Fluid Milk Processing

(Dairy Technology)

Practical Manual for

CLASS XI

CENTRAL BOARD OF SECONDARY EDUCATION, DELHI

Shiksha Kendra, 2 Community Centre, Preet Vihar, Delhi-110092, India

नया आगाज़

आज समय की माँग पर
आगाज़ नया इक होगा
निरंतर योग्यता के निर्णय से
परिणाम आकलन होगा।

परिवर्तन नियम जीवन का
नियम अब नया बनेगा
अब परिणामों के भय से
नहीं बालक कोई डरेगा

निरंतर योग्यता के निर्णय से
परिणाम आकलन होगा।

बदले शिक्षा का स्वरूप
नई खिले आशा की धूप
अब किसी कोमल-से मन पर
कोई बोझ न होगा

निरंतर योग्यता के निर्णय से
परिणाम आकलन होगा।
नई राह पर चलकर मंज़िल को हमें पाना है
इस नए प्रयास को हमने सफल बनाना है
बेहतर शिक्षा से बदले देश, ऐसे इसे अपनाए
शिक्षक, शिक्षा और शिक्षित
बस आगे बढते जाएँ
बस आगे बढते जाएँ
बस आगे बढते जाएँ.....

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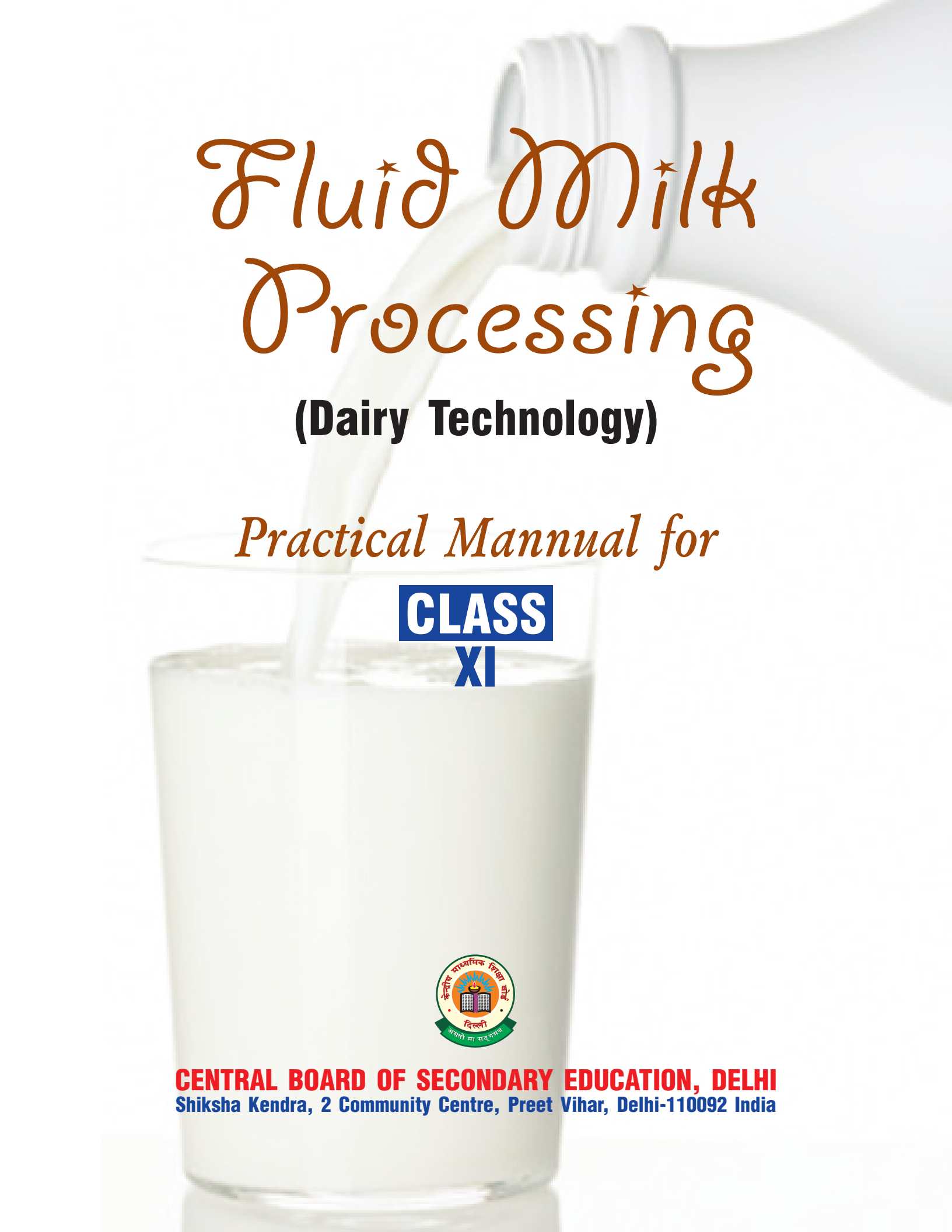

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Preface

Dairy Technology is a vocational/professional course and therefore practical aspect of this course has been given greater emphasis. This practical manual is designed to supplement textbook on **"Fluid Milk Processing"** for XI students and is an integral part of the Dairy Technology curriculum. There are sixteen exercises in this book to impart practical knowledge to the students. Practicals covered in this book are milk reception, platform tests, chilling, storage, clarification, cream separation, pasteurization, homogenization, packaging, sterilization, cleaning, sanitization etc. Schools may set up a small lab with pilot scale equipments and models. Educational visits to dairy processing plant may be arranged for the students.

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भारत का संविधान

उद्देशिका

हम, भारत के लोग, भारत को एक '[सम्पूर्ण प्रभुत्व-संपन्न समाजवादी पंथनिरपेक्ष लोकतंत्रात्मक गणराज्य] बनाने के लिए, तथा उसके समस्त नागरिकों को:

सामाजिक, आर्थिक और राजनैतिक न्याय,
विचार, अभिव्यक्ति, विश्वास, धर्म
और उपासना की स्वतंत्रता,
प्रतिष्ठा और अवसर की समता

प्राप्त कराने के लिए, तथा उन सब में, व्यक्ति की गरिमा और [राष्ट्र की एकता और अखण्डता] सुनिश्चित करने वाली बंधुता बढ़ाने के लिए दृढ़संकल्प होकर अपनी इस संविधान सभा में आज तारीख 26 नवम्बर, 1949 ई॰ को एतद्द्वारा इस संविधान को अंगीकृत, अधिनियमित और आत्मार्पित करते हैं।

1. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977) से "प्रभुत्व-संपन्न लोकतंत्रात्मक गणराज्य" के स्थान पर प्रतिस्थापित।
2. संविधान (बयालीसवां संशोधन) अधिनियम, 1976 की धारा 2 द्वारा (3.1.1977 से), "राष्ट्र की एकता" के स्थान पर प्रतिस्थापित।

भाग 4 क

मूल कर्त्तव्य

51 क. मूल कर्त्तव्य – भारत के प्रत्येक नागरिक का यह कर्त्तव्य होगा कि वह –

(क) संविधान का पालन करे और उसके आदर्शों, संस्थाओं, राष्ट्रध्वज और राष्ट्रगान का आदर करे;

(ख) स्वतंत्रता के लिए हमारे राष्ट्रीय आंदोलन को प्रेरित करने वाले उच्च आदर्शों को हृदय में संजोए रखे और उनका पालन करे;

(ग) भारत की प्रभुता, एकता और अखंडता की रक्षा करे और उसे अक्षुण्ण रखे;

(घ) देश की रक्षा करे और आह्वान किए जाने पर राष्ट्र की सेवा करे;

(ङ) भारत के सभी लोगों में समरसता और समान भ्रातृत्व की भावना का निर्माण करे जो धर्म, भाषा और प्रदेश या वर्ग पर आधारित सभी भेदभाव से परे हों, ऐसी प्रथाओं का त्याग करे जो स्त्रियों के सम्मान के विरुद्ध हैं;

(च) हमारी सामासिक संस्कृति की गौरवशाली परंपरा का महत्त्व समझे और उसका परीक्षण करे;

(छ) प्राकृतिक पर्यावरण की जिसके अंतर्गत वन, झील, नदी, और वन्य जीव हैं, रक्षा करे और उसका संवर्धन करे तथा प्राणिमात्र के प्रति दयाभाव रखे;

(ज) वैज्ञानिक दृष्टिकोण, मानववाद और ज्ञानार्जन तथा सुधार की भावना का विकास करे;

(झ) सार्वजनिक संपत्ति को सुरक्षित रखे और हिंसा से दूर रहे;

(ञ) व्यक्तिगत और सामूहिक गतिविधियों के सभी क्षेत्रों में उत्कर्ष की ओर बढ़ने का सतत प्रयास करे जिससे राष्ट्र निरंतर बढ़ते हुए प्रयत्न और उपलब्धि की नई उंचाइयों को छू ले।

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a [1] **SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the [2] [unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do **HEREBY TO OURSELVES THIS CONSTITUTION.**

1. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "Sovereign Democratic Republic (w.e.f. 3.1.1977)
2. Subs, by the Constitution (Forty-Second Amendment) Act. 1976, sec. 2, for "unity of the Nation (w.e.f. 3.1.1977)

THE CONSTITUTION OF INDIA

Chapter IV A

Fundamental Duties

ARTICLE 51A

Fundamental Duties - It shall be the duty of every citizen of India-

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) To promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement.

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Practical exercise 1

Milk receiption operation

Objectives

This exercise helps students about understanding various milk reception activities.

Introduction

Milk should be chilled to 4°C immediately after milking and be kept at this temperature all the way to dairy processing plant. Breaking of cold chains causes the growth and multiplication of micro-organisms and spoils the raw milk. Milk is transported from producer to collecting centre, where milk is collected from individual producers followed by cooling and subsequently sent to the dairy for processing. Milk is collected at different places in a milk catchment area such a collection at dairy cooperative society followed by sending to dairy processing plant as such or after chilling of milk. Milk is also collected at chilling centre where the production and processing sites are far away. Milk is collected at chilling centres where milk is cooled and stored under refrigerated conditions and sent milk at by refrigerated milk tankers to dairy processing plant. Nearby producers directly send the milk to dairy processing plant immediately after production. Large organized dairy farm produce milk which is cooled and stored in bulk chillier before sending the milk through insulated road tankers to dairy processing plant. The milk collected from cooperative dairy society collection centres, chilling centres etc is chilled at dairy processing plant and stored in insulated silos to keep the milk temperature below 5°C to prevent microbial growth and spoilages of milk. The collection and flow of milk from producers to dairy processing plant is depicted in Figure 1.1.

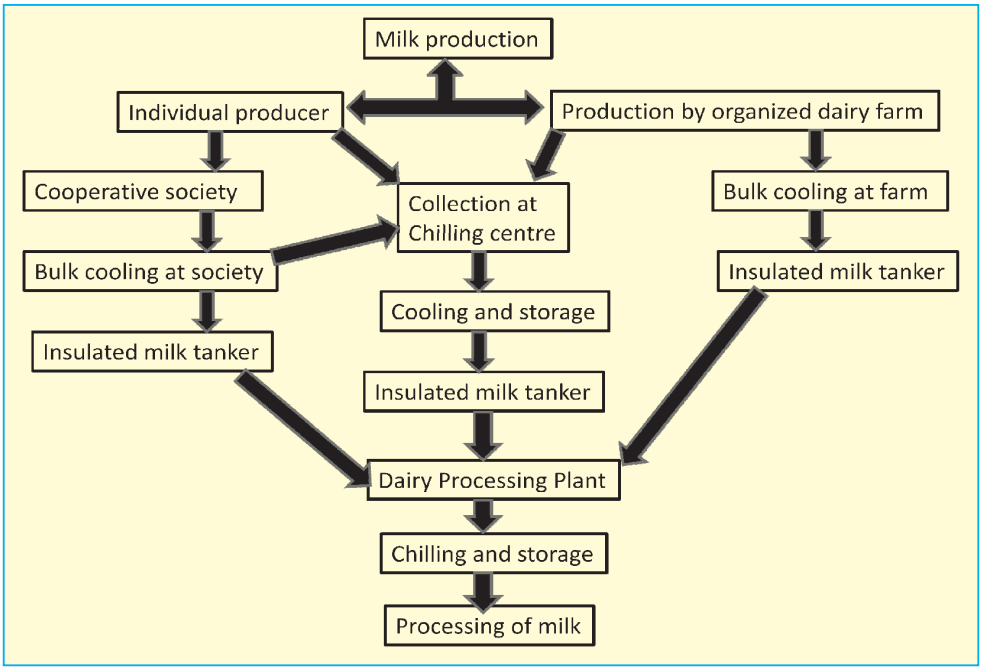

Fig.1.1. Flow of milk from producers to processing plant

Collection from small producers

Milk is transported by various sizes container, the most common being of 10 to 50 litres capacity. It is done just before arrival of collecting truck. Milk collecting centres is established in regions where there is no good road to the dairy farm, when water and/or electricity are not available on the farm, or when the milk quantities are too small to justify investment in cooling facilities. Another alternative is that neighbouring farmers deliver their un-cooled milk in milk can to a larger farm for cooling and subsequent transfer to chilling centres or dairy processing plant. The can-collecting lorry follows a planned schedule path so that it always arrives at each collection point in time and ultimately transports the milk to processing plant immediately. Each farm/ producers has unique code number, which is stamped on cans and it is used to trace the milk for making payment. Subsequently, milk is collected at processing plant after conducting thorough tests. It is then chilled and stored in insulated silos until processing.

Bulk collection

When milk is collected by tanker, it may be possible to drive all the way to the farm milk room. The insulated tanker is loaded from the farm cooling tank or bulk cooling tank at bulk cooling centre at society level or chilling centres. The tanker is fitted with a flow meter for measuring the volume of milk or volume is measured by difference of volume

of initial and leftover milk. The tank of the bulk collection vehicle is divided into a number of compartments to prevent the milk from splashing during transportation.

Milk reception

Dairies have special reception departments to handle the milk brought in from the farms. The first thing done at reception is to determine the quantity of the milk. The quantity is recorded and entered into the weighing system that the dairy uses to weigh the intake and compare it with the output. The quantity of the intake can be measured by volume or by weight (Fig.1.2).

After weighing raw milk is pumped to storage tanks to await processing. The empty cans are conveyed to a cleaning station, where they are washed with water and detergent to remove all traces of milk.

Fig.1.2. Milk weight balance

Tanker reception

Tankers arriving at the dairy drive straight into a reception hall, often large enough to accommodate several vehicles. The milk is measured either by volume or by weight (Fig.1.3).

