MINISTRY OF FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

सत्यमेव जयते

Dairy Processing Handbook

for

Trainers

under

PMFME

National Institute of Food Technology Entrepreneurship and Management
Deemed to be University (De-novo Category) under Section 3 of the UGC Act, 1956
An Autonomous Institution under Ministry of Food Processing Industries, Government of India, Sonepat, Haryana, India

Contents

Chapter – 1

1.1 Introduction

Milk, liquid secreted by the mammary glands of female mammals to nourish their young for a period beginning immediately after birth. The milk of domesticated animals is also an important food source for humans, either as a fresh fluid or processed into a number of dairy products such as butter and cheese (https://www.britannica.com). Milk is a nutritious choice as it provides nine essential nutrients our body needs. Milk contains essential nutrients like high-quality protein, calcium, vitamin D and more. These nutrients help our bodies function properly. For example: Protein helps build and repair muscle tissue Calcium and vitamin D helps build and maintain strong bones and teeth Milk also contains B vitamins, which can help your body convert food into energy.

1.2 Dairy Industry in India

India is leading milk producing country in the world, accounting for 19 percent of the global market share and expected to grow at compound annual growth rate (CAGR) of 14.8% between FY 2018 – 2023. As per fiscal year 2019, milk production in India amounted to about 187 million metric tons. As per FY – 2018, around 81% of the Indian dairy and milk processing market comes under unorganized sector, where milk is processed in unhygienic infrastructure, which affects the overall quality of milk and milk-based products. Consumption patterns of liquid milk at the farm level and less infrastructure for processing is the main reason for low value addition of milk. The demand for value added products especially traditional dairy products is increasing day by day and the dairy industry of the country is trying to meet the present demand.

Uttar Pradesh, Rajasthan and Gujarat are the major milk producing states in India. Uttar Pradesh is the largest milk-producing state, as it has the highest buffalo population and the second-highest cattle population in the country. Majority of the rural population in this state is engaged in livestock nurture and dairy farming. Gujarat holds several cooperative dairy unions, milk cooperative societies and private dairy plants, which play vital roles in the production of milk and milk-based products in the state.

1.3 Insight on value-added product

Apart from processed liquid milk, Indian dairy and milk processing industry generates revenue from several value-added products such as butter, curd, paneer, ghee, whey, flavoured milk, ultra-high temperature (UHT) milk, cheese, yogurt, dairy whitener and milk powder. During the FY 2016 – 2020, the market size of dairy ingredients is expected to grow by around 14%.

1.4 Export-import opportunities

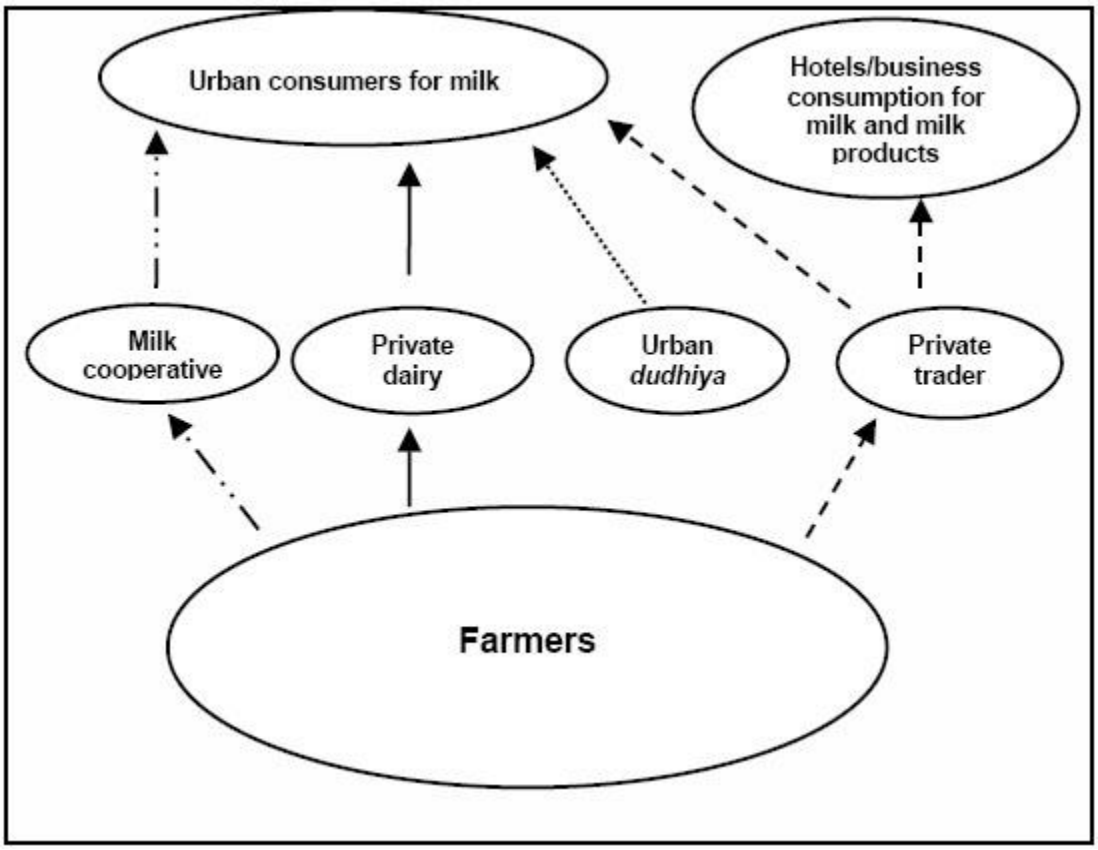
The export of dairy products from India has increased to countries like Bhutan, Afghanistan, Canada, Egypt, and the United Arab Emirates. India has also imported a significant number of dairy products from countries like France, New Zealand, Ireland, France, Ukraine, and Italy.

1.5 Key deterrents to the growth of the market

Despite having a significant livestock base of milch animals, India lacks in terms of good processing facility and availability of cold storages which results in wastage of dairy output. Lack of sufficient storage facilities and inefficient distribution channels are hampering the growth of the Indian dairy and milk processing industry.

Sufficient quantity and good quality of feed and fodder are required for proper animal rearing and milk production. Improper droughts and flood management affect the production of fodder in India. Deficiency of proper feed and fodder for milch animals, due to high usage of agricultural crop residues by producers of fibreboard, paper, and liquid fuels, affect its availability for dairy production and milk processing.

Dairy marketing channels in India



Reference: FAO

1.6 Need for Processing Milk

Milk is considered wholesome food mainly because of its high nutritive value. It has to be processed to;

- Increase the shelf life, because it is highly perishable.
- Prepare value added products like dahi, cheese, paneer, butter, ghee, AMF, flavoured milk, cheese, and yogurt, dairy whitener, milk powder etc. and many more dairy based products, for a good health.
- Make business out of it, create job opportunities, consequently building financially strong Nation.

