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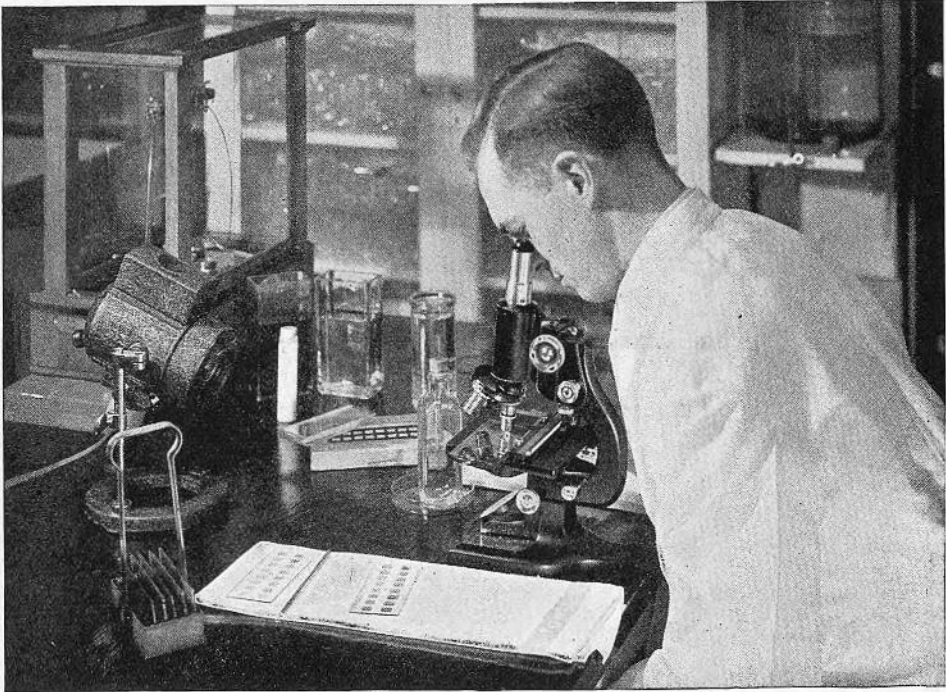
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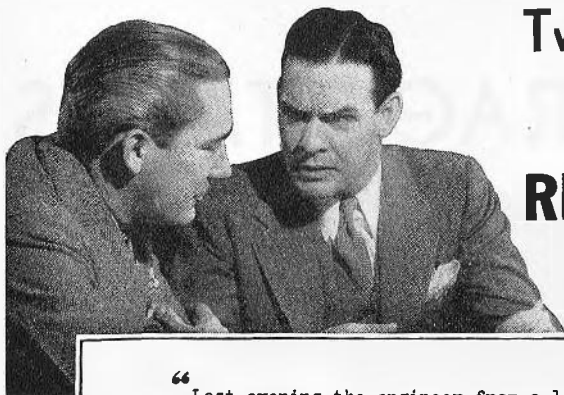
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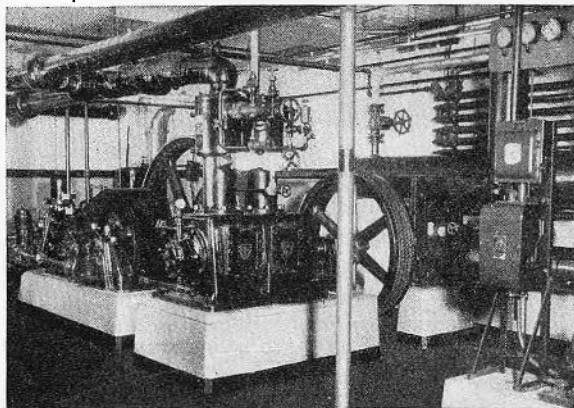
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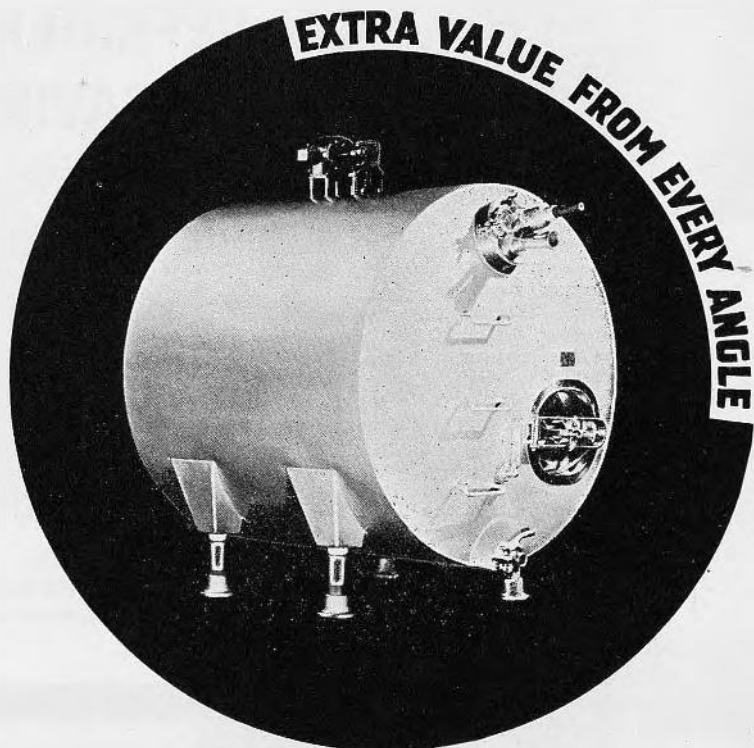
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Editorial Section

*The opinions and ideas expressed in papers and editorials are those of the respective authors.
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Sanitation of Paper Containers and Fibre Products

One of the weak links in the sanitary handling of dairy products has been the condition of bottle caps, cover hoods, milk containers, and cartons for ice cream, butter, and cheese. Some of these come into immediate contact with the food product, and others purport to protect it from contamination. In spite of the great care and expense involved in securing milk from healthy cows, and in pasteurizing it under scientific control by operators free from communicable disease, it has been common practice to use milk caps of uncertain sanitary history, to say the least. Pouring lips of glass milk bottles are protected by paper devices of one kind or another whose sanitary history is nondescript. The same considerations obtain in the increasing use of fibre containers for ice cream, both retail and wholesale.

It is common knowledge that paper and other fibre products have not been manufactured under such excellent sanitary conditions as usually obtain in food handling operations. Direct contact of high quality dairy products with containers of high, low, and indifferent degrees of cleanliness is as incongruous as the hand capping of milk bottles or the dispensing of ice cream under the faulty conditions of sanitation which obtains at many fountains. The effects of expensive and careful processing are weakened or possibly nullified by such practices.

These conditions are being studied and remedies devised by the extensive researches now being conducted at the New York State Agricultural Experiment Station at Geneva. Methods have been reported for determining the bacterial content of fibre products. Sanitary standards are being developed to guide the operations of the mills. Suggested regulations have been drawn up and offered as a tentative control procedure to protect the public and the industry from hasty and ill-considered official regulatory measures. An educational program has been inaugurated to demonstrate to the mills what constitutes sanitation according to the standards of public health officials and of the dairy industry. Pulp and paper mills are being inspected and rated for sanitary conditions and methods. A list of those having approved ratings will be published later when all have had an opportunity to make necessary improvements and corrections. This is a valuable contribution to dairy technology and sanitation.

Some mills are now producing high quality products. Their operations are open for sanitary inspection. Others are not operating on this basis. Why are they

not? One answer is not new; they have a market for their products which are being produced as heretofore, and as yet are not prepared to go to the expense necessary to make their operations comply with the modern conceptions of sanitation. In some cases, they have not realized that conditions which may be satisfactory for routine paper production will not always meet sanitary standards which must be maintained for food and dairy containers.

The health officer, the conscientious dealer, and the consuming public have a right to know what makes of paper wrappers and containers, commensurate in sanitary quality to milk and ice cream, are available. Obviously, reliance cannot be placed on the claims of salesmen. Inspection by an impartial agency, which is authorized to certify to compliance, and to publish the names of such brands, would meet the need. Firms which are now producing high quality products should be known by this fact, and not be made to wait for some indefinite time in the future when the laggards can be listed at the same time as the pioneers.

J. H. S.

The New Federal Food, Drug, and Cosmetic Act

The new Federal Food, Drug, and Cosmetic Act became law on June 25, 1938. Its general provisions will become effective one year from that date. The new law preserves the worthy features of the Federal Food and Drugs Act of June 30, 1906, and strengthens it in many respects. Its scope has been broadened over that of the 1906 act to include cosmetics and therapeutic appliances, and to include some new features of interest to food control officials. The original bill also contained provisions which sought to prevent false advertisement, including newspaper and radio publicity, but these have been comprised in a separate act which will be enforced by the Federal Trade Commission. The new food, drug, and cosmetic act will be enforced by the Secretary of Agriculture.

The chief provisions of this new act of interest to food control officials are: the authorization for the promulgation of food definitions and standards which will have legal force and effect and which will not be merely advisory as heretofore; the prohibition of traffic in food which may be injurious to health (whereas the 1906 law prohibits such food only when the poisonous substance is *added*); the issuance of emergency permits for the production of food that may be injurious because of contamination with microorganisms if the public health cannot otherwise be protected; the exemption of the declaration of added colors to butter, cheese, and ice cream; the proscription of the use of containers which may render the contents injurious to health; the prohibition of commerce in food which has been handled under insanitary conditions; the proscription of slack packaging or filling; the prohibition of the use of deceptive containers; the authorization for federal factory inspection of food establishments; the increase in criminal penalties for violations; the authorization for federal courts to restrain violation by injunction; and the prescription of procedures for seizure cases and prosecutions for the misbranding of any article.

Inasmuch as many of the states have modeled their food laws on the original federal act, it is to be expected that these states will modify their existing acts to conform to the new law. The availability of funds under the federal Social Security Act will provide the finances for employing inspectors and laboratorians to enforce the control provisions.

All of this means a tightening of food control. The new act was necessary. Adequate protection could not be assured under the 1906 act because of its legal limitations. We commend the perseverance of its sponsors, and hope that state and municipal officials will support this advance against unwholesome, adulterated, and misbranded food, including dairy products.

J. H. S.

Studies on Milk Samples from Bang-Positive and Bang-Negative Cows*

H. B. Morrison, Jr., *Dairy Section*

and

F. E. Hull, *Department of Animal Pathology,*
University of Kentucky

One of the essentials in the production of a desirable milk supply is that it should come from clean, healthy cows. Therefore, one of the important problems of milk sanitarians is to see that only this kind of cows is producing milk for use by the public.

Ordinarily one thinks of disease as causing some definite symptoms that would be noticeable to anyone on a visual examination of the animal. However, some of the important diseases which should disqualify cows, or at least impair their value as a source of milk, are recognized only through more or less specific tests. Examples of these are tuberculosis, Bang's disease, and chronic or sub-clinical mastitis. While the state and federal governments have made the eradication of tuberculosis mandatory, the eradication of Bang's disease and mastitis rests with the individual dairyman, and in some cases with the local health authorities charged with supervision of the local milk supply.

Bang's disease is more important from a public health standpoint than mastitis because of the possibility of humans becoming infected with the organism causing it and contracting Brucelliosis or undulant fever. The large majority of cases of mastitis are caused by an organism that is non-pathogenic for humans and is a much smaller factor in human disease. Both these diseases, however, are responsible for large economic losses to the dairyman. Because of this the milk sani-

tarian has an effective means of approach in order to secure the cooperation of the dairyman in eradicating these diseases, and at the same time improving both the milk supply and the economic status of the dairyman.

Attention has been called by many writers to the economic losses caused by Bang's disease and by mastitis. Several have noted a higher incidence of mastitis in Bang's disease reactors than in non-reactors. A few years ago we began making some tests on the milk from cows in our own herd. The results from these tests led us to try to secure similar data from other herds. Two dairymen who maintained rather large commercial herds very kindly consented to let us make a similar study on milk from the cows in their herds. Each of these herds contained cows which were positive and negative to Bang's disease. Fortunately, different systems of management were used in the different herds, and the effectiveness of each, especially in relation to mastitis, is shown in the resulting data.

CONDITIONS OF HERD MANAGEMENT

In Herd No. 1, the Bang's disease positive cows and Bang's disease negative cows had been separated about four years prior to the time we took our samples. They were pastured in separate paddocks, and housed in separate barns about two hundred yards apart. The two groups were milked by hand, and cared for by different crews of men so that they had no contact with each other. The positive cows were mainly older cows which were kept largely because of their value as breeding stock.

Herd No. 2, while on one farm, was

*The investigation reported in this paper is in connection with a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director. Read at the Twenty-sixth Annual Meeting of the International Association of Milk Sanitarians, Louisville, Ky., Oct. 11-13, 1937.

kept in two units designated as 2a and 2b, as they were located more than a mile apart, and the systems of management were considerably different. In one of the herds which we shall call No. 2a, the positive and negative cows were kept in separate pastures but housed in the same barn. They entered the barn by different doors, and a feed alley separated the positive and negative cows. All these cows were milked by hand by the same group of men. The cows in Herd 2b were pastured and housed together. No attempt was made to keep them separated in the barn.

The positive and negative cows in Herd No. 3 used separate pastures but were housed in the same barn. They were kept together in groups in the barn with at least one vacant stall separating the positive and negative animals. The same men handled both groups of cows. Milking was done by machine, the same ones being used for both groups. The negative cows were milked first.

PROCEDURE

Milk samples were taken aseptically from each quarter of each cow's udder. The udder was washed and dried, and a few streams were milked from each teat and discarded. The milk for the samples was then collected in sterile glass containers. The milk samples were tested to determine the agglutination reaction for *Brucella abortus*, the presence of streptococci, the bromthymol blue reaction, and the number of leucocytes per milliliter. Samples for the agglutination test for *Brucella abortus* were transferred to small test tubes containing approximately 0.01 gram of powdered rennet. The serum which exuded from the clot was used in the agglutination test. Determinations were made at a dilution of 1 to 50 by the rapid method using Huddleson *Brucella abortus* antigen. Agglutination reactions were recorded as negative, +, ++, +++, and complete. For the sake of brevity, the +, ++, and +++ reactions are included under the heading in the tables, "partial agglutination". A portion of each sample was incubated overnight at 37° C.

