CHAPTER 5

TYPES OF PASTEURIZING PLANT

The following three main systems of pasteurization are in common use in those countries which have clearly defined regulations governing the types of plant permitted :

(1) The " batch " system, in which milk is heated or cooled in individual batches in one, two, or sometimes three tanks. This type of plant is suited only to capacities of up to 1,000 litres (220 gallons) per hour.

(2) The " continuous-holding " or " retarding " systems, in which a number of tanks are used, and in which the filling, holding, and discharging operations are carried out automatically in a timed cycle. This type of plant is suitable for capacities from 700 litres (150 gallons) per hour upwards.

(3) The modern HTST system, where milk is treated in a continuous flow at higher temperatures and held for much shorter periods than in systems (1) and (2). This type of plant is suitable for all capacities from 230 litres (50 gallons) per hour upwards.

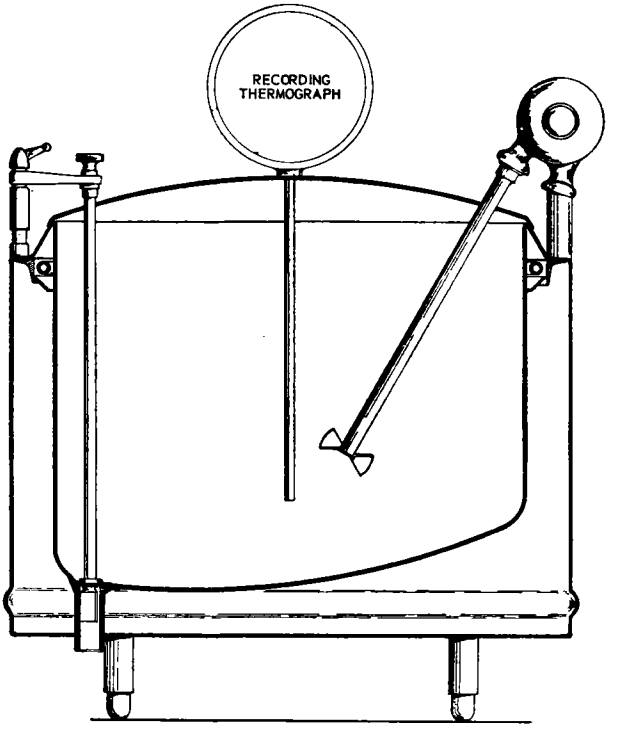
Each type has points in its favour. It is proposed to examine the main features of each in turn, and the questions it is necessary to bear in mind in making a choice.

The Batch Plant

The batch plant (see fig. 22) is based on a jacketed vessel or vessels in which the milk to be treated is heated, held for the required time, and partly cooled. In the space formed between the inner vessel and the outer jacket, water is heated to a temperature high enough to heat the milk, the milk itself being circulated gently by means of a propeller or some other form of mechanical agitation. Heating the water in the jacket is most commonly carried out by means of an external steam-and-water-mixing tee, the resulting heated water being sprayed downwards over the outer surface of the inner vessel by means of a spray coil fitted round it. Alternatively, direct steam-heating may be employed, the steam being sprayed in the same way over the inner vessel. The milk, having been heated to the required temperature (e.g., 63°C), is then allowed to remain at that

temperature for the necessary period (e.g., 30 minutes), during which time the steam or water is shut off. At the end of the holding period, and while the milk is being discharged, the hot water in the jacket is drained off, and in its place cold water is sprayed over the outer surface of the inner vessel, passing away from the bottom of the latter to the drain.

