

UNIT 11 STORAGE AND DISTRIBUTION SYSTEMS

Structure

- 11.0 Objectives
- 11.1 Introduction
- 11.2 Storage of Processed Milk
 - Storage of bulk milk
 - Storage of milk packed in multiple-use packages
 - Storage of milk packed in single-use packages
- 11.3 Distribution of Processed Milk
 - Distribution of bulk milk
 - Distribution of milk packed in multiple-use packages
 - Distribution of milk packed in single-use packages
 - Comparison of bulk and retail sale of milk
- 11.4 Let Us Sum Up
- 11.5 Key Words
- 11.6 Some Useful books
- 11.7 Answers to Check Your Progress

11.0 OBJECTIVES

After reading this unit, we should be able to:

- store the processed milk in bulk, multiuse and single use containers
- enumerate the different distribution systems for processed milk and explain them.

11.1 INTRODUCTION

The selection of a packaging, storage and distribution system will depend on existing economic ability, production and distribution efficiency, retailing pattern, consumer preferences and ecological aspects. The distribution systems that exist have been tabulated in the following table.

Table 11.1: Packaging and distribution systems for processed milk

Type of milk	Multiple-use containers			Single-use containers				By tanker to vending machines
	Glass bottles	Plastic bottles	Cans	Cartons	Sachets	Plastic bottles	Bag in box	
Pasteurised	*	*	*	*	*	*	*	*
Sterilised	*					*		
UHT				*	*	*		

11.2 STORAGE OF PROCESSED MILK

While designing a milk plant, adequate amenities must be provided for storing packaged milk in terms of area as well as facilities such as refrigeration. Space

would also be required for storing packaging materials, whether they be empty bottles and crates or rolls of packaging films.

i. Storage of Bulk Milk

Insulated tanks: Bulk milk after processing, is stored in insulated storage tanks in the dairy till transportation. The milk remains in the chilled condition. It is recommended that milk be transported to the place of delivery as soon as possible. However, due to limitations in infrastructure milk is stored for periods ranging from 4 to 12 hours after processing.

Storage in cans: Processed milk for bulk supply is also sometimes stored in cans. Since the beginning of the second half of last century aluminium milk cans have replaced mild steel cans that were used earlier. The most common are cans with lids which do not require rubber gaskets for sealing. An adequate sealing arrangement is achieved with sunken grip or mushroom lids. Lids attached to the cans by chains are no longer used owing to problems in mechanical washing. Lead or other seals can be applied through simple arrangements at the lid ring to avoid tampering and pilferage. Normally floor conveyors are used to transport cans from one place to another in the processing area of the dairy plant.

Full cans are stored in one layer, thus permitting about 320 to 360 litres of milk to be stored per square metre excluding movement and working space. Empty cans, after washing, are stacked in layers horizontally, up to a height of 1.5 m. For storing and moving washed empty cans simple trolleys on which the cans can be stored in 4–5 layers are very useful. For example, about 20 cans each of 40 litres capacity can be stored on trolleys about 1.7×0.7 m with a supporting frame made of a 1/2" pipe. Fig 11.1 illustrates the general dimensions and stacking of empty milk cans.

ii. Storage of Milk Packed in Multiple-use Packages

Storage in bottles: Bottles with wide necks (36 to 40 mm), suitable for sealing with aluminium foil caps are most commonly used for packaging of pasteurized milk in multi-use containers. The filled bottles are placed in plastic crates. These were earlier made of galvanized steel wires or strips, but plastic is in vogue these days. The crates have internal divisions so that the bottles are not in contact with one another to minimize risk of breakage. They are designed to interlock, so that a stable stack can be built. Crates with filled bottles are stacked five and six high for one-litre and half-litre bottles respectively for manual handling. Two to three crates more can be put in one stack for empty bottles. Crates can generally hold twenty half-litre and twelve to fifteen one-litre bottles. The stacks can be moved manually or by hand trolleys.

There exist no international standards for the dimensions of pasteurized milk bottles and crates. A general idea about these is provided in Fig. 11.2. It is evident from the figure that the floor area occupied by one stack of crates is thus about 0.15 m². This corresponds to a milk storage capacity of 400–470 l/m² depending on bottle capacity and stack height. For crated empty bottles the equivalent storage capacity is about 30% greater. Additional space must be allowed for entry, working and movement.

