• In-place Cleaning
• of
• Milk Pasteurizing
• Equipment

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DIGEST

The cleaning in-place of stainless steel milk lines, using acid and alkaline rinses, and sanitizing them with chlorine, is a satisfactory procedure. In the study reported in this bulletin the critical part of the vat system used for pasteurization was the preheater in which the temperature gradient was high enough to cause a milk stone deposit.

In-place cleaning and sanitizing of a plate type regenerator-pasteurizer-cooler is satisfactory, if following the water-acid-water-alkali rinse sequence, the plates in the unit are inspected and freed of milk residues by light brushing or hosing with cold water.

When acid rinses are used each time the unit is cleaned, there are no milk stone deposits on plates when the flow rate of solutions is at least 28 gallons per minute, although short sections of 2-inch line are in the same circuit with 1½-inch line.

A rinse of 200 parts per million (p.p.m.) chlorine is adequate for a system, previously cleaned in-place, after an interval of 40 hours.

Acid and alkaline rinses at 165° F. are satisfactory in a system in which milk has been heated to 163 - 164° F.

In-place Cleaning of Milk Pasteurizing Equipment

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UNTIL THE PAST FEW YEARS, milk processing equipment has been traditionally washed and sanitized by methods that required dismantling (1, 2, 3).

Cleaning in-place saves time and labor. It also prevents possible damage that may result if pipe lines are dropped.

Cleaning milk equipment is a process with al clear-cut objectives, other than that of taining high quality. These are the emulsi- of fat, softening of protein, neutralizing acid and preventing the formation and de- ion of a film. The latter objective is neces- because of the minerals in the milk, the wash and the cleaning compounds used. All these s of deposited minerals are of greater con- n heated equipment surfaces. Such films been referred to for many years as "milk " Following the cleaning process, there be a sanitizing treatment that will insure imum of bacteriological contamination in ceeding milk processed. Sanitizing, as used s bulletin, implies "practical," but not neces- "complete" sterilizing.

n-place cleaning of dairy processing equip- was first recognized by the U. S. Public h Service in its 1953 Milk Ordinance and (4). It outlines certain recommendations operly cleaning in-place. While the prin- of satisfactorily cleaning and sanitizing ipe lines and plate type heat exchangers e same, the method of treating pipes must dified when a plate type heat exchanger or -time press" is included in the circuit.

his study was conducted in two phases. The first phase covered a 10-week period during which the milk was vat pasteurized each day except Sunday. The second phase covered an 8-month period during which a high-temperature, short-time unit was used each Monday, Wednesday and Friday.

Source of Milk

The cleaning and sanitizing procedures in this study were carefully planned, since the milk processed was the regular College Creamery supply.

This study preceded the publication of the 1953 Ordinance and Code, and since the Texas State Health Department follows the ordinance, **per se,** for all standards, it was necessary to obtain permission to clean in-place while continuing to label milk "Grade A." The State Health Department granted this permission so that a reasonable supply of milk could be handled through the equipment being studied.

The raw milk supply was from the College herd and averaged about 450 gallons daily. It was produced under excellent sanitary conditions through the use of mechanical milkers, a closed-pipe system including a filter, and a water-cooled, enclosed surface cooler. The milk was piped directly from the surface cooler to an insulated stainless steel-lined truck tank and delivered to the Creamery once daily. Upon arrival at the Creamery, the milk was usually below 50° F. and contained fewer than 15,000 bacteria per milliliter. The tank was emptied into a refrigerated storage vat.

Cleaning Procedure for the Pipe System

After the day's run of milk had been processed, the cloth bag was removed from the filter, the homogenizer by-passed and all valves removed and scrubbed by hand. With the valves replaced, rinse solutions prepared in the receiving vat were circulated through the box-tube pre-heater, the filter and the entire line up to the holding vats. This was a total of about 180 feet of 1½-inch stainless steel line. Rinses were conducted through a 50-foot length of 1-inch Tygon tubing which connected the end of the sanitary line and the re-

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ceiving vat. The receiving vat milk pump provided a flow velocity of 25 gallons per minute throughout the system.

