CONTROLS USED IN THE OPERATION OF VACUUM FLAVOR EQUIPMENT AND IN HIGH HEAT PASTEURIZERS USED FOR PROCESSING FLUID MILK AND MILK PRODUCTS IN TENNESSEE

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INTRODUCTION

The sudden influx of new equipment in the milk industry for processing fluid grade A milk and milk products has created a pressing problem for regulatory officials and the dairy industry in safeguarding the product from a public health standpoint. This study was conducted to determine the public health problems involved, if any, and the controls and other safeguards required to conform with the provisions of the Milk Ordinance and Code—1953 Recommendations of the Public Health Service.

Legal control of milk in Tennessee is vested in the Department of Agriculture. The State Department of Public Health provides consultation service to local departments of health in the enforcement of locally adopted U. S. Public Health Service Milk Ordinances. Beginning in 1954 and increasing rapidly to the present time, numerous installations of vacuum flavor control equipment have been made in Tennessee. The geographical location of this state, as well as the assortment of weeds and grasses and variations in water conditions that are responsible for off-flavors in milk, made Tennessee suitable for conducting such a field study. The magnitude of the problem of regulating this equipment was seriously considered before a pilot installation by each of the interested equipment companies was provisionally approved by the Tennessee Department of Public Health for operation in a commercial milk plant.

Those making this study decided that this type of equipment had a place in the fluid milk industry in that benefits could be realized by the producer, processor, and consumer in those areas where feed, weeds, and water presented flavor problems. Sales charts of plants employing vacuum flavor control equipment do not show the usual decline during the spring months when onion, garlic, and weed flavors had previously caused customer complaints or rejection of the milk.

It was immediately recognized that certain controls would be necessary to safeguard the product and to assure that provisions of the Recommended U. S. Public Health Service Milk Ordinance were not violated. This was particularly true when the vacuum equipment was used in conjunction with a high temperature, short time pasteurizer with milk-to-milk regenerator.

A policy was established requiring each company to submit plans, specifications, and a description of the operation for each proposed installation. This requirement was necessary since each installation was different even with the same type equipment. In addition, data were not available to substantiate compliance of this type equipment with the provisions of the Recommended U. S. Public Health Service Milk Ordinance. Furthermore, there was a continuous change of instruments and other devices which affected the H.T.S.T. pasteurization process, particularly the holding time, pressure differentials within the regenerator, and the proper operation of the flow diversion valve.

FLOW CHARACTERISTICS OF VACUUM FLAVOR EQUIPMENT

Group I—Flavor control equipment employing vacuum and steam treatment used in conjunction with high-temperature, short-time pasteurization.

A. Two chambers—Flow through this equipment is as shown in Fig. 1. Cold raw milk is drawn by vacuum from the balance tank through the raw regenerator section of the H.T.S.T. pasteurizer by the timing pump. Milk is heated by regeneration from approximately 40°F. to about 130°F. depending upon the regeneration efficiency of each installation. The preheated milk is pumped by the timing pump to the heater section of the H.T.S.T. pasteurizer where the temperature of the milk is raised high enough to assure that the milk, after passing through the holding tube will be at least 161°F. upon reaching the temperature controls of the flow diversion valve. Pasteurized milk leaves the forward flow port of the flow diversion valve and enters chamber No. 1. In this chamber the milk is treated with steam and the temperature of the pasteurized milk is raised to the temperature desired for the amount of treatment required, normally about 185°F. This chamber is under approximately 8" vacuum which is below that required to flash or boil milk at this temperature. (See Table 1). The milk is drawn by vacuum from chamber No. 1 to chamber No. 2, through a common
线。乳进入第2室的温度由20°F的真空下落至161.5°F。真空的释放使可挥发的风味和异味，以及第1室蒸汽引入的水得以去除。这些蒸气被真空泵或其他真空产生设备（图11）抽取。温度和真空之间的平衡由自动控制来维持。

B. 单室—此设备的流程与第I-A组相同，但蒸汽直接注入冷却的乳线上游的消毒乳线。通过特殊的卫生设备（加强器或文丘里喷射器）增加乳和蒸汽之间的混合，从而防止烧焦。煮熟的乳温度在10°F到40°F之间上升，升高的程度取决于产品和处理所需去味和提高保质期的要求（图2）。

C. 三室—此设备的流程与第I-A组相同，除了用来自原料再生器的预热乳（130°F）外，还增加了预热乳。第一室蒸汽与乳混合，温度从约130°F上升到200°F。在第二和第三室，热量被去除，乳离开真空设备的温度与进入温度（130°F）相同或更低。真空-蒸汽处理的乳被泵入一个升高的冲压罐，与大气直接接触，然后由重力流到均质机，发挥定时泵作用。在最近的安装中，真空-蒸汽冲压罐已被两个离心泵代替。第二泵用于真空设备的空气泵的双叶泵，它能泵送真空。对于处理奶油线乳，...
three-way sanitary valve may be located on the discharge side of the conventional H.T.S.T. timing pump to by-pass the vacuum chambers and homogenizer (Fig. 3).

