Dairy Products Processing
Level-III

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

Module Title: - Setting up a Production and Packaging Line

LG Code: IND DPP3 M06 LO (1-2) LG (21-22)
TTLM Code: IND DPP3 TTLM 0321V1

March, 2021

With the support of
United Nations Educational, Scientific and Cultural Organization
Republic of Korea Funds-in Trust

Table of content

LG #21	LO #1- Prepare for Line setup

Instruction sheet

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

- Confirming available materials
- Confirming and fitting equipment and related accessories
- Making available tools and equipment for line setup
- Identifying processing parameters and settings

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

- Confirm available materials
- Confirm and fit equipment and related accessories
- Make available tools and equipment for line setup
- Identify processing parameters and settings

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key answers to correct your work.
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the LAP Test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, go back to “Operation sheets”.

Information Sheet 1- Confirming available materials

1.1. Introduction

Dairiy products manufacturing plants that process milk products, cultured milk product such as sour cream, yogurt, and fermented milk products are subject to the food safety requirements of the pasteurized, ultra-pasteurized, and aseptically processed milk and milk products. These requirements dictate the construction of Floors, Walls, Ceilings, Door, Windows, Aproper Lighting and Ventilation.

Floors in all rooms of the processing facility where milk products are handled, processed, and sorted or in which milk container, utensils, and equipment are washed must be constructed of concrete or other equally impervious and easily cleanable material. The floor must be properly sloped with trapped drains. Storage rooms for dry ingredients need not have drains and may have floors constructed of wood. Walls and ceilings should be smooth, light-colored, washable, and in good repair.

Doors and windows should prevent access to insects and rodents and all opening to the outside must have solid doors or glazed windows. However, other methods of effectively protecting opening to the outer air such as screening, fans, air curtains, and properly constructed flaps may be used provided that the entrance of insect and rodents are prevented.

1.2. Materials for processing and product requirements

Dairy technology is a part of food engineering which deals with the processing of milk & its product. Equipment mainly used for dairy product processing includes buckets, milk cans, cloths used for straining the milk are frequently the source of bacterial contamination of the milk.

Therefore all product contact surfaces should be kept cleaned immediately before and after use, Equipment and utensils should be disinfected immediately, Equipment repairs and maintenance should preferably be carried out. The surface of the milk utensils like buckets and cans should be smooth and without seams and have rounded edges to make them easy to clean.

Table 1: Milk processing equipment and their uses

Equipment	Use
Buckets/bowls	Plastic, aluminum or stainless steel, for mixing ingredients
Cheese cloths	Filtering whey from curd, pressing
Filtering incoming milk	Filters Filtering incoming milk
First aid box	Materials for treating cuts and burns
Funnels	To transfer liquids into narrow-necked containers
Measuring jugs, scoops, spoons	For measuring correct volumes of liquid or powder ingredients
pH meter	For measuring acidity of the milk
Nail brushes	To clean hands of operators
Scales	Weighing ingredients
Standby generator	Refrigerator power
Storage bins	For bulk ingredient
Thermometers	0–110ºC for testing product temperature and 0 to –30ºC for checking refrigerator and freezer temperatures
Work tables Processing	Processing/packing, made from aluminum or stainless steel

1.3 Materials for product packaging requirements

Packaging refers to the process of design, evaluation and production of packages. it is certainly dynamic and constantly changing. New materials need new methods, a new methods demand new machinery, new machinery results in better quality and better quality opens up new markets which require changes in packaging.

There are different forms of packaging based on the packaging material.

a. **Primary packaging:** is the material that first envelops the product. It envelops and holds the food product with direct contact.
b. **Secondary packaging:** is outside the primary packaging perhaps used to group primary packages together and exterior to the primary packaging.
c. **Tertiary packaging:** It is the tough outermost covering is used for bulk handling, warehouse storage and transport shipping.

The primary purpose of packaging must continue to be maintaining the safety, wholesomeness, and quality of food among the basic functions:

a. Containment (Holding the product)
b. Protection (Quality, Safety, Freshness).
c. Medium of communication (Labels)
d. Means of minimizing costs of production
e. Means of selling product

1.3.1 Packaging Materials

Different types of materials are used for packaging different dairy products. The right selection of packaging materials and technologies maintain product quality and freshness during distribution and storage dairy products.

1.3.2 Characteristic of an ideal packaging material

Good Packaging material should have the following characteristics;

- Compatible with product and Fit into a production line.
- Protection from Mechanical hazards especially during transportation.
- Advertising potential.
- Attractive appearance.
- Easy to handle during Production, storage and Distribution
- Resistance to Moisture, Grease, Oil, Insects rodents, etc.
- Economic and easily available, etc.

1.3.3 Types of packaging materials

The choice of the proper packaging material will be made by the food processor based on the requirements:

- Composition of the food (solid or liquid)
- Physical, chemical, and microbiological and deteriorative reactions
- Socioeconomic situation of the anticipated customer or market
- Cost of the packaging material, etc.

a. Glass Containers

Glass generally refers to hard, brittle, transparent material, such as those used for windows, many bottles, or eyewear. Glass is one of the most important packaging materials because of its high barrier and see-through properties. The transparency of glass allows consumers to see the product, yet variations in glass color can protect light-sensitive contents. Glass Containers have the following merit;

- They are resistant to moisture, gases, odors, and microorganisms.
- They are inert and do not react with or migrate into food products.
- They are transparent and display the contents.
- They are perceived by the customer to add value to the product.

Figure 1: Glass containers

b. Metal Cans

Metal is the most versatile of all packaging forms. It offers a combination of excellent physical protection and barrier properties, formability and decorative potential, recyclability, and consumer acceptance.

They are appropriate for packaging of light, moisture and oxygen sensitive products and carbonated beverages such as soft drinks, flavored milk etc. Metal Cans have the following merits;

- They have a high strength-to-weight ratio.
- They can be heat processed.
- They have excellent barrier and protective properties.
- When sealed with a double-seam they provide total protection of the contents,
- They can be made in a wide range of shapes and sizes.

Figure 2: Metal and tin plate steel containers

c. Plastics Containers

Multiple types of plastics are being used as materials for packaging food, including polyolefin, polyester, polyvinyl chloride, polyvinylidene chloride, polystyrene, polyamide, and ethylene vinyl alcohol.

Plastic containers have the following benefits of plastics over other packaging materials;

- Good Versatility/ flexibility
- Plastic containers are light weight, flexible/rigid, has strength, so less breaking
- Cost of plastics is comparatively lower than that of glass and metal containers.
- Consumer's convenience at lower cost.
- Ease in Transportation and Distribution:
- Plastics are non-corrosive.
- Plastics can be recycled.

Figure 3 Plastic packaging materials

d. Paper Containers

Paper and paperboards are commonly used in corrugated boxes, milk cartons, folding cartons, bags and sacks, cups, wrapping paper, tissue paper and paper plates. Laminated paper is used to package dehydrated products such as ready to serve soups, spices and grounded herbs.

Figure 4 : Paper and wooden and cardboard boxes Containers

Self- Check _1	Written test

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

Part I: Choose the best answer (10 points)

1. Which one of the following is advantage of packaging?

   A. Protect the product B. Medium communication **C.** Containment D. All

2. ---------- It is the tough outermost covering is used for bulk handling, warehouse storage and transport shipping.

   A. Secondary packaging B. Tertiary packaging C. Primary packaging D. None

3. Primary packages should have the following characteristics , except:

   A. Sanitary B. Toxic C. Easy to pick up and handle D. Display the product

4. Which one is Characteristic of an ideal package?

   A. Compatible with product and Fit into a production line C. Attractive appearance

   B. Advertising potential D. All

5. Which One is the cost effective packaging material?

   A. Aluminum cans B. Glass C. Metal Cans D. Plastic

Part II: Short Answer Questions (5 points)

6. Define packaging. (2 points each)
7. List and discuss forms of packaging. (3 points each)

Note: **Satisfactory rating - 15 points** **Unsatisfactory - below 15 points**

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

Score = _____

Rating: _____

Information Sheet 2- Confirming and fitting equipment and related accessories

2.1 Positioning valves and related equipment settings

There are many junctions in a piping system where product normally flows from one line to the other, but which must sometimes be closed off so that two different media can flow through the two lines without being mixed. When the lines are isolated from each other, any leakage must go to drain without any possibility of one medium mixed with the other

This is a common problem faced when engineering dairy plants. Dairy products and cleaning solutions flow in separate lines, and have to keep separate.

2.1.1 Mix proof valve

Mix proof valves either double-seat or double-seal, but when discussing mix proof valves, it generally the double-seat type that referred. A double-seated valve has two independent plug seals separating two liquids, forming a leakage chamber between them under atmospheric pressure during every working condition.

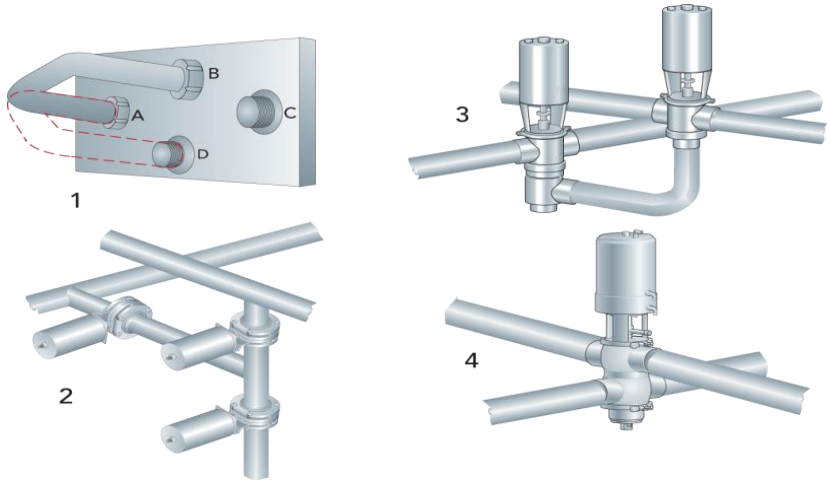


Figure 5: Sanitary mix-proof valve systems.

1. Swing bend for manual change between different lines.
2. Three shut-off valves can perform the same function.
3. One shut-off valve and one changeover valve can do the same job.
4. One mix proof valve is enough for securing and switching the flow.

2.1.2 Shut-off and changeover valves

There are many places in a piping system where it must be possible to stop the flow or divert it to another line. These functions performed by valves, Seat valves, manually or pneumatically controlled, or butterfly valves used for this purpose.

2.1.3 Seat valves

The valve body has a seat for the closing plug at the end of the stem. The plug lifted from and lowered onto the seat by the stem, which moved by a crank or a pneumatic actuator.

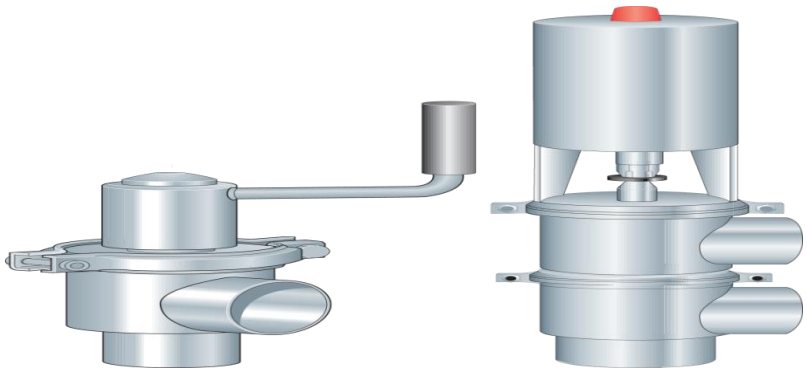


Figure 6: Manual shut-off seat valve and pneumatically operated changeover seat valve.

The operating mechanism is interchangeable between shut-off and changeover seat valves.

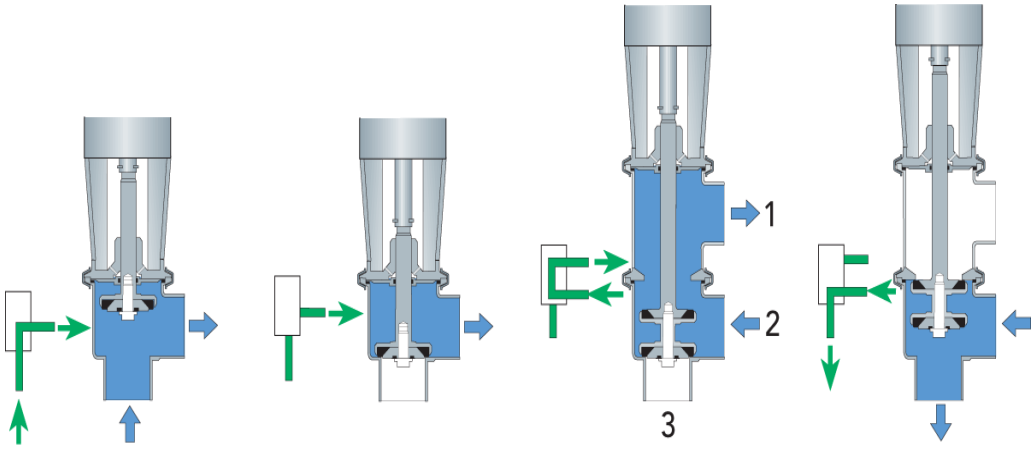


Figure 7: Shut-off and change over valves with the plug in different positions and the corresponding flow chart symbols

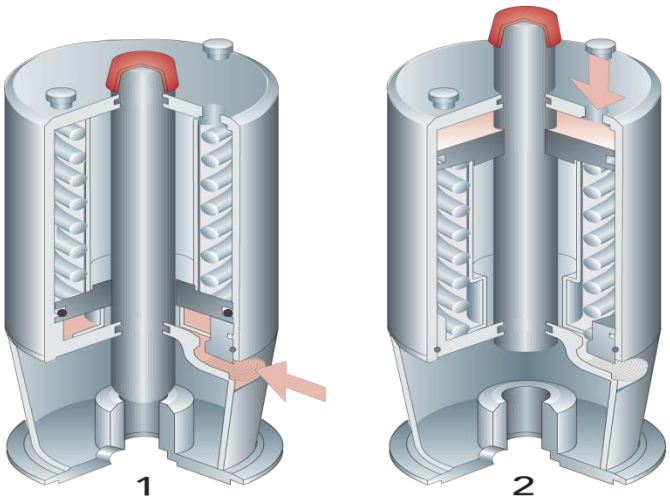


Figure 8: Examples of pneumatically operated actuators.

- Valve opened by spring Closed with compressed air.
- Valve closed by spring. Opened with compressed air

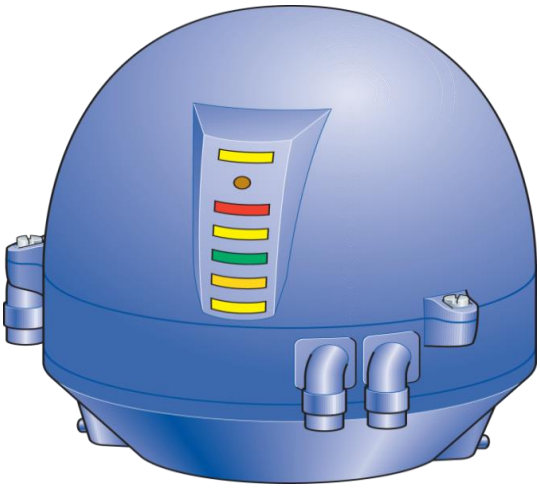


Figure 9: Valve plug position and control unit fitted on top of the actuator.

2.1.4 Butterfly valves

The butterfly valve is a shut-off valve. Two valves must use to obtain a changeover function. Butterfly valves often used for sensitive products, such as yoghurt and other cultured milk products, as the restriction through the valve very small, resulting in very low-pressure drop and no turbulence. It is also good for high viscosities and, being a straight-through valve, it fitted in straight pipes.

The valve usually consists of two identical halves with a seal ring clamped between them. A streamlined disc fitted in the center of the valve. It usually supported by bushes to prevent the stem from seizing against the valve bodies. With the disc in the open position, the valve offers very low flow resistance. In the closed position, the disc seals against the seal ring.

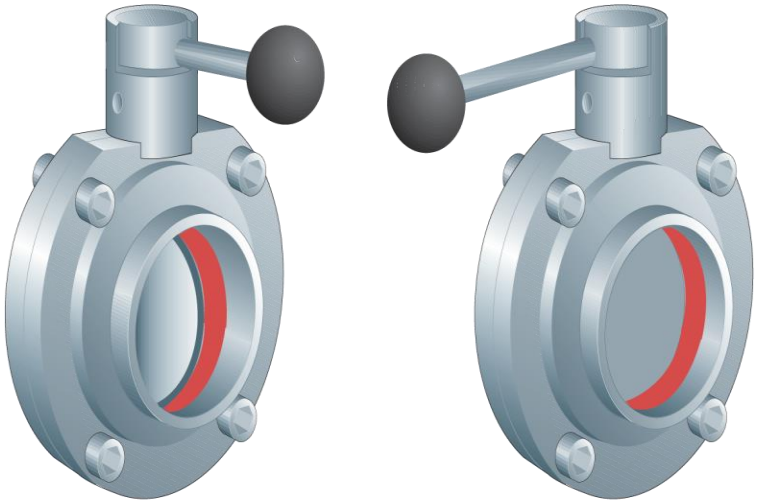
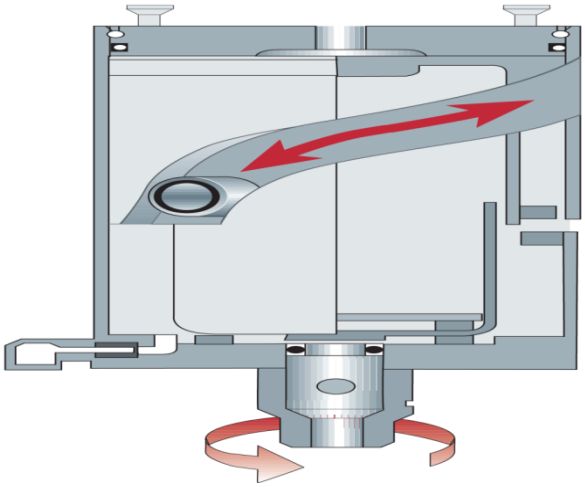


Figure10: Manually controlled butterfly valve in open position (left) and in closed position (right).

- **Manual control:** the butterfly valve is fitted with a handle, usually for two positions open and closed. This type of valve not suitable as a control valve, but can be used for coarse control with a special handle for infinite positions.
- **Automatic control: a**n air actuator used for automatic control of the butterfly valve. The function can be:
  - ✓ Spring closing/air opening (Normally closed, NC)
  - ✓ Air closing/spring opening (Normally open, NO)
  - ✓ Air opening and closing (A/A)

The disc easy to turn until it touches the seal ring. Then it needs more power to compress the rubber. A normal spring powered actuator strongest in the beginning, when less power required, and weaker at the end, when more power required, it is therefore an advantage to use actuators, which designed so that they provide the correct power at the right time.

Another type of the butterfly valve is the flange valve. It is the same type of butterfly valve as described above, but it fitted between two flanges welded to the line. Its function is the same as an ordinary butterfly valve. During operation, it clamped between the flanges with screws. For servicing, the screws loosened. The valve part pulled out for easy servicing.



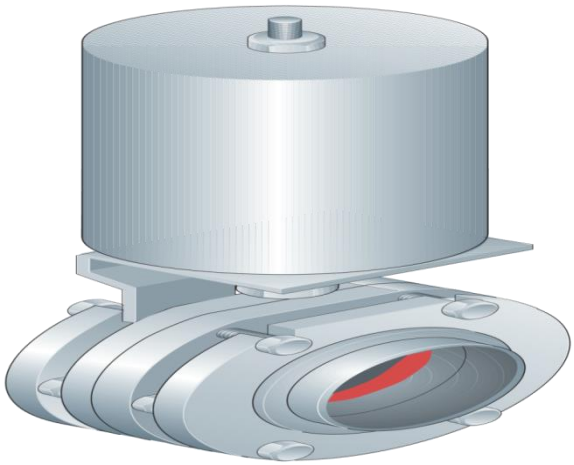


Figure 11: Air driven actuator for butterfly valves. **Figure 12:** Pneumatically operated butterfly flange valve design

2.2 Fitting and adjusting machine components and attachments

2.2.1 Butter Churner

a. Electrical butter churner machine

Machine used to get butter by churning fermented milk or cream to separate the butterfat from the buttermilk. The agitation of the cream or fermented whole milk caused by the mechanical motion of the device disrupts the milk fat. The membranes that surround the fats are broken down, latterly forming clumps known as butter grains.

The butter grains, during the process of churning, fuse with each other and form larger fat globules, called butter. For proper function of churner machine fitting and adjusting machine components and attachments mandatory.

The butter churner machine has the following components:

Churner body cover: the cover of the butter churner is sheet of stainless steel that folds to fit the body with negligible loss of milk during churning and it has handle to open and close.

