COOLING MILK ON THE FARM

NOWADAYS it is common knowledge that the souring of milk is caused by bacteria which grow very rapidly if the milk remains warm. Consequently, it is necessary to cool the milk to 50°F. or lower if it must be held for any length of time before being pasteurized or consumed.

High grade milk may be produced by maintaining a healthy herd, and by milking under conditions which keep the number of bacteria to a minimum, followed by thorough cooling to check the growth of the few bacteria which may be present. Unfortunately, there has been a tendency to over-emphasize the importance of cooling as compared with the need for careful production methods; cooling is very important, but it cannot take the place of clean milking[1].

When Cooling Should Be Done

To prevent bacterial growth and subsequent spoliage, *milk should be cooled immediately after it is drawn.* The importance of this is not always realized. Milk cooled without delay will keep sweet many hours longer than will another portion of the same milk, the cooling of which is delayed for an hour or two. When milk must be shipped long distances without adequate protection during warm weather, immediate cooling may make all the difference between its being accepted or rejected at the plant.

Methods of Cooling

General Considerations.—The speed at which milk can be cooled depends upon the rate at which the heat contained in the milk can be passed on to something else which will absorb heat. Some materials absorb heat much more rapidly than others. Air absorbs heat very slowly; consequently, if a can of warm milk is placed in a refrigerated room where the air temperature is at the freezing point, it will be about 12 hours before the temperature of the milk has fallen to 50°F. This explains *why attempts to cool milk in winter by setting the cans in a snow-bank or exposing them to outdoor temperature so often lead to trouble.*

Water absorbs heat much more rapidly, and will cool milk over 20 times faster than air. Since the milk must give up its heat to the surrounding water, the larger the volume of water and the lower its temperature, the more quickly the milk will be cooled. Furthermore, cooling is more rapid when either the milk or the water or both are kept in motion. The value of stirring the milk is

[1] The essential factors in production are discussed in War-Time Production Series Pamphlet No. 7, ...g Clean Milk.

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generally known; that equally good results may be obtained by stirring the water is not so well known. In stirring the milk, however, there is risk of adding bacteria if the stirring rods are not thoroughly washed and sterilized; hence the better method is to stir the water by means of a propeller driven by a small windmill, or by an electric motor.

Several methods are available for cooling milk. Methods which are satisfactory for the cooling of cheese milk, which need not be cooled to below 60° to 65°F. for holding overnight, are not usually suitable for milk going to markets where low bacterial counts are required. The following cooling systems, if used in connection with clean production methods, will provide milk which will meet the more exacting standards.

Ice Cooling.—Placing the cans of warm milk in water in an *insulated* cooling tank is a simple and effective method which is strongly recommended. In changing from ice to water at 32°F., one pound of ice will take up as much heat as would be required to raise the same quantity of water to 176°F. Consequently, when ice is present in the cooling tank, the heat passing from the milk to the water is used up largely in melting the ice, thus greatly increasing the efficiency of the cooling system. This is especially important where water at around 40°F. is not available in sufficient quantity to cool milk to the required temperature.

Mechanical Cooling.—During recent years a number of efficient mechanical refrigeration units have been developed. These provide automatic, dependable cooling to a set temperature without the disadvantages which attend the use of ice. Some outfits can be bought with a factory-built insulated portable metal tank. This type is intended primarily for the tenant farmer; most farmers, however, prefer to build a well-insulated tank of concrete. Mechanical refrigeration is at present largely confined to farms where electric power is available.

It pays to install a machine large enough that it does not have to run too many hours out of the 24. Where only the night's milk is to be cooled, there should be at least $\frac{1}{12}$ horse-power per can; where both night's and morning's milk are to be cooled, at least $\frac{1}{8}$ horse-power is needed. These larger units use power more efficiently and this saving helps to offset the higher first cost, interest and depreciation charges.

The amount of electricity used to cool an 8-gallon can of milk varies from one installation to another; a good average figure would be approximately one kilowatt-hour to cool from 95° to 45°F. Thorough insulation of the tank is the most important factor influencing current consumption, but other things play a part. The location of the milk-house, and of the tank within the milk-house, the size of the tank, and the ventilation provided for the compressor all enter into the picture. The latter point is too often overlooked. It must be remembered that the heat withdrawn from the milk in the tank must be got rid of by the compressor. A screened opening, protected by a hood or louvres, should be provided in the wall so that the fan may draw air from outside to help carry this heat away.

Few figures are available in Canada regarding the relative costs of cooling with electricity and with ice. Where power is available at low rates, electric cooling may even be the cheaper. The cost of electric cooling is less per pound of milk as the quantity of milk increases, so that the larger the production, the more favourable the comparison becomes. The advantages of rapid automatic cooling are regarded by many milk producers as ample compensation for any slight increase in cost of cooling. With the present shortage of farm help, few farmers who have installed an electric cooler would consider going back to the use of ice.

Insulated Cooling Tanks

On the majority of farms roughly half the cooling value of the ice is lost by leakage of heat into the tank. This leakage may be greatly reduced by insulating the walls and cover. In many cases the cost of insulation has been paid for through the saving of ice and labour in a single season, to say nothing of the saving of losses due to faulty cooling. Where mechanical refrigeration units are used, the heat leaking into a tank which is not well insulated may be enough to keep the compressor running continuously. The insulation also prevents the milk from freezing during extremely cold weather. Even though there may be no immediate intention to install mechanical cooling, farmers are advised to replace old-style tanks with properly insulated tanks.