Before the experiment, paper gaskets were used throughout the milk-processing equipment. During the study, all but three of these were replaced with neoprene gaskets. The three paper gaskets were examined daily as the experiment progressed and were replaced every 2 to 3 days as they showed evidence of becoming soft and disintegrated. The neoprene gaskets were examined every few days, and at the end of 4 weeks they were still resilient and in satisfactory condition.

The following sequence of rinse solutions was used:

1. Water at 110-120° F., flushed through, but not recirculated; this rinse was continued until it no longer appeared milky.

2. Thirty gallons of acid solution were made up in the receiving vat, according to the manufacturer's directions, and recirculated at 125° F. for 40 minutes. This solution was then discarded.

3. Thirty gallons of water at 110° F. recirculated for 5 minutes, then discarded.

4. Thirty gallons of alkaline solution, made up according to the manufacturer's directions, recirculated for 40 minutes at 125° F., then discarded.

5. Cold water flushed through, but not recirculated, for 5 minutes. The system then stood idle until the next morning, an interval of about 17 hours. There was an additional idle period of 24 hours each Sunday.

6. Before processing began, a new filter cloth was installed, the homogenizer connected into the circuit and 30 gallons of 200 p.p.m. hypochlorite solution pumped through the system. This was not recirculated, but went on through the holding vats, pump, plate cooler, surge tank and bottle filler. The hypochlorite was finally discarded as some of it was "milked" out of each filler valve.

Results With the Pipe System

Milk was processed daily, except Sunday, throughout the 10-week study. Each day one bottle of milk was collected at the filler from the beginning of the run and one from the end of the run. Standard procedures were used to test these samples for total bacteria count and for coliform organisms. The results of analyses for bacteria in the milk and swab tests of lines, gaskets and elbows the first 3 days of the experiment, indicated that further use of swabs would be of no benefit, since they were all sterile. After 15 days of using the washing procedure outlined, the excellent condition of the lines and the consistently low bacteria counts of the milk indicated that the time of recirculating the acid and alkali solutions could be reduced.

The washing procedure was modified for 4 consecutive days; the 40-minute recirculating periods for the acid and alkali solutions were reduced to 20-minute periods. This resulted in a milk stone accumulation that grew progressively worse in the preheater during the 4 days; in addition pinpoint colonies, indicating heat-tolerant organisms, appeared in the end-of-the run milk samples. The preheater tubes were thoroughly brushed and cleaned with acid and all gaskets were replaced.

The 40-minute period for acid rinsing was resumed, but the alkali rinsing period was held to 20 minutes For the duration of this part of the study — 39 operating days — the procedure was as originally outlined, except that the alkali rinsing time was 20 minutes. All pipe continued to be bright and clean looking during this treatment. After 4 weeks of continuous use, a set of neoprene gaskets was removed and examined bacteriologically. None was contaminated and all were resilient. No estimate of their probable maximum life was determined.

Tables 1, 2 and 3 summarize the bacteriological quality of the homogenized-pasteurized-bottled milk when the lines from the receiving vat to the pasteuring vats were cleaned in-place by three slightly different procedures. There was one instance of a count exceeding the Grade A standard of 30,000. This occurred at the beginning of one run. At the end of the run on the same day, the count was 2,650. Since all lines and other milk surfaces beyond the pasteurizing vats were conventionally washed by dismantling this one high count may have come as a result of a bottle being contaminated.

Table 1. Standard plate counts and coliform counts of vat-pasteurized, homogenized milk when lines were cleaned in-place—acid and alkali rinses each circulated 40 minutes[1]

	Total count		Coliform count	
Degree	Beginning of run	End of run	Beginning of run	End of run
Maximum	520	1020	None in 1 ml.	None in 1 m
Minimum	25	30	None in 1 ml.	None in 1 m

[1]Fifteen consecutive operating days, except Sunday.

Table 2. Standard plate counts and coliform counts of vat-pasteurized, homogenized milk when lines were cleaned in-place—acid and alkali rinses each circulated 20 minutes[1]

	Total count		Coliform count	
Day	Beginning of run	End of run	Beginning of run	End of run
1	200	1200[2]	None in 1 ml.	None in 1 m
2	130	500[2]	None in 1 ml.	None in 1 m
3	140	300[2]	None in 1 ml.	None in 1 m
4	80	5100[2]	None in 1 ml.	None in 1 m

[1]Four consecutive operating days.
[2]Uncountable pinpoints in 1-10 and 1-100 dilutions.