Churner body: the body of the butter churner is the part, which takes or carries the fresh or fermented cream.

Adjusting Churning temperature gauge: the temperature of the cream during churning has great importance.

- If too cool, butter formation delayed and the grain is small and difficult to handle.
- If the temperature is too high, the butter yield will be low because a large proportion of the fat will remain in the buttermilk, and the butter will be spongy and of poor quality.
- Cream should churn adjusting the machine temperature gauge.
  - ✓ At 10--12°C in the hot season and
  - ✓ At 14--17°C in the cold season.
- The temperature rose by standing the vessel containing the cream in hot water, and lowered by standing the vessel in cold spring water for a few hours before the cream churned.
- The churning temperature adjusted by the water used to dilute the cream.
- In the hot season, the coldest water available should be used, preferably water that has been stored in a refrigerator.

The amount of cream to churned

- The amount of cream to churn should not exceed one-half the volumetric capacity of the churn.
- An airtight churn should ventilate frequently during the first 10 minutes of churning to release gases driven out of solution by the agitation.
- If butter is slow in forming, adding a little water which is warmer than the churning temperature, but never over 25°C, usually causes it to form more quickly.

- When the butter appears like wet maize meal, water (1 liter per 4 liters of cream) at 2°C below the churning temperature should added.
- It may be necessary to add water a second time to maintain butter grains of the required size.
- Churning should cease when the butter grains are the size of small wheat grains.

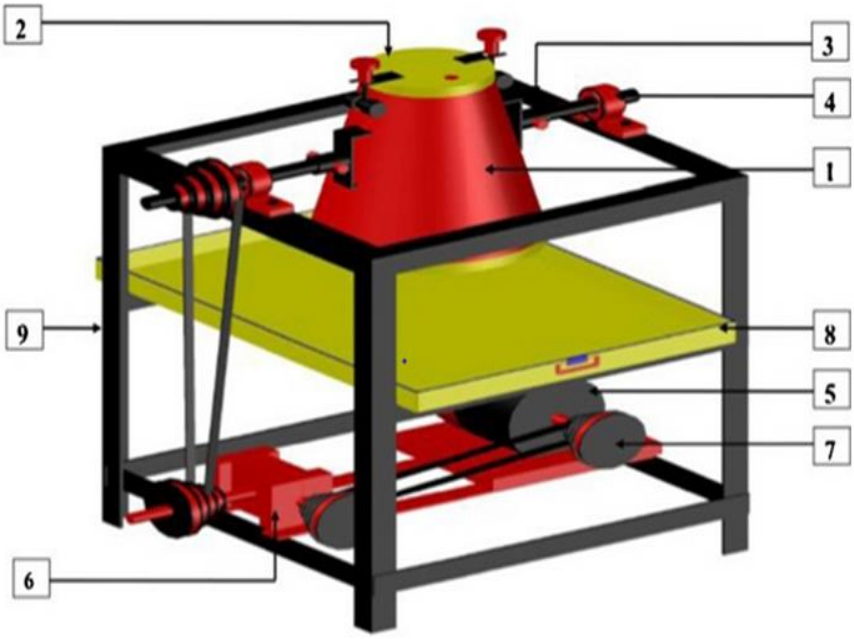


Figure13: Churner

1. Butter Churner body	4. Bearing	7. Step-down Pulley
2. Head and Closure	5. Motor	8. Tray
3. Shaft	6. Gear box	9. Stand

b. Manual butter churner

Butter Churner is a machine used to get Butter by churning fresh or fermented cream to separate the butterfat from the buttermilk. The agitation of the cream, caused by the mechanical motion of the device, disrupts the milk fat. The membranes that surround the fats are broken down, subsequently forming clumps known as butter grains. These butter grains, during the process of churning, fuse with each other and form larger fat globules.

The machine has four main sub parts or components. These are:

1. Cover
2. Body
3. Agitator
4. Frame

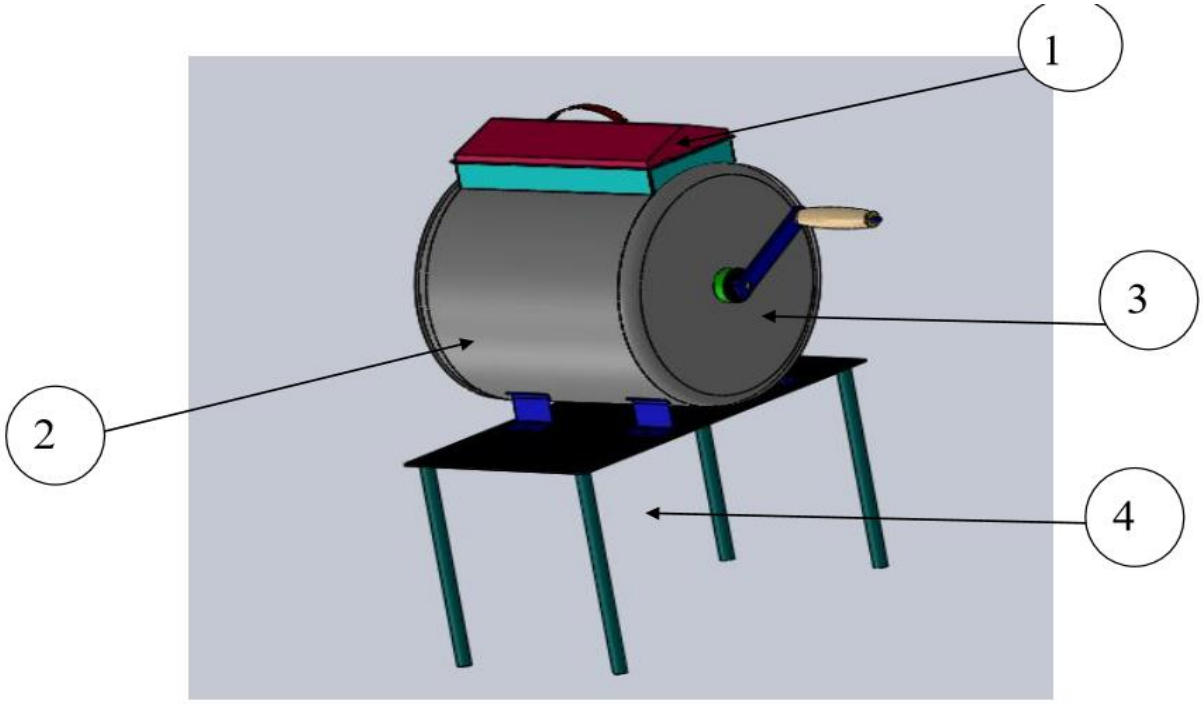


Figure 14: Manual butter churner machine

2.2.2 Fitting and adjusting Cream separator

Cream separator can be adjust

- Put the bowl cover pin assembly back to gather.
- Sure the bowl fit base notch.
- Tighten the bowl nut well.
- Place the milk contact parts over the spindle.
- Starting with milk spout. Next place the bowl assembly making sure it seats properly on the tapered head of the spindle shaft.

- Put the cream spout on the next place the float chamber.
- Next to float chamber put the milk tank “ON” the float chamber.
- Make sure the milk tank is placed with on label at the front.
- Tighten the tank tap handle put the tap in “OFF” position.
- Your separator is now ready for use.

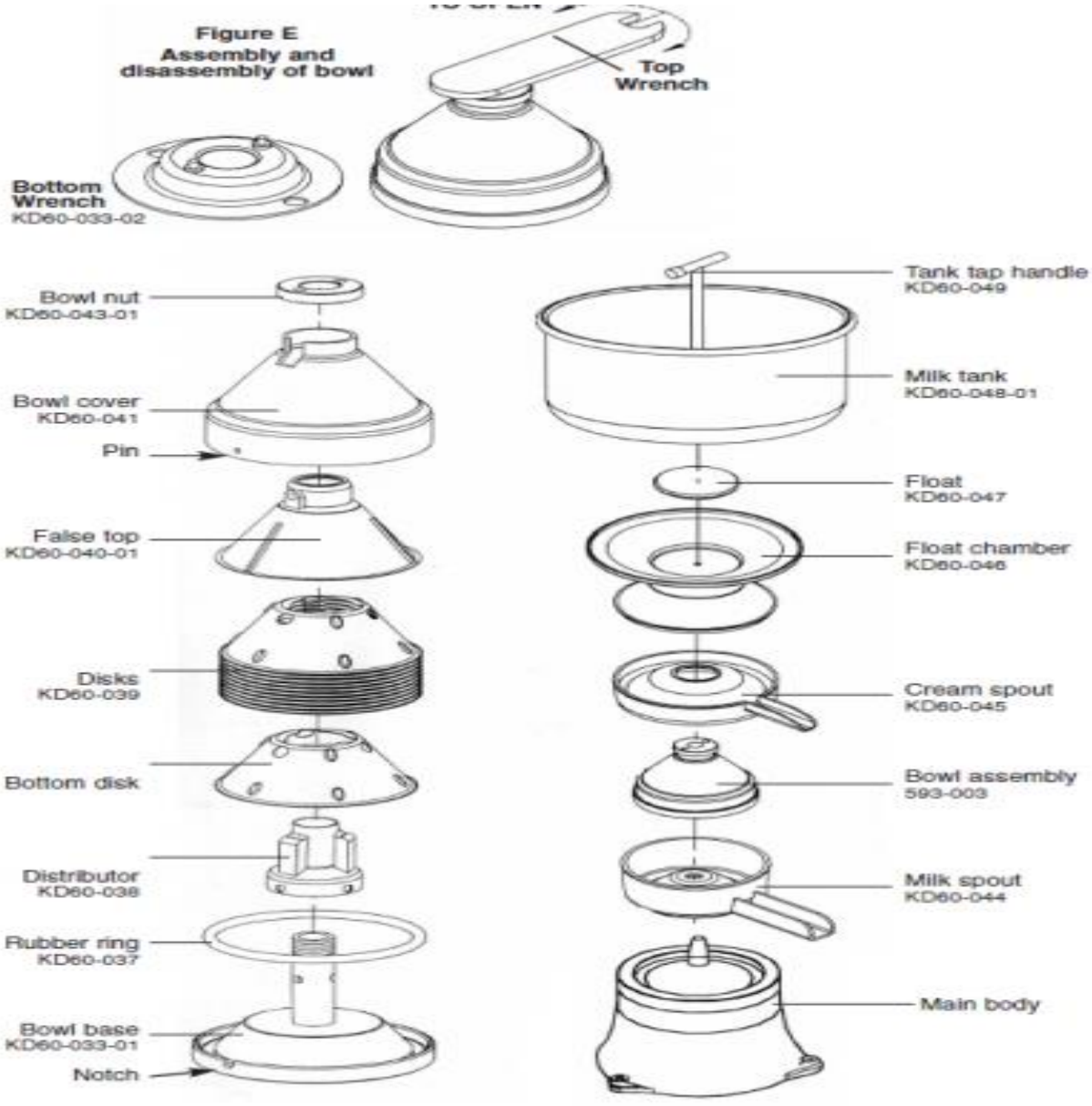


Figure 15 Electric cream separator machine spare part

Figure 16. Electric cream separator machine

2.2.3 Components of a custom filling machine

Every liquid filling project include unique characteristics and features, which in turn will require packaging machinery to handle these characteristics and features.

c. Frame

The frame used to manufacture a filling machine change with the needs of the packaging process. A somewhat standard, portable frame will be used for most automatic machines. However, even these standard frames may be modified in certain circumstances. For instance, large bottles may require a width extension in order to support the manifold of the machine and get product to multiple bottles during each fill cycle.

While portable frames can be rolled up to an existing conveyor line and put into production, other frames can be used to create stand-alone filling stations, using a slide track rather than a power conveyor and requiring the operator to place and remove bottles.

d. Tanks

Different filling machines will use different tanks, sometimes at different locations. For example, overflow filler will use a re-supply or recirculation tank. This tank will be used for product returning from the overflow nozzles. Gravity filling machines will use a product supply tank that will rest over the top of the nozzles while other filling machines may or may not use tanks for product supply.

The tank size, location and material will depend on a number of different factors, including the fill principle, the product, the production demands, etc.

e. Product pathway and Nozzles/ Spouts

Product needs to get from the holding tank or supply tank to the waiting bottles and containers. The product pathway is the plumbing, tubes and nozzles that are used to achieve this goal. The actual physical path taken may differ from machine to machine based on the type of fill and tank location.

At the end of that product pathway is a nozzle that allows product to be efficiently dispersed into the bottle or container. Nozzles are another item that will often be custom fit to the project at hand. Nozzle sizes may change based on the size of the containers or container opening and types may change based on the filling principle.

These are a few of the common areas where customization may take place on a filling machine. Different pumps and motors may be required for certain projects. Product pathways may need to be heated for molten materials. Agitators may also be required to keep product viscosity consistent. While filling a bottle with product may seem like an easy process or concept, there are many factors to take into account to keep the fill efficient, reliable, consistent and cost-effective.

2.3 Equipment adjustment tools

Technicians conduct maintenance or adjustment activity should analyze which tools and equipment requires for the right maintenance and adjustment activity. Inappropriate selection of tools and equipment will be as a source of workplace hazards. There should be safe and correct use of specific hand tools to adjust equipment. A hand tool used for equipment adjustment includes:

a. Screw drivers

It used to tighten or loosen screws of different sizes. Flat ended screwdrivers are used to tighten or loosen flat head screws, whilst Philips screwdrivers (“star”) are used for star head screws. Some screwdrivers are magnetic and will hold the screw to the tip of the screwdriver.

Figure 17: Screw drivers

b. Spanners sizes 6-24

Various bolts can be fastened or loosened using the spanner of the correct size.

Figure 18: Spanners sizes 6-24

c. Pipe wrench

Used to tighten and loosen pipe couplings. It is also used to grip round edges to enable other turning/loosening/tightening actions.

Figure 19: Pipe wrench

d. Shifting spanner

It has a similar function to regular spanners but provides option of using only on bolts of varying sizes. This means you do not have to transport a range of sizes.

Figure 20: Shifting spanner

e. Wire cutters

Cutting wire and stripping outer coatings off electrical cable.

Figure 21: Wire cutters

f. Pliers

Selected pliers are equipped with wire stripping edges and can strip the outer insulating layer off electrical cord. Pliers are used for various purposes, including:

- Tightening wire.
- Fixing wire.
- Gripping bolts to tighten with a spanner.

Figure 22: Pliers

All tools can be handled correctly which enhances the functionality and safety of tools. Incorrect use impairs functionality, is detrimental to the tool and may be dangerous to the user and or other people.

Self-Check _ 2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I. Choose the best answer (6 point)

5. Which one of the following machine is used to separate cream and skim milk separately?

   A. Homogenizer B. Cream separator C. Churner D. Pasteurizer

6. _____ Machine used to separate fermented milk or cream to form butterfat and buttermilk.

   A. Milk tank B. Pasteurizer C. Evaporator D) Churner

7. Which part of the churner carries the fresh or fermented cream?

A. Churner body covers B. Churner temperatures gauge C. Churner body D. None

Part II. Short Answer Questions (9 point)

8. Write down different types of valves and discuss them. **(4 point)**
9. Write down at least five hand tools used to adjust machines. (5 points)

Note: **Satisfactory rating - 15 points** **Unsatisfactory - below 15 points**

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

Score = _____

Rating: _____

Information Sheet 3- Making available tools and equipment for line setup

3.1 Dairy product processing Equipment

All dairy equipment should be designed and constructed so that it can be easily dismantled for cleaning e.g. there should be no blank ends to pipework that would harbor stagnant milk. Mixing bowls, boiling pans etc. should have a smooth internal surface without corners, and all welds should be ground to a smooth finish.

Ideally, all dairy equipment should be made from stainless steel, but alternatives include polished aluminium, or food grade plastic for containers and equipment that are not heated. Mild steel cannot be used because it will rust and contaminate products, and brass, iron or copper cannot be used because they promote rancidity in milk fats.

The layout of equipment within the room should allow food to move between different stages in a process without the paths crossing. This reduces the risk of contaminating finished products with raw milk. There should also be sufficient room behind equipment for cleaning.

3.1.1 Homogenizer

A homogenizer is a machine that takes a substance and makes it a uniform consistency and helps reduce separation. It reduces the big fat globules into smaller one. Provides uniform consistency and give a smooth, rich flavor.

Homogenizer mainly works by agitating the liquid that is to be homogenized. It is secure and gets higher power and set up with one or two position homogenizers top and driven electrically.

Figure 23: Homogenizer

3.1.2 Pasteurizers

A pasteurizer is a device which pasteurizes, treating a food product to kill disease-causing organisms such as bacteria. Milk is one of the most widely pasteurized foods, but pasteurizers can also be used with a variety of other liquids, and some other foods can be pasteurized as well.

Pasteurization is used to make food safer, so that it can be sold commercially without concerns that people will get sick when they consume it. The milk pasteurizer is useful for pasteurization that is essential to increase milk safety by process of heat treatment.

Methods of Pasteurization

a. Batch pasteurization

Batch or vat pasteurization is the simplest and oldest method for pasteurizing milk. Milk is heated to 63^0C in a large container and held at that temperature for 30 minutes. This process can be carried out at home on the stovetop using a large pot or, for small-scale dairies, with steam-heated kettles and fancy temperature control equipment.

b. High-temperature short-time pasteurization

The milk is heated to a temperature of 72^0C and held for 15 seconds and then cooled rapidly. The heat treatment is accomplished using a plate heat exchanger. It is the most common method these days, especially for higher volume processing. This is faster and more energy efficient than batch pasteurization.

Figure 24: Milk pasteurizer in Holland Dairy processingplant at Debrezeit town

3.1.3 Evaporators

An evaporator is a device used to turn the liquid form of a chemical into its gaseous form. The liquid is evaporated, or vaporized, into a gas, or evaporation is an important unit operation commonly employed to remove water from dilute liquid foods to obtain concentrated liquid products.

Removal of water from foods provides microbiological stability and assists in reducing transportation and storage cost.

The basic factors that affect the rate of evaporation are:

- The rate at which heat can be transferred to the liquid,
- The quantity of heat required to evaporate each kg of water,
- The maximum allowable temperature of the liquid,
- The pressure at which the evaporation takes place,
- The changes that occur in the food during the course of the evaporation process.

Methods of Operation of Evaporators

- Single-effect evaporators
- Multiple effect evaporators
- Forward-feed multiple-effect evaporators
- Backward-feed multiple-effect evaporators
- Parallel-feed multiple-effect evaporators

Uses of evaporators

An evaporator is used in an air-conditioning system to allow a compressed cooling chemical. It can also be used to remove water or other liquids from mixtures. The process of evaporation is widely used to concentrate foods and chemicals as well as salvage solvents. In the concentration process, the goal of evaporation is to vaporize most of the water from a solution which contains the desired product.

3.1.4 Dryers

The term drying refers generally to the removal of moisture from a substance. It is one of the oldest, most commonly used and most energy consuming unit operation in the process industries.

There are different types of dryers:

a. Spray drying

It is a method of producing a dry powder from a liquid or slurry by rapidly drying with a hot gas.

b. Drum drying

It is a method used for drying out liquids from raw materials with drying drum. In the drum- drying process, pureed raw ingredients are dried at relatively low temperatures over rotating, high-capacity drums that produce sheets of drum-dried product.

c. Freezers

Those equipment which help in the freezing process so as to maintain the shelf life of a product and prevents the growth of microorganisms. Slow down the self-decomposition of food products and enzymatic activity of product and chemical changes within the product.

3.1.5 Milk tanks

Tanks are useful for receive and store raw milk that keeps the reliability and deficiency of milk. Tanks are made from stainless steel that are designed and make with high quality and excellence.

The new and automated milk receiving equipment ensures to keep all beneficial aspects of milk. It contains filter and determine volume and cools down milk quick to 4 ºC.

Figure 25: Milk cans

3.1.6 Milk separators

Milk separators contain higher capacity and effectiveness that works automatically. It gives superior separation of milk compound and excellent technological, constructional and efficient figures.

Figure 26: Milk separator

3.1.7 Automatic filling machines

Automatic filling machines are useful for milk and some other liquid dairy products. They produce different types of cups, plastic bags and box-filling machines for the customers according to their demand.

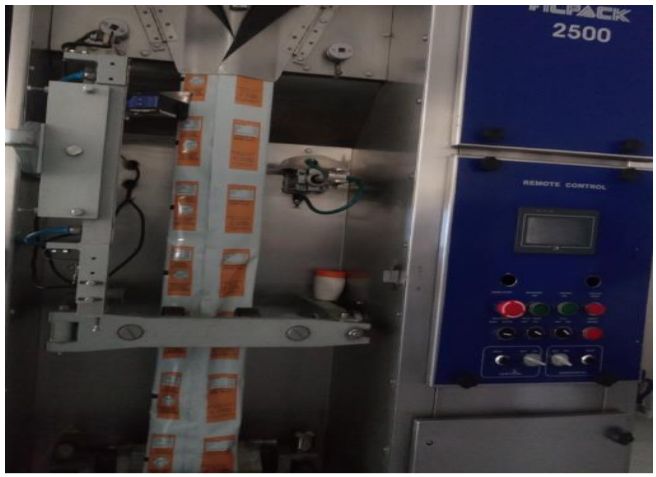


Figure 27: Automatic filling &Sealing machine in Holland Dairy processing plant at Debrezeit town

3.1.8 Bulk milk collection tanker

When milk is collected by the tanker, it must be possible to drive all the way to the farm milk room. The loading hose from the tanker is connected to the outlet valve on the farm cooling tank. The tanker is usually fitted with a flow meter and pump so that the volume is automatically recorded. Otherwise, the volume is measured by recording the level difference which, for the size of the tank in question, represents a certain volume. In many cases, the tanker is equipped with an air-eliminator.