Fig. 11.2: General Dimensions and Storage Pattern of Glass Bottles, Crates and Stacks for Pasteurized Milk

Bottles used for in-bottle milk sterilization have narrower necks (26 mm) than the pasteurized milk bottles so that a more effective seal can be made. Prefabricated crown seals are used to seal the bottles. The requirements with regard to sturdiness during mechanical and thermal shocks are higher than those of a pasteurized milk bottle. The bottles are packed in crates as is done for pasteurized milk bottles. The stacking system and the resulting storage area required are also similar. As with pasteurized milk, dimensions differ from country to country but a neck diameter of 26 mm is universal. A general idea of the bottle dimensions is given in Fig. 11.3. Crates and stacks in this case have the same dimensions as for pasteurized milk.

Fig. 11.3: General Dimensions of a Sterilized Milk Bottle

iii. Storage of milk packed in single-use packages

The common feature of single-use containers is that they are discarded after emptying. This fact has an important bearing on the milk plant construction, organization and on the economics of the whole business. There is no collection and washing of the milk packages. Only the crates that carry the filled milk packages are collected and washed. Single-service delivery wraps, trays or boxes may also replace these. Intermediate storage of packing material and filled packages has to be organized at the plant.

Storage in pouches: The pillow-shaped sachets of pasteurized milk are collected in tubs after they are cut and separated from the packaging machine. They are placed in rectangular plastic crates holding 20 packages each and the crates are

then stacked. The approximate dimensions of a crate for holding pouches are given in Fig. 11.4. Thus with crates stacked 10-high containing 1/2-litre sachets the store capacity without space for entry, movement and working is about 500–600 1/m². Both 1-litre and 1/2-litre packages have the same width and thickness (0.09 m). Varying the distance between transverse seals facilitates changing the capacity. It is important that the film is free from pinholes so as to avoid leakage, particularly when subjected to pressure from the adjoining pouches in the crates. Table 11.2 illustrates the general details and space requirement for storage of film rolls used for pouch filling.

Fig. 11.4: Approximate Dimensions of a Stackable Crate for Holding Milk Pouches

Table 11.2: Space requirement for storing film rolls for milk sachets*

Capacity (litre)	Width (m)	Weight of one roll (kg)	Number of pouches per roll	Rolls for one million pouches		
				Number	Weight (kg)	Space requirement (m ²)
0.5	0.3	25	5500	180	4500	7
1.0	0.3	25	4000	250	6250	10

* Approximate calculations

Storage in cartons: In several countries, pasteurized milk is packaged in cartons on similar lines as UHT-milk. These may shaped as a rectangular block or tetrahedron, as given in Fig. 11.5. Rectangular cartons are normally used for UHT milk, though this is not a strict regulation. The tetrahedral packages, after filling, are placed in hexagonal plastic crates holding 18 cartons each. The crates are then stacked normally 6-high as illustrated in Fig. 11.6. Thus with a 6-high stack of crates containing 1/2- litre cartons, the storage capacity excluding the area required for entry and working is about 500 1/m².

Empty crates for tetrahedral cartons are normally stacked 15-high. The crates occupy less space when empty, as they are tapered. Rectangular crates occupy the same space empty or full. Table 11.3 and 11.4 give the space requirements for storage of packaging material for tetrahedral and rectangular cartons, respectively. The quantity of raw stock to be stored depends on the location of the milk plant

Fig. 11.5: Most Common Shape of Milk Cartons and their General Dimensions

Fig. 11.6: Approximate Dimensions of a Stackable Crate for Tetrahedral Cartons

and the paper supplier and also the purchasing power of the producer. It is generally necessary to carry two to three months' stock.

Table 11.3: Storage space requirement for paper rolls for tetrahedral milk cartons*

Capacity (litre)	Width (m)	Weight of one roll (kg)	Number of pouches per roll	Rolls for one million pouches		
				Number	Weight (kg)	Space requirement (m ²)
0.5	0.287	53	5000	200	10600	16
1.0	0.362	72	4000	250	18000	24

* Approximate calculations

Table 11.4: Storage space requirement for paper rolls for rectangular milk cartons*

Capacity (litre)	Width (m)	Weight of one roll (kg)	Number of pouches per roll	Rolls for one million pouches		
				Number	Weight (kg)	Space requirement (m ²)
0.5	0.322	60	3500	285	17100	24
1.0	0.322	63	2500	400	25200	34

* Approximate calculations

Check Your Progress 1

- Name the common packaging systems used for processed milk.