Smears of the incubated milk were examined microscopically for the presence of long-chain streptococci. Samples containing chains of ten or more cells were considered positive.

The bromthymol blue reaction was determined as soon as the group of samples had been collected. It was conducted according to the method of Udall, using 5 ml. of milk and 0.5 ml. of a 0.5 percent solution of bromthymol blue. Reactions were recorded as negative (normal), +, ++, +++, and +++++, according to the intensity of the color produced. Samples showing a + or greater reaction are recorded as + in the tables.

Leucocyte counts were made by the Breed smear technic, using Newman's stain. Samples containing less than 500,000 leucocytes per ml. were recorded as negative, and those containing more than 500,000 per ml. as positive. The cows were classed as Bang's disease positive or negative according to the results of the latest blood agglutination test previous to the collection of the milk samples.

RESULTS

There was a considerable variation both in the size of the different herds and in the proportion of Bang's disease positive and negative cows, as indicated in Table 1. More than one set of samples were taken from some of the cows in Herd 3 while only one set was taken from the cows in the other two herds. These data represent 448 samples (Table 2) from 99 Bang's disease reactors and 699 samples from 132 non-reactors. In all, 1147 samples were taken from 231 cows.

TABLE 1.

Number of Cows from which Milk Samples Were Taken.

Herd No.	Bang's Disease +	Bang's Disease --	Total
1	51	32	83
2a	9	44	53
2b	27	21	48
3	12	35	47
Total	99	132	231

It is well known that *Brucella abortus*, the organism causing Bang's disease, com-

monly is found in the udder as well as in the reproductive organs of cows infected with this disease. Previous investigators have shown that agglutinins for *Brucella abortus* may be produced in the udder due to the presence of this organism. Investigators, however, are not agreed on a significant agglutinin titer of milk at which this organism may be consistently found in milk. Several have reported finding *Brucella abortus* in milk with a titer of 1:50 or less while others found it only at higher titers. The agglutinin titer of the milk of Bang's disease reactors is usually lower than that of their blood, and many reactors have a negative agglutinin titer in their milk. As shown in Table 3, milk samples from 35.4 percent of the Bang's disease reactors in these herds showed no agglutination for *Brucella abortus*. Milk from 20.2 percent of the reactors showed partial agglutination, or in other words had an agglutinin titer of less than 1:50. Samples from one or more quarters of nearly half (44.4 percent) of the reactors showed an agglutinin titer of 1:50 or higher. In view of the reports of other investigators, it would seem that *Brucella abortus* might be found in the milk from the majority of this group. Milk from only one non-reactor, a cow in Herd 2b, showed any agglutination, and the agglutination in this case was only partial.

TABLE 2.

Number of Milk Samples.

Herd No.	From Bang's Disease + Cows	From Bang's Disease - Cows	All Cows
1	197	126	323
2a	35	173	208
2b	100	79	179
3	116	321	437
Total	448	699	1147

TABLE 3.

Milk Agglutination Reactions of Bang's Disease Positive Cows.

	%
All Quarters negative	35.4
Partial agglutination in one or more quarters	20.2
Complete agglutination in one or more quarters	44.4

On the basis of individual quarter milk samples from the Bang's disease positive cows (Table 4), 50.7 percent of the samples showed no agglutination whereas 19.4 percent showed partial and 29.9 percent complete agglutination at a dilution of 1:50.

TABLE 4.

Percent of Agglutinations in Milk Samples from Bang's Disease Positive Cows.

Herd No.	None %	Partial %	Complete %
1	43.7	13.2	43.1
2a	45.7	37.2	17.1
2b	60.0	21.0	19.0
3	56.0	23.3	20.7
All herds	50.7	19.4	29.9

A summary of the examinations for the presence of streptococci (Table 5) shows that among the Bang's disease positive cows, two out of three cows gave milk which contained streptococci. The proportion of positive cows whose milk showed streptococci and those whose milk did not, was relatively constant in the three herds. Among the negative cows, there was a large variation in the proportion of cows in whose milk streptococci were found. However, only 40 percent of the negative cows had streptococci in their milk. The large variation may have been due to difference of management of the cows, as indicated by the fact that in the herd where the positive and negative cows had no contact with each other, (Herd 1), only 3 percent of the cows gave milk containing this organism. In Herd 2b where the positive and negative cows were together at all times, milk from 90 percent of the negative cows contained streptococci. This is even higher than among the positive cows in that herd.

TABLE 5.

Percent of Cows in whose Milk Streptococci Were Found.

Herd No.	Bang's Disease Positive Cows		Bang's Disease Negative Cows	
	S+ %	S- %	S+ %	S- %
1	62.7	37.3	3.1	96.9
2a	66.7	33.3	43.2	56.8
2b	74.1	25.9	90.5	9.5
Three herds	66.7	33.3	40.2	59.8

Streptococci were found in 46 percent of the milk samples from the positive cows, and in only 22 percent of the milk samples from the negative cows as shown in Table 6. Not only did milk from a higher percentage of the positive cows contain streptococci, but also the average number of infected quarters per cow was higher in the positive than in the negative group.

TABLE 6.

Percent of Samples in which Streptococci Were Found.

Herd No.	Bang's Disease Positive Cows		Bang's Disease Negative Cows	
	S + %	S — %	S + %	S — %
1	43.1	56.9	.8	99.2
2a	45.7	54.3	22.5	77.5
2b	53.0	47.0	55.7	44.3
Three herds	46.4	53.6	22.2	77.8

It is generally accepted that the majority of mastitis cases is caused by streptococci, and these figures indicate definitely a higher incidence of mastitis among the Bang's disease positive cows than among the Bang's disease negative cows.

Another test that is often used in detecting mastitis or abnormal milk is the bromthymol blue test. The results of this test applied to the milk samples (Table 7) show that nearly 78 percent of the Bang's disease reactors gave a positive reaction to this test as compared to

TABLE 7.

Percent of Cows Showing Reactions to Bromthymol Blue Test.

Herd No.	Bang's Disease Positive Cows		Bang's Disease Negative Cows	
	BTB + %	BTB — %	BTB + %	BTB — %
1	74.5	25.5	37.5	62.5
2a	77.8	22.2	59.1	40.9
2b	77.8	22.2	85.7	14.3
3	82.8	17.2	8.0	92.0

31 percent of the negative cows. Again we find that the proportion of cows showing positive and negative reactions is quite constant among the Bang's reactors but varies considerably among the non-reactors.

The number of leucocytes per ml. present in milk gives still another index to disturbances in the cow's udder. Investigators are not entirely agreed on the number allowable in normal milk, some recommending as low as 300,000 per ml. and others as high as 1,000,000 per ml. as the point at which to separate the normal from the abnormal samples. In this study separation was made at 500,000 per ml. As was the case in the other tests, the percentage of Bang's disease reactors giving milk containing more than 500,000 leucocytes per ml. was considerably higher (87 percent) than that of the non-reactors (57 percent). While high leucocyte counts may be due to disturbances other than mastitis, probably the majority of them are due to udder infections. The results of the leucocyte and bromthymol blue tests are combined in Table 9. It will be noted that 74 percent of the reactors showed both bromthymol blue positive and leucocyte positive tests as compared with 28 percent of the non-reactors. On the other hand, only 8 percent of the reactors were negative to both of these tests while about 40 percent of the non-reactors showed no positive reactions to either test. It will be noted that when a cow gave a positive bromthymol blue test, her milk was practically always high in leucocytes. Many of the cows having high leucocyte counts, however, did not give a positive bromthymol blue reaction.

TABLE 8.

Percent of Cows with High and Low Leucocyte Counts.

Herd No.	Bang's Disease Positive Cows		Bang's Disease Negative Cows	
	over 500,000 per ml. %	under 500,000 per ml. %	over 500,000 per ml. %	under 500,000 per ml. %
1	88.2	11.8	78.1	21.9
2a	100.0	0.0	63.6	36.4
2b	74.1	25.9	85.7	14.3
3	93.1	6.9	43.7	56.3
All herds	87.1	12.9	57.4	42.6

TABLE 9.

Percent of Cows Reacting to both Bromthymol Blue and Leucocyte Tests.

Reaction	Bang's Disease	Bang's Disease
	Positive Cows	Negative Cows
	%	%
BTB + L +	74.1	27.8
BTB + L -	4.3	2.3
BTB - L +	13.8	29.7
BTB - L -	7.8	40.2

TABLE 10.

Percent of Cows Reacting to Bromthymol Blue and Streptococcic Tests

Reaction	Bang's Disease	Bang's Disease
	Positive Cows	Negative Cows
	%	%
BTB + S +	60.9	33.0
BTB + S -	16.1	23.7
BTB - S +	5.7	8.3
BTB - S -	17.3	35.0

Combining results of the bromthymol blue and streptococcic examinations, we find that streptococci and positive bromthymol blue reactions were found in milk from 61 percent of the reactors as compared with 33 percent of the non-reactors. Seventeen percent of the reactors and 33 percent of the non-reactors gave no positive reactions to these tests. Nearly all the cows whose milk contained streptococci also showed a positive reaction to the bromthymol blue test. Streptococci were not found, however, in milk from a considerable number of cows whose milk showed reactions to the bromthymol blue test. On the other hand, streptococci were often found in milk from cows that showed no positive bromthymol blue reaction.

A combination of the results of leucocyte and streptococcic examinations is given in Table 11. Again we find that the

TABLE 11.

Percent of Cows Reacting to Leucocyte and Streptococcic Tests.

Reaction	Bang's Disease	Bang's Disease
	Positive Cows	Negative Cows
	%	%
L + S +	63.2	34.0
L + S -	21.8	40.2
L - S +	3.5	5.2
L - S -	11.5	20.6

largest proportion (63 percent) of the Bang's disease reactors gave milk which was positive for both leucocytes and streptococci. This may be compared with 34 percent of the non-reactors giving positive leucocyte and streptococcic tests. Among the Bang's disease reactors streptococci were found in milk from about three out of four cows showing a high leucocyte count, while among the non-reactors slightly less than half of the cows with a high leucocyte count showed streptococci in their milk. In a large majority of cases, a high leucocyte count accompanied the presence of streptococci. In Table 12, the reactions to the bromthymol blue, streptococcic and leucocyte tests have been combined. It will be noticed that approximately one-fourth of the Bang's disease reactors were positive to all these tests and about one-fourth were negative to all three tests. Among the non-reactors, however, only 12 percent reacted to all three tests while nearly half were negative.

TABLE 12.

Percent of Cows Reacting to Bromthymol Blue, Streptococcic and Leucocyte Tests.

Reaction	Bang's Disease	Bang's Disease
	Positive Cows	Negative Cows
	%	%
All +	28.9	12.0
2 +	23.8	19.7
2 -	20.8	22.4
All -	26.5	45.9

SUMMARY

These results lead us to several conclusions. A high percentage of Bang's disease reactors gave milk with an agglutinin titer for *Brucella abortus* of 1:50 or higher; many of these cows may discharge *Brucella abortus* in their milk. The higher percentage of Bang's disease positive cows giving positive reactions to other tests for mastitis indicates that resistance of these cows to other udder infections may be lowered because of the Bang's disease. The management of a herd containing both Bang's disease positive and negative cows is an important factor in the control of mastitis. The best method of management is the immediate elimination of

all Bang's disease reactors from the herd. If this is not feasible, the reactors should be isolated from the non-reactors as completely as possible. Under no circumstances should the reactors and non-reactors be allowed to use the same pasture or occupy adjoining stalls in the barn. If reactors and non-reactors are housed in the same barn, the reactors should be milked first. Each of these diseases in itself causes severe economic loss to the

dairyman; when both occur together it may mean the difference between success or failure of the dairy enterprise because of the large loss these diseases cause the dairyman.

The large economic loss to the farmer caused by Bang's disease and mastitis may make it easier for the milk sanitarian to secure the cooperation of the dairyman in efforts to eliminate these diseases and thus improve the milk supply.

"Gassed" Cream

William B. Palmer

*Executive Officer, Milk Inspection Association of the Oranges
and Maplewood, N. J., City Hall, Orange, N. J.*

Whipped cream is now being extensively supplanted in some areas by gas-charged cream at soda fountains and other establishments. The cream is placed in a small steel cylinder which is filled with nitrous oxide gas under high pressure from a cartridge. Nitrous oxide is used because it is more soluble than other gases, and is tasteless and nontoxic. The cream is discharged as required by operating a needle-valve. The release of the pressure results in the formation of minute gas bubbles throughout the cream. The delivered product resembles ordinary whipped cream.

In commercial practice, the users of the apparatus supposedly follow printed instructions furnished them by the manufacturers. Equipment consists of numerous intricate parts, difficult and tedious to disassemble, clean, sterilize, and reassemble. Frequently, inspections demonstrate that units are unclean and that the parts contain cream that is decomposed. The several types of apparatus are designed to be placed in cooling wells in soda fountains, but the cream cylinders are only partially submerged. Under this arrangement, only a part of the contents is refrigerated. The head of the equipment, consisting of

washers, checks, fittings, tubing, channels, valve, and delivery nozzle, is not refrigerated and is constantly exposed to room temperature.

Manufacturers are endeavoring to redesign equipment so as to reduce the number of parts with the idea of facilitating the cleaning procedure. Some progress has been made, but further improvements are necessary. Improved and more explicit instructions for cleaning and care of the equipment are being issued to purchasers and users. However, refrigeration remains a problem.

Many of the factors encountered with this kind of apparatus are similar in some phases to those found in milk pumps and dispensing machines which are generally disapproved or prohibited. Some health departments are now taking cognizance of these facts.

Although there are no official standards for consistency of whipped cream, the commercial advantages of these so-called cream whipping machines is well demonstrated when it is noted that "gassed cream" has a 300 percent or more overrun as compared to approximately 100 percent in ordinary whipped cream.

Contamination of Pasteurized Milk by Improper Relative Pressures in Regenerators*

By A. W. Fuchs,

Senior Sanitary Engineer, United States Public Health Service

INTRODUCTION

Many of the larger milk pasteurization plants employ regenerators (also known as heat exchangers or regenerative heater-coolers) in which a continuous flow of hot pasteurized milk on one side of a metal partition warms the incoming raw milk on the other side. This in brief is the principle of the milk-to-milk regenerator. Another type is the milk-to-water-to-milk regenerator, in which the pasteurized product transfers its heat to a circulating water medium which in turn warms the raw milk. Pasteurized milk must be cooled before bottling, and, conversely, the raw milk, which has been kept cold during transit and storage, must be heated for pasteurization. Hence heat exchange by means of regenerators permits a substantial saving in heating and refrigeration costs.