The volume of milk is recorded by fitting a flow meter during emptying of tanker. Measuring can be improved by fitting an air eliminator before the flowmeter. The tanker outlet valve is connected to an air-eliminator and from this the

Fig.1.3. Milk tanker for transportation of milk under chilled conditions

milk – free from air – is pumped through the flowmeter, which continuously indicates the total flow. The milk is pumped to a storage (silo) tank directly or through suitable chillers for cooling the milk before storage in silo.

Measurement of weight of milk is done in two ways: A) Weighing the tanker before and after unloading and then subtracting one value from the other and B) Using special weighing tanks with load cells in the feet. The tanker is driven onto a weighbridge at the dairy. Operation may be manual or automatic. When empty, the tanker is weighed again and the tare weight is deducted from the previously recorded gross weight. After this the milk is pumped to a silo tank. Tankers are cleaned every day, as a rule at the end of a collection round. Cleaning can be carried out by connecting the tanker to a cleaning system while in the reception area, or by driving it to a special cleaning station.

Chilling and storage of raw milk

The temperature of milk may increase to above 4°C during transportation. The milk is usually cooled to below 4°C in a plate heat exchanger after reception of milk at dairy processing plant and stored in insulated storage tank (silo tank) till processing. The untreated raw milk – whole milk – is stored in large vertical tanks – silo tanks – which have capacities from about 5,000 litres up to 1,00,000 litres (Fig.1.4). Silo tanks are of double-wall construction, with insulation between the walls. The inner tank is of stainless steel, polished on the inside, and the outer wall is usually of welded sheet metal.

Fig.1.4. Milk storage silos

Sampling of milk during milk collection

Quality control in the dairy industry must cover all the quality aspects of milk and milk products throughout the total milk chain from the dairy cow to the consumer. Quality control and assurance must begin at the farm. Farmers must use approved practices of milk production and handling. Also all regulations regarding the use of veterinary drugs on lactating animals and against adulteration of milk, etc. must be observed.

Milk Sampling

Accurate sampling is the first prerequisite for fair and just quality control system. Liquid milk in cans and bulk tanks should be thoroughly mixed to disperse the milk fat before a milk sample is taken for any chemical tests. Representative samples of packed products must be taken for any investigation on quality. Plungers and dippers are used in sampling milk from milk cans.

Sampling milk for bacteriological tests require a lot of care. On the spot sterilisation may be employed using 70% Alcohol swab and flaming or scaling in hot steam or boiling water for 1 minute.

Sample Preservation

Chemical Tests

Milk samples for butterfat testing may be preserved with chemicals like Potassium dichromate (1 Tablet or ~ ml 14% solution in a 1/4 litre sample bottle is adequate.) Milk samples that have been kept cooling a refrigerator or ice-box must first be warmed in water bath at 40°C, cooled to 20°C, mixed and a sample then taken for butterfat determination. Other preservative chemicals include Sodium acid at the rate of 0.08% and Bronopol (2-bromo-2-nitro-l, 3-propanediol) used at the rate of 0.02%.

If the laboratory cannot start work on a sample immediately after sampling, the sample must be cooled to near freezing point quickly and be kept cool till the work can start. If samples are to be taken in the field e.g. at a milk cooling centre, ice boxes with ice packs are useful.

Labelling and Records Keeping

Samples must be clearly labelled with name of farmer or code number and records of dates, and places included in standard data sheets. Good records must be kept neat and in a dry place. It is desirable that milk producers should see their milk being tested, and the records should be made available to them if they so require.

Milk sampling at milk collection centres

All milk from different farmers must be checked for quantity, wholesomeness, acidity and hygienic quality.

After the milk has left the farm where it is produced, the first control takes place when it arrives at the collection centre or at the platform of the dairy plant. Information is required about the quantity, quality, hygiene, composition, water content, etc. This is needed to determine the payment that the producer will receive for his or her milk. The level of information required depends on many factors. To get an impression about the quality of the supplied milk a sample is taken and placed in sample bottles with preservatives added. Potassium dichromate is usually added to keep the samples in a good condition. Always try to keep milk samples as cool as possible.

Milk must be thoroughly mixed before sampling to make sure that all ingredients and substances are dispersed throughout the container. The next procedures are recommended at the Collection Centre.

1. Agitate the milk at least ten times with the full length of a plunger or dipper. Immediately after this take the sample of the required volume, put it into a sample bottle and close it. To make sure that a sample will represent all the milk well, one can take half of the required sample from the lower portion and half from the upper portion of the milk can.

2. If no plunger is available, agitate the milk as good as possible with a dipper with a long enough handle. Take half of the sample from the lower portion and half from the upper portion of the milk can.

3. Sampling from a smaller milk container can be done after turning the container ten times upside down. Take care that the container is closed well. Make sure that the samples are labeled and that all information about the sample is carefully recorded to avoid confusion. Some examples of milk tests are briefly described below, with

an emphasis on simple and cost effective methods. These focus on milk reception tests (the platform tests) that can be carried out at Milk Collection Centres.

Milk receiption at dairy factories

Milk from individual farmers or bulked milk from various Milk Collection Centres must be checked for quantity plus bacteriological and compositional quality. Also tests on the presence of antibiotics are carried out regularly.

Activities

- Visit a milk collection centre/ dairy plant reception dock and observe and note down the activities.

REVIEW QUESTIONS

1. What is the importance of chilling of milk after collection?
2. What is the need of sampling of milk during reception?
3. What do you mean by bulk milk chiller?
4. What is importance of platform tests?
5. How is the milk for chemical analysis preserved?

Practical Exercise 2

Platform tests for milk

Objective

Platform tests of milk are the commonly used tests carried out at collection and/or reception for rapid evaluation of quality of the incoming raw milk. These are carried out at the Milk Collection Centres and at Milk Processing Plants. This is important in dairy processing as single lot of milk of poor quality can spoil the whole mixed milk lot. Platform tests do not directly involve the laboratory analysis of raw milk samples. The suspected milk will be segregated and will not be mixed with bulk milk. The milk not fulfilling the compliance with previously set quality standards is subjected to rejection.

A. Organoleptic tests

Quality of milk judged by a person's senses view, smell, and taste is called organoleptic tests. The tests are the first screening of incoming raw milk at reception dock. No equipment is required for conducting the tests. Trained and experienced person yield the reliable results. The appearance of milk and lid of milk can is observed and inspected instantly after removal of lid. Judge smells the milk, observes the appearance, checks the can for cleanliness, looks for sediment, flies, etc. and tastes if necessary. For classifying the milk according to cleanliness, milk is filtered with a special milk filter. If there is any doubts the milk samples are subjected to other laboratory tests for confirming the quality.

Protocol

1. Open the can/ container of milk.
2. Immediately smell the milk.
3. Observe the appearance of the milk.
4. If still unable to make a clear judgement, taste the milk, but do not swallow it. Spit the milk sample into a bucket provided for that purpose or into a drain basin, flush with water.
5. Look at the can lid and the milk can to check cleanliness.

Observations/Judgement

- Condition of containers/cans : _____
- Appearance of milk : _____
- Colour of milk : _____
- Extraneous matter : _____
- Accept/reject milk : _____
- Comments : _____

Abnormal smell and taste may be caused by:

- *Atmospheric taint (e.g. barny/ cowy odour).*
- *Physiological taints (hormonal imbalance, cows in late lactation-spontaneous rancidity).*
- *Bacterial taints.*
- *Chemical taints or discolouring.*
- *Advanced acidification (pH < 6.4).*

B. Indicator test

The acidity developed in milk due to bacterial activity is measured in terms of pH value as indicated by special indicator dyes, e.g. brom thymol blue and brom-cresol purple.

Observation

Acidity of milk : _____

Accept or reject milk : _____

C. Sediment test

Milk is passed through a funnel containing a filter disc and the amount of dirt and dust collected is compared visually or by weight. The test indicates the gross impurities and dirt in milk as a result of unhygienic conditions of production.

Sediment test

Presence of sediment : _____

Accept or reject milk : _____

D. Lactometer or density test

During the organoleptic inspection, if the milk appears to too thin and watery and its colour is “blue thin”, it is suspected that the milk contains added water. Lactometer test serves as a quick method to determine adulteration of milk by adding water. The test is based on the fact that the specific gravity of whole milk, skim milk and water differ from each other.

The density or specific gravity of milk is determined by lactometer reading. At 15 ºC the normal specific gravity of the milk ranges from 1.028 to 1.033. Below the value indicate the possible addition of water to the milk. It is also possible the lactometer reading can be combined with the fat test to have the total solid levels in milk. Density of fat is lower than that of milk. Results of the low fat test and higher specific gravity indicate the possible skimming of milk. Results of low fat test and low specific gravity indicate the possible addition of water in milk. Always read the temperature of the milk first; the lactometer reading varies according to temperature.

Fig.2.1. Measurement of density of milk using lactometer

Observations

1. Type of lactometer : _____
2. Temp of milk : _____
3. Lactometer reading : _____
4. Specific gravity of milk : _____

E. Clot-on-boiling test

This test is performed simply by heating a small amount (5 ml) of milk in a test tube over a flame or by immersing it in boiling water for four minutes. The result can be seen immediately. If the milk is sour or if the milk is abnormal (colostrum or mastitis milk) the milk will clot and not pass this test. Heating will precipitate the proteins in the milk if it is sour. This test is not very sensitive to slightly sour milk, but still very useful. If no coagulation occurs the milk can stand heating operations at the time of testing.

Protocol

1. Boil a small amount of milk in a test tube.
2. Observe the clot formation, coagulation or precipitation.
3. When the developed acidity of milk is more than 0.20% Lactic acid, COB test is positive.

F. Alcohol test

Alcohol test is used for rapid determination of an elevated acidity or alteration of salt balance due to admixing of colostrums to milk. It is carried out by mixing equal quantities (2 ml) of milk and of a 68% ethanol solution (made by mixing 68 ml of 96% alcohol with 28 ml distilled water) in a test tube. If acidity of milk is more than 0.21% acid, the milk will be coagulated. The milk will not be suitable for heat processing like pasteurization. Hence, alcohol test is recommended for each and every incoming milk-can and container, whenever the milk is to be pasteurized. If the result of the alcohol test indicates a too high acidity, a milk sample can be taken to the laboratory for a more detailed testing by the titratable acidity test.

Protocol

1. Mix equal amounts of milk and 68% of ethanol solution in a small test tube. For routine testing 2 ml milk is mixed with 2 ml 68% alcohol.
2. Observe the coagulation, clotting or precipitation in milk.
3. The first clotting due to acid development can first be seen at 0.21-0.23% lactic acid.

G. Alcohol-Alizarin test

The procedure for carrying out the test is the same as for alcohol test but this test is more helpful. Alizarin is a colour indicator changing colour according to the acidity of milk. The Alcohol-Alizarin solution can be bought readymade or be prepared (0.4 g alizarin powder) in 1 lit of alcohol (61%).

Protocol

1. Mix equal amounts of milk and 68% of ethanol solution in a small test tube. For routine testing 2 ml milk is mixed with 2 ml 68% alcohol.
2. Observe the coagulation, clotting or precipitation in milk and change in colour of milk.

Observations/Results for alcohol-alizatin test

Parameter	Normal milk	Slightly acid Milk	Acid milk	Alkaline Milk
pH	6.6 – 6.7	6.4 – 6.6	6.3 or lower	6.8 or higher
Colour	Red brown	Yellowish-brown	Yellowish	Lilac
Appearance of milk	No coagulation no lumps	No coagulation	Coagulation	No coagulation

H. Titratable acidity test

Test measures the concentration of lactic acid in the milk. Higher acidity (more than 0.18 % lactic acid) indicates that milk quality is poor and it cannot be heated and processed as during heat processing milk will be curdled. Sodium hydroxide solution is added to the milk by titration. More the sodium hydroxide solution required for neutralization higher the acidity of the milk.

Materials

- Small conical flask or beaker
- Pipette (1 and 10 ml)
- Burette (0.1 ml graduations)
- Phenophtalein indicator solution (0.5% in 50% alcohol)Sodium hydroxide solution (1/9 N)

Procedure

1. Take 10 ml of the milk into conical flask or beaker
2. Add 1 ml Phenopthalein indicator in the milk and mix thoroughly.

3. Titrate the milk against 1/9 N NaOH using burette under continuous mixing, until a faint pink colour appears.

4. The volume of Sodium hydroxide solution required for titration is divided by 10 expresses the percentage of lactic acid.

I. Gerber test to determine fat content in milk

Test is used to determine fat content of milk. Some milk is added to a butyrometer together with sulphuric acid and amyl-alcohol. A special centrifuge and a water bath are needed for this test. The test does not give an accurate result when the fat content of the milk is less than 3.2%.

Materials

- Gerber butyrameters (0-6% or 0-8% BF)
- Rubber stoppers for butyrometers
- 10.94 or 11 ml pipettes for milk
- 10 ml pippetes or dispensers for Gerber Acid
- 1 ml pippetes or dispensers for Amyl alcohol
- Stands for butyrometers
- Gerber sulphuric acid (sp. gr. 1.82)
- Amyl alcohol

Prococol

1. Mix well the fresh milk (approx. 20ºC) and warm low temperature of stored milk to approx. 20ºC before mixing.

2. Transfer 10 ml sulphuric acid to the butyrometer

3. Add 10.75 ml of well mixed milk into the butyrometer slowly.

4. Add 1 ml of Amyl alcohol and insert stopper.

5. Shake the butyrometer gently till the curd dissolves and place the butyrometer in the water bath (65ºC) for warming

6. Place the butyrometer in the centrifuge with the stem (scale) pointing towards the centre of the centrifuge and centrifuge at 1100 rpm for 5 min.

7. Take the butyrometers after centrifugation.

8. Put the butyrometers in a water bath (65ºC) for 3 min.

9. The fat column should be read from the lowest point of the meniscus of the interface of the acid-fat to the 0-mark of the scale and read the butterfat percentage.

J. 10 min Resazurin test

Resazurin test is the most widely used test for hygiene and the potential keeping quality of raw milk. Resazurin is a dye indicator. Under specified conditions Resazurin is dissolved in distilled boiled water. The Resazurin solution can later be used to test the microbial activity in a given milk sample. The 10 min Resazurin test is useful and rapid, screening test used at the milk platform. The 1 hr test and 3 hr tests provide more accurate information about the milk quality, but after a fairy long time . They are usually carried out in the laboratory.