Group II—High-heat pasteurization employing vacuum and steam treatment.

A. Three chambers—Vacuum pasteurizer (milk pump stop installation)—Milk is preheated to about 130°F. by plate or tubular heat exchangers before entering the vacuum pasteurizer. The flow of milk through the vacuum pasteurizer is the same as that described in Group I-C except that milk must be heat treated, by a regulated steam supply, to at least 194°F. in the first chamber. This chamber must be equipped with proper controls to satisfy the requirements for pasteurization as defined by the U. S. Public Health Service. Milk leaving the vacuum pasteurizer should be of the same or less temperature as when it entered and is homogenized and cooled by plate or tubular heat exchangers that must satisfy the requirements for milk-to-milk and milk-to-water regenerators closed to the atmosphere (Fig. 4).

Group III—Flavor control equipment employing vacuum treatment used in conjunction with high-heat pasteurization (Fig. 5).

A. One chamber—High-heat pasteurization of milk consists of heating milk to a temperature of 194°F. or higher with a calculated holding time of three seconds or more. Higher heating is accomplished by means of the pasteurizer which in some cases raises
the milk to 260°F. or higher. An electrical high temperature stop is usually employed to prevent burn-on in the pasteurizer. The high temperature stop is wired to the micro-switch of the flow diversion valve so as to divert the milk if the pre-set temperature is exceeded.

From the pasteurizer heater the pasteurized milk is discharged through the flow diversion valve to the second stage milk-to-milk regenerator and to the homogenizer by the timing pump. From the homogenizer the milk is discharged through the first stage regenerator to the final cooler and to filler. In this installation the controls are the same as those for Group IV-A, except that requirements for the use of a booster pump upstream from the first stage milk-to-milk regenerator must be satisfied by use of a non-adjustable pressure differential valve and pressure switch in the pasteurized milk outlet line from the first stage milk-to-milk regenerator.

**B. One or two chambers—High-heat pasteurization**

The controls and flow through in this equipment when two chambers are used are the same as that described in Group IV-A (Fig. 6). If only one chamber is used, it is located on the downstream side of the raw regenerator and the temperature in this chamber must be controlled by limiting vacuum and temperature so that excessive concentration will not occur. A temperature differential controller will automatically control the concentration. If a booster pump is used, it must meet the code requirements.

**Group IV—Flavor control equipment employing vacuum treatment used in conjunction with high-temperature, short-time pasteurization.**

**A. Two chambers** (No. 1 chamber downstream from raw side of regenerator, No. 2 chamber upstream from pasteurized side of regenerator). In this system 40°F. raw milk from the balance tank of the H.T.S.T. pasteurizer is drawn through the raw...
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milk side of the regenerator into chamber No. 1 by vacuum. Both chambers are interconnected through a vacuum-vapor line to the source of vacuum. The vacuum in both chambers will be about the same or approximately 24" Hg. Preheated raw milk enters the top of chamber No. 1 at approximately 130°F, depending upon the amount of heat transfer to the raw milk in the regenerator. At 24" of vacuum, and 130°F, which is less than the saturation temperature of the milk, no flashing or boiling occurs in this chamber. Vapors entering chamber No. 1 from chamber No. 2 through the vapor line, contain latent heat at a higher temperature than the vapors in chamber No. 1. This heat is given up as water of condensation in chamber No. 1. In so doing, approximately 50% of the water vapor is condensed and recombined with the milk thereby raising its temperature. From the bottom of chamber No. 1 the milk is drawn by the timing pump of the H.T.S.T. pasteurizer and pumped through the heater section, holding tube, and flow diversion valve to vacuum chamber No. 2. Neither vacuum from this chamber nor excessive back pressure (more than the valve is designed for) should be permitted on the forward flow port of the flow diversion valve to interfere with its proper function. This is accomplished by means of a vacuum breaker, a back pressure relief valve, and a positive shut-off valve. The latter is air operated and wired through the micro-switch of the flow diversion valve. This valve and the flow diversion valve operate in unison. All these devices are located between the flow diversion valve and chamber No. 2. Pasteurized milk entering the side of chamber No. 2 at 161°-170°F. flows in a thin film down the sides of the chamber. The vacuum treated milk is reduced in temperature to not less than 141°F. (24" vacuum—see Table 1) and is drawn from the bottom of this chamber by a centrifugal pump and discharged through a float and by-pass assembly to the homogenizer or, when processing creamline milk, to the pasteurized side of the regenerator in the H.T.S.T. pasteurizer unit as described in I-A (Fig. 6).