Such equipment is of concern to health officers because of the danger of contamination of the pasteurized product by the raw milk in case flaws develop in the metal or the joints separating the two. Raw milk must be considered a potential source of pathogenic bacteria. Much of the value of pasteurization is lost if the product subsequent to pasteurization is subjected to possible contamination by raw milk. To combat this danger, control regulations frequently include provisions similar to the following, quoted from the Public Health Service Milk Ordinance and Code (Public Health Bulletin No. 220, 1936 edition, p. 101):

Regenerative heater-coolers shall be so constructed and operated that, in the case of milk-to-milk regenerators, the pasteurized milk will at all times, including shut-down periods, be kept under higher pressure than the raw milk, and, in the case of milk-to-water-to-milk regenerators, the heat-transfer medium will at all times, including shut-down periods, be kept under higher pressure than the raw milk.

In the case of milk-to-water-to-milk equipment the intent of such a requirement is to prevent the raw milk from contaminating the heat-transfer medium, which in turn could contaminate the pasteurized product. The heat-transfer water, for which a potable supply must be used and which is confined in a closed circuit and is periodically reheated by the pasteurized milk, will not contaminate the latter unless such medium has first been mixed with raw milk. The pasteurized product could also be properly protected by requiring that it be kept at all times under higher pressure than the heat-transfer water, but this alternative method would not prevent the objectionable fouling of the water by the raw milk if flaws developed in the metal or the joints between them.

The methods for securing compliance with such a regulation are of a technical nature. The explanation accompanying this regulation in the Public Health Service Milk Code suggests certain procedures, but more recent study has demonstrated their inadequacy. It is the purpose of this paper, therefore, to fill the need for such detailed objective specifications as will enable control officials to determine readily whether the relative-pressure requirements are satisfied in the various types of regenerator hook-ups.

*Reprinted from Public Health Reports, No. 13, Vol. 53, pages 496-505, by permission of the Surgeon-General.

PRESSURE GAGES

Relative pressures may obviously be determined by means of pressure gages, or a differential pressure gage, or other pressure-indicating devices.

When gages are employed they should be located at the critical-pressure points of the regenerator, i. e., (1) at the raw-milk inlet, and (2) either at the pasteurized-milk outlet in the case of milk-to-milk regenerators, or at the heat-transfer-medium outlet from the raw-milk section in the case of milk-to-water-to-milk types. Counter-current flow is practically universally used in regenerators because of its greater heat-exchange efficiency. With counter-current flow, points (1) and (2) are always at the elevation where the pressure on the pasteurized-milk (or the heat-transfer-medium) side, if greater than that on the raw-milk side, exceeds the latter by the least amount. This is true for all types of regenerators, with either or both sides closed to the atmosphere, at all times while milk is in the regenerator, irrespective of whether the raw milk enters at the top or the bottom. For any side open to the atmosphere, a pressure gage is, of course, unnecessary.

Pressure-indicating devices will not indicate compliance or non-compliance with the relative-pressure requirements between inspections. Pressure-recording devices would overcome this objection by furnishing the inspector with a graphic history of the pressures. Aside from their high cost, such gages are likely to be none too sensitive or reliable at the relatively low pressure differentials ordinarily encountered in milk regenerators. A difference of an inch or two in gravity head between the two sides of a regenerator, which might be sufficient to reverse the pressure relationship during shut-downs, would not be indicated or recorded by the type of gages suitable for milk equipment. Gages would have to be tested for accuracy and sensitivity at frequent intervals. The pressure relationship would have to be determined for every rearrangement of the hook-up,

every change in the pumping rate, and every change in equipment and size of piping. But the most serious objection to the use of pressure gages lies in the fact that the health officer would be powerless to remedy any damage that might have resulted from improper relative pressures occurring between inspections.

For these reasons pressure-indicating or recording devices are not recommended and should not be relied upon for determining compliance with the regulation. Instead, control officials should demand hook-ups like the following, which automatically insure the required relative pressures at all times.

MILK-TO-MILK REGENERATORS

Four types of milk-to-milk regenerators are possible. In the most common design both the raw milk and the pasteurized product flow through either a series of connected plates or two concentric pipes, so that both sides are closed to the atmosphere. In others the pasteurized milk is on the inside of a pipe, while the raw milk flows downward on the outside open to the atmosphere. The third design is like the second, but the raw milk is on the inside and the pasteurized on the outside. In the fourth possible type, not used at present, the raw milk flows downward on one side of a corrugated partition and the pasteurized on the other side, with both sides open to atmospheric pressure.

On *milk-to-milk regenerators with both sides closed to the atmosphere* (fig. 1) the required relative pressures will be automatically insured when the following conditions obtain:

(a) The pasteurized milk, between its outlet from the regenerator and its nearest downstream point open to the atmosphere, rises to an elevation higher, by at least 3 percent of the static raw-milk head on the bottom of the regenerator, than any raw milk downstream from the free raw-milk level nearest upstream from the regenerator, provided that such excess head is at least 6 percent if water or chlorine

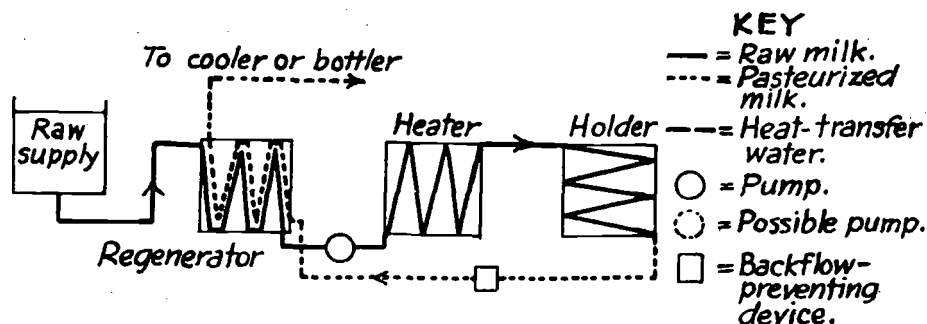


FIGURE 1.—Milk-to-milk regenerators with both sides closed to atmosphere (diagrammatic elevation).

solution precedes the milk at the beginning of a run; and

(b) No pump is located between the pasteurized-milk outlet from the regenerator and the nearest downstream point open to the atmosphere; and

(c) No pump is located between the raw-milk inlet to the regenerator and the free raw-milk level nearest upstream therefrom; and

(d) A backflow-preventing device, such as a positive-type pump or a check valve, is installed in the line between the pasteurized-milk inlet to the regenerator and either the nearest upstream point open to the atmosphere or the raw-milk outlet from the regenerator, whichever is farther downstream; provided that if said valve or pump or any portion of the system downstream therefrom leaks, storage for the pasteurized milk shall be provided downstream from its outlet from the regenerator and at the elevation specified in (a), either in the pipe line or in a tank equipped with a bottom inlet, equal in volume to at least one hour's leakage; and

(e) Hot water or chlorine solution or previously pasteurized milk is pumped through the system until it reaches the elevation specified in (a) before any raw milk is admitted to the regenerator.

The reasons for these specifications may not be apparent. If (a) is satisfied all pasteurized milk in the regenerator will be under greater pressure than the raw milk, provided (b) and (c) are satisfied during operation, (d) during shut-downs, and (e) at the beginning of the run.

The 3 percent excess head provided in

(a) is intended to compensate, during shut-downs, for the difference in specific gravity between pasteurized milk at 160° F. or more and raw milk at 40° F. or less. Similarly, the 6 percent excess head required when water or chlorine solution precedes the milk at the beginning of a run serves to compensate, during shut-downs occurring at the beginning of a run, for the difference in specific gravity between water at 160° F. or more and milk at 40° F. or less.

A pump located as described in (b) could during operation reduce the pasteurized-milk pressure on its suction side to below that of the raw milk in the regenerator.

When the raw milk is sucked through the regenerator, an auxiliary pump provided with slip is sometimes located as described in (c), in order to overcome priming difficulties in the main pump and to maintain the raw milk in the regenerator at or above atmospheric pressure so as to avoid sucking in air. A raw-milk supply tank with its milk level higher than the regenerator at the beginning of the run would overcome priming difficulties, and placing the entire tank higher than the regenerator would attain both objectives, thus eliminating the need for an auxiliary pump. A raw-milk pump upstream from the regenerator could increase the raw-milk pressure to above that of the pasteurized milk in the regenerator during operation even if (a) and (b) were satisfied. It is possible to avoid this objection by placing in the pasteurized-milk line downstream from the regenerator a

sufficient gravity head or pressure-increasing restriction, as by means of a valve. Whether such gravity head or restriction is sufficient to accomplish its purpose would have to be determined for each installation and for every change in the hook-up by means of pressure gages. Proper relative pressures could not be automatically insured.

The positive-type pump or the check valve specified in (d) will prevent backflow of the pasteurized milk through the regenerator, provided no leakage occurs. A flow-diversion valve cannot be relied upon to prevent backflow during the first few minutes following a pump shut-down while the milk is still at a sufficiently high temperature to keep the diversion valve in the forward-flow position. Backflow would lower the level of the pasteurized milk during pump shut-downs and thus might reduce its pressure to below that of the raw milk in the regenerator. The first alternative location for the device applies to systems with pasteurizer-holders or other intermediate tanks open to the atmosphere; the second, to completely closed systems. The second provision of (d) will insure an adequate pasteurized-milk pressure throughout a shut-down of

ized milk in the line has fallen below the level specified in (a) after a pump shut-down of 1 hour. If the petcock were opened momentarily and no milk escaped, it would be positive evidence that additional storage is needed.

At the beginning of a run the raw milk in the regenerator may be under greater pressure than the pasteurized-milk side from the time the raw milk enters the regenerator until the pasteurized milk has risen to the elevation specified in (a) downstream from and above the regenerator. The procedure described in (e) will overcome this danger. Water or previously pasteurized milk preceding the milk will temporarily provide the necessary pressure on the pasteurized-milk side until replaced by the freshly pasteurized milk.

On *milk-to-milk regenerators with only the raw milk open to the atmosphere* (fig. 2) the required relative pressures are automatically insured when

(a) The pasteurized milk, between its outlet from the regenerator and its nearest downstream point open to the atmosphere, rises higher than the top of the regenerator; and

(b) No pump is located between the

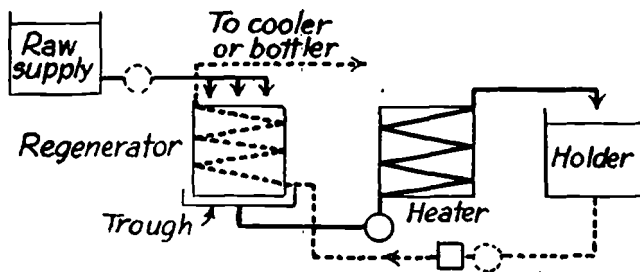


FIGURE 2.—Milk-to-milk regenerator with only raw milk open to atmosphere (diagrammatic elevation).

at least 1 hour's duration, even if there is some backflow due to leakage. Shut-downs of such duration are infrequent. The adequacy of the storage provided to compensate for leakage should be checked occasionally by determining, by means of a petcock installed in the line, a sterile probe, or otherwise, whether the pasteur-

pasteurized-milk outlet from the regenerator and the nearest downstream point open to the atmosphere; and

(c) A backflow-preventing device, such as a positive-type pump or a check valve, is installed in the line between the pasteurized-milk inlet to the regenerator and either the nearest upstream point open to

the atmosphere or the raw-milk outlet from the regenerator, whichever is farther downstream; provided that if said valve or pump or any portion of the system downstream therefrom leaks, storage for the pasteurized milk shall be provided downstream from its outlet from the regenerator, either in the pipe line or in a tank equipped with a bottom inlet, at a higher elevation than the top of the regenerator, equal in volume to at least 1 hour's leakage; and

(d) Hot water or chlorine solution or previously pasteurized milk is pumped through the system until it reaches the elevation specified in (a) before any raw milk is admitted to the regenerator.

The reasons for these specifications are similar to those for the preceding type. In both designs the purpose is to maintain the pasteurized product under greater pressure than the raw at all times, the only difference being that where the raw milk is open to the atmosphere the pasteurized milk need be kept only above atmospheric pressure rather than at a higher level than all raw milk in the system. If (a) is complied with all pasteurized milk in the regenerator will be under greater pressure than atmospheric, provided (b) is satisfied during operation, (c) during shut-downs, and (d) at the beginning of the run. In this type there is no objection to a raw-milk pump upstream from the regenerator, since the raw-milk side is open to the atmosphere and cannot be above atmospheric pressure.

Milk-to-milk regenerators with only the pasteurized milk open to the atmosphere

(fig. 3) should not be approved, since no conditions are apparent which will insure that all of the raw milk in the regenerator will be maintained at subatmospheric pressure (i. e., at lower pressure than the pasteurized milk) throughout a shut-down.

Even with a raw-supply tank below the bottom of the regenerator and no pump between the two, any air sucked into the line between the raw-milk inlet to the regenerator and the pump nearest downstream therefrom could, during a shut-down, soon destroy the suction and increase up to atmospheric (or even above atmospheric in plate-type regenerators) the pressure on the raw-milk side of the regenerator.

Milk-to-milk regenerators with both sides open to the atmosphere (fig. 4) should not be approved, since with both sides at atmospheric pressure the pasteurized-milk side cannot ever be under greater pressure than the raw-milk side. This type of regenerator is not, however, being used nor is it likely to be used because of its inefficiency. It is subject to large heat losses to the atmosphere, and as the raw milk and the pasteurized milk must both flow downward it cannot utilize counter-current flow.

