TVET CERTIFICATE IV IN FOOD PROCESSING

FOPFM401

Competence

FOPFM401: - FRESH MILK PROCESSING

Process fresh milk

Credits: 8

Learning hours: 80hrs

Sector: Agriculture

Sub-sector: FOOD PROCESSING

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Purpose statement

Milk is a perishable product that needs to be quickly processed. In order to reduce milk losses, extend its shelf-life and protect consumers against adulteration, a competence on fresh milk processing has been designed. At the end of this module, the learner will be able to Prepare the work area and equipment for fresh milk processing, Prepare raw milk, Make pasteurized milk and UHT milk andPackage and store fresh milk products. The learner will have marketable hands-on skills in processing fresh milk. This will contribute to the increase of professional fresh milk processors who can support the dairy industry and especially the milk processing SMEs development.

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Introduction

To ensure safe milk that is free from disease producing bacteria, toxic substances and foreign flavors, fresh whole milk has to be processed before marketing. The processing helps produce milk that has an initial low bacterial count, good flavor and acceptable storage qualities.

Learning Unit 1 – Prepare work area, equipments, tools and utensils

The ceiling, walls, floor and all work surfaces of milk preparation area must be in a good state of repair and made so that they can be effectively cleaned.

LO 1.1 – Describe work area

- Topic 1: work area description

✓ Floors of milk processing premises must be made of hard washable surface. Walls should be smooth and washable to about 2 meters from floor level and painted with light color.

✓ Doors should be self-shutting while windows should be rendered insect proof by mosquito netting to keep flies out.

✓ Rooms should be kept clean and in good repair.

✓ All product-contact surfaces should be kept clean immediately before use or as often as necessary, by cleaning techniques appropriate to the equipment and process.

✓ Equipment and utensils should be disinfected immediately before use, and whenever there has been possibility of accidental contamination.

✓ Equipment repairs and maintenance must be carried out after processing.

✓ Whenever machines have to be fixed during production runs, reasonable precautions should be taken to prevent contamination of dairy products.

- **Topic 2:** Processing flowchart of cleaning work area

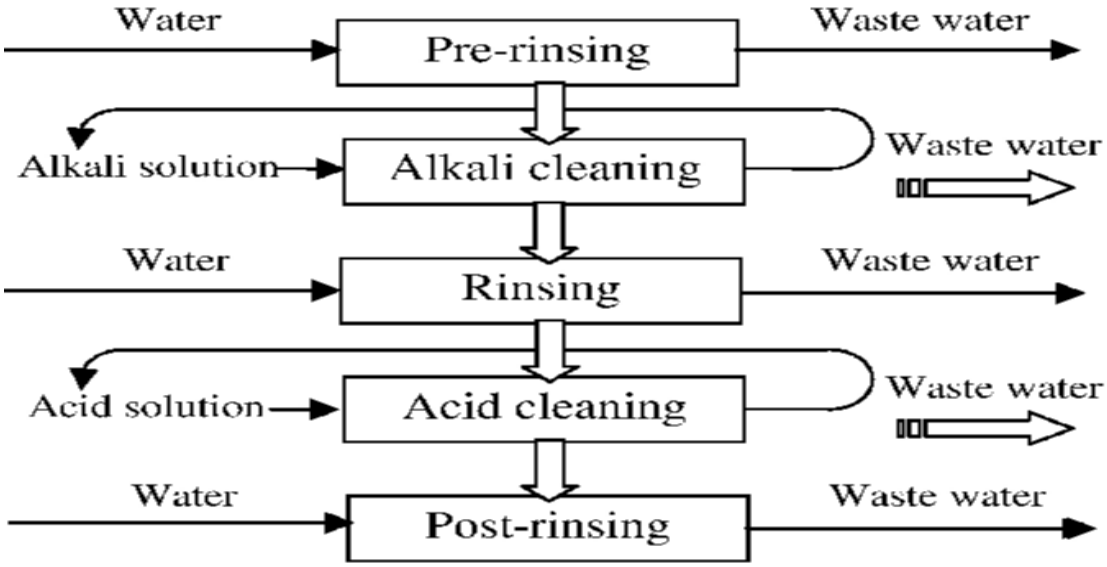


Fig1. Cleaning steps of the CIP process in dairy plants

A: **The basic steps of cleaning work area and equipments**

1. Rinsing with water to remove excess soil. Cold or lukewarm water (40-50° C) may be used, but hot water of up to 85◦C may be used for buffer nuking equipment.
2. Washing with a detergent must continue until the surface of the equipment is cleaned. This may be used in conjunction with physical scrubbing or ClP cleaning depending on the type of equipment.
3. A final rinse with cold potable water should be done until the surface of work area and/ equipment is cleaned.

B:Disinfection of dairy equipment may be carried out by means of:

✓ Steam - Steaming should be done for 10- l5 minutes after the condensate has attained 85°C.

✓ Hot water - Hot water at 80° C (use soft water only to prevent deposition of salts) for at least 20 minutes in circulation cleaning for 15 minutes at 85°C.

✓ Detergents/disinfectants - used as part of the cleaning operation at temperatures between 45-60°C in physical cleaning and for cold milk lines, storage tanks and tanker.

C: The cleaning cycle in a dairy work area comprises the following stages:

✓ Recovery of product residues by scraping, drainage and expulsion with water or compressed air

✓ Pre-rinsing with water to remove loose dirt

✓ Cleaning with detergent

✓ Rinsing with clean water

✓ Disinfection by heating or with chemical agents (optional); if this step is included, the cycle ends with a final rinse, if the water quality is good.

Each stage requires a certain length of time to achieve an acceptable result.

- **Topic 3:** Localization of equipments

Equipments are localized according to products processing line,this processing line can be help cleaning process,save the cleaning products and cleaning time etc.

Example of equpments:

✓ **Refrigerated Farm Bulk Tanks:**

In dairy farming a bulk milk cooling tank is a large storage tank for cooling and holding milk at a cold temperature until it can be picked up by a milk hauler. The bulk milk cooling tank is an important piece of dairy farm equipment. It is usually made of stainless steel and used every day to store the raw milk on the farm in good condition. It must be cleaned after each milk collection. The milk cooling tank can be the property of the farmer or be rented from a dairy plant.

Most tanks include an automatic cleaning system. Using hot and cold water, an acid and/or alkaline cleaning fluid, a pump and a spray lance will clean the inner tank, ensuring an hygienic inner environment each time the tank is emptied.

There are two primary methods of cleaning cooling tank, via manual scrubbing or automatic washing. Both methods generally use four steps to clean the tank:

- prerinsing with water to wet the surface and rinse off remaining milk residue
- washing with hot soapy water
- rinsing with water to remove the soap
- final *sanitizing* rinse with an approved bulk tank sanitizer solution

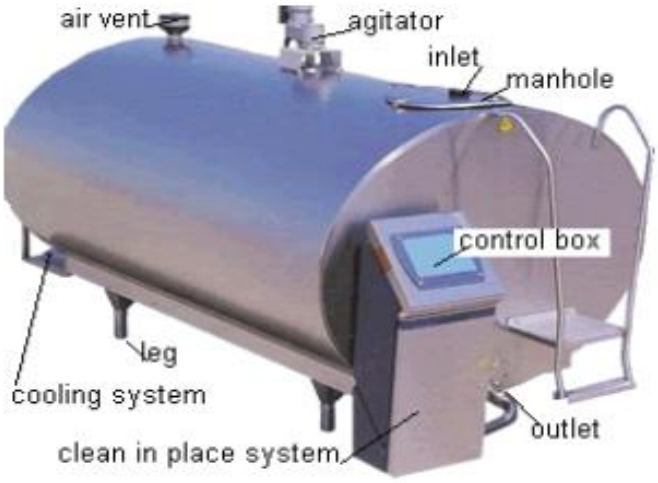


Fig:2 **Refrigerated Farm Bulk Tanks**

✓ **Pasteurizer/HSTS Pasteurizer Heat Exchanger**, separators and homogenizers

Pasteurizers, homogenizers and separators are at the core of any dairy processing plant. Running them efficiently and keeping them clean is vital.

Fig3: **HSTS Pasteurizer Heat Exchanger**

✓ Homogenizer

Fig4: **Homogenizer**

Those are some example of equpments located in milk plant or worshop,according their location in worshop related to to cleaning process and systems such as CIP or/and COP(by desembling equipment)

Fig5**: Cleaning according to equipments and tools localization**

- **Topic 4: critical points Identification**

✓ Milk contact surfaces area must be appropriately cleaned and disinfected immediately after each milking.

✓ All equipment in work area must be kept clean and in good condition.

✓ Bulk tanks must be cleaned and disinfected after each milk collection and kept in good condition.

✓ Roof or loft floors should be made of dust proof sheet material and be easy to clean.

✓ All drainage of work area should discharge to a suitable drainage system.

✓ A suitable bin should be available for the disposal of used towels and other waste. This should be emptied and cleaned after each processing.

✓ Within a milk processing area all floors, walls, fittings and touch points should be cleaned thoroughly after every processing.

✓ The upper walls and ceiling of work area should be kept free from accumulations of dust and cobwebs. Any soiling of the milk processing equipment must be washed.

The interior surfaces of the tank must be cleaned each time the tank is emptied.

- Rinse with potable water.
- Clean with sanitizer solution.
- Rinse with potable water

The exterior of the storage tank should be kept clean.

LO 1.2 – clean work area

The work area environment influences employees' productivity, performance and well-being. Maintaining a clean work area may help keep staff members safe, milk as food healthy and efficient.

- **Topic 1 : Cleaning products**

Chlorine Free Dairy Deterge.

Disinfectants

Fig6: **Disinfectants**

It is important to ensure that the correct cleaning products are used to ensure safety and hygiene in the work area.

For example:

✓ **Detergents:** These are used to remove food debris, grease and dirt. They cannot kill bacteria and microorganisms. Detergents are usually used to wash crockery and cutlery and are especially designed for use either by hand or in a dishwasher.

✓ **Types of detergents are:**

Anionic detergents Anionic detergents are sodium salts of sulphonated long chain alcohols or hydrocarbons.

Alkyl hydrogen sulphates formed by treating long chain alcohols with concentrated sulphuric acid are neutralised with alkali to form anionic detergents. Similarly alkyl benzene sulphonates are obtained by neutralising alkyl benzene sulphonic acids with alkali.
In anionic detergents, the anionic part of the molecule is involved in the cleansing action. Sodium salts of alkyl benzene sulphonates are an important class of anionic detergents.They are mostly used for household work. Anionic detergents are also used in toothpastes.

Cationic detergents Cationic detergents are quarternary ammonium salts of amines with acetates, chlorides or bromides as anions. Cationic part possess a long hydrocarbon chain and a positive charge on nitrogen atom. Hence, these are called cationic detergents.Cetyl trimethylammonium bromide is a popular cationic detergent and is used in hair conditioners.Cationic detergents have germicidal properties and are expensive,therefore, these are of limited use.

Non-ionic detergents

Non-ionic detergents do not contain any ionin their constitution. One such detergent is formed when stearicacid reacts with polyethyleneglycol.

Liquid dish washing detergents are non-ionic type. Mechanism of cleansing action of this type of detergents is the same as that of soaps. These also remove grease and oil by micelle formation

✓ **Disinfectants:** These are used to destroy the harmful bacteria which can remain on equipments even work area and cause food contamination and cross-contamination. Disinfectants include diluted bleaches and antibacterial solutions.

Equipment and food contact surfaces must be disinfected between two different types of food preparation.

✓ **Sanitizers:** These contain both detergents and disinfectants and may be used in washing floors, shelves and walls.

Dirty equipment and machinery may contaminate milk products.

✓ Equipment used for handling milk and products should preferably be cleaned and disinfected after each period of use and at least daily.

✓ Equipment used in handling fat rich products such as butter and cheese should be cleaned as required, but in any case not less than once a week.

✓ Prevent damage by taking care when using equipment and machinery will make them last longer and not waste time or money repairing them.

✓ Have machinery ready for use will prevent delays and accidents if there is a hand-over to staff on the next shift.

The basic steps of cleaning work area and equipment are:

1. Rinsing with water to remove excess soil. Cold or lukewarm water (40-50° C) may be used, but hot water of up to 85◦C may be used for buffer nuking equipment.
2. Washing with a detergent must continue until the surface of the equipment is cleaned. This may be used in conjunction with physical scrubbing or ClP cleaning depending on the type of equipment.
3. A final rinse with cold potable water should be done until the surface is five of detergent.

Disinfection of dairy equipment may be carried out by means of:

✓ Steam - Steaming should be done for 10- l5 minutes after the condensate has attained 85°C.

✓ Hot water - Hot water at 800 C (use soft water only to prevent deposition of salts) for at least 20 minutes in circulation cleaning for 15 minutes at 85°C.

✓ Detergents/disinfectants - used as part of the cleaning operation at temperatures between 45-60°C in physical cleaning and for cold milk lines, storage tanks and tanker.

- **Topic 2 : cleaning products types**

Main Types of Cleaning Agents

✓ **Water -** the simplest cleaner of all. Applied under pressure it cleans hard surfaces such as floors and walls. Water can also be used to rinse out dirt removed from a surface by other cleaning agents.

✓ **General purpose or neutral detergents** - these are able to penetrate moderately greasy and dirty surfaces. They are suitable for cleaning floors and walls. Neutral washing agents are pH-neutral and based on non-ionic surfactants that disperse different types.

✓ **Sanitizers** - these agents clean and disinfect surfaces. However, they do not replace the need for thorough washing with a detergent. Sanitizer wipes are available for wiping small areas and specialized equipment such as temperature probes. These should be discarded after use.

✓ **Hard surface cleaners** - these are used for heavier or more specialized tasks. Care should be taken as they are corrosive and may damage surfaces if used incorrectly

✓ **Solvents** - dissolve heavy grease and oil which water based cleaners cannot dissolve.**Abrasive powders** - mostly used for cleaning enamel and ceramic surfaces like tiles, e.g. Ajax.

✓ **Common cleaning agent:**

- Acetic acid (vinegar)
- Acetone (can damage plastics)
- Various forms of alcohol including isopropyl alcohol or rubbing alcohol
- Ammonia solution
- Amyl nitrite and other nitrites
- Borax
- Calcium hypochlorite (powdered bleach)
- Carbon dioxide
- Chromic acid
- Citric acid

- Freon (e.g. dichlorodifluoromethane) (discontinued in 1995 due to damage to the ozone layer)
- Saltwater soap (a potassium based soap)
- Soap or detergent
- Sodium bicarbonate (baking soda)
- Sodium hydroxide (lye)
- Sodium hypochlorite (liquid bleach)
- Sodium perborate
- Sodium percarbonate
- Tetrachloroethylene (dry cleaning)
- Trisodium phosphate
- Water, the most common cleaning agent, which is a very powerful polar solventXylene (can damage plastics.