FIG. 22. BATCH HOLDER PLANT — I: SECTIONAL VIEW

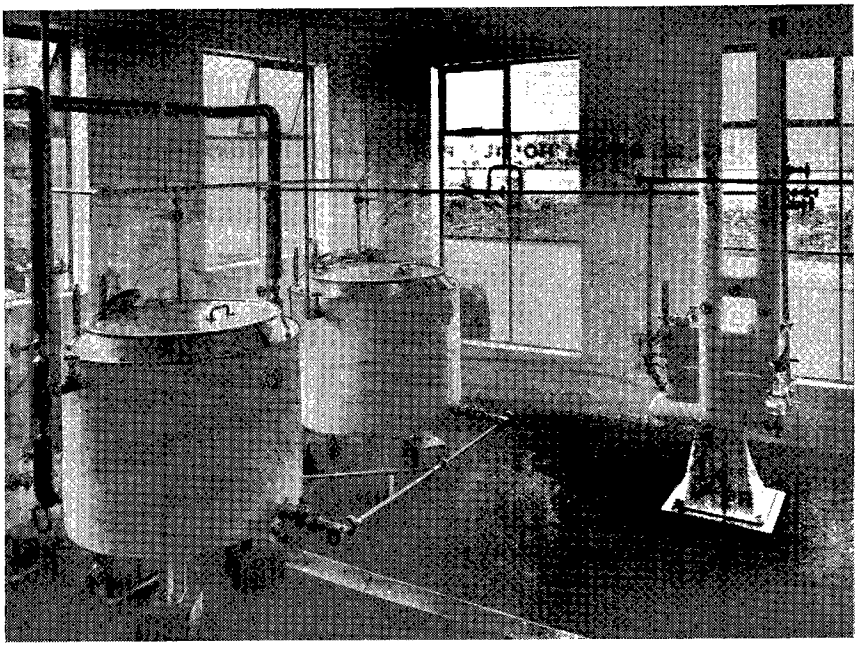


It is impossible, by this means, to cool the milk to a temperature low enough to be bacteriologically stable. It must, therefore, be pumped from the vessel either over an open or surface-type cooler or—and this is the better practice—through a plate-type heat-exchanger (as shown in fig. 23) where it is cooled down finally to a temperature of about 4°-5°C.

The vessels are usually fitted with two stem thermometers—one in the jacket, to indicate the temperature of the water, and one in the milk. Modern vessels are also fitted with a thermograph to record the temperature of the milk.

The milk is usually filled into the vessel through the top cover, and discharged through the base. With some earlier vessels, both filling and

FIG. 23. BATCH HOLDER PLANT — II: GENERAL VIEW



discharging took place through the same connexion in the bottom of the vessel. This is a dangerous practice, to be avoided at all costs, because it may result in contamination of the finished product by the raw milk in the pipe-line to and from the vessel.

In the modern plant, both inner and outer vessels are usually of stainless steel, but mild steel is sometimes used for the outer vessel. Monel metal or tinned copper may also be used for the inner vessel, but in the latter case care must be taken to preserve the tinned surface as, otherwise, if the milk comes into contact with bare copper, it is likely to become tainted with a " tallowy " or " cardboard " flavour.

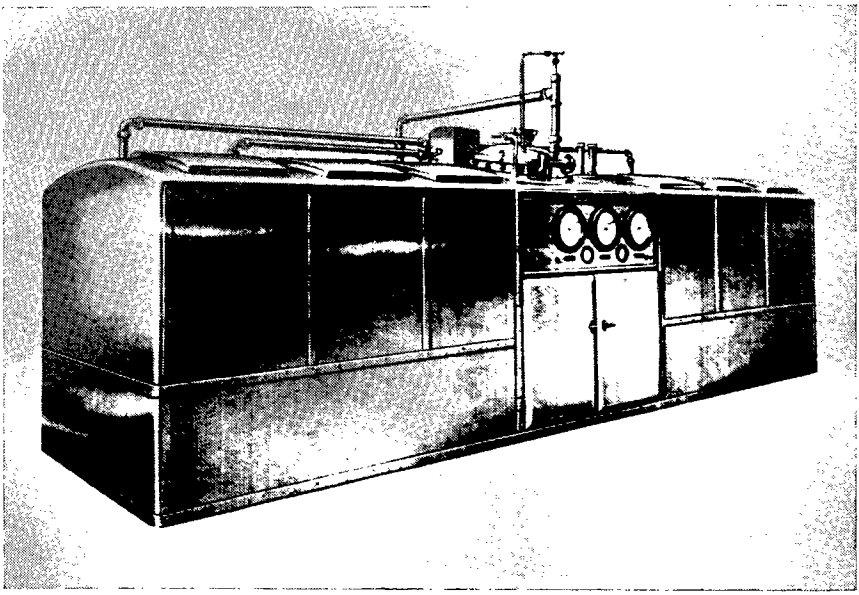
The main advantage of the batch system lies in its low initial cost, and it is very suitable for dairies handling up to 1,000 litres (220 gallons) of milk per day. Beyond that capacity, however, it becomes more and more uneconomical to operate, particularly if two or, as is sometimes necessary, three vessels have to be employed. It is the slowest of all three processes. The time taken to fill and heat to the required temperature is seldom less than 45 minutes, while that necessary to cool down is usually even longer.