MILK-TO-WATER-TO-MILK
REGENERATORS

Many types of milk-to-water-to-milk regenerators could be designed, but only the two types on the market will be discussed. The number of possible combinations may be gaged by the fact that in either or both the raw-milk and the

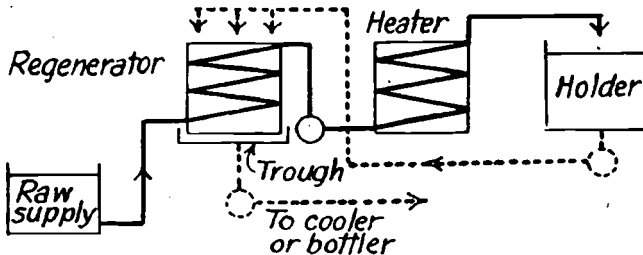


FIGURE 3.—Milk-to-milk regenerator with only pasteurized milk open to atmosphere (diagrammatic elevation).

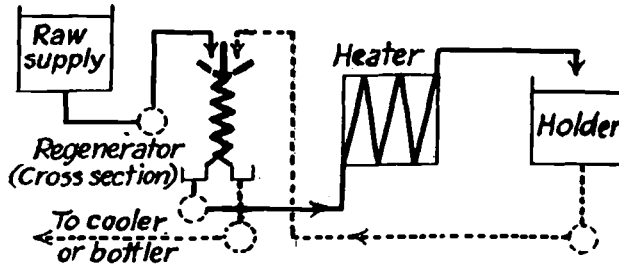


FIGURE 4.—Milk-to-milk regenerator with both sides open to atmosphere (diagrammatic elevation).

pasteurized-milk sections both the milk and the heat-transfer medium may be either open or closed to the atmosphere. In connection with the relative-pressure requirement, conditions existing in the pasteurized-milk section are immaterial and only the raw-milk section need be considered.

On milk-to-water-to-milk regenerators with both the milk and the heat-transfer water in the raw-milk section closed to the atmosphere (fig. 5) the required relative pressures are automatically insured if—

(a) The highest point of the heat-transfer-water circuit is in a covered tank at an elevation higher, by at least 6 percent of the static raw-milk head on the bottom of the regenerator, than any raw milk downstream from the free raw-milk level nearest upstream from the regenerator; and

(b) No heat-transfer-water pump is installed in that portion of the heat-trans-

fer-water circuit which lies upstream from such tank and downstream from the heat-transfer-water inlet to the raw-milk section of the regenerator; and

(c) No milk pump is located between the raw-milk inlet to the regenerator and the free raw-milk level nearest upstream therefrom; and

(d) The heat-transfer-water circuit is full of water at the beginning of the run, and all loss of water from the circuit (through backsiphonage, open drain valve, leakage, evaporation, etc.) is prevented or automatically and immediately replenished whenever raw milk is present in the regenerator.

Most of these requirements and the reasons therefor are similar to those already discussed for milk-to-milk regenerators with both sides closed to the atmosphere. Compliance with (a) will place all of the heat-transfer water in the raw-milk section of the regenerator under greater pressure than the raw milk at all

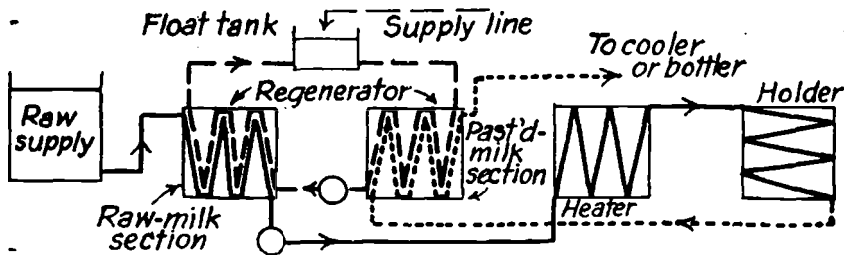


FIGURE 5.—Milk-to-water-to-milk regenerator with both milk and water in raw-milk section closed to atmosphere (diagrammatic elevation).

times, provided (b), (c), and (d) are also satisfied. The excess head specified in (a) for the heat-transfer-water circuit will compensate, during shutdowns, for the difference in specific gravity between milk at 40° F. or less and water at 160° F. or more.

A heat-transfer-medium pump located as described in (b) could, when operating, reduce the heat-transfer-water pressure on its suction side to below that of the raw milk in the regenerator. A milk pump located as shown in (c) could during operation increase the raw-milk pressure to above that of the heat-transfer water in the regenerator even if all other requirements were satisfied.

The full heat-transfer-water circuit required at all times by (d) is considered the simplest means of insuring proper relative pressures. The heat-transfer-water pump could, when operating, satisfy the pressure requirement even if the circuit were not full; but when not operating it will not satisfy this requirement unless there is enough water in the circuit to fill the upstream portion between the pump and the tank, and unless all backflow and loss of water from this portion of the circuit are prevented. The most practical solution is, therefore, a constant-level tank at the highest point specified in (a). A covered tank will protect the water against contamination, but the cover should not be airtight. Although the float in the tank will automatically open the supply-line valve whenever any loss of water from the circuit

occurs, the drain valve should be kept closed throughout the day's run to avoid unnecessary risks. The tank should be supplied with an overflow, and all supply lines feeding the heat-transfer-water circuit should enter at the tank and through a sufficient air gap to prevent loss of water through backsiphonage into the supply line.

On *milk-to-water-to-milk regenerator*: with the water closed but the milk open to the atmosphere in the raw-milk section (fig. 6) the required relative pressures are automatically insured when the following conditions are satisfied:

(a) The highest point of the heat-transfer-water circuit is in a covered tank at a higher elevation than the top of the raw-milk section of the regenerator; and

(b) No heat-transfer-water pump is installed in that portion of the heat-transfer-water circuit which lies upstream from such tank and downstream from the heat-transfer-water inlet to the raw-milk section of the regenerator; and

(c) The heat-transfer-water circuit is full of water at the beginning of the run, and all loss of water from the circuit (through backsiphonage, open drain valve, leakage, evaporation, etc.) is prevented or automatically and immediately replenished whenever raw milk is present in the regenerator.

These specifications and the reasons therefor are almost identical with those of the type immediately preceding, except that the raw-milk pump upstream

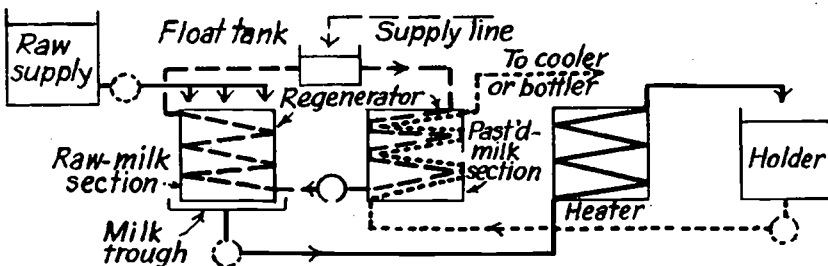


FIGURE 6.—Milk-to-water-to-milk regenerator with water closed but milk open to atmosphere in raw-milk section (diagrammatic elevation).

from the regenerator is not prohibited since the raw-milk pressure in this type of regenerator cannot exceed atmospheric.

ACKNOWLEDGMENTS

The valuable aid of Senior Sanitary Engineer L. C. Frank and Assistant Public Health Engineer W. N. Dashiell in reviewing the manuscript and suggesting revisions is appreciated.

SUMMARY

Milk regenerators, in which the hot pasteurized milk heats and is cooled by the cold raw milk either directly or through an intermediate water circuit, may

permit contamination of the pasteurized product by the raw milk in case flaws develop in the metal or the joints separating the two. To combat this danger, control regulations usually require that the pasteurized milk (or the heat-transfer water) be under greater pressure at all times than the raw milk.

Objective criteria are presented to enable control officials to determine whether such regulations are satisfied. Methods are described for automatically insuring the required relative pressures in various types of milk-to-milk and milk-to-water-to-milk regenerators.

Plan NOW to attend the
ANNUAL MEETING
of the
**INTERNATIONAL ASSOCIATION OF
MILK SANITARIANS**
at Cleveland, Ohio, during
MILK WEEK, Oct. 17 - 22

Other attractions there in the same week are the meetings of
the International Association of Milk Dealers,
the International Association of Ice Cream Manufacturers
the Dairy and Ice Cream Machinery
and Supplies Association,
and
THE DAIRY INDUSTRIES EXPOSITION

Make your reservations at the Hotel Allerton,
headquarters of this Association

The Role of Platform Tests and Farm Inspections in Milk Control*

W. D. Tiedeman,

Chief, Bureau of Milk Sanitation, New York State Department of Health

Farm inspection has become so deeply rooted in our American system of milk control that we are inclined to take it as a matter of course without inquiry as to whether or not we are getting value received for the funds expended. The problem of concentrating effort where it will accomplish most deserves our consideration.

LIMITATIONS OF FARM INSPECTIONS

It is evident that a single inspection of a dairy farm each year, made between milkings, will not tell us much about farm practices nor accomplish much except bring to light gross deficiencies in buildings and equipment. Such inspections will probably cost at least eight-five cents each, although this is quite variable. Dairymen who want to cooperate may benefit educationally from the right kind of inspection, but routine yearly inspections have little influence on the non-cooperative dairymen. This is an old theme. We all recognize that farm inspection is costly. The best of farm inspection as carried on today leaves an irreducible number of dairies which pass inspection, but either regularly, frequently, or occasionally deliver to the plants milk of unsatisfactory sanitary quality.

These facts become all the more impressive along the border lines of metropolitan milksheds where, in some instances, anywhere from two to nine different milk inspectors cover the same dairy farms at different times of the year. Each inspector is attempting to enforce slightly different regulations, all apparently designed to improve the sanitary

quality of milk. It would be difficult to prove that the quality of milk delivered by these much-inspected dairies is any better than that delivered to neighboring plants by dairies under a single inspection.

The intelligent farmer knows that many of the things he is requested to do by the inspector have no direct bearing on the sanitary quality of the milk he delivers to the plant, and that after the inspector has made his visit he is not likely to see him again for a long time. Multiple inspections by different inspectors, each finding different faults which cost money to correct, tend to antagonize the dairyman, and make the inspector, whether right or wrong, look ridiculous.

The relative ineffectiveness of farm inspection has been revealed by the examination of milk delivered to plants. There have been practical demonstrations of the value in improving milk quality of the application of simple tests to the milk at the receiving platform, and rejecting unsatisfactory cans without attempting inspection of the farms. More improvement has been accomplished by using platform tests to point out the farms that need inspection, and concentrating inspection there. The payment of premiums for milk of low bacteria count has had a marked effect in reducing counts, although plants using this simple test often continue to receive and pay premiums for low count milk that is dirty or of bad flavor.

EXAMINATION OF DELIVERED MILK

We believe that municipalities having limited funds for the quality control of milk delivered for pasteurization might well devote a considerable part of such

*Read at the Twenty-sixth Annual Meeting of the International Association of Milk Sanitarians, Louisville, Ky., Oct. 11-13, 1937.

money to the testing of individual cans of milk as received at plants, the rejecting of substandard milk, and the following up of such rejection by a farm inspection designed to assist the farmer in finding and eliminating the cause for rejection.

Many tests of milk have been used on receiving platforms, including temperature, sediment, strainer dipper, odor, and the collection of samples for methylene blue test, resazurin test, direct microscopic count, and standard plate count. Many comparisons have been made between these tests severally, and it has been recognized that each test has its particular applications and perhaps limitations.

A little more than a year ago, when the New York City Department of Health was considering revising the program for the supervision of country receiving stations, our Department joined in some extensive comparisons of a majority of these tests on individual can samples of milk. The State Agricultural Experiment Station at Geneva also participated in the work. The plan called for the examination of about two hundred cans of milk at each of three Grade A and three Grade B plants for temperature, sediment, and odor, and by use of strainer dipper, methylene blue test, and direct microscopic count. Incidentally, the dairies supplying milk to all of these plants have been under the inspection of experienced farm inspectors for many years.

In these tests, samples were taken from individual cans rather than from all the milk delivered by each patron and mixed in the weigh vat. This more laborious sampling procedure was followed because first, it was recognized that a patron delivering ten cans of milk might have only one can of unsatisfactory milk, which would be diluted greatly if mixed with nine cans of good milk; and second, we wished to find a simple test that quickly would detect bad milk in the can in order that such milk might be sent back to the producer.

The routine followed in general was to station a man outside the plant to

number the cans consecutively and another to record after this serial number the patron's number, to note whether the milk was from the morning's or night's milking, and whether the can was filled or partly full. Next, the can was opened, and the odor observed by one man and recorded by another. Then the strainer dipper test was made by one worker and recorded by another. Following this, two workers collected samples in glass vials by means of metal thieves for direct microscopic examination and methylene blue determination. The next worker took the temperature which another recorded. Finally, a worker made sediment tests, using a rapid tester which pumped a pint of milk directly from the bottom of the can. Another placed the discs in rotation to dry, and helped change discs. It is recognized that this test would show more if the milk in the can had not been stirred before the test was made, as it was by the strainer dipper. However, this could not be avoided without placing the strainer dipper test at the same disadvantage.

The direct microscopic counts were made by Dr. M. W. Yale, N. J. Hohl and C. H. Colvin. The counts expressed by the letters "E", "S", "U" and "V" are as follows:

"E" (Excellent)—up to 300,000 individual bacteria per cc.

"S" (Satisfactory)—300,000 to 900,000 individual bacteria per cc.

"U" (Unsatisfactory)—900,000 to 3,000,000 individual bacteria per cc.

"V" (Very Unsatisfactory)—over 3,000,000 individual bacteria per cc.

The corresponding probable standard plate counts are "E", up to 100,000; "S", 100,000 to 300,000; "U", 300,000 to 1,000,000; and "V" over 1,000,000. Records were also made of the average number of cells per field, and also of the predominating forms of organisms.

The strainer dipper tests were made by E. R. McHale and Dr. J. F. Jansen who were both experienced in the use of this test. Perhaps more information could have been obtained if time had been taken

to determine and record the type of flakes observed.

The classification used for describing the findings of the strainer dipper test were as follows:

"Flakes—Reject" indicating that the size and number of flakes found, showed such poor quality as to warrant the rejection of the milk.

"Dirt—Reject" describing samples which in the opinion of the tester should have been rejected because of an excessive amount of visible dirt.

"Slight flakes" designating samples with few flakes, indicating some carelessness in the methods of production, but not warranting rejection of the milk.