- Topic 3 :Handling cleaning products Handling (Storage conditions, Safety precautions, shelflife)

- If any of the products used for cleaning at your workplace are capable of injuring people or damaging property, they are considered hazardous chemicals and must be stored safely.
- Cleaning products must be clearly labeled, and stored safely away from food service areas, this will help processor understand his/her legal obligations when storing cleaning products at work.
- One of the most important aspects of storing cleaning products is making sure they are clearly labeled. It is so easy for cleaning products to be mixed up and confused with other items.
- Cleaning products usually arrive from your supplier in bulk containers. These usually act as the permanent storage containers and must be clearly marked with:

✓ Name of the chemical
✓ Pictogram code
✓ Signal word
✓ Hazard Statement

When labeling portable containers you need to name the chemical (along with it's hazards) on the bottle or beaker. You also need to make sure:

✓ the label is legible and easy to read

✓ the label is permanent and cannot be defaced or washed off

✓ Safety Data Sheet (SDS) are still accessible

✓ Staff are trained to use the chemical and know the location of the SDS in the event of an emergency.

Some specifications of your storage space should include:

- Store in a clean, cool, dry space. Some cleaning chemicals can have hazardous reactions when they experience extreme temperature fluctuations or high levels of humidity.
- Store in well-ventilated areas. This helps prevent any fumes from spreading to other areas of the facility.
- Store no higher than eye level, and never on the top shelf of a storage area.
- Do not overcrowd shelves and include anti-roll lips to avoid falling containers.
- Never store cleaning chemicals on the floor, even temporarily.
- Oxidizers, flammable chemicals, and combustible chemicals should be stored away from ignition sources such as flames, heat, sunlight, work operations that might cause a spark, and in some cases, even static electricity.

List safety precautions.

Shelf life of some cleaning products:

- Window cleaner should be effective for about two years.
- All-purpose cleaners begin to lose their effectiveness after two years.
- Antibacterial cleaners have a shelf life of about one year, however if the product is diluted or exposed to extreme temperature, the shelf life will likely be shorter.
- Most metal polishes should be replaced after two years.
- Unopened laundry detergent will start to degrade at about nine months; if opened, shelf life is only about six months.
- Lysol cleaning products tend to remain effective for about two years.
- Spray air fresheners lose effectiveness after about about two years.

Product group	*Shelf life in container that has been opened*
Alcohol-based hand disinfectants	12 months (shelf life can vary when used in dispenser, see "Shelf life when using hand/skin products in wall dispensers")
Alcohol-based skin disinfectants	12 months
Skin-/hand-cleaning products Exception: Stellisept med gloves	12 months 1 week
Skin-/hand-care products	12 months
Instrument disinfectants	12 months
Surface disinfectants Exception: Bacillol Wipes Bacillol Tissues Bacillol AF Tissues Bacillol 30 Tissues Mikrobac Tissues Mikrobac Virucidal Tissues Kohrsolin extra Tissues Kohrsolin FF Tissues	12 months 4 weeks 3 months 3 months 3 months 3 months When used daily, use for a maximum of four weeks. Once opened, the package must be discarded if not used for more than one week. 3 months 3 months
Surface cleaner	2 months

Source: BODE chimie GmbH, a company of the HARTMANN GROUP

It is the user's responsibility to label products concerning their shelf life after opening.

- Topic4 : Effectiveness of the cleaning products

Effective cleaning requires a correctly designed and installed milking system, adequate volumes of water at an appropriate temperature, with cleaning chemicals added at the correct rate. It is also critical that a regular, monitored routine is followed by everyone involved in the plant-cleaning operation.

While effective plant sanitisation is an essential component of a Bactoscan control programme, effective cleaning is also essential to control levels of thermoduric bacteria. Thermodurics are heat-resistant bacteria that can survive the pasteurisation process and cause serious problems for milk processors, especially in the cheese-making process. Many milk processors now monitor thermoduric

levels in milk routinely, and it seems likely that this will soon form part of some milk-supply contracts.

The vast majority of milking systems are sanitised after milking using a method described as circulation cleaning. This form of cleaning comprises three distinct phases:

- **Pre-rinse** – to remove milky residues.
- **Circulation** – to remove fats, proteins and minerals.
- **Final rinse** – to remove chemicals from the plant to prevent contamination of milk; certain disinfectants can be added to the final rinse.

Topic5 : Cleaning methods/techniques

Cleaning Methods There are many different cleaning options available to manufacturers depending on the contaminant to be removed and the level of cleanliness required. Cleaning method choice should consider both ability to remove the contaminant and the cost effectiveness of the method.

A. **Wet cleaning** is a term used to define alternative to dry cleaning techniques. They involve the immersion of a garment in water with detergents and other additives. The process is identical to the one followed in traditional home washing machines, but in modern industrial applications it is much milder and gentler.

B. **Dry cleaning** is one of the easiest methods to reduce cleaning requirements.

✓ when using dry cleaning techniques, remove as much product from plant and equipment as possible. In some cases product can also be recovered and returned for processing or sold as a by-product, for example, sawdust for compost

✓ use drip/catch trays or lips on equipment and benches to help reduce the amount of material landing on the floor or into drains

✓ use scrapers, brushes and vacuum devices to pre-clean containers, equipment and conveyors prior to washing. Scrubber and vacuum cleaners can wet or dry clean floors and remove gross soiling before washing with water.

✓ These cleaners are fast and efficient and reduce chemical use, but may be unsuitable for small areas, or areas with restricted access.

C. **High-pressure cleaning systems**

✓ High-pressure cleaners are a water efficient option for floor and equipment washdown. Cleaning with high-pressure water can use up to 60 per cent less water, compared with using mains hoses.

✓ Mobile high-pressure cleaners have flow rates ranging from 4 L/min to 20 L/min with pressures of up to 500 kPa. To reduce the time required to set up mobile pressure washers, it is worth considering installing a ring main system.

✓ It is important that high-pressure cleaners complement cleaning procedures and should not replace dry cleaning. The use of high-pressure cleaning systems may not be suitable for some areas of the plant as aerosols from spray and splash can cause the deposition of microorganisms from the floor to settle back onto equipment and product.

D. Clean in Place

✓ A clean-in-place (CIP) system automatically delivers a standard number of wash and rinse cycles to the internal surfaces of a closed system. CIP systems can allow equipment, tanks and pipes to be cleaned without being disassembled, saving labour and eliminating human contact with chemicals.

✓ A CIP system usually consists of several chemical and rinse water-holding tanks, associated pumps and piping to allow the recirculation of rinse water and cleaning chemicals.

✓ Full recovery systems can recover up to 99 per cent of the cleaning solution.

Important of CIP

CIP is an important component in guaranteeing food safety in food processing plants. Successful cleaning between production runs avoids potential contamination and products that don't meet quality standards.

The effectiveness of CIP systems can be improved by:

✓ maintaining and calibrating in-line monitoring instrumentation

✓ reviewing cleaning cycle lengths to ensure they have not become excessive

✓ assessing chemicals, blends and concentrations to ensure that they achieve effective cleaning, but are safe for the operator, and environment

✓ checking for excessively high or low temperatures

✓ checking for opportunities to recover more rinse water and spent solution

- ✓ training operators and adequately supervising to improve efficiency and safety
- ✓ regularly monitoring equipment and repairing promptly.

E. Cleaning Out of Place:

Cleaning Out of Place is defined as a method of cleaning equipment items by removing them from their operational area and taking them to a designated cleaning station for cleaning. It requires dismantling an apparatus, washing it in a central washing area using an automated system, and checking it at reassembly.

Once any changes have been made, the system must be validated to ensure safety of the fresh milk.

There are many different cleaning options available to manufacturers depending on the contaminant to be removed and the level of cleanliness required.

Cleaning method choice should consider both ability to remove the contaminant and the cost effectiveness of the method.

The following table provides a comparison of some different cleaning methods.

Cleaning method	Description and Application	Advantages	Disadvantages
Caustic cleaners	Traditional cleaner containing sodium. Used as a general cleaner and removes organic components such as	Cheap, widespread.	Contributes to high total dissolved solids (TDS) (e.g. sodium) levels in wastewater stream. Difficult to remove from wastewater streams without energy intensive

	proteins and fats.		membrane treatment.
Potassium cleaners	Replaces sodium of the caustic cleaners with potassium, Same applications as caustic cleaners.	Irrigation with wastewater streams containing low levels of potassium can provide nutrient benefits to plants.	High levels in wastewater streams can have detrimental impact on soil structure and function if used for irrigation. Costs more than sodium based cleaning products.
Steam	Water is turned into steam at high pressure and temperature. Applications include removal of fats, oils and microorganisms and dislodging soiling.	High pressure steam dissolves fats and oils, and kills microbes. Dry steam cleaning can clean sensitive areas in processing plants. Dry steam is very water efficient	High pressure can spread airborne bacteria if not properly controlled.

		with only 5-6% moisture.	
Electrolysed water	Generated from brine solution using electrolysis. Produces an alkaline solution – pH 11-13; and acidic solution – oxidising agent. Applications include killing bacteria, viruses, protozoa, algae, fungi and spores.	More effective than sodium hypochlorite at similar concentrations. Does not require rinsing. No hazardous chemicals required.	Increases total dissolved solids levels in wastewater stream compared with cleaning system such as ozone. System requires backwashing to remove calcium build up on membranes.
Ozone	Ozone is generated and oxidises when it comes into contact with the object to	Oxidation gives antimicrobial properties. Degrades to oxygen at	Needs to be generated on site immediately prior to use. Can degrade rubber in high concentrations.

	be cleaned. Effective on a broad spectrum of microorganisms including bacteria, fungi, viruses, protozoa, bacterial and fungal spores.	room temperature in both air and water. Can be used in wastewater treatment system to reduce Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD).	Higher capital and maintenance costs compared with chemical methods but operating costs are only electricity. Can be expensive operating costs due to the amount of energy required. Does not provide residual sanitisation.
Thermal cleaning	Heating the object to temperatures which remove organic material through oxidation. Removal of organic material.	Can clean large quantities of parts simultaneously. Cleaning results are consistent. Cost of cleaning relatively low.	Flash rusting may occur on cleaned parts from moisture present in the air. Subsequent treatment is required to remove ash and/or rust from part surfaces. Unacceptable softening of

		Removed multiple contaminants – e.g. oil, grease, paint, gaskets and rubber. Reduction in amount of waste to be disposed of. Not labour intensive.	substrates may occur, particularly aluminium.
Aqueous cleaners	Water is primary solvent with detergents, surfactants, pH buffers, emulsifiers etc as required. Acidic aqueous solutions remove: scale, rust and oxides from metals.	Alkaline aqueous cleaners used at a broad range of temperatures. Can be used in pressure spray washing, ultrasonic and immersion	Acidic aqueous cleaners can attack metal objects. Wastewater and sludge generated.

	Alkaline aqueous solutions remove: salts, organic soils, oxides, metal chips, grease.		
Semiaqueous cleaners	Made of natural or synthetic organic solvents, surfactants or corrosion inhibitors and other additives. Removes waxes, heavy greases, tar and baked-on organic materials. Reduced volatile organic compounds (VOCs) emissions.	Often used with immersion or ultrasonic systems. Water soluble or insoluble.	Can contain VOCs. Concerns of aquatic toxicity, human health effects and flammability. May alter wastewater discharge requirements.

Source: www.coldjet.com.au/dry_ice_faqs.html

LO 1.3 : Prepare the machines

Topic 1: Identifying the machines

Requirements to process equipment, machinery, tools, ware and tare.

✓ Technological equipment, machinery, ware, tare, tools, film and articles made of plastic and other synthetic materials designed for packaging of milk and milk products shall be made from materials permitted by the bodies of the State Sanitary and Epidemiological Supervision for food contact.

✓ Tanks, metal ware, chutes, conduits, gutters, etc., shall have smooth, easy to clean interior surfaces, without cracks, gaps, protruding screws 25 or rivets, which hamper their cleaning. Using wood and other materials that are badly washed and disinfected shall be avoided.

✓ Working surfaces (coatings) of the tables used for food processing shall be smooth, without cracks and gaps, made of stainless metal or polymeric materials permitted by bodies of the State Sanitary and Epidemiological Supervision for food contact.

✓ Technological equipment and machinery shall be painted from the outside with light tone paint (except for the equipment made of or lined with stainless material) that does not contain harmful impurities. Painting of ware and tools with paints containing lead, cadmium, chromium is not allowed.

✓ Layout of technological equipment shall be made in accordance with the technological scheme, ensure a continuous performance of the technological process, short and direct layout of milk lines, eliminate counter flows of raw materials and finished products.

✓ When laying out the equipment the conditions shall be observed which ensure free access to workers operating it to it; sanitary control of production processes, quality of raw materials, intermediate and finished products, as well as a possibility to wash, clean and disinfect the premises and equipment .

✓ Machinery, equipment, and the milk pipes shall be mounted in such a manner that a complete discharge of milk, detergent and disinfectant solutions is arranged.

All the parts which contact with milk and milk products shall be accessible for cleaning, washing and disinfection. Metal milk pipes shall be dismountable. Glass thermometers without a protective case must not be used.

✓ Tanks for the manufacture and storage of milk, cream, sour cream and other milk products (except those used to produce cottage cheese and cheese) shall be equipped with tight-fitting lids.

✓ Machines, tanks and other equipment that are used to manufacture milk products shall be connected to the sewerage system with a jet rupture through the siphoned cones (see Section 7 hereof). The direct connection of the equipment with the sewerage system and discharge of water from them onto the floor are not allowed.

✓ Internal factory transport and intrashop tare shall be assigned to certain types of raw materials and finished products and marked accordingly.

- Topic 2: Cleaning products for machines

Effective cleaning of milking equipment begins with analysis of the water supply for mineral content or hardness and choosing a cleaning compound that is compatible with the water.

When the water hardness exceeds 10 grains per gallon, it may be necessary to increase detergent concentration. In very hard water (30 grains per gallon or more), a water softener should be used.

The bicarbonates, sulfates, and chlorides of calcium or magnesium present in hard water can neutralize detergents, decrease rinsability, create films on machines and cause problems with water heaters.

The compatible cleaners would then be used according to manufacturer's directions in relation to amount and concentration of cleaner, temperature of the cleaning solution, and contact time of the cleaning solution and the surface to be cleaned.

Measure the correct amount of water to be used in the cleaning cycle.

✓ Usually an alkaline or chlorinated cleaner (alkaline cleaner with added chlorine) followed by an acid cleaner is used. Alkaline cleaners usually contain basic alkalies, phosphates, wetting agents, and chelating agents.

✓ They dissolve milk fats, proteins, and carbohydrates and loosen and suspend other soil particles so that they can be removed by mechanical action, i.e., by brushing or by circulation cleaning.

✓ The chlorine aids the removal of protein deposits and prevents the formation of film.

✓ They are not sanitizing agents! Acid cleaners remove or prevent accumulated mineral deposits or milkstone buildup.

✓ Rinse the pipeline with an acid rinse (e.g., 1 oz acid per 5 gallons of water) immediately after the detergent solution is rinsed from the system.