Pumping is stopped as soon as the cooling tank has been emptied. This prevents air from being mixed into the milk. The tank of the bulk collection vehicle is divided into a number of compartments to prevent the milk from sloshing around during transportation. Each compartment is filled in turn, and when the tanker has completed its scheduled round, it delivers the milk to the dairy.

Figure 28: Bulk collection at the farm

3.1.9 Agitation in silo tanks

These large tanks must have some form of agitation arrangement to prevent cream separation by gravity. The agitation must be very smooth. Extreme agitation causes aeration of the milk and fat globule disintegration. This exposes the fat to attack from the lipase enzymes in the milk. Gentle agitation is therefore a basic rule in the treatment of milk. The tank has a propeller agitator, often used with good results in silo tanks. In very high tanks it may be necessary to fit two agitators at different levels to obtain the required effect.

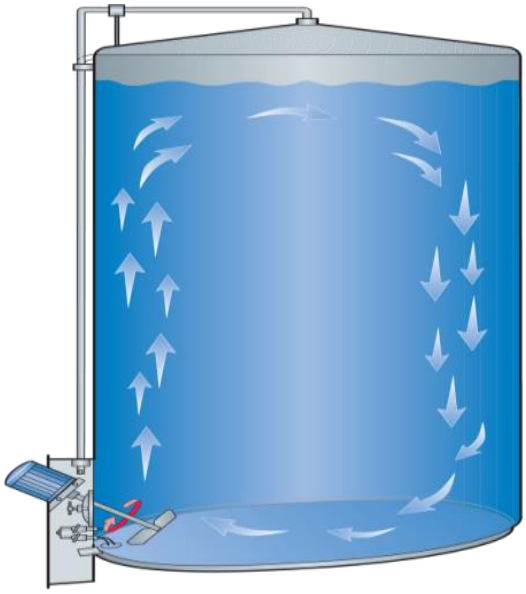


Figure 29: Silo tank with propeller agitator.

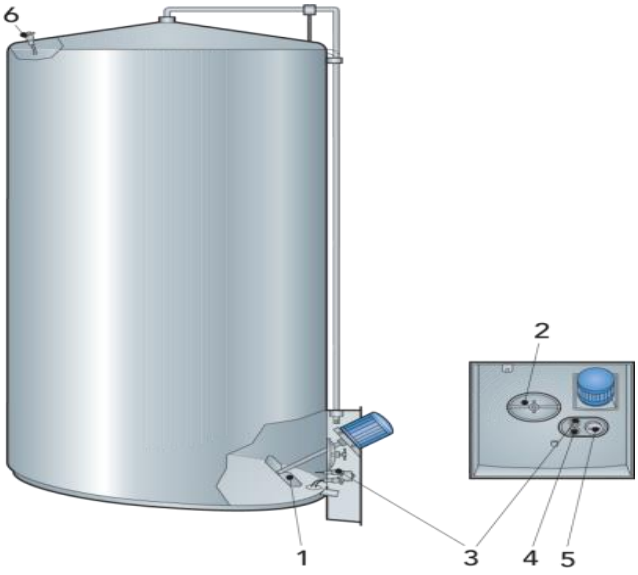


Figure 30: Silo tank with alcove for manhole, indicators

1. Agitator
2. Manhole
3. Temperature indicator
4. Low-level electrode
5. Pneumatic level indicator
6. High-level electrode

Self-Check – 3	Written test

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

Part I. Choose the correct answer (4 points)

1. ---------- is a machine that takes a substance and makes it a uniform consistency and helps reduce separation.
   A. Pasteurizer B. Cream Separator C. Homogenizer D. Evaporator
2. ---------- is a device which treating a food product to kill disease-causing organisms such as bacteria.
   A. Pasteurizer B. Cream Separator C. Homogenizer D. Evaporator

Part II. Short Answer Questions (11 points)

3. List at least four machines used in dairy processing line setup. (4 points)
4. Write down the basic factors that affect the rate of evaporation. (4 points)
5. What is dairy processing plant? (3 points)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

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

Score = _____

Rating: _____

Information Sheet 4- Identifying processing parameters and settings

4.1 Selecting transfer equipment settings and operating parameters

There are many milk transferring equipment setting and operating parameter system in modern dairy production and product processing. Some of them are:

A. The pipe system

The product flows between the components of the plant in the pipe system. Dairy production also has pipe systems for other media such as water, steam, cleaning solutions, coolant and compressed air.

Wastewater disposing system to drain the production area is necessary. All these systems built up in the same way. The difference in the materials used, design of the components and the sizes of the pipes. All components of pipe, which contact with the milk product, are made of Stainless steel but various materials used in the other systems made up:

- Cast iron, steel, copper and aluminums
- Plastic used for water and airlines
- Ceramic for drainage and sewage pipes.

The following types of fittings are included in the product pipe system:

- Straight pipes, bends, tees, reducers and unions
- Special fittings such as sight glasses, instrument bends, etc.
- Valves for stopping and directing the flow
- Valves for pressure and flow control
- Pipe supports

For hygiene reasons in dairy product pipeline are;

- All product-wetted parts of dairy equipment are made of stainless steel.
- Two main grades are used, AISI 304 and AISI 316
- The latter grade is often called acid-proof steel.

B. Connectors

Permanent joints welded, where disconnection required the pipe connection in the form of a threaded union with a male end and a retained nut with a joint ring in between, or a clamped union with a joint ring. The union permits disconnection without disturbing other pipe work. This type of joint used to connect;

- Process equipment
- Instruments that need to be removed for cleaning, repair or replacement.

Bends tees and similar fittings are available for welding, and with welded unions. In the latter case, the fitting ordered with nut or male ends or with clamp fittings. All unions must tighten firmly to prevent liquid from leaking out or air from sucked into the system and causing problems in downstream parts of the process.

Figure 31: Different type of Connectors in Holland Dairy processing in Debrezeit town

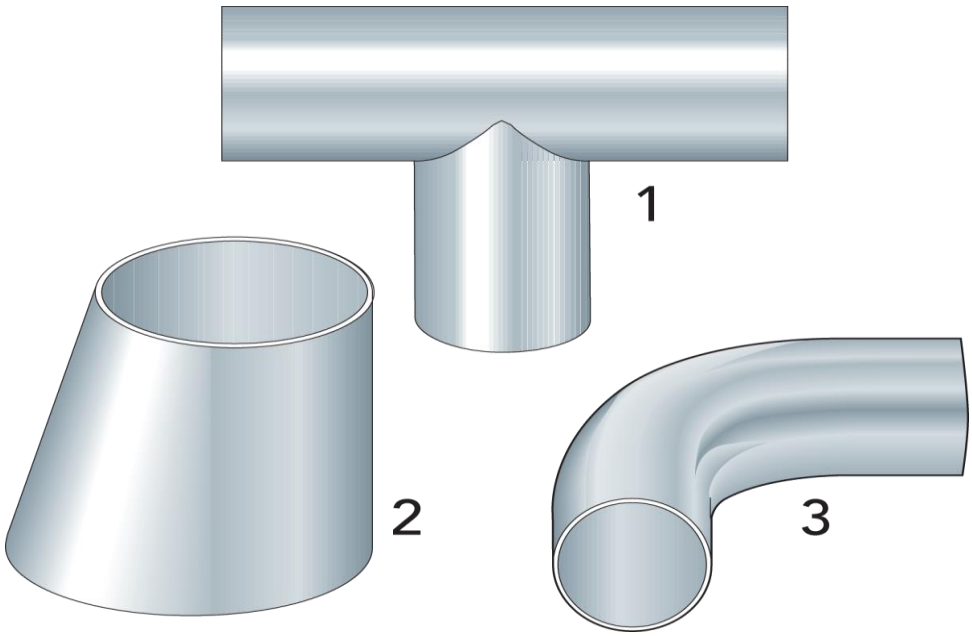


Figure 32: Some examples of fittings for permanent welding.

1. Tees
2. Reducers
3. Bends

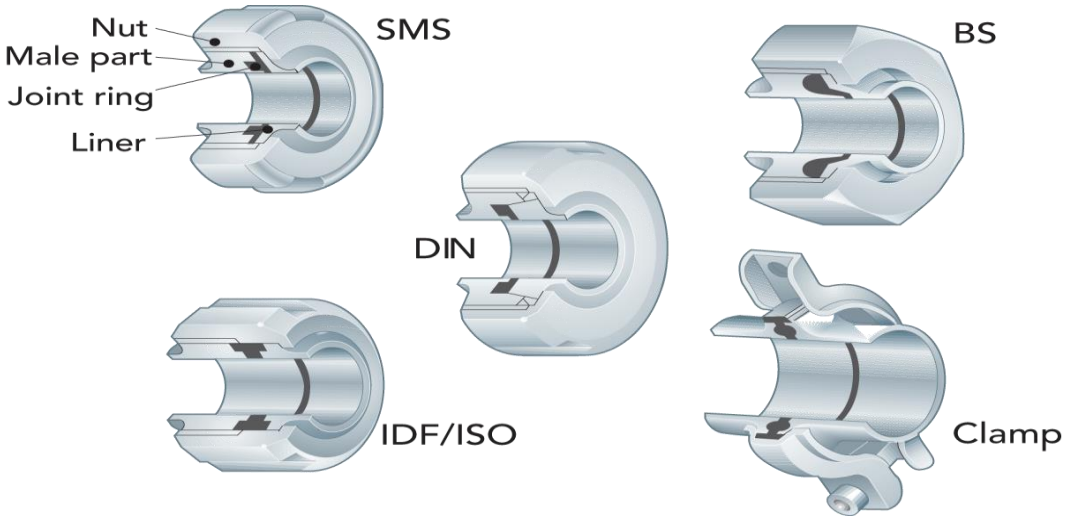


Figure 33: Dairy unions of different standards

C. Special pipefittings

Sight glasses fitted in the line where a visual check of the product required. Bends with instrument connections used for fitting instruments like;

- Thermometers
- Gauges. The sensor should directed against the flow to make accurate readings.
- The connection boss used for a sampling cock.
- Instrument connections provided with welding special bosses directly onto the pipe during installation.

D. Sampling devices

Sampling devices need to install at strategic points in the plant to collect:

- Product samples for analysis.
- Quality control such as determining fat content of milk, the pH value of products.
- The samples can collected from a sampling cock
- For hygienic quality tests, the sampling method must prevent any risk of contamination from outside the pipe.

The aseptic sampling valve consists of three parts;

- Valve body
- Valve head
- Membrane. The rubber membrane placed on the stem of the valve head and works as a stretchable plug.

The aseptic sampling valve designed for sterilization before and after each sampling. The manual valve opened by rotating a handle or by activating a lever. The stem and the membrane then retracted, allowing liquid to pass. Using the reverse procedure the built-in spring closes the valve and keeps the channel between the hose pieces open for sterilization. Samples of aseptic products heat treated at high temperature that they are sterile always collected through an aseptic sampling valve to avoid reinfection.

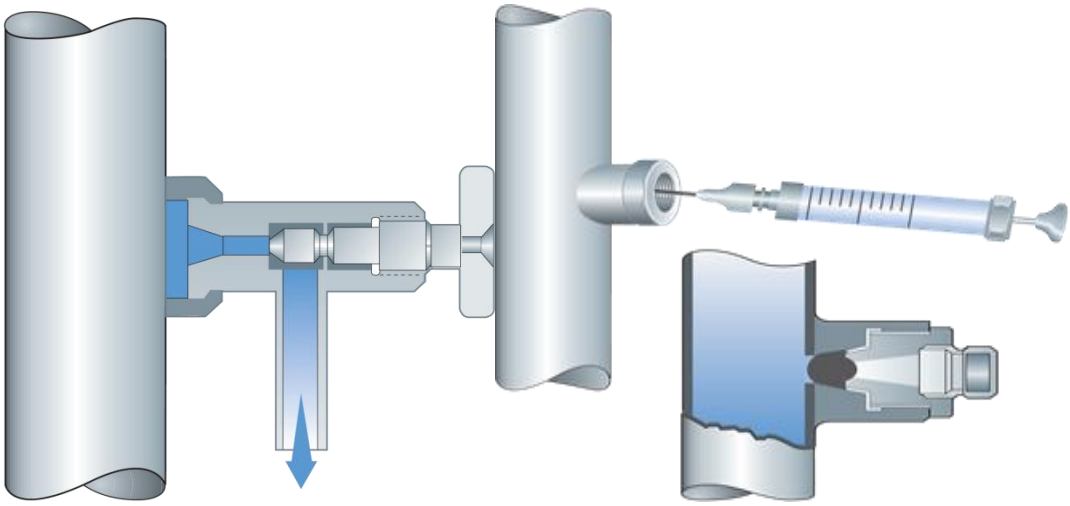


Figure 34: Sampling cock

Figure 35: Sampling cock for bacteriological analysis

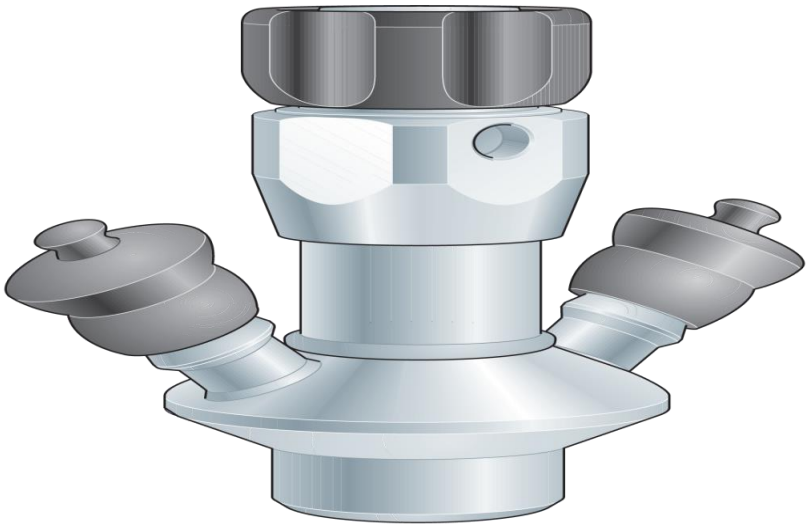


Figure 36: Plug for aseptic sampling

E. Control panels

Control panels are buttons which are used for;

- Time adjustment,
- Power adjustment,
- Temperature adjustment, etc.

Figure 37: Different Control panels in Holland Dairy processing in Debrezeit town

4.2 Equipment operating parameters

During operating dairy processing equipment and machines, there should be appropriate operating parameter for each machines and equipment based on standard and nature of product to be produced, such as;

- Time adjustment for pasteurizers, refrigerators, homogenizers, etc.
- Temperature control for pasteurizers, refrigerators, homogenizers, etc.
- pH correction for thermometer
- Adjustment of curd cutter during cheese preparation.
- Perform regular inspection on control panels, etc.

Self-Check _4	Written Test

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

Part I. Choose the correct answer (4 points)

1. Which one of the following is Control panels function?

A. Time adjustment B. Power adjustment C. Temperature adjustment D. All

2. During operating dairy processing machines, which operating parameter for each machine should be controlled?

A. Time adjustment C. pH correction for thermometer

B. Temperature control D. All

Part II. Short Answer Questions (11 points)

3. List down types of product pipefitting system! (4 points)
4. List down the hygiene reasons dairy product pipeline (4 points)
5. List down the three parts of aseptic sampling valve! (3 points)

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 15 points**

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

Score = _____

Rating: _____

Operation Sheet 1- Fitting, adjusting and operating manual churner machine

Objectives:

- To fit manual churner.
- To adjust manual churner.
- To operate manual churner.
- To manufacture butter by using manual. Churner.

Materials, tools and equipment required to fitting, adjusting and operating manual churner;

- Personal protective equipment
- Screw Drivers
- Bowel
- Spanners
- Hammer

Fitting, adjusting and operating manual churner Procedures;

Following the steps outlined below help to ensure successful Fitting, adjusting and operating manual butter churner machine.

Step 1: Wear appropriate personal protective equipment.

Step 2: Prepare hand tools.

Step 3: Differentiate different parts of churner.

Step 4: Inspect the machine sensitive parts like bolts, drain cap tightness and pins.

Step 5: Adjust or assemble and fit parts of the churner.

Step 6: Load a milk on the cover part.

Step 7. Crank the agitator manually by handle crank.

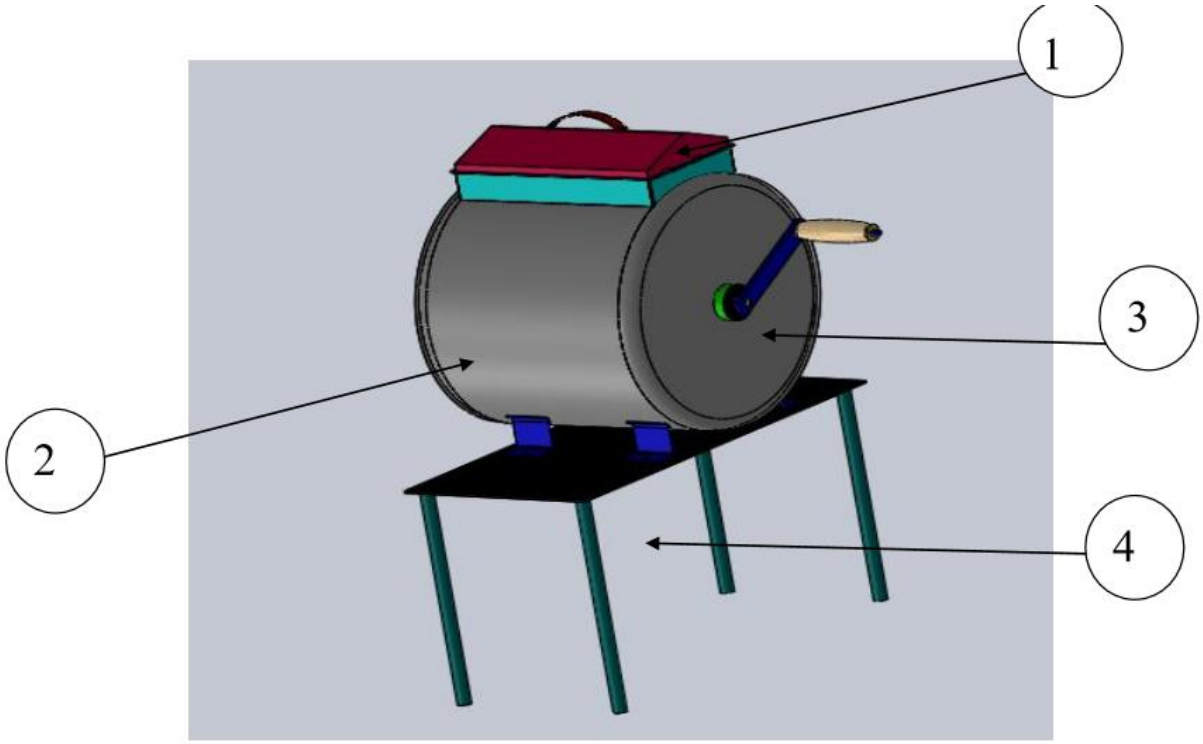


Figure 38: Manual butter churner

LAP Test	Performance Test

Name……ID……..Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **3:00** hour. The project is expected from each student to do it.

Task 1. Fitting, adjusting and operating manual churner machine.

LG #22	LO #2- Set up the Line for Operation

Instruction sheet

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

- Identifying and confirming cleaning and maintenance requirements and status
- Inspecting equipment
- Adjusting machine settings
- Entering processing or packaging parameters
- Checking and adjusting equipment performance
- Carrying out pre-start checks
- Completing line setup
- Reporting maintenance requirement
- Conducting work based on environmental guidelines
- Notifying relevant personnel

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

- Identify and confirm cleaning and maintenance requirements and status
- Inspect equipment
- Adjust machine settings
- Enter processing or packaging parameters
- Check and adjust equipment performance
- Carry out pre-start checks
- Complete line setup
- Report maintenance requirement
- Conduct work based on environmental guidelines
- Notify relevant personnel

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key answers to correct your work.
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the LAP Test” which is placed following “Operation sheets”.
8. If your performance is satisfactory proceed to the next learning guide.
9. If your performance is unsatisfactory, go back to “Operation sheets”.