Materials

- Resazurin tablets
- Test tubes with 10 ml mark
- 1 ml pipette or dispenser for Resazurin solution.
- Water bath thermostatically controlled
- Lovibond comparator with Resazurin disc 4/9

Protocol

1. The solution of Resazurin as prepared by adding one tablet to 50 ml of distilled sterile water. Rasazurin solution must not be exposed to sunlight, and it should not be used for more than eight hours because it losses strength.

2. Mix the milk and with a sanitized dipper put 10 ml milk into a sterile test tube.

3. Add one ml of Resazurin solution, stopper with a sterile stopper, mix gently the dye into the milk and mark the tube before the incubation in a water bath, place the test

tube in a Lovibond comparator with Resazurin disk and compare it colourimetrically with a test tube containing 10 ml milk of the same sample, but without the dye (Blank).

Observations

Resazurin disc No.	Colour	Grade of milk	Action
6	Blue	Excellent	Accept
5	Light blue	v. good	Accept
4	Purple	Good	Accept
3	Purple pink	Fair	Separate
2	Light pink	Poor	Separate
1	Pink	Bad	Reject
0	white	Very bad	Reject

K. Detection of Adulteration:

a) Detection of starch

- Take 3 ml milk in a test tube.
- Boil the milk sample.
- Cool it and add a few drop of iodine solution (1%).
- Appearance of blue colour indicates the presence of starch.
- Blue colour disappears when the sample is boiled.

b) Detection of cane sugar

- Take 1 ml milk in test tube.
- Add 1ml HCl.
- Add 0.1g resorcinol powder and mix well.
- Place the test tube in boiling water for 5-10 min.

- Appearance of red colour indicates the presence of cane sugar in milk sample.

c) Detection of neutralizers

- Take 1 ml milk in test tube.
- Add 5 ml alcohol.
- Add a few drops of rosalic acid solution (1%) and mix well.
- Appearance of rose red colour indicates the presence of carbonate.

Activities

- Perform the various plat form tests by taking pure raw milk, old acidic milk, and raw milk with added adulterants.
- Visit a milk collection centre/ dairy plant reception doc and observe and note down the activities performed by the analysts.

REVIEW QUESTIONS

1. Define platform tests?
2. What is the need of platform tests in a milk reception doc?
3. How are water addition/ skimming of milk checked?
4. What is the importance of 10 min Resazurin test?
5. What is importance of alcohol test?
6. Define developed acidity of milk.

Practical Exercise 3

Straining, filtration and clarification of milk

Objective

To improve the aesthetic quality of milk by removing visible foreign matter in order increase consumer acceptability

Principle

Filtration and straining removes suspended foreign particles like dirt, fly, straw, hair etc. by the straining process while clarification removes the same by centrifugal sedimentation.

Strainer and straining of milk

Even after maintaining strict hygienic conditions, milk may contain some foreign matter like dirt, fly, straw etc. Funnel shaped strainer made of SS-304 is suitable for pouring of milk from producer's vessel to milk cans or balance tank. At the funnel's conical bottom, there is a removable type stainless steel 40 mesh strainer for filtering extraneous matter in the milk (Figs. 3.1). The SS filter is round in shape and is properly fixed at the periphery by SS strip ring. The filter rests in a grooved step in the funnel. Typical dimensions of the funnel type strainer are mentioned below:

Top Diameter :320 mm

Bottom Diameter :127 mm +/- 2 mm

Height :190 mm +/- 2 mm

Strainer Diameter :127 mm +/- 5 mm

Material of Construction : AISI 304

Thickness of the sheet :1.2 mm

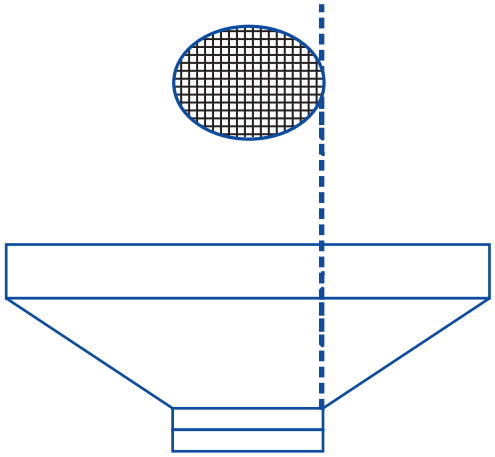

Fig.3.1. Schematic diagram of Strainer

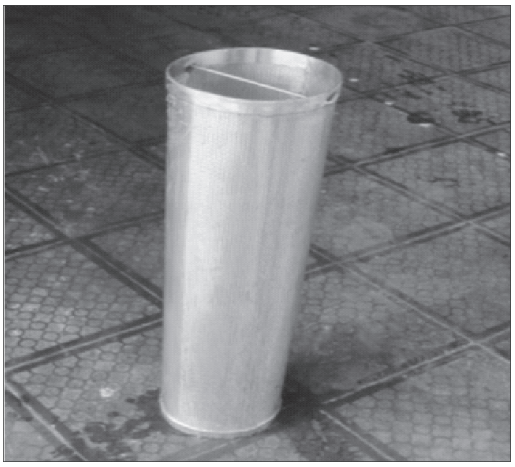

Fig.3.2. In-line strainer

Filter and filtration of milk

Filtration of milk ensures that sediment or other extraneous matter is removed from the milk. It is a cloth or pad of the desired pore size which can retain the smallest particle. A frame or support is kept to compress and hold the margins of the cloth or pad so that milk can only pass through the pores the cloth or pad is also supported by perforated metal which will not tear or break under the pressure of the milk. The filter is designed in such a way that cloths or pads can be changed quickly and all parts are easily accessible for washing. Filtration can also be done at farm by in-line filter installed in the automatic milking system. Forcing milk through an in-line filter (Fig. 3.2) by a pump is the most common method of filtering milk in modern milking plants. The in-line filters are of tube in tube type (Table 3.1). The milk filter media consists of a nylon filter bag/pad supported on a perforated stainless steel (SS) filter element. Filter element is held in an SS casing with a blank nut/clamp lid, milk distributor, inlet and outlet connections. In-line filters should be installed before the chiller. This allows the milk to be warm when filtered and facilitates the passage of milk fat through the filter. Filters should be cleaned periodically in 8-10 hours depending upon the deposits. Usually two filters are installed in parallel to facilitate cleaning of filter while other is in use (Fig. 3.3). One of the biggest drawbacks

of filter is the drop in flow rate over time because a thicker and thicker filter layer builds up. Therefore use of in-line filters is for removal of course impurities.

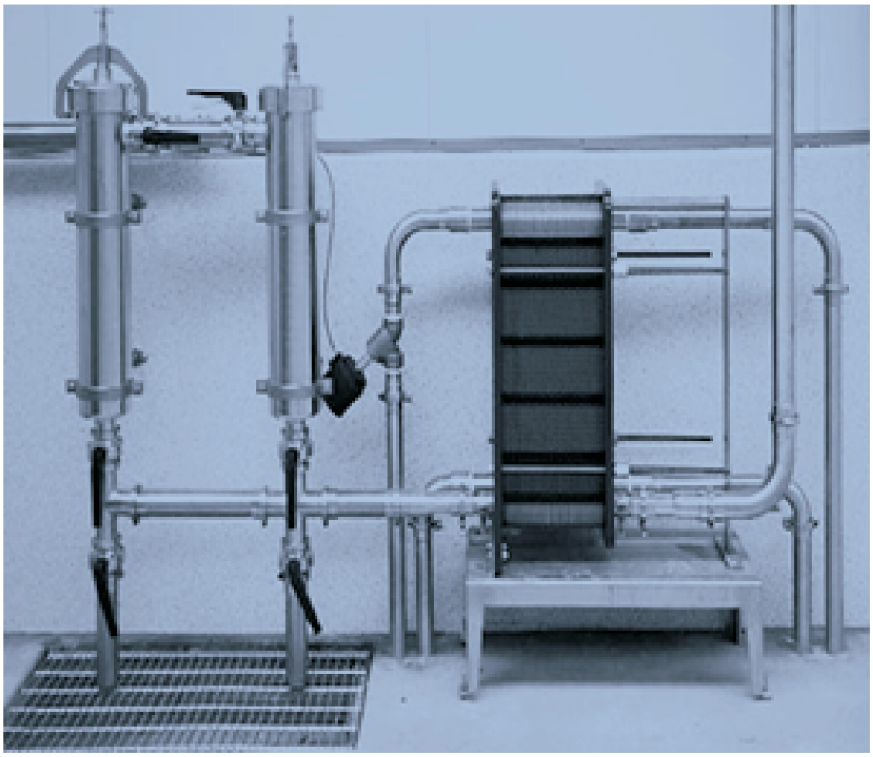

Fig.3.3. In-line milk filters

Table 3.1. Details of in-line filter for filtration of milk

Parameters	Milk plant capacity	
	5000 litre/hour	10000 litre/hour
Diameter of in-line filter	75-80 mm	100-110 mm
Inlet pipe size	38 mm	51 mm
Outlet pipe size	51 mm	63 mm
Type of filtering element	SS-304 perforated screen (1-1.5 mm holes)	SS-304 perforated screen (1-1.5 mm holes)
Diameter of filtering element	63 mm	70 mm
Length of filtering element	225-250 mm	225-250 mm
Provision of cleaning	Blank nut/Clamp	Blank nut/Clamp

Clarifier and clarification of milk

Filtration is for removal of material lighter than milk such as wood, cellulose, packaging material residue etc., whereas clarification is done to remove components heavier than milk. Milk clarification is the process of removing undesirable foreign matter such as dirt, curd particles, blood corpuscles, epithelial cells, bacteria sediment, sludge etc from the milk. To some extent bacteria also get removed as slime during the clarification process. However, clarification cannot be considered an effective means of bacteria removal.

Clarifier is similar to that of centrifugal cream separator, however, it has only one outlet compared to cream separator which has two outlet one for one for cream and another for skim milk. The discs in the clarifier bowl are smaller in diameter to allow accumulation of large slime and the milk distribution holes are at the outer edge of the discs in clarifier.

The clarifier consists of conical discs stacked over each other which rotate inside the clarifier bowls. Milk is introduced into the separation channels at the outer edge of the disc stack, flows readily inwards through the channels towards the axis of rotation and leaves through the outlet at the top (Fig. 3.4). Particles, which are denser than the continuous milk phase, are thrown back to the perimeter. The sludge gets collected in the space around the disc and milk being lighter moves up towards the outlet. The amount of solids that collect will vary however it must be manually removed from the centrifuge at regular intervals. From the studies it has been established that warm clarification of milk, e.g. at 50 to 55°C is preferred to cold clarification.

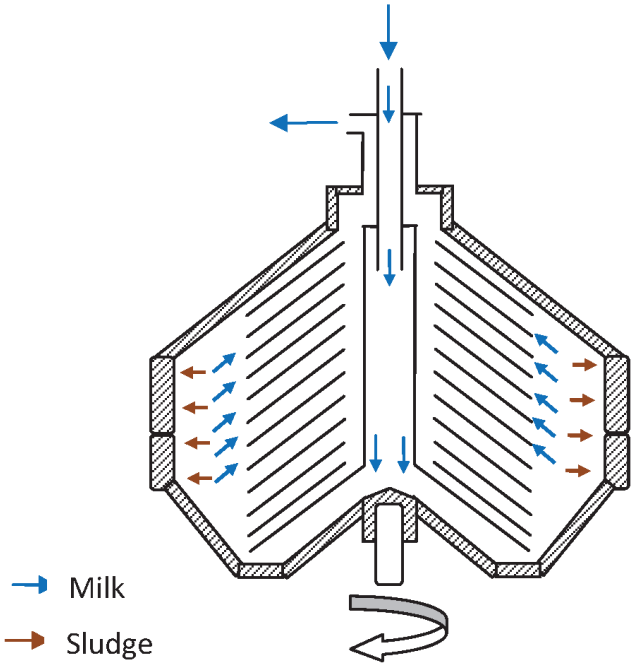

Fig.3.4. Schematic diagram of clarifier

Fig.3.5. In-line modern clarifier

Modern clarifiers are of self-cleaning type which allows for continuous operation (Fig.3.5). The clarifier bowl has discharge ports which open up periodically. These discharge ports remain closed under pressure. Release of pressure opens the port and sludge is evacuated from the space. Such removal of sludge results in about 0.05-0.10% of milk being lost.

REVIEW QUESTIONS

1. What do you mean by straining, filtration and clarification of milk?
2. How clarifier is different from cream separator?
3. What are the parts of strainer and clarifier?
4. What are the disadvantages of clarification of milk?
5. Will you suggest straining/filtration/clarification of milk? Why if yes or not?

Practical Exercise 4

Chilling and storage of milk

Objective

To know about the chilling and storage process of milk

a) at village cooperative/ at big dairy form using bulk milk cooler

b) at chilling centre or at main processing plant

Principle

Raw milk is perishable commodity and have limited shelf life few hours at ambient temperature (around 30°C), because milk has all the necessary nutrition for required for microorganisms to grow. This leads to utilization of lactose (milk sugar) and production of lactic acid. This causes the development of acidity in milk and cause curdling of milk upon boiling or thermal processing. Therefore, milk must be stored at temperature less than 4°C as quickly as possible. This chilled storage restricts the growth of microorganisms and hence prevents or delays the acidity development in the milk. Milk is collected from the farmers or milk producers at village cooperative society, if the volume of milk collection is more than 2000 litres per day, then bulk milk cooler (BMC) is provided to a particular society or dairy form. If the if the volume of milk collection is less than 2000 litres per day than milk is collected in can and these can are unloaded at chilling centre or at main processing plant whichever is near to village milk cooperative society.

Requirements

Milk, plate chiller, storage tank, thermometer thermocouple

Procedure

a) At village cooperative / at big dairy farm using bulk milk cooler (BMC)

i. Open the lid of the BMC

ii. Thoroughly clean the BMC with detergent solution manually

iii. Pour the milk to BMC through filter cloth

iv. Close the lid of BMC

v. Set the temperature 4°C

vi. Turn-on cooling unit and agitator

vii. Record the initial temperature and time to reach 4°C

b) At chilling centre or at main processing plant

i. Receive the milk cans according to the society wise at reception dock

ii. Open the cans lid and record the sensory quality and also perform other platform tests if necessary

iii. Unload the accepted cans and collect the milk in dump tank

iv. Record the temperature and collect the sample for chemical and microbial analysis of milk

v. Turn-on the chilled water supply to plate-chiller

vi. Switch-On centrifugal pump connected to dump tank

vii. Turn the valve to allow the chilled raw milk flow to raw milk collection tank

viii. Switch-on the agitator of raw milk storage tank

Observations

Record the following observations

i. BMC capacity _____litres

ii. Raw milk temperature before dumping into BMC _____°C

iii. Final cooling temperature _____°C

iv. Time taken to reach the final temperature _____minutes

v. Dump tank capacity _____litres

vi. Capacity of milk pump (centrifugal) _____litres

vii. Temperature of milk in dump tank _____°C

viii. Temperature of milk after chilling _____°C

ix. Temperature of milk in raw milk storage tank _____°C

x. Capacity of raw milk storage tank _____litres

REVIEW QUESTIONS

1. What is the importance of chilling?
2. Briefly describe procedure of milk chilling at village cooperative/dairy farm.
3. Briefly describe procedure of milk cooling at chilling centre.
4. What is the temperature of milk chilling?
5. How will you determine BMC capacity?