Its main disadvantage, however, is that it is carried out in what is essentially a hand-operated plant, with all the dangers attendant on mistakes or carelessness in operating technique. Without very greatly adding

to the cost of the equipment, the automatic temperature-control and " safeguards " which are so necessary in the modern pasteurizing plant cannot be fitted. For this reason, it is regarded with disfavour by licensing authorities in some countries. By way of example, the functioning of the hot-milk thermograph on this type of equipment may be considered. The prime function of the thermograph in the modern pasteurizing plant is to provide, as far as possible, an indisputable record of all that has happened to the milk under process so that, in the event of a processing failure, the charts may be consulted and, together with the bacteriological records, may form a reliable guide in tracing its cause.

Such is hardly possible with the conventional form of batch plant. For example, when milk is beginning to fill into the holder vessel it will, on touching the thermograph bulb, cause the pen arm to rise at once to the temperature of the milk. If the operator is so inclined, however, he can begin to discharge the milk immediately; indeed, he can do so at any time before the real holding-time commences. He can be discharging for, say, 30 minutes and, at the end of that period, can allow the milk to fall below the level of the thermograph, whereupon the pen arm will drop again. On inspecting the chart, it will appear to those not realizing the weakness of the usual form of thermograph arrangement, that the milk has been held for half an hour at a particular temperature.

FIG. 24. HOLDER PLANT — I: HOLDING TANKS WITH DISTRIBUTING MECHANISM AND CONTROLS

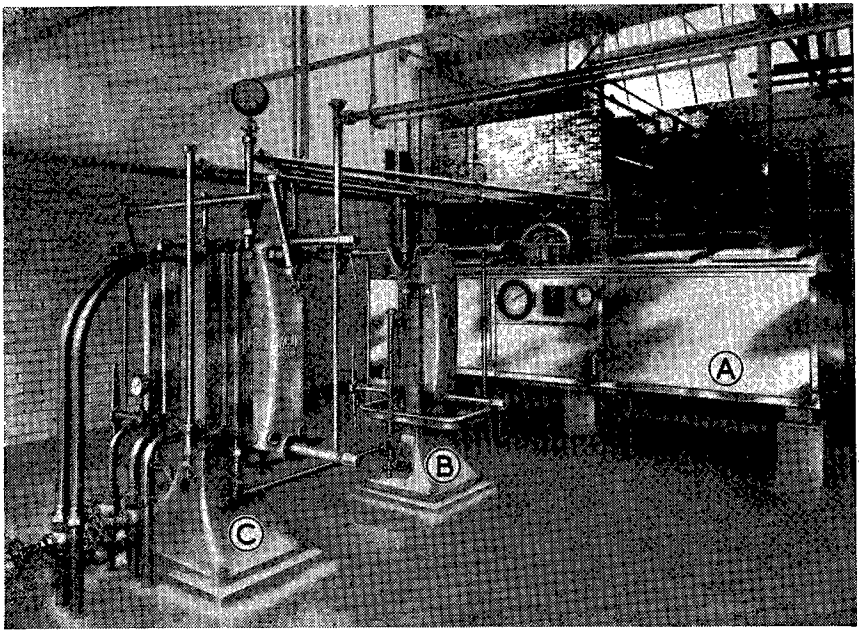


Despite these drawbacks, the initial cost of the plant is so low by comparison with the more modern methods that it is often all the smaller dairyman can afford, and it should be recommended in those circumstances where the only alternative is no plant at all.

The Continuous-Holding or Retarding System

The holder method of milk pasteurization is a development of the batch method, except that in this case there is a larger number of vessels—usually from four to eight—whose filling, holding, and emptying periods are mechanically controlled, each operation following the other in a mechanical and automatically-timed sequence. There are a great number of different makes of this type of plant, and many different arrangements and shapes of tanks. In some plants the tanks may be arranged in the form of separate vessels, either rectangular or cylindrical in shape, in some as a series of vessels comprising a composite unit (as shown in fig. 24), and in others the entire nest of tanks, arranged as segments in a circular vessel, rotates during a fixed period, the filling, holding, and discharging periods being controlled by the time of rotation of the vessel.