The classification "Slight dirt" was used by the tester to describe fine dirt found in small quantities, not indicating sufficient negligence to justify rejection.

In the brief summary, shown in Table 1, we have simply thrown all the positive findings in one class and the negative in the other.

All the odors were observed by the same man, namely, Don Lee, who has had considerable experience in this work.

The classifications used for describing the various odors found in milk were as follows:

"Bacteria odor—Rejects." This classification included milk believed to contain such a large number of organisms as to justify rejection of the milk.

"Other miscellaneous odor—Rejects." This class included "Feed odors," "Stable odors," "Cows' odors," "Musty odors," "Stale odors," "Disinfectant odors," and "Suspicious odors." These odors, though not necessarily indicating an excessive count, were present to such a degree that it was believed that the flavor of the general supply would be effected if included, and therefore were marked for rejection.

"Slight bacteria odors." This classification included the same type of odor as described under "Bacteria odor—rejects" but to a lesser degree. The milk was not of high quality but was not bad enough to be rejected.

"Other slight miscellaneous odors" included the same type of odors as indicated under the classification "Other Miscellaneous Odors—Rejects", but the odors were not pronounced enough to warrant rejection.

"Satisfactory odor." This classification included normal milk. In the present summary, shown in Table 1, these are simply classed as satisfactory and unsatisfactory.

BACTERIAL ODORS

It is naturally difficult to describe odors but Mr. Lee has attempted to describe the odor classed as "bacterial." He says, "In the first place, this odor possesses varying degrees of potency depending upon the extent of bacterial growth in the milk, types of bacterial growth predominating, and temperature of milk. Apparently the growth of a very few of the proteolytic types gives a pronounced odor denoting decomposition. It is necessary to have large numbers of the lactic acid type to produce an odor. Upon precise analysis, my experience prompts me to state that the first odor produced in milk by bacteria which is detectable has an entirely different description than the one in the latter stages of growth when the odor is easily detected.

"The odor produced by mastitis and lactic acid organisms may be classified as pungent, fermented, turned, acidity, or lactic. As it begins to become more pronounced in milk, it is almost identical to the odor of gluten feed. It may be referred to as charred or caramelized in nature. The recognition of this particular gluten feed odor in milk, coupled with the pungency, fermented, or lactic acidity reaction, is definite proof that milk is very high in bacteria. This description will cover the most common bacterial odors in milk. In cases very often where there is a high contamination of proteolytic bacteria, the reaction to the sense of smell denotes decomposition, a taint. In most cases, this odor is usually combined with lactose fermentation, and will be identical to that of 'gluten feed' as referred to, with that added taint of decomposition.

TABLE I
COMPARISON BETWEEN THE MICROSCOPIC COUNT AND THE RESULTS OF THE ODOR TEST,
STRAINER DIPPER TEST AND METHYLENE BLUE TEST

Showing the number of can samples in the various microscopic classification and the percentage of these samples placed by the odor test in the various odor classifications.

Microscopic Count Classifications	Number of Samples so Classified (Microscopic)		Can samples in the various microscopic classifications found by the various tests to be "Unsatisfactory" and "Satisfactory"											
			Odor Test				Strainer Dipper Test				Methylene Blue Test			
			All "Unsatisfactory" Odors		All "Satisfactory" Odors		All "Flakes" and "Dirt" Findings		All "Satisfactory" Findings		Reduction in 5½ or less hours		Reduction in more than 5½ hours	
			No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
GRADE B CAN SAMPLES														
E=0 to 300,000	377	62.4	104	27.6	273	72.4	190	50.4	187	49.6	17	4.5	360	95.5
S=300,000 to 900,000	129	21.3	60	46.5	69	53.5	67	52.0	62	48.1	30	23.3	99	76.7
U=900,000 to 3,000,000	77	12.7	51	66.2	26	33.7	43	55.8	34	44.1	42	54.6	35	45.4
V=over 3,000,000	21	3.5	18	85.7	3	14.3	17	81.0	4	19.0	11	52.4	10	47.6
Total	604	—	233	38.5	371	61.5	317	52.3	287	47.7	100	16.6	504	83.4
U and V=over 900,000	98	16.2	69	70.4	29	29.6	60	61.2	38	38.8	53	54.1	45	45.9
S, U and V=over 300,000	227	37.5	129	56.8	98	43.2	127	55.9	100	44.1	83	36.6	144	63.4
GRADE A CAN SAMPLES														
E=0 to 300,000	584	95.6	187	32.0	397	68.0	336	57.6	248	42.5	1	0.2	583	99.8
S=300,000 to 900,000	20	3.3	9	45.0	11	55.0	9	45.0	11	55.0	3	15.0	17	85.0
U=900,000 to 3,000,000	4	0.7	2	50.0	2	50.0	1	25.0	3	75.0	0	—	4	100.0
V=over 3,000,000	3	0.5	3	100.0	—	—	1	33.3	2	66.7	2	66.7	1	33.3
Total	611	—	201	32.9	410	67.1	347	56.8	264	43.2	6	1.0	605	99.0
U and V=over 900,000	7	1.1	5	71.4	2	28.6	2	28.6	5	71.4	2	28.6	5	71.4
S, U and V=over 300,000	27	4.4	14	51.8	13	48.1	11	40.7	16	59.3	5	18.5	22	81.5

"Bacteria other than those of the lactic acid group may produce odors of a decomposed nature denoting filth. I mention this since we very often discover odors of this nature which have been caused by some one individual strain of proteolytic bacteria. Such odors are more easily detected than those of lactose fermentation since their reaction to the olfactory nerve is that of decay, rotting, or decomposition, and gives you the impression immediately of filth from unclean utensils of some nature. This, I believe, has been the underlying principle which prompted the layman in the past to refer to such odors as dirty strainer cloth, dish rag, dish water, and dirty milking machine. This nomenclature arose during the days of the cheese factory when the clean lactic flavored milk was desirable for cheese-making, and the decomposed odor milk was very objectionable."

RESULTS OF TESTS

If the bacterial content of milk is to be the sole criterion of sanitary quality, the direct microscopic examination of the milk, of course, gave the best results. However, a number of samples classified as dirty by sediment test, a number having decided "off odors," and a number in which the physical properties of the milk were damaged according to strainer dipper examination, were rated as satisfactory according to the direct microscopic examination.

It is interesting to note here the effect of the payment of premiums for low count milk at Grade A plants. Whereas only 62.4 percent of the 604 samples collected at Grade B plants gave microscopic cell counts classified as "excellent" i. e., less than 300,000, 95.6 percent of the 611 Grade A samples were so classified. At the same time 57.6 percent of these Grade A samples rated excellent by direct microscopic count showed flakes or dirt in the strainer dipper, and only 50.4 percent of the Grade B samples so rated were found to be flaky or dirty by strainer dipper.

Most of us were surprised at the comparative value of the results obtained by

the odor test, and no doubt this is the outstanding feature of the work. About 70 percent of the samples classified as "unsatisfactory" and "very unsatisfactory" by the direct microscopic test were recorded as having unsatisfactory odors. Of this same group of samples, only 61 percent were reported as showing flakes or dirt on the strainer dipper, and only 54 percent reduced methylene blue in five and one-half hours or less.

The results show that the methylene blue test is not entirely satisfactory for detecting high count milk under New York milk shed conditions. The test has the advantage of simplicity, and relatively inexperienced persons can be taught to run it. Like the direct microscopic count, it should be used in conjunction with a test for dirt. It has the disadvantage that considerable equipment is required. An important disadvantage is that the results are not available immediately, thus making it impractical to use the test under New York State conditions as a basis for rejecting unsatisfactory cans of milk.

The results show that the strainer dipper test can best be used as a test for dirt, and not for milk of unsatisfactory bacteria count. It will reveal mastitis flakes, but will not always detect milk from herds in which mastitis is present. This test stood alone in revealing mixed morning's and night's milk by the presence of typical flakes. However, we can not attach any public health significance to the mixing of low count warm and cold milk which the presence of these flakes indicates. Advantages are that little equipment is needed, that men can be readily trained to run the test, the results are immediately available to show to the man who brought the milk, and the cans of unsatisfactory milk can be returned. This ease of application may be a disadvantage in that it encourages the plant employee to attempt to use it beyond its field.

The sediment test necessarily did not get a fair trial in this work due to stirring of the cans before testing as previously explained. It did reveal a few

instances of very fine dirt which the strainer dipper missed. The test as made has the advantage that it can be run as fast as the cans are dumped, and leaves a permanent record in the form of a sediment disc.

CONCLUSIONS

The results of this work show that the odor test is of considerable value, particularly at Grade B plants. Mr. Lee has demonstrated to our satisfaction that there is an odor to milk associated with high bacteria count that may be used as a basis for rejecting milk on the receiving platform. Although the test did not reject as much milk as the direct microscopic technic, it did reject a large part of the high count milk, and did not erroneously reject for bacterial odors any larger proportion of low count milk than the methylene blue test. Furthermore, the test revealed "off odors" other than bacterial which were undesirable from the standpoint of quality. Although quality is not of direct public health significance, it is of decided importance indirectly. If pasteurized milk does not taste right, people, particularly the children who need it most, will not drink as much milk as they would otherwise, and may even turn to relatively unsafe raw milk if that is available and tastes better. It is believed that the test will be fair to the farmer and yet eliminate enough of the high count milk to accomplish material improvements in the supplies. Although this test should also be supplemented by a test for dirt, it is possible for the man who is smelling the milk to observe any dirt that may float on the milk. The test has advantages of requiring no equipment, and of being easily and quickly performed, thus permitting the test to be made and unsatisfactory cans returned to the producer

without delaying operations of the receiving room.

We were inclined to feel that perhaps the odor test required a "superman" or "supernose." Since the completion of this work, thirty-three field men of the New York City Department of Health have been successfully trained to use the odor test.

This work convinced us of the value of the use of the odor test. Our conclusion was to recommend to plant operators the daily use of the odor test on patrons' milk to be checked every month or two by the city inspector. In addition, the plant operator was required to make strainer dipper or sediment tests at least once a month, and to make direct microscopic counts on samples from individual cans taken in groups on different days. These results were to be checked by occasional examinations by the city inspector.

It is not the purpose of this discussion to sell this program, but simply to point out that a number of simple tests of considerable value are available for testing milk on the receiving platform that may be used by plant operators or inspectors with little expenditure for equipment and with little special training. Also, that the money spent in applying these tests and making inspections of farms only when it is found that poor milk is delivered is going to bring quicker returns in improvement of actual quality of the milk than a continual round of farm inspection without platform testing.

Furthermore, the inspector is much more likely to find the farmer in a receptive mood and willing to accept advice when he goes to help find and eliminate the cause of poor quality milk, than when he goes to the farm to try to find flaws that are not always apparent and may not exist.

Ice Cream Sanitation and Hygiene*

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The public health safety of ice cream and related products is rapidly claiming a larger share of the attention of public health officials, and to some extent is entering the consciousness of consumers. Standards of ice cream sanitation and safety, and measures of ice cream quality are being critically scrutinized these days. There have been rumors of attempts to grade ice cream, as milk is now being graded in many communities. Limits for the bacterial content of ice cream are being adopted. Higher criteria for plant arrangement and equipment are being established. Even the materials of which can liners and cartons are made are being studied for bacterial, mold, and yeast contamination.

The bacterial content of ice cream—or frozen desserts, the new term—is a subject about which relatively few of us have until recently concerned ourselves. Some of the larger cities throughout the country have fixed standards, or limits, although they have not always been rigidly enforced. The Alabama State Board of Health regulations at present include no bacterial plate count limits. About eighteen months ago, we undertook a study of the bacterial content of ice cream and mix, with the primary object of comparing counter freezer ice cream and that of regular ice cream plants. The initial results of this study were reported at the meeting of the American Public Health Association in New Orleans, in October 1936. The study has been continued, with numerous interruptions, through 1937, with some very interesting results.

About 560 samples of commercial, counter freezer, and drug store ice cream and sherbet, and mix in various stages of manufacture, storage, and shipment, have been examined since July, 1936. Bacterial plate counts have varied through a wide range—from 900 to 6,500,000 per gram; so that average counts are rather meaningless because they give no indication of the numbers of high or low counts, or the extent of the extremes. Also, some supplies have been examined several times, whereas others have not been examined at all. Therefore, average results would not be representative of the whole supply.

Our results may be separated into a number of categories: (1) ice cream made in counter freezers; (2) ice cream made by commercial manufacturers; and (3) ice cream mix.

In 117 samples of commercial ice cream examined, the plate counts ranged from 1,000 to 1,500,000 colony counts of organisms per gram. The limit fixed in some ice cream ordinances is 100,000 per gram. The figure that is being considered in the U. S. Public Health Service Frozen Desserts Ordinance is 30,000 per gram. Of these 117 plate counts, 77—nearly two-thirds of the total number—contained 100,000 colonies or less per gram; but in only 44 cases—about three-eighths—was the count 30,000 or less per gram. In other words, 73 of the 117 counts, or 62.4 percent, exceeded the proposed limit for Grade A frozen desserts. Four counts were one million or more per gram.

There is considerable encouragement, however, to be found in the fact that there has been quite a general improvement in

*Read at meeting of the Alabama Dairy Products Association, Montgomery, Ala., January 10, 1938.

the counts of successive samples. Among the first samples, 52.8 percent were under 100,000, but this percentage increased to 88.9 percent as successive sets were taken. Only 36.4 percent of the counts of samples taken directly from the freezer ran less than 100,000 per gram; 69.0 percent on 68 samples taken from plant storage, in packages and bulk, were 100,000 or less per gram; and 57.7 percent at retail outlets were under this limit. These counts were not taken on the same batches, so that the conclusion that counts are reduced in storage is not necessarily justified by these particular figures.

Fifty-nine samples of packaged ice cream were sampled—47 from plant storage and 12 from retail distributors. The percentage of counts under 100,000 per gram, and the average counts of the samples taken at soda fountains were better than those on the samples taken from plant storage. Four counts of one million or over per gram occurred in samples of package ice cream taken from plant storage.

In the case of bulk ice cream, 61.8 percent of the 21 samples taken from plant storage yielded counts under 100,000 per gram, while only 42.8 percent of the counts of samples taken from bulk at soda fountains were under this limit. Contamination of the ice cream remaining in the can from dippers may have been a factor in the counts of these samples.

