UNIT 10 OPERATIONAL DETAILS OF COMMON PACKAGING SYSTEMS FOR FLUID MILK

Structure

10.0 OBJECTIVES

After reading this unit, we should be able to:

- operate the bottle washing machine
- operate the bottle filling machine
- operate the pouch filling machine

10.1 INTRODUCTION

The pasteurized and cooled milk is immediately packaged in suitable containers or bottles so as to protect the product against contamination, loss, spillage, pilferage, evaporation and/or damage due to microbial attack, insect, exposure to light, heat, moisture or oxygen. It also helps in marketing the product. The several processing operations that milk is subjected to provide the producer a choice of the packaging system, depending on the availability of the raw materials and the consumers' preference. These different packaging systems have different operating procedures, which are briefly described below.

10.2 PACKAGING IN MULTI-USE CONTAINERS

The basic aspect of packaging systems using multi-use containers is collection of empty containers and washing these prior to refilling. There may be need for intermediate storage of unwashed as well as washed empties, depending on capacities of machines and operating times. Storage of unwashed containers is normally essential and may extend overnight so that washing and filling operations begin next morning before the day's load of unwashed empties arrives. Storage of washed cans is permissible as cans have lids, but storage of washed bottles is a bad practice as they do not have lids and are exposed to contamination. Filled cans and bottles normally need refrigerated storage to synchronise with the distribution timings and arrangements. The storage and operational requirements are depicted schematically in the following figure.

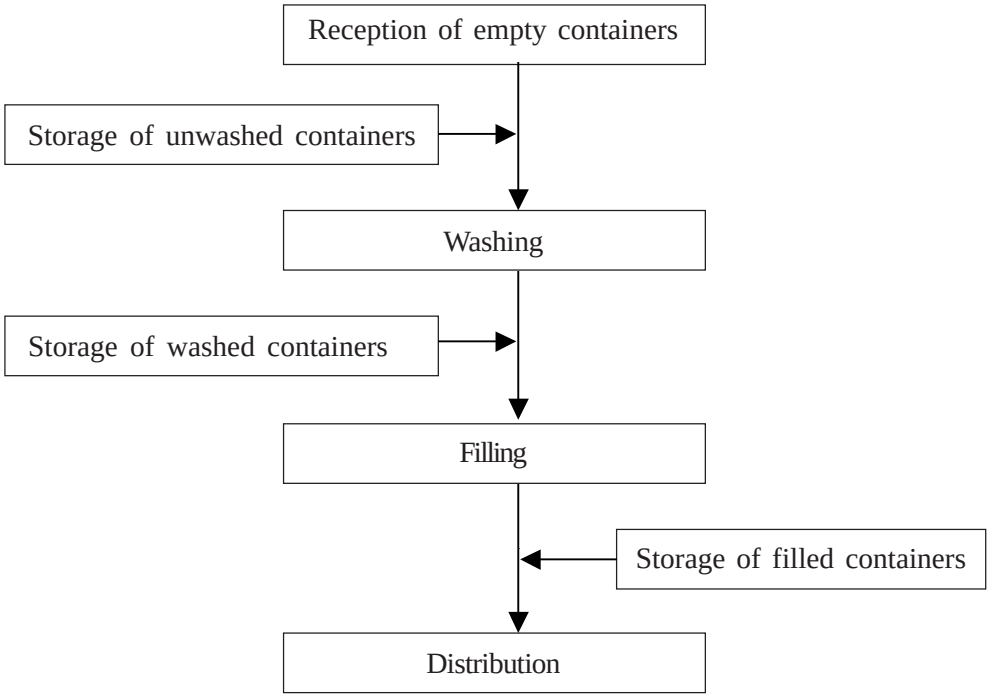

Fig. 10.1: Sequence of operations with multi-use containers

Thus, packaging in bottles may be explained in two phases: first, the bottle filling operation along with the bottle-capping process and second, the bottle washing operation. Bottles with wide necks (36 to 40 mm), suitable for sealing with aluminium foil caps made in place from reeled strip, forms the most common system for packaging of pasteurized milk in multiuse containers. Bottle washing, filling and capping machines should be of matching capacity, otherwise the labour-intensive operations of filling and emptying crates, unstacking and stacking would have to be repeated unnecessarily. This problem does not arise with cans, since they are not crated and may be easily stored empty after cleaning.

i. Bottle Fillers

There are two types of bottle fillers in operation, the gravity fillers and the vacuum fillers. In both the types, the filling force is the force of gravity. While one filling tank is maintained under atmospheric pressure, the unit using vacuum filling is under negative pressure. The head of milk over the bottle determines the speed of filling. The filling nozzles in both types are arranged in a circle. Bottles are fed from the bottle washer into the filler in a single row. On this single lane conveyor, the bottle in-feed to the filler may be stopped by a bottle stop. This bottle stop is free to rotate under normal circumstances. But if the operator wishes to stop the machine for any reason, the clutch-operated bottle stop would prevent further movement of bottles to the filling machine.