1.7 Different Departments in a unique Dairy Processing Plant

Production is the main body of any food processing unit. Based on the capacity and product variants, different supporting departments made to deliver right product at right time to the consumer and consequently generate revenue. Departments are majorly categorized into;

1. Production and Operation: Production planning, Scheduling, managing daily production
2. Quality Assurance and Regulatory: Assure quality of the product, Establish food safety, Organizing internal audits, Certifications (FSSAI, FSSC 22000, Agmark, Halal, BRC etc.) and updating of food safety manual
3. Research and Development: New Product development
4. Engineering
    a. Engaged in new projects
    b. Maintenance of the machinery and infrastructure
    c. Managing water treatment plant (WTP)
    d. Managing power supply unit (UPS, Generators, Solar panels, and coordination with electricity board)
5. Procurement: Engaged in procurement of raw material, packing material, engineering items, vendor development etc.
6. Store: Maintaining the inventory and alarm procurement, maintaining FIFO, LIFO etc.
7. Logistic and Supply Chain: Deliver products to the consumer at right time
8. Sales and Marketing: Manager is responsible for researching and developing marketing opportunities and planning and implementing new sales plans.
9. Safety Health and Environment (SHE): Ensure safety personnel, premises and environment, coordinating with Pollution control board
10. Human Resource and Legal

    Role and Responsibilities:

- Recruitment: To ensure that right people are recruited for right position and in right number to meet the requirement.
- Medical examination and health card record keeping: Medical examination of the employee is carried out to ensure that they are medically fit to carry out their work.
- Contract labor engagement: To describe a procedure for contract labor engagement.
- Attendance and leave policy: To describe a procedure for monitoring the employees the punctuality and discipline.
- Training for Roll and contractual labor employees: To describe a procedure for carrying out training for all employees and to ensure proper training records are maintained at plant level.
- Skill matrix: To ensure the effectiveness of occupational/working skill for employee.

Table: Nutritional values of milk

Nutritional Factor	Description	Energy Value
Protein	Milk protein is casein, a high-quality protein. All essential amino acids are present in Milk.	4.1 KC/g
Minerals	Milk contains phosphorus and calcium.	
Vitamins	Milk contains vitamins A, D, thiamine, and riboflavin.	
Fat	Milk fat is responsible of good flavor and physical properties. The fat content in cow milk is generally from 3.5 to 4.5 %	9.3 KC/g
Lactose	Lactose is the sugar component of milk and it supply energy.	4.1 KC/g

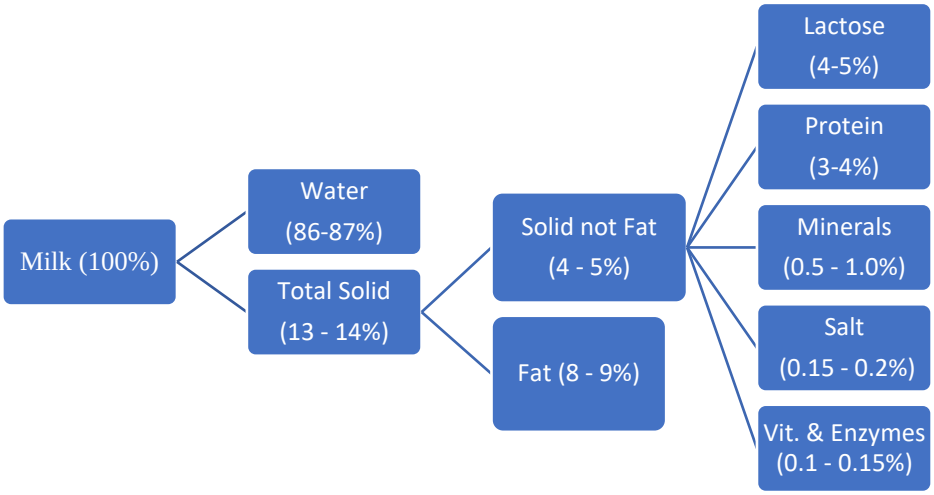
1.8 Composition of Milk

Milk composition varies with species, breed (Holstein, Jersey), feed, and the stage of lactation.

As per FSSAI, “Milk is a whole, fresh, clean lacteal secretion obtained by complete milking of one or more healthy milch animals excluding that obtained within 15 days before calving or 5 days after

calving. Market milk must possess the pre-determined percentage of milk fat and SNF (Solid Not Fat)."

Milk of different classes and types must conform to the standards laid down by FSSAI. Mixed milk means a combination of the milk from cow and buffalo or any other milch animal. The combination also should at par with FSSAI standards.

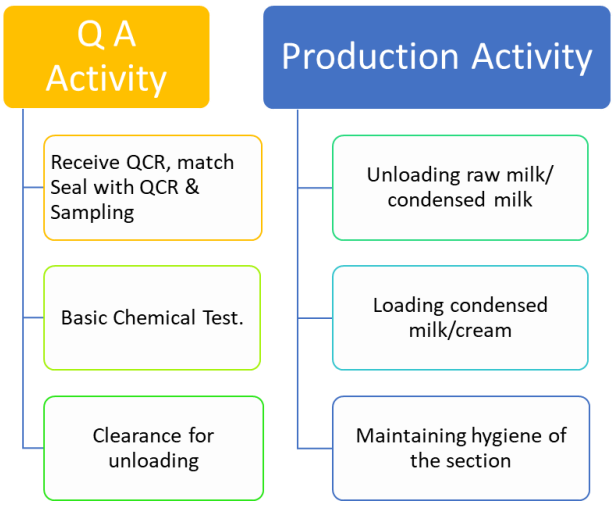


1.8 Different Sections in a unique dairy Processing Unit

- RMRD: Raw Milk Reception Section
- Primary Processing Section: Pasteurization, Cream Separation, Standardization etc
- Secondary Processing Section: Production of milk-based products such as Paneer, Curd, Yogurt, Butter, Ghee, Flavoured milk etc.

1. Raw Milk Reception Dock (RMRD)
   Milk reception in India is basically done in two ways i.e., with milk cans and milk tankers. Tankers are of different capacity and single compartment to three compartments.

Responsibilities at RMRD



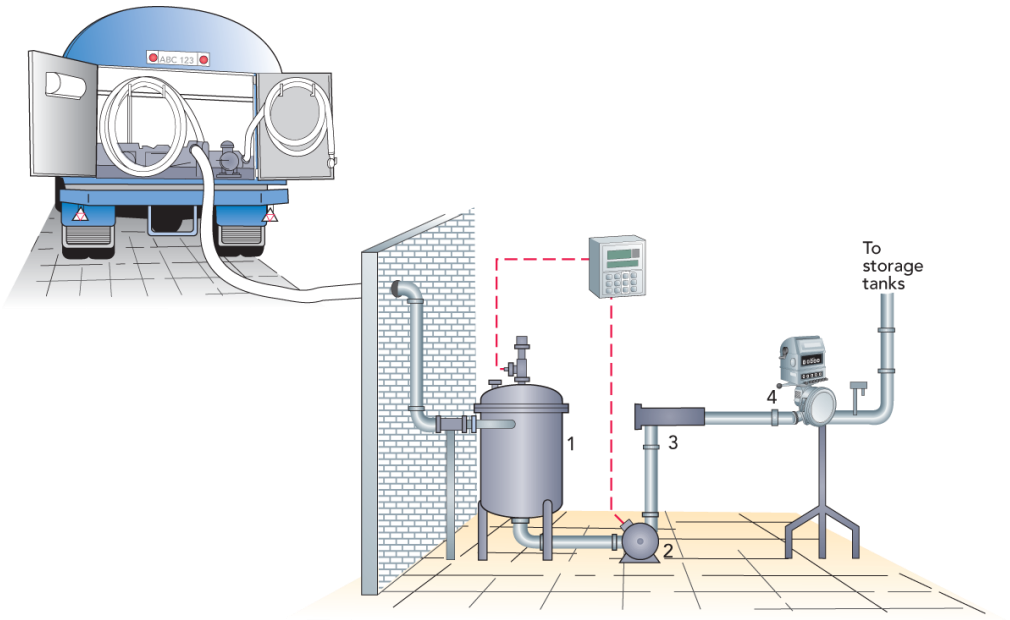


Fig: Raw milk reception dock. 1. De-aeration tank or air eliminator 2. Pump 3. Filter 4. Mass flow meter

Sample from all the compartments of the tanker are collected after mixing (normally called plunging) the milk for 10-15 min. in a and following tests are conducted.