Information Sheet 1- Identifying and confirming cleaning and maintenance requirements and status

1.1 Cleaning Objectives

Cleaning is the complete removal of dirt particles from the surface of machines, tools and equipment using appropriate detergent chemicals under recommended conditions. Talking about cleaning results, the following terms are used to define the degree of cleanliness:

- Physical cleanliness- removal of all visible dirt from the surface.
- Chemical cleanliness- removes all visible dirt and also microscopic residues that can be detected by taste or smell but are not visible to the naked eye.
- Bacteriological cleanliness- attained by disinfection.
- Sterile cleanliness- destruction of all microorganisms.

1.2 Aspects of Cleaning

The arrangements for cleaning equipment that comes in contact with products are an essential part of a food processing plant. It must be kept in mind that food manufacturers are always appreciative to maintain high hygienic standards; this applies both to the equipment and, naturally, to the staff involved in production. This obligation can be considered under three headings;

a. Trade obligations aspect

Good, wholesome, clean products that keep well and are free from health hazards are obviously good for trade; customers will buy the same product again. However, if a product is contaminated, does not keep well or is the subject of complaints to the authorities, the reverse is true, and the resulting publicity is very damaging. The potential effects of poor cleaning, poor standards and poor quality must be kept in mind at all times.

b. Moral obligation aspect

Most of the customers who consume the products never see the factory or how the products are handled. They trust the company, rely on its reputation, and take it for granted that operations are carried out under the cleanest of conditions by well-trained staffs that are constantly aware and conscious of these factors.

c. Legal obligation

The law attempts to protect the customer and purchaser in respect of health and quality. Failure to meet legal obligations, national or local, can result in very severe action, and prosecution proceedings can be very costly. Milk and milk products by their nature are ideal media for the growth of microorganisms, including many pathogens. There is more legislation concerning milk its production, handling, processing, packaging, storage and distribution than any other food product.

1.3 Cleaning Methods

There are various methods which can be used to apply detergents and disinfectants for cleaning and sanitizing dairy equipment and machines.

a. Manual cleaning

Cleaning of dairy equipment was previously done and still is in some places by people armed with brushes and detergent solutions, who had to dismantle equipment and enter tanks to get to the surfaces. This was not only laborious but also ineffective; products were often reinfected from imperfectly cleaned equipment.

Manual cleaning is practiced using cloths, mops, brushes, pads, etc. It is normally used in small areas, equipment that is non-water proof or requires dismantling or areas which are difficult to clean by other methods.

b. Spray cleaning

Spray cleaning uses a lance on a pressure washer with chemical induction by venture. This method can be wasteful of chemical and can be slow to produce foam. It should be used where foaming properties are not essential for the cleaning action.

c. Foam cleaning

This is the common method for cleaning most food operations. A foam blanket, created using a wide range of available equipment is projected from a nozzle and allowed time to act on the dirt particle.

It is then rinsed off with the released deposits. Large areas such as floors, walls, conveyors, tables and well-designed production equipment are ideal for foam cleaning. Foam is a carrier for the detergent. The foam should be applied in an even layer. Coverage rates are quick and chemical usage is economical.

Figure 39: Foam cleaning

d. Machine washing

This is normally an automatic or semi-automatic washing process conducted within a purpose built machine. There are many machine designs depending on the application. But failure to maintain them correctly can lead to a contamination risk to the product. Chemicals used in these machines should be low foaming. An effective system for controlling the dose of chemical should be employed and temperature control systems should be used where critical.

1.4 Cleaning Procedure

Cleaning is a complex process and it is conducted correctly a defined and systematic approach is required that takes into account a number of factors previously covered. This approach takes the form of a procedure and this is usually a legal requirement in addition to a fundamental requirement of global food standards. Thing to be clean from machines, equipment, pipe lines, and the working room includes;

Dirt: It consists of deposits stuck to a surface and its composition, in this particular case, is based on milk components that are utilized by bacteria hidden in the dirt.

Heated surfaces: When milk is heated above 60°C, milk fouling starts to form which is a deposit of calcium and magnesium phosphates, proteins, fat, etc. The result easily sees on heat exchanger plates after a long production run.

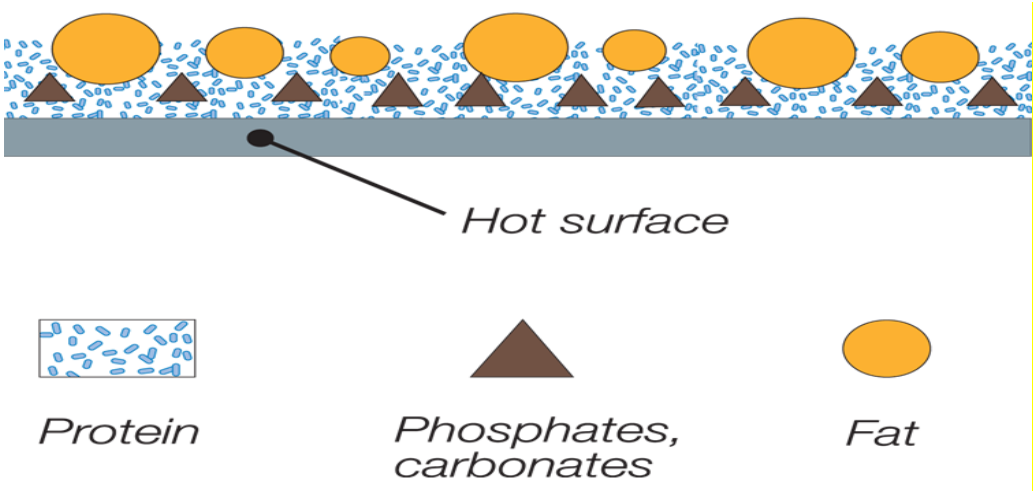


Figure 40: Deposits on a heated surface

Cold surfaces: a film of milk follows to the walls of pipelines, pumps, tanks, etc. (cold surfaces). When a system is emptied, cleaning should start as soon as possible, or otherwise this film will dry out and be harder to remove.

The cleaning cycle in a dairy processing comprises the following stagess:

i. Recovery of product residues

All product residues should be recovered from the production line at the end of the run by scraping, drainage and exclusion with water or compressed air.

Recovery of product residues is important for three reasons:

- Minimize product losses,
- Facilitate cleaning,
- Reduce the load on the sewage system, which often means a considerable saving in sewage treatment costs.Time must be allowed for the product to drain from tank walls and pipes. Before cleaning starts, the remaining milk is forced out of the production lines with water.

ii. Pre-rinsing with water to remove loose dirt

Pre-rinsing should always be carried out immediately after the production run. Otherwise, the milk residues will dry and stick to the surfaces, making them harder to clean. Milk fat residues are more easily flushed out if the pre-rinsing water is warm, but the temperature should not exceed 55°C, to avoid coagulation of proteins.

Pre-rinsing must continue until the water leaving the system is clear, as any loose dirt left will increase detergent consumption. If there are dried milk residues on the surfaces, it may be an advantage to soak the equipment. Soaking softens the dirt and makes cleaning more efficient. The mixture of water and milk from the initial pre-rinsing can be collected in a tank for special processing.

iii. Cleaning with Detergent (Detergent application)

The dirt on heated surfaces is normally washed off with alkaline and acid detergents, in that order or the reverse order, with intermediate water flushing, whereas cold surfaces are normally cleaned with alkalis and only occasionally with an acid solution. To obtain good contact between the alkaline detergent solutions typically caustic soda *(NaOH)* and the film of dirt, it may be necessary to add a wetting agent (surfactant), which lowers the surface tension of the liquid.

The detergent must also be capable of dispersing dirt and encapsulating the suspended particles to prevent flocculation. Polyphosphates are effective emulsifying and dispersing agents that also soften water.

The most commonly used are sodium triphosphate and complex phosphate compounds. There are number of variables must be carefully controlled to ensure satisfactory results with a given detergent solution. These are:

- Concentration of the detergent solution
- Temperature of the detergent solution
- Mechanical effect on the cleaned surfaces (velocity)
- Duration of cleaning (time)

iv. Rinsing with clean water (Post-rinsing)

After cleaning with detergent, the surfaces must be flushed with water long enough to remove all traces of the detergent. Any detergent left in the system after cleaning can contaminate the milk so, all parts of the system must be thoroughly drained after rinsing. The equipment and pipe systems are practically sterile after the treatment with strong alkaline and acid solutions at a high temperature. It is then necessary to prevent overnight growth of bacteria in the residual rinsing water in the system.

v. Disinfection by heating or with chemical agents (Disinfection)

Properly carried out cleaning with acid and alkaline detergents renders the equipment not only physically and chemically but also, to a large extent, bacteriologically clean.

Disinfection can be done in the morning, immediately before milk processing begins. If disinfection takes place at the end of the day, the disinfectant solution should be flushed out with water to avoid leaving any residues that may attack the metal surfaces. Dairy equipment can be disinfected in the following ways:

- Thermal disinfection (boiling water, hot water, steam)
- Chemical disinfection (chlorine, acids, hydrogen peroxide, etc.)

Generally, there two types of cleaning systems;

i. Cleaning-in-place systems (CIP)

Cleaning-in-place means that rinsing water and detergent solutions are circulated through tanks, pipes and process lines without the equipment having to be dismantled. The passage of the high-velocity flow of liquids over the equipment surfaces generates a mechanical washing effect that removes dirt deposits. This only applies to the flow in pipes, heat exchangers, pumps, valves, separators, etc. The normal technique for cleaning large tanks is to spray the detergent on the upper surfaces and then allow it to run down the walls.

The type of equipment that can be cleaned in the same circuit is determined according to the following factors:

- The product residue deposits must be of the same type, so that the same detergents and disinfectants can be used.
- The surfaces of the equipment to be cleaned must be of the same material or, at least of materials compatible with the same detergent and disinfectant.
- All components in the circuit must be available for cleaning at the same time.

For effective CIP, the equipment must be designed to fit into a cleaning circuit and must also be easy to clean. All surfaces must be accessible to the detergent solution. There must be no dead ends that the detergent cannot reach or through which it cannot flow. A CIP programme for a pasteurizer, hot components, circuit can consist of the following steps:

1. Rinsing with warm water for about 10 minutes
2. Circulation of an alkaline detergent solution 0.5 - 1.5 % for 30 minutes at 75 °C.
3. Rinsing out alkaline detergent with warm water for about five 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 eight minutes

A CIP programme for a circuit with pipes, tanks and other 'cold components' can comprise the following steps:

1. Rinsing with warm water for three minutes
2. Circulation of a 0.5-1.5 % alkaline detergent at 75 ^{0}C for about 10 minutes
3. Rinsing with warm water for about three minutes
4. Disinfection with hot water 90- 95 ^{0}C for five minutes
5. Gradual cooling with cold tap water for 10 minutes.

Design of CIP systems

The CIP station in a dairy consists of all necessary equipment for storage, monitoring and distribution of cleaning fluids to the various CIP circuits. There are two types of design for CIP circuits which are centralized and decentralized CIPs.

a. Centralized CIP:

It is used mainly in small dairy plants with relatively short communication lines.

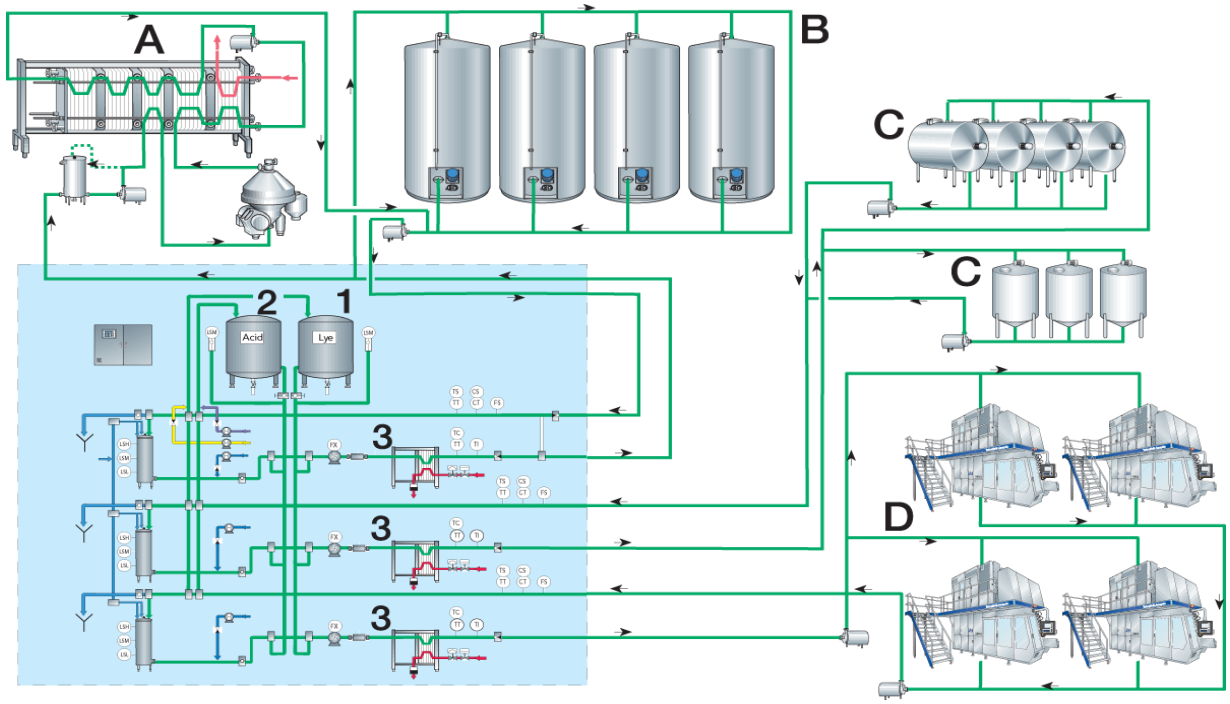


Figure 41: Principle of the centralized CIP system

Cleaning unit (within the broken line):

1. Tank for alkaline detergent
2. Tank for acid detergent
3. Plate heat exchanger

Object to be cleaned:

A - Milk treatment
B - Silo tanks
C - Tank gardens
D - Filling machines

Water and detergent solutions are pumped from storage tanks in the central station to various CIP circuits. The detergent solutions and hot water are kept hot in insulated tanks. The required temperatures are maintained by heat exchangers. A station of this type is usually highly automated. The tanks have electrodes for high and low level monitoring. Returning of the cleaning solutions is controlled by conductivity transmitters.

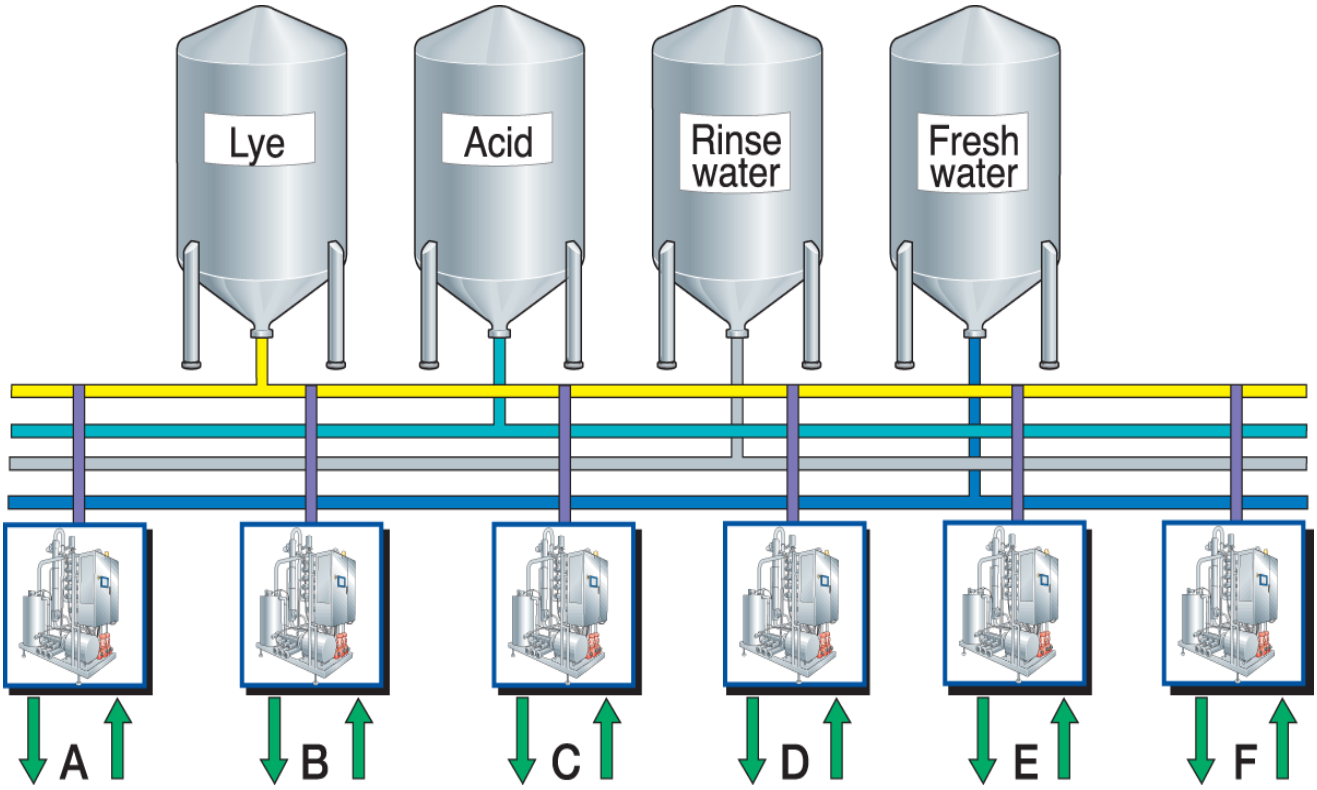


Figure 42: A common tank garden supply several CIP stations (A to F) different solutions

b. Decentralized CIP

It is an attractive alternative for large dairies, where the distance between a centrally located CIP station and peripheral CIP circuits would be extremely long. The large CIP station is replaced by a number of smaller units located close to the various groups of process equipment in the dairy.

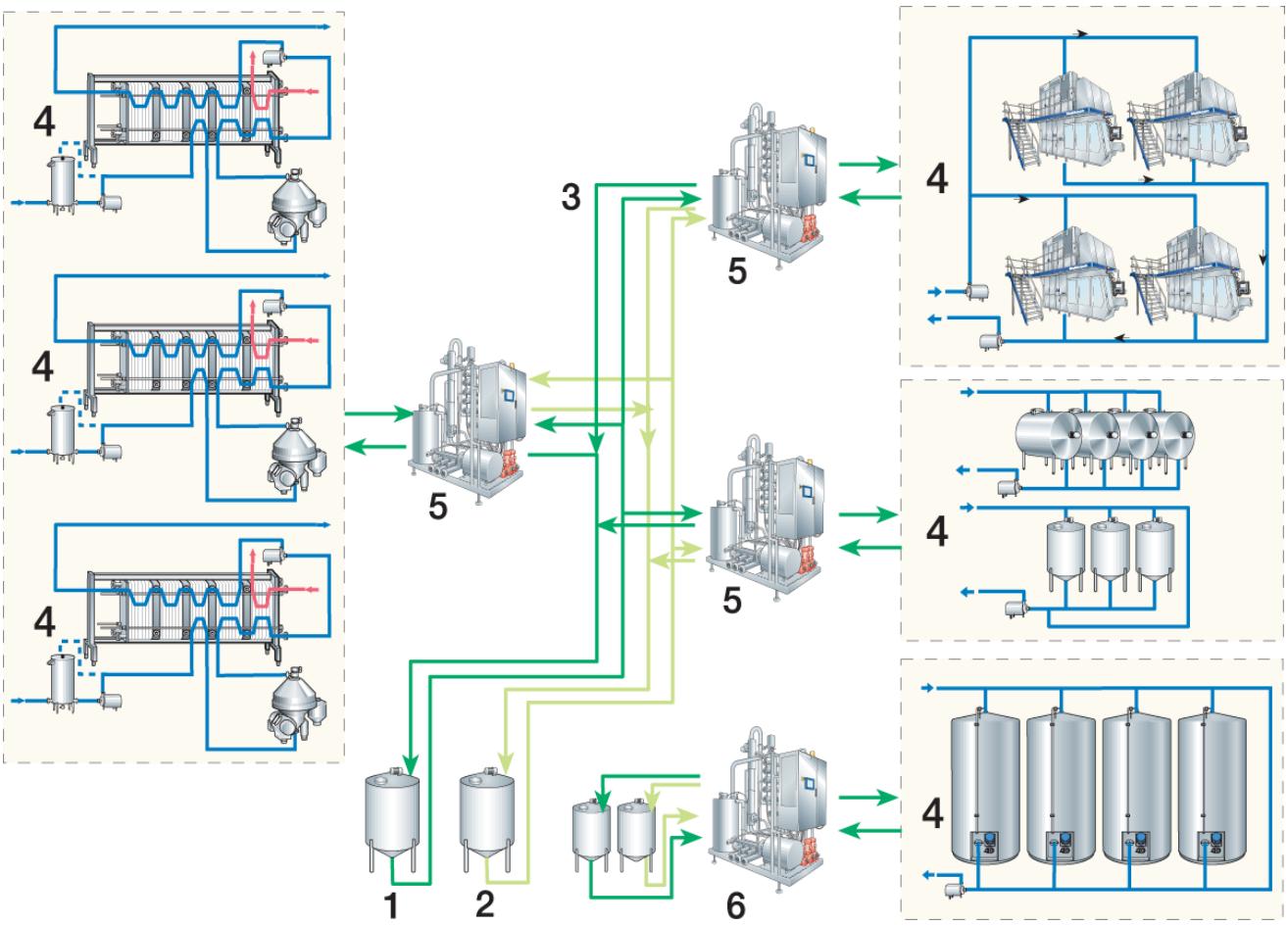


Figure 43: Decentralized CIP system

1. Storage tank for alkaline detergent
2. Storage tank for acid detergent
3. Ring lines for detergents
4. Objects to be cleaned
5. Decentralized CIP units
6. Decentralized CIP system with its own detergent tanks

This still has a central station for storage of the alkaline and acid detergents, which are individually distributed to the individual CIP units in main lines. Supply and heating of rinsing water and detergent when required are arranged locally at the satellite stations.

