There are three questions that must be satisfactorily answered regarding high-temperature short-time pasteurization. They are as follows:

1. At what temperature and for what length of time must milk be held to insure proper pasteurization?

The United States Public Health Service and other health agencies have studied this method of pasteurization for over 15 years. Their recommendations of 160° F. for 15 seconds in approved and properly operated equipment are satisfactory.

2. Accepting that temperature and holding time as safe and satisfactory, the next question to be answered is: how can that temperature and holding time be accurately controlled?

The flow diversion valve, when properly adjusted and sealed answers this point.

3. The third and most important question to be answered is: when is a high-temperature short-time unit approved and properly operated?

Health departments may favor and approve the method of high-temperature short-time pasteurization and even go so far as to adopt local and state laws and ordinances making this method legal but they certainly should not stop there. Every unit and installation should not be given approval until it has been thoroughly and frequently checked and found to be properly operated. In certain localities high-temperature short-time units are installed and placed in operation without being checked by any health agency. This is a grave mistake.

What constitutes properly operated installations? A high-temperature short-time installation is properly operated when the following items have been fully and continuously complied with:

1. When the recording and indicating thermometers (meeting United States Public Health Service specifications) have been tested for proper "lag" and also found to be accurate to within 0.5° F. between 150° and 160° F.

2. When the flow diversion pen is in perfect working condition and is recording every diversion of milk from the forward flow to the diversion tank. Note: Some operators have not been properly informed regarding the purpose of this part of the recording device or its use.

3. When the holding time has been carefully checked and found to be at least 15 seconds.

4. When the diversion adjustment has been set and officially sealed to divert properly all milk below 160° F. back to the raw milk ballast tank.

5. When the variable speed pump has been set and officially sealed to insure continuously a holding time of not less than 15 seconds. Note: One make of variable speed pump has been found to increase its speed, due to wear and stretching of the belt.

6. When the pressure on the pasteurized side of the plates is at all times greater than the pressure on the raw side of the plates. At the beginning of the run, water may precede...
the milk and establish proper pressures. In the regenerator sufficient pasteurized milk head should be present to maintain a milk level for one hour during shut down.

7. When a proper slope of at least one half inch to the foot is insured, for the holder tube, from the outlet to the inlet. Low points, other than the inlet, trap air and shorten the holding period. Note: Eccentric fitting on the ends of the holder tubes makes possible the improper change of slope of the tube. Bell type or concentric fittings should be used.

8. When all air and milk leaks have been completely stopped. Air sucked into units greatly reduces the capacity of the machine.

9. When there is an absence of leakage to the forward flow while the valve is in the diversion position.

10. When a constant head of milk is maintained in the surge tank.

11. When measured capacity corresponds to the calculated capacity from a pre-determined accurate check of the actual holding time. For example, suppose we had a unit equipped with a holder tube having a capacity of 50.42 pounds of milk and a variable speed pump set to give a 15 second holding time. This unit should then deliver 11,000 pounds per hour. If in checking the capacity of this unit at some later date the capacity was found to be greatly above or below 11,000 pounds per hour, then we could not say that the unit was properly operated.

12. When temperature control is operating smoothly insuring a steady flow of milk above 160° F. Frequent diversions are not desirable. They are bad for the product and may be dangerous.

13. When parts to controlled pump are properly put together to insure an air-tight seal. Wear on the back bearings or the reversing of the back bearings of certain pumps permits air intake thus decreasing the unit's capacity.

14. When all openings to the units are labeled so that the operator knows what products can be obtained and at what temperatures they may be obtained from such openings.

15. When holding time is at least 15 seconds during diversion.

CHECKING HIGH-TEMPERATURE SHORT-TIME UNITS

To same time and to facilitate the original testing, the units should be completely installed and thoroughly tested by the manufacturer or his agents. When the manufacturer has properly installed and checked the equipment and is satisfied that the units are adjusted to pasteurize milk properly, then the milk inspection authorities should be asked to make their test and seal the units for operation. No installation should be commercially used until tested and sealed by the inspection department.

THE STEPS TO BE FOLLOWED

1. With a level, check the slope of the holding tubes ; slope to be not less than one-half inch per foot towards the inlet. If slope is found incorrect, adjustments must be made before further checking of the unit, as a low point other than the inlet will make possible the "trapping" of air pockets, which will decrease the holding time materially. If the pump is sealed for a 15 second "holding period," the capacity of the unit will be greatly reduced.

2. With the proper slope of the "holder tube," see that the standards that support the tube are so constructed and permanently set that changes of slope will be impossible. Note: This item has given the plant operator and health authorities a great deal of unnecessary trouble. Milk samples from one plant that supplied the Army and Navy were found to give positive phosphatase readings. In checking this high-temperature short-time unit, the holding time was found to be only 12 seconds instead of 16 seconds. The slope of the holder tube...
had been changed, throwing a low spot at the wrong point in the holder tube. Pipes dropping from the final heater to the inlet of the holder tubes should be marked for identification as the substitution of shorter lengths of pipe have been found to change the slope of the holder tubes.