B. Two chambers—Both vacuum chambers are located in parallel in the milk circuit immediately downstream from the raw regenerator of the H.T.S.T. unit. The milk is drawn by vacuum and/or a booster pump (installed as required by U.S. Public Health Service Code) from the raw milk balance tank through the raw regenerator and enters the top of the vacuum chambers through baffled drop tubes. Air is introduced into the milk intermittently through bacteriological filters located on top of the chambers. Milk is drawn from the bottom outlets of the vacuum chambers by the timing pump and is discharged to the homogenizer and to the heating section, holding tube, pasteurized side of regenerator, and cooling section of the H.T.S.T. unit. When creamline milk is being processed, the homogenizer is by-passed. When processing homogenized milk, the homogenizer becomes the timing pump as is discussed elsewhere in this paper in connection with other installations (Fig. 7).

C. One chamber downstream from the raw regenerator section with or without a booster pump—In installations not using a booster pump the raw milk is drawn from the balance tank through the raw side of the regenerator to the vacuum chamber by the vacuum being applied on the chamber. Milk is drawn from the bottom of the chamber by the timing pump of the H.T.S.T., through the constant level control or by-pass assembly, to the homogenizer or to the heater section of the H.T.S.T. unit. If a booster
pump is used, the applicable provisions of the Public Health Service Ordinance for booster pumps must be satisfied. The flow of milk through the H.T.S.T. unit is the same in either case since the vacuum chamber remains on the downstream side of the raw regenerator. A water jacket to facilitate pumping and to assist in the recovery of water of vaporization from the milk is used around the outlet and bottom of the vacuum chamber. Waste water from this jacket is regulated to run warm and is discharged to waste through an open trapped drain (Fig 8).

Group V—Flavor control equipment employing vacuum treatment used in conjunction with vat pasteurization.

Pasteurized milk is drawn from the pasteurization vat through a two-way throttling valve to the vacuum chamber. The product entering the chamber is broken up into a spray by a float throttling valve and the milk falls toward the bottom of the chamber over a series of baffles. The milk is exposed to vacuum in this chamber and the temperature is lowered to the saturation point (125°F.) for the vacuum applied (26" Hg.). Vapors and/or volatile gases are drawn off through the vapor line through a water cooled condenser to the vacuum pump and to waste. Water vapors from the milk are condensed and flow back by gravity into the milk. The non-condensable vapors are discharged to waste through the vacuum system. The vacuum treated product is removed from the bottom of the chamber by a sanitary pump which feeds the homogenizer. From the homogenizer the milk is pumped to the cooler and to filler or...
storage. Maximum limitations for temperature (150°F) and vacuum (26" Hg) treatment and condenser controls (minimum of five pounds water pressure) were established to prevent excessive concentration of the product (Fig. 9).