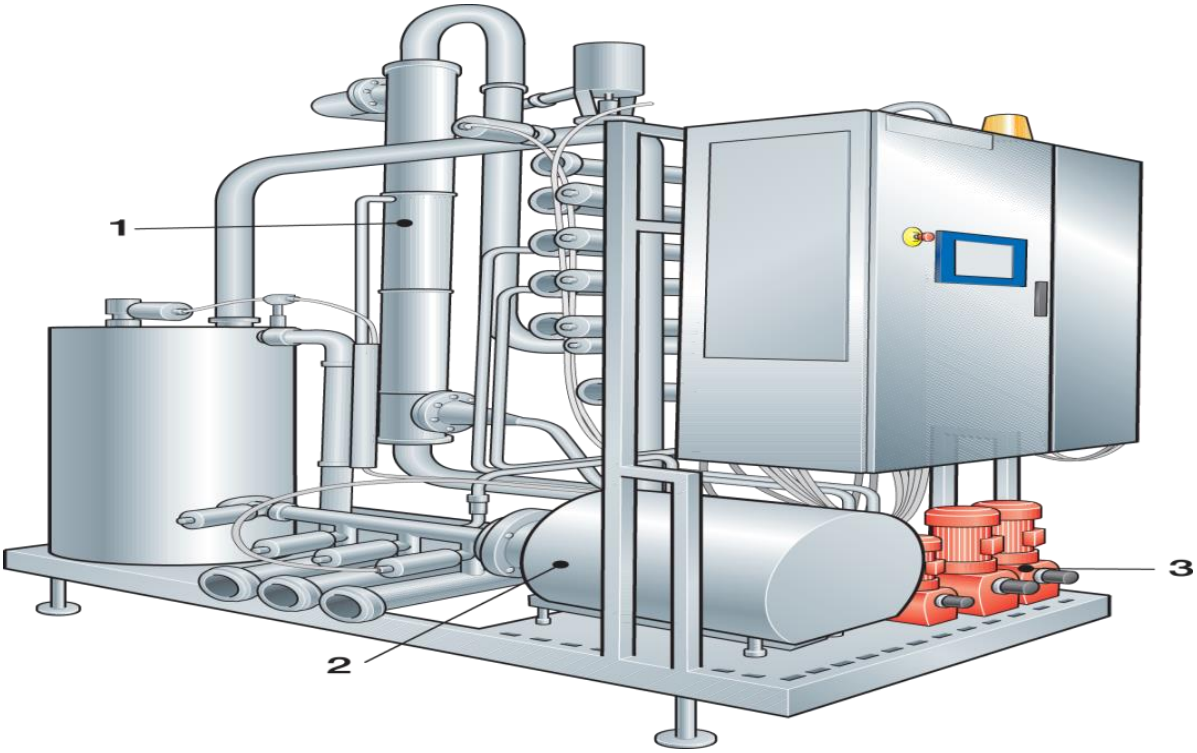


Figure 44: CIP Unit

1. Heat exchanger
2. Pressure pump
3. Dosing pumps

1.5 Dairy equipment Maintenance requirements

Maintenance is the upkeep of plant and machinery in proper working condition at all times. There are different types of equipment maintenance systems.

1.5.1 Preventive Maintenance

This is the persistent and systematic procedure for the care of all production, control and auxiliary machinery in a dairy factory including regular servicing, upkeep and overhaul, record keeping and stocking of essential spare parts for the purpose of preventing breakdowns and emergency shut downs for repair. Preventive maintenance must begin with the purchase of the right type of equipment for any specific job.

The machine must always do the job of its right capacity for high durability. Preventive maintenance is necessary because it will prevent loss of money and profits due to:

- Unnecessary machinery shut downs
- Shortened machine life
- Machine inefficiency and
- Reduced productivity

The main objective of preventive maintenance is to:

- Increase the efficiency and improve the performance of all service equipment.
- Increase the overall productivity of the entire plant by achieving coordinated and continuous operation of all plant equipment
- Increase the certainty of meeting daily production schedules
- Reduce unscheduled down time
- Extend the useful life of all plant equipment
- Minimize property and personnel hazards.

A good preventive maintenance programme must include the following ***elements***:

- Routine external inspection of all equipment
- Periodic internal inspection
- Systematic lubrication
- Prompt adjustment, repair or replacement of defective parts
- Record keeping system
- Periodic analysis of systems operating parameters
- Spare parts inventory and inventory control
- Scheduled major overhaul of machinery
- Economic basis for scrapping off of equipment
- Maintenance cast analysis and reporting to management
- Capable maintenance supervision

"Preventive Maintenance is a procedure utilizing programmed and coordinated lubrication, internal and external inspections, timely adjustments, repairs and replacements performed by skilled and trained personnel under qualified supervision, fair the purpose of preventing unscheduled down time, preserving equipment, maximizing overall plant performance, minimizing maintenance costs, and thereby contributing to an improved profit position".

1.5.2 Scheduled Maintenance

Replacement of parts at preset time or service intervals may be prescribed for certain parts. They must be replaced when due for replacement. It applies for gaskets, O-rings, oil and air filters.

1.5.3 Economical Maintenance

The secret of economical upkeep is to train operators to handle the equipment as if it were their own, and to keep a continuous inspection for the small things that go wrong. This should be supplemented by a periodic general inspection.

In small plants, it is advisable for each operator to take care of the equipment he/she runs, when minor repairs are needed since there is seldom an engineer around. In large plants, a trained engineer should usually be available for all required repairs.

Self-Check – 1	Written test

Name…… ID…… Date…….

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

Instruction: Short Answer Questions (20 points)

1. Define cleaning? (3 points)
2. Write down different Cleaning aspects. (3 points)
3. Write cleaning methods? (5 points)
4. Distinguish the difference between COP and CIP. (4 points)
5. Write the correct sequence of general cleaning procedures? (5 points)

Note: Satisfactory rating - 20 points **Unsatisfactory - below 20 points**

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

Score = _____

Rating: _____

Information Sheet 2- Inspecting equipment

2.1 Inspecting Dairy equipment

Dairy product safety and quality can benefit from the use of inspection/detection and check weighing equipment. Earlier articles in this series described some of the reasons why detecting foreign objects in dairy products is challenging, and examined the challenges specific to each type of dairy product.

Installing these inspection systems in multiple places on the processing and packaging line can positively impact the quality, accuracy and safety of the food item being marketed. The specific inspection solution is dependent on;

- The product characteristics,
- Placement in the line (before or after packaging), and
- Inspection/detection objectives.

2.2 Types of equipment inspection

Equipment inspection or detection for dairy equipment can be done on the following circumstances of the milk processing plant;

a. Incoming ingredients

Dairies that use bulk incoming ingredients such as raw milk, powders, fruits or nuts as part of their formulation may inspect products before incorporating them into the formulation. Drop through; pipeline and bulk flow metal detectors are ideal choices.

b. Liquid flow

Metal detectors work in pipeline applications for novelties and other liquid fill products.

c. After filling/packaging

The inspection equipment type will depend on the packaging type, product type, and its potential for product effect. Since many dairy products have high moisture content resulting in high conductivity, they are more suited for X-ray inspection at this stage.

Inspection at this location is typically the last hazard analysis and critical control point for foreign materials, since the product is now packaged. Check weathers are often placed here to ensure the product weight is within minimum/maximum specifications.

d. After case packing

In some cases final package (case) inspection can be beneficial and this is typically done via X-ray inspection when the machine's aperture is large enough to accommodate the case. X-ray systems can be used to confirm a specified count is loaded into the case and to detect large foreign materials that may have fallen into the case. In certain situations check weathers can also be used to find missing components and maintain final package weights.

2.3 Popular inspection and detection solutions

Metal detectors are ideally suited for dairy applications and typically can withstand the harsh wash down environments in dairy plants. Systems are available to meet HACCP and retailer food safety and quality requirements with limited false rejection rates and high efficiencies. Check weathers are flexible and able to handle cartons, cans, bottles or pouches of dairy products, and they work in both dry and wet environments.

A healthy product inspection program at the appropriate stages can help ensure a high level of consumer satisfaction. With such equipment in place, deviations in product quality and safety are identified and resolved before products find their way to market.

2.4 Importance of equipment inspections

The importance of an inspection is to identify whether work equipment can be operated, adjusted and maintained safely with any deterioration detected and resolved before it results in a health and safety risk. The need for inspection and inspection frequencies should be determined through risk assessment.

One of the most important inspections is to check the liners on the pulsate to make sure they are operating properly. If the liners fail, you can end up with faulty milking, which can quickly add up in a larger dairy and cause health problems for a dairy herd.

2.5 Inspection schedules

Dairy product processing or milk products manufacture requires machines and installations by the use of which the raw material is transformed into a product. Each and every piece of equipment of which the plant is assembled must perform its duty.

It is essential to determine what should be inspected, how often and how to leave out of the procedure any collection of information which does not serve the main purpose. On the other hand the system must be bearded toward prompt discovery of each and every deviation from normal in the plant or in the machine operation and also toward immediate action aiming at corrections at the detected sources of the deviation.

Machine inspection methods can be done most of the time in our sense organ and then putting a judgment for the observed result, such as;

- Sight or visualization
- Touching
- Hearing machine sound

Self-Check – 2	Written test

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

Part I. Short Answer Questions (15 points)

1. What are the dependent factors for specific inspection solution? (5 points)
2. Write down types of equipment inspection. (5 points)
3. Importance of equipment inspections. (5 points)

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 15 points**

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

Score = _____

Rating: _____

Information Sheet 3- Adjusting machine settings

3.1 Setting up of Machinery

In setting machinery, the equipment should be located in appropriate position, if possible in a lighted dry place with plenty of room to work around it for cleaning and repairs. The arrangement should be that the minimum amount of sanitary piping is used, consistent with efficient operation.

Related equipment may be grouped together to facilitate supervision. Straight-line flow of product is usually desirable. If possible allow space for unit machine to be added later when the business grows. Machines especially the heavy ones, are set directly on the floor or on concrete base and grated in thoroughly with a rich cement mixture and sufficient water. For improved sanitation, use is made of the ball foot mounting with equipment such as tanks, freezers, fillers etc., on a pipe legs 6-12 inches long having a round foot. Where machinery is bolted down, it is customary to see bolts in the concrete.

3.2 The pipe system

A dairy also has conduit systems for other media such as water, steam, cleaning solutions, coolant and compressed air. A waste-water system to the drain is also necessary. All these systems are basically built up in the same way. The difference is in the materials used, the design of the components and the sizes of the pipes. All components in contact with the product are made of stainless steel. The following types of fittings are included in the product pipe system:

- Straight pipes,
- Bends, tees,
- Reducers and
- Unions

- Special fittings such as sight glasses, instrument bends, etc.
- Valves for stopping and directing the flow .
- Valves for pressure and flow control
- Pipe supports

For hygienic reasons, all product-wetted parts of dairy equipment are made of stainless steel. Two main grades are used, AISI 304 and AISI 316. The latter grade is often called acidproof steel. Bends, tees and similar fittings are available for welding, and with welded unions. In the latter case, the fitting can be ordered with nut or male ends or with clamp fittings.

All unions must be tightened firmly to prevent liquid from leaking out or air from being sucked into the system and causing problems in downstream parts of the process.

Permanent joints are welded. Where disconnection is required, the pipe connection is in the form of a threaded union with a male end and a retained nut with a joint ring in between, or a clamped union with a joint ring, The union permits disconnection without disturbing other pipework. This type of joint is therefore used to connect process equipment, instruments, etc. that need to be removed for cleaning, repair or replacement.

3.3 Pipe supports

Pipes usually run about 2-3 meters above the dairy floor. All components must be easily accessible for inspection and maintenance. The lines should slope slightly (1:200-1:1000) to be self-draining. There should be no pockets at any point along the line where the product or cleaning fluid can collect. Pipes must be firmly supported. On the other hand the pipes should not be so restrained that movement is prevented.

The pipes will expand considerably, when the product temperatures are high and during cleaning. The resulting increase in length and torsional forces in bends and equipment must be absorbed. This, plus the fact that the various components make the pipe system

very heavy, place great demands on accuracy and on the experience of the system designer.

Figure 45: Pipe support

3.4 Automation Process control

Automation means: that all actions needed to control a process with optimal efficiency are handled by a control system on the basis of instructions that have been programmed into it. An operator interface is used by the process operator to communicate with the control system and the process. It denotes the decision-making mechanism which makes it possible to perform a given task according to a given pattern.

Figure 46: Process operator communicate with the control system

Self Check – 3	Written Test

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

Part I. Short Answer Questions (10 points)

1. Mention at least five types of fittings included in the product pipe system. (5 points)
2. What is process Automation control? (3 points)
3. For hygienic reasons, what are the two main grades of equipment used in dairy processing? (2 points)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

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

Score = _____

Rating: _____

Information Sheet 4- Entering processing or packaging parameters

4.1. Entering processing or operating parameters

For a proper processing parameters entry, records must kept to allow proper plant management and control. Performance records are required to identify changes in operating conditions, identify reasons for process failure or water quality reduction, for process optimisation, to record changes in influent quality and process conditions, etc.

The following data should recorded as a minimum by the shift personnel to have accurate processing parameters:

- Flow-rate: influent, sludge scouring, filter backwash, chemicals dosage, water
- Pressure: pump inlet and outlet
- Number of filters in operation, filtration rate, number of filters washed
- Chemical parameters: record all on-line and in-line monitor results. Important aspects in this regard are pH, conductivity, disinfectant concentration etc.
- Physical parameters: record all on-line and in-line monitor results, here turbidity (both inlet and outlet) and temperature are to be recorded.

During milk processing operation in to different products, milk preparation and operation should consider the following points to have accurate processing parametr;

- Milk must be strained to remove any dirt or particle
- The milk is warm and stays warn though out the separating process
- Pre warm the separator
- Place the containers under the spout to catch the water
- Place adequately sized containers to receive the cream and skimmed milk, which, will come out of the spout.

4.2 Processing parameters

4.2.1 Temperature control

A constant pasteurization temperature is maintained by a temperature controller acting on the steam regulating valve. Any tendency for the product temperature to drop is immediately detected by a sensor in the product line before the holding tube. The sensor then changes the signal to the controller, which opens the steam regulating valve to supply more steam to the water. This increases the temperature of the circulating water and stops the temperature drop in the product.

4.2.2 Holding

The length and size of the externally located holding tube are calculated according to the known holding time and hourly capacity of the plant and the pipe dimension, typically the same as for the pipes feeding the pasteurization plant. Typically the holding tube is covered by a stainless steel hood to preventing people from being burnt when touching and from radiation as well.

4.2.3 Pasteurization control

It is essential to be certain that the milk has in fact been properly pasteurized before it leaves the plate heat exchanger. If the temperature drops below 72^0C, the unpasteurized milk must be kept apart from the already pasteurized product. To accomplish this, a temperature transmitter and flow diversion valve are fitted in the pipe downstream of the holding tube. The valve returns unpasteurized milk to the balance tank if the temperature transmitter detects that the milk passing it has not been sufficiently heated.

Pasteurizer cooling system as already noted, the product is cooled mainly by regenerative heat exchange. The maximum practical efficiency of regeneration is about 94-95%, which means that the lowest temperature obtained by regenerative cooling is about 8-9^0C.

Chilling the milk to 4^0C for storage therefore requires a cooling medium with a temperature of about 2^0C. Ice water can only be used if the final temperature is above 3-4^0C. For lower temperatures it is necessary to use brine or alcohol solutions to avoid the risk of freezing cooling media.

The coolant is circulated from the dairy refrigeration plant to the point of use. The flow of coolant to the pasteurizer cooling section is controlled to maintain a constant product outlet temperature. This is done by a regulating circuit consisting of a temperature transmitter in the outgoing product line, a temperature controller in the control panel and a regulating valve in the coolant supply line. The position of the regulating valve is altered by the controller in response to signals from the transmitter.

The signal from the transmitter is directly proportional to the temperature of the product leaving the pasteurizer. This signal is often connected to a temperature recorder in the control panel and recorded on a graph, together with the pasteurization temperature and the position of the flow diversion valve.

4.3 Operation procedure of packaging equipment

Operating procedures are followed to start and operate packaging equipment to achieve required outcome. Provision of clear, concise and accurate operating procedures is the most effective measure to prevent, control and mitigate accidents. This packaging operation procedure aims to:

- Increase employee awareness on the safe use of equipment used;
- Ensure that packaging equipment is suitable for packaging purpose;
- Ensure that packaging equipment is inspected at regular intervals;
- Ensure that equipment is maintained in good working order and repair;
- Ensure employees receive relevant information, instruction and training in relation to using work equipment.

Comprehensive written operating procedures should be generated where applicable that address:

- Standard operating procedures and operating philosophy;
- Plant Start-up;
- Plant Shut-down;
- Bulk loading and unloading;

Generally, operating procedures should cover the following;

- Material safety data control of substances hazardous to health states that general requirements on employers to protect employees and other persons from the hazards of substances used at work;
- Plant operatives should have an awareness and understanding of material safety data for raw materials, intermediates, products and effluent;
- Material safety data sheet (MSDS) is the document that list information relating to OHS for the use of various substances and products. These include:
  - ✓ Control measures and personal protective equipment;
  - ✓ Location of plant where process to be undertaken;
  - ✓ Roles and responsibilities of individuals involved in plant operations;
  - ✓ Plant fit for packaging purpose;
  - ✓ The condition of main process plant and equipment should be established as being fit for purpose;
  - ✓ Plant correctly set-up for processing;
  - ✓ Process monitoring and recording;
  - ✓ Monitoring and recording of key process parameters
  - ✓ Packaging of final product, etc.

Self-Check – 4	Written test

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

Part I. Short Answer Questions (10 points)

1. What type of record can be taken by the shift personnel to have accurate processing parameters? (3 points)
2. Write down packaging operation procedure objectives. (4 points)
3. Define Material safety data sheet (MSDS) and list information it includes. (3 pts)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

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

Score = _____

Rating: _____

Information Sheet 5- Checking and adjusting equipment performance

2.4 Checking and adjusting equipment Performance

Achieving the exact performance objectives of the plant as a whole requires maximizing the efficiency of all equipment. The term efficiency is used in this context as a comparison between the designed and the actual performance. Should, for instance, the set holding temperature in a pasteurization plant be 72^0C ($\pm1^0$C), the efficiency of the process is determined by checking whether, in the course of pasteurization of the product, any deviation from the wanted temperature levels occurs. In other words determining the efficiency requires collecting data concerning the actual performances and comparing them with those expected.

Any equipment is subjected to wear and tear and its efficiency and performance decrease with time of service. Keeping the plant performance at the required level is the responsibility of the dairy engineer and his staff. By detecting a drop in performance he can take corrective action. But his first duty is to prevent any drop in efficiency by taking care of the equipment in a rational way or in other words by servicing the machine. This servicing procedure will be structured according to the needs of the plant but it will always be based on:

- Inspection of performance based on log book entries;
- Scheduled inspection combined with scheduled servicing at selected points considered crucial for plant efficiency;
- Scheduled inspection of all other sections of the plant aiming at detection of faults not detectable by other routine procedures.

The practice of plant performance inspection and servicing of machines should be carried out with sufficient simplicity and thoroughness to yield the best results. The creation of a routine system in this respect is the first step in establishing good habits of proper care of all items of equipment.

2.5 Equipment and their performance

2.5.1 Butter Churner for butter making

This Electric butter churner machine eliminates the hard manual work, as the motor rotates the churning blades to produce butter.

- Only need to press the button and watch as the machine converts the cream into butter and buttermilk.
- It has a capacity of 15 liters and comes fitted with three-propeller turbulence system that does the work of converting cream to butter.
- The system is easy to work with since the propellers can be easily dismantled, and cleaned by hand.
- Inner parts are made of food grade stainless steel for hygiene and ease of handling.
- The system comes fitted with a European standard 220V top plug. You may need a converter if your outlet and mains voltage is different.