Some comparative figures on Alabama-made commercial ice cream and counter freezer ice cream are of interest. These are given in Table 1.

Although it appears from these figures that counter freezer ice cream made in this state falls far short of the standard—barely one-half of the samples being under the limit of 100,000 per gram, and 15 percent having counts exceeding one million per gram, the picture is not nearly so dark when we analyze these counts on the basis of consecutive samples, or samples taken in 1936 and 1937. In a practically equal number of samples in 1936 and 1937, the percentage of counts under 100,000 per gram were 42.3 percent and 61.6 percent respectively. Twenty of the 1936 counts were over one million, and there were only 6 such high counts in 1937.

With regard to ice cream mix, samples have been obtained in all stages of manufacture and storage at the place of manufacture, before and after transportation over long distances, after transfer from shippers' containers to those of the freezer, and just prior to placing in the freezer. If we classify the samples as (a) those of Alabama origin, and (b) those of origin in other states, we find that Alabama products are, in general, of better bacterial quality than those of out-of-state manufacturers when they arrive in this state. Of course, transportation exigencies no doubt played a major part in this situation. However, whatever the cause, in 102 samples of Alabama-made mix, 43.1 percent of the counts were 30,000 or less per gram, as compared with 40.7 percent of 118 counts of out-of-state mix; 66.6 percent of Alabama mix counts were 100,000 or less, as compared with 52.6 per-

TABLE 1.

Comparison of Commercial and Counter Freezer Ice Cream

	No. of Samples	Arithmetic Avg. Bact. Count	Logarithmic Avg. Bact. Count	% of Counts Under 30,000	% of Counts 100,000 or less	% of Counts 500,000 or over	% of Counts 1,000,000 or over
Commercial Ice Cream.....	117	154,400	52,000	37.6	65.8	7.8	3.4
Counter Freezer Ice Cream	171	540,200	92,000	32.2	52.1	21.0	15.2

cent of out-of-state mix. The difference is not so apparent until we compare the counts in the higher ranges. In Alabama mix, 14.7 percent of the counts exceeded 500,000 per gram; in other mix, this percentage was 27.1, or nearly twice as large. There were 9.8 percent of Alabama mix counts which exceeded one million per gram whereas 18.6 percent of the counts of other mix were in this range.

We have compared the average bacterial quality of the mix of certain manufacturers with the average bacterial quality of the ice cream made from that mix. These findings are listed in Table 2.

In this study we have included only plants which sell mix to counter freezer operators because the number of samples from the mix and ice cream of numerous other manufacturers are too small to justify the drawing of conclusions.

Most ordinances provide that mix shall be kept at a temperature of 50° F. or less. Briefly, 63.2 percent of the temperature readings of mix at the plant where made, at the place of freezing, and in transit were 50° F. or less, 36.8 percent exceeded this figure, and 4 readings (or 3.5 percent) were over 60° F. The temperatures of mix in plant storage, as well as that in the possession of the freezers—that is, in the cans in which it was received or in 5-quart cans to which it had been transferred—were at 50° F. or less in 80 and 75 percent respectively of the cases. However, out of 23 samples taken in transit or

immediately upon arrival, only 26.1 percent were at 50° F. or less, 60.9 percent were between 51° and 60°, 8.7 percent were between 61° and 70°, and 1 was above 70°. This very general rise in temperature of ice cream mix in transit is an important gap or breach in the defense against bacterial multiplication and high counts in the frozen ice cream.

With regard to the contamination of the material of which cartons and canliners are fabricated, it has been reported that some of the stock is made of collected waste, such as rags, and that it is heavily contaminated with foreign material, and even with spores of organisms which were not destroyed in the manufacturing process. These might revert to the vegetative stage and contaminate the ice cream, under certain conditions. All users of this type of material should assure themselves that these products are made of stock from virgin wood pulp and fabricated under sanitary conditions.

Every ice cream freezing plant in Alabama is now required to obtain a permit from the health officer. The primary object of this provision has been the control of the installation of counter freezers, so that the health departments would be informed of such installations, and could take steps to obtain compliance with the regulations before installation is made. Prospective counter freezer operators will also have to obtain permits before they start freezing.

TABLE 2

Relationship of Mix and Ice Cream Bacterial Counts

Plant	No. of Counts	MIX			No. of Counts	ICE CREAM		
		Under 30,000 %	Under 100,000 %	Over 1,000,000 %		Under 30,000 %	Over 100,000 %	Over 1,000,000 %
A	5	60.0	80.0	0.0	9	55.6	88.9	0.0
B	8	62.5	75.0	0.0	14	57.2	78.6	0.0
C	6	83.3	83.3	0.0	11	54.5	72.7	9.1
D	8	75.0	82.5	0.0	16	56.3	75.0	12.5
E	9	55.6	100.0	0.0	9	44.6	66.6	11.1
F	13	46.2	76.9	7.7	7	28.6	42.9	0.0
G	16	25.0	56.3	12.5	24	29.2	58.4	16.7
H	70	29.1	43.0	27.8	81	21.0	37.3	21.0

The Microscope in the Production of High Quality Milk*

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The direct microscopic examination of milk as developed by Breed (1) was a most noteworthy achievement with respect to the rapid checking of milk for its bacterial content. Lazarus (2) suggests further application of the microscope in the examination of raw milk.

This study was undertaken to determine the original source of the bacteria found in poor quality, high count raw milk, and utilizing this information to suggest the probable source of contamination to the dairyman in order that he may correct or improve his procedure of milk production. Furthermore, the results of the microscopic examination are compared with those of other quality tests; these include both platform and laboratory quality tests.

METHODS

The original source of bacteria was determined by going to dairy farms and obtaining specimens from the various sources that might contribute contamination including the utensils and other equipment, and checking for the types of bacteria present.

Each month for one year a (producer composite) sample of milk was collected at the receiving dairy from each of the approximately 1000 producers in the Lansing milk shed. All milk from one patron for one day was dumped into the weighing vat, and a sufficient sample was removed for making a direct microscopic examination and the methylene blue reduction test. The dipper used in obtaining the samples was rinsed in warm running water between samples. This was sufficient to prevent any carrying over of

the bacteria to the following sample. Sediment tests were made once a month of at least one can of a producer's milk. A tube sediment tester was used to obtain the one pint of milk for test from the bottom of the can.

A minor deviation from Breed's original technic was made in the manner of preparing smears for microscopic examination. A platinum loop of four millimeters outside diameter was used to transfer a uniform amount of milk to a microscopic slide, over an area of 4 by 8 millimeters. This amount of milk per microscopic field was identical with that in smears prepared according to Breed's technic. This system makes it possible to place the smears of 20 patrons' milk on each microscopic slide, and is valuable in increasing the speed of making slides and decreasing the time required to clean the equipment necessary to make slides.

RESULTS AND DISCUSSION

1. *The direct microscopic examination of raw milk.* The forms of bacteria found in high count raw milk were recorded. Rod and coccus forms of bacteria were frequently present; in addition, yeast cells and mold spores or mycelium were infrequently found. The original source of the above microorganisms was determined by checking specimens from various sources that might contribute contamination to the milk. The accuracy of these findings was further checked by farm inspection in those cases where large numbers of a specific type of microbe were found in the milk produced on such farms. The types of microorganisms and sources of excess contamination

*Journal article No. 327 N. S. from the Michigan Agricultural Experiment Station.

which they indicate are given in Table I. The small pictures present individual microbes or a small group of similar microbes. It is significant to note that in practically each case two forms of microbes have their origin in the same place, and thereby serve as a double check on the suspected source of contamination. The microscopic examination also makes it possible to determine the number of cells in the milk. This information indicates a number of things about the producing cows of the herd such as being near the beginning or end of the lactation period, or the udder being injured by either traumatic or infectious agents. The source of contamination as indicated by the microscopic examination of the high count (patrons') milk was confirmed upon farm inspection. The suspected trouble was indicated only in those cases where the bacteria count exceeded 100,000 per cubic centimeter of milk. The counts reported in this paper are clump counts in which clumps or individuals are counted as one. A number of representative fields of poor quality high count milk are shown, together with a short description of each. The samples were encountered in making routine microscopic examinations of raw milk as it arrived at the receiving plant.

2. *A patron quality report sheet.* The milk of each producer in the Lansing milk shed was subjected to a number of quality tests each month. Some of these tests were the methylene blue reduction test which resulted in a keeping quality score, the sediment test, and bacteria count (microscopic). These results were given certain values. The sediment standards used in classifying the amount of visible dirt in milk are indicated in Figure I. Temperature readings were also taken except during the winter months; this information was utilized in arriving at each patron's monthly score. The values assigned to each class of all tests were selected so as to encourage the production of a clean high quality milk, and to discourage the production of a dirty milk of very low quality. The essentials

in high quality milk production are listed in the score sheet in Table II, on page 31. In addition, if the milk is of poor quality, the suspected source of trouble is checked for the patron's information.

3. *A comparison of the microscopic count with the results of other tests of milk.* The microscopic count of low count milk is inaccurate, and indicates only that the milk has a very low bacteria count. The accuracy increases as the count of the milk increases. The bacteria counts are divided into four classes. The results of microscopic counts are compared with the results of other quality tests. The results obtained in this comparative study are presented in Table III.

The number of patrons during the six months period of study varied from the maximum of 996 in April to the minimum of 916 in September. These are normal variations to be expected in any milk shed. The patrons for each month are grouped in classes according to the number of bacteria present in the milk, and these in turn are classified on the basis of methylene blue test rating, sediment rating, suspected trouble, temperature, and score.

The majority of the samples with a count of less than 100,000 bacteria per c. c. were of class 1 methylene blue, and class 1, 2, or 3 of the sediment test. In this count range, no suspected trouble is indicated except cells and mastitis streptococci as noted; the scarcity of bacteria does not permit indicating any suspected source of excess contamination. During the cooler month of April, 798 of the 996 patrons produced a class 1 (bacteria count) milk; this number decreased steadily until the hot month of July, and then again increased somewhat during August and September. The temperature of the milk as it arrived at the plant, for the most part, was below 65° F., and during the cooler months when nature aided in cooling and keeping milk cold, it was below 60° F. The fact that the cooled milk continuously rated a passing score clearly indicates the value of prompt, efficient cooling in the production of a low count milk.

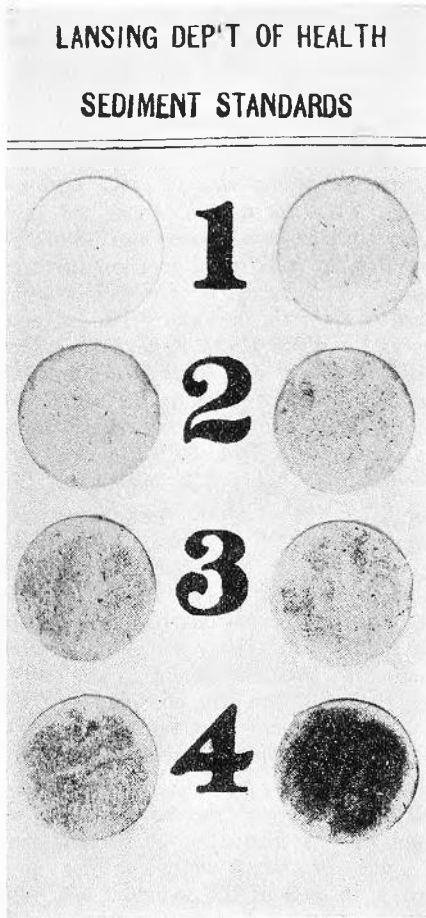
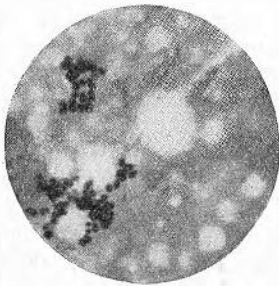


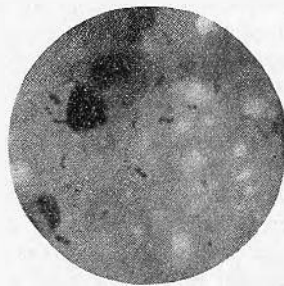
FIGURE 1.
Sediment Standards



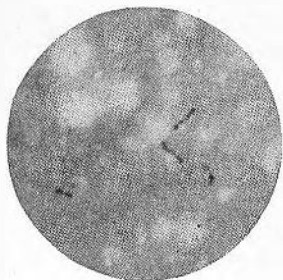
Cocci in singles or clumps indicate the source of contamination to be *utensils-scum*. The cocci accumulate in dented utensils, open seams etc., as a scum. 1500 x

In considering the score of the milk in class I (bacteria count), it is necessary to bear in mind that the total number of patrons producing such milk decreased during the warm summer months; those continuing to produce this milk usually rated a passing score of 75 points or more. The excess amount of sediment was responsible, in most cases, where the milk with less than 100,000 bacteria per cubic centimeter did not rate a passing score. These data demonstrate the value of measuring the visible sediment of milk which may sometimes be comparatively free of bacteria, in addition to determining the number of bacteria present.