CONTROL AND INSPECTION POINTS

Primary Control Factors

In H.T.S.T., vacuum and high-heat pasteurizers, employing regenerative heating and cooling with both sides closed to the atmosphere, there are three primary control factors. These are necessary to satisfy the applicable requirements of the U. S. Public Health Milk Ordinance and state laws and regulations. The control factors are: (a) holding time (and temperature for vacuum and high heat pasteurizers); (b) maintenance of a pressure differential in the regenerator section (at least 1 pound greater in the pasteurized side); and (c) adulteration and excessive concentration of the product. In Group I-A and B and in Group IV-A the holding time can be influenced by vacuum or excessive back pressure at the forward flow port of the flow diversion valve. Vacuum is prevented from spreading to the flow diversion valve by the installation of a vacuum breaker immediately downstream from the forward flow port, by a back pressure regulating valve and/or a positive shut-off valve located between the vacuum breaker and the entrance to the vacuum chamber; and when a variable speed timing pump is used, by limiting minimum flow which must be determined for each installation. A minimum of 5 p.s.i. pressure is required to keep the vacuum breaker closed except in the case of an air operated vacuum breaker which opens to the atmosphere when the flow diversion valve is in diverted flow. Any vacuum on the flow diversion valve may speed up flow, shorten holding time and prevent leak detector or poppet valves from functioning properly when the valve changes position. Excessive product back pressure (more than the valve is designed for) on the flow diversion valve will cause sluggish operation and failure to divert in one second as required, or hold the valve in a partially diverted position. Where excessive product back pressure is anticipated, a pressure differential valve open to the atmosphere and adjusted no higher than maximum product pressure of the flow diversion valve, is installed immediately downstream therefrom. When pasteurized milk is homogenized and the legal maximum flow (15 seconds holding time) exceeds the homogenizer capacity, the variable speed timing pump must be reduced to the same or less capacity as the homogenizer; thereby making a bypass or equalizer line mandatory from the discharge to the intake lines of the homogenizer. If the speed of the timing pump is adjusted as described above, the need for a relief line from the intake line of the homogenizer back to the raw milk balance tank is eliminated. Such a line is illegal and hazardous if the capacity of homogenizer is not satisfied at all times. This facilitates uniform flow and meets requirements for pumps capable of producing forward flow located downstream from the holding tube or holder.

In a three-chamber vacuum treatment unit (Group I-C) both the variable speed timing pump and the homogenizer must be wired in with the recorder con-
troller since the homogenizer is the timing pump when not processing creamline milk.

The requirement that the pasteurized milk in regenerative heater coolers must automatically be under greater pressure at all times than the raw milk is satisfied by providing bypasses on the centrifugal pump in the outlet line from the final vacuum chamber and on the homogenizer. These bypasses assure uniform flow by preventing surging, foaming and pump cavitation. A check valve located downstream from the homogenizer bypass line keeps the pasteurized regenerator section full at all times and satisfies maintenance of the pressure differential requirement.

In a vacuum pasteurizer using regenerative heating and cooling, the same requirements for maintenance of the pressure differential must be satisfied as in a H.T.S.T. unit employing regenerative heating and cooling.

In steam treatment equipment, adulteration and concentration is controlled automatically by an automatic temperature differential controller provided the steam is supplied as shown in Fig. 217. By agreement with equipment companies and with state regulatory officials, a limitation of 1% concentration or dilution, based upon Mojonier tests, was established. The automatic temperature differential controller was set slightly on the concentrated side to take into account radiation heat loss through the equipment. Water jackets on the vacuum chambers will distort this field method somewhat in that heat will be removed without removing moisture.

In Group II-A, the vacuum pasteurizer, a milk pump-stop installation, all primary control factors have been discussed previously except those that apply to this particular equipment only, viz., vacuum pasteurizer with regenerative heating and cooling. Before this equipment will operate, when properly installed, the temperature at the outlet of the pasteurizing chamber must be at least 194°F, the vacuum in the intermediate chamber must be at least 8" and the steam supply pressure must be above 35 p.s.i. (Figs. 4 and 10). The controls are as follows:

(a) The infeed product pump must be set and sealed at a rate not to exceed the manufacturer's rated capacity of the vacuum pasteurizer. The infeed pump must be so wired that it reverses for 2 seconds immediately after stopping to relieve pressure on the product flow stop and allow it to close within the required one second.

(b) The vacuum switch on the intermediate chamber must be set at a minimum of 8". Failure to maintain 8" vacuum in this chamber stops the infeed product pump. Sealing of this switch is optional.

(c) A minimum pressure switch on the steam line is set and sealed so that the infeed pump stops when the steam pressure falls to 35 p.s.i.

(d) A steam orifice plate in the incoming steam line is sized by trial and error to give a minimum temperature of 194°F. at maximum flow and under all operating conditions. When the correct orifice size has been determined, the orifice union is sealed so that it cannot be changed by an unauthorized person. For higher operating temperatures, the orifice may be bypassed (Fig. 10).
(e) The recorder controller must be adjusted so that neither cut-in nor cut-out is below 194°F. and wired so that the infeed pump stops if the temperature falls below this point. Seal controller plate.

(f) The automatic temperature differential controller would be set at a ratio of 1:1 if there were no heat loss through radiation, and the outgoing temperature would be exactly the same as the incoming temperature. However, a ratio setting of one to slightly less than one takes the radiation loss through the vacuum chamber walls into account. Room temperature and design of equipment are some of the factors determining radiation loss. This instrument must be sealed.