✓ Bulk tanks can be rinsed with acidified water after the detergent solution is rinsed off by installing a spray unit to the water line that automatically adds the proper concentration of milkstone remover.

Cleaning Procedures

✓ Equipment and bulk tank cleaning procedures should be posted on the milk-house wall and rigidly followed.

✓ The precise course of action, compounds used, and water temperatures will vary. In general, equipment should be rinsed with lukewarm (100° to 110°F) water immediately after milking to prevent drying of milk solids on surfaces.

✓ Water that is too hot can cause denaturation of proteins and a protein film on surfaces, while water that is too cold can cause fat crystallization and the formation of a greasy film on surfaces.

✓ Washing and rinsing should follow. Wash water should remain above 120°F.

✓ Start with water at 170°F.

✓ In clean-in-place (CIP) systems, velocity and air in the system are also essential. A minimum velocity of 5 ft/sec is necessary to ensure effective cleaning action.

✓ Introducing air into the system provides slugging or turbulence and increases scouring action. The wash cycle should take 6 to 10 minutes.

✓ With longer times, the water becomes too cold. The concentration depends upon water hardness and iron content.

✓ **Acid rinse**:Rinse the line with acidified water (pH 3.0 to 4.0) to remove all traces of cleaning solution (2 to 3 minutes minimum contact time). This should be done

after every milking. It helps prevent mineral deposits, and the lower pH is bacteriostatic.

✓ All equipment and utensils should be stored in a manner that permits water to drain and equipment to air dry. In CIP systems, a drain should be located at the lowest point in the system.

✓ Teat cup liners and other rubber parts that come into contact with milk must also be thoroughly cleaned after each milking and sanitized before the next milking.

✓ Liners and other rubber parts should be replaced when they have been used for the recommended number of milkings (e.g., 1,200) or when they become soft, cracked, or rough or when they have holes. Pores and cracks in rubber parts protect soil and microorganisms from the effects of cleaning and sanitizing.

Bulk Milk Tanks

✓ Bulk tanks also must be properly cleaned and sanitized, or psychrophilic bacteria (microorganisms capable of rapid growth at temperatures of 35° to 50°F) multiply rapidly.

✓ Tanks are cleaned by using essentially the same procedures as recommended for milking equipment. The milk hauler is normally responsible for rinsing the tank immediately after the milk is removed. Rinse water temperature should be 90° to 120°F.

✓ Following this, the tank must be washed, rinsed, and sanitized. Allow the mechanical cleaning device to operate until clean (6 to 10 min)

✓ Cleaning solution temperature should remain above 120°F during the wash cycle, and that means starting with hot water (170°F).

✓ Rinse the tank completely with tepid water, finishing the rinse with acidified water as it neutralizes and removes detergent residues and removes inorganic soils.

✓ Tank covers and gaskets should be disassembled and the calibration rod removed for manual cleaning. The outlet connection and outlet valve must be cleaned manually.

✓ The tank exterior should be washed.

✓ Sanitizing should occur just before the next milking. Allow the sanitizer to drain from the outlet to prevent sanitizer residues in milk.

✓ Tanks may be cleaned manually or with CIP or mechanical systems.

- Topic 3: Cleaning techniques (CIP (cleaning-in-place, COP (Cleaning-out of-place)

CIP Equipment

The development of automatic (CIP) milking and bulk tank systems has been a great time-saver for dairy farmers. However, these systems must be properly maintained. Many problems will occur if these systems are not checked regularly, at least twice a year.

Improper or careless cleaning and sanitizing of equipment and tanks is a major cause of inferior milk quality. It need not be if cleaning water and cleaning compounds are compatible and a precise procedure is formulated and followed.

Steps of CIP

1. Rinsing with warm water for about 10 minutes.
2. Circulation of an alkaline detergent solution (0.5 – 1.5%) for about 30 minutes at 75°C.
3. Rinsing out alkaline detergent with warm water for about 5 minutes.
4. Circulation of (nitric) acid solution (0.5 – 1.0 %) for about 20 minutes at 70°C.
5. Post-rinsing with cold water.
6. Gradual cooling with cold water for about 8 minutes

- **Topic4: Calibration (pH-meters)**

The pH meter is an electrical /and digital device that determines the acidity or basicity of milk. To use a pH meter, the pH electrode is first calibrated with standard buffer solutions with known pH values that span the range being measured.

Calibration is an important step in ensuring accurate. results we recommend calibrating before each use to **calibrate** your Ph- meter press and hold the button for 3 seconds until Cal appears on the screen rinse according types of pH -meter. The electrode in deionized water and place the tester in your pH 7.01 buffer and wait for stable

To make a pH measurement, the electrode is immersed into the milk sample until a steady reading is reached. The electrode is then rinsed after each sample and stored in a storage solution after all the measurements have been completed.

The measurement of pH in milk is important in testing for impurities, spoilage, and signs of mastitis infection. While there are a number of factors that affect the composition of milk, pH measurements can help producers understand what might be causing certain copositional changes.

Procedure of pH-meter calibration

- ✓ Standard Buffers 4,7,10
- ✓ Rinse small beaker with buffer or distled water
- ✓ Pour 40 ml of buffer in beaker
- ✓ Each individual Ph meter has its own set of step by step calibration instructions
- ✓ Discard after calibration,never pour used buffer back into original bottle

N.B: DO's

- ✓ Do strore electrode in electrode storage solution
- ✓ Do calibrate pH meter daily
- ✓ Do keep electrode moist

DON'Ts

- ✓ Do not strore electrode in distlled water
- ✓ Do not leave exposed to air
- ✓ Do not wipe electrode but blot with lint free tissue

- Topic5: Adjustment of machines

Adjustment and Calibration are two similar processes that are often confused and wrongly used interchangeably. **Calibration** is the process of comparing measurements taken by a test instrument against those taken by a standard device (with known accuracy). It plays an important role in quality assurance and compliance for many industries, but it is especially important for companies in the food, beverage and pharma sectors

Adjustment is defined as the operation of bringing a measuring instrument into a state of performance suitable for its use. This is not calibration.

Learning Unit 2 – Prepare the raw milk

LO 2.1 – Control milk quality

Milk quality control is the use of approved tests to ensure the application of approved practices, standards and regulations concerning the milk and milk products. The tests are designed to ensure that milk products meet accepted standards for chemical composition and purity as well as levels of different micro-organisms.

- Topic 1: Milk acidity

Allowed milk acidity in term of pH should be 6.4–6.8. Lower values generally mean an acidification process due to bacterial growth, while higher values can indicate the presence of mastitis.

Allowed milk acidity in term of Titratable acidity should be in ranges from 0.10 to 0.20% and this ranges indicate concentration of lactic acid in milk. Any value in excess of 0.20 % can safely be reckoned as developed lactic acid. Due to the opacity of milk, the end-point of titration is not sharp, so care has to be taken to adjust the conditions to reach the same end-point.

Chemical used: Phenolphthalein indicator solution & sodium hydroxide solution.

Percentage of Lactic acid is calculated by this formula: ***Lactic - acid (%) = (A*0.OO9*100)/V***

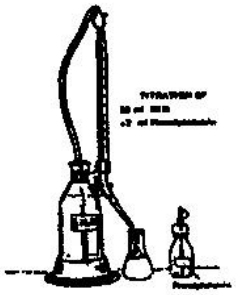
Where A=ml of 0.1NaOH required for titration,

V=ml of milk sample taken for the test

Procedures used to control milk in terms of titratable acidity and pH.

Apparatus:

- ✓ A porcelain dish or small conical flask
- ✓ 10 ml pipette, graduated
- ✓ 1 ml pipette
- ✓ A Burette, 0.1 ml graduations
- ✓ A glass rod for stirring the milk in the dish
- ✓ A Phenophtalein indicator solution, 0.5%in 50% Alcohol
- ✓ Sodium hydroxide solution.



Procedure:

9 ml of the milk measured into the porcelain dish/conical flask,1 ml Phenopthalein is added and then slowly from the burret, 0.1 N Sodium hydroxide under continuous mixing, until a faint pink colour appears.

The number of mls of Sodium hydroxide solution divided by 10 expresses the percentage of lactic acid.

- Topic 2 :Milk composition

Milk is a white opaque liquid produced /secreted by the mammary glands of mammals for feeding infants and used for processing others dairy products for human consumption . Milk contains proteins, carbohydrates, fat, vitamins, minerals and water as mains milk compositions.

✓ An important milk protein is casein about 80% and whey protein or serum about 20%.

✓ Milk fat is present in the form of small fat globules which are lighter than the other constituents of milk. When cow milk is allowed to stand, these globules gather on top of milk and form a layer of cream.

✓ Milk sugar gives milk its sweet taste. The lactose ferments by the influence of microorganism (sour milk).lactose is complex carbohydrate composed by fructose and galactose

✓ Milk is also a valuable source of vitamins: A; B1; B2; B3; B9; B12; D; E; vitamin C is little in milk.

✓ The composition of milk is not consistent and shows a wide variation. In the first place, the composition depends on the species of the cow.

✓ In the species, there is a significant difference between the breeds and individual animals within a breed

✓ The composition might even change from day to day, depending on feeding and climate changes etc. Also, during milking the first milk differs from the last milk drops. Below are average figures of the composition of milk from cows, sheep and goats.

Figure 1: Nutritional Value of Milk

	Cow's milk (%)	Goats milk (%)	Sheep milk (%)
Water	87.2	85.8	81.6
Total Solids	12.8	14.2	18.4
Fat	4.0	4.9	6.5
Protein	3.4	4.3	6.7
Lactose	4.5	4.1	4.3
Ash (minerals)	0.9	0.9	0.9

Source: IDF Doc. No.9002

Topic3: Milk control by Microbial state

Microorganisms are living organisms that are individually too small to see with the naked eye. Microorganisms are found everywhere and are essential to many of our planets life processes. With regards to the dairy industry, they can cause spoilage, prevent spoilage through fermentation, or can be the cause of human illness.

Microbial Standards for Raw milk

✓ Total bacteria is 30,000 CFU/ml

✓ Somatic cell count should Not exceed 750, 000 CFU/ml

The total bacteria count is the number of bacteria in a sample that can grow and form countable colonies on *Standard Methods Agar* after being held at 32°C (90°F) for 48 hours.

The coliform count is the number of colonies in a sample that grow and form distinctive countable colonies on *Violet Red Bile Agar* after being held at 32°C (90°F) for 24 hours. Coliforms are generally only present in food that have been fecally or environmentally contaminated.

Somatic cells are blood cells that fight infection and occur naturally in milk. The presence of mastitis (an infection of the mammary gland) in the cow will increase

the somatic cell count. The somatic cell count can be determined by direct microscopic examination or by electronic instruments designed to count somatic cells.

- Topic4: Milk control by Physical state

It is a white opaque fluid in color in which fat is present as an emulsion, protein and some mineral matters in colloidal suspension and lactose together with some minerals and soluble proteins in true solution. The opacity of milk is due to its content of suspended particles of fat, proteins and certain minerals. The color varies from white to yellow depending on the carotene content of the fat. Milk has a pleasant, slightly sweet taste, and pleasant odor. It is an excellent source of calcium, phosphates and riboflavin. If during the organoleptic inspection the milk appears to be too thin and watery and its color is “blue thin”, it is suspected that the milk contains added water.

The following procedure is used to control physical state of milk:

✓ Open a can of milk

✓ Look at the can lid and can

✓ Immediately smell the milk

✓ Observe the appearance of the milk

✓ Taste the milk without swallow it ,if there is not a clear judgment

✓ Accept the milk if color, flavor, taste are normal according standards of normal milk

✓ Reject the milk if the organoleptic test is positive

Factors affecting physical state of milk:

✓ The feed consumed by animals may lead to some undesirable flavors and taste.

✓ Bacterial growth in milk causes fruity, barny, malty or acid flavors and an unclean taste or bitter taste.

✓ Enzyme activities also may lead to unnatural flavors, rancidity due to lipase action being a classic example.

✓ Oxidative reactions may cause a cardboard flavor in milk.

✓ Cooked flavor occurs during milk processing.

✓ Seasonal changes with milk flavors.

✓ Cleanliness or equipments use and maintenance cause milk flavors.

✓ Exposure to metals such as various light sources during storage affect milk taste and color.

✓ Farm environment contribute to the taste of milk leaving the udder.

✓ Seasonal changes with milk compositions, these changes can be reflected in the taste and color of the milk.

✓ Temperature and transportation way change milk taste.

✓ Cleanliness or equipments use and maintenance cause milk taste.

✓ Breed, stage of lactation, milking time, udder health status, pasture grazing and seasonal calving. Etc.

LO 2.2 –2.2: Milk grading (for processing)

- Topic 1: Grading by microbial state

✓ Raw milk as it leaves the udder of healthy cows normally contains very low numbers of microorganisms and generally will contain less than 1,000 total bacteria per ml.Acceptable range of bacteria in raw milk content:Total bacteria is 30,000/mL more than this number can not accepted for processing milkSomatic cell count should Not exceed 750, 000/mL more than this number can not accepted for processing milk

- Topic 2: Grading by fat content

Categories of milk based on fat content:

✓ Low fat milk

✓ Fat free milk

✓ High fat milk

Example of terms for mik fat content by some country

Fat content by weight	**American Terminology**
100%	Clarified butter or Ghee
69%	Butter
45%	Manufacturer's cream
36%	Heavy whipping cream

30%	Whipping cream or light whipping cream
25%	Medium cream
18–30%	Light cream, coffee cream, or table cream
10.5–18%	Half and half
3.25%	Whole milk or regular milk
2%	2% milk or reduced fat milk
1%	1% milk or low fat milk
0–0.5%	Skim milk or nonfat milk

Autralia

While regular or whole milk has an average of 3.5% fat, reduced-fat milks have at least 25% less fat than regular milk. Low-fat milk must contain less than 1.5% fat and skim or 'fat-free' milk has no more than 0.15% fat

Canada

Fat content by weight	**Canadian terminology**
3.25%	*3.25% milk* or*Whole milk* or *Homogenized milk* or *Homo milk*
2%	2% milk
1%	1% milk
0-0.1%	Skim milk
UK	
5%	Channel Island milk or breakfast milk
4%	Whole milk or full fat milk
2%	Semi-skimmed milk or 2% milk
1%	1% milk
Less than 0.3%	Skimmed milk

- Topic3: Grading by density

If during the organoleptic inspection the milk appears to be too thin and watery and its color is “blue thin”.

it is suspected that the milk contains added water.

The lactometer test serves as a quick method to determine adulteration of milk by adding or removing water and other substances.

Farmers, milk traders, transporters and milk shoppers often add water and other substances to milk, to increase their profits.

Raw milk has a density (specific gravity) of 1.028 to 1.032 grams per ml. Addition of water or other substances changes the density of raw milk.

Addition of water reduces the density, while addition of solids increases the density considerably.If density is outside the normal range, it means the milk has been adulterated.

At 15 ºC the normal density of the milk ranges from 1.028 to 1.032 g/ml, whereas water has a density of 1.0 g/ml.