The milk samples in class II, on the basis of the number of bacteria present (100,000 to 500,000 bacteria per cubic centimeter), were found to be mainly in class 2 methylene blue test, with a very few in classes 1, 3, and 4. The number of these samples in classes III and IV varied directly with the number of patrons whose milk arrived at the plant with a temperature above 65° F. The high temperature may account for placing this milk in class II of the bacteria test, rather than in class I, because multiplication of the bacteria raises the count above 100,000 per cubic centimeter of milk. The microscopic appearance of the milk in this class indicates that poor cooling is essen-

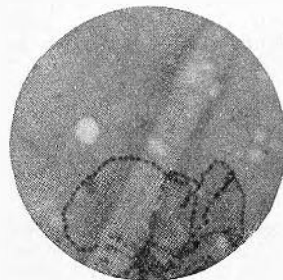
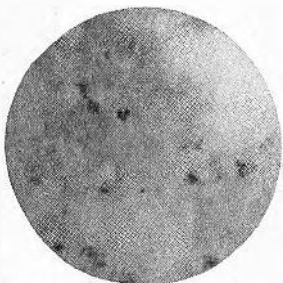


The microscopic appearance of milk exposed to excess contamination from *dirty cows or barn* (rod bacteria) and *dirty utensils* (short-paired rods). In addition an increased number of *cells* are present in this milk. 1500 x



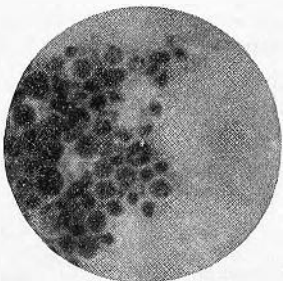
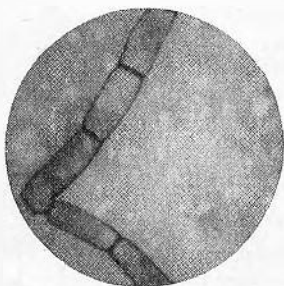
The normal milk souring bacteria are desirable in the milk unless they are present in large numbers. Their action of souring milk should be delayed by proper cooling, thereby increasing the keeping quality of milk. *Streptococcus lactis* in large numbers indicates poor cooling. 1500 x

Rod forms of bacteria, other than short-paired rods, indicate excess contamination from *dirty cows or barn*. In some cases spores may be observed. These bacteria originate in the soil, dust, manure, and dirt that drops in from the flank or air. Wet-milking also affords a means of their getting into the milk. 1500 x



Cocci in tetrad arrangement indicate contamination from *dirty cows or barn*. These bacteria therefore indicate that the technic of milking and care of cows in the barn are at fault; thus permitting them to gain entrance to the milk. 1500 x

The presence of long chain streptococci in milk indicates *streptococcal mastitis* infection among the lactating cows of the herd. 1500 x

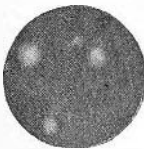

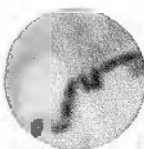

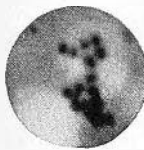

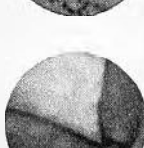

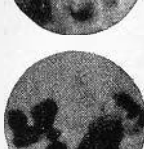



Mold mycelium or spores in milk indicate *dust* contamination. Dust in the barn (with the dust getting into the milk) is the potent source of mold mycelium or spores. 1500 x

When milk utensils are exposed to *dust contamination in the milk-house*, yeast cells are usually present. The yeast cells find suitable lodgment in unclean milking machine tubes. 1500 x

TABLE 1.
The Direct Microscopic Examination of Milk

The Microscopic appearance of high grade low count milk

	<i>Shape and Type of Organism</i>	<i>Probable Cause</i>	
Rods	Short paired (scattered, clumps or in chains)	Utensils—wet unclean surfaces especially milking machines	
	Short thick Long thick (scattered, clumps or in chains) Long thin Short thin	<i>Dirty cows or barn manure, dust, dirt, wet milking, flanks</i>	
	Very high counts (with high temperature)	} <i>Poor Cooling</i>	
	Short chains (2-5 elements <i>Strep. lactis</i>)		
Cocci	Clumps or singles (Staphylococci)	Utensils — scum accu- mulations in crevices or open seams	
	Tetrads (group of 4) (scattered or clumps)	<i>Dirty cows or barn</i>	
	Streptococci (more than 6 elements)	<i>Strep. mastitis</i>	
	Various types scattered throughout (insanitary in every respect)	<i>Poor Production</i>	
Mold	(spores or mycelium)	<i>Dust — in barn or milkhouse</i>	
Yeast	(especially milking machines kept in dusty atmosphere)	<i>Utensils—dust</i>	
Cells	/ Polymorphonuclear Lymphocyte Epithelial	<i>One of the following:</i>	
		<ol style="list-style-type: none"> 1. Milk used too soon after freshening 2. Milk used too long at end of lactation period 3. Injury to udder (traumatic) 4. Streptococcal mastitis—if streptococci are found in unincubated or incubated milk samples. 	

tially responsible for the high count; the initial contamination is contributed by dirty utensils and dirty cows or barn. The major portion of this milk is fairly clean or class 2 of the sediment test. Approximately 50 percent of this milk received a passing score of 75 or more points, with the remaining 50 percent receiving a score below passing. These results again demonstrate the value of measuring the invisible dirt (bacterial content) present in milk as well as examining the milk for visible dirt (sediment test) to determine the quality of milk.

The number of patrons producing milk with a bacteria count of from 500,000 to 1,000,000 per cubic centimeter (class III)

is very small as compared to the total number of patrons producing milk in the milk shed. The methylene blue test rating of this milk is mainly class 3 with fewer in class 2 and very few in classes 1 and 4. Considering the number of patrons producing class III bacteria count milk, the major difficulty in production as indicated by the microscope and farm inspection is poor production, indicating that a thorough cleanup is in order. Poor cooling, dirty utensils, and dirty cows or barn are about equally responsible for the excess contamination of the milk. Approximately 75 percent of the patrons' milk arrived at the plant at a temperature of 65° F. or more. Proper cooling and

TABLE II.
A Patron Quality Report Sheet

Dairy

Quality Report for Patron Month.....19.....

Date	Sediment Score	Date	Microscopic test—Bacteria
	Clean 20		Good (less than 100,000 per cc) 40
	Fairly clean 15		Fair (100,000 to 500,000) 35
	Dirty —5		Poor (500,000 to 1,000,00) 15
	Very dirty —10		Unsatisfactory (over 1,000,000) 0

Date	Keeping Quality Score		
	Good 40	Perfect score	100
	Fair 35	Passing score	75
	Poor 15	Your score	—
	Unsatisfactory 0		

Essentials in high quality milk production:

1. Healthy cows.
2. Clean cows—clip udder and flanks.
3. Clean barns.
4. Do not strain dirt out. *Keep it out.*
5. Milk with clean dry hands.
6. Wash utensils after use and sterilize just before using.
7. Cool milk immediately below 60° F. and hold at that temperature. (*Do not guess—use a thermometer.*)

The temperature of your milk as it arrived at the plant was.....° F.

- 60°—65° F. —2
- Above 65° F. —5

Examining your milk of low score under the microscope we believe the trouble to be:

1. Utensils not properly cleaned and sterilized.
2. Poor cooling—lack of prompt efficient cooling.
3. Dirty cows or barn—with dirt getting into milk.
4. Dirt—in barn or milkhouse.
5. Poor production—insanitary in every respect.
6. Udder infection.
7. Cells—one of the following:
 - (a) Milk used too soon after freshening.
 - (b) Milk used too long at the end of lactation period.
 - (c) Injured udder.

TABLE III.

A comparison of the bacteria count (microscopic) with the results of other quality tests of milk; together with score of the milk and suspected trouble in the case of poor quality milk. The figures refer to the number of patrons.

Bacteria count	Meth. Blue				Sediment				Suspected trouble							Temperature			Score		Class Total	Month	Total Patrons
	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	< 60°	60° 65°	> 65°	< 75	> 75			
Class I	740	56	2	0	251	380	127	40	0	0	0	0	0	1	24	665	123	10	54	744	798	April	996
Less than 100,000	496	79	1	0	116	341	89	30	0	0	0	0	0	0	7	693	96	9	47	572	576	May	957
	164	58	2	0	49	138	32	5	0	0	0	0	0	0	43	147	69	8	30	224	224	June	974
	105	27	0	0	22	74	29	6	0	0	0	0	0	0	40	28	99	4	33	98	131	July	927
	121	28	1	0	18	88	26	18	0	0	0	0	0	0	50	10	111	29	59	91	150	August	984
	219	52	1	0	24	108	92	48	0	0	0	0	0	1	12	48	168	56	127	147	272	September	916
Class II	13	90	14	3	26	75	16	3	73	28	21	2	3	0	0	87	13	20	37	83	120	April	
100,000 to 500,000	28	134	22	0	30	118	33	3	118	39	33	0	30	0	7	32	44	108	66	118	184	May	
	17	306	75	6	65	255	57	17	264	193	77	3	14	0	34	61	185	149	173	216	394	June	
	16	263	54	21	39	183	84	48	183	100	155	4	29	2	35	59	217	78	159	195	354	July	
	60	301	62	19	51	247	76	68	237	393	142	0	4	0	37	4	264	174	229	213	442	August	
	41	386	78	1	41	197	178	80	225	302	190	0	1	12	42	25	303	168	295	201	496	September	
Class III	3	12	14	0	7	17	3	1	21	9	2	0	6	0	0	18	8	3	28	1	29	April	
500,000 to 1,000,000	0	20	47	1	13	41	7	7	45	23	6	0	24	0	20	19	21	28	68	0	68	May	
	0	27	96	3	18	80	14	11	73	80	40	0	31	0	14	8	39	89	121	5	126	June	
	2	40	74	29	12	67	31	35	67	52	45	2	35	0	14	8	73	64	145	0	145	July	
	0	32	49	87	23	80	20	45	34	57	31	0	13	0	5	31	46	91	168	0	168	August	
	0	23	35	1	5	14	23	17	28	42	34	0	12	0	2	2	24	33	59	0	59	September	
Class IV	1	4	20	24	10	25	14	0	17	22	4	0	23	0	0	10	13	26	49	0	49	April	
More than 1,000,000	1	12	35	72	6	70	37	16	23	22	6	0	95	0	1	12	17	100	129	0	129	May	
	0	12	64	163	38	120	55	26	87	190	39	0	145	0	6	4	66	160	239	0	239	June	
	0	22	99	175	20	115	84	78	50	200	50	4	200	0	24	3	107	187	297	0	297	July	
	0	3	87	134	26	102	50	46	35	228	30	0	200	0	21	3	87	134	224	0	224	August	
	0	12	45	53	11	39	39	28	34	108	30	0	76	13	9	2	29	89	120	0	120	September	

maintenance of the low temperature, together with care in production, are essential for the production of a low bacteria count milk. This milk was equally distributed between classes 1, 2, 3, and 4 in the sediment test. These results indicate that there is no definite relationship between the amount of visible dirt in milk and the number of bacteria in the milk. Only 6 of the 589 patrons whose milk contained between 500,000 to 1,000,000 bacteria per cubic centimeter during the six months period received a passing score.

The patrons who produced milk with a count of more than 1,000,000 bacteria per cubic centimeter (class IV) were disappointed because none of their milk rated a passing score of 75 or more. The major portion of this milk was of class 4 methylene blue test, with some in class 3 and very little in classes 2 and 1. The bacteria count and methylene blue rating did not give any indication as to the amount of visible dirt in the milk, since this milk was about equally distributed among the four classes of the sediment test. The morphological types of bacteria present in this milk indicated that poor production practices were being followed on the respective dairy farms. Only a few of these producers cooled their milk sufficiently low to maintain a temperature of 60° F. or less. The majority of the milk of this class had a temperature above 65° F. when received at the plant, and the temperature of the remaining milk was between 60° and 65° F.

A similar study was carried out independently on the milk of patrons of Castanea Dairies in New Jersey. The results obtained confirm the data herein reported.

The score card of Table II has been in constant use for more than one year in the Lansing milk shed; the data of a six months period are tabulated in Table III. The writers have eliminated the methylene blue reduction test from their routine procedure of determining the quality of raw milk and have adopted the score card of Table IV. The milk is classified into one of nine classes on the basis of bacteria count. The sediment group-

ing is unchanged from the previous score card. This procedure of checking on raw milk as indicated on the simplified score card of Table IV does not significantly increase or decrease the score of any of the milk as compared with the previous score, makes possible the testing of more samples in a given period of time, and gives the same information concerning each milk checked. This patron quality report has the essentials in high quality milk production listed on the reverse side.

SUMMARY

A key based upon the morphology of microorganisms is presented to aid in determining the suspected source of trouble in the case of poor quality high count milk.

The results of the methylene blue reduction test, sediment test, direct microscopic count, and temperature readings of the milk as it arrives at the plant are utilized in arriving at a score on a patron quality report.

The majority of raw milk samples having a count of less than 100,000 bacteria per c. c. (class I) are of class 1 methylene blue and classes 1, 2, and 3 of the sediment test. Practically all of this milk arrived at the plant at a temperature of 60° F. or less and with a passing score, while during the warmer summer months the temperature was higher and the number of milk samples with a score below passing increased.

The samples in class II of the microscopic examination (100,000 to 500,000 bacteria per c. c.) were in class 2 and some in class 3 of the methylene blue test, and in classes 2 and 3 of the sediment test. Dirty utensils, poor cooling, and dirty cows or barn were the major sources of contamination in this group. The number of samples having a temperature greater than 65° F. also increased. Approximately 50 percent of this milk had a passing score, whereas the remaining milk was below passing. It is evident that the bulk of the milk sent to Lansing over a six months period was of class I and II on the basis of the bacteria count.

TABLE IV.
LANSING DEPARTMENT OF HEALTH
BUREAU OF SANITATION AND FOOD

DAIRY.....DATE.....PATRON NO.....

Microscopic Bacteria count			Visible dirt Sediment test	
Less than	25,000 per C.C.	80	Clean	20
25 T. to	50,000 " "	75	Fairly clean	15
50 T. to	100,000 " "	70
100 T. to	250,000 " "	65	Dirty	-5
250 T. to	500,000 " "	60	Very dirty	-10
.....			
500 T. to	750,000 " "	50	Temperature	
750 T. to	1,000,000 " "	30	60° to 65° F.	-5
1 to	5,000,000 " "	0	Above 65° F.	-10
Over	5,000,000 " "	-20	The temperature of your milk as it arrived at the plant was.....° F. This should never be above 60° F.	
Examining your milk of low score under the microscope we believe the trouble to be:			Your bacteria and sediment score should always be above the dotted line.	
1. Utensils not properly cleaned and sterilized.			Perfect score	100
2. Poor cooling—lack of prompt efficient cooling.			Passing score	75
3. Dirty cows or barn—with dirt getting into milk.			Your score
4. Dust—in barn or milkhouse.			Signed	
5. Poor production—insanitary in every respect.			The purpose of this score card is to aid you in producing a milk of high quality. If your milk score is low, a suspected source of trouble is indicated for your benefit.	
6. Udder infection.				
7. Cells—one of the following:				
(a) milk used too soon after freshening.				
(b) milk used too long at end of lactation period.				
(c) injured udder.				