1) Methylene Blue reduction Test (MBRT): This test is done to find the microbial load in the raw milk. (10ml milk + 1ml methylene blue) is heated at 36-37 degree Celsius and change in color is observed. The quicker will be the color removed the higher will be the microbial load.
2) Delvo Test: This test is done to find the presence of antibiotics in milk.
3) Temperature measurement: It should not be more than 6 degree Celsius.
4) Determination of Fat, SNF and protein using Equipment “IndiFOSS”
5) Organoleptic Test: This test is done to find taste, flavor and appearance i.e. normal pleasant test/sour/sweet/salty/bitter/abnormal test.
6) Acidity test: Reading 0.130-0.148 is accepted while 0.150 and above is rejected.
7) Alcohol Test: (5ml milk+5ml alcohol) is mixed and appearance of any clot or flake is observed. The presence of any flakes or clots shows appositive test.
8) Clot and Boiling (COB) Test: 5ml of sample is taken in attest tube and kept in boiling water for 5 min. The formation of clot denotes a positive test. A positive COB test has acidity above 0.17% as lactic acid and is not suitable for distribution as liquid milk or for processing.
9) Neutralization Test: (5ml milk + 5ml alcohol + 5ml rosalic acid) is mixed; a red rose colour shows the presence of Carbonates.
10) Preservative Test: (10ml milk in wide mouth test tube + 5ml concentrated sulphuric acid); observe the color at the junction of two liquid. The presence of violet or blue color indicates the presence of Formaldehyde.
11) Adulteration Test:
    a. Sugar: (15ml well mixed milk in test tube + 0.1ml concentrated hydrochloric acid +0.1gm resorcinol) place the tube in the boiling water bath for 5min. appearance of red color shows presence of sugar.

b. Starch: (5ml milk is boiled in water bath and cooled to room temperature) + a drop 1% iodine solution. Observe the presence of blue color in the presence of starch which disappears on boiling and appears on cooling.
c. Salt: (5ml silver nitrate + 2drops indicator solution + 1ml milk) keep for 2 min. the formation of pale yellow color indicates salt +ve and if color remains brownish, salt test is –ve.
d. Urea Test: (5ml milk + 5ml dimethyl amino benzaldehyde) mix properly and observe the colour change. The presence of bright yellow colour shows Urea +ve.

Chapter – 2

Primary Processing and Pouch Milk

2.1 Introduction

Primary processing is basically referred as Pasteurization of milk. Cream Separation, Standardization and Homogenization are intermediate process of pasteurization

2.2 Milk Pasteurization

The French Scientist Louis Pasteur invented the process called pasteurization, during the nineteenth century. Pasteur found that, heating milk to a high temperature and then quickly cooling it before bottling or packaging it could increase the shelf life of milk.

Today, the pasteurisation process is widely used within the beverage and food industry, and is considered as the most common heat treatment process. Pasteurisation ensures, the milk is safe to consume, at the same time increasing its shelf life.

The Pasteurisation process involves heating milk to 72°C for at least 15 seconds (more than 25 seconds). The time temperature combination varies with elevation, the same shall be defined by the process owner and validated.

Looking into the nature of the heat treatment, it sometimes referred to as the 'High Temperature Short Time' (HTST) process. Once the milk is heated to the defined temperature, it is cooled quickly to less than 3°C temperature. The equipment used to heat and cool the milk is called a 'heat exchanger'. There are different types of heat exchangers used in process industry. The most commonly used heat exchanger is plate heat exchanger (PHE). It is compact in design and requires less space. Once the milk has been pasteurised it is bottled or packaged to be sold to consumers. The pasteurized milk is kept below 5°C till it is consumed. The two methods of pasteurization are Batch Pasteurization and Continuous Pasteurization. Commonly used method at industrial scale is continuous pasteurization.