So when the lactometer reads a value closer to 1.0, probably water has been added to the milk.

If possible the lactometer reading can be combined with the fat test.

The density of fat is lower than that of milk.

So in case the results of the fat test are low and the found density is still high (e.g. 1.035), then the milk might have been skimmed.

If the results of the fat test are low and the density is low (e.g. 1.025), then water might have been added to the milk.Always read the temperature of the milk first; the lactometer reading varies according to temperature.

Procedure:

✓ Mix the milk sample gently and pour it gently into a measuring cylinder (300-500). Let the Lactometer sink slowly into the milk.

✓ Read and record the last Lactometer degree (ºL) just above the surface of the milk. If the temperature of the milk is different from the calibration temperature

(Calibration temperature may be=20^0C) of the lactometer, calculate the temperature correction.

Fig7: **Grading by density**

Example if the lactometer reading was 28 and the temperature was at 77°F at the time

Given data:

Lactometer reading(LR):28

Temperature:77^{o}F

Formular: SG or Density=$\frac{Corrected\ RL\ at\ 60\ ^\circ\mathrm{F}}{1000}+1$

Solution: Different= 77°F - 60°F = 17°F

Conversion of the temperature difference :17 x 0.1 = 1.7 Lactometer units

Correcting the lactometer reading: we have to add or subtract the lactometer units obtained from the reading (if the temperature was above, add; if the temperature was below, subtract): 28 + 1.7 = 29.7

The density would then be: $\frac{29.7}{1000}+1$=1.029

Conclusion :milk is accepted

N.B: To convert Celcius degrees into Fahrenheit, use the following formular:

°F = °C x 9/5 + 32

°C = (°F - 32) x 5/9

LO 2.3 – Cool the milk

Cooling milk immediately after milking keeps bacteria from multiplying rapidly. Holding **milk** at temperatures below 40°F (4°C) and above freezing maintains its

excellent quality until it is processed for fluid **milk** or manufactured into dairy products.

- Topic 1 : Cooling system

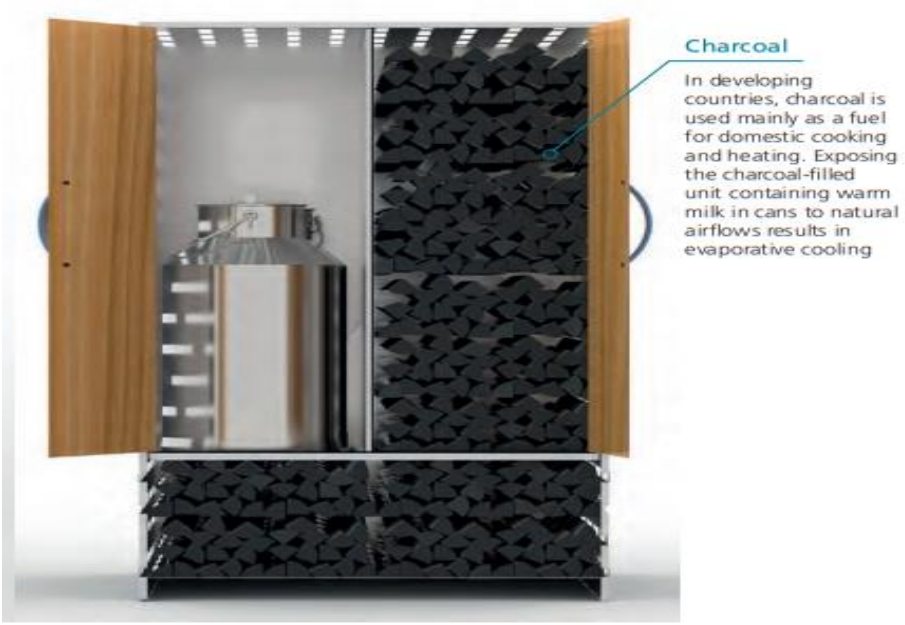
Cooling systems are used to cool the milk by releasing the heat outside. Most cooling systems include a refrigeration compressor, a condenser unit (air-cooled), and a refrigerated bulk tank. Add-ons are often used to reduce the milk's temperature before it reaches the refrigeration tank.

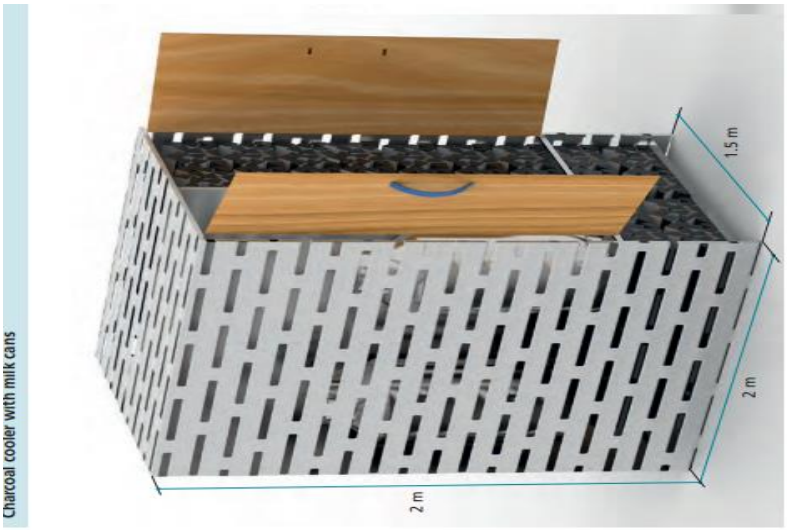
Cooling to 10 °C within two hours of milking and to 4 °C within three to four hours is essential, but more rapid cooling is much preferred. In many temperate and tropical countries, refrigerated cooling systems may not be available at the producer. The methods for cooling to 10 °C and below are governed by local circumstances and simple smallscale methods can be employed the following:

a) Evaporative cooling using a charcoal cooler.

Evaporative cooling is of very limited use other than for small-scale and domestic applications. In this system, the heat from the milk is used to evaporate water contained in a charcoal structure, thus removing heat from the milk and eventually cooling it.

In very small-scale operations, evaporative cooling can reduce the temperature of warm milk, but this system has limitations because it depends on the difference between the wet- and dry-bulb temperatures of the surrounding air. As the relative humidity of the air increases, the performance of an evaporative cooling system will decrease, limit ng its use in moist climates with high humidity. Evaporative cooling is most effective in climates where the relative humidity is less than 30 percent.





Source: Sonnet Malakaran George and Tek .B. Thapa, 2015.

Fig8: **charcoal cooler**

b) Cooling with natural water systems – mains, well or groundwater

Immersion cooling methods include placing the milk cans in a stream, river, lake or tank. This method is most effective when the water temperature is 10 °C or below. Cooling milk to below 10 °C slows bacterial growth.

Diverting the water source to a cooling tank in which milk cans are placed is another common method. When available, ice can be added to the water tank to facilitate the cooling, but ice should never be added directly to warm fresh milk to cool it. To

avoid any heating effect from the surrounding air, cooling tanks should be insulated.

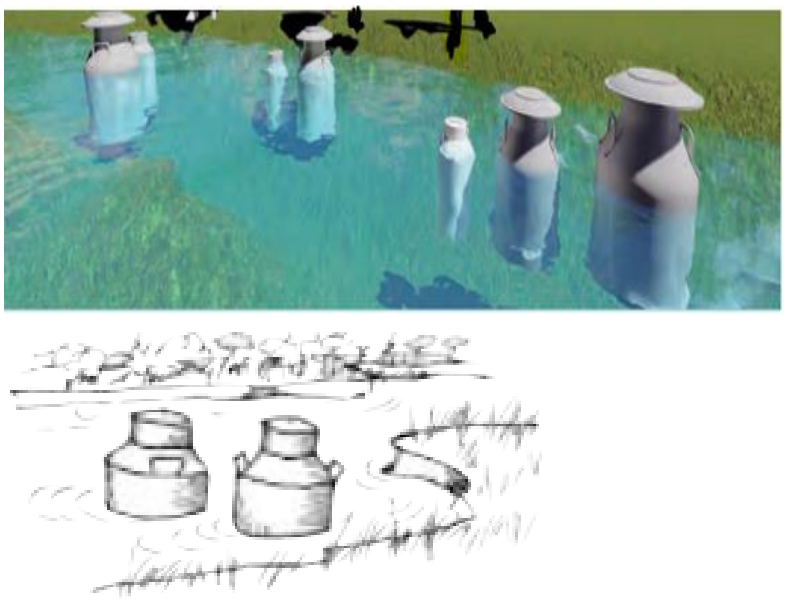


Fig9: **groundwater cooler**

c) **Surface milk coolers (open cooling systems):**

An open cooling system is based on surface coolers that use pressurized water from the mains or pumped from a natural source. Surface coolers can be constructed from horizontal stainless steel pipes attached to a vertical metal plate; the cooling water is passed through the pipes. Warm milk is fed on to the vertical plate from a small tank mounted at the top of the unit.

The milk cools as it passes over the plate and is collected into milk cans As they are open to the air, surface coolers are subject to contamination from dust and insects, and considerable care has to be exercised to ensure correct cleaning and sanitation.

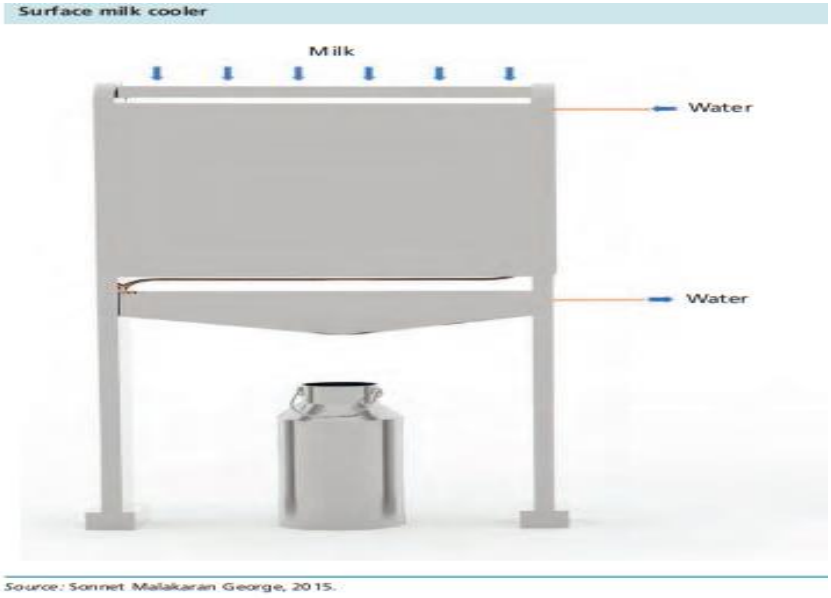


Fig 10: **Surface milk coolers**

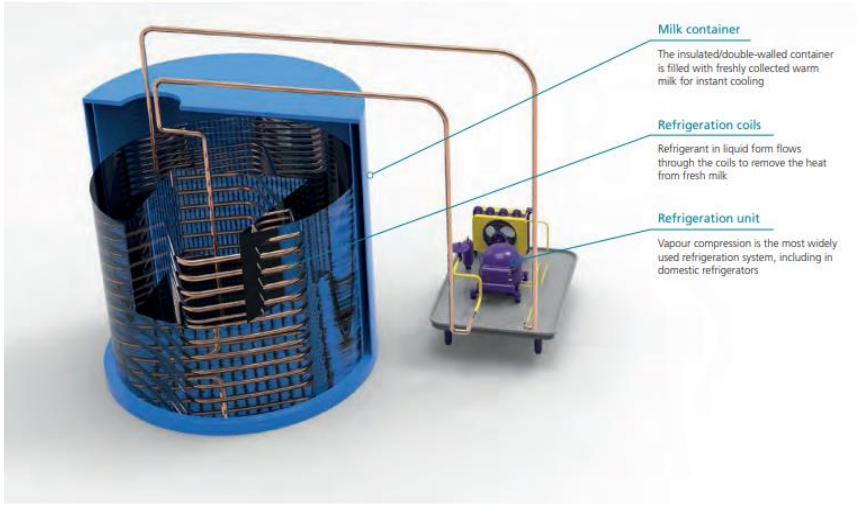
d) Refrigerated immersion cooler or cooling rings

Immersion cooling rings also use pressurized water from the mains or pumped from a natural source and can be used to cool milk in cans. In this system, a perforated tubular ring is placed over the neck of the milk can and cold (or iced) water is passed through the ring to run down the exterior of the can and cool its contents.

A small-scale refrigeration system can be used for immersion cooling where a single-phase power supply is available. The refrigeration system is attached to a cooling head, which is inserted into a can of warm milk or a specially designed insulated stainless steel container with capacity of 25–125 litres.

A refrigerant is passed through the immersion coil to reduce the milk temperature. The system often includes a trolley to allow easy transportation of the milk tank. Such systems may be of use in very small MCCs or privately owned milk cooling stations or milk shops.

Immersion cooler with refrigeration unit and insulated cooling and storage container



Source: Sonnet Malakaran George and Tek B. Thapa, 2015.

Fig11: Cooling methods:

1. keep the milk in the shade not in the sun
2. keep the milk in a well-ventilated place
3. use cold water to cool the milk (You can for example put the milk in a water bath, or in a stream)
4. use ice to cool the milk
5. use the following cooling equipment:

conventional refrigerator for small amounts of milkevaporative charcoal lined coolersurface coolersa bulk (direct expansion) milk cooling tank an in-can rotary cooler.

- Topic 2: cooling condition

Raw milk must be cooled within 4 h to 10°C or less from the start of milking, and then to 7°C or less within 2 h after the completion of milking. In addition, subsequent milk collections added to previously collected milk must not raise the temperature of the blended bulk milk above 10°C.

The batch of raw milk was split in 2 portions, and a plate heat exchanger was used to quickly cool one portion to <6°C within 1 min. The second portion was stored in a jacketed bulk tank and slowly cooled over 4 h to <10°C.

Learning Unit 3 – Make pasteurized milk

The process of pasteurisation involves heating milk to 71.7°C for at least 15 seconds (and no more than 25 seconds). Because of the nature of the heat treatment it sometimes referred to as the 'High Temperature Short Time' (HTST) process. Once the milk has been heated, it is then cooled very quickly to less than 3°C. The equipment which is used to heat and cool the milk is called a 'heat exchanger'. When the milk has been pasteurised it is bottled or packaged to be sold to consumers.

The Purpose of Pasteurization

1. To increase milk safety for the consumer by destroying disease causing microorganisms (pathogens) that may be present in milk.

To increase keeping the quality of milk products by destroying spoilage microorganisms and enzymes that contribute to the reduced quality and shelf life of milk.