Table 3. Standard plate counts and coliform counts of vat-pasteurized, homogenized milk when lines were cleaned in-place — acid rinse circulated 40 minutes; alkali rinse circulated 20 minutes[1]

	Total count		Coliform count	
	Beginning of run	End of run	Beginning of run	End of run
Count	Number of days			
Less than 1	0	0	32	28
1	0	0	4	7
2 to 9	0	0	2	3
10 to 99	7	5	1	1
100 to 499	25	26	0	0
500 to 999	2	3	0	0
1,000 to 4,999	2	4	0	0
5,000 to 10,000	2	1	0	0
Over 10,000	1(32,000)	0	0	0

[1]Thirty-nine consecutive operating days, except Sundays

Beginning and End-of-run Bacteria Counts

The only period during which there was a significant increase in the bacteria count in milk at the end of the run over that at the beginning, was when both the acid and alkali rinses were used for 20 minutes. This was caused by heat-tolerant bacteria that produced pinpoint colonies. When both the acid and alkali rinses were used for 40 minutes, and in the third period of the study when acid was used for 40 minutes and alkali for 20 minutes, there were about the same number of counts higher as there were lower at the end of the run. Since most of the counts were low, those that were higher at the end of the run may be considered unimportant.

Saturday to Monday Bacteria Counts

The system was idle from each Saturday noon until Monday morning. No change in the manner of cleaning or sanitizing was made because of this extra day between runs. Any buildup of bacterial growth that might have occurred was adequately eliminated by the chlorine rinse that immediately preceded processing. Any buildup, however, was most unlikely in view of the excellent condition of the lines and gaskets. The Saturday to Monday counts for 7 weeks were:

End of run, Saturday	Beginning of run, Monday
550	100
150	30
280	200
110	6500[1]
120	170
300	150
610	150

[1]Contaminated bottle suspected.

Cleaning and Sanitizing the High-temperature, Short-time System In-place

After the raw milk was standardized in the holding vat, it was routed through an in-line filter, 3-section regenerator-pasteurizer-cooler with a 16-second holding tube, homogenizer, surge tank and filler. Homogenization took place before pasteurization. This circuit included about 100 feet of 1½-inch stainless steel pipe.

The acid and alkaline rinses were applied to the entire system up to the surge tank, excluding the homogenizer and the flow diversion valve. The chlorine rinse was applied to the entire system. At the surge tank, a 50-foot length of 1-inch Tygon tubing was used to complete the circuit back to the solution vat. The use of Tygon tubing was approved for this research but it does not meet the requirements of the U. S. Public Health Service even though such tubing is not used to convey milk. The 1953 code states: "Return, recirculating lines are installed, and are of the same or equivalent material and construction as the milk line." (p. 89, par. 5c).

Previous experience (8) indicated that neoprene gaskets are satisfactory and may be left in place indefinitely. These were used in parts of the system; in places that were inspected daily, paper gaskets were used, but for one day only.

During this second phase of the study, the acid and alkaline detergents manufactured by 5 suppliers were used. There are no significant differences in the recommendations for using these materials. The procedure followed was a composite of the recommendations made by the detergent suppliers and those of a dairy industry group (6)[1].

After the flow of milk was stopped, both heating and cooling media to the plate unit were shut off. Sanitary valves were removed, hand brushed and replaced. Milk remaining in the press was drained. The inline filter element was removed and the filter casing reconnected. Pressure on the plate gaskets was increased slightly to avoid leakage while the solutions were pumped through. The Tygon tubing was connected at the surge tank. A temperature-time recorder bulb was placed in the make-up vat.

1. The flow diversion valve was disconnected and the homogenizer by-passed.

2. Water at 100° F. was flushed through the system and wasted on the receiving room floor until it ran clear. The system was drained free of rinse water.

3. An organic acid solution was prepared in the make-up vat to maintain a level of 18 inches above the outlet after the system was full. The milk pump on the vat also served as a solution-

[1]The first of several "Tentative Suggested Procedures for Cleaned in-place Pipe Lines Used in Plants Handling Milk and Milk Products" was prepared by a Dairy Industry Supply Association task committee in June 1951. (5) The committee included representatives of the International Association of Milk and Food Sanitarians, the U. S. Public Health Service, and a Dairy Industry Committee. A later report of the group that includes the layout and engineering phases of in-place cleaning, as well as the suggested cleaning procedure, was published in the March-April 1953 issue of the Journal of Milk and Food Technology, Vol. 16, No. 2, pp. 77-78.

recirculating pump. The acid solution was adjusted to 165° F. and circulated for 30 minutes, after which it was discarded.