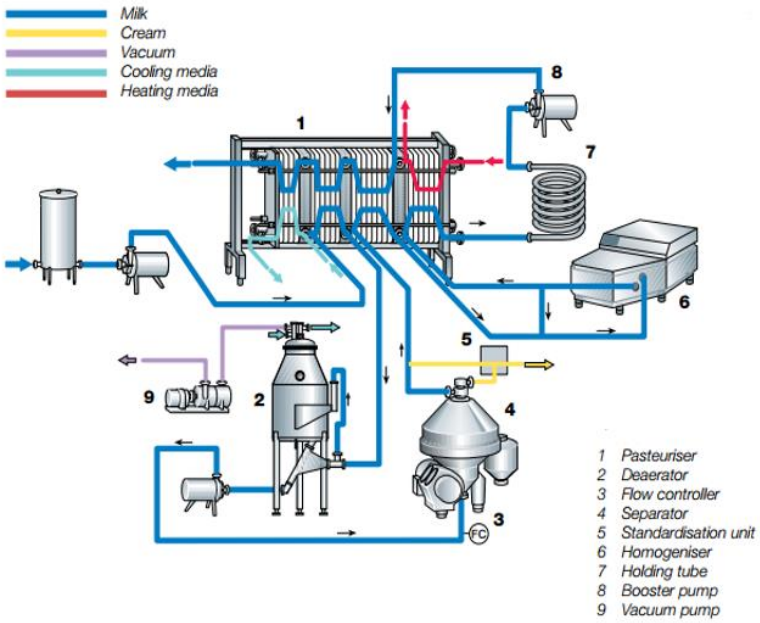


Fig: Typical Milk Pasteurizer Unit

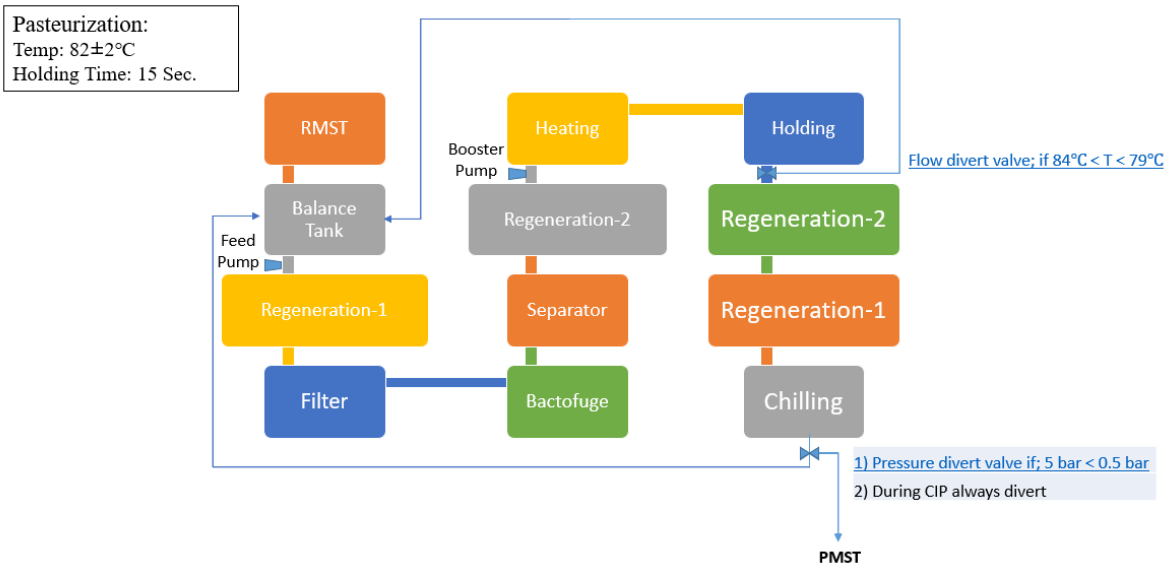


Fig: Typical Milk Pasteurizer Flow Diagram. Indicated temperature and time may vary

2.3 Cream Separation

There are many unit operations in milk processing, cream separation is one among them. At industrial level, it is an intermediate process in pasteurization. Cream separation is mainly done

1. To recover fat from milk: Fat is used to prepare value added products such as ghee, butter, etc.
2. To obtain a low fat or fat-free milk (Skim milk): Skim milk is used to prepare skim milk powder, dairy whitener, condensed skim milk etc.
3. To standardize the fat content of milk.

There are two different methods separate cream from milk;

1. Gravity Method: In this method, milk is hold undisturbed for some time. Cream being lighter than other compositions, comes up and is taken out manually. This is not a controlled method and hence proper separation cannot be ensured.
2. Centrifugal Method: In this method, a centrifugal agitation is given to the milk with some agitator manually or a dedicated machine called cream separator. Cream separator is installed along with pasteurizer, normally after regeneration – 1. The percentage of cream to be separated from the milk can set in the machine.

Fig. Cream Separator

2.4 Homogenization

Homogenization is the process of reducing the size of fat globules in milk. It prevents the formation of a cream layer and easy digestion. Homogenized milk has a uniform flavour throughout. It tastes richer, smoother and creamier than unhomogenized milk due to an increase in the surface area of the fat globules which are uniformly distributed in milk. Homogenizer machine used to perform the process.

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

Fig. Homogenizer

2.5 Standardization

Standardization of milk generally refers to balancing the percentage of fat and solid not fat (SNF), to comply with the legal requirements of market milk. Standardizing milk might require control of only one component (usually fat) while allowing the others to vary or control two or more components simultaneously. Skim milk powder, condensed skim milk and fresh cream is generally to standardize.

Methods of Calculation

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

1. Pearson's Square method
2. Algebraic equations

Different Class of Market Milk sold in India

Class of Milk	Designation	Locality	Min %	
			Fat	SNF
Toned Milk	Pasteurised, flavoured and sterilized	All India	3	8.5
Double Toned milk	Pasteurised, flavoured and sterilized	All India	1.5	9.0
Standardized milk	Pasteurised, flavoured and sterilized	All India	4.5	8.5
Full Cream Milk	Pasteurised and sterilized	All India	6.0	9

Reconstituted milk: It is the liquid milk obtained by adding water to skim milk powder or whole milk powder.

Recombined milk: It is the liquid milk obtained by adding water to skim milk powder and adding milk fat separately in such a quantity that the desired fat content is achieved.

2.6 Calculation for Standardization

Example - 1:

2000 kg of milk (with 87.6% water, 3.8% fat, 3.2% protein, 4.6% lactose, and 0.7% ash content) has to be reduced in fat content from 3.8% to 2.5% by removal of cream with 40% fat content from the milk. How much milk will have to be removed?

Solution:

TMB: 2000 = C + M

FMB: 2000*0.038 = 0.4*C + 0.025*M

2000*0.025 = 0.025*C + 0.025*M

Solving the equations will give the values of C = 69.3 kg and the remaining milk M = 1930.7 kg.

Example - 2:

How much whole milk with 3.9% fat and skimmed milk with 0.04% fat content will you need to produce 2000 kg of standardized milk with 2.5% fat?

Solution:

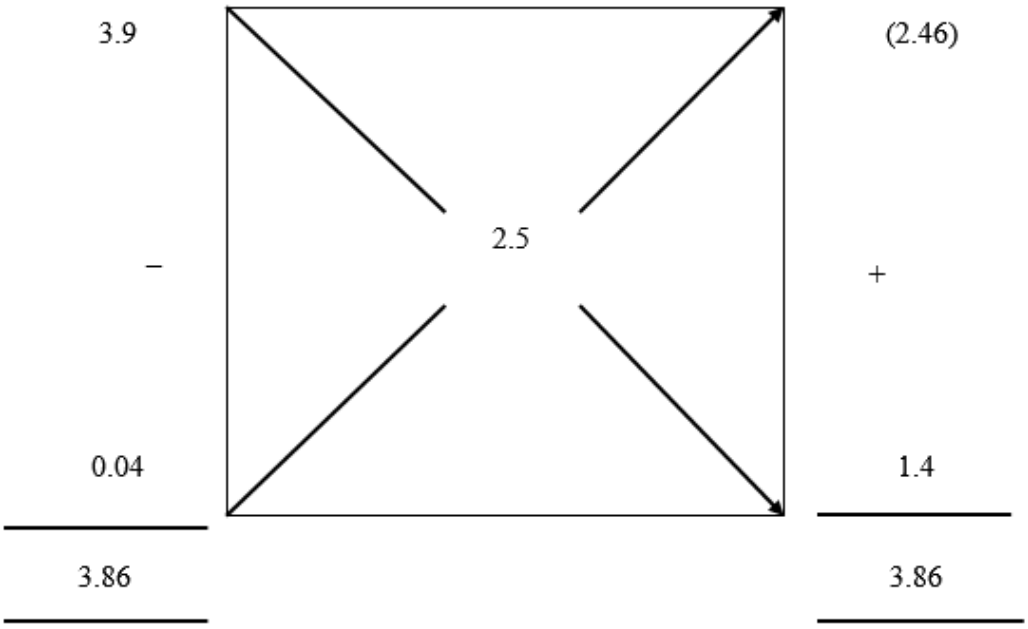
Using mass balance method:

TMB: W + S = 2000

FMB: 0.039*W + 0.0004*S = 0.025*2000

Solving for W = 1274.6 kg and S = 725.4 kg

Using Pearson's Square method



Proportion of the whole milk = 2.46/3.86

Amount of whole milk required = (2.46/3.86)*2000 = 1274.6 kg

Proportion of skimmed milk = 1.4/3.86

Amount of skimmed milk required = (1.4/3.86)*2000 = 725.4 kg

(or 2000 – 1274.6)

2.7 Different tests carried out to assure the quality

1) **Organoleptic Test:** Color, taste and flavour of milk
2) **Clot and Boiling Test (COB):** To check the clotting of milk. 2ml milk (dry test tube) is boiled on spirit flame. Formation of ppt shows COB test is positive.
3) **Acidity test:** Take 20ml milk in 100 ml beaker, add 8 drops of phenolphthalein indicator and titrate with N/10 NaOH till pinkish colour appears.