The main components of the filling machine are the float chamber, the filling nozzles and the supports. The assembly of supports revolves the bottles, which are automatically fed into the bottle supports or lifts. Each support raises the bottle in it so that its mouth is pressed and sealed against the rubber gasket of the filling nozzle. The efficiency of this seal depends on the bottleneck finish, hardness and state of the rubber gasket and the sealing pressure. The bottle is now in the position to be filled, being arranged just below the filling valve and the product to be filled in the filling bowl.

The milk flows into the bottle while it still moves along the assembly. The bottle filling valves are opened and closed by a lever from cams fitted to the stationary filling frame. The valves are triggered as the filling bowl and consequently, the valve-activating lever pass the cam. In case no bottle is in position, the centering

bell does not lift and therefore, the situation can be sensed. This is a mechanical system to ensure that the filling valve is not activated. Therefore, no filling takes place when no bottle is in place, thus avoiding spillage and losses. After the bottle is filled, just prior to completing a full revolution, the bottle is automatically brought down and an empty bottle takes its place.

Gravity fillers: The bottle-filling system works on the same principle as filling a bottle under a tap from an overhead tank. However, certain conditions are to be fulfilled for the efficient and automatic working of the system. Firstly, the filler bowl should have enough liquid (milk). This is easily achieved by installing a float, which closes the connection to the main tank when the bowl is filled and opens up when the milk level falls.

The next step is to ensure that the bottle mouth is adequately sealed to the filler bowl. To achieve this, the bottle is connected to a filling tube attached to the filling bowl. In the simplest design, this is achieved by placing the bottle on a stirrup that could be lifted up to seal against the gasket on the filler bowl. Therefore, the neck design and quality of the bottle should be capable of creating this seal. Once the bottle is sealed to the bowl, the flow of milk can start. To control the flow, the filling valve in the filling tube opens to start the flow and closes when the bottle is filled. The lifting stirrup is then lowered and the bottle is removed from the filler and the next empty bottle is introduced into the line.

The pressure head from the top of the filling bowl to the outlet of the filling valve provides the ‘driving force’ or the ‘gravitational force’ to fill the container. As indicated in Fig. 10.2, when valve the V is opened, the milk flows from the filling bowl under gravity head G into the bottle. The bottle is kept filled to a predetermined level from the filler bowl by installing a balance tube T. Once the milk in the bottle covers this balance tube, flow stops because the pressure in the bottle then exceeds the pressure in the headspace of the filling bowl.

Fig. 10.2: Operation of Gravity Filler

Vacuum fillers: In this case, the filling bowl is closed and as opposed to the gravity fillers, which work under atmospheric pressure, a negative pressure of about 0.05 bar is applied to it. The bottle is placed in position such that an airtight seal is created between the filling bowl and the bottle to be filled. However, this type of

filler is not suitable for liquids of low viscosity that tend to foam. This is because the liquid in the balance tube is sucked back into the filling bowl owing to the vacuum that exists, as the bottle is lowered from the seal on the filling bowl. Therefore, vacuum fillers are normally used for liquids of higher viscosity.

A high-speed centrifugal blower creates the moderate vacuum in the filler bowl by connecting its suction inlet to the top of the filler bowl (Fig. 10.3). The vacuum pipe is connected to the vacuum in the filler bowl through the filling valve. As the bottle on the stirrup rises towards the filler bowl, it is connected to the vacuum chamber through the vacuum pipe and allows the milk to flow down into the bottle. The distance by which the vacuum tube extends into the bottle determines the level of milk in the bottle. Vacuum fillers will not fill a broken bottle.