Steam Supply for Steam Treatment (Fig. 10)

From the flow diagram it should be apparent that a clean, saturated, and adequate steam supply with automatic controls is essential.

Boiler waters that need treating should be treated before entering the steam generating equipment unless treatment is for slight hardness only. The use of boiler compounds is not recommended. However, if compounds are used in the boiler, the manufacturer of such materials should present written evidence that they are free from odors and from toxic and volatile substances.

All control devices such as separator with filter, pressure gauges, condensate traps, pressure regulator, strainer, bypass lines with valves for manual operation, radiation pipe, purifier, blow down line and orifices should be installed in the relative position and manner as indicated in the diagram (Fig. 10).

Sufficient condensate traps, including a separator, with filter properly located in the steam supply line, are needed to furnish a saturated steam supply free from non-volatile substances and from water of condensation. These traps should drain to open traps or to the atmosphere. Free drainage to the atmosphere is recommended since back-pressure, air locks, and failure of trap to function in closed condensate return lines to the boiler, may go unnoticed and the trap be inoperative for a considerable period of time.

The two steam pressure gauges are needed to determine (a) if the source of supply is adequate at all times, and (b) if the reduced saturated supply (35-40 p.s.i.) is constant for milk treatment.

The bypass lines around automatic controls are needed for manual operation should the automatic controls become inoperative or if processing is desired at a higher temperature. When the automatic controls are bypassed, no hazard is involved since milk cannot be processed at a temperature lower than the automatic controls, if in use, would permit.

A steam pressure regulator is needed to provide a constant pressure (35-40 lbs.) of saturated steam from the source of supply to the milk treatment unit. The 40 feet of radiation pipe installed in a horizontal position is required to remove super heat and to provide saturated steam for the treatment unit. This radiation pipe should extend from the pressure regulator to the point of application and slope 1" in 20 feet upward to the pressure regulator.

A steam purifier with condensate trap and blow-down line, should be installed vertically and as close to the point of application as possible.

In H.T.S.T. units the solenoid valve in the line upstream from the point of steam application should be wired through the flow diversion valve and vacuum pump or other vacuum creating devices so that steam will not be applied to the treatment unit or line unless the vacuum pump is on and the H.T.S.T. unit is in forward flow. In other types of installations, for safety purposes, it should be impossible to apply steam without first starting the vacuum pump or other vacuum creating devices. The added requirement that the unit be in forward flow when steam is applied prevents waste of steam, possible adulteration of milk with water of condensation from the steam being applied when milk is not entering chamber, improper operation of instrument (automatic temperature differential controller) to control adulteration or excessive concentration of the processed milk, and to eliminate the necessity of hand-operation of the steam control valve. All steam supply assembly controls, inspection, and seal points should be inspected routinely to see if they are functioning properly and to see that no unauthorized changes have been made to the installation since the last inspection.

Typical Vacuum Systems With or Without Steam Treatment (Fig. 11)

Most of the vacuum systems being used have similar characteristics. If steam is used, vapor cooling facilities in addition to water sprays or baths may be used. The water vapor and most of the volatile gases are drawn off through the vapor line from the top of the chamber into water sprays, baths, or condensers. Water vapor and some of the volatile gases are recondensed and discharged to waste through a drain open to the atmosphere. When a plant water supply is used to recondense water vapors drawn off through a plate condenser section or other sanitary heat transfer equipment, the water may be re-used in other plant operations such as bottle washers and steam generating equipment. Ejector-condensers requiring large amounts of water may have a recirculating system to permit re-use of water, providing it is protected from contamination (Fig. 12).

From the drawing you will note that the horizontal vapor line is of sanitary construction from the top of the chamber to a point at least 12 inches below the
top of the chamber. This sanitary vapor line should slope a minimum of \( \frac{1}{4} \) inch per foot toward the source of vacuum. The \( \frac{1}{4} \) inch slope in the vapor line is to prevent any water or other contaminating material from draining back into the milk when the vacuum is off. A check valve is required above the point at which the water is introduced into the vapor line to prevent fouled water from backing up into the vacuum chamber via this vapor line from the vacuum pump. Water lines for sprays, baths, pumps, makeup line for water ejectors, and other devices with submerged inlets should be protected against back siphonage by an open air gap or siphon breaker in the supply line. An automatic air or electrically operated solenoid valve wired in with vacuum pump or vacuum device to cut off the water when the vacuum is off, prevents waste of water and possible flooding of the vapor line and chamber.