   %TA= 0.045 x ml of NaOH used

4) **Alcohol Test:** 5ml of milk in attest tube is mixed with (60 to 78% by vol.) alcohol with constant shake. Formation of precipitate shows alcohol test positive.
5) **Neutralization Test:** 5ml milk in a test tube, add 5ml alcohol and mix it, then add 4 to 5 drops of 1% Rosolic acid. Red rose colour indicates neutralization test is positive and brownish colour shows test is negative.
6) **Sugar Test:** 5ml milk in attest tube, add a pinch of Resorcinol and conc. HCl. Mix well and keep test tube in boiling water for 5min. brick red color formation shows sugar test positive.
7) **Starch Test:** 2 ml milk in a test tube, boil and cool in tap water. Add 3-3 drops of 1% Iodine solution. Appearance of blue color indicates starch test positive.
8) **Urea Test:** 2ml milk in test tube, add 2ml DMAB solution and mix the content. Appearance of yellow color indicates urea test positive.
9) **Test for detection of (salt) sodium chloride in milk:** In 5ml of 0.134% silver nitrate, add 2-3 drop of 1% potassium chromate. Then add 1ml milk. Appearance of yellow color indicates presence of dissolved chloride.
10) **Formalin Test:** 5ml milk in test tube, add 0.5 ml of $FeCl_3$ solution and mix well. Add conc. H_2SO_4 slowly along the side of tube. Formation of volatile ring at juncture of two liquid confirms the presence of formalin positive.
11) **Hydrogen peroxide Test:** 5ml milk in test tube, add 2drop of Paraphenyl diamine hydrochloride (1%). Formation of blue colour indicates hydrogen peroxide is present.
12) **Detection of detergent:** 5ml milk in 15ml test tube, add 1ml methylene blue dye followed by addition of 2ml chloroform. Vortex the content for about 15 sec. and centrifuge at about 1100rpm for 30 min. note the intensity of blue colour in lower and upper level. Relatively more intense blue colour in lower layer indicates presence of detergent in milk, whereas more intense blue colour in the upper level indicates absence of detergent.
13) **Determination of fat in milk (Gerber method):** 10ml H_2SO_4 in into a butyrometer tube without wetting the neck of the tube. Mix the milk sample (10.75ml at 27-29 ^{0}C) gently and fill in the tube. Add 1ml amyl alcohol. Close with a lock stopper, shake well and invert for complete admixture. Centrifuge 5min for raw milk and 10 min for homogenized milk. Take the reading of colour less liquid.

14) **Phosphatase test for pasteurization of milk:** Pipette 5ml of buffer substrate solution, bring the temperature to 37^0C for 2hrs. Incubate one blank prepared from boiled milk of the same type. Remove the milk after 2hrs and content should be well mixed. Place the boiled blank on the left side of the comparator and test sample on the right. Take the reading in reflected light by revolving the disk.
15) **Milk homogenization efficiency Test (NIZO Test):** Heat milk to 40^0C and transfer one portion of milk to 25ml centrifuge tube, keep another portion of the milk for fat analysis. Centrifuge for 20min in Remi Centrifuge at (1100-1200rpm). Do Gerber milk fat determination for the two portions of the milk?

Efficiency % = {(centrifuged milk's fat)/(normal milk's fat)} X 100

16) **Determination of SNF% in milk:** Warm milk to 29^0C and mix. Fill the prepared milk in cylinder. Invert the lactometer and allow to float freely. Take lactometer reading and calculate SNF using formula.
For lite curd, dilute milk with distilled water (200ml milk + 100ml distilled water), then follow the procedure to measure LR. Calculate CLR= (LR/2) X 3

For Tamil Nadu and butter milk; SNF% = (CLR/4) + 0.36 + (0.2 X F)
For Karnataka milk; SNF% = (CLR/4) + 0.44 + (0.2 X F)

17) **Methylene Blue Reduction Test (MBRT):** This test is done to get the rough estimation of bacterial load.
(10ml milk + 1ml Methylene Blue) mix well and heat at 37^0C. Observe the color change.
Greater the no of bacteria in the milk, sooner the color disappear.

Chapter – 3

Butter Making Process

3.1 Introduction

Butter is an emulsion of water dispersed in fat. Fresh milk or cream, on a microscopic level. Commercial butter is 80–82 percent milk fat, 16–17 percent water, and 1–2 percent milk solids other than fat (sometimes referred to as curd). Butter is a powerful antioxidant that has anti-cancer properties among other benefits. Consuming butter can help you boost your immune system.

3.2 Butter Making Process

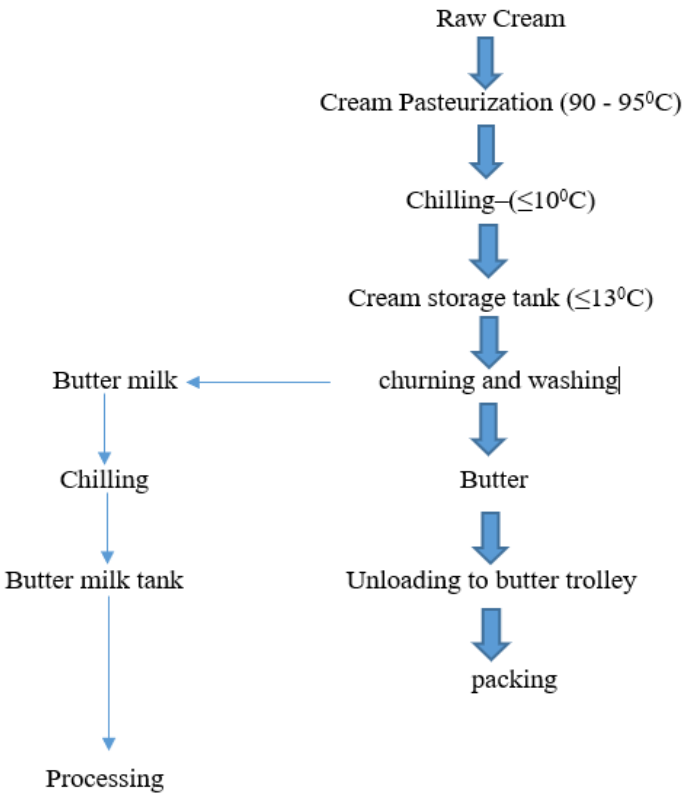


Fig. Flow Chart for Butter Making

Churning: Churning is the process of mixing or stirring, especially for cream to separate butter. The equipment used for churning is called churner or churn. Butter during the process of churning fuse with each other and form large fat globules. Air bubbles via the continued mechanical action of the churn. The butter grains become denser as fat globules attached with the air is forced out of the mixture. This process produces a liquid known as butter milk. With constant churning the fat globules eventually form solid butter and separate from the butter milk. The churning time for one batch is 60 – 75 min.