FIG. 25. HOLDER PLANT — II



A = holding tank B = pressure-type filter C = heat-exchanger

Probably the most common form, or some variation of it, is that shown in fig. 25. This plant comprises, basically, the holding tank (A), the pressure-type filter (B) where the milk is filtered through special cloths at pasteurizing temperature, and the heat-exchanger (C), wherein are carried out all the operations of milk heating and cooling.

The advantage of this plant over the batch plant is that the system is almost completely automatic and, in consequence, lends itself admirably to the fitting of instruments, controls, and safeguards. Unlike the batch plant, much more comprehensive and accurate records can be produced on this type of plant. Further, with proper operation, and adequate cleansing and sterilization of the plant, milk-quality results are comparable with those from the modern HTST plant except, perhaps, where thermophilic bacteria are present in the raw milk.

Of the disadvantages of this system, the following may be cited:

(1) By comparison with the HTST plant described hereafter, a given quantity of milk will take approximately 42 minutes longer to process. It may take, for example, 15 minutes to fill a particular vessel. This time, added to the 30 minutes' holding time, represents a total of 45 minutes before the milk comes back for cooling and bottling.

(2) It takes up a great deal more floor space than the HTST plant for a given output.

(3) It is difficult to obtain quite the same accuracy of temperature control with such a plant as is possible with the HTST plant, largely because of the unavoidable slight changes in rate of milk-flow consequent on the change-over from one tank to another.

(4) There is a strong tendency for froth to form on the top of the milk in the holders; this froth, being usually at a lower temperature than the main body of milk, provides favourable conditions for the growth and multiplication of thermophilic bacteria. Though these bacteria have no public-health significance, they may reduce, and sometimes reduce markedly, the keeping quality of the pasteurized milk; they also interfere with the assessment of bactericidal efficiency as judged by the colony count. For these reasons, it was the practice, when this type of plant was in common use in many countries, to limit the length of plant run to not more than six hours, thus avoiding the high bacterial colony counts which are so common a feature at the end of long runs in equipment of this type.

(5) The holder plant is not quite so "flexible" as the HTST plant for, to increase its throughput, a good deal more alteration and expense is entailed than would be necessary in the same circumstances for the HTST plant.

(6) Its initial cost is much higher than that of the HTST plant.

Taking all these reasons together, there can be no doubt that the continuous-holding or retarding system, though capable of giving perfectly satisfactory bacteriological results, has certain economic and other disadvantages not present in the HTST system.

The HTST Plant

The HTST plant, in most countries where heat-treatment of milk is the normal procedure, is now the most common form of pasteurizing equipment.

These plants are mainly of the types shown in fig. 26, 27, 28, and 29, that is, those embodying the plate-type heat-exchanger whose function is to heat and cool the milk before and after pasteurization. In Great Britain, Sweden, and the USA, the HTST plant has all but completely supplanted all other types. In Great Britain, for example, more than three-quarters of the nation's milk is pasteurized in this type of equipment.

