

## CLARIFYING, COOLING AND STORAGE OF MILK

R. J. MacWALTER, B.Sc., Ph.D., F.R.I.C., M.I.Chem.E. \*

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Milk may be received at the processing dairy in cans direct from producers, or in cans or tanks from a collecting centre. Following acceptance of the consignment, it is necessary to measure the quantity received. This may be done volumetrically by inspection of the level in each can, or by the use of a dip rod in the case of delivery by tank. This method demands the use of receptacles which are calibrated in units of volume, and the consignor is then credited with the whole of the volume *delivered*. Alternatively, the consignment may be tipped into a weigh-tank, and the weight of the milk "received" into the dairy is credited to the consignor.

Whichever method is adopted, the first stage of the process of reception involves emptying the cans over the tip-tank or weigh-tank (see Fig. 1). This process may be carried out entirely by hand, by a mechanical inverter, or by a "hand-assisted" method whereby, as it falls, the can is guided in a regulated manner into the inverted position. This process of inversion may be a serious source of contamination of the tipped milk by soil from the exterior of the can, and some dairies adopt inclined tipping whereby the can is not completely inverted to a vertical position. Thus the base of the can is never directly above the surface of the milk in the receiving tank. Drainage of the can is important and it is generally considered that for cans of 40-l capacity a drainage time of at least 30 seconds should be allowed.

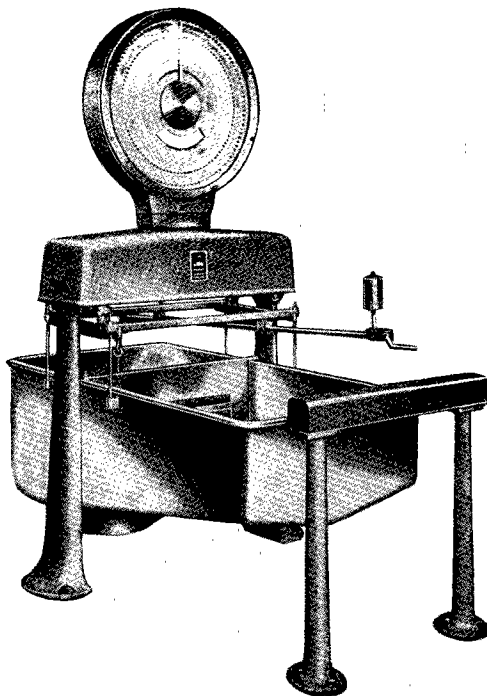
Where weigh-tanks are installed, after the weight of the consignment has been recorded the contents are discharged into a tank immediately below it from which the milk is pumped through a cooler to a storage tank. Where milk is measured volumetrically the cans are tipped directly into the tip-tank, from which the milk is pumped to the cooler.

In either case the tank serving the pump is fitted with a fine metal-gauze strainer to remove particulate matter.

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\* Chief Chemist, Central Laboratory, United Dairies, Ltd., London, England.

FIG. 1  
WEIGH-TANK



## Cooling

Milk which is to be stored upon receipt from the farm for periods in excess of one hour should be immediately cooled to 4°C. In temperate climates, where water cooling at the farm is normally practised, it is common to cool the milk by means of a plate-type heat-exchanger using a secondary refrigerant. In warmer countries, and where a copious supply of cold water from a river or artesian well is available, an intermediate stage of water cooling in the heat-exchanger may be advantageous.

With such heat-exchangers the circulating secondary refrigerant is usually a 20% solution of calcium chloride at between -7° and -4°C or chilled water

at between 1.5° and 2.5°C. There are a number of advantages in the use of chilled water in preference to calcium chloride or other salt solutions:

- (1) The corrosion hazard for stainless steel is greatly reduced.
- (2) Deposits on cooler plates are less readily formed.
- (3) It is impossible for the milk in the cooler to freeze if the flow of milk is interrupted without stoppage of the refrigerant circulation.
- (4) Designs of water chillers are available in which a reserve of ice may be built up during periods when no milk-cooling duty takes place. This permits a refrigerating unit to be used for cooling loads in excess of its rated capacity for short periods.
- (5) If the secondary refrigerant (water) is lost it may be replaced without cost.

In small installations a "capillary" or "surface" cooler (see Fig. 4 of chapter by Rice, page 476) may be employed in which the milk flows over a corrugated metal surface, the internal surface of which is cooled by water or refrigerant (or both in two stages). In the smaller sizes direct expansion refrigeration is often employed. In such a case, however, heat sterilization

of the milk-contacting surfaces may present difficulties unless provision is made for the refrigerant to be pumped away from the cooler beforehand.

Whichever system of cooling is employed, it is desirable that the capacity of the plant should be matched as closely as possible to the rate of discharge of milk at the reception point so that the flow of milk to be cooled is subjected to as few interruptions as possible.