Fig. Butter Churner with butter trolley

Butter trolley: It receives butter from the churner and transfers with the help of screw pump (NIMA PUMP) for packing.

3.3 Composition of butter

Butter is principally composed of milk fat, moisture, salt and curd. It also contains small amount of fat, lactose, acids, phospholipids, air, microorganisms, enzymes and vitamins. The proportion of principal constituents in butter is largely controlled by the method of manufacture and this is turn is chiefly regulated to conform to the standards of butter prescribed by regulatory authorities such as codex and FSSAI. General composition of butter is given in table. Butter is considered as high calorie food as 100 g of butter provides almost 700 Kcal. Butter is extremely rich in minerals like Calcium, Phosphorus and Potassium. It has good amount of sodium and small amounts of fluoride, selenium, zinc and magnesium. It is also rich in Vitamin A, Vitamin E, Riboflavin, Niacin and Pantothenic acid. It also has Vitamin K, Folate and Vitamin B12 in small amounts.

Composition of butter

Constituents	Quantity (% w/w)
Fat	80 - 83
Moisture	15.5 - 16.0
Salt	*0 - 3
Curd	1-1.5

0 indicate unsalted butter. Unsalted butter is also known as white butter

3.3 Classification of Butter

1. Based on salt content
   a. Salted butter: Butter to which salt has been added. It is added to improve flavour and keeping quality of butter.
   b. Unsalted butter: This type of butter contains no salt. It is usually prepared for manufacturing other products such as ghee and butteroil.
2. Based on end use (as followed by BIS)
   a. Table Butter: the product made from pasteurized cream obtained from cow or buffalo milk or a combination thereof with or without ripening with the use of standard lactic culture,

addition of common salt, annatto or carotene as colouring matter and diacetyl as flavouring agent.

b. White Butter: the product made from pasteurized cream obtained from cow or buffalo milk or a combination thereof without ripening and without addition of any preservative including common salt, any added colouring matter or any added flavouring agent.

3. Based on the manufacturing practice (as followed by FSSAI)
   a. Pasteurized cream butter/ Pasteurized Table butter: This is made usually from pasteurized sweet cream. Such butter usually has a milder flavour than that made from similar cream not pasteurized.
   b. Desi butter: The butter obtained by traditional process of churning dahi or malai as practiced at domestic levels.

Chapter – 4

Paneer Making Process

4.1 Introduction

As per Food Safety and Standards Regulations (FSSR), 2011 Paneer is the heat assisted coagulated product resulted from the coagulation of cow or buffalo milk or a combination thereof with the help of lactic acid or citric acid. The paneer must have the moisture content less than 70 %. The fat per cent of paneer shall be greater than 50.0 of the dry matter. Milk powder may also be used in the preparation of paneer. The moisture and fat percent of low-fat paneer shall not be more than 70 and 15 respectively on dry matter basis. According to Bureau of Indian Standards (IS 10484:1983), paneer shall contain a minimum of 50% fat on dry matter basis but the moisture content shall not go beyond 60%.

4.2 Preparation of Paneer: Paneer may be prepared from Buffalo milk or Cow milk or their combination. The process steps are mentioned below

Flow Chart 1: Processing steps of Paneer in general

Good quality buffalo milk
↓
Filtration
↓
Standardization (Fat: SNF 1:1.65 using buffalo skim milk)
↓
Heating (82^0C, 5 min)
↓
Cooling (70^0C)
↓
Addition of coagulant (1 % Citric acid solution at 70^0C)
↓
Continuous stirring till clear whey separates out
↓
Settling for 10 min
↓
Draining of whey
↓
Pressing the coagulum after filling in muslin cloth lined hoops
↓
Removal of blocks and cutting into desired size
↓
Immersion of *paneer* blocks in chilled water (4^0C)
↓
Draining of water and wiping surface
↓
Packaging and storage at 4^0C

1. Take standardized milk (fat: SNF 1:1.65) in a clean and sterilised SS vat. The milk will be heated up to 82^0C. Maintain the same temperature for 5 minutes and then cool the milk to 70^0C.

2. 1% citric acid solution with respect to the milk is used as a coagulant. The temperature of coagulant is maintained at 70^0C, which is same as the temperature of milk at the time of addition of coagulants.

3. The coagulant should be added in optimum quantity so that a clear whey separation shall be achieved. The green colour of the whey indicates proper coagulation. Stirring should not be intense otherwise this will lead to the break up the curd mass.

4. When the pH of whey reached in the range of 5.7 to 6.0, allow the curd mass to be settle for about 5 - 10 minutes. Allow the whey to be drained out through a muslin cloth and the coagulated curd remains in the vat/cloth. It is advised that the whey temperature should not fall below 63^0C during the whole process.

5. The curd mass shall be filled in the SS hoops lined with muslin cloth and pressed for 15- 20 min. Pressing can be achieved through a manual press or pneumatic press.

6. Immersed the pressed paneer blocks in chilled water (4- 6^0C) or 5% brine solution (4- 6%) for 2 - 3 hours to achieve firmness. Further the paneer blocks were cuts and dried to remove extra free water.

7. At last, the paneer slices were packed in a vacuum-package made of high-density polyethylene (HDPE) and stored at 5 - 8^0C for further sales/distribution.

Process detail of paneer manufacturing (step wise)

Receiving milk in a multipurpose vat: Standardized milk	
Heating at 90 ^{0}C as per process requirement. The protein present in the milk denature at this temperature.	
Cooling at 70 ^{0}C as per process requirement for the addition of coagulant.	

Testing: Final testing of milk prior to the addition of Acid Coagulant	
Preparation of Acid Coagulation: Citric acid at 1-2 % concentration is the most widely used coagulant for paneer making. The optimum pH of coagulation suggested by researchers should be in the range of 5.3-5.35 for buffalo milk and 5.20-5.25 for cow milk paneer. With the decrease in pH, the moisture retention in paneer also decrease. This results in reduced yield and profit.	
Mixing of Acid Coagulation at 70^0C	
Formation of curd	
Side-line the curd for easy whey removal from the outlet	

Whey Removal: Whey may be stored for further use	
Straining with muslin cloth	
Hooping: The coagulated mass was collected from the vat and transferred manually to a hoop, lined with muslin cloth.	
Pneumatic Press: The pressing of paneer mass placed in the hoops (MOC: SS) were subjected to pressing with the help of compressed air. The excess whey drained in this process and resulted compact block of paneer.	
Cooling: After pressing, the paneer blocks are immersed in the pasteurized chilled water maintained at 4-5^{o}C for 2 hours. This process facilitates cooling of paneer blocks. It enhances the moisture content of paneer and improves the body and texture of final paneer blocks.	
Paneer Slicer: As per requirement	