3. Make certain that gaskets are placed in their proper locations, and that all joints are air tight. Leaks on vacuum lines can go unnoticed if careful attention is not given to them. If the unit is checked and sealed while air leaks are present it will be possible to decrease the holding time and increase the capacity when these air leaks are later eliminated. Vacuum gauges should be a part of each high-temperature short-time unit to detect these leaks.

4. Prepare to check the accuracy of the thermometers. Remove the recorder stem from holding tube. Insert accurate test thermometer with proper immersion line through a rubber cork or special seat and into the hole at the top of the holder tube. This will leave the regular indicating thermometer in position along with the test thermometer. Both thermometers should be so placed as to come in contact with a full flow of water. Start the unit and circulate water through it at 160°F. When the temperature of the water has become stabilized, check the temperature of the indicating thermometer against the check thermometer. If correct remove test thermometer and insert recorder bulb. Start unit and bring the temperature to slightly above 160°F. (to prevent diversion while testing is being done). Check accuracy of recorder, adjust if not correct.

5. Determine the diversion temperature by circulating water at a temperature above 160°F. Bring the temperature of the heating medium down slowly until the diversion point has been found; if it is too high or too low, adjust diversion regulator located within the recorder box. When the diversion point has been determined to be 160°F or slightly above, replace the plate over the diversion adjuster and seal it with properly identified lead sealers. Lead seals equipped with copper or brass wires only should be used.

6. The holding time can now be checked. Supply sufficient water to raw diversion tank to insure against air entering the unit. Two methods may be used with a fair degree of accuracy.

a. By pumping in a small charge of methylene blue into the inlet of the "holder tube" and recording the time with a stop watch at the inlet and by recording the time the dye appears at the pet cock (provided for this purpose) at the outlet of the holder tube. The following precautions should be taken:

(1) A small pipe closed at the end and perforated with about four small holes should protrude slightly inside of inlet of holder tube and this connected to a pump or pressure gun giving a measured amount of dye.

(2) Valves on the gun or pressure tank should be as close as possible to the end of holder tube. Note: Each inch will increase the inaccuracy of the timing. In checking the time required for the dye to reach the outlet of the holder, place a white paper background near the end of the faucet. This will aid in detecting the dye when it appears. The first appearance of color should be considered the end point.

b. The second method of checking, which may be considered the most accurate, is the salt and potentiometer method. The following equipment is necessary:

(1) High pressure cylinder with air guage. Capacity about two quarts. This should be equipped with flexible high pressure tubing and spring type air valve. Note: One pressure on air value at 80 pounds pressure will release about 20 ml. of saturated salt solution.

(2) Make up a quart of saturated
salt solution and place it in the cylinder and attach cylinder to inlet of holder. Pump in air to desired pressure.

(3) A potentiometer (similar to those used in checking caustic solutions) may be used. By enlarging the contact points with light sheet copper the sensitivity may be greatly increased. This can be easily made to detect 0.3 ml. of a saturated salt solution in 100 ml. of water, and will also show the presence of air within the system.

Procedure: Place the end of electric cord with removable enlarged points through the indicator thermometer outlet. Be certain that the points are about in the center of the “T” of the connection at top of the holder tube and seal cord with proper rubber seat to prevent leakage. Note: the small two-point trailer light plugs are the proper size to use, as they will pass through the holes in the end of the holder tube.

Procedure: “Start the unit and circulate water at slightly above 160°F. (to prevent diversion during checking). Inject about 18 ml. of salt solution into inlet of holder tube with pressure gun. Record the time at which the salt solution is injected, and also the time the potentiometer indicates the appearance of salt. When a 15 second holding time has been finally determined check the capacity of the unit by determining the time it takes to fill a ten gallon can.” The weight of 86 pounds for ten gallons should be used as more milk than water is pumped due to the more efficient sealing of joints by milk. When the exact holding time has been determined the variable speed pump should be sealed making it impossible for the operator to change the capacity of the pump. Each unit should be checked thoroughly more than once and at monthly intervals. The complete phosphatase test should also be used frequently on all high temperature milk, but should not be used to substitute the other method of checking.

The following formula may be of assistance in determining capacities of high-temperature short-time units:

**EXAMPLE 1**

If the desired capacity of the unit is 11,000 pounds per hour what capacity will be needed for the holder tube to insure 11,000 pounds?

\[
\frac{11,000 \text{ lbs.} \times 15 \text{ (seconds holding time)} \times 1.1 \text{ (safety factor)}}{3600 \text{ (seconds per hour)}} = 50.42 \text{ lbs. or capacity of holder tube use.}
\]

**EXAMPLE 2**

Given the size of the holder tube, how can the capacity of a unit be determined?

\[
16.5 x = 181,512 \ or \ (50.42 \times 3600) \Rightarrow x = 11,000 \text{ lbs. or capacity of unit.}
\]

The author believes that the pasteurization of milk by the high-temperature short-time method is safer and has many advantages over the “holding” method. Proper supervision must be maintained over each installation.