FIG. 26. TYPICAL HTST PLANT —

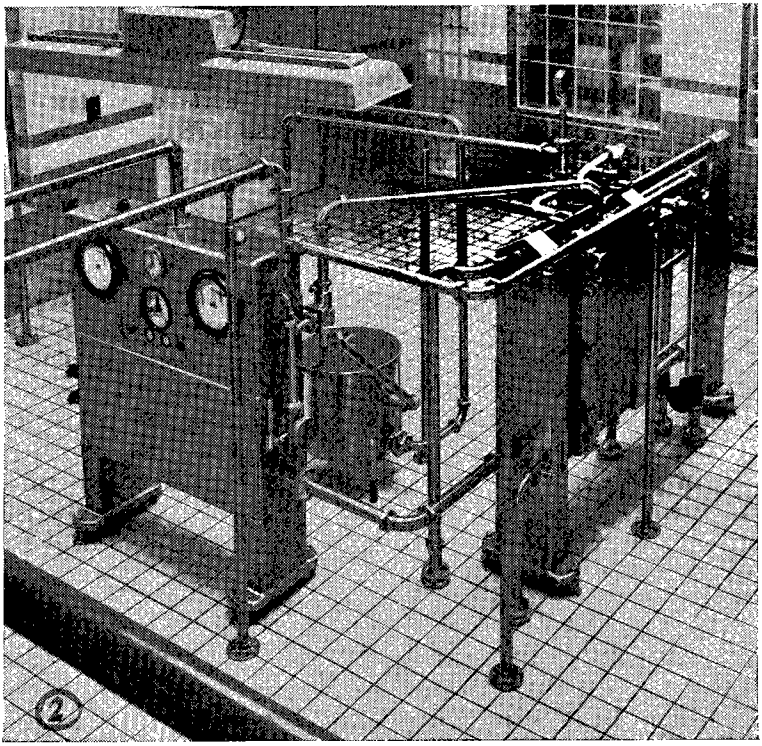
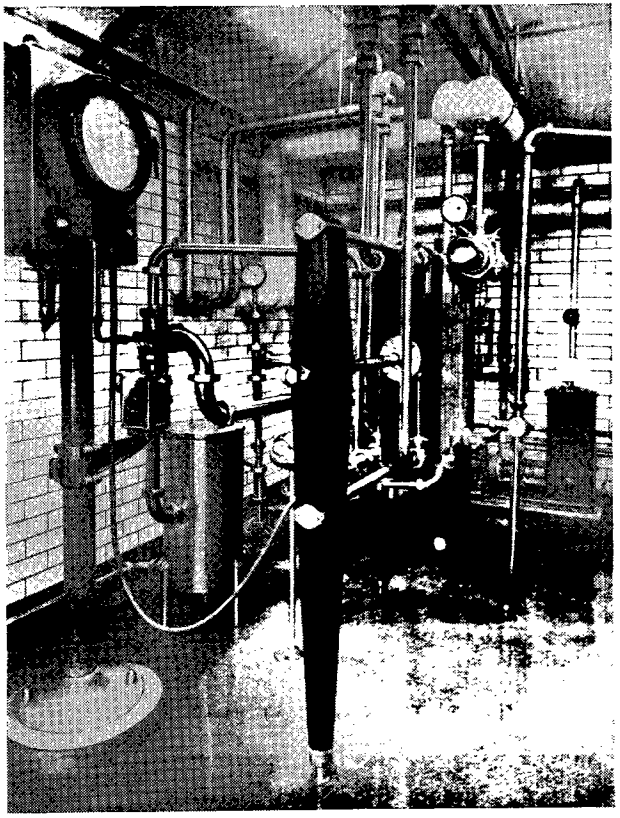
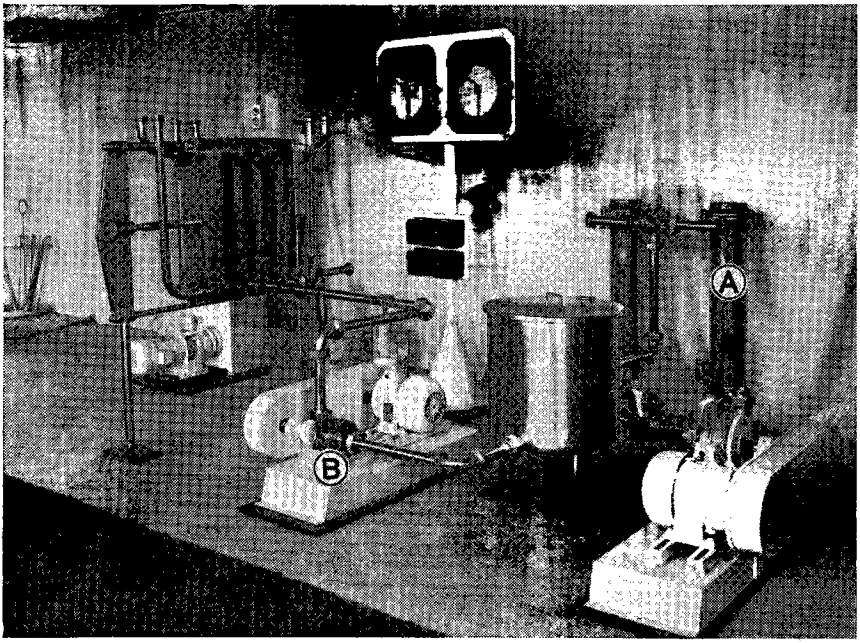