Manual slicing: As per requirement	
Convening and draining of extra moisture Paneer having 51-54% moisture is expected to exhibit yield of 21-23% and 17-18% when made out of standardized buffalo and cow milk respectively.	
Printing of packaging details on the package like 1. MRP 2. Batch number 3. Manufacturing code 4. Date and time of packaging	
Packaging, weighing and vacuum sealing in 200 gms, 500gms	
Shelf life of paneer packaged in laminated pouches is 30 days under refrigeration (6^{o}C). Secondary Packaging for storage and transportation under refrigerated conditions	

4.3 Types of Paneer

Paneer from Buffalo Milk

In this process, buffalo milk with fat content 5.8 to 6.0% was heated to 90 **ºC** without holding. This milk is further cooled down to 70 **ºC** and coagulated with 1 to 1.5 % per cent citric acid solution which is also uphold at 70 **ºC**. Stirring is preferred till the separation of clear whey. Remove all the whey produce in this process and collect the coagulated mass in the hoops lined with muslin cloth. The whey temperature must be maintained above 63 **ºC** during draining. The filled hoops were further pressed (manually or pneumatically) for 10-20 minutes. After this the block of curd is removed and immersed in pasteurized chilled water maintained at 5-6 **ºC** for around 2 hours.

Dipping of paneer pieces helps to improve the body and texture of paneer along with cooling. Further, the paneer blocks/pieces were placed on the perforated tray to allow loose water to drain. The moisture

per cent of final paneer also increases after dipping. Finally, it is packed and stored under refrigeration environment for further sale

Paneer from Cow Milk

Paneer may be prepared from standardized cow milk (using cream extracted from cow milk only) with a fat per cent in the range of 4.5 - 5.0. Calcium chloride is also added to this milk in the range of 0.05 to 0.10%. The milk is heated to 90 **ºC** without holding and further cooled down to 85 **ºC**. For coagulation, citric acid solution (2%), which was prepared and maintained at temperature of 85 **ºC** was mixed with the milk at this temperature only.

All others steps will remain the same as Paneer from buffalo milk.

Recombined Milk Paneer

Recombined milk means a milk which is prepared with skim milk powder, cream/butter and good quality water. This milk is standardized (fat 5.8% and SNF 9.5%) and homogenized for further process. This milk is then heated to 90 **ºC** without holding and coagulated with the help of 10% citric acid solution maintained at the same temperature. All others steps will remain the same as Paneer from buffalo milk.

Reconstituted Milk Paneer

In this type, whole milk powder is dissolved in good quality water at 50 **ºC** and hold in a tank for 3-4 hours for proper hydration of milk components. Calcium chloride (0.1 to 0.15%) is added to the milk and the mixed milk is heated to 90 **ºC** without holding.

All others steps will remain the same as Recombined Milk Paneer.

4.4 Composition of Paneer

Product	Moisture (%)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)
Paneer made from Buffalo Milk	52.3	27.0	15.8	2.2	1.9
Paneer made from Cow Milk	52.5	25.0	17.3	2.2	2.0

4.5 Chemical/Physical criteria

Description	Standard
Smell + taste	Fresh creamy to slightly fresh sour
Colour	White to light yellow
Appearance + texture	Solid dices or blocks
Foreign particles	No foreign particles
Fat	Minimum 50% in the DM
Moisture content	52 – 53 %
Friability	Good
Acidity	20 - 23% LA or 22 - 25,5 ºN
Phosphatase test	Negative

4.6 Microbiological criteria

As per 10th Amendment Regulations, 2016, Food Safety & Standards Authority of India (FSSAI) has specified microbiological requirements for process hygiene and food safety.

Microbiological data for paneer

	Minimum	**Maximum**
TPC	150,000/gm	350,000/gm
Coliform (cfu/gm)	10/gm	100/gm
Yeast and mould (cfu/gm	50/g	150/gm
E. coli	Less than 10/gm	
S. aureus	10/gm	100/gm

4.7 Packaging

Packaging materials used for packing Paneer

1. Vegetable parchment: paneer can keep well 3-4 days at 21-270C, 10 days at refrigerated storage.
2. Vegetable paper parchment treated with Na-propionate increases the keeping quality of paneer.
3. Wax/plastic coated paper: 55-60 gsm / 0.02 mm ---0.009-0.02 mm.
4. Poster paper/Al-foil/LDPE - 150 gauze.
5. MST Cellulose (300)/LDPE – 150 gauze.
6. Poster paper/Al-foil (0.02 mm)/LDPE.
7. Al-foil 0.009 mm, 4-50C 100% RH Poster paper laminate (0.02 mm).
8. Al-foil 0.009 mm is found superior to MST-300/LDPE which has minimum keeping quality.

Vegetable parchment paper and PE bags are generally used. PE gives greater keeping quality (7 days at 50C) than that given by vegetable parchment Paper. The Cryovac system using shrink film is being successfully used. Retortable tins are also used. Long life can be given by Metallized polyester or Nylon – PET / METPET/ PE or Aluminium foil or Nylon or LDPE/LLD.

Paneer is packed in laminated tin container along with the brine. These tins are sterilized and it may be having a slight cooked flavour and maillard browning which will increase with storage period.

Vacuum packaging:

Paneer is high in fat compare to milk and subjected to decrease in quality. The shelf life of paneer is normally 1 day in an ambient temperature but the same may be enhance significantly with the help of vacuum packaging. A laminated or co-extruded pouch along with vacuum also helps in enhancing the shelf life further. As reported in literature, the shelf life of paneer packed in an oxygen barrier film along with vacuum and heat treatment at 90 °C for one min may reaches up to 90 days under refrigeration.

Advantages

1. Extended Shelf Life - As reported in literature, the shelf-life of paneer packed in vacuum packaged may improve from 50%-400%. This type of packaging is available with the organized dairy sector throughout the world.

2. Minimized Product Loss – The moisture present in the paneer will retain with the vacuum type of packaging methods as the packaging films is not permeable for water. This will maintain the package weight throughout the storage period.
3. In case of vacuum packaging, no need of chemical preservatives for the extended shelf life.

Coding and Labelling of Packaging Material

As per food industrial norms, a food package must possess a label with the information as follows:

- Manufacturer's name and address
- Marketer's name and address
- Brand name of the Manufacturer (if any)
- Net quantity in weight or gram or any other unit as per market practice
- Time and date of manufacturing
- Nutritive or calorific values
- List of ingredients
- Information about the permitted color, stabilizer, emulsifier etc.
- Best before uses
- MRP

4.8 Storage conditions

Paneer is stored in the freezer room at -20 ºC for maximum 1 month. In general, the shelf life is 15 days as mentioned on the paneer package if store under refrigerated condition.

4.9 Quality Analysis of Finished product

Preparation of Sample of Paneer (Ref – IS 12758 - 1989 / I.S.O 1735-1987 Cheese and Processed Cheese products - Determination of fat content by gravimetric method - reference method. Bureau of Indian Standards, New Delhi).

Grate the paneer sample quickly through a suitable grater. Mix the grated sample thoroughly. Transfer the grated sample to an air-tight container to await analysis, which should be carried as soon as possible after grinding. Keep sample in an airtight container until the time of analysis. If delay is unavoidable, take all precautions to ensure proper preservation of the sample, and to prevent condensation of moisture on the inside surface of the container. The storage temperature should be below 10°C.

