in milk,British Jour-nal of Nutrition,84(Suppl. 1): S103-S110.

15. Oliver, S.P., Boor, K.J., Murphy, S.C. and Murinda, S.E. (2009) Food safety hazards associ-ated with consumption of raw milk,Foodborne Pathogens and Disease,6: 793–806.
16. Pieter Walstra, Jan T.M. Wouters, T.J. Geurts, 2006. Dairy science and technology. 2nd ed. Wageningen, The Netherlands

WEB ADDRESSES

1. https://bizfluent.com/info-8505404-five-sources-process-variation-manufacturing.html
2. https://detail.en.china.cn/provide/p141281914.html
3. https://www.alibaba.com/product-detail/herb-medicine-slicing-machine-tea-leaf_62073355456.html?spm=a2700.7724857.normallist.24.638e11aevxec59
4. https://www.plantengineering.com/articles/seven-steps-for-a-successful-shutdown/
5. https://www.spicesinc.com/t-recipes.aspx
6. http://www.taylorandfrancis.com
7. http://www.crcpress.com
8. https://dairytechnologist.com/wp-content/cache/all/milk-pasteurization//index.html
9. https://www.sciencedirect.com/topics/food-science/pasteurized-milk
10. https://www.britannica.com/technology/pasteurization
11. https://www.sciencedirect.com/sdfe/pdf/download/eid/3-s2.0 B9781855736764500184/first-page-pdf
12. https://www.uoguelph.ca/foodscience/book/export/html/1898
13. https://www.motherearthnews.com/real-food/pasteurize-raw-milk-at-home

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