LO 3.1 – Adjust the equipment

- Topic 1: Pasteurizer types

A.Batch pasteurizer

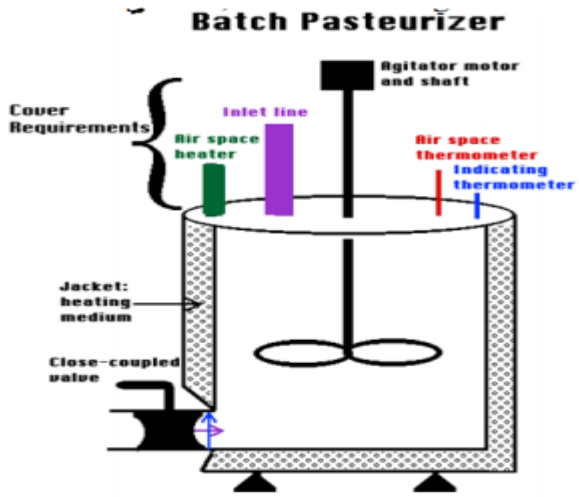


Fig12:**Batch pasteurizer**

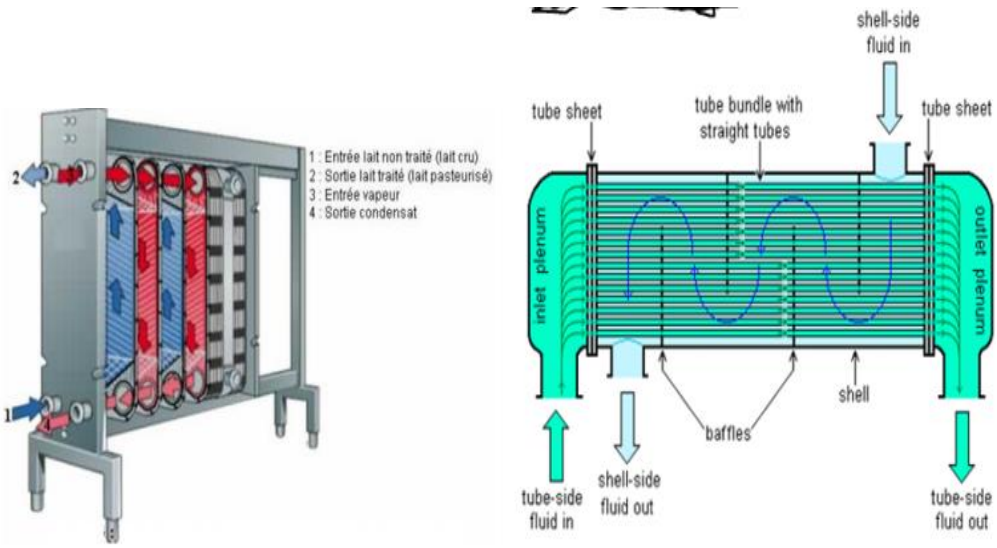
Batch pasteurizers require specific design features and auxiliary equipment to ensure that every particle of milk is pasteurized. Milk is heated in the vat to the desired temperature by means of hot water either sprayed on the sides of the vat or circulated around the double jacket or by means of heating coils surrounding the inner jacket.

General conditions

A single- or two- speed agitator, and a vertical baffle plate inside the vat are used to create efficient agitation for proper heat transfer. Effective agitation reduces the chance of burn-on on the inside wall.

- ✓ Operate the agitator during pasteurization.
- ✓ The exterior and interior of the vat is constructed of stainless steel
- ✓ Keep clean and in good mechanical condition.
- ✓ Slope the bottom of the vat to permit free drainage.
- ✓ Remove and clean sanitary seals, coils, and valves daily.
- ✓ Ensure the agitation is such that the temperature difference between the milk in the centre of the vat and the coldest milk in the vat does not exceed 0.5°C (1°F) at any time during the holding operation

B. Plate heat exchanger



Fi13: **Plate heat exchanger Straight-tube heat exchanger**

Determination of the Capacity

Since the heat exchanger can only transfer the energy produced by a source, it is recommended that this primary energy source and the other devices in the system (boiler, chiller, pump, etc.) provide the required energy and, if this is not possible, the heat exchanger capacity is determined according to the existing primary energy source.

In the case of large capacities or critical tasks, it may be more reliable to use more than one heat exchanger in parallel, either by dividing the total capacity or by considering a certain amount of reserve capacity.

Temperature Scenarios

The most important rule to note here is that the outlet temperature of the hot milk (T4) will not be lower than the inlet temperature of the cold milk (T3) and the cold milk will not be able to be heated to a temperature (T2) higher than the inlet temperature of the hot milk (T1).

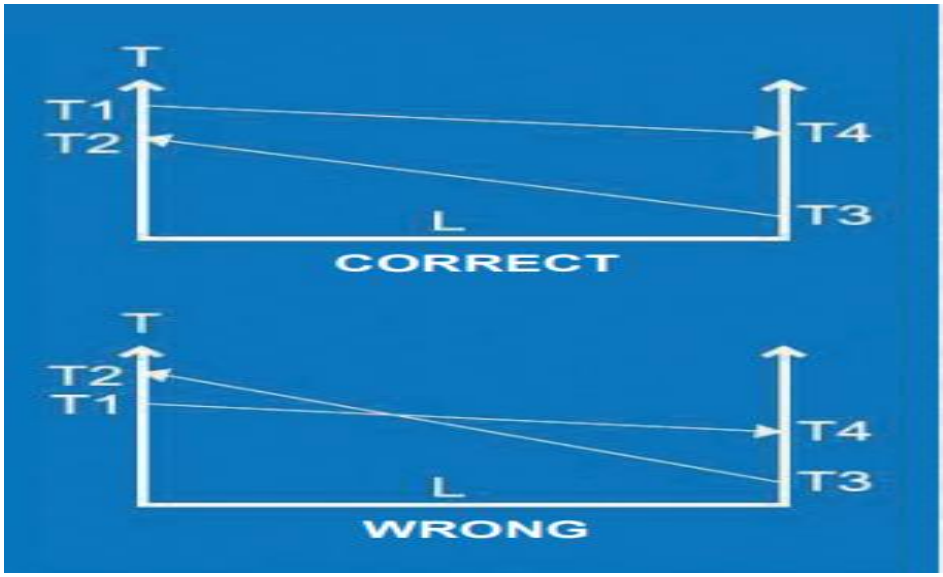


Fig14: **Temperature Scenarios**

- Topic2 : Separator Adjustment

✓ Do not operate the separator with an incorrectly installed drum or an insecure mount of the separator.

✓ If abnormal noise or chattering are detected, stop the separator. Investigate and remove the cause of malfunction before returning to operation.

✓ Do not operate the separator with a loose drum nut.

✓ The separator handle should not be turned faster than 75 rpm.

✓ Do not disassemble any part of the separator until the drum fully stops.

✓ Do not attempt to stop drum rotation with your hand or by use of a cloth

LO 3.2 –Adjust fat content (optional)

Many dairy processes require adjustiment of the chemical composition of milk meant for market purpose or milk products manufacture.

Adjustiment of milk might require control of only one component (usually fat) while allowing the others to vary or control two or more components simultaneously.

- Topic 1 : Purpose of adjusting fat content

✓ market purpose

✓ milk products manufacture

In market milk industry, this normally involves reducing the butterfat content by addition of skim milk or through the removal of cream.

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.

- Topic 2 : Techniques/methods of separation

Separation of milk can be carried out by the following methods

✓ By gravity

✓ By centrifugal force

Separation by gravity

Milk was left in a vessel where, after some time (hours), the fat globules aggregate and float on the surface forming a layer called '*malai*' on top of the milk.

There are two types of gravity separation as discussed below:

a) Shallow pan method

The milk is poured into the pans, immediately after milking. The pans, which are four inches deep, are placed preferably in a cool place. Skimming is done at the end of 24 h, and by this time, the milk below the cream is coagulated. Skim milk from the shallow pan system contains 0.5-1.5% fat.

b) Deep setting method

In this method, milk is set in 20 inches deep cans which are 8"-15" in diameter, maintained at 8-10°C. Glass strips are inserted in the wall of the can, one near the bottom and other near the top, to absorb cream. Due to low temperature better quality product results. After 12-14 h of storage, the fat layer from the top is skimmed off leaving skim milk in the container.

Advantages of Centrifugal Separation over Gravity Separation

✓ Speed of separation is greater (instantaneous) for centrifugal separation.

✓ Bacteriological quality of cream and skim milk is superior in centrifugal separation than gravity separation.

✓ Greater fat percentage of cream is possible using centrifugal separation (25-80%) vs. gravity separation (10-25%).

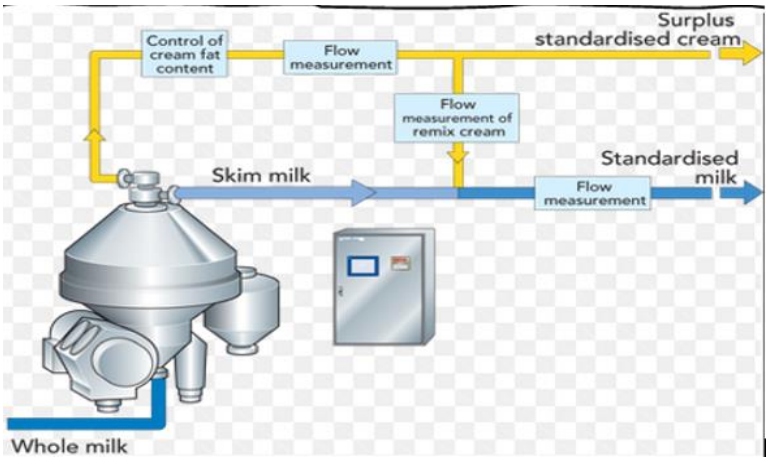
✓ Fat recovery in cream is 99-99.5% for centrifugal separation. Such value for gravity separation is about 75% or so.

- Topic3: Conditions of separation

✓ Separation can be performed on milk either hot or cold.

✓ Hot milk separation is done at a temperature of about 50°C, while cold separation is typically at 10°C or lower. Because hot milk is less viscous than cold milk, it can pass faster through the separator, enabling higher production volumes – and is sometimes preferred by dairies for this reason.

Milk Separation procedures/steps



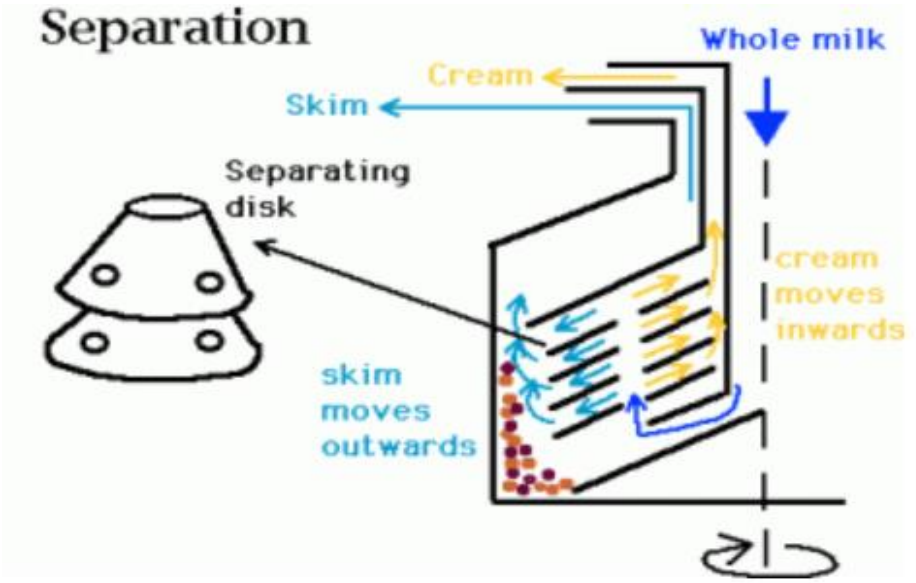
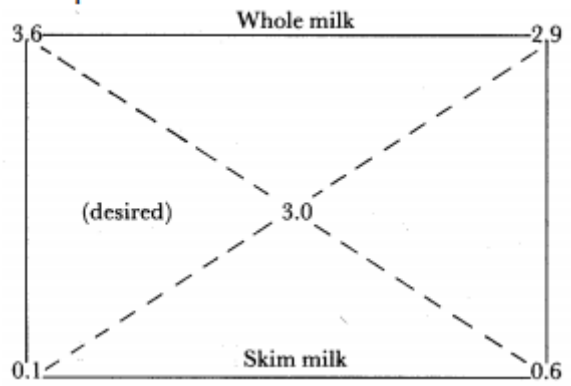


Fig 15**: Milk Separation line**

- **Fat adjustment by Calculation**

Example:



In this example, the fat content of whole milk is to be reduced to 3.0%, using skim milk produced from some of the whole milk. Using Pearson's Square;

1. Write in the center of the square the desired final fat content for the standardized milk. In this example the desired fat content is 3%

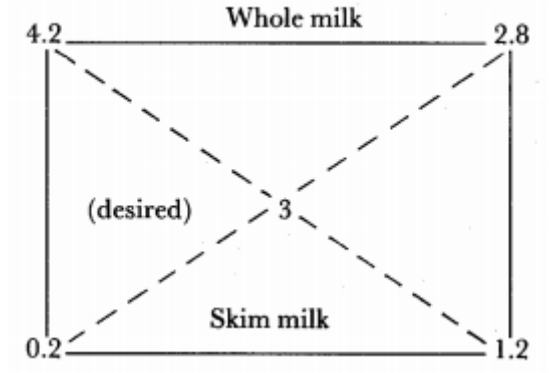
2. Write the fat content of the whole milk on the top left corner of the square. In this example it is 3.6%

3. Write the fat content of the skim milk on the low left corner of the square. In this example it is 0.1%

4. Substract the values diagonally and ratios (of whole milk and skim milk) to be mixed are obtained: it can be seen, in this example, that for every 2.9 parts (liters or Kgs) of whole milk, 0.6 parts of skim milk must be added.

Exercise 1: The fat content of 300 kg of whole milk must be reduced from 4.2% to 3% using skim milk containing 0.2% fat.

Answer:



In order to reduce the fat content from 4.2% to 3%, 2.8 parts of whole milk have to be mixed with 1.2 parts of skim milk. Therefore:

- 2.8 kg of whole milk requires 1.2 kg skim milk
- 300 kg of whole milk requires (1.2 × 300)/2.8 = 128.6 kg of skim milk

Thus, 128.6 kg of skim milk (0.2% fat) must be added to 300 kg of whole milk (4.2% fat) to give 428.6 kg of milk containing 3% fat.

Exercise 2: Constituent balance of milk

Skim milk is prepared by the removal of some of the fat from whole milk. This skim milk is found to contain 90.5% water, 3.5% protein, 5.1% carbohydrate, 0.1% fat and 0.8% ash. If the original milk contained 4.5% fat, calculate its composition assuming that fat only was removed to make the skim milk and that there are no losses in processing.

Basis: 100 kg of skim milk. This contains, therefore, 0.1 kg of fat. Let the fat which was removed from it to make skim milk be *x* kg.