The amount of vacuum used in treating the product is regulated automatically by an instrument (automatic temperature differential controller) when steam treatment is used. If steam is not used, the maximum temperature and vacuum to be used are set and the regulators are sealed at these maximum settings. Instruments for controlling vacuum and/or temperature automatically should be provided if steam treatment is not used. This takes the "human element" out of the plant operation, and a more uniform product is the result.

**Summary and Conclusions**

An attempt has been made to discuss the major types of flavor control equipment using vacuum and vacuum and steam in the processing of fluid milk. This equipment is used in connection with vat, high-temperature short-time, high-heat and vacuum pasteurization.

Although there are many possible variations in such equipment, the controls are generally the same, depending only upon the type treatment used.

The primary control and inspection points, their functions and need have been discussed and drawings have been used to further simplify their installation in the several types of equipment. In addition specific controls for high heat pasteurization have been listed. A schematic drawing outlining the reuse of water from ejector-condensers, used in connection with vacuum pasteurizers is given.

It is concluded that:

(a) Vacuum and vacuum-steam treatment of milk for off-flavors is apparently successful as evidenced by sales charts of various milk plants. Although numerous processors have indicated that this equipment does not eliminate the importance of quality raw milk or of rigid platform inspection, certain amounts of undesirable flavors in milk such as onion, garlic, certain feed and weed flavors, and barny odors can be removed while bitter weeds and some other non-volatile flavors cannot be removed.

(b) Specific controls are necessary when this equipment is used. Even though some of the controls discussed were evolved by the trial and error method, they have proven to be necessary in protecting the safety of the product and in satisfying the applicable requirements of the U. S. Public Health Service Milk Ordinance. In this field study in Tennessee, laboratory tests have indicated that when steam treatment is used, an automatic temperature
differential controller is necessary to prevent excessive concentration and/or dilution.

(c) The writers are in agreement that basic research on the operation and control of this equipment should be done by the manufacturer in conjunction with the U. S. Public Health Service prior to the time it is installed in a commercial milk plant.

(d) The next revision of, or supplement to, the U. S. Public Health Service Milk Ordinance and Code should give specific, official coverage to flavor control equipment, vacuum pasteurization and to the definition of high-heat pasteurization. This would standardize installation and inspection of this equipment.

(e) The sanitary design and construction of equipment such as steam injectors or booster heaters, vacuum chambers, pressure differential valves, vacuum breakers, product flow stops should be evaluated and 3-A standards developed therefor.

(f) Vacuum and high-heat pasteurization equipment included in this study were found adaptable to circulation and in place cleaning with the exception of areas exposed to the highest temperature and/or low turbulence. Areas difficult to clean have been found to be domes of vacuum chambers, baffles, distribution nozzles, vacuum breakers, air operated valves and steam injection devices.

(g) In view of the recent Federal Food and Drug Administration ruling that the tolerance for any foreign substance in milk is zero, the use of boiler compounds in steam generating equipment, used in connection with steam-vacuum treatment of milk, needs further study. The treatment of infed potable water to steam generators should be done, when practical, before it enters the boiler. Since each water supply may be an individual problem, a reputable chemical firm that specializes in treating boiler water should be consulted. A number of different chemicals now in general use for the treatment of boiler water and which have been found to be satisfactory are: sodium triphosphate, sodium hexametaphosphate, sodium hydroxide, sodium sulfite, sodium silicate, sodium aluminate, and sodium alginate, all of which are nonvolatile. Tannin is also frequently added to boiler water to facilitate the removal of sludge during the blow down of the boiler. This product is essentially nonvolatile but is reported by processors to create an odor problem in the milk or milk products. Therefore, tannin should be used with extreme caution. The naming of the above compounds is not a proprietary endorsement and does not represent a complete list of all chemical compounds which are nonvolatile, nontoxic and odorless and to which no objection has been found. Volatile chemicals used to prevent corrosion and scale in boilers or to facilitate the removal of sludge, cannot be used when steam is injected directly into the milk.

(h) The experience gained in working with flavor control equipment has convinced the writers that a thorough, practical knowledge of the U. S. Public Health Service Ordinance and Code is very necessary if the regulatory official is to adequately supervise the installation and operation of this equipment. Every opportunity should be used to gain a working knowledge through the study of reliable texts, brochures, flow diagrams, and through discussions with installation engineers and plant operators.

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