FIG. 2  
BATTERY OF INSULATED STORAGE TANKS OF 3000-GALLON CAPACITY,  
AIR-AGITATED



### Storage

Modern storage tanks for raw milk are generally of horizontal cylindrical shape (see Fig. 2). In temperate climates where the storage period is not to exceed 24 hours it is often considered unnecessary to insulate tanks of 12 000-l capacity in order to maintain the desired maximum temperature of 4°C. In warmer climates, and with tanks of smaller capacity, insulation with 7-10 cm of cork or other insulating material is desirable. In such cases a watertight sheet metal covering for the insulating material is essential.

Means for agitation of the milk during storage must be provided and may take the form of a submerged rotating paddle or of a continuous flow of bubbles of air from a series of apertures in a pipe placed along the base of the tank. The paddle may be driven from above the tank, or the spindle may pass through the side of the tank by means of a hygienic form of gland. Formerly these glands were regarded as a source of bacterial contamination and this led to the development of the air agitation system. Modern designs of gland have, however, removed this hazard. With the largest tanks of 25 000-l capacity air agitation is likely to be the more efficient. With either method, however, a balance needs to be found between too much agitation, leading to the formation of granules of butter, and too little, leading to creaming of the milk.

Opinions differ as to whether it is better to fill storage tanks from below, or by means of an inlet pipe at or near the top. Local considerations often dictate the chosen method, but it is important to avoid foaming of the milk during filling. If the tank is filled from an inlet near the top it is desirable to set this pipe so as to direct the milk against the wall of the tank, thus avoiding splashing.

The contents of storage tanks may be measured by means of a vertical open-ended glass tube connected at the bottom with the contents of the tank. The height of milk in the tube indicates the level of milk in the tank. This is not, however, hygienically satisfactory, and measurement by means of a dip rod inserted through an aperture in the top of the tank is preferable. In either case careful calibration of the capacity of the tank in its final working position is essential.

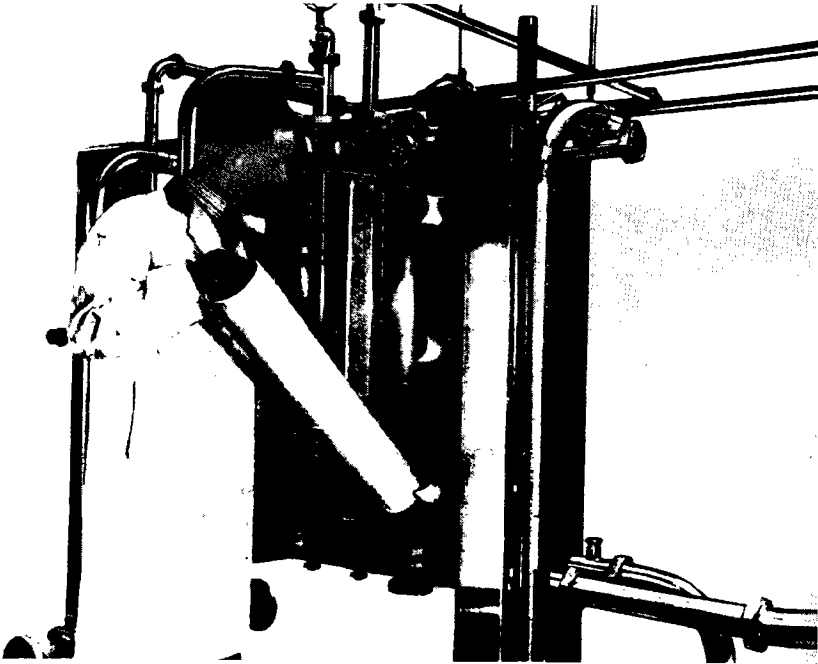
Access manholes for cleaning are provided either at a low level or near the top of the tank, and two sight windows are essential. As with all equipment in the dairy, tanks should be supported on legs so designed as to provide minimum obstruction to the cleaning of the dairy floor, and modern practice dictates that tank bodies should be constructed of polished stainless steel sheet.

### Clarification

The cooled stored milk must be clarified before pasteurization. In this context the term clarification is used to indicate the process of removal of insoluble material foreign to milk. Milk produced under satisfactory hygienic conditions will be substantially free from obvious foreign matter and will be passed through cloth strainers before the transport cans are filled. It is, however, good practice to introduce at the receiving dairy additional, and generally more efficient, means of clarification than are available at the farm, so as to ensure that the final product is entirely free from animal hairs, dust, soil and other debris. It is perhaps relevant to mention that this process has little effect on the bacteriological condition of the milk, for any

micro-organisms associated with the foreign matter are likely to have been transferred to the milk before clarification. For this reason the use of sediment pads for the judgement of the hygienic quality of production has a limited value, for whilst poor grading for sediment indicates unhygienic conditions, high grading may merely demonstrate that equally unsatisfactory milk has been efficiently clarified before filling into cans.