Practical Exercise 5

Study of cream separator

Objective

To study construction and working of cream separator

Principle

The fat content in raw milk varies widely from 3.5-6.0%. Cream has to be removed from raw milk to make standard, toned or double toned milk. Sometimes entire cream is removed which is known as skimming. This cream is removed from the whole milk by using cream separator (Fig.5.1 and 5.2).

Fig.5.1. Cream separator

Construction

Parts of A cream separator.

1. **Outer Casing:** It covers the motor, gear system and bowl assembly.
2. **Drive mechanism:** Drive mechanism consists of electric motor and gear system. Motor shaft is connected to

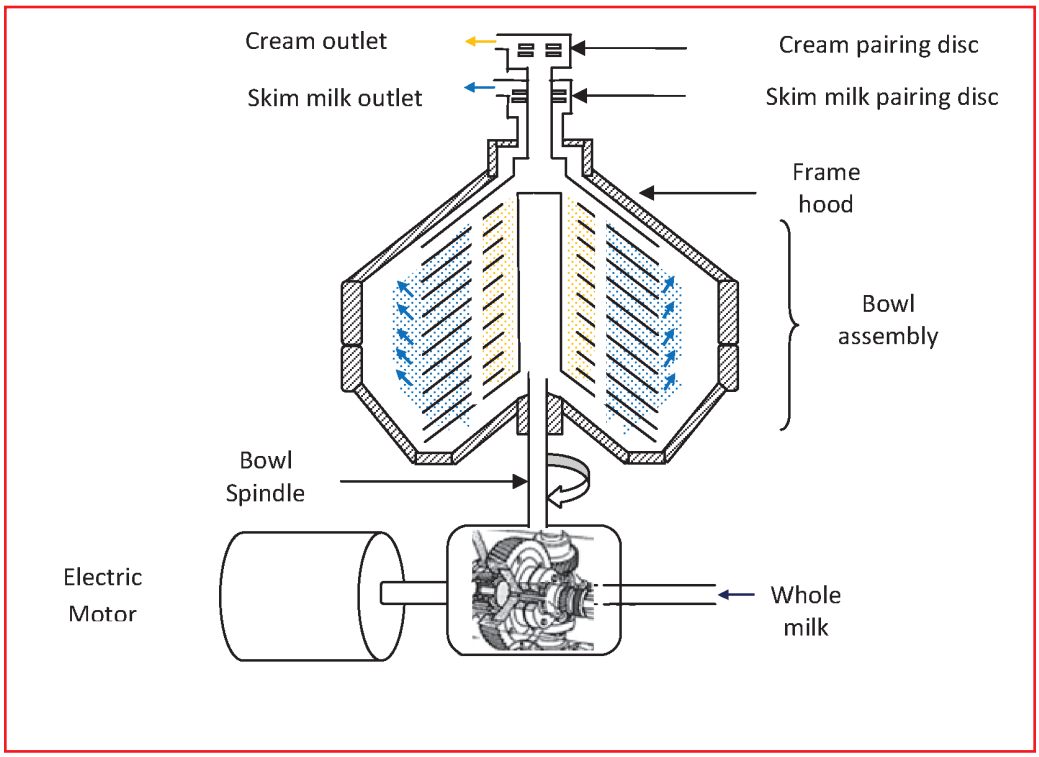

Fig.5.2. Construction of cream separator

a gear system which increases the rotational rpm (Revolution per minute) which is required for centrifugal separation. Advanced cream separators has provision to vary operational rpm to operate separator at different capacity.

3. **Bowl assembly:** It consists of bowl, bowl hood (cover) and disc stack

4. **Disc stack:** It has numbers of cone shaped discs which are stacked one above the other. The discs are made up of stainless steel. It has distribution holes which are positioned one above the other making channel for the ascending liquid

5. **Pairing disc or centripetal pump:** There are two centripetal pumps located at the top of disc bowl in a cream separator. One is for pumping cream and other is for skimmed milk. Centripetal pump has rotating vanes to pump milk or cream towards the outlet.

6. **Cream outlet:** The cream after separation through the disc stacks is discharged from the cream outlet.

7. **Milk/skim milk outlet:** Milk from which cream has been removed is discharged from the milk outlet.

Working principle

Milk is pumped into the cream separator at 50-55 ^{o}C which is the optimum temperature for cream separation. Milk enters the bottom of bowl assembly through the hollow bowl spindle. An electric motor rotates the bowl assembly at a high rpm. Due to high rotational speed and centrifugal force the heavier phase (milk plasma) flows away from the axis towards the bowl walls. This Milk plasma or the skimmed milk is pumped out by a centripetal pump toward the milk outlet. Simultaneously, the lighter phase (fat/cream) in the milk is separated from the whole milk and flows towards the axis of the bowl assembly. Cream is channeled upwards through the distribution holes in the disc and then it is pumped by the centripetal pump towards the cream outlet.

REVIEW QUESTIONS

1. What is the purpose of cream separator?
2. With a net diagram show various part of a cream separator?
3. Briefly describe the working principle of a cream separator?
4. What is the function of pairing disc?

Practical Exercise 6

Study of can washer

Objective

To know working of rotary and straight through can washer

Requirements

Can washer, cans

Can washer

Raw milk is brought to the chilling centre or processing plants in cans. Can are made of aluminium, stainless steel or plastics. For a small capacity plant cleaning of cans is done manually. But in a large plant cans are cleaned by automatic system. In a milk collection cum chilling centre of capacity 20,000 litres milk per day, the number of cans handled will be around 500. Thus automatic system will be required. Methods of can washing are:

a. Manual

b. Rotary can washer (100-200 cans/h)

c. Straight through can washer

- Single track (600-900 cans/h)
- Double track (1200-1800 cans/h)

Types of can washer

1. Rotary can washer

Rotary can washers are semi automatic type having washing capacity of 100-200 cans/h. The equipment has a rotating disc partitioned into different segments for cleaning (Fig. 6.1). Cans are loaded inverted on the rotating disc.

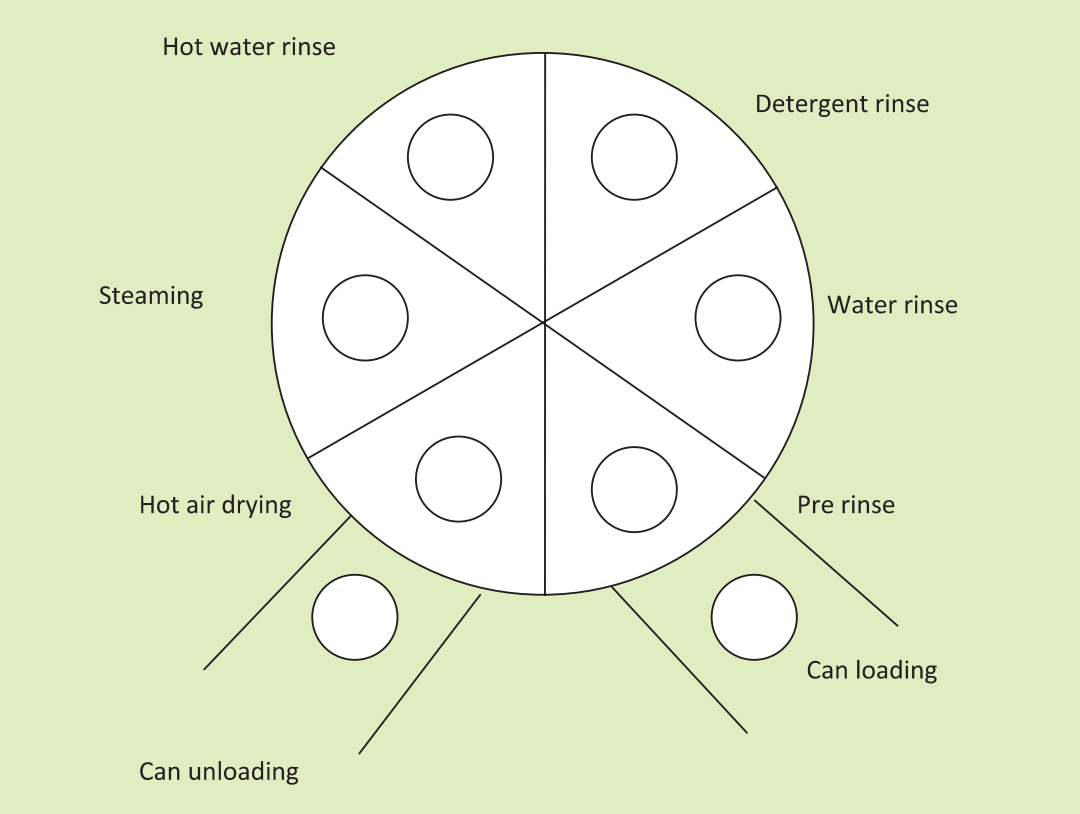

Fig.6.1. Rotary can washer

2. Straight through can washer

It is called “straight through” because washing of cans takes place in a straight line on a conveyor. The cans enter the washer in inverted position and cleaning is done by jet nozzles at various section of the washer. The washer has provision for washing of can lids. The sequence of cleaning is as follows:

1. **Loading:** cans are loaded into washer by conveyor
2. **Pre-rinse:** Water is sprayed through jets into cans to remove traces of milk

3. **Detergent rinse:** Detergent (Alkali/acid) solution is circulated at 65 – 70°C

4. **Hot water rinse:** Hot water at 80-90°C is sprayed in the cans.

5. **Steam sterilization:** Steam is injected into cans for sterilization

6. **Hot air drying:** Drying of cans is by blowing hot air (120-130°C)

7. **Inverting of can:** At the end of the washer a mechanical system inverts the cans to straight position.

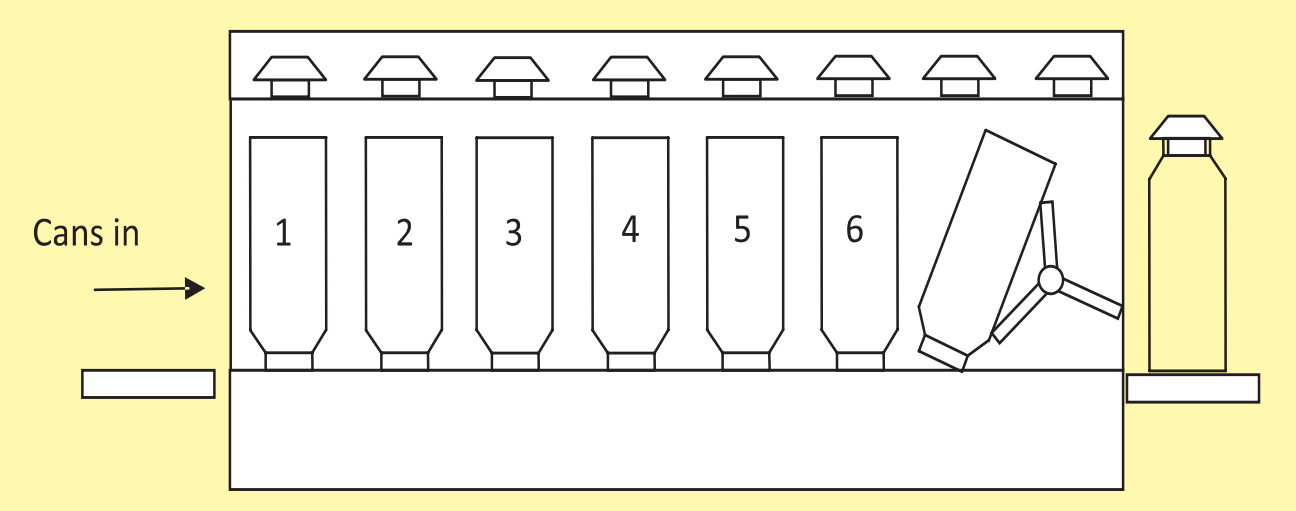

Fig.6.2. Straight through can washer

REVIEW QUESTIONS

1. With a neat diagram explain rotary type can washer?
2. Briefly describe working of straight through can washer?
3. Differentiate between rotary and straight through can washer?
4. What is the procedure for sterilization of cans?

Practical Exercise 7

Standardization of milk

Objectives

To understood method for milk standardization

Principle

According to the Food Safety and Standard Rules (2011), different types of liquid milk (market milk) are sold in the market. The minimum fat and SNF requirements for such milks is given in Table 7.1. So, the raw milk received at the dairy processing plant has to be adjusted to requested level of fat and SNF so that the particular type of milk confirms the regulatory standards.

Table 7.1. Minimum requirements of different classes of milk sold in Indian market

Class of milk	Milk fat	Milk solids-not-fat (SNF)
	Minimum (%)	
Double toned milk	1.5	9.0
Toned milk	3.0	8.5
Recombined milk	3.0	8.5
Standardized milk	4.5	8.5
Full cream milk	6.0	9.0

Basically, there are two methods by which whole milk can be standardized. They are: (i) removal of excess fat by separation, (ii) addition of skim milk or skim milk powder and water. In non-availability of whole milk, skim milk powder and cream or white butter (butter that doesn't contain salt) or butter oil can also be used for standardization. For standardization of a single component i.e, fat of SNF of milk, "Pearson's square" method is used. However, for standardization of both fat and SNF, algebraic method is commonly used.

Objective

To prepare full cream or standardized or toned or double toned milk from given raw materials.

Principle

For standardization of milk either for fat or SNF, "Pearson's square" method is commonly used. At first, it is necessary to know the relative amounts and fat or SNF contents of all raw materials that should be mixed together to give a product with desired fat or SNF content. The principle of Pearson's square method is illustrated in Fig. 1. It consists of drawing a square and placing the desired fat or SNF at the centre of the square (C). At the left hand corners of the square, fat or SNF percentage of given raw materials is placed. The material containing highest fat or SNF content (A) is placed at the top left corner and the lowest fat or SNF content (B) is placed at the bottom left corner of the square. The difference between the number in the centre and the number at the top left corner is placed at the bottom right corner of the square (A-C). Similarly, the difference between the number in the centre and the number at the bottom left corner is placed at the top right corner of the square (B-C). These two values placed at the right represent the proportions or relative amounts of the given raw materials to be mixed. The top right value represents the amount of the product at top left corner while the bottom right value represents the amount of the product at the bottom left corner. The two new values obtained on the right corners are summed to obtain a third value [(A-C) + (B-C)] which represents proportion of the desired final product.