Figure 47: Electric churner

2.5.2 Separators

The unique feature of this equipment helps from air during entire process and gives us super product quality, as well as production flexibility and high separation efficiency.

The separators mainly used for milk clarification;

- Pure milk fat
- Hot and cold milk separation

Figure 48: Separators

2.5.3 Homogenizers

The homogenizers the main equipment that plays the main role in achieving the different variety of product, improves the taste, texture and viscosity of juice based drink or cream and prevents a sedimentation and cream line in the milk products.

Figure 49: Homogenizers

2.5.4 Milk Tanks

The milk tanks are prime components associated with milk production in processing type of business. There are various uses of milk tank in the dairy business.

- It used for store-standardized types of milk, skimmed milk or cream.
- The pre stack tanks, interim tank, milk tanks and mixing tanks will always give a good quantity of milk with all necessary characteristics.

Figure 50: Milk Tanks

2.5.5 Pasteurizers

The pasteurization is very important in making of any product. The pasteurizers are the main milk processing equipment that provides the heat treatment to a product to reduce enzymatic activity and kill pathogenic bacteria. The main purpose of using this equipment is to make product safe to lengthen product life and for consumption.

Figure 51: Pasteurizers

2.5.6 Centrifugal separation

Gravity separation is slow and inefficient. Centrifugal separation is quicker and more efficient leaving less than 0.1% fat in the separated milk compared with 0.5--0.6% after gravity separation.

It also allowed removal of cream on the cream spout above and recovery of the skim milk dropped on lower skim milk spout in a fresh state.

- Milk enters rapidly revolving bowl at the top, middle or bottom.
- In separation, milk introduced into separation channels at the outer edge of the disc stack and flows inwards.

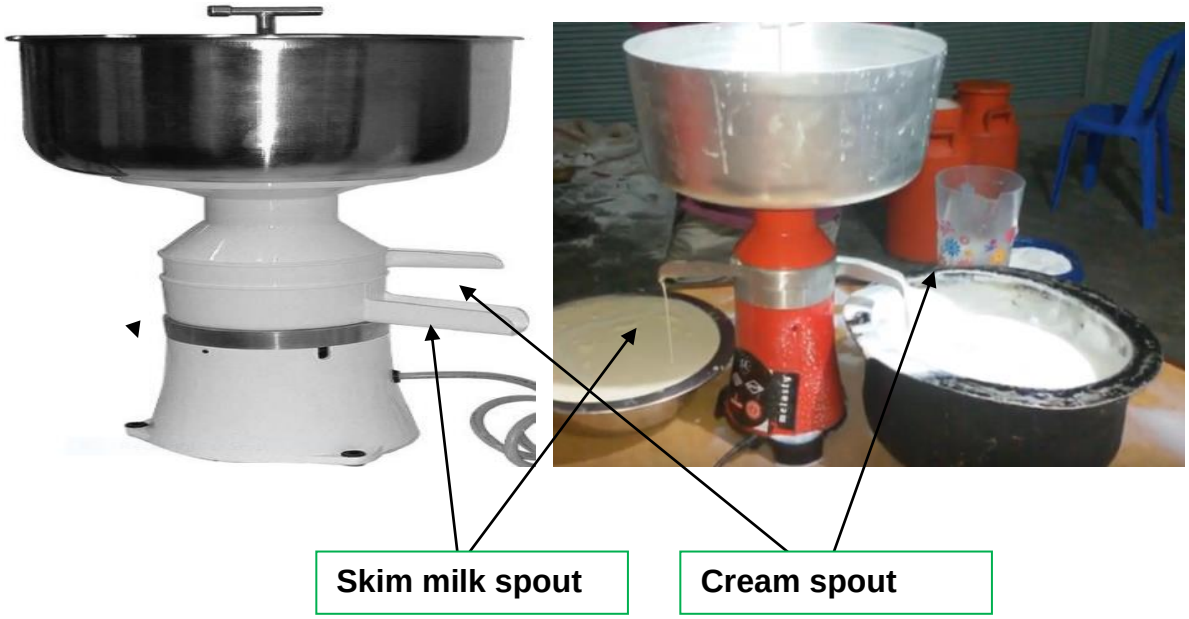


Figure 52: cream separator machine and cream separating operation

Self-Check – 5	Written Test

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

Part I. Short Answer Questions (10 points)

1. Write factors determine machine adjustment? (4 points)
2. What is the main purpose of homogenizer machine? (2 points)
3. What is the main function of pasteurizer machine? (4 points)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

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

Score = _____

Rating: _____

Information Sheet 6- Carrying out pre-start checks

6.1 Pre-start checking for dairy product processing equipment

The main objective of practicing pre-start inspection for dairy machineries and equipment is to ensure those equipment and machineries are safe to use. There are three key objectives of pre-start inspection for machineries and equipment;

- The equipment is inspected about its performance.
- Identified faults or hazards reported and rectified.
- Unsafe equipment taken out of service until it is safe to use.

In dairy industry, there are many types of machineries need to be operated. For example:

- Pasteurizer machine
- Cream separator machine
- Homogenizer machine
- Filing and sealing machine
- Evaporators
- Dryers, etc.

Before starting any operation, the operator should be check the main parts of the equipment appropriately and identify faulty and unfit parts or components of the machine then adjust and fit all parts or components of the machine identified.

Before we are going to operate machine, we have to check whether it is in a good operating condition or not. Checking conditions of operating equipment has a vital role for the operator's safety, quality of a product and also for equipment safety.

Safety check is very important to minimize hazards and risks on operator and to prevent machine damage. Main parts of machine need to check and make sure there is no foreign matter on their different parts.

Pre start check on equipment includes;

- Check bolts and other loosen parts and tighten it before operation start.
- When maintaining, inspecting, attaching and detaching parts, park the machine at flat and safe place.
- Use proper tools to maintain the machine and check working area is safe during Operating.
- Only allow responsible person, who are familiar with the instructions, to operate the machine.
- To start the machine, first inspect the machine sensitive parts such as;
  - ✓ Bolts
  - ✓ Drain
  - ✓ Cap tightness
  - ✓ Pins.

Before start using machine and manipulate operations, consider guidelines like;

- Parameter setting pressure, temperature, flow rate, etc.
- Identify faulty conditions.
- Identify the possible hazards.
- Check it is complete, with all safeguards fitted, and free from defects.
- Follow manufacturer specification.
- Establish a safe system of work for using and maintaining the machine.
- Maintenance as required to prevent risk.
- Choose the right machine for the job.
- Make sure the machine/ equipment is;
  - ✓ Safe for work that has to be done when setting up, clearing blockages, carrying out repairs for breakdowns, and maintenance;
  - ✓ Properly switched off, isolated or locked-off before taking any action to remove blockages, clean or adjust the machine.

6.2 The Pre- and post- operation equipment inspection Checklist

Before and after doing pre start check on equipment, the following inspection check lists can be practiced;

- Clear any accumulated debris from the equipment.
- Check for leaking or pooled fluid around and under the machine.
- Check for new signs of structural damage, scratches on the machine.
- Familiarize with the control style and change as needed.
- Identify auxiliary/attachment controls.
- Start the power and review comfort indicators and warnings.
- Review all external surroundings.
- Finally test the machine as post operation task.

Self Check – 6	Written test

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

Part I. Short Answer Questions (15 points)

1. What is the purpose of pre-start inspection? (2 points**)**
2. What are the three key objectives of pre-start inspection? (3 points**)**
3. Write down at least four guidelines to be considered before start using machine and manipulate operations. (4 points**)**
4. List and discuss in detail what you have to do during performing the Pre- operation equipment Inspection on a machine.(6 points)

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 15 points**

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

Score = _____

Rating: _____

Information Sheet 7- Completing line setup

7.1 Completing dairy processing line setup

The processing plant must be designed so the separate rooms are provided for each of the following operations:

- The pasteurizing, processing, cooling, reconstitution, condensing, drying, and packaging of milk and milk products.
- Packaging of dry milk or milk products.
- The cleaning of milk cans, containers, bottles, cases, and dry milk or milk product containers.
- The fabrication of containers and closures for milk and milk products.
- Cleaning and sanitizing facilities for milk tank trucks in milk plants receiving milk or whey.
- Receiving cans of milk and milk products in milk plants receiving such cans.
- Every milk processing plant should have toilet and hand-washing facilities with hot and cold running water, soap, and individual sanitary towels or approved hand-drying devices. The water supply should be adequate, safe, and of sanitary quality.

7.1.1 Water supply

Water serves many functions in a dairy, such as washing, indirect heating, cooling milk and adjusting product composition. Water comes into direct contact with the product. It is important, therefore, to locate the dairy near a plentiful supply of clean water. Water can be collected from the roof of a dairy building or nearby barns by putting guttering around the roof and directing the water to a storage tank.

7.1.2 Electric power

Dairies normally purchase their electric power from local distributors. In most cases it is supplied at high voltage, between 3000 and 30000V, but dairies with a power demand of up to approximately 300 kW may also take low-voltage supplies of 200-440V. The principal components of the electrical system are:

- High voltage switchgear
- Power transformers
- Low voltage switchgear
- Generating set
- Motor control centers

7.2 Dairy processing Unit operations

The four major unit operations that take place between storage of raw milk and storage of finished product prior to packaging are:

7.2.1 Separation Unit operation

The purpose of this step is to separate milk into cream and skim milk. All incoming raw milk is passed through separators, which are essentially high-speed centrifuges. They separate milk into lighter cream fraction and heavier skim milk fraction. A separator of adequate bowl capacity should collect all the slime material containing heavy casein particles, leukocytes, larger bacteria, body cells from cow‘s udder, dust and dirt particles, and hair. If the particulate fraction of raw milk is not removed, homogenized milk will develop sediment upon storage. Skim milk and cream are stored separately for further processing.

7.2.2 Standardization Unit operation

Once the milk has been separated the resulting products can be combined in a variety of process systems to make products with standardized milk fat contents. Use of a separator also permits fractionation of whole milk into standardized milk (or skim milk, low-fat milk) and cream.

Skim milk should normally contain 0.01% fat or less. Standardization valve on the separator permits the operator to get separated milk of predetermined fat content. Increased back pressure on cream discharge port will increase fat content in standardized milk. By blending cream and skim milk fractions, various fluid milk and cream products of required milk fat content can be produced.

7.2.3 Heat treatment (Pasteurization) Unit operation

Milk is produced in an environment that is inherently capable of harboring pathogenic bacteria that can contaminate the milk during the milk harvesting process. Hence, heat treatment of milk is advantageous to kill all the disease-producing organisms and to enhance its shelf life by removing approximately 95% of all the contaminating organisms. Heat treatment is an integral part of all processes used in dairy manufacturing plants.

The main purpose of thermal is to inactivate pathogenic micro-organisms, thereby making milk safe for consumption. In addition, spoilage micro-organisms and enzymes are inactivated, which has the benefit of improving the shelf-life of the product.

There are several types of heat treatment commonly applied in the dairy industry:

a. Thermisation for the inactivation of psychotropic micro-organisms:

Preheat the milk to a temperature below the pasteurization temperature to temporarily inhibit bacterial growth. This process miscalled thermisation. The milk is heated to 63-65°C for about 15 seconds, a time/temperature combination that does not inactivate the phosphatase enzyme.

To prevent aerobic spore-forming bacteria from multiplying after thermisation, the milk must be rapidly chilled to 4°C or below and it must not be mixed with untreated milk. Thermisation should be applied only in exceptional cases. The objective should be to pasteurize all the incoming milk within 24 hours of arrival at the processing.

b. Low temperature, long time (LTLT) pasteurization:

The current time/temperature relationship for batch pasteurization of milk is 63^0C for 30 minutes. The original type of heat treatment was a batch process in which milk is heated to 63^0C in open vats and held at that temperature for 30 minutes. This method is called the holder method or low temperature, long time (LTLT) method. LTLT used for the inactivation of psychotropic and pathogenic micro-organisms.

c. High temperature, short time (HTST) pasteurization

HTST used for the inactivation of all micro-organisms excluding spores, and for the inactivation of all micro-organisms including spores. The HTST process for milk involves heating it to 72-75^0C with a hold of 15-20 seconds before it is cooled. The phosphatase enzyme is destroyed by this time/temperature combination. The phosphatase test is therefore used to check that milk has been properly pasteurized.

d. Sterilization:

The original form of sterilization, still used, is in-container sterilization, usually at 115 - 120°C for some 20–30 minutes. After fat standardization, homogenization and heating to about 80°C, the milk is packed in clean containers usually glass or plastic bottles for milk, and cans for evaporated milk. The product, still hot, is transferred to autoclaves in batch production or to a hydrostatic tower in continuous production.

A further step in the heat treatment of milk products uses technology similar to ultra-pasteurization systems. The ultra-high temperature (UHT) sterilization of milk is most effectively achieved with direct steam injection or infusion. While ultra-pasteurized (ESL) products require cooling to temperatures less than 4.4^0C prior to packaging and storage, sterile UHT products need only be cooled to room temperature prior to packaging the product.

e. Ultra-high temperature treatment (UHT):

UHT treatment is a technique for preserving liquid food products by exposing them to brief, intense heating, normally to temperatures in the range of 135-140°C. This kills micro-organisms which would otherwise destroy the products.

UHT treatment is a continuous process which takes place in a closed system that prevents the product from being contaminated by airborne microorganisms. The product passes through heating and cooling stages in quick succession. Aseptic filling, to avoid reinfection of the product, is an integral part of the process.

7.2.4 Homogenization Unit operation

This process reduces the size of fat globules of milk by pumping milk at high pressure through a small orifice, called valve. The device for size reduction is called a homogenizer which subjects fat particles to a combination of turbulence and cavitation.

Homogenization is carried out at temperatures higher than 37^0C. The process causes splitting of original fat globules (average diameter approximately 3.5 µm) into a very large number of much smaller fat globules (average size <1 µm). As a result, a significant increase in surface area is generated. The surface of the newly generated fat globules is then covered by new membrane formed from milk proteins.

Homogenization primarily causes disruption of fat globules into much smaller ones. Consequently it diminishes creaming and may also diminish the tendency of globules to clump or coalesce. Essentially all homogenized milk is produced by mechanical means. Milk is forced through a small passage at high velocity.

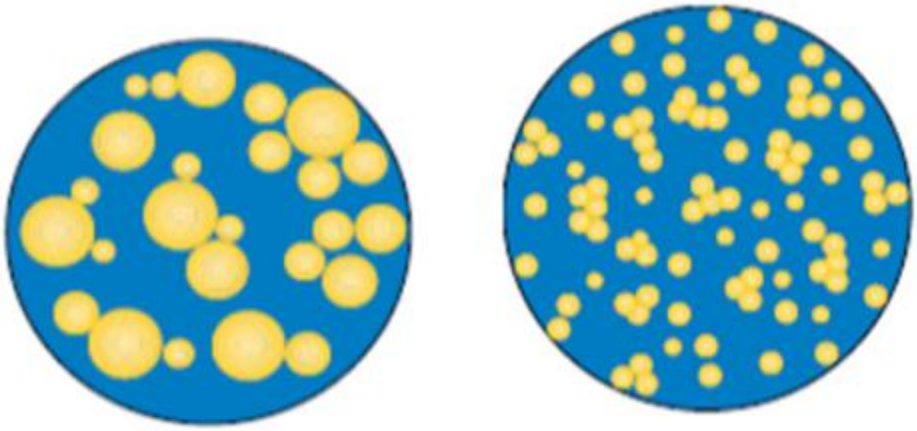


Figure 53: Splitting of original fat globules by homogenization

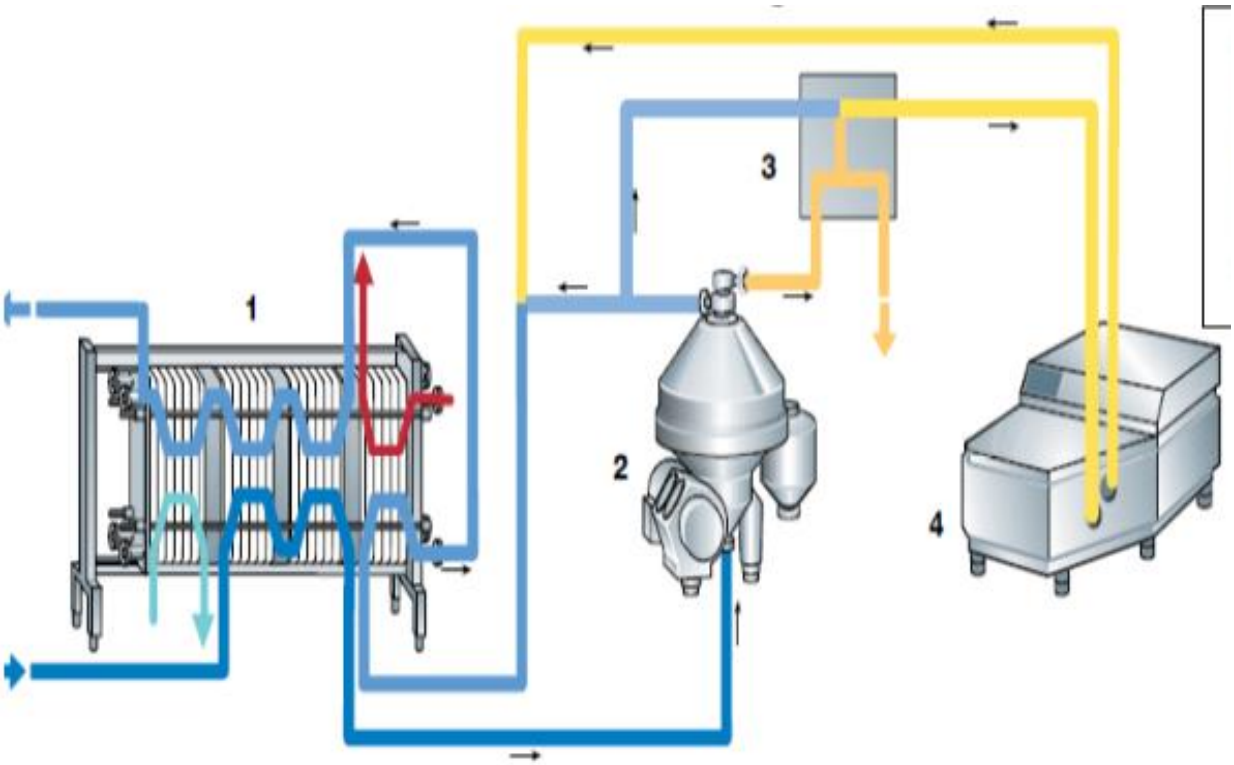


Figure 54: Heat exchanger, separator, standardization device and homogenizer

1. Heat exchanger
2. Centrifugal separator
3. Automatic fat standardization device
4. Homogenizer

7.2.5 Refrigeration (Cold room) Unit operation

Many stages in the process require that the product is heated to a certain temperature. Any increase in temperature will naturally result in increased activity by any micro-organisms which may be present in the product, as well as speeding up the chemical reactions which are controlled by enzymes.

Activity of this kind must be avoided as much as possible, so it is important for the product temperature to be reduced quickly as soon as a particular stage of production has been completed. The need for refrigeration in dairies is consequently very great, and the operating costs of the refrigeration plant represent a significant item in the budget of any dairy.

7.2.6 Packaging Unit operation

Packaging can be broken down in to single-use (disposable) or multiuse (reusable) containers. Glass bottles are the most common multiuse container. Glass bottles are heavy, fragile, and bulky and when returned to the dairy plant for cleaning and refilling they have potential for bringing contaminants back into the plant environment.

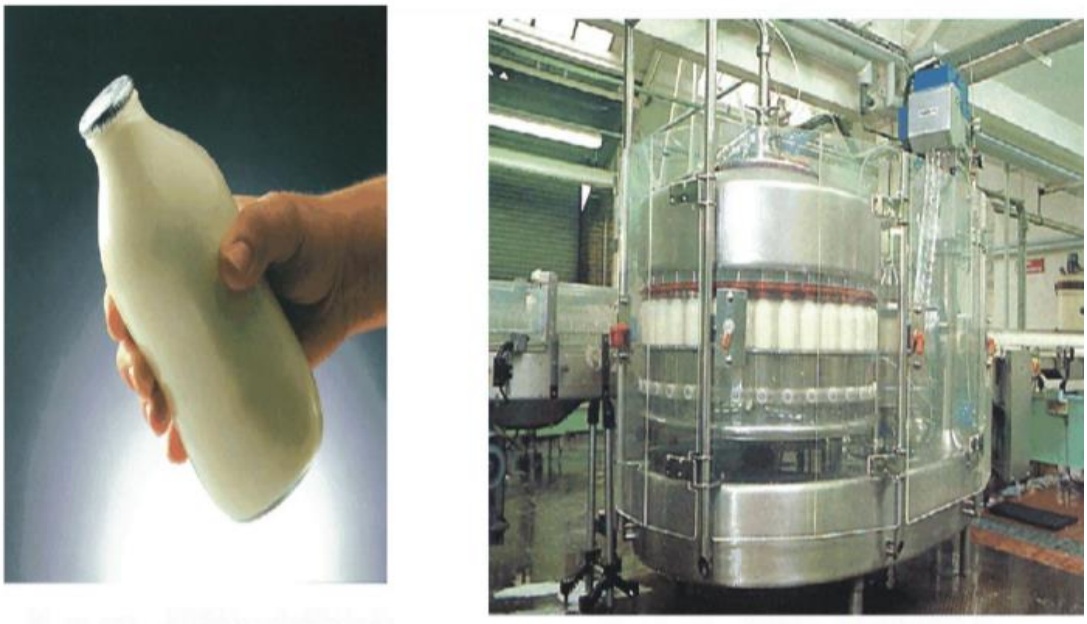


Figure 55: Packing machine

7.3 Milk processing tools and equipment

7.3.1 Milk sorage tanks

Bulk milk handling and storage Storage tanks may be refrigerated or insulated. They hold milk up to a period of 72 hours (usually 24 hours) before processing. The tanks may be horizontal or vertical in configuration.