Total original fat = (x + 0.1) kg
Total original mass = (100 + *x*) kg

and as it is known that the original fat content was 4.5% so

$$\frac{x + 0.1}{100 + x} = 0.045$$

whence $x + 0.1 = 0.045(100 + x)$

$x = 4.6$ kg

So the composition of the whole milk is then

Fat	=	4.5%
Water	$= \frac{90.5}{104.6}$	= 86.5 %
Protein	$= \frac{3.5}{104.6}$	= 3.3 %
Carbohydrate	$= \frac{5.1}{104.6}$	= 4.9%
and Ash	$= \frac{0.8}{104.6}$	= 0.8%

LO 3.3 – Pasteurize the milk

Pasteurization or pasteurisation is a process in which packaged and non-packaged milk are treated with mild heat, usually to less than 100 °C (212 °F), to eliminate pathogens and extend shelf life.

- Topic 1 : Pasteurization purpose

To increase milk safety for the consumer by destroying disease causing microorganisms (pathogens) that may be present in milk.

To increase keeping the quality of milk products by destroying spoilage microorganisms and enzymes that contribute to the reduced quality and shelf life of milk.

Pasteurizing milk destroys 99.9% of disease-causing microorganisms and extends the shelf life to 16-21 days from the time it was packaged.

- Topic 2 : Pasteurizer working mechanisms

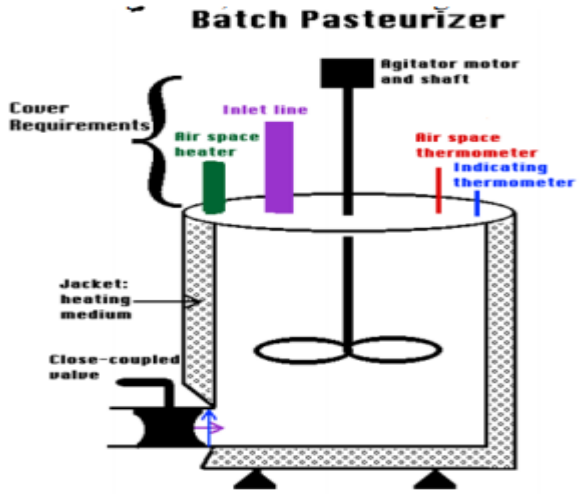


Fig16: **Pasteurizer**

The pasteurizer uses a vat pasteurizer which consists of a jacketed vat surrounded by either circulating water, steam or heating coils of water or steam.

In the vat the milk is heated and held throughout the holding period while being agitated. The milk may be cooled in the vat or removed hot after the holding time is completed for every particle.

- Topic3: Pasteurization temperatures and holding times

A. Low Temperature Long Time

The process of pasteurisation involves heating milk to 145 °F (62 °C) for 30 minutes, followed by rapid cooling.

B. High Temperature Short Time

This method involves using metal plates and hot water to raise the temperature of the milk to at least 161 °F (71 °C) for no less than 15 seconds.

C. Higher Heat Shorter Time

Similar to HTST pasteurization, Higher Heat Shorter Time (HHST) uses slightly different equipment and higher temperatures for a shorter time. Using HHST, milk can be heated anywhere from 191 °F (89 °C) – 212 °F (100 °C) for its specified time (15 seconds)

D. Ultra High Temperature

This process involves heating the milk using commercially sterile equipment and filling it under aseptic conditions into hermetically sealed packaging. The milk must be heated to 280 °F (138 °C) for at least two seconds, then rapidly cooling it down. UHT kills more bacteria (good and bad) and gives it a much longer shelf life. UHT milk does not need refrigeration, until opened, and is shelf stable for at least six months.

E. Ultra Pasteurized

Not to be confused with UHT, Ultra Pasteurized (UP) milk is heated using commercially sterile equipment, but it is not considered sterile because it is not hermetically sealed. Milk is heated to 280 °F (138 °C) for at least two seconds, then rapidly cooling it down. Since the milk is not hermetically sealed, it must be refrigerated with an average shelf life of 30 – 90 days.

The equipment which is used to heat and cool the milk is called a 'heat exchanger'.

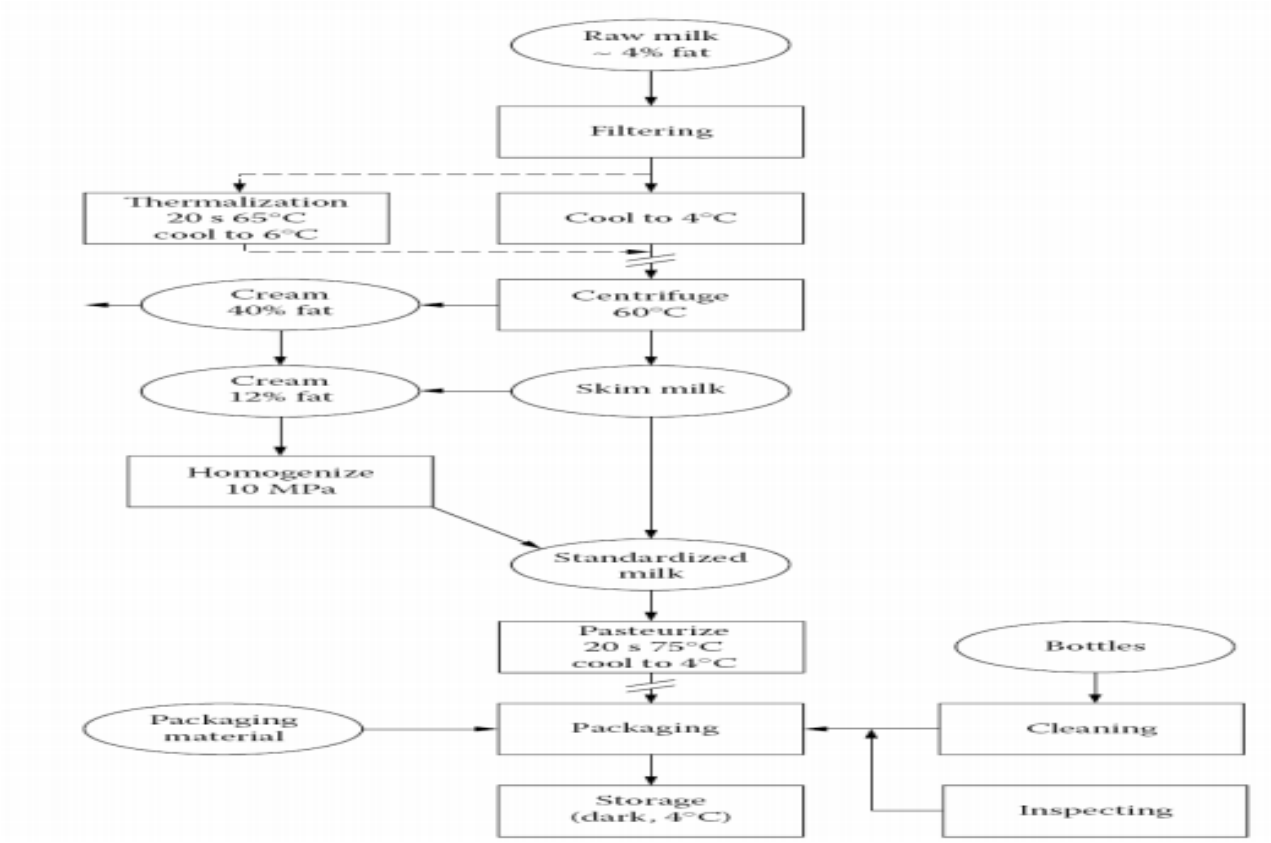
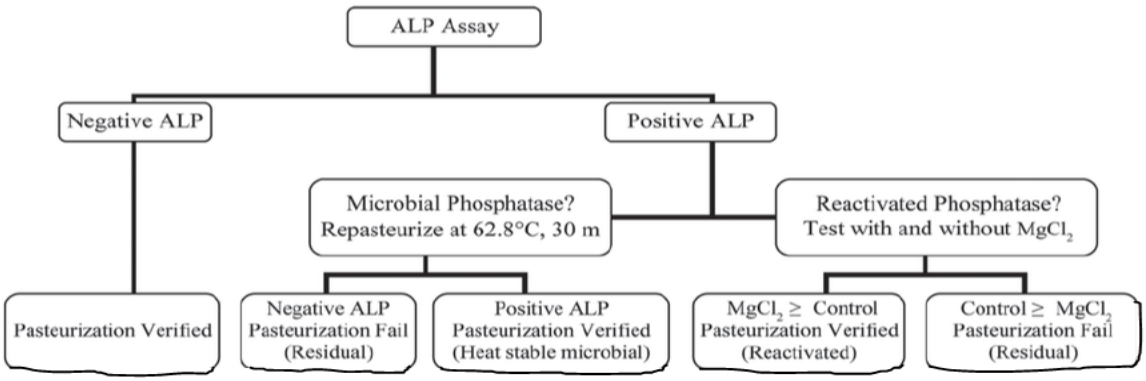


Fig17:**Flow chart of uht milk processing**

- Topic 5: Check pasteurization effectiveness (alkaline Phosphatase test)



Milk pasteurisation efficacy is typically monitored by checking for the presence of alkaline phosphatase (ALP) an enzyme present in raw milk,thus ensuring a product is safe for consumption. ALP is inactivated under high temperature/short time pasteurisation processes and is used as a marker of pasteurisation.

Procedures of testing ALP

✓ The alkaline phosphatase (ALP) is an enzyme normally present in raw milk and it is inactivated in conditions of heat treatment.

✓ The temperature of inactivation of ALP is slightly higher than that required for the destruction of pathogenic bacteria.

✓ So the ALP test in pasteurized milk is used to verify if the heating process of pasteurization is done correctly.

Apparatus required

1. Water-Bath -maintained at 37±l^{o}C, thermostatically controlled.
2. Comparator - with special discs of standard colour glasses calibrated in µg p-nitrophenol per ml milk, and 2 x 25 mm cells.
3. Test Tubes - of size 16 x 1.50 mm and rubber stoppers to fit.
4. Pipettes - 1, 5, and 10 ml.
5. Filter Paper - Whatman No. 2 or equivalent.
6. Litmus Paper

Reagants

Fig17: Example of reagents used to ALP test

Pipette 5 ml of buffer substrate into a clean, dry test tube followed by 1 ml of the milk to be tested. Stopper the tube, mix by inversion and place in the water-bath.

At the same time place in the water-bath a control tube containing 5 ml of the buffer substrate and 1 ml of boiled milk of the same kind as that under test that is pasteurized homogenized, low fat.

After 2 hours, remove the tubes from the bath, invert each and read the colour developed using the comparator and special disc, the tube containing the boiled milk control being placed on the left of the stand and the tube containing the

sample under test on the right. Record readings which lie between two standard colour discs by adding a plus (+) or minus (-) sign to the figure of the nearest standard.

N.B: If artificial light is needed when taking these readings, an approved 'day light' source of illumination must be used.

L. O 3.4 -Homogenize the pasteurized milk

Homogenization serves to prevent the formation of a cream layer in the package during storage. Many users dislike such a layer. Therefore, the pasteurized milk is usually homogenized. As a rule, not all of the milk is homogenized but only its cream fraction (partial homogenization), to reduce cost.

Homogenization clusters should be absent after the homogenization; therefore, the fat content of the cream should be rather low (10% to 12%) and the homogenizer temperature not too low (55°C).

Usually the homogenization precedes the pasteurization, to minimize the risk of recontamination. Because milk lipase is still present, the milk should immediately be pasteurized. Homogenization is a mechanical treatment of the fat globules in milk which is achieved by passing milk under high pressure 10 MPa through a tiny orifice, which results in a decrease in the average diameter and an increase in number and surface area, of the fat globules.

- Topic 1 : Homogenization purpose

The main goal of homogenization is to break up the large fat globules and create a stable emulsion that has an increased shelf life, a better taste, prevent the formation of a cream layer in the package during storage and improved mouth feel.

- Topic 2 : Homogenization mechanism

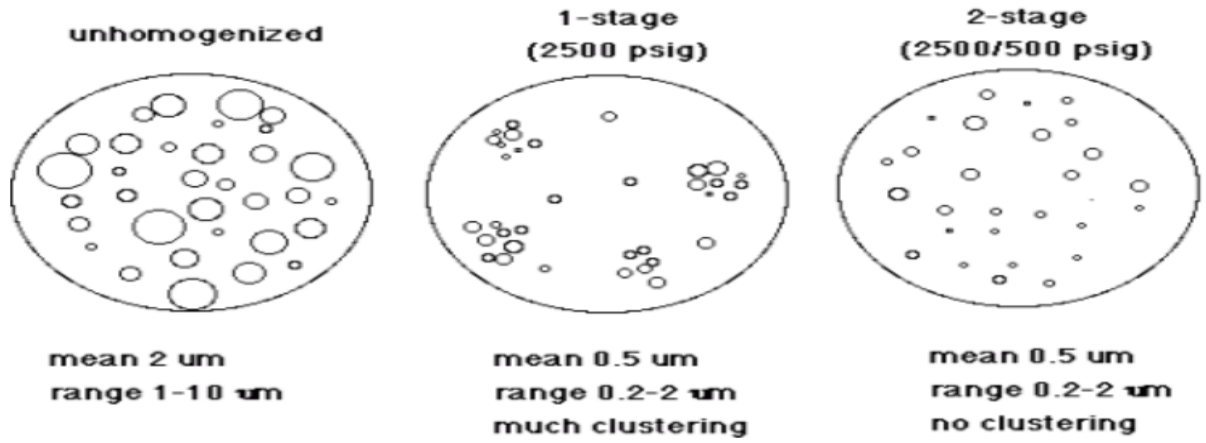
To understand the mechanism, consider a conventional homogenizing valve processing an emulsion such as milk at a flow rate of 20,000 l/hr. at 14 MPa (2100 psig). As it first enters the valve, liquid velocity is about 4 to 6 m/s. It then moves into the gap. between the valve and the valve seat and its velocity is increased to 120 meter/sec in about 0.2 millisec.