Determination of Moisture in Paneer (Ref – IS:2785:1979; Reaffirmed 1995). The moisture content of paneer is the loss in mass, expressed as a percentage by mass when the product is heated in an air oven at 102 ± 2°C to constant mass.

4.10 Documentation and Record Keeping

Every organization has to maintain records of raw material procurement, production processes, and sales. This is to ensure that the business runs effectively and is profitable. Listed below are some reasons why there is a need for documentation:

1. It gives detailed knowledge about running the business.
2. It helps to control product quality.
3. It helps to keep track of the money invested in the business.
4. It helps to identify the separate costs of raw material or product ingredients.
5. It helps to identify the production cost of a particular process.
6. It helps to make sure that all the quality assurance practices were followed during the production.

7. It helps to make sure that the production equipment is running smoothly/effectively.
8. It works as an evidence for legal procedures.
9. It helps to set an appropriate product price.
10. It helps to take corrective measures at the right time.

How to Keep Records

Every food processing organization follows a more or less similar way of keeping records. Production records keep a log of the following:

- The quantity and type of raw materials received
- The quantity and type of ingredients used during processing
- The processing conditions in which production took place (e.g. the temperature set or the air pressure applied)
- The product quality produced

Product quality can be maintained only when:

- The same quantity and quality of ingredients and raw materials are mixed in every batch
- A standard formulation is used for every batch
- Standard process parameters are applied for every batch

Every batch of food is given a batch number. This number is recorded in:

- Stock control books (where raw material procurement is noted)
- Processing logbooks (where production process is noted)
- Product sales records (where sales and distribution is noted)

The batch number must correlate with the product code number, which is printed on labels. This helps the processor to trace any fault found in a batch back to the raw material used or the production process

Paneer Processing Record		
Date:		Batch No:

Parameters		
Milk	Fat %	
	SNF %	
	Ratio of SNF to Fat	
	TS%	
	Acidity % LA (= ºN x 0.9/100)	
	Coliform count per gram	
Processing	Qty of Milk (kg)	
	Heat Treatment ºC (90 ºC)	
	Time taken for heating in minutes	
	Coagulation Temp. ºC (70 ºC)	
	Time taken for cooling in minutes	
	Temp of Citric solution ºC (70 ºC)	
	Concentration of Coagulants (2%)	
	Qty of citric acid used per litre of milk (1.65 gr/L)	
	Quantity Coagulants (82.5 ml/L milk)	
	Dipping time	
	Hooping Temp ºC	
	Load in kg of Pressing	
	Time of Pressing in min.	
	Temp of Chilled Water ºC	
	Soaking Time in min.	
	Temp of Paneer after Soaking ºC (40 ºC)	
	Drying Temp.ºC	
	Drying Time	
	Temp. After Drying in ºC	

	pH of Whey	
Paneer	Moisture %	
	Acidity % LA	
	Fat %	
	Fat on Dry matter %	
	Qty in kg	
	Yield %	
	SPC per gram	
	Coilform per gram	
	Colour	
	Texture	
	Flavour & Taste	
	Friability	
	No of 200g pack made	
	Actual yield in kg	
	Handling losses in %	

(Production Supervisor) (Production Manager)

Chapter – 5

Cleaning and CIP

5.1 Tanker Washing

The main objective of this unit is to clean the tankers properly after unloading or before uploading milk or any other dairy ingredients to avoid microbial and bacterial growth.

Stepwise washing operation:

Normal Tanker:

1. Manual Cleaning – Inside and outside (20 min.).
2. Normal water – Out food (20 sec.).
3. Hot water – Out food (20 sec.).
4. Hot water circulation (10 min).

Butter, Ghee, skim milk Tanker:

1. Manual Cleaning – Inside and outside (20 min.).
2. Normal water – Out food (20 sec.).
3. Hot water – Out food (20 sec.).
4. Lye circulation – 30 min. (85^0C).
5. Hot water circulation – 30min. (95^0C).

5.2 Crate Washing:

Washing Steps

1. Solid waste removal – Manually
2. Water washing
3. Caustic washing
4. Hot water washing

5.3 Effluent Treatment Plant (ETP)

ETP is a 24 hrs. continuous process. It takes hazardous outlet from all the process as inlet, treat it in three stages (Primary, Secondary and Tertiary stage) to reach the environmental standard. The outlets of the plant namely solid waste and treated water are respectively disposed in field and used for irrigation purpose in plant to develop green belt.

Effluent Sources:

1. CIP: Caustic and Nitric Acid
2. Backwash: Water
3. Tanker wash: Caustic and Nitric Acid
4. Boiler: Water
5. Caret wash: Caustic

Stepwise description of ETP functioning:

1) Screen chamber: Raw effluent from the plant is received by screen chamber and suspended particles are removed here.
2) Collection and equalization tank: After the screening the effluent enters the collection and equalization tank, where it is neutralized with hydrochloric acid and the effluent is made homogeneous.

3) Holding tank: It only meant for storage when excess amount of effluent is discharged from plant during CIP
4) Dissolved Air Floatation (DAF): The neutralized effluent from collection and equalization tank is received here and aluminum sulphate (a non-ferric alum) is added. The suspended and emulsified solids are separated here.
5) Buffer tank: It is an over flaw storage tank
6) Up blow Anaerobic Suspended Sludge Blanket (UASSB) Reactor (I&II): 12% to15% of the total volume of this tank is filled with biomass. It receives the effluent from DAF from the bottom of the tank. There are two type of bacteria present here.
    a. Acetogenesis: - It converts the large chain molecule to small chain molecule and produces amino acid.
    b. Methenogenesis: - It converts to methane gas, and hence organic load decreases
7) Hopper bottom tank: It is just a tank to control the escaped microbes from UASSBR and again recirculate it.
8) Aeration tank: In this tank aerobic microbes are developed
9) Lamella clarifier: It is used for solid settling purpose i.e. the solid liquid separation takes place here
10) Secondary clarifier: Here the aerobic culture is settled and again circulated to aeration tank to maintain the amount.
11) Treated water tank: Here the treated water from secondary clarifier or lamella clarifier is collected.

Plant Performance and Monitoring:

- Carryout regular monitoring program involving maintenance of record and analysis of effluent sample.
- ETP assistants have to collect samples at different stages of treatment system in presence of ETP in-charge for analysis.
- ETP in-charge has to do the analysis and record the result also report the result to EHS-engineer and EHS-officer. EHS-engineer and EHS-officer both will assess the performance of the plant based on laboratory analysis report and instruct the ETP in-charge and assistants about the action to be taken in case of any deviation from normal.
- The treated effluent has to be analyzed on daily basis and the results are recorded

Environmental Management System (EMS): Implementation and operation:

2. **Level-1:** EMS manual; describes the core elements of the EMS and their interactions. It outlines the structure of the document used in the EMS in line with-ISO 14001-2004 manual also describe the procedures elaborately how various requirements of ISO 14001-2004 are implemented.
3. **Level-2:** Documents; the filled formats which conveys the data that affects the environment. Ex – Operational control process, environmental management programs, emergency procedures, monitoring and management plans, training plan etc.
4. **Lavel-3:** Formats; used for recording and conveying data effecting the environment