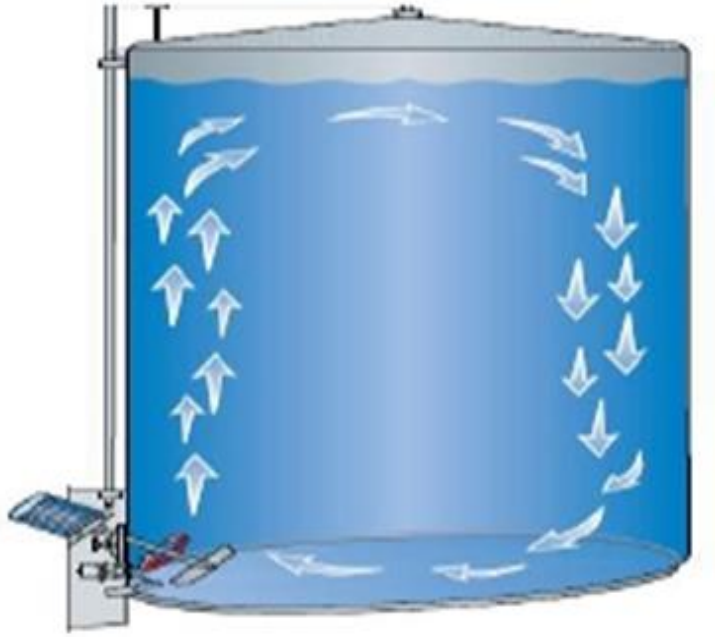


Figure 56: Large milk tanks having some form of agitation

There are different tanks according to their functions.

a. Silo tanks

Silo tanks used for milk reception and storage. The number and size of the silo tanks are determined by such factors as;

- The milk intake per day,
- The number of days per working week,
- The number of hours per working day (1, 2 or 3 shifts),
- The number of different products to be manufactured and ,
- The quantities involved.

b. Intermediate storage tanks

These tanks are used to store a product for a short time before it continues along the line. They are used for buffer storage, to level out variations in flow. After heat treatment and cooling, the milk is pumped to a buffer tank, and from there to filling. If filling is interrupted, the processed milk is buffered in the tank until operation can be resumed.

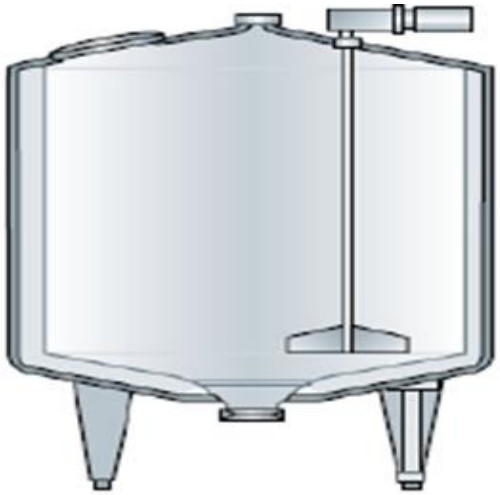


Figure 57: A typical storage tank has a capacity of 1,000 litres up to about 50,000 litres

c. Mixing tanks

As the name implies, these tanks, are used for mixing different products and for the admixture of ingredients to the product. The tanks may be of the insulated type or have a single stainless steel shell. Equipment for temperature control may also be fitted. Insulated tanks, with mineral wool between the inner and outer shells, have a jacket outside the inner shell through which a heating/cooling medium is pumped. The jacket consists of welded-on channels. Agitators for mixing tanks are designed to suit the specific application.

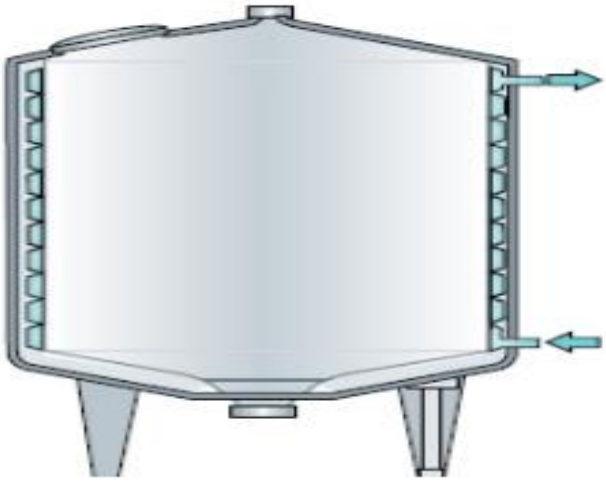


Figure 58: Mixing tank with welded-on heating/cooling channels

d. Process tanks

In these tanks, the product is treated for the purpose of changing its properties. They are widely used in dairies, e.g. ripening tanks for butter cream and for cultured products such as yoghurt, crystallization tanks for whipping cream, and tanks for preparing starter cultures.

There are many different types of process tanks. The application determines the design. Common features are some form of agitator and temperature control. They have stainless steel shells, with or without insulation. Monitoring and control equipment may also be fitted.

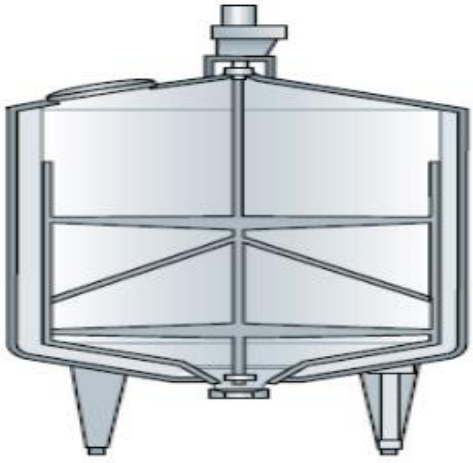


Figure 59: An insulated process tank with scraper agitator for viscous products

e. Balance tank

The balance tank keeps the product at a constant level above the pump inlet. In other words, the head on the suction side is kept constant.

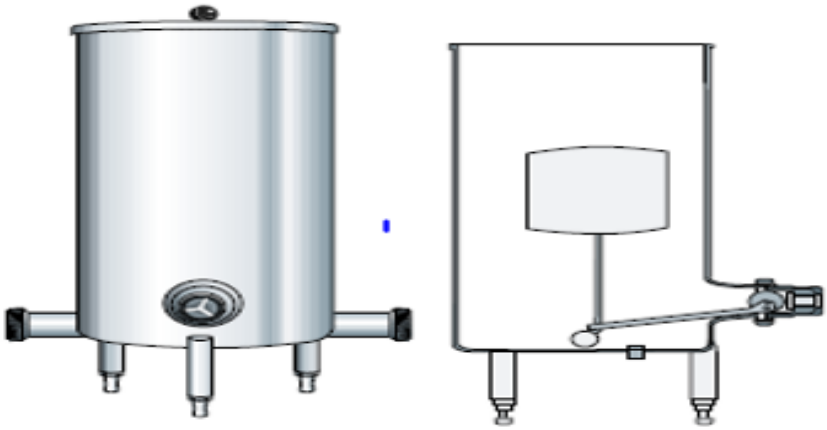
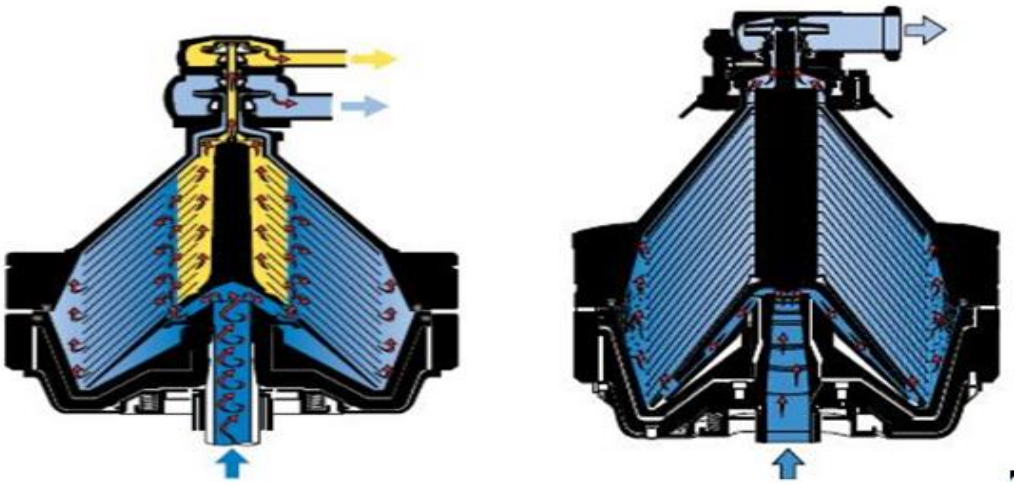


Figure 60: Balance tank for constant inlet pressure to the pump

7.3.2 Centrifugal clarifier

Centrifugal clarifier, the milk is introduced into the separation channels at the outer edge of the disc stack, flows radially inwards through the channels towards the axis of rotation and leaves through the outlet at the top.



Centrifugal separator Centrifugal clarifier

Figure 61: Centrifugal clarifier and separator

7.3.3 Cream separator

Cream Separator is essentially high-speed centrifuges separate raw milk into lighter cream fraction and heavier skim milk fraction.

Standardization valve on the separator permits the operator to get separated milk of predetermined fat content. Increased back pressure on cream discharge port will increase fat content in standardized milk. By blending cream and skim milk fractions, various fluid milk and cream products of required milk fat content can be produced.

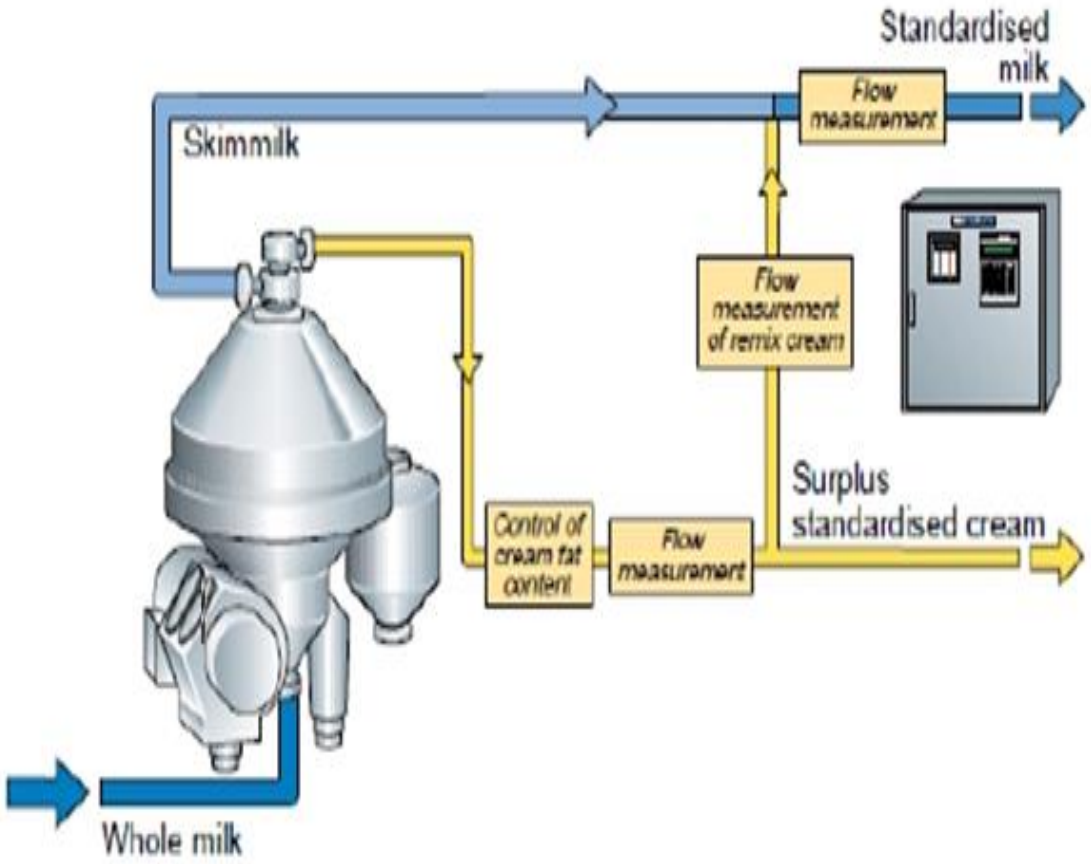


Figure 62: Cream separator and standardization unit

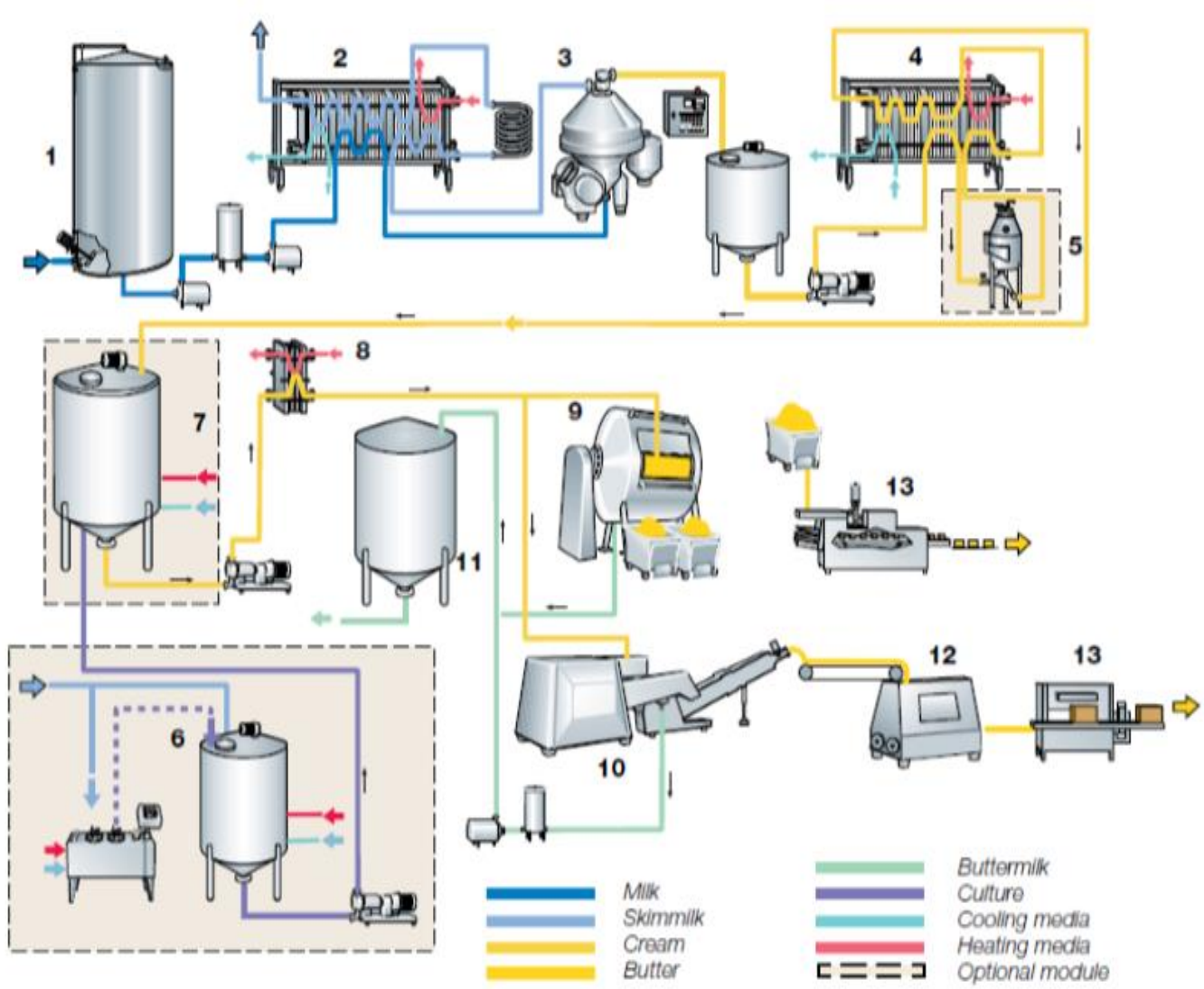


Figure 63: Process steps in batch and continuous production of cultured butter

1. Milk reception
2. Preheating and pasteurization of skim milk
3. Fat separation
4. Cream pasteurization
5. Vacuum deaeration, when used
6. Culture preparation, when used
7. Milk reception
8. Preheating and pasteurization of skim milk
9. Fat separation
10. Cream pasteurization
11. Vacuum deaeration, when used
12. Culture preparation, when used
13. Packaging machines

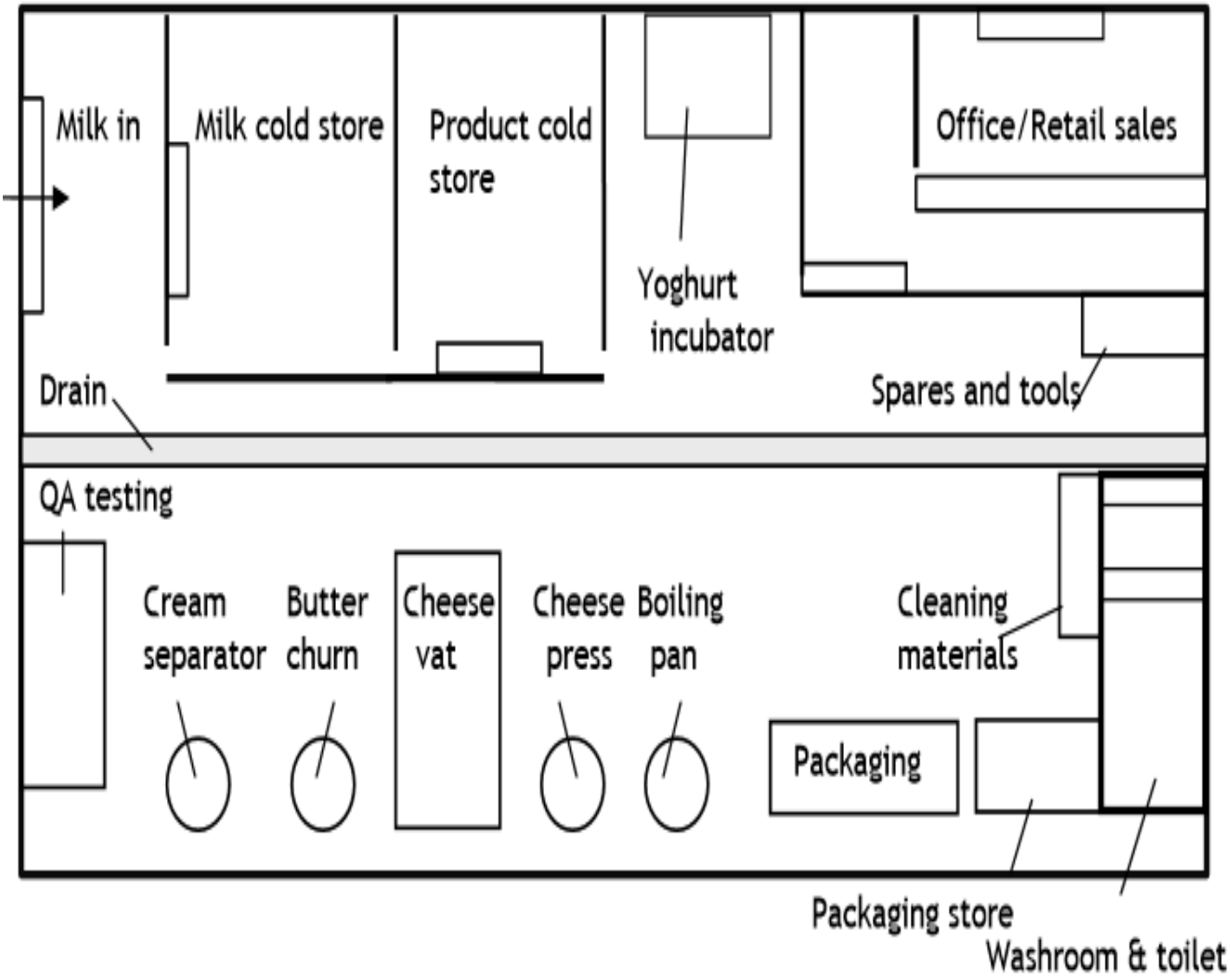


Figure 64: Layout of a small dairy

Figure 65: Milk collection and collecting to processing plant in Holland Dairy processing at Debrezeit town

Figure 66: Dairy processing set up of Holland Dairy processing plant in Debrezeit town

Self Check – 7	Written Test

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

Part I. Short Answer Questions (20 points)

1. Write down at least five activities to be operated in the processing plant. (5 points)
2. What are the major unit of operations in dairy processing plant? (5 points)
3. Write down various types of pasteurization. (5 points)
4. Define homogenization and write it's important. (5 points)

Note: **Satisfactory rating – 20 points** **Unsatisfactory - below 20 points**

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

Score = _____

Rating: _____

Information Sheet 8- Reporting maintenance requirement

8.1 Reporting maintenance requirement

It is important to report maintenance jobs that are performed on positions and adjustments of equipment and machineries in the processing plant. Report when the actual work or inspection has been performed and enter information about the operation. This information includes details about the time spent on the operation, materials used and inspection results.