Fig. 10.3 Schematic Diagram of Vacuum Bottle Filler

ii. Bottle Cappers

Bottle-filling and capping are related activities and have to be considered in combination with one another. The filled bottles move in a smooth continuous fashion to the capping section. A movable support raises the bottle against the capping machine. The rising bottle activates a mechanism that slides a cap over the bottle and then brings the capped bottle against a plunger. The plunger is backed by a spring so that the cap is forced onto the bottle under regulated pressure.

The most commonly used closures for bottles are aluminium caps and crown corks. The former has a thickness ranging from 0.04 to 0.06 microns. The cap should cover the bottle mouth entirely and should be sterilized before use. Crown corks are the oldest types of closures and are sill used widely in the beverage industry. They are made from precoated tin plate or tin-free steel sheets. These sheets pass through a press tool machine, which produces discs and also shapes them into crowns with corrugated edges. A liner is inserted in the crown. This compounds the crown and also acts as the main seal. When closing the bottle, a vertical load is applied to the bottle to ensure that the liner is pressed on to the neck finish. At the same time, a specially designed circular disk is forced onto the crown edges, forcing them inwards and making a lock around the edge of the bottle mouth. Crown corks are normally used for sterilized milk bottles.

iii. Bottle Washers

Bottle washing machines work on any of the following principles: 1) Spray or hydro-rotary, 2) straight-through soaker hydro type and 3) soaker type.

The jet or spray type washer sprays the inside and outside of the bottle with jets of washing solutions. This design is simple and compact. It is, however, not as efficient as the soaker type. Its initial cost, however, is less than the soaker type machines. It is more suited for smaller plants.

The come-back-soaker-hydro machine is the most common in large dairies. Bottles are kept soaked in a strong alkali solution for some time (~ 5-10 min). An endless (round) conveyor carries the bottle carriers through the washer.

The typical washing sequence (Fig. 10.4), in which the carrier conveyor chains dip in and out of the soak tanks allowing sufficient type for soaking consists of the following steps:

- Pre-rinse with tap water, warm clear water or the overflow from the final rinse tank. The bottles are either jetted with water or soaked. Water temperature: ~ 35-40° C.
- Empty the residue in bottles.
- Prerinse using warm water. Water temperature: ~ 55° C.
- Soak in hot solution of strong alkali. Solution strength depends on its temperature and soaking time. (usually ~ 3% alkali, 55° C, 5 min soaking). Temperature ranges unto 80° C with alkali solutions of 1-3% strength.
- Scrub with solution. Bottles are exposed to hot solution jets at high pressure from inside and outside to dislodge stubborn particles that stick to surfaces.
- Rinse bottles with warm water. Water temperature: ~ 60° C.
- Repeat the above two steps at ~ 80° C.
- Invert the bottles to empty contents.
- Pressure rinse with warm water inside and outside. Water temperature: 35-40° C or higher. This water is not circulated, but is normally routed to the pre-rinse tank. Empty the bottles.
- First rinse with fresh water. Jets from inside and outside. Empty the bottles.
- Final rinse with fresh water. This water may be chlorinated to ensure sanitisation. Sodium hypochlorite of strength 25-50 ppm of available chlorine. Empty the bottles.

Whatever the principle on which the bottle washer works, the following basic conditions should be fulfilled by the machine.

- The cleaning and sterilizing solutions should reach all corners inside and outside of the bottles being washed.
- Sufficient contact time should be allowed for efficient washing and cleaning.
- Different solutions should be in individual chambers and should not be allowed to mix.
- There should be of predetermined concentration and should not be diluted with rinse water or steam injections.
- The temperature and strength of detergent solutions should be maintained.
- Soft water should be used.
- Cleaning solutions should be changed at least once a week and all tanks are cleaned.
- If hard water is used sodium gluconate and/or tetrasodium pyrophosphate should be added to the washing solutions.
- A 15% solution of muriatic acid along with an inhibitor may be used as a descaling agent in bottle washers.

Fig. 10.4: Glass Bottle Washer

After bottle washing, inspection should be done for dirty bottles, chipped bottles, residual liquid and foreign objects in bottles.

Check Your Progress 1

1. With a flow diagram describe the operations of a multi-use milk packages.

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2. What is the difference between gravity fillers and vacuum fillers?

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3. Indicate the sequence of bottle washing.

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4. What are the basic conditions that should be fulfilled by a bottle washing machine?