When the bacteria count was in class III (500,000 to 1,000,000), the methylene blue rating dropped to classes 2, 3, and 4, with the greatest portion of the milk showing a larger amount of visible dirt as indicated by the sediment test. In addition to individual cases where poor cooling, utensils, dirty cows, or barn were the chief sources of contamination, the types of microbes found in many samples would indicate the necessity of a thorough cleanup of all phases of milk production, and is indicated on the score card as poor production. The temperature of this milk was high, and practically none of this milk rated a passing score.

The milk with a count of more than 1,000,000 per c. c. (class IV) was mainly of classes 3 and 4 methylene blue, and 2, 3 and 4 sediment test. The types of contamination responsible for this high count milk were similar to those of class 3 (microscopic count). The temperature of most of this milk as it arrived at the receiving plant was over 65° F. and none rated a passing score.

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Improvements in the Rapid Phosphatase Test For Detection of Improper Pasteurization of Milk and Its Products*.

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Since publication of our first report on the rapid phosphatase** pasteurization test (1), improvements have been made conducive to greater sensitivity and to extending its application to the analysis of butter, cheese and ice cream. In response to many requests, some of these developments are presented herewith briefly.

Early in our investigations, it was noted that the disodium phenylphosphate available commercially varied widely in pH (3.8 to 9.9), usually showed excessive amounts of free phenol, frequently contained as much as 44 percent of Na_2HPO_4 , and was unstable—all of which to some extent interfered with duplication by others of the reported results. Recently we succeeded in having prepared commercially a stable ester carefully controlled as to pH, practically phenol free (requiring no purification for the test), and containing an almost negligible amount of Na_2HPO_4 . This ester is of such purity that a 50 percent reduction in the concentration of the substrate is feasible.

(Editor: This special grade of disodium phenylphosphate is available under the name "Phenfree".)

Preparation of the BQC reagent (2,6 dibromo-quinone-chloroimide) has been improved, resulting in a compound of special purity which reacts more quickly and gives better results. Stability of a solution of this compound is increased if stored in a brown glass bottle.

The catalytic effect of magnesium has been investigated (2), resulting in a further gain in hydrolysis of the substrate per unit of enzyme. This, together with

other improvements discussed infra, yield an accuracy on the 10 minute field test comparable to that of the one hour laboratory test (1) or the 24 hour Kay-Graham technic (3).

Improvements in the reagents are reflected in the preparation of some of the tablets marketed for use with the test. The stability is constantly being improved, and in the very near future, tablets should be available which are completely stable. At present, the substrate tablets may develop small amounts of phenol on exposure to heat, sunlight, or moisture; accordingly they should be stored under refrigeration until needed. The substrate solution, whether prepared from the reagents or from the tablets, is less stable than the tablets, and therefore, unless prepared shortly before use, should be refrigerated or preserved by the addition of a few drops of chloroform or toluene.

Space limitation inhibits presentation of improvements in the 1 hour laboratory test. However, turbidity in the filtrate can be cleared up by the addition of a few drops of $M/5 \text{ Na}_4\text{P}_2\text{O}_7$ solution.

At the conclusion of this article, the improved rapid field test is detailed. The preparation of permanent color standards for use with the improved field test is given below:

Red Color Solution

Dissolve 5.959 grams $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ and dilute to 100 ml. 1% HCl W/V

Blue Color Solution

Dissolve 6.243 grams $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and dilute to 100 ml. 1% HCl W/V

Yellow Color Solution

Dissolve 4.505 grams $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ and dilute to 100 ml. 1% HCl W/V

*Publication authorized by Dr. John L. Rice, Commissioner of Health, New York, N. Y.

**The term phosphatase as used in this article refers to the alkaline phosphomonoesterase found in milk with an optimum activity at a pH of about 9.6.

Mix the quantities indicated as follows, and dilute to 5 ml. with distilled water:

	Red	Blue	Yellow
Two units	0.4 ml.	1.5 ml.	0.5 ml.
Five units	0.2 ml.	2.2 ml.	0.5 ml.

No color is obtained from milk processed correctly at 143° F. for 30 minutes. Two units represents the addition of 0.2 percent raw milk, or equivalent deficiency in temperature or shortage in holding time. Five units represents the addition of 0.5 percent raw milk or equivalent. Two units also represents the average value obtained from milk commercially pasteurized at 142° F. for 30 minutes. Generally speaking, these color standards represent minimum values. Additional indophenol may be obtained because of variation in the enzyme content of raw milk. If the BQC solution be partially decomposed, reddish blue values may be obtained, and the suggestion is made that for exact work, fresh solutions not over 12 hours old be used.

MILK

In order to become familiar with the method, one should make tests on a thoroughly pasteurized milk (or a boiled milk), and the same milk containing 0.1, 0.2, 0.5, and 1.0 percent added raw milk. Experience has enabled many users to detect the appearance of blue color represented by the addition of as little as 0.1 percent raw milk, even without the butyl alcohol extraction. In extracting the indophenol, the test tubes should be inverted SLOWLY, with time allowed for the bubbles to break before again inverting. This procedure effects a sharp separation of the alcohol layer. The normal butyl alcohol utilized should be neutral or slightly alkaline to Brom thymol blue, by the addition of NaOH solution.

Even minor errors in pasteurization technic or faulty equipment can be revealed by proper use of the test.

CREAM

Cream gives a whiter background than milk. This makes the indophenol more readily detected, and usually precludes the need for the extraction technic. If the butyl alcohol extraction be resorted to, it is usually sufficient to invert the test tube 4 or 5 times. Further inversion may extract the fat, adding yellow and green colors to the alcohol layer. Cream high in carotene may yield these off colors.

ICE CREAM

The mix should be treated as a cream, and presents no additional difficulty. In ice cream, flavorings such as vanilla powder, vanillin, and coumarin, if present in sufficient quantity, react with the BQC reagent to give misleading results. A duplicate analysis with the substitution of buffered water for the buffered substrate will indicate the extent of the indophenol color due to residual phenols or other interfering substances. By subtraction, the amount of enzyme activity may be evaluated.

Colored ice creams are best analyzed by the laboratory method because of the solubility of the coloring agents in the butyl alcohol. Fresh fruits or unroasted nut meats may introduce the enzyme.

BUTTER

Butter made from pasteurized cream may be differentiated from that made with the raw or improperly pasteurized product by introducing into the substrate a sample portion of butter the size of a pea. The mixture should be shaken occasionally while incubating to disperse the fat globules. If the extraction technic be resorted to, invert about 5 times. More uniform results are obtained if the butter be allowed to melt at a temperature not over 40° C. and a 1/2 ml. portion of sample used.

Butter made from cream pasteurized at 141° F. for 30 minutes, or from correctly pasteurized cream to which raw cream

is added, can readily be detected by the development of the characteristic indophenol blue. Storage conditions have little if any effect on the enzyme activity.

CHEESE

Phosphatase activity can be found in undiminished strength in cheese made from raw milk, even after 18 months of storage, but is absent in cheese made from milk correctly pasteurized by the holding process or the short time-high temperature method. Sub-standard temperature treatment or sub-standard holding intervals in the processing of milk give positive phosphatase findings in the resulting cheese. Aging under storage conditions or prolonged ripening at room temperatures apparently do not affect the phosphatase values.

Usually, in making the test, a small portion of the cheese sample may be added directly to the buffered substrate as in the case of butter. Better results are obtained, especially with cheese having a high acidity, by grinding 5 grams of the cheese with 5 ml. of water and 5 ml. of the buffer, and then adding a 1/2 ml. portion to the buffered substrate.

The results of our investigations of the past year on butter, cheese, ice cream, and other products will be elaborated in a forthcoming article.

Sanitarians frequently overlook the fact that to properly interpret holding time of multiple unit pasteurizers as shown by the

recording charts, they should know the rate of pre-heating, the time consumed in filling and emptying the holding tanks, the amount of milk in the holding tank, and the location of the thermometer bulbs. Commercial pasteurization, if efficiently conducted, should result in "over-pasteurization" through the additive holding incurred by flow rate requirements. Improper relative pressure in regenerators (4) is a possible source of introduction of raw milk; and should not be ignored.

Reports indicate that wherever this test has been regularly employed, there has been a marked improvement in the efficiency of pasteurization. Operators, encouraged to use the test because of its simplicity, are voluntarily reducing or eliminating the hazards arising from equipment factors or faulty practices. The advantages of a quick method requiring no elaborate apparatus are self evident, and should prove valuable to milk sanitarians, public health officials, and plant control laboratories.

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The Improved Rapid Field Test for Efficiency of Pasteurization

The buffered substrate (white) tablet contains the phenyl phosphoric ester, magnesium to catalyze the enzyme reaction and adequate buffer to make 50 cc. of the buffered substrate solution—sufficient for ten tests. The BQC (yellow) tablet contains 2.6 dibromoquinone-chloroimide and a stabilizer—sufficient for 30 or more tests. These tablets should be kept under refrigeration if possible.

The buffered substrate tablets available commercially may develop varying amounts of phenol under certain conditions of storage such as exposure to light or heat. Since the extraction technique is extremely sensitive, it is necessary to work with a phenol-free substrate; therefore the following procedure is utilized to

remove any phenol and is recommended in all cases:

Crush buffered substrate tablet in test tube, dissolve in 5 ml. of distilled water. Add 2 drops of BQC solution. Allow five minutes for color development, then extract the indophenol with 2-2.5 ml. of normal butyl alcohol. Allow to stand until alcohol layer has separated at top of tube. Remove alcohol layer with medicine dropper and discard. Dilute remainder of solution to 50 ml. This solution is then phenol free. Dissolve the BQC tablet in 5 ml. of 95% ethyl or methyl alcohol. **DO NOT USE A DENATURED ALCOHOL.** Transfer to dropping bottle delivering 50 drops per ml.

METHOD

Add $\frac{1}{2}$ ml. of sample to 5 ml. of buffered substrate. Shake briefly. Incubate for 10 minutes in a water bath at 98° F. (If no water bath be available, incubate in pocket for somewhat longer period). Remove from bath, add 6 drops of BQC solution. Shake well immediately. After five minutes compare color with opaque standards.

Properly pasteurized milk will be a gray or brown.

Properly pasteurized cream will be a gray or white. Raw milk or cream will be an intense blue. The appearance of any blue is indicative of improper pasteurization; the degree of intensity of color being proportional to the seriousness of the condition.

After development of color as above, add 2 ml. of normal butyl alcohol (neutral). Invert the test tube SLOWLY at least ten times and allow to stand. Rapid inversion will result in an emulsion being formed but if correctly performed, the alcohol will separate clearly and will have extracted the indophenol formed by the test.

The appearance of any blue or blue green in this alcohol layer is indicative of improper pasteurization. In the absence of a properly pasteurized milk to be used as a control, a boiled milk may be substituted.

This test has been standardized with milk pasteurized—under laboratory conditions satisfying legal requirements—namely, a preheating period of one to five minutes, and a holding

period of exactly 30 minutes at 143° F. Under commercial conditions varying time of preheating and filling and emptying of tanks should be taken into consideration. Even under extreme over-lapping conditions, the appearance of any blue is indicative of improper pasteurization.

Inorganic standards have been prepared presenting the maximum color value permissible for pasteurization at 142° F. for 30 minutes.

CAUTION

All equipment should be thoroughly washed and rinsed before reuse. Avoid the use of phenolic resin bottle closures anywhere in the test. The BQC reagent is sufficiently sensitive to demonstrate the leaching of phenol from the resin by water.

Both solutions decompose with age and should be stored under refrigeration or prepared shortly before use.

A reagent blank should be made by adding 3 drops of BQC to 5 ml. of the substrate. If a blue color results, the substrate solution should be discarded. If the butyl alcohol procedure is utilized this reagent blank should be extracted with the alcohol.

*Department of Health
New York City.*

(Editorial Note: The equipment and materials for this field test already assembled, can be purchased from R. P. Cargille, 118 Liberty Street, New York City. N. Y.)

"Hit-or-Miss" Methods of Controlling Washing and Sterilization*

By

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When we consider that the dairy industry in this country started, in general, with a farmer distributing milk to a small group of customers, it was not strange that this producer-distributor used the methods of cleaning that were practiced in the kitchen of his own home. Such methods were good enough for the kitchen because the food was sterilized by cooking, but when they were applied to the cleaning of dairy utensils, they lacked the precision and the scientific understanding of the factors that contribute to a satisfactory cleaning operation.

CLEANING PRACTICES

A common practice in preparing a cleaning solution was and, in many cases, still is to add a scoopful of cleaning powder or, if the job appeared to be a little harder than usual, two or three scoopful. The weight of these was not known any more than the volume of water to which they were added. Again, the more difficult the cleaning to be done, the higher was the temperature to which the solution was raised. No attempt was made to control the temperature of the hot solution with a thermometer, to prevent any injury to the surface of the metal. Under such conditions, with no exact control, cleaning frequently removed a considerable amount of tin plate from the equipment. When the workman had not guessed right on the quantity of powder and the temperature of the solution, or had not been willing to do his part of the labor, the equipment often had just the semblance of cleanliness. Dependence was placed on sterilization. Such

cleaning, of course, eventually had its effect on the product.

The fault has not all been with the men on the cleaning gang. The equipment manufacturer contributed to it. Can washers are an outstanding example. The dairyman's problem of some types of off-flavor, ropiness, and other bacterial contaminations are traceable to faults in the design of these machines. One of these is the lack of proper control for the strength of the solution. In preparing the solution for them, a frequent practice of the operator was to dissolve about ten pounds of powder in the tank and heat the solution to about 150° F. This temperature as a rule was not controlled. The steam was turned on to heat the solution, and when it was hot enough to satisfy the operator, he started putting cans through. After washing approximately three hundred cans, he added five pounds of powder, and then continued. The first cans were well washed while the last cans—the less said about them the better. Where old style washers are in use, this "hit-or-miss" method is still followed.

The Lehmkuhl unit for maintaining uniformity of alkaline strength has made it possible to establish a very satisfactory control of the solution in those instances where the water is relatively soft. In the exceptions, when it is hard, the briquets of uniform chemical composition have not proved equally good detergents. Perhaps a small drip tank with a solution of water softener could be supplied with the unit to soften the water independently, and so prevent scale deposits from forming on the machine and at the same time maintain uniformity of strength in the detergent solution.

*Presented at the Fifteenth Annual Conference of the New