Materials required

Stainless steel multipurpose vat and other containers, weighing balance, stirrers, bottles, lactometer, thermometers, buffalo milk or cow milk or skim milk of known composition,

skim milk powder and/or cream or butter oil or white butter of known composition and fat testing kit (comprising Gerber centrifuge, Gerber acid, amyl alcohol, butyrometer, rubber cork, key for opening and closing the butyrometer with cork).

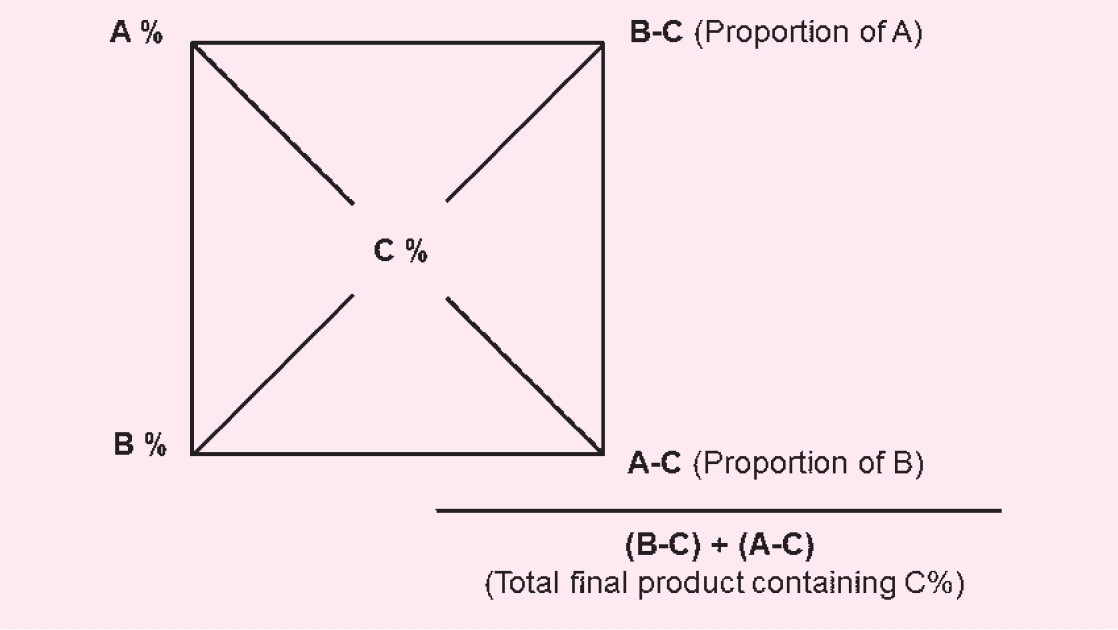

Fig.7.1. Illustration of Pearson's square method

Procedure

1. Determine the fat and SNF of raw materials chosen.
2. Calculate the quantity of cream, milk, skim milk or skim powder required in the standardized milk.
3. Weigh each ingredient separately.
4. Mix the ingredients thoroughly in a multipurpose vat.
5. In case SNF level is to be raised, mix skim milk powder while constantly stirring the contents in the vat.
6. Pasteurize the product by the batch or HTST process and cool below 4-5°C.
7. Fill the milk in clean sterile bottle or polyethylene pouches and cap or seal as the case may be.
8. Store milk around 4-5°C till distribution.

Observations

The following observations should be recorded:

1. Composition of ingredients

Item	Fat (%)	SNF (%)
Milk		
Cream		
Skim milk		
Skim milk powder		
White butter		

2. Quantity of ingredients

Item	Quantity (Kg)
Cow / Buffalo milk	
Skim milk	
Skim milk powder	
Cream	
White butter	

3. Type of milk prepared: _____

4. Quantity of milk prepared: _____ Kg

5. Composition of milk prepared

Fat %	
SNF %	

6. Quantity of milk packed: _____ Kg

7. Loss of milk: _____ Kg

8. Temperature of storage of milk: _____ °C

Results

1. Quantity of _____ milk packed _____ Kgs
2. Percent loss of milk is _____

REVIEW QUESTIONS

1. What do you understand by milk standardization?
2. Explain the principle for standardization of milk?
3. Give minimum fat/SNF toned and double toned milk?
4. Give minimum fat/SNF standardized and full cream milk?
5. Describe procedure for preparation of standardized and full cream milk.

Practical Exercise 8

Study of batch pasteurizer and HTST pasteurizer

Objective

To study batch and HTST pasteurizer.

Requirements

Batch pasteurizer and HTST (high temperature short time) pasteurizer

Principle

Pasteurization is a heat treatment to destroy all pathogenic microorganisms in milk. This process makes milk safe to consume. The method used for pasteurization are:

a. Batch method: Low temperature long time (LTLT) pasteurizer

In Low Temperature Long Time (LTLT) method, milk is heated to 63°C in a jacketed tank or vat with agitator. Milk in the vat is heated by using hot water or steam (Fig. 8.1). Milk is kept for 30 minutes at 63ºC temperature and then it is allowed to cool. This method is used for processing milk upto 5000 liters.

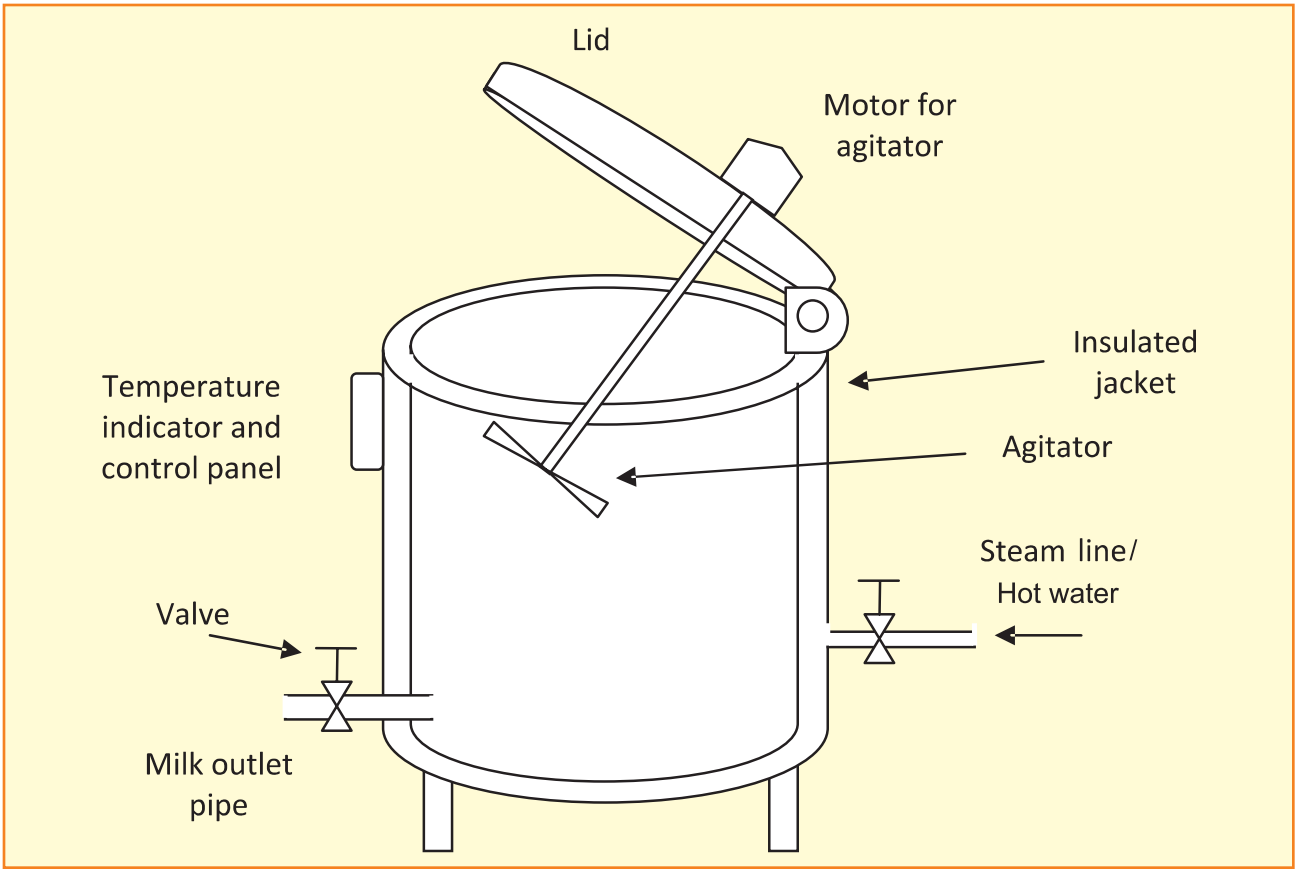

Fig.8.1. Batch pasteurizer

b. Continuous method: High temperature short time (HTST) pasteurizer

High Temperature-Short Time (HTST) pasteurization is the most widely used method for commercial processing of milk (Fig. 8.2 and 8.3). Milk is heated to a temperature of at least 72°C and is kept at this temperature for not less than 15 seconds. Milk is then immediately cooled to a temperature of less than 4°C.

Working of HTST pasteurizer

- Raw chilled milk which is at 4-5 °C is pumped into the balance tank of pasteurizer from the milk silos.
- Milk from the balance tank is pumped by a centrifugal pump to the inlet of regeneration section.

- In the regeneration section, temperature of raw milk is raised by the returning pasteurised milk. This helps to recover and utilize heat of the pasteurized milk. This process saves energy for heating raw chilled milk.
- Milk from the regeneration section then flows into the heating section. Milk is heated upto 72°C in the heating section and is kept for 15 sec in the holding tubes.
- A temperature sensor at the end of holding tube measures the temperature. If milk temperature is less than 72°C then the flow diversion valve (FDV) is set to divert flow mode. Milk temperature less than 72°C indicates that milk is not properly pasteurized. Milk flow is diverted by the FDV towards the raw milk balance tank.
- If the milk temperature is more than 72 °C then FDV is set to forward flow mode. Pasteurized milk flows toward the regeneration section where it cooled by the incoming raw milk.
- Milk enters the chilling section and milk temperature is lowered to 4 °C by the chilled water.
- From the chilling section milk flows towards the packaging section.

Fig.8.2. HTST Pasteurizer

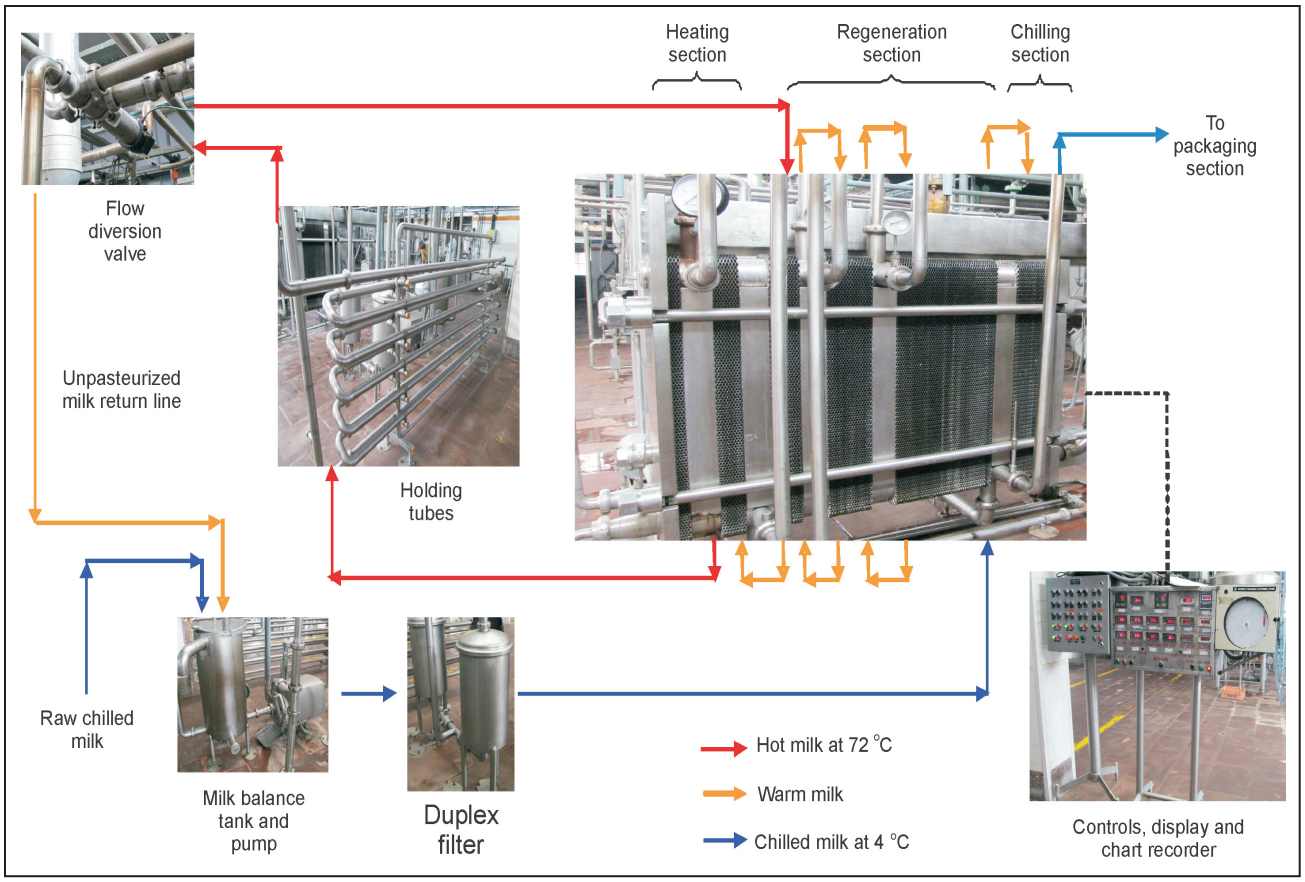

Fig.8.3. HTST Pasteurizer

REVIEW QUESTIONS

1. List differences between LTLT and HTST pasteurization?
2. What is the purpose of FDV valve?
3. Describe working of HTST pasteurizer?
4. What is the purpose of regeneration section?
5. With a neat diagram describe batch pasteurizer.