4. Water from the hose at 120° F. was then used to flush out the acid solution. This required about 10 minutes.

5. Alkaline detergent solution at 165° F. was circulated for 30 minutes.

6. Cold water was again flushed through until the alkali was removed. This required about 10 minutes. At this point, the press was opened for inspection. The plates were brushed lightly and cold water was used to rinse them.

7. The press was again tightened and new paper gaskets were installed.

8. After complete draining of the final cold water rinse, the system stood without further treatment until the next milk was to be processed. In most cases, this was a 40-hour interval, on a 3-day-a-week processing schedule.

9. Immediately before processing began, a 200 p.p.m. chlorine solution was pumped through the entire system, including the surge tank and filler.

General Observations on Cleaning the H.T.S.T. System

As would be expected, the critical parts of the system were the heating and regenerating sections of the press. On opening the press, it was found in many instances that there were flakes of semi-jellied milk solids on the plates in these sections, particularly on those in the heating section. These flakes were not, however, stuck to the plates. They were easily removed by light brushing or by hosing with water, but they did have to be so removed. This required only a few minutes. Milk stone never accumulated on the plates, even though the speed of the solutions was not sufficient to flush out all of these flakes. Milk stone did form in the thermometer well, a short 3-inch section of pipe immediately in front of the flow diversion valve. This section was hand-scrubbed each time the press was opened.

Owing to excessive pressure on the plate gaskets, it was impractical to maintain the recommended flow rate of 5 feet per second. The 2-inch, 16-second holding tube would require a discharge of 43 gallons per minute at a 5-foot-per-second velocity. Therefore, it was necessary to lower this volume 35 percent, or to 28 gallons per minute, a velocity 3.25 feet per second. It has been reported (7) that, under proper conditions, velocities as low as 1.5 feet per second are satisfactory. The physical condition of the rinsed surfaces and the bacteriological condition of the milk justify this reduced velocity. The daily use of the acid rinse may have been responsible for these good results.

While the D.I.S.A. task committee recommends the acid rinse on an "if necessary" basis, experience during the previous study here (8) indicated that it was a daily necessity, even though the water supply at the Creamery is soft (about 4 p.p.m. of calcium carbonate). There was no attempt to eliminate the acid rinse in this study, nor to use it intermittently. The object was to avoid hand scrubbing.

There was no apparent damage to any part of the system as a result of the above cleaning procedure. The strengths of acid and alkaline rinses were maintained according to the recommendations of the manufacturers. At no time was it necessary to resort to hand cleaning, except as noted above.

The acid and alkali detergents furnished by the five manufacturers were apparently equal in efficiency of cleaning. Each was used for 3 or more weeks.

Bacteria Counts of Bottled Milk

Routine standard plate counts for total organisms and for coliforms were made on bottled milk samples from the beginning and end of each day's processing. During most of the study period, the plant operated 3 days a week. Samples were usually plated 48 hours after bottling in order that counts would be comparable with those reported by local inspection agencies.

Table 4. Standard plate and coliform counts of homogenized-pasteurized bottled milk, processed in a plate type pasteurizer, cleaned in-place[1]

	Total count		Coliform count	
	Beginning of run	End of run	Beginning of run	End of run
Number	Number of days			
Less than 1	0	0	64	60
Less than 10	0	0	76	79
11-20	0	0	5	4
21-30	0	0	3	1
100-499	43	48	0	0
500-999	32	31	0	0
1,000-3,000	7	5	0	0
Over 3,000	2[2]	0	0	0

[1] 84 operating days.
[2] 3,800, 3,760.

All of the total counts were within the limit (30,000) for Grade A pasteurized milk. The coliform count exceeded 10 in 13 instances, but it is doubtful that there is any relation between the incidence of coliforms and the method used to clean and sanitize the equipment. There was no practical difference between total counts or coliforms found at the beginning and at the end of runs.

Acknowledgment

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