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10.3 PACKAGING IN SINGLE-SERVICE POUCHES

The sequence of operations when packaging into single-service pouches includes forming the container, filling and sealing, storage of the packaged product and dispatch to wholesale and retail outlets. The parts of the packaging machine are enclosed in a stainless steel (SS) cabinet. All parts are made of SS or treated aluminium protected by a coat of weatherproof paint.

Plastic sachets are pillow-shaped and made of low-density polyethylene film (LDPE). The packaging material may come in a roll of single or double film or as a flat tube. The material should be coloured to reduce light transmission. Heat-sealable film rolls are mounted inside the compartment at the rear bottom. The film is sterilized by exposing to ultra violet rays just before use. The film is shaped and heat-sealed into a tube by a vertical electrode. The flat tube type comes pre-shaped as a tube and so there will be no longitudinal seam.

After vertical sealing, the film is then moved downwards by a set of rubber rollers. It then comes to contact with the horizontal electrode. A simultaneous seal is made at the bottom of each packet and across the top of the preceding packet. The transverse seals are thus made above milk level. This also separates one pouch from the other. Injection of milk into the pouch takes place between the strokes of the horizontal electrode. The milk is kept in a small balance tank above the packaging machine, where the level is kept constant by means of a float. A timer-controlled pneumatically operated valve is used to dispense constant quantities of milk. The heat generated by both the sealing valves is removed by circulating soft water.

After the packaging operation, the machine should be washed and cleaned. A general set of instructions for washing is given below.

- Bring the machine to manual operation.
- Switch off the horizontal seal and liquid injection systems.
- Empty the product in the balance tank into a can.
- Flush the balance tank with water and drain.
- Clean by circulating 1% caustic soda at 80° C.

- Drain alkali and flush with sufficient quantity of water.
- Cool machine and switch off.

The following is the daily maintenance schedule of a pouch-filling machine.

- Clean parts of the machine with a soft brush and warm liquid soap solution.
- Wash with clean water.
- Dry with air blower.
- Lubricate parts that need it.
- Check horizontal and vertical electrodes for deposition of milk solids. Do not use sharp materials for removing these.
- Elements should be replaced in case of burns or physical damages.

Check Your Progress 2

1. Explain in brief the operation of a pouch-filling machine.

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2. How would you clean a pouch-filling machine?

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3. List the steps to be taken during maintenance of a pouch-filling machine.

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10.4 PACKAGING LONG-LIFE MILK

Ultra-High-Temperature (UHT) processing and packaging of milk are employed to increase its shelf life. This process needs special equipment for aseptic packaging of UHT Milk.

10.5 LET US SUM UP

Processed milk is packaged in different types of containers that may be used only once (single-service) or many times (multi-service). The packaging systems used and their operation depends on the type of containers used. The multi-use containers such as bottles need to be collected and brought to the processing dairy from the distribution points. They have to be cleaned and sanitized before filling again. In the case of single-use containers such as pouches, the job of collecting empty containers and washing them is done away with. However, disposing these should be done in a manner that is not harmful to the environment.

10.6 KEY WORDS

Gravity filling : Filling done by placing the milk storage tank

above the filling machine and allowing the liquid to flow into the machine at atmospheric pressure

Vacuum-filling : Filling done by removal of air from the system and allowing operating below atmospheric pressure (negative pressure)

Conveyor : A moving part of chains linked to each other to carry material across a space.

10.7 SOME USEFUL BOOKS

De, S. (1980). Outlines of Dairy Technology. Oxford University Press. Delhi.

Edgar, S. (1995). Milk and Dairy Product Technology. Marcel Dekker, Inc. New York, Basel, Hong Kong.

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.

10.8 ANSWERS TO 'CHECK YOUR PROGRESS' EXERCISES

Check Your Progress 1

1) i. A line or block diagram of different steps in operation of a multiuse container for packaging (Refer Fig. 2.1)

   ii. A brief explanation of the same

2) i. Your answer should explain differences in the principle of operation of the two types of fillers.

3) i. Your answer should list the steps of bottle washing with brief explanation of each step.

4) i. Your answer should list and explain in brief the operational features to be fulfilled by the machine.

Check Your Progress 2

1) i. Your answer should list sequence of operation of a pouch-filling machine and explain each briefly.

2) ii. You should list and explain the steps of cleaning a pouch-filling machine.

3) iii. Maintenance schedule to be followed for a pouch-filling machine and briefly explain each step.