Practical Exercise 9

Pasteurization of milk

Objective

To study pasteurization of milk.

Requirements

Electric batch pasteurizer or steam batch pasteurizer or steam jacketed kettle, digital thermometer, stop watch

Procedure (Electric batch pasteurizer)

i. Fill electric batch pasteurizer upto three fourth volume of the heating vessel or marked level (Fig.9.1).

ii. Switch on the equipment and agitator.

iii. Set thermostat temperature control at 63 °C.

Fig.9.1. Electric batch pasteurizer

iv. Start measuring the time with a stop watch after milk temperature reaches 63 °C.

v. If temperature is uniformly maintained at 63 °C, milk will be pasteurized in 30 minutes.

Procedure (steam batch pasteurizer or steam jacketed kettle)

i. Fill steam batch pasteurizer (Fig. 9.2) or steam jacketed kettle (Fig. 9.3) upto three fourth volume.

ii. Open the steam valve to supply steam to the pasteurizer or steam jacketed kettle.

iii. Set steam pressure to maintain the temperature of milk at 63 °C.

iv. Start measuring the time with a stop watch after milk temperature reaches 63 °C.

v. If temperature is uniformly maintained at 63 °C, milk will be pasteurized in 30 minutes.

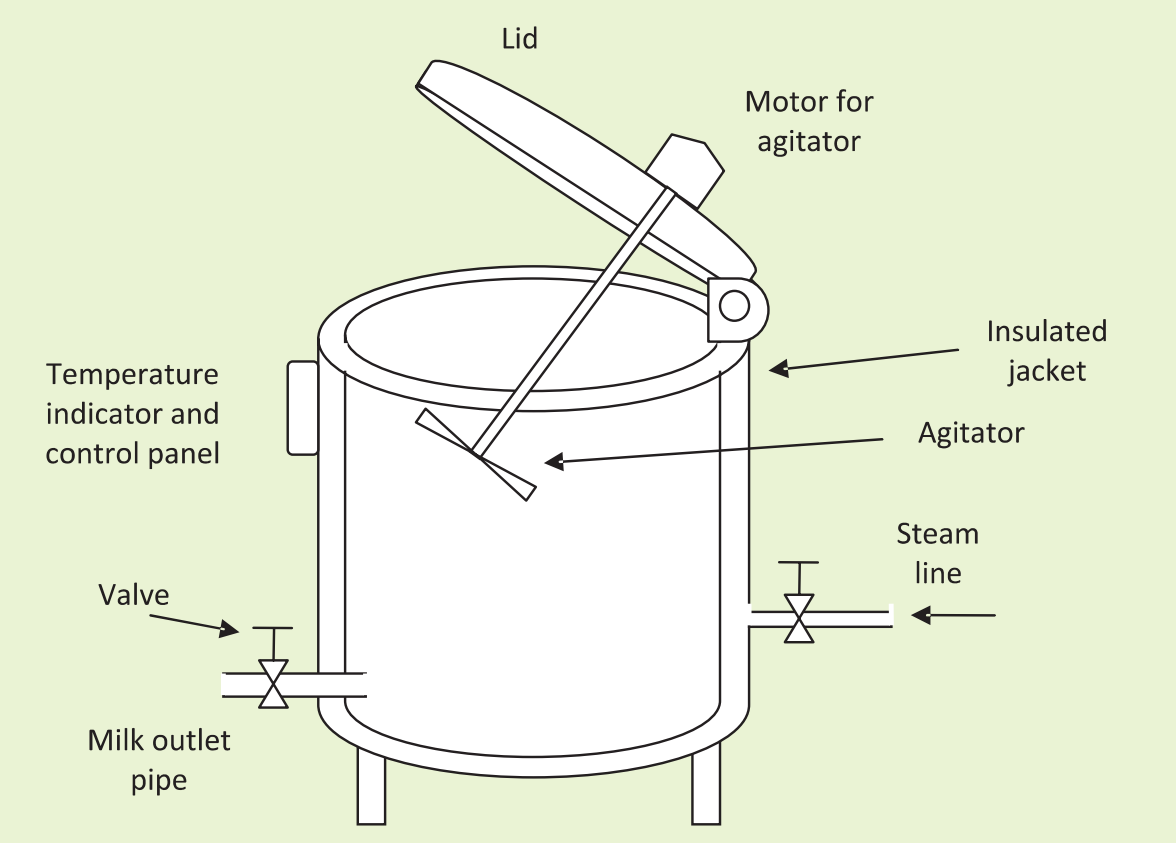

Fig.9.2. Steam batch pasteurizer

Fig.9.3. Steam jacketed kettle

REVIEW QUESTIONS

1. Describe procedure for electric batch pasteurization.
2. Describe procedure for steam batch pasteurization.
3. What is the function of thermostat?

Practical Exercise 10

Determination of efficiency of pasteurization

Objective

Determination of efficiency of pasteurization

Requirements

A. Buffer solution: 1.5 g of sodium bicarbonate and 3.5 g of anhydrous sodium carbonate are dissolved in water to make it one litre. Store in a refrigerator and discard after 1 month.

B. Disodium p- nitrophenylphosphate. The solid substrate must be kept in the refrigerator.

C. Buffer-substrate solution - Weigh accurately 0.15 g of substrate (disodium p-nitrophenyl phosphate) into a 100 ml measuring cylinder and make it up to 100 ml with buffer solution. The solution should be stored in refrigerator and protected from light. The solution should give a reading of less than the standard marked 10 on comparator disc APTW or APTW 7 when viewed through a 25 mm cell (distilled water is used as a blank). The solution must be discarded after one week.

D. A Lovibond Comparator with stand for work in reflected light.

E. A lovibomd comparator disc APTW or APTW 7.

F. Two Fused glass cells of 25 mm depth.

G. A water bath or incubator capable of being maintained at 37.5 ± 0.5°C.

H. 1 ml pipette and 5 ml pipette.

I. 1 litre graduated flask.

J. 100 ml measuring cylinder.

K. Test tubes, nominal size 150/16 mm with rubber stoppers.

Introduction

Alkaline phosphatase enzyme is naturally present its milk. The enzyme activity is destroyed at pasteurization temperature and has been adopted as an index of the efficiency of pasteurization. Since milk is a proven vector for a number of pathogenic bacteria, including Salmonella, Campylobactor and Listeria, the test is of very great significance to the dairy industry as a means of policing the thoroughness of heat treatments or the addition of raw milk to heated or unheated products In the following method, a solution of disodium p-nitrophenyl phosphate in a buffer of pH 10.2 is used as substrate. This compound, colourless in solution, is hydrolyzed by alkaline phosphatase of milk to liberate p-nitrophenol, which under alkaline condition gives an intense yellow colouration to the solution. The liberated p-nitrophenol is measured by direct comparison with standard colour discs in a Lovibond comparator. The test does not apply to sour milk and milk preserved with chemical preservatives.

Procedure

In a test tube pipette, 5 ml of buffer substrate solution, place stopper and bring the temperature to 37°C. Add 1 ml of test milk to it, shake and replace stopper, incubate at 37°C for 2 hrs. Incubate one blank prepared from boiled milk of the same type as that undergoing the test with each series of sample. Remove the tubes after 2 h and the content should be well mixed. Place the boiled milk blank on left hand side of the comparator stand and test sample on the right. Take reading in reflected light by revolving the disc until the test sample is matched. Record readings falling between two standards by affixing a plus or minus sign to the figure for the nearest standard.

The test is considered satisfactory if it gives a reading of 10 µg or less of p-nitrophenyl per ml of milk. Properly pasteurized milk gives no discernible colour.

Reference

FSSAI.2012. Manual of methods of analysis of foods. Milk and milk products. Ministry of Health and Family Welfare, GOI, New Delhi

REVIEW QUESTIONS

1. What is the importance of alkaline Phosphatise test?
2. Describe procedure for determination of pasteurization efficiency.
3. List reagents for pasteurization efficiency test.

Practical Exercise 11

Study of homogenizer, homogenization of milk and determination of homogenizer efficiency

Objective

Study of homogenizer, homogenization of milk and determination of homogenizer efficiency

Requirements

Homogenizer, 1 litre measuring cylinder

A. Study of homogenizer

Homogenizer is used to break the fat globules present in milk into smaller size. Homogenization process helps to prevent cream separation and formation of cream layer.

Observation

Make and model _____

Capacity _____ kg/h

Pressure 1st stage _____

Pressure 2nd stage _____

B. Procedure for determination of homogenizer efficiency

Analytical methods for determining homogenisation efficiency can be divided into two groups.

1. Studies of creaming rate

The oldest way of determining the creaming rate is to take a sample, store it for a given time, and analyse the fat contents of different layers in the sample. A sample around 1,000 ml is stored for 48 hours, after which the fat content of the top 100 ml is determined as well as the fat content of the rest. Homogenisation is reckoned to be sufficient if 0.90 times the top fat content is less than the bottom fat content.

The NIZO method is based on the same principle, but with this method a sample around 25 ml is centrifuged for 30 minutes at 1,000 rpm, 40°C and a radius of 250 mm. The fat content of the 20 ml at the bottom is divided by the fat content of the whole sample, and the ratio is multiplied by 100. The resulting index is called the NIZO value. The NIZO value of pasteurised milk is normally 50 – 80%.

2. Size distribution analysis

The size distribution of the particles or droplets in a sample can be determined in a well defined way by using a laser diffraction unit, which sends a laser beam through a sample in a cuvette. The light will be scattered depending on the size and numbers of particles in the sample. The result is presented as size distribution curves.

REVIEW QUESTIONS

1. What is the primary purpose of homogenization?
2. What are the advantages of homogenization?
3. Briefly describe NIZO process.
4. Briefly describe size distribution analysis.

Practical Exercise 12

Study of sterilizer, sterilization of milk and determination of sterilization efficiency

Objective

Study of sterilizer, sterilization of milk and determination of sterilization efficiency

Requirements

Batch sterilizer, milk, reagent (listed in the practical)

Study of batch steriliser and sterilization of milk

i. Fill milk in crown cork bottles and seal it with crown cork.

ii. Load the milk bottles into the sterilizer (Fig.12.1).

iii. Close the lid of the sterilizer tightly.

iv. Open the steam valve to supply steam to the sterilizer and set the steam control valve such that pressure inside the sterilizer is 15 PSI.

v. Maintain 15 psi pressure for 20 minutes.

vi. Open the vent slowly and allow steam to get released.

vii. Remove the bottles and allow cooling at room temperature.

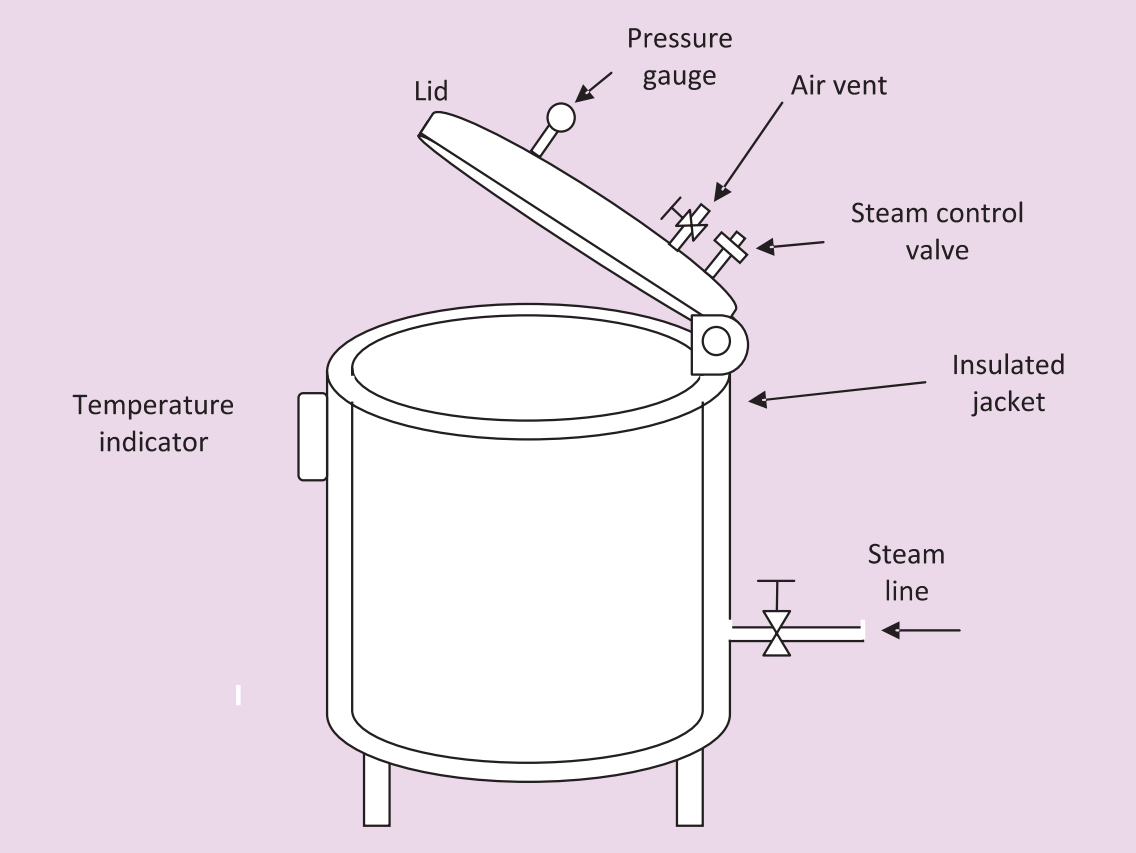

Fig.12.1. Batch sterilizer

Determination of sterilization efficiency by turbidity test

The turbidity test depends upon the denaturation of proteins of milk especially albumin after sterilization. When solutions of inorganic salts or acids are added albumin separates with the casein. The sample after treatment with ammonium sulphate is filtered and heating of the filtrate shows turbidity due to presence of albumin on account of insufficient heat treatment. If milk has been sterilized properly all albumin will have been precipitated and no turbidity will be produced. The test is not suitable for UHT milk.

Materials

- Ammonium sulphate AR
- Conical flask, 50 ml
- Graduated cylinder, 25ml.
- Test tubes 150 /16 mm
- Funnels, 6 cm dia.
- Beaker, 400 ml.
- Whatman No. 12 or equivalent, 12.5 cm folded filter paper
- Pipette, 20 ml

Procedure

Pipette 20 ml of milk in a 50 ml conical flask, add 4.0±0.1 g of ammonium sulphate. Shake the flask till the ammonium sulphate is completely dissolved. Allow the mixture to settle for 5 min, filter through a folded filter paper in a test tube. Keep about 5 ml of the above filtrate in a boiling water bath for 5 min. Cool the tube in a beaker of cold water and examine the contents for turbidity by moving the tube in front of an electric light shaded from the eyes of the observer. The milk is considered sterilized when the filtrate shows no turbidity.