Approve work order operations when the operations have been reported. Operations may be automatically approved, as is the case for inspection operations. When an operation requires manual approval, the approval is likely to be done by a supervisor who makes sure that the work has been performed according to the original requirements.

Close the operations when they are reported and approved. It is possible to close an entire work order when all operations are closed. When we close an operation, we also make sure that there are no outstanding materials or purchases connected to the operation. Close the work order header when all operations contained within the work order are completed and closed. This step can be automated, allowing the work order header to be automatically closed when the last operation is closed.

The report shows maintenance details of each event in the time range, setup time, instructions, event type and time, facility, ID, service, etc. During writing maintenance report, it should have the following elements;

- Cover Page
- Cover Letter
- Device Information
- New Parts Cost Details
- Suggestions and Signature, etc. should be involved.

Table 2: Example of simple "Repair Report"

Gear drive repair report					
Location: Building 55, 1st floor			Machine Creamseparator		
Gear drive type: Reducer 1:20			Serial no.: 10245156		
Date of putting in operation: 5/20/1997			Manufacturer: Flender Germany		
Date of Repair: 10/03/2021 Special maintenance requirements: Oil Grade 05			Auxiliary drives: □ Belts _____ □ Chain _____ □ Coupling Flexible Coupling _____ □ Others _____		
Part	**Failure**	**Mark**	**Part**	**Failure**	**Mark**
Auxiliary Drive	Chain or belt broken		**Gears**	Seat worn out	
	Pulley worn out			Broken teeth	
	Keyway problem			Worn out teeth	X
	Drive shaft bent			Others	
	Coupling damaged		**Lubrication**	No oil	
	Coupling rubber broken	X		Little oil	X
	Others			Dirty oil	
Sealing	Lip seal defective	X		Water in oil	X
	Housing seal defective			Breather defective	
	Others			Others	

8.2 Standard Operating Procedure (SOP)

SOP is a set of written instructions that document a routine or repetitive activity followed by an organization. The development and use of SOPs are integral part of a successful quality system as it provides individuals with the information to perform a job properly, and facilitates consistency in the quality and integrity of a product or end-result.

Standard Operating Procedures are components of good processing practice that emphasize sanitation procedure which include;

- Safety of water that gets in contact with product during processing;
- Condition and cleanliness of product contact surfaces;
- Measures to prevent contamination;
- Employee hygiene practices;
- Control of employee health conditions that could result in contamination of food and food surfaces;
- Protection of contact surfaces from adulteration with toxic and other harmful components;
- Proper labelling and storage of products;
- Control of insects and pests, etc.

8.3 Workplace information of milk and milk product processing

Workplace information of milk and milk product processing include:

- Standard Operating Procedures (SOPs),
- Specifications for raw milk reception and processing
- Production schedules
- Sampling and tests requirements
- Packaging and storage
- Reporting arrangements
- Certificate of analysis
- Recording collected milk from farm and stored milk in milk silo.

Self-Check _8	Written test

Name…… ID…… Date…….

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

Part I: Short Answer Questions (15%)

1. Define reporting maintenance activity. (5 point)
2. Define SOP and write down its principles. 5 points)
3. Write down at least three work place information. (5 point)

Note: **Satisfactory rating – 15 points** **Unsatisfactory - below 15 points**

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

Score = _____

Rating: _____

Information Sheet 9 - Conducting work based on environmental guidelines

9.1 Conducting work with workplace environmental guidelines

Dairy processing plant should have a safe and healthy physical work environment which is critical to eliminating and controlling risk in the workplace. This includes ensuring the work environment, facilities and amenities are compliant with legislative and other identified requirements.

To manage environmental issues, disciplinary process might cover two areas: employee performance and general workplace conduct in order to maintain environmental protections. Principles of conducting work identified as:

- Organize dairy processing work to maximize efficiency and productivity.
- Train and motivate workers to implement HACCP principles.
- Monitor both the work and work systems to ensure desired results are attained.
- Proper disposal and waste management.

9.2 Point of consideration during conducting work

a. Nature of work performed

The requirements of amenities and facilities will depend on the type of work being performed and the equipment being used.

b. Size and location of the work area

Consideration should be given to the location of work area such as the processing area being in a building, outdoors ad has good waste disposal and management system.

c. The composition of the workforce

The workforce may be comprised of people of different categories, experiences and those people with special needs. This will influence the provision of amenities and facilities to accommodate the various needs.

d. Type of workplace

Different requirements may need to be applied where the workplace is permanent or temporary.

e. Access

Consideration should be given to the ability of a person to access the amenities and facilities. The means of access to the facility or amenities should be safe and accessible for all persons who require access.

f. Maintenance

The work environment, facilities and amenities are required to be maintained in a safe and healthy condition, and need to be hygienic, secure and in a serviceable condition. This includes replenishment of consumables, repair of broken or damaged furnishings and equipment and ensuing cleanliness of these areas.

9.3 Legislation requirement for dairy products

In most countries, the legislation for dairy foods is more stringent than for many other types of food. In addition to general regulations that govern labeling, weights and measures and hygiene when handling foods, special regulations govern the manufacture and sale of dairy products that are eaten cold without cooking.

The legislation covers all aspects related to the operation of a dairy and the microbiological and chemical quality of products. Dairy processors should contact the responsible Ministry for copies of national regulations related to their products, and get advice from a university or Bureau of Standards if necessary to clarify what the regulations mean.

They should also obtain a Health Permit from the Ministry of Health or Local Authority licensing the premises to be used for food production, obtains a Manufacturing License from the Local Authority or Ministry of Industry, and obtains Medical Certificates from the Health Authority to certify that all workers are fit to handle food.

9.4 Quality assurance of milk supply

Since milk has a high risk of causing food poisoning, it is essential that processors have attention to the quality of milk. Infections from the living animal that are passed to the milk and infections caused by contamination of the milk are among dangers.

Contamination of milk in the milking shed can come from contact with animal hides and faeces, poor quality water, dirty equipment and poor hygiene by milking staff. To ensure that good quality milk is used, dairy processors should only buy milk from reputable farmers or suppliers, and not rely on local street markets or middlemen.

Milk should be bought using quality specifications and agreements with farmers. It is important that dairy farmers ensure that:

- All milking equipment should be cleaned and disinfected and after each use.
- People milking animals should wash their hands using clean water.
- Animals should be inspected each day for disease to prevent bacteria from an infected animal being passed by hands to healthy animals or into the milk.
- Personal hygiene rules are observed.
- Milk is kept in containers that are covered and it is cooled as quickly as possible.
- Milk is transported to collection centres in shortest time possible.

Self-Check _9	Written test

Name…… ID…… Date…….

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

Part I: Short Answer Questions (10%)

1. Write down principles to conduct work. (5 point)
2. What point of consideration will have during conducting work? Write at least three points. (5 point)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

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

Score = _____

Rating: _____

Information Sheet 10- Notifying relevant personnel

10.1 Notifying relevant personnel for setup completion

Relevant Personnel means all full-time, part-time, or contract personnel whose job responsibilities related in any way to the receiving, processing, packaging, storing, marketing, or distribution of milk or any other products. It means, with respect to any individual, partnership, corporation, Limited Liability Company, unincorporated organization or other entity, such Person's officers, directors, employees, agents, distributors and other persons acting for or on behalf of such person.

There are different key points for notifying relevant personnel in dairy processing plant line setup.

c. Relevant experience

Make sure that the jobs, experience, and awards that you do include are relevant to the position applying for.

d. The right skills

This is a great time to run wild with those keywords found in the job description. Participated in facility safety committee in order to ensure all Occupational Health and Safety guidelines were met.

e. Quantifiable achievements

Achievements and awards relevant to the position speak louder than a high GPA, especially if you can quantify your achievement with a number.

f. Your unique qualities

Recruiters and hiring managers are looking at hundreds of resumes.

g. Strong Content

If there are a lot of jobs, this should not necessarily be a list of all of them. This is a document designed to market you to a potential employer, so choose the strongest content.

10.2 Responsibility of relevant personnel

Each responsibility should b provided for relevant personnel to;

- Maintain compliance with the regulations of Occupational Health and Safety Act guidelines /OHSA/.
- Monitor facility for signs of potential risks and product loss prevention.
- Maintain standard of cleanliness of processing plant.
- Perform cleanliness of all processed products for consumer/employee use.
- Ensure OHSA guidelines were being followed properly for prevention of hazard in the processing plant.
- Maintain proper OHSA standards for set up and break down of equipment in the processing plant.

Self-Check _10	Written test

Name…… ID…… Date…….

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

Part I: Short Answer Questions (10 %)

1. What does mean Relevant Personnel? (2 point)
2. Write down at least four key points for notifying relevant personnel. (4 points)
3. Write down Responsibility of relevant personnel. (4 point)

Note: **Satisfactory rating – 10 points** **Unsatisfactory - below 10 points**

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

Score = _____

Rating: _____

Operation Sheet 1- Undertake CIP program for a circuit with tanks and other cold components

Objectives:

- To clean pipes, tanks and cold components.
- To improve product quality by mitigating contamination.

Materials, tools and equipment required to undertake CIP program for tanks and cold components;

- Rinse water
- Alkaline detergent 0.5- 1.5 %
- Fresh Water
- Acid
- Lye

Undertake CIP program for tanks and cold components Procedures;

Following the steps outlined below help to ensure successful Fitting and adjusting machine components and related attachments.

Step 1: Wear appropriate personal protective equipment.

Step 2: Prepare materials and equipment's.

Step 3: Rinsing with warm water for three minutes.

Step 4: Circulation of a 0.5- 1.5 % alkaline detergent at 75 °C for about 10 minutes.

Step 5: Rinsing with warm water for about three minutes.

Step 6: Disinfection with hot water 90 – 95 °C for five minutes.

Step 7: Gradual cooling with cold tap water for 10 minutes.

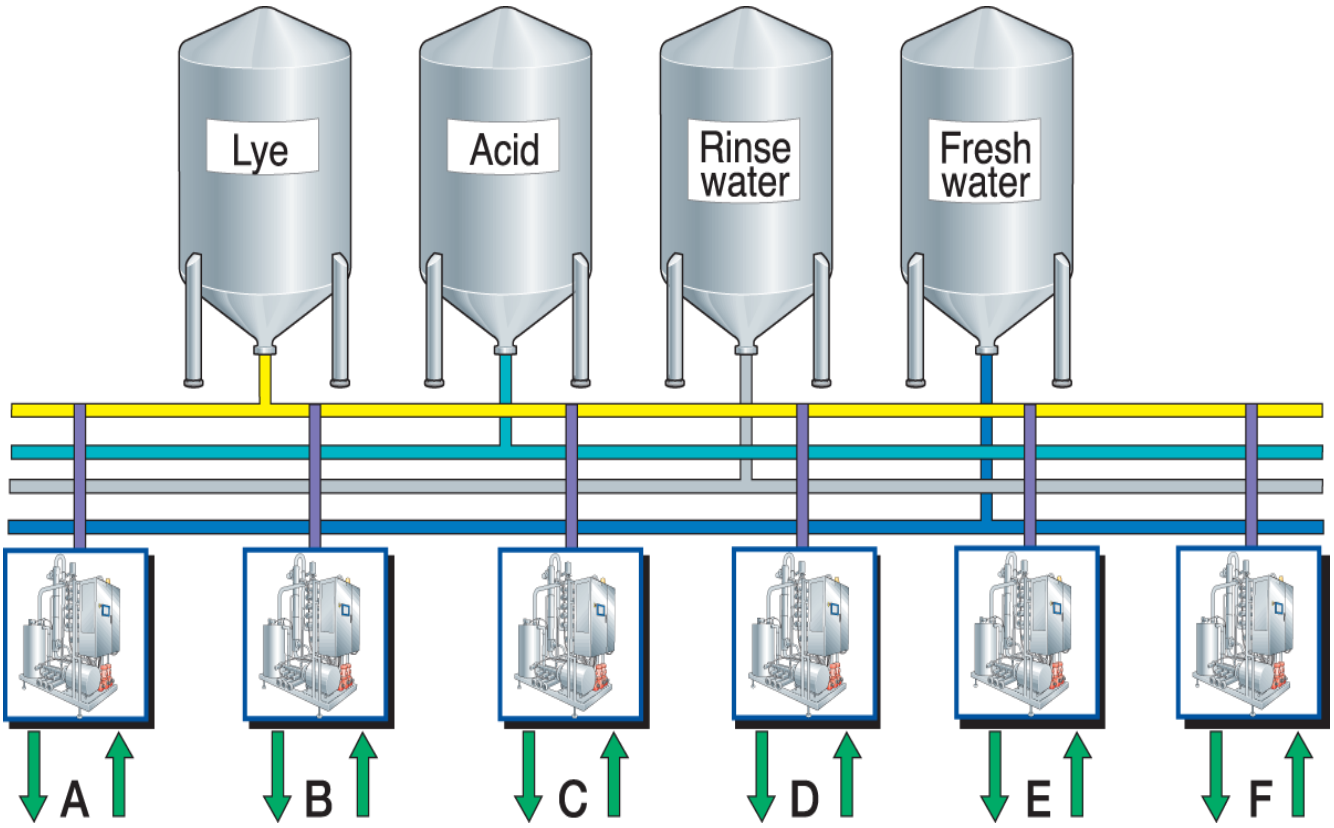


Figure 67:A common tank garden supply several CIP stations

Operation Sheet 2- Carrying out pre start check

Objectives:

- To inspect normal functioning of machines.
- To maintain machines from damage.
- To keep workers from OHS hazards related to machines.

Materials, tools and equipment required to carry out machine pre start checks;

- Personal protective equipment.
- Hand tools like screw driver.
- Cleaning equipment and materials.

Carrying out machine pre start check Procedures;

Step 1: Wear appropriate personal protective equipment.

Step 2: prepare materials and tools.

Step 3: Clean each components of the equipment.

Step 4: Inspect each parts of the machine.

Step 5: Identify and maintain faulty parts.

Step 6: Operate the required task, if there is machine problem, repair or replace faulty machine parts.

Step 7: Report each work outcomes.

LAP Test	Performance Test

Name…….ID……..Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **4:40 hour**. The project is expected from each student to do it.

Task 1. Undertake CIP programme for a circuit with pipes, tanks and other cold components.

Task 2. Carrying out machine pre start check.

Reference Materials

Book:

Opportunities in Dairy Processing , Fellows, P.J. and Axtell, B.L.A., (Eds.), CTA, 2008. Soured milk and yoghurt , Practical Action Technical Brief.

Dairy Processing - Food Cycle Technology Sourcebook , Aguhob, S. and Axtell, B.L.A., IT Publications, London, UK., 1996.

Dairy Science and Technology Education , Goff, D., University of Guelph, Canada,

Dairy Science and Technology: Principles and Applications , La Fondation de Technologie Laitiere et Department de Science et Technologie des Aliments Universite Laval. Les Presses de l'Universite Laval, Quebec. 1985.

Dairy Technology . Walstra, P., Geurts, T.J., Noomen, A., Jellema, A. and van Boekel, M.A., Marcel Dekker. New York., 1998.

Preparation of Dairy Products, Agrodok 36 , Agromisa Foundation, P.O. Box 41, 6700 AA Wageningen, The Netherlands 1991. www.agromisa.org/

Rural Dairy Technology, O'Connor, C.B., ILRI Training Manual 1. International Livestock Research Institute (ILRI), Nairobi, Kenya. 1995.

Adnan Y. Tamime (2009): Milk Processing and Quality Management. Blackwell Publishing Ltd. ISBN: 978-1-405-14530-5.

Asaminew T. and Eyassu S. (2011): Microbial quality of raw cow‘s milk collected from farmers and dairy cooperatives in Bahir Dar Zuria and Mecha district, Ethiopia

Azza A. Mostafa (2013): Treatment of Cheese Processing Wastewater by Physicochemical and Biological Methods International Journal of Microbiological Research 4 (3): 321-332.

FAO and IDF, (2011): Guide to good dairy farming practice. Animal Production and Health Guidelines, No. 8. Rome.

Felleke G. (2003): Milk and Dairy Products, Post-harvest Losses and Food Safety in SubSaharan Africa and the Near East. A Review of the Small Scale Dairy Sector – Ethiopia. FAO Prevention of Food Losses Programme. FAO, Rome, Italy.

Fellows, P.J. and Axtell, B. (Eds): Setting up and running a small-scale dairy processing business. Opportunities in food processing series. Wageningen: ACP-EU Technical Centre for Agricultural and Rural Cooperation (CTA), 2008. 188 pages, ISBN 978-929081-377-4

Gerrit Smit (2003): Dairy processing-Improving quality. Woodhead Publishing Limited, Abington Hall, Abington, Cambridge CB1 6AH, England, www.woodheadpublishing.com.

Gösta Bylund. Dairy processing handbook. Tetra Pak Processing Systems AB S-221 86 Lund, Sweden.

Jerry Issa (1983): To make cheese and yogurt. Jerrick Publications Trenton, Michigan U.S.A., Updated: (2003)

Land O'Lakes (2010): The next stage in dairy development for Ethiopia. Dairy value chains, end markets and food security. Land O'Lakes, Addis Ababa, Ethiopia. Agric. Biol. J. N. Am., 2(1): 29-33.

Mansel W. Griffiths (2010): Improving the safety and quality of milk. Volume 1: Milk production and processing Published by Woodhead Publishing Limited, Abington Hall,

WEB ADDRESSES

1. www.fao.org/ag/AGA/AGAP/Dairyman/Dairy/title1.htm
2. www.foodsci.uoguelph.ca/dairyedu/home.html
3. www.fao.org/ag/aga/lps/dairy/index.htm
4. www.cgiar.org/ilri/training/span/manual.pdf (full version online).
5. www.fao.org/docrep/007/y3548e/y3548e09.htm or www.fao.org

AKNOWLEDGEMENT

We would like to express our appreciation to the TVET instructors and experts of regional TVET bureau, TVET College, and Federal Technical and Vocational Education and Training Agency (FTVETA) who made the development of this learning module with required standards and quality possible. We wish thanks and appreciation to the representatives of BEAR II UNESCO project who covers the financial expenses, scarifying their time and commitments to develop this learning module.

The trainers who developed this learning guide

S.N	Name	Level	Educational Background	Institution	Region	Telephone	E-mail
1	Tesfaye Asrat	B	Animal Science	Motta PTC	Amhara	0923233339	tesfaye99love @gmail.com
2	Geresu Germamo	B	Food Science & Post harvest Technology	Wolayita Sodo PTC	SNNP	0916610590	geresug57@g mail.com
3	Hirpha Ketema	A	Animal Production	Holeta PTC	Oromia	0969432985	hirphaketema2 @gmail.com
4	Mulugeta Tesfaye	A	Dairy Science	EMDIDI	Oromia	0911984834	tmulugeta47@y ahoo.com
5	Sefi Shiferaw	B	Food Science & Post harvest Technology	Holeta PTC	Oromia	0938872353	sefishifera@gm ail.com
6	Tadessu Fikrie	A	Animal Production	Burie PTC	Amhara	0946238747	tadesufikre201 6@gmail.com
7	Tarekegn Cheo	B	Agricultural & Process Engineering	Hawasa PTC	Sidama	0931239119	tarekegecheo15 5@gmail.com
8	Abera Shiferaw	B	Animal Production & Health	Holeta PTC	Oromia	0911556155	aberashiferaw 2014@gmail.co m
9	Wondye Hatew	B	Animal Production	Holeta PTC	Oromia	0925255341	harme2013@g mail.com

Federal TVET Coordinator

S.N	Full Name	Organization	Position	Telephone	E-mail
1	Workneh Asmamaw	Federal TVET Agency	TVET Curriculum TTLM Expert	0955205855	workasmamaw@gmail.Com