- Why is it necessary to match the dimension of a milk bottle to that of a crate for bottles?

- Why does packaging in single-use containers reduce the work in a dairy?

11.3 DISTRIBUTION OF PROCESSED MILK

There are many methods and regulations for the distribution or retailing of milk, depending on the country and type of milk that is being distributed. The dairy industry does not invest in liquid milk retailing in most countries, other than for

promotion and demonstration centres and automatic vending machines. The grocers sell and sometimes distribute the milk delivered by the plant. They charge a little extra (the 'retail margin') over the milk plant price for their services. In countries where the milk plant delivers milk directly to consumers, the plant absorbs the retail margin. There is no common system for establishing retail margins. They vary considerably between countries and sometimes, even between localities within the same country due to variation in cost of labour, transport and capital.

i. Distribution of bulk milk

Distribution in cans: Bulk milk may be distributed to institutions such as catering establishments, university hostels and hospitals in cans. These cans are filled in the dairy directly from the tanks in which milk is stored, either by pumps or by gravity filling. They are then transported to the consumer in appropriate vehicles (tempo, trucks etc.). The consumers empty the cans into their own storage systems and return the cans immediately. Alternatively, the cans may be retained and the previous time's empty and cleaned can are returned to the vehicle for transport to the dairy. This cycle is maintained. It is important that the cans are cleaned again in the dairy, even if they have been cleaned at the consumer's location.

Distribution in automatic vending machines: The sale of milk in bulk through automatic vending machines has been introduced successfully in Mexico and India. This system does not involve retail packaging by the milk plant as the consumer provides his own container. Thus, the milk is handled in bulk up to the point of retail sale. This eliminates the cost of packaging and there is substantial saving in running cost. The milk plant sells milk directly to the consumer and so, there is no need for middlemen or a distribution network.

A tanker delivers the refrigerated pasteurized milk to the vending station housed in a simple building. This consists of a refrigerated room in which a milk storage tank of the requisite capacity is placed at a high level. A small service room for the cleaning-in-place (CIP) equipment is essential. Office or storage facilities may also be required. The milk is pumped from the tanker to the storage tank. From there, it is discharged as required by the customer through the coin- or token-operated dispensers as shown in Fig. 11.7.

ii. Distribution of milk packed in multiple-use packages

Countries that use glass bottles for packaging at least some portion of their total packaged pasteurized milk include Bulgaria, India, Japan, Malta, New Zealand, Poland, South Africa and the United Kingdom. The proper working of the distribution system involving re-use of containers - mostly glass bottles - depends entirely on how effectively the empty bottles are retrieved. There are normally three ways in which this is done.

In the first case, the milk may be delivered to the customer's doorstep and empty bottles recovered at the same time. This system has the advantage that it can work in the customer's absence. The payment may be collected after a set period of time, for instance, once per week.

Secondly, vehicles carrying the packaged milk may tour the customers' locality with many stops in each street. They normally announce their presence by blowing the horn or any other audible signal. The customers come to the vehicle bringing empty bottles. The customers need to pay a deposit on empty bottles, normally equal to the cost of the bottle. If they require more full bottles than the number of empties they return, extra deposits must be paid. If they require less a corresponding credit is allowed.

In the third method, milk may be sold only from shops to which the customer must go to purchase milk. A similar system as before, for paying a deposit on the bottle prevails here also.

iii. Distribution of milk packed in single-use packages

Single-use packages offer the advantage of doing away with the cleaning-collecting-returning-cleaning routine that is needed for the multiple use containers. Out of several distribution methods, the most commonly used is the stacking of the filled packages in crates. Sometimes they are also wrapped in non-returnable materials. Crating already has been mentioned in the section dealing with pasteurized milk in tetrahedral cartons. For single-use transport packaging, shrink-film is most often used. This wrapping can be applied manually or mechanically. This system is used where short storage times and short distribution distances are involved. This has the disadvantage that the film does not give much mechanical support to the packages. Cartons wrapped in shrink-on film are often susceptible to damage, leakage and contamination, especially when handled manually. Special (perforated) shrink-films may be required in areas with high humidity to prevent condensation.