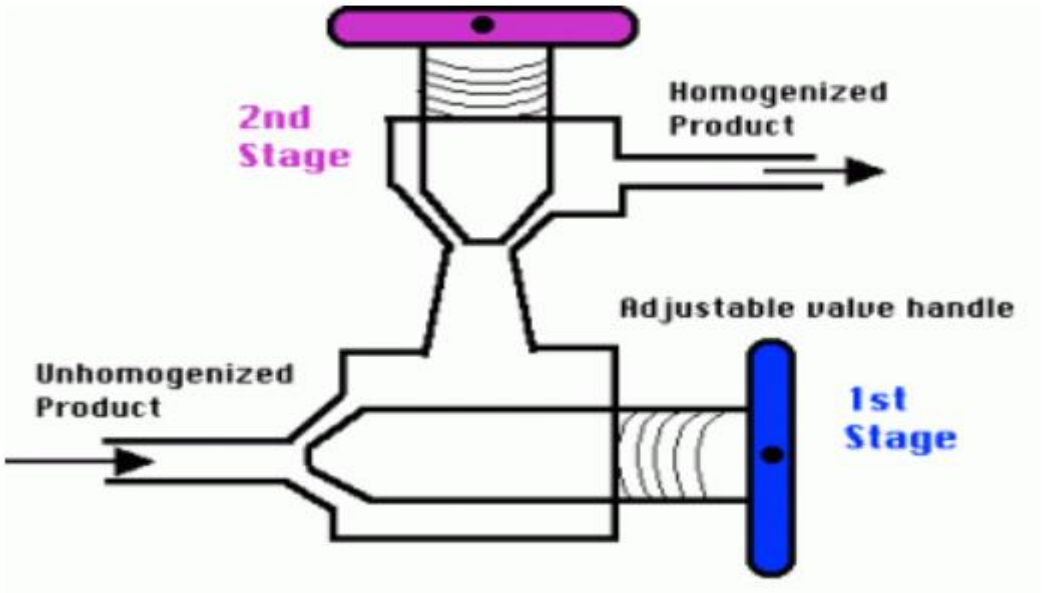
The fluid (milk) then moves across the face of the valve seat (the land) and exits in about 50 microsec. The homogenization phenomena is completed before the

fluid(milk) leaves the area between the valve and the seat, and therefore emulsification is initiated and completed in less than 50 microsec. The whole process occurs between 2 pieces of steel in a steel valve assembly. The product may then pass through a second stage valve similar to the first stage.

While most of the fat globule reduction takes place in the first stage, there is a tendency for clumping or clustering of the reduced fat globules. The second stage valve permits the separation of those clusters into individual fat globules.

The Effects of 2-stage Homogenization on Fat Globule Size Distribution as Seen Under the Light Microscope





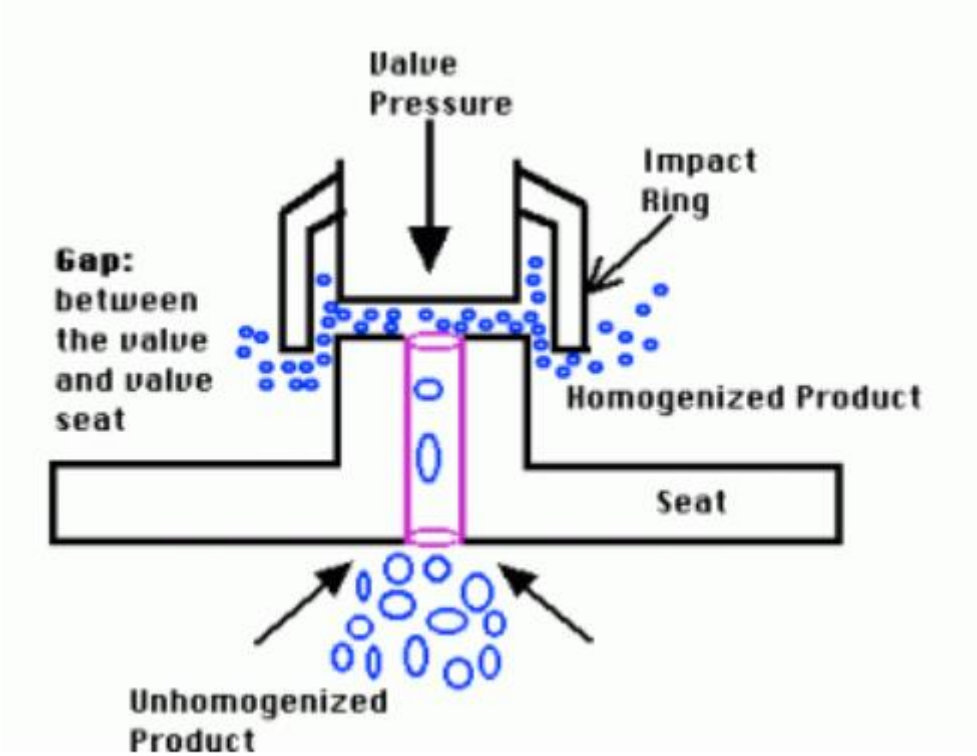


Fig18**: Homogenization mechanism**

In summary, the homogenization variables are:

- ✓ type of valve
- ✓ pressure
- ✓ single or two-stage
- ✓ fat content
- ✓ surfactant type and content
- ✓ viscosity
- ✓ temperature

Effect of Homogenization

Surface layers The milk fat globule has a native membrane, picked up at the time of secretion, made of amphiphilic molecules with both hydrophilic and hydrophobic sections. This membrane lowers the interfacial tension resulting in a more stable emulsion. During homogenization, there is a tremendous increase in surface area and the native milk fat globule membrane (MFGM) is lost. However, there are many amphiphilic molecules present from the milk plasma that readily adsorb: casein micelles (partly spread) and whey proteins. The interfacial tension of raw milk is 1-

2 mN/m, immediately after homogenization it is unstable at 15 mN/m, and shortly becomes stable (3-4 mN/m) as a result of the adsorption of protein. The transport of proteins is not by diffusion but mainly by convection. Rapid coverage is achieved in less than 10 sec but is subject to some rearrangement.

Surface excess is a measure of how much protein is adsorbed; for example 10 mg/m2 translates to a thickness of adsorbed layer of approximately 15 nm.

- Topic 3 : Homogenization parameters (time,pressure and temperature)

Increasing the homogenization temperature decreases the viscosity of milk and improves the transport of membrane material to the fat globules. Homogenization temperatures normally applied are 55 – **80 °C**, and homogenization pressure is between 10 and 25 MPa (100 – 250 bar), depending on the product.

Effect of Homogenization

The effect of homogenization on the physical structure of milk has many advantages

✓ Small fat globules leading to less cream-line formation

✓ Whiter and more appetizing color

✓ Reduced sensitivity to fat oxidation

✓ More full-boiled flavor, and better mouthfeel

✓ Better stability of cultured milk products

Disavantages of homogenization

Somewhta increased sensibility to light-sunlight and fluorescent tubes-can result in sunlight flavor

The milk might be less suitable for production of simi-hard or hardcheeses because the coagulum will be too soft and difficulty to dewater

L. O. 3.5:Check the pasteurized milk

- Topic 1 : Organoleptic properties

✓ Pleasant mounth-feel due to presence of macromolecules,such as colloidal proteins and fat globules

✓ Sweet and salt taste due to lactose and milk salts

✓ Weak aroma due to volatile counstituent found in milk

✓ Production ,processing and storage practices can profoundly affect milk quality

✓ Milk flavor results mainly from proteins,carbohydrates and small amounts of other components.

✓ Excess pasteurization can cause maullard rection

- Topic 2 : Chemical composition

Pasteurized milk showed that total solids was 4.03 to 11.32%, fat content ranged between 1 to 2.8%, protein was 2.13 to 3.6%, lactose was 2.13 to 4.8%, ash was 0.33 to 0.69%, titratable acidity was 0.14 to 0.86% and the freezing point was -0.41 to -0.67.

- Topic 3 : Microbial state (pathogens)

The milk can be contaminated by unsanitary handling after the completion of the pasteurization process. Redmond defines pasteurization, as a process of heating a liquid, particularly milk, to a temperature between 55 °C and 70 °C, to destroy harmful bacteria without materially changing the composition, flavor, or nutritive value of the liquid.

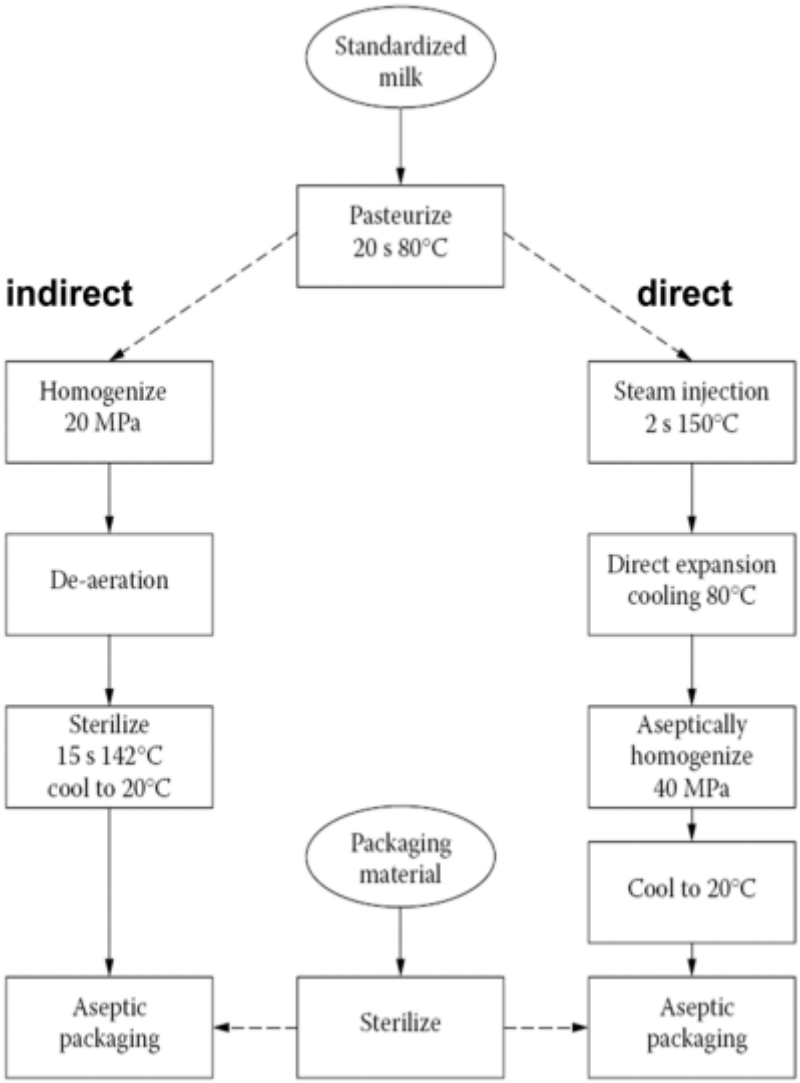
The viability of bacteria in milk after heat treatments can be assessed by using three different viability indicators: (i) colony forming unit (CFU) on plate count agar, (ii) de novo expression of a *gfp* reporter gene, and (iii) membrane integrity based on propidium iodide exclusion.

The methylene blue reduction and phosphatase tests are methods widely used to detect the presence of microbes in pasteurized milk. The standard plate count is used to determine the total number of bacteria present in a specified amount of milk, usually a milliliter (mL). This is used for the grading of milk. The coliform plate count is widely used to determine the total number of coliforms present in one mL of milk sample.

The standard plate count limit for pasteurized milk is 20 000 SPC/mL and the coliform plate count limit is 10 CFU/mL. Therefore the standard plate count is acceptable as it is less than 20 000 SPC/mL but the coliform count is unacceptable since it exceeds the acceptable limit of 10 CFU/mL.

Learning Unit 4 – Make UHT milk

HTST method is also called ‘continuous flow’ or ‘flash’ pasteurization. It is modern method of milk pasteurization and is invariably used where large volume of milk is handled. This system gives a continuous flow of milk, which is heated to 72°C or above for 15s or less and promptly cooled to 5°C or below.



Examples of the manufacture of UHT-sterilized milk (indirect or direct heating) with aseptic packing

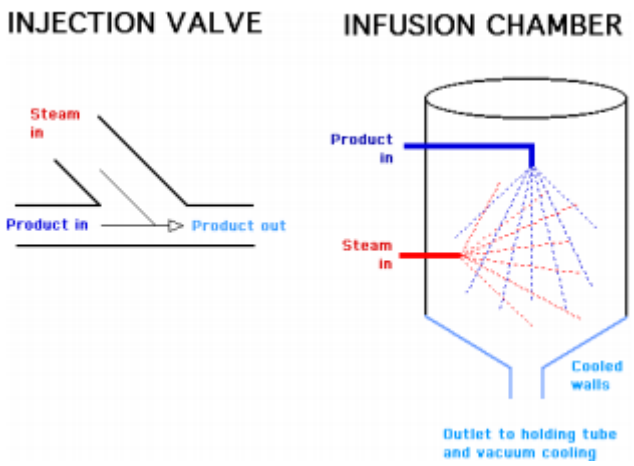


Fig18:**Injection valve**

The two methods that can be used for UHT direct heating:

Injection: High pressure steam is injected into pre-heated liquid by a steam injector leading to a rapid rise in temperature. After holding, the product is flash-cooled in a vacuum to remove water equivalent to amount of condensed steam used. This method allows fast heating and cooling, and volatile removal, but is only suitable for some products. It is energy intensive and because the product comes in contact with hot equipment, there is potential for flavour damage.

Infusion: The liquid product stream is pumped through a distributing nozzle into a chamber of high pressure steam. This system is characterized by a large steam volume and a small product volume, distributed in a large surface area of product. Product temperature is accurately controlled via pressure. Additional holding time may be accomplished through the use of plate or tubular heat exchangers, followed by flash cooling in vacuum chamber.

This method has several advantages:

- ✓ instantaneous heating and rapid cooling
- ✓ no localized overheating or burn-on
- ✓ suitable for low and higher viscosity products

Indirect UHT heating system

Just like in pasteurization, the heating medium and product are not in direct contact, but separated by equipment contact surfaces.

Several types of heat exchangers are applicable: plate or tubular. In general the UHT methods have some advantages: The reduction in the process time due to ultra-high temperatures (UHTST)

The come-up and cool-down short times lead to a high quality product

Longer shelflife products: more than six months at ambient temperature

The UHT process presents also some difficulties:

- ✓ Assuring sterility/aseptic conditions throughout the process
- ✓ Some nutrients are lost (Table A) and cooked flavors can be generated

Changes to different milk components due to UHT process

Constituents	Heat effects
Fat	No changes
Lactose	Marginal changes
Proteins	Partial denaturation of whey proteins
Mineral salts	Partial precipitation
Vitamins	Marginal losses

L. O 4.1.Adjust the equipment

- Topic 1 : UHT machines

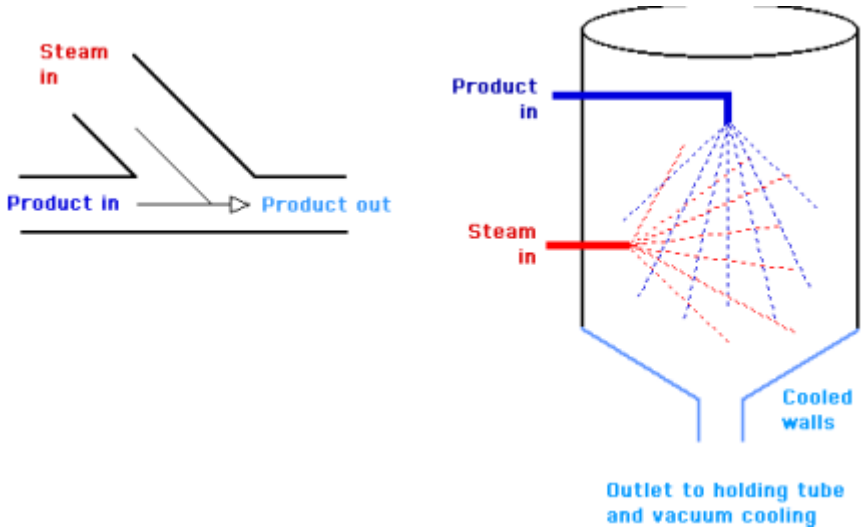


Fig19:**UHT direct heating**

Operation of HTST Pasteurizer

Initial preparation

1. The plant must be sterilized.
2. All water remaining in the plant must be drained.
3. Clean filter clothes/nylon filters should be fitted in the filter.