One of the best insulating materials is corkboard, which is 25 times as efficient as concrete in stopping the passage of heat. During war-time, however, there may be some difficulty in securing corkboard, and it may be necessary to use other types of insulating material. No matter what material is used, *it must be kept dry;* otherwise heat will leak into the tank almost as readily as into an uninsulated tank.

Where it is planned to install an electric cooler, details of tank dimensions, etc., should be obtained from the manufacturer, as some outfits call for a special size of tank. Plans and directions covering the building of insulated tanks for use either with ice or electric coolers may also be obtained from the manufacturers of cement and insulating material. The Department of Agricultural Engineering, Macdonald College, Quebec, has available a pamphlet entitled "How to Build an Insulated Milk Cooling Tank" (20 cents per copy), while the corresponding Department at Ontario Agricultural College, Guelph, Ontario, has published a circular on the same subject.

At the moment it seems not unlikely that a shortage of corkboard may develop. Should this occur, directions for the use of alternative materials will be obtainable from the Division of Bacteriology and Dairy Research, Science Service, Department of Agriculture, Ottawa.

Tank Sizes and Ice Requirements.—It is important that the cooling tank should have adequate capacity. Unless there is a sufficient volume of ice water, cooling of the milk will be delayed. It is generally agreed that the ratio of ice water to milk should never be less than 2 : 1, while a wider ratio will enable more rapid cooling to a lower temperature. Particularly where the morning's milk is picked up early and rapid cooling is essential, the tank should be made as large as is convenient. Furthermore, a larger tank will be handy should milk production be increased in the future.

With a well-insulated tank, approximately 30 pounds of ice should be allowed for each 8-gallon can of milk to be cooled. (An uninsulated tank will require approximately twice as much.) In calculating the amount of ice to be stored, allowance should be made for a shrinkage of a third or more in storage and during preparation for the cooling tank. Assuming that ice is required for cooling from May 15 to November 15, an average production of 400 pounds of milk per day would require about 150 pounds of ice in an insulated tank each day. Making due allowance for shrinkage, at least 18 tons of ice should be provided. Plans for the construction of ice houses, small cold storages, etc., may be obtained from the Dairy Products Division, Marketing Service, Department of Agriculture, Ottawa.

Further Observations

With electric coolers there is one disadvantage not found with ice cooling. Where both night's and morning's cans are cooled in the tank together, it is more difficult to keep the water level at the proper height for cooling the night's milk. Where blocks of ice are placed in the tank at each milking this presents no great problem, but with the electric cooler special steps must be taken. Since from 90 to 99 per cent of the bacteria in a can of milk are found in the cream layer after a few hours of cooling, it is obvious that if the upper portion of the milk is above the water level and not properly cooled, considerable bacterial growth may take place. This may be avoided by filling the cans of night's milk only to the level reached by the water. Then before the morning milking the cold milk is transferred from one or more cans to fill up the remainder, and the empty cans used for the morning's milk. Another scheme is to place empty cans in the tank and weight them down or wedge them in place. These are then removed for the morning milking. If the milk is picked up quite early, it may be permissible to remove the cans of night's milk from the tank before the morning's milk is put in. If this practice is followed, it is well to cover the cans with a clean wet tarpaulin to protect them from warming up.

Farmers with insulated tanks sometimes encounter trouble during the winter months. The insulation which prevents heat from leaking into the tank during the warmer months also prevents the escape of heat from inside the tank in the winter, and the milk remains at a high temperature. If the milk-house is cold enough to freeze a layer of ice on the surface of the tank water when the lid is left open, there should be no trouble getting the milk cooled down. Failing this, either fresh cold water should be run into the tank daily, or, if there is mechanical refrigeration, this should be used to provide the necessary cooling.

Because there is little growth of bacteria during the first two or three hours after milk is drawn, the practice has grown up in certain districts of accepting uncooled morning's milk where it can be delivered to the plant before a certain hour. There is, however, a growing tendency to require that morning's milk be cooled to as low a temperature as possible before shipment, particularly where the milk will be some hours in transit. In this way the quality of milk is safeguarded in case of delay in reaching the plant, while there is less chance for the night's milk to warm up in transit through contact with cans of warm morning's milk.

Much of the trouble experienced by milk producers could be avoided by actually *measuring* the temperature of the cooling water and of the milk instead of merely *guessing* at it. A floating dairy thermometer should be part of the equipment in every milk-house, and should be used each day where mechanical refrigeration is not employed.

Summary

The keeping quality of milk is greatly influenced by the temperature to which it is cooled. Prompt cooling to 50°F. or lower is necessary to check the growth of bacteria which cause spoilage.

Cooling is best accomplished by immersing the cans of milk in cold water in an insulated tank. Where the water is not cold enough to bring the milk to the proper temperature, either natural ice or electric refrigeration should be used, and the water should be stirred.

Insulation of the cooling tank greatly reduces the cost of cooling by the saving in ice or electric power consumption. Milk is also cooled more quickly and held at a lower temperature than is possible in an uninsulated tank.

Electric refrigeration offers automatic cooling to a set temperature while avoiding the disadvantages attending the use of ice. Where electric power is available at reasonable rates, this method should be carefully considered, particularly where help is scarce.

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