Rectangular cartons filled with milk are placed first on a flat tray blank in groups of twelve. The sides of the blank are then folded up tightly around the cartons. Thus, the pressure-absorbing ability of the filled cartons is fully utilized. The packed corrugated tray is then wrapped in shrink-on film, thus protecting against dust and moisture. It also presses the sides of the tray in towards the cartons so as to improve the pressure-absorbing ability of the corrugated tray. This method is a safe, but more expensive system than the shrink-wrap. The units can easily be handled manually. This system is normally used for UHT milk, which is to be stored for longer periods and distributed over greater distances.

iv. Comparison of bulk and retail sale of milk

The merits and demerits of either of these systems depend on the locality and attitude of consumers and the type of milk being sold. Some of the differences in the two systems are enumerated below.

1. Although pasteurized milk can be sold in bulk, sterilized and UHT milk cannot be sold without packaging.
2. Packaged milk is measured accurately.

3. Milk sold in bulk is amenable to adulteration at different levels: transportation as well as vending.
4. Keeping quality of pasteurised milk depends on maintaining the ‘cold chain’ throughout its distribution network. If milk that leaves the plant at temperatures much below 10° C in insulated vehicles and is kept by the retailer under refrigeration, the quality of milk is bound to be much better than the bulk-vended milk, particularly in cans.
5. The sale of milk in automatic vending machines ensures the continuity of the cold chain. However, there may be a need to redesign or reconstruct buildings to accommodate the equipment, which is often difficult in crowded cities. In Mexico and India, where this system is in operation, it is considered a success and has the full support of every group of customers. However, there is feedback regarding the equipment, which comes in capacities of 1000 and 2000 litres. The machines need to be developed further, in order to make them more suitable to varying conditions and requirements.

Check Your Progress 2

1. What do you understand by ‘retail margin’?

2. Explain the working of the automatic milk vending machine with the help of a neat diagram.

3. What are the different systems for retrieval of empty milk bottles from customers?

4. Enumerate the differences between bulk sale and retail sale of milk.

11.4 LET US SUM UP

Packaged milk is stored in the dairy or at the retail outlet till the time of sale. Several methods exist for the storage, depending on the type of milk and the type of package. Milk in bottles, flexible pillow pouches and cartons are normally stored in crates of appropriate sizes. Cartons may sometimes be packages in shrink-wrap films also. The distribution or retailing of milk in bulk may be done by automatic vending machines. Packaged milk is retailed through vehicles, shops or sold at the customers’ doorstep, depending on the area and type of milk. Maintaining the pasteurized milk at cold conditions is necessary for achieving the necessary keeping quality of the milk.

11.5 KEY WORDS

- Retail margin** : The profit given to retail sales agents for their services.
- Retailing** : The method by which the packaged material actually reaches the customer.
- Bulk vending** : The sale of material in bulk without any systematic packaging.

11.6 SOME USEFUL BOOKS

- De, S. (1980). Outlines of Dairy Technology. Oxford University Press. Delhi.
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- Giles, G.A. (Ed.). (1999). Handbook of Beverage Packaging. Sheffield Academic Press. CRC Press. Canada, USA.
- Robinson, R.K. (Ed.). (1994). Modern Dairy Technology. Vol. 1 and 2. Chapman and Hall. London, Glasgow, New York.
- Walstra, P., Guerts, T.J., Noomen, A., Jellema, A. and van Boekel, M.A.J.S. (1999). Dairy Technology. Marcel Dekker, Inc. New York, Basel.

11.7 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

- 1) i. List the packaging systems used for different kinds of milk
- 2) i. Indicate what would happen if the
 - bottle is oversized
 - bottle is undersized
- 3) i. Explain how the system of returning the bottles, their cleaning and storage is cumbersome as compared to single-use packaging.

Check Your Progress 2

- 1) i. Explain the concept of rewarding the retailer for his services.
- 2) i. A neat and labeled line diagram of the automatic vending machine
 - ii. Explain the parts
 - iii. Describe the actual sequence of working
- 3) i. Enumerate the three existing systems of returning empty bottles with their merits and demerits.
- 4) i. List the comparative advantages and disadvantages of the two systems of sale of milk.