FIG. 27. TYPICAL HTST PLANT — II



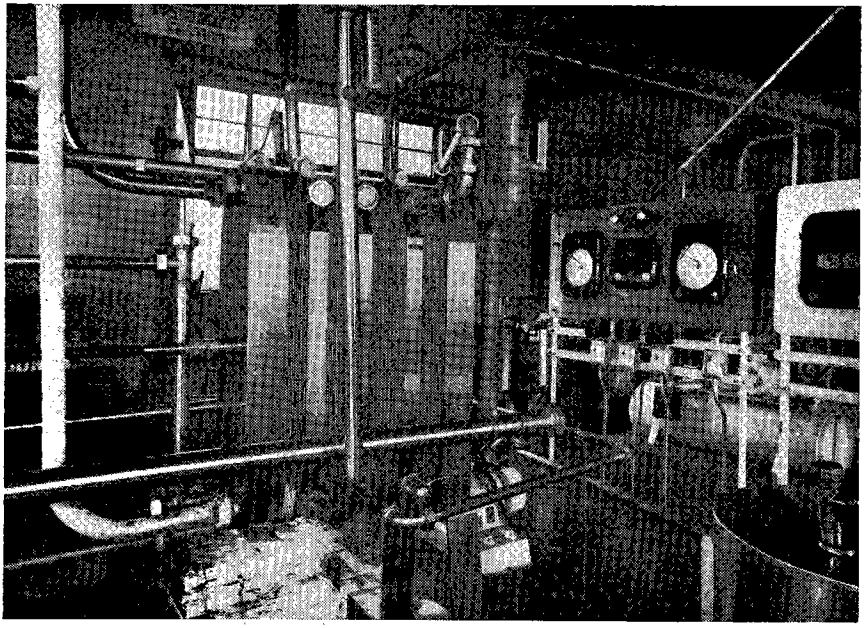
Much research has been done to compare the bactericidal effects of the holder system with those obtained in the HTST plant, and it can now be said with certainty that, in this respect, the HTST plant will do all that the holder plant will do. It has, indeed, one advantage over the holder plant. Where thermophilic bacteria are present in the raw milk it is not necessary, as it is with the holder plant, to limit the length of run (see page 69). The system, which is continuously scavenged by the milk passing through it, affords very little opportunity for thermophiles to lodge in the plant. For this reason, it has been found possible to run the HTST plant for a much longer daily period than is advisable with the holder system. The only technological factor limiting the length of daily run is the extent to which milk solids will accumulate on the plate surfaces, making cleaning more or less difficult according to the amount of milk which has passed through the plant.

FIG. 28. TYPICAL HTST PLANT — III



A = cloth-type filter B = raw-milk pump

FIG. 29. TYPICAL HTST PLANT — IV



The HTST plant has the following advantages over other forms of pasteurizing equipment:

(1) Lower initial cost: For comparable outputs, the HTST plant is considerably cheaper than the holder plant. The main saving is in the elimination of holding tanks (compare fig. 25 and 26).

(2) Less plant to clean: The labour time required for cleaning the HTST plant is much less than for the holder plant. This again is mainly by reason of the absence of any holding tanks. With the modern HTST plant, and using up-to-date methods of detergency, cleaning of the equipment is largely a semi-automatic process, consisting almost entirely in the circulation of detergents through the plate heat-exchanger and pipe-lines.

(3) It is more economical in floor space: With most modern HTST plants it is possible to pasteurize 10,000 litres (2,200 gallons) of milk per hour in a floor space no larger than 4.5 m^2 (48 square feet). The advantages of this will be obvious, for it means that pasteurizing units short of space can step up their daily throughput without needing to obtain additional floor space or new premises.

(4) Milk is available more quickly for distribution: Unlike the holding plant where, as mentioned previously, a period of about 45 minutes must elapse before the milk comes back for cooling and distribution, the HTST plant provides pasteurized milk in under three minutes from the time the raw milk has entered the plant.

(5) It is more " flexible " than other types of plant: Flexibility in this sense means the ability to increase or decrease with ease the hourly capacity of the plant. This can be done in the HTST plant relatively easily by adding or removing plates from the plate heat-exchanger and changing the holding system and pumps—a much simpler operation than in the case of the holding plant where the entire rearrangement and installation of new tankage have to be considered.

(6) It lends itself more readily to recording and safeguarding: This is probably its most important feature. It is possible to fit recording thermographs to the HTST plant in such a way that very accurate records of the processing history of the milk are produced. This plant is also peculiarly suited to the fitting of devices which can automatically reject, or divert for re-treatment, any milk not heated to the requisite temperature. The present-day HTST plant is more automatic and foolproof than any other type.

(7) Lower operating costs: Because there is less plant to clean, and because it requires much less manipulation and is almost entirely automatic, labour costs in operation are much less than those with the holding plant in comparable circumstances.