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 71.7°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.

Note: The diluted milk that comes out first should not be collected in the balance tank.

- Topic 2 : Temperature adjustment

Pasteurization Type	Typical Product	Typical Storage	Temperature	Holding Time
Batch, vat	Milk	Refrigerated	145°F (62.8°C)	30 min
Continuous, high temperature short time (HTST)	Milk	"	161°F (71.7°C)	15 sec
Continuous, higher heat shorter time (HHST)	Milk	"	191°F (88.3°C)	1 sec
Aseptic, ultra high temperature (UHT)	Milk	Room temperature	275-302°F (135-150°C)	4-15 sec

L. O. 4.3: Sterilize the milk

- Topic 1 : Sterilization purpose

Sterilization of milk is aimed at killing all microorganisms present, including bacterial spores, so that the packaged product can be stored for a long period at ambient temperature, without spoilage by microorganisms.

Since molds and yeasts are readily killed, we are only concerned about bacteria. To that end, 30 min at 110°C (in-bottle sterilization), 30 sec at 130°C, or 1 s at 145°C usually suffices.

The latter two are examples of so-called UHT (ultra-high-temperature, short time) treatment.

Heating for 30 min at 110°C inactivates all milk enzymes, but not all bacterial lipases and proteinases are fully inactivated; it causes extensive Maillard reactions, leading to browning, formation of a sterilized milk flavor, and some loss of available lysine; it reduces the content of some vitamins; causes considerable changes in the proteins including casein; and decreases the pH of the milk by about 0.2 unit.

- Topic 2 : UHT machine working mechanisms

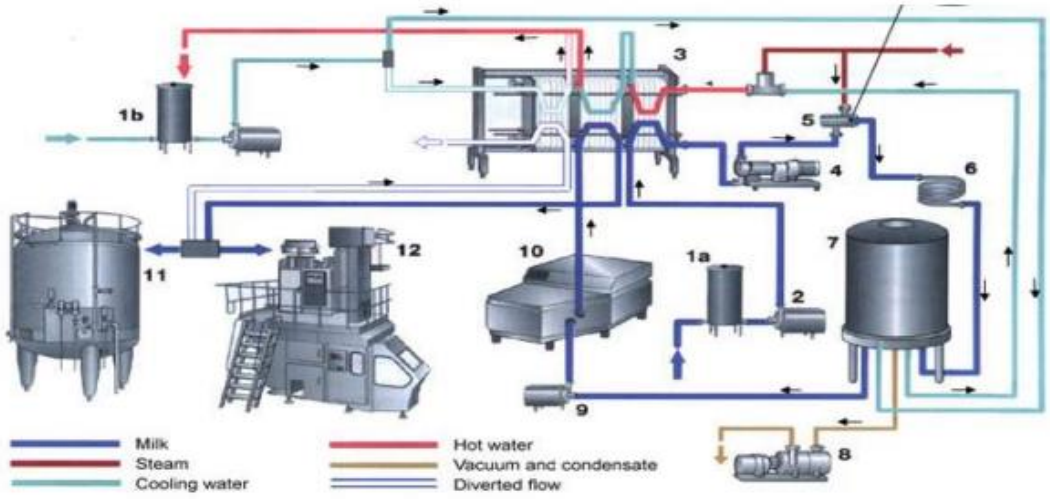


Fig20**: UHT machine working mechanisms**

(1a: Balance tank milk, 1b: Balance tank water, 2: Feed pump, 3: Plate heat exchanger, 4: Positive pump, 5: Steam injection head, 6: Holding tube, 7: Expansion chamber, 8: Vacuum pump, 9: Centrifugal pump, 10: Aseptic homogenizer, 11: Aseptic tank, 12: Aseptic filling)

- Topic 3 : UHT temperature and holding time

Ultra-high temperature processing (UHT), ultra-heat treatment, or ultra-pasteurization is a food processing technology that sterilizes liquid food by heating it above **135 °C** (**275 °F**) the temperature required to kill bacterial endospores for 2 to 5 seconds.

The major steps in a UHT process are as follows:

- ✓ Preheating, with or without a holding time
- ✓ Homogenisation (for indirect systems)
- ✓ Heating to sterilisation temperature
- ✓ Holding at sterilisation temperature
- ✓ Initial cooling
- ✓ Homogenisation (alternative position for direct or indirect systems)
- ✓ Final cooling
- ✓ Aseptic packaging

The preheating stage takes the temperature from ~ 5°C to ~90°C, using the hot milk post-sterilisation as the heating source in tubular or plate heat exchangers.

The major reason for this step is to reduce the amount of fouling, or deposit formation, in subsequent heat exchangers although, as noted below, it can also have a major effect on the quality of the final product by inactivating a natural milk enzyme.

The final heating step to the required sterilisation temperature is achieved by one of two major types of heating, the so-called direct and indirect systems.

Direct systems heat milk by direct contact with culinary superheated steam while indirect systems employ heat exchangers in which superheated steam heats the milk indirectly through a stainless steel barrier in the form of either a tube or a plate.

Direct systems can be either an injection type in which steam is injected into the milk, or an infusion type in which milk is infused into a chamber of superheated steam. The major difference between direct and indirect systems is the rate at which the milk is heated.

Direct systems heat milk from preheat temperature to sterilisation temperature in less than one second whereas indirect systems can take several seconds to minutes.

The major consequence of this difference is that, for the same bactericidal effect, the direct systems produce much less chemical change in the milk constituents than the indirect systems

Many chemical and microbiological changes occur in the heating step immediately before and in the cooling step immediately after the sterilisation step.

The initial cooling of the product in direct systems is achieved very rapidly as it is passed through a vacuum chamber which removes the water condensed into the product during the steam heating and in so doing returns the temperature of the product to close to the temperature from which it was heated, usually around 75°C.

In the final cooling step in direct systems, and in both cooling steps in indirect systems, the heat from the hot milk is transferred to the cold milk in the preheating/heat regeneration steps.

The aseptic packaging step is a crucial one. The product must be transferred after cooling to the final package and the package sealed without introducing even one bacterial cell.

In most commercial plants, the product is held in an aseptic tank before it is sent to the aseptic packer. Various packaging types are available but the most common are paperboard and multilayered plastic. The packages are sterilised before being filled, usually with hot hydrogen peroxide followed by hot air to remove residual peroxide.

L. O 4. 5.Check the UHT milk

- Topic 1 : Organoleptic properties

UHT milk often appears to have a cooked or heated flavour.

The typical flavour of UHT milk is due a combination of flavours, the chief of which are sulphurous flavours caused by volatile sulphur compounds released from the whey protein, and the proteins in membrane surrounding the milk fat globule.

Other contributors are the aliphatic carbonyl compounds formed during heating and compounds formed in the Maillard reaction.

Immediately after manufacture, UHT milk has a strong sulphurous smell and taste due to hydrogen sulphide and other volatile sulphur compounds such as methane thiol.

These compounds are markedly reduced in the first week, presumably through oxidation.

- Topic 2 : Chemical composition

✓ The whey proteins, particularly β-lactoglobulin which forms about 50 per cent of these soluble proteins in milk, are denatured by heating over about 70°C so that in UHT milk, a large percentage of the whey proteins are in the denatured state and exist largely as complexes with caseins.

✓ The instability of the whey proteins to heat has another consequence during UHT processing.

✓ Surprisingly, the UHT process has only a minimal effect on the nutrient value of milk.

✓ There is a small decrease in the water-soluble vitamins but virtually no change in the fatsoluble vitamins.

✓ UHT treatment may also reduce the allergenicity of the milk proteins.

- Topic 3 : Microbial state (pathogens)

The microbial state or pathogens are accepted according to countries standards

✓ Bacterial absence might be due to no problem in UHT process.

✓ The presence of bacteria in UHT milk might be due to many factors including the milk quality, process plant sanitation, status of packaging material and also the handling process.

✓ Total Coliform Count :The presence of coliform bacteria Escherichia coli, in uth milk is an indication of fecal contamination.(can be from worker during packaging or uncleaned packaging materials,…..)

Milk in glass bottle

Fig21: **Some Packaging materials**

Learning Unit 5. Package and store fresh milk

L.O 5.1. Package and label the pasteurized/UHT milk

- Topic 1 : Types of packaging materials (for P/UHT milk)

✓ The glass bottle as the retail package for milk was used until the 1930s, at which time waxed paper was introduced. The development and introduction of plastic materials, both alone and in combination with paper, resulted in a wide range of containers suitable for dairy products packaging.

✓ The shelf-life of bottled fluid milk is reported to average between 10 and 21 days when stored at 4-8°C. The shelf life varies depending on raw milk quality, processing conditions, microbial growth, and packaging materials, exposure to light and temperature abuse.

✓ polyethylene (PE) monolayer materials, high-density polyethylene (PE-HD) bottles, low-density polyethylene (PE-LD) pouch, pigmented with titanium dioxide (TiO_2),

✓ PE/PAP/PE

✓ Bottle:PE-HD+TiO2

✓ Pouch:PE-LD+TiO2

✓ Multi-layered plastic bottles with a high barrier

✓ Polyethylene terephthalate (PET) is another plastic material used for milk packaging.

✓ Pigmented PET enhances its versatility by protecting the food from light, which in turn helps to protect food flavour against light-induced lipid oxidation.

- Topic 2 : Packaging material handling

Packaging materials should be:

✓ Stored in a dry place away from manufacturing areas

✓ Used in a clean and sanitary manner

✓ Non-toxic

- Topic 3 : Material quality and utility

A. Function of packaging materials

✓ To protect product from external factors

✓ Preservation of product shelf life

✓ Communication tools for marketing

✓ Facilitate transport and handling of product safely

✓ Traceability of products

✓ Avoid loss of same quality parameters of bread

B. Parameter for selecting packaging materials:

✓ Product forms or type

✓ Expected product shelf life

✓ Factor affecting product shelf life

✓ Bio-chemical degradation of packed products

✓ Reactivity of product

✓ Storage conditions

- Topic 4 : Packaging hygienic conditions

Packaging should be carried out in such a way that:

- Avoids contamination of processed products
- Protects the product against contamination until the product reaches the consumer.
- Topic 5 : Label (label elements, shelf life)

Label is a slip (as of paper or cloth) attached to packaged milk to identify or describe it.

The most important components to include on your label

1. **Your Brand Name**

The brand name of your product is one of the most important components. It's the name by which your product will be referred to, asked about, and recommended.

No matter the graphic design that you choose for your brand name and logo, make sure that the brand is both readable and memorable.

If you haven't developed your brand yet, keep in mind that your brand name does not necessarily have to match up with your company name. For example, our company name is Centra Foods but the brand that we sell is Bella Vina.

2. **Product Name**

You'll need to describe exactly what it is on the label so customers clear understand what they're buying. For example, when we sell bulk oils we need to explain what kind of oil it is (Olive, Canola, Soybean, etc.) and then what grade of oil it is on top of that (Extra Virgin Olive Oil, Expeller Pressed Non-GMO Canola Oil).

3. **Packaging Size**

You will need to list the packaging size of your product on the label.

4. **Barcode**

Your product will need to have a barcode if there's any chance you'll be selling it in a store. This barcode will be used for scanning and recognition as a unique product.

5. **Company Name, City, State and ZIP Code**

For consumer information and traceability, the company name needs to be on the label. You'll also need to list the city, state and zip code of that company. If there are multiple locations, the corporate address can be used. The full street address does not need to be listed.

6. Your Product's Story

Your Product's Story: If you have a product that will be sold on retail store shelves, it's vital to tell your product's story. Where did it come from? How was the recipe originally created? Where did your business grow out of and where has grown in to?

More and more, consumers want to be involved in the food that they are eating--especially in the specialty foods and natural marketplace. They want to hear your story, how you created the food that you did, and why you think it's so important that they enjoy it. Other markets like bulk, wholesale, and food service don't rely on the stories on the label as much, but they still remain an important part of your product's overall marketing.

9 Nutritional information

You will need to include your products nutritional information on the label, required by the FDA. A basic requirement to selling any food these days. To obtain the nutritional information, you can either

a. combine your suppliers nutritional information in the correct percentages, or

b. you can get your own nutritional testing done on your finished product (preferred).

Generally label present information of processed milk such as:

- ✓ product identity
- ✓ Manufacturer
- ✓ Net quantity
- ✓ Manufacturing date and Expiry date
- ✓ Lot number or batch number, Bar code
- ✓ Universal product card/barcode
- ✓ Advertising
- ✓ Ingredients
- ✓ Direction for use
- ✓ Nutritional information
- ✓ Serving quantity

L. O 5.2 Store fresh milk

- **Topic 1 :** Storage conditions (temperature, environment)

All fresh fluid milks should be stored at temperatures below 40 °F and should not be stacked high in

the display cases. If stored above 40 °F, milk will begin to develop signs of spoilage, including sour

odor, off-flavor and curdled consistency.

Fresh animal **milk** should be always kept in the fridge. UHT **milk** may be safely kept outside the fridge. The best **place** to **store milk** is the top or middle shelf of a fridge, not in the door.

Losses of ascorbic acid (AA) during milk storage have been reported for UHT milk storage at various temperatures; durations of storage; and with different packaging materials, such as C-enamelled tinplate cans; brown glass bottles; and aseptic multilayer containers.

- Topic 2 : Store room monitoring (pests, temperature)

A. Pest Control

Pest Control is important as pests can be both a nuisance and a danger to health. They can attack and contaminate milk intended for humans, damage the structure of your premises (such as electric cables) and spread many forms of disease and harmful bacteria that can cause milk poisoning. However good the business sooner or later an insect or a rodent will be a threat.

Food hygiene legislation states that businesses must ensure protection against pests and have adequate procedures in place to ensure pests are controlled.

Types of pest

There are 3 main groups of pests that are encountered in food businesses:

1. Rodents - rats and mice
2. Insects - cockroaches, beetles, flies etc
3. Birds - pigeons, seagulls etc.

Those first ones are major pests of milk which cause milk contamination

B. Temperature Control

The Food Hygiene Regulations require all flesh milk business operators to control the temperature of milk that are capable of supporting the growth of harmful bacteria. By controlling the temperature of flesh milk you restrict the growth of bacteria which reduces the risk of milk poisoning. As you are aware, bacteria require warmth to live and multiply. Generally their growth is prevented at temperatures of less than 4^{o}c and above 63^{o}c. The range between these two temperatures is where bacteria will grow rapidly. Therefore, you must avoid keeping milk at temperatures within this range.

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