Reference

FSSAI. 2012. Manual of methods of analysis of foods. Milk and milk products. Ministry of Health and Family Welfare, GOI, New Delhi

REVIEW QUESTIONS

1. Describe procedure for milk sterilization by batch method?
2. How will you determine sterilization efficiency?
3. At what pressure and time duration milk bottles should be sterilized?
4. Why it is necessary to determine sterilization efficiency?

Practical Exercise 13

Study of packaging system of milk

Objective

To know about the packaging material and machinery used for packaging of fluid milk

Requirements

Milk, LDPE (Low density polythylene) roll, VFFS (Vertical from fill seal) packaging machine

Procedure

i. Place the packaging roll in the roller assembly

ii. Connect the film to pouch forming assembly

iii. Switch on UV (Ultra Violet) lamp provided for sterilizing the film

iv. Check the teflon tapes of horizontal seal and vertical seal for proper integrity

v. Check the water connection to sealer head

vi. Set the pouch size to either 500ml or 1000ml

vii. Fill the milk to buffering tank of packaging machine

viii. Start the machine in manual mode

ix. Check for seal integrity whether it is sended properly or not and weight of the pouch

x. Store the packed pouches in cold room

Observations

Make and model of the VFFS machine _____

Capacity of machine _____litre per hour

Type of milk _____

Quantity of milk _____kg

Thickness of the film _____micron

Weight of 500ml pouch _____g

Weight of 1000ml pouch _____g

Number of 500ml pouches obtained per minute _____

Number of 1000ml pouches obtained per minute _____

REVIEW QUESTIONS

1. What is the procedure for operating vertical from fill seal (VFFS) packaging machine?
2. What is the purpose of UV lamp in the packaging machine?
3. Why checking of seal integrity important?
4. How will you determine capacity of packaging machine in terms of milk pouch per hour?

Practical Exercise 14

Preparation of toned milk, double toned milk, flavoured milk and reconstituted milk and recombined milk

Objective

To know about the method of preparation of

a) toned milk and double toned milk

b) flavoured milk

c) reconstituted milk and

d) recombined milk

Principle

Milk should meet the minimum legal requirements prescribed by Food Safety Standards Authority of India (FSSAI) in order to sell in market. FSSAI prescribe the minimum fat and SNF level for different market milks as listed below.

	Fat % (min.)	SNF% (min.)
Toned Milk	3.0	8.5
Double tone milk	1.5	9.0

The flavoured milk should have minimum fat and SNF level as that of toned or double toned or from the milk which has been prepared. The standards for reconstituted milk were not suggested as reconstituted milk has not been sold in the market rather reconstituted milk is used for standardization purpose largely. The recombined milk should have minimum fat and SNF level as that of toned milk. So standardization is an important step in preparing all these types of milk. Homogenization may be performed to avoid cream plug in the milk and for better quality. Thermal processing of these milk is performed either pasteurization or UHT processing or retort sterilization. Retort sterilization is applicable largely for flavoured milk preparation

a) Preparation of toned milk and double toned milk

Requirements

Stainless steel containers, Conical flask, pipettes, burette, beaker, weighing balance, measuring cylinder, water bath, ice-bath, milk butyrometer, lactometer, thermometer, lock stoppers, lactometer jar, Gerber acid, amyl alcohol, homogenizer

Procedure

i. Analyse the raw materials given for preparation of toned milk.

ii. Calculate the quantity of various ingredients required for making toned milk and double toned using the methods described at Exercise No. 07.

iii. Carefully weigh the liquid ingredients in a clean and dry container required for preparation of both the products.

iv. Carefully weigh dry ingredient (SMP if required) in a clean and dry container.

v. Pre-heat liquid ingredients to 35 – 40°C and mix well.

vi. SMP can be mixed at pre-heating temperatures.

vii. Filter the contents and heat to 65°C and pass through homogenizer at 2500 psi in first stage and 500 psi in the second stage.

viii. Heat the milk further to 72°C for 15 seconds if it is continuous mtheod or heat to 63°C for 30 minutes

ix. Immediately cool the contents to 4° C.

x. Fill in requisite containers or packaged in VFFS machine and store at 4° C in a cold room.

xi. Draw a representative sample and test the final product.

Observations

Amount of skim milk used	____kg
Amount of cream used	____kg
Amount of whole milk used	____kg
Fat & SNF percent in cream	____% and ___%
Fat & SNF percent in skim milk	____% and ___%
Fat & SNF percent in whole milk	____% and ___%

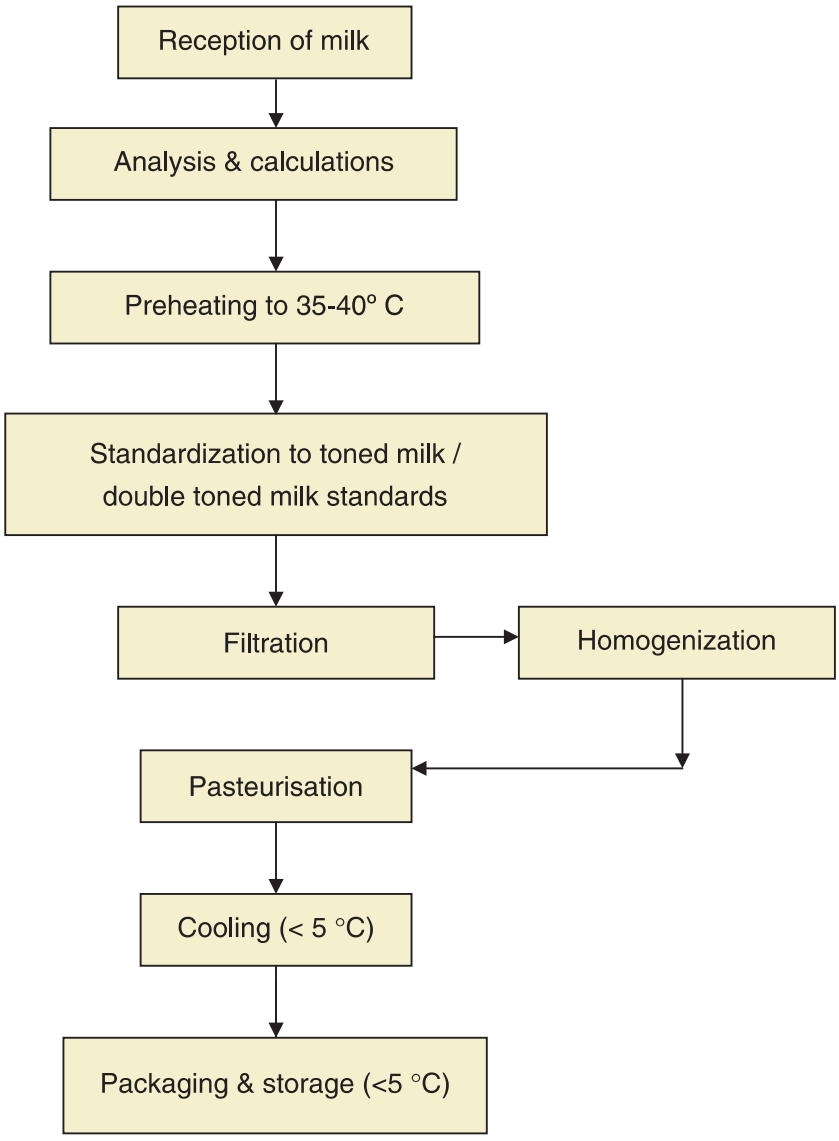

Fig.14.1. Preparation of toned milk and double toned milk

b) Preparation of sterilized flavoured milk

Requirements: - Stainless steel containers, pipettes, beaker, weighing balance, measuring cylinder, homogeniser, sterilizer, glass bottles crown cork, sterilizer, corking machine, milk butyrometer, lactometer, thermometer, lock stoppers, lactometer jar, Gerber acid, amyl alcohol

Procedure:

i. Prepare the milk to either of toned milk or double toned milk standards.

ii. Heat to 40 – 45°C

iii. Add sugar (7 – 8 %), colour (less than 100ppm)and flavor (0.15 to 0.2%) and mix thoroughly and then filter it.

iv. Heat to 65°C and homogenize in a double stage homogenizer

v. Fill the contents in crown cork bottles and hermetically seal with crown cork.

vi. Stack the bottles in a vertical or horizontal sterilizer.

vii. Close the lid of the sterilizer tightly to avoid leakage of steam.

viii. Start the sterilizer and open the vent.

ix. When steam starts to escape, close the vent fully.

x. Allow to built 15 psi pressure and maintain the same for 15-20 minutes.

xi. Open the vent slowly and allow the steam to release until pressure is neutralized.

xii. Open the lid of the sterilizer and remove the bottles and allow cooling at room temperature.

xiii. Store sterilized milk bottles at room temperature and cool to 8° C before use.

Observations

Quantity of milk used	____kg
Fat & SNF percent of milk	____% and ___%
Quantity of sugar	____kg
Quantity of colour added	____kg
Colour used	____
Quantity of flavor added	____ml
Fat & SNF percent of finished product	____% and ___%

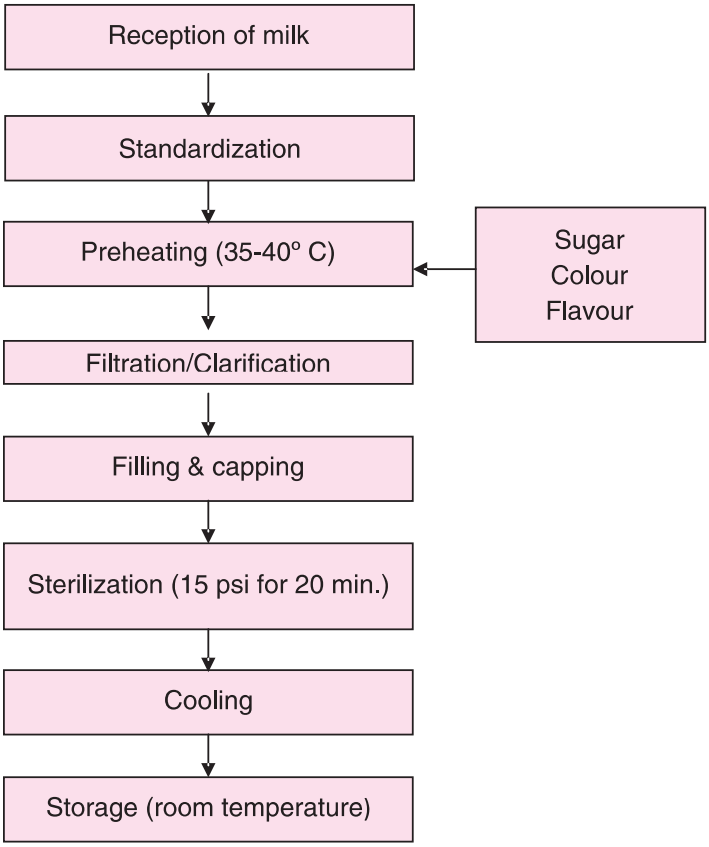

Fig.14.2. Preparation of sterilized flavoured milk

c) Preparation of reconstituted milk

Requirements

Stainless steel containers, Conical flask, pipettes, burette, beaker, weighing balance, measuring cylinder, water bath, ice-bath, crate, bottles, milk butyrometer, lactometer, thermometer, lock stoppers, lactometer jar, Gerber acid, amyl alcohol, SMP, WMP

Procedure:

i. Take good quality Whole or Skim milk powder.

ii. Analyse milk powder for fat and SNF content.

iii. Calculate the quantity of milk powder and water needed for required amount of reconstituted milk.

iv. Take the calculated amount of water in a clean container and heat to 40-45° C.

v. Slowly add calculated amount of milk powder while mixing the contents.

vi. Continue mixing until all the milk powder is properly dissolved.

vii. Pasteurize the contents at 72° C for 16 seconds or 63° C for 30 minutes.

viii. Immediately cool the contents to 4 – 6° C using chilled water or ice bath.

ix. Fill into clean and dry container (bottles) and secure with a cap.

x. Place the bottles in a crate.

xi. Store the crates containing bottles of reconstituted milk at 4°C in a cold store.

Observations

Amount of skim milk powder used ____kg

Amount of water used ____kg

Quantity of reconstituted milk obtained ____Kg

Fat & SNF percent of skim milk powder ____% and ___%

Fat & SNF percent of reconstituted milk ____% and ___%

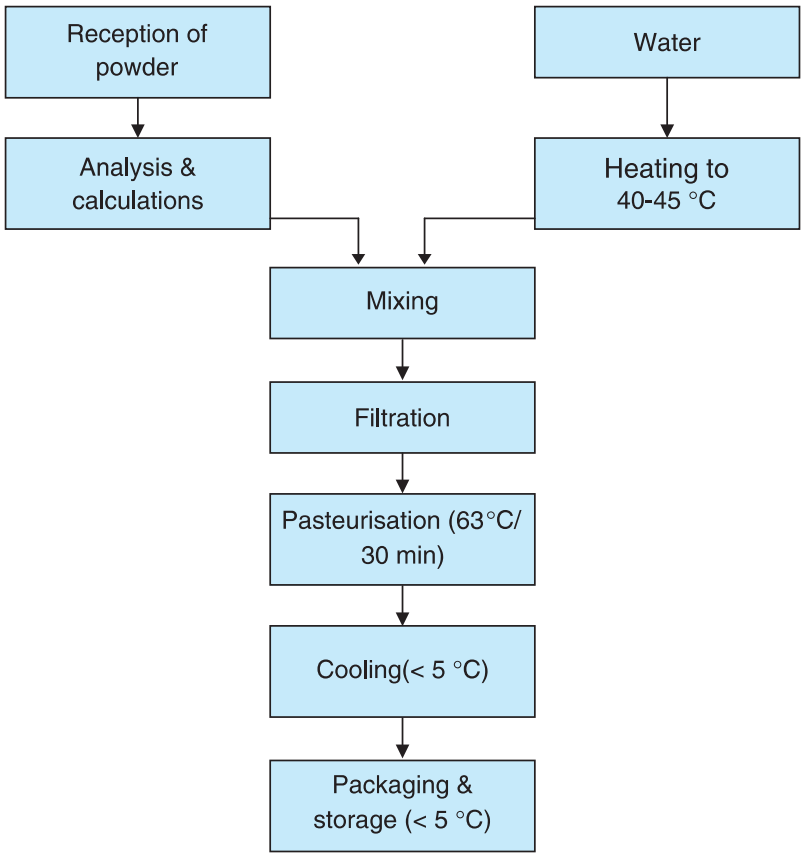

Fig.14.3. Flow diagram for preparation of reconstituted milk

d) Preparation of recombined milk

Requirements

Stainless steel containers, Conical flask, pipettes, burette, beaker, weighing balance, measuring cylinder, water bath, ice-bath, milk butyrometer, lactometer, thermometer, lock stoppers, lactometer jar, Gerber acid, amyl alcohol

Procedure

i. Take calculated amounts of fresh or reconstituted skim milk as a source of SNF for the resultant product.

ii. Take calculated amount of high fat cream, butter or butter oil as a source of fat.

iii. Bring the temperature of the contents to 40 – 45°C and mix well.

iv. Homogenize the contents in a double stage homogeniser using pressure of 2000psi and 500psi.

v. Blend and standardize the mixture to desired fat and SNF content.

vi. Pasteurize the contents at 73°C for 15 seconds or 63°C for 30 minutes.

vii. Immediately cool to 4°C and fill in required containers.

viii. Store at 4°C in cold room.