FIG. 3  
CLOTH FILTER



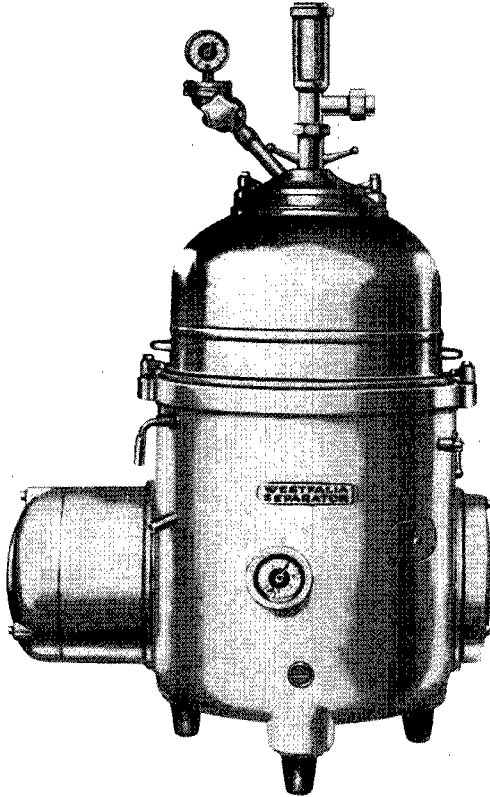
The strainer mentioned earlier serves merely to protect the coolers and other equipment from deposits derived from the milk. Two methods are used for efficient clarification—filter cloths (see Fig. 3) and centrifugal clarifier (see Fig. 4).

Filtration with cloth usually takes place after the milk has been partially heated in its passage through the pasteurizer, since at elevated temperatures the reduced viscosity of the milk reduces the resistance to its passage through the filter. In modern pasteurizing plants such filters are incorporated in the machine, usually in the form of cylindrical “stockings” fitted over perforated tubes of stainless steel. By employing two such units in parallel it is possible to use them alternately so that one filter may be taken out

of use for replacement without interrupting the flow of milk. Filtration takes place at 35°-60°C; the cloth used has a woolly nap on the side facing the direction from which the milk flows.

Centrifugal clarification takes place before the milk reaches the pasteurizer, and in modern installations the process is carried out in the cold. This apparatus is similar to the cream separator, but the internal design is slightly

FIG. 4  
CENTRIFUGAL CLARIFIER



modified so that cream and separated milk do not flow separately from the machine. The insoluble matter is thrown to the rotating bowl of the machine and collects there, whence it is removed at intervals. Such machines are more efficient than cloth filters but, of course, need the mechanical maintenance characteristic of high-speed centrifuges. There is one application where the superior efficiency of this method is of considerable advantage. When milk is homogenized traces of insoluble matter, particularly epithelial cells, are more likely to deposit from the milk on standing than is the case with ordinary milk. This gives rise on occasion to a dark-coloured sediment even if the milk has been filtered before homogenization. Such sediments may be completely eliminated by the use of cold centrifugal clarifiers owing to their greater efficiency.

### Cleaning and Sterilizing

It is considered good practice for the whole plant used for reception, cooling, and storage of raw milk, including pipelines and pumps, to be cleaned and sterilized each day after the last of the milk has been received. Tanks used for raw milk storage should be cleaned and sterilized each time they are emptied.

In many dairies efficient methods of cleaning-in-place are practised whereby the detergent solution is circulated through the assembled plant, which is then flushed with water and finally sterilized with water at 85°C without the need for dismantling. It is, however, necessary to be sure that the method used is capable of completely removing all milk residues before reliance can be placed on it. Somewhat similar methods may be used for storage-tank cleaning by fitting a whirling spray to project the detergent solution over the whole of the milk-contacting surfaces.

### **Hygienic Effect of Clarifying and Cooling**

Although, as has been stated, the influence of removal of particulate matter on the bacterial quality of milk is not of marked significance, its aesthetic importance is considerable. Consumers of milk and milk products have the right to demand that these foods shall be free from extraneous matter, and the obligation rests with the processor to ensure this condition by efficient clarification of the milk for all purposes.

As regards the importance of cooling, this is of vital concern to processor and consumer alike. At a temperature of 4°C few organisms of significance are likely to grow, except the group known as psychrophiles which can proliferate under these conditions. This group is of relatively small importance.

At temperatures between 10°C and 15°C appreciable deterioration in milk supplies may take place in a few hours, the effect being much more marked with supplies produced under poor than under satisfactory hygienic conditions.

This is not to say that by cooling to 4°C all deterioration is arrested, nor that the hygienic condition for storage of milk at this temperature can be lightly regarded. In fact, organisms associated with improperly sterilized apparatus have been found to have high heat resistance and to be responsible for loss of keeping quality. The same hygienic standards of cleaning and sterilizing are required at this stage as elsewhere in dairies; refrigerated milk should not be stored for longer periods than necessary, and in any case not longer than 48 hours.

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