Observations

Quantity of reconstituted or fresh skim milk used	____kg
Quantity of butter or cream butteroil used	____kg
Fat & SNF percent of cream / butter / butteroil	____% and ___%
Fat & SNF percent of reconstituted or fresh skim milk	____% and ___%
Fat & SNF percent of recombined milk	____% and ___%
Quantity of recombined milk obtained	____kg

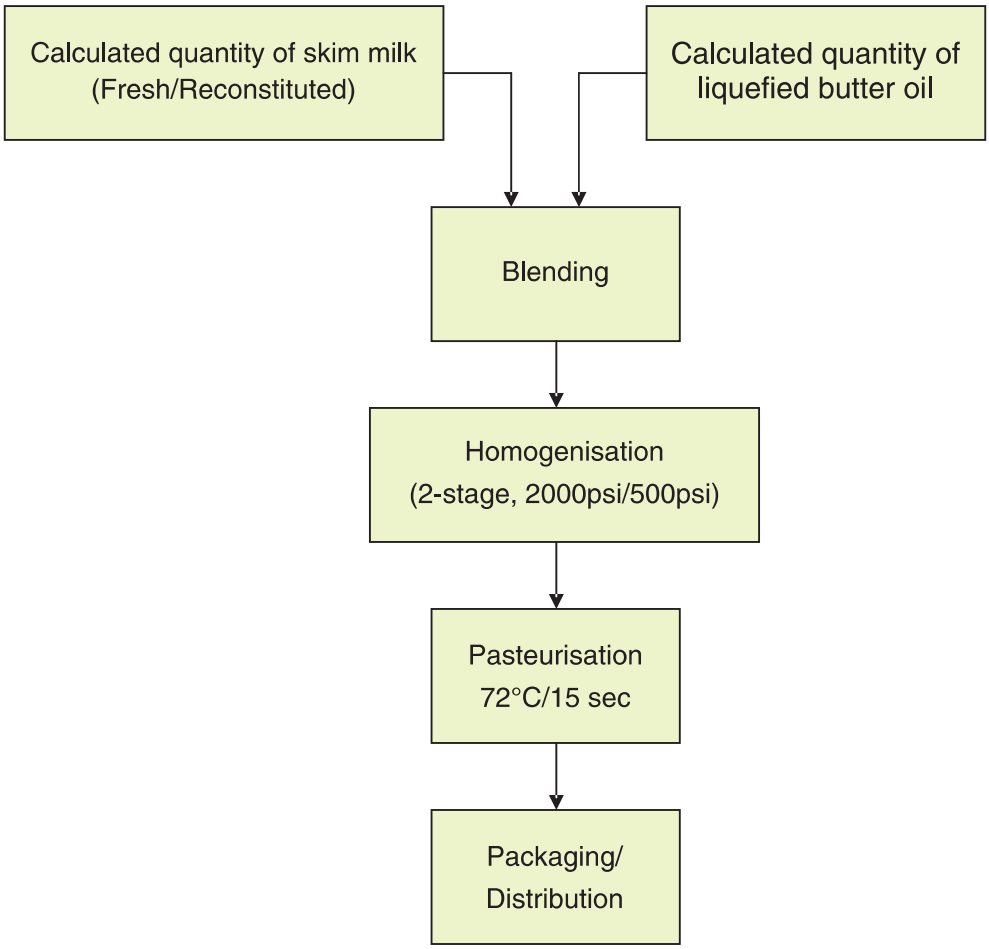

Fig.14.4. Flow diagram for preparation of recombined milk

REVIEW QUESTIONS

1. Describe method for preparation of toned and double toned milk?
2. What is the procedure for preparing flavoured milk?
3. What is reconstituted milk?
4. Briefly describe method to prepare reconstituted milk.
5. Briefly describe method to prepare recombined milk.

Practical Exercise 15

Cleaning and sanitation of equipment

Objective

To learn about cleaning and sanitation of equipment

Principle

Milk and milk products have a tendency to form deposit on the equipment contact surfaces which is known as soil. Cleaning is the complete removal of such deposits or soil using suitable detergent chemicals under recommended conditions.

Cleaning methods

It is important that personnel involved have proper understanding of the nature of the different types of soil, conditions and chemistry of its removal. Cleaning methods can be classified as:

- Clean-in-place (CIP): Also known as mechanical cleaning requires no disassembly or partial disassembly of the equipments.
- Clean-out-of-Place (COP): Equipments are partially fully disassembled and cleaned in specialized COP pressure tanks.
- Manual Cleaning: Equipments are completely disassembled for cleaning and inspection.

Cleaning compounds

The properties desirable for cleaning compound used in a dairy processing plant are:

- Economical to use
- Water softening characteristics
- Quick and complete solubility
- Good wetting or penetrating action
- Noncorrosive
- Germicidal action.
- Low toxicity
- Easily rinsed

The cleaning compounds may be categorized into:

Alkalis - Soften water, emulsify, saponify fats

Acids - Soften water, mineral deposit control

Chelating - Are organic compounds, soften water by sequestering, prevent mineral deposits, peptize proteins

Surfactant - Also known as wetting agents as it improves wetting properties, emulsify and disperse fats

Complex Phosphates - soften water by sequestering, disperse and suspend soils, emulsify fats and oils, peptize proteins

CIP CLEANING CYCLES

The following cleaning stages used in succession are possible and are used in practise depending on the nature of the soiling matter:

- W — C — W
- W — C — W — A — W
- W — A — W — C — W
- W — A — W — C — W — A — W

W = Water rinse, water pre-rinse if W is at the beginning
C = Caustic rinse
A = Acid rinse

Table 15.1. CIP cycle for tank cleaning

Cycle	Temperature °C	Duration (min)
Water rinse	40-60	5
Caustic soda (2.5%) rinse	65-75	10
Intermediate water rinse	65-75	5
Nitric acid (1%) rinse	65-75	10
Final water rinse	65-75	5-10
Steam sterilization	130-150	20

Note: The protocol for CIP varies for different models and milk plants

Table 15.2. CIP cycle for HTST pasteurizer

Cycle	Temperature °C	Duration (min)
Cold water rinse	-	-
Warm water rinse	< 38	-
Nitric acid (0.5%) rinse	60-65	30
Hot water rinse	60-65	10-15
Alkali (0.25-0.5%) rinse*	60-75	30
Cold water rinse	-	-
Hot water sterilization	80-90	15

*Soda, ash, tri sodium phosphate or sodium silicate

Note: The protocol for CIP varies for different models and milk plants

Sanitization

Sanitization refers to the reduction of microorganisms to safe levels considering public health. Sanitation procedures have set process, duration and chemical conditions. The official definition (Association of Official Analytical Chemists) of sanitizing for food product contact surfaces is a process which reduces the contamination level by 99.999% (5 logs) in 30 sec. The official definition for non-product contact surfaces requires a contamination

reduction of 99.9% (3 logs or more) in 5 min. The standard test organisms used are *Staphylococcus aureus* and *Escherichia coli*. General types of sanitization include the following:

- Thermal Sanitization: Hot water or steam for a specified temperature and contact time.
- Chemical Sanitization: Use of an approved chemical sanitizer at a specified concentration, and contact time

REVIEW QUESTIONS

1. What are methods used for equipment cleaning?
2. What are differences between CIP and COP?
3. List the properties desirable for cleaning compound used in a dairy processing plant.
4. What do you understand by sanitation.

Practical Exercise 16

Design and layout of a dairy plant

Objective

To understand design and layout of a dairy plant

General design consideration for milk processing plant

1. The milk route should be as short as possible. This will minimise the cost of pipe length, pumping requirement and save time in cleaning.

2. Reception and dispatch Platforms must be arranged in relation to plant in such a way that congestion of transport vehicles is avoided.

3. A small dairy handling milk upto 20,000 liters/day may have reception and despatch at one dock as there will not be much rush of vehicles. In large dairies, this separation is essential. Generally milk reception and despatch of washed cans is on one side (because whased cans are reloaded on the same vehicle and returned to milk producers) and dirty bottle reception is on the other side.

4. Where space is available, single storey building is most suited. The plan may have a rectangular shape with road on all sides.

5. The floor level of milk reception and dispatch docks and of all rooms concerned with milk cans and bottles should be at the same height above the ground level suited to vehicles. However, the weigh tank and raw milk pump should be at a lower level in order to have a convenient tipping height. A well or pit must be constructed for the weigh tank and raw milk pump.

6. The raw milk storage tank and pasteurized milk balance tank may be mounted on a staging in order to save floor space and to provide a gravity head to fillers.

7. It is desired to have a refrigeration compressor room and boiler house in the same building, the floor level of these rooms should be at par with ground level.

8. Laboratory should have easy approach to processing room, reception room and filling room.

9. Boiler should be located near the place where steam is required.

10. Refrigeration machinery room should be near the process room and cold store.

11. Security and watch and ward offices should be located near gate.

Procedure

The steps for designing and preparation of plant layout is as follows:

1. In the first step, capacity of the equipments is determined according to the flow diagram and process schedule.

2. A section is designed on the basis of:

    a. Space required by the equipments

    b. Space is left around the equipment for movement of persons, maintenance, assembling and dismantling of equipments. Generally it is 2.5 time space occupied by the equipments.

    c. Space is provided for future expansion of section or addition of equipments.

    d. Space required by pipes, drainage, control etc.

3. Various sections are arranged together. It gives the total layout of the dairy plant building as shown in the figure 16.1.

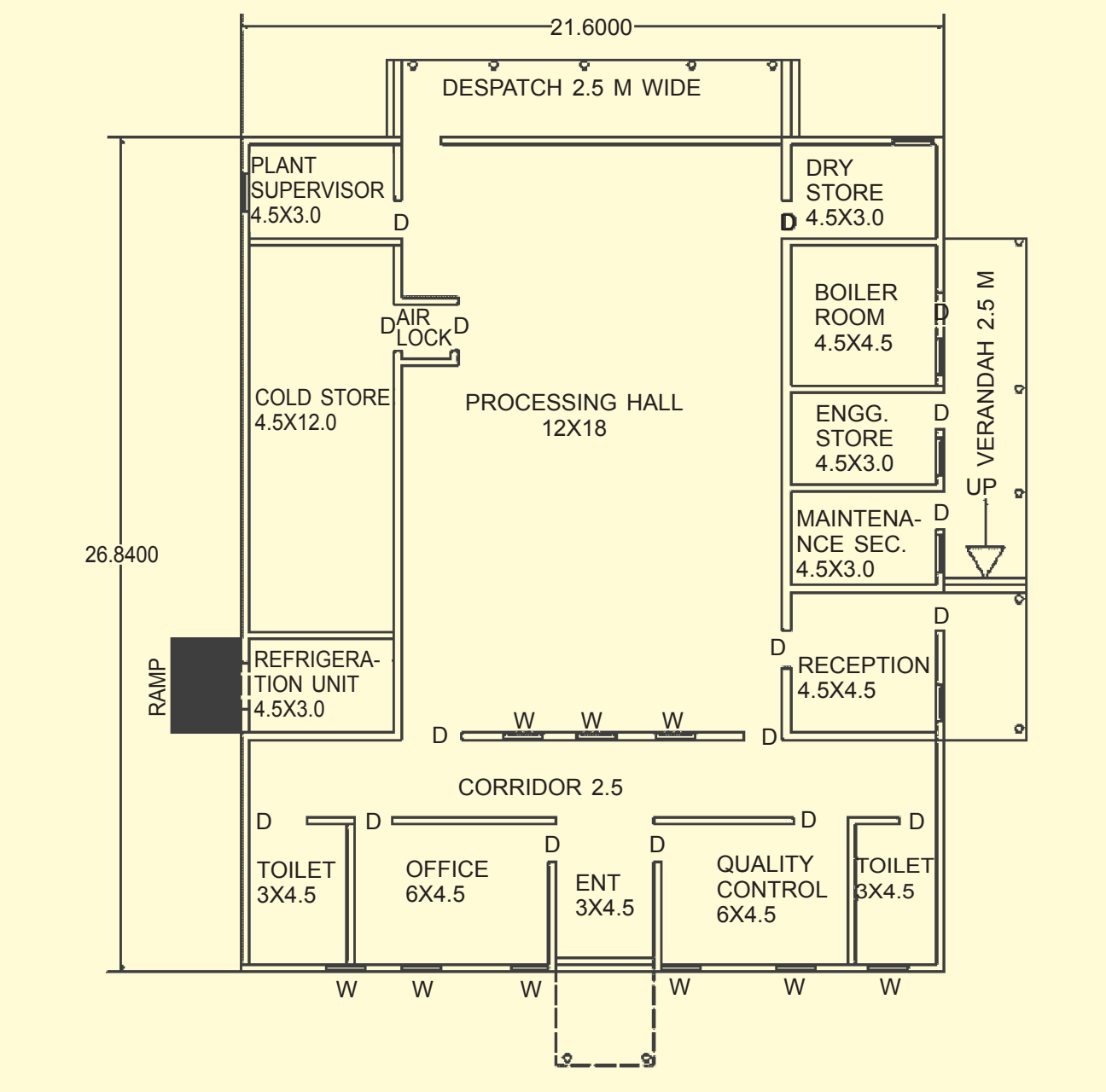

Fig.16.1. Layout of a milk processing plant (Capacity 20,000 to 40,000 litres milk per day)

REVIEW QUESTIONS

1. What are the steps involved in design and preparation of plant layout?
2. What are the advantages of drawing layout of a dairy plant?
3. How will you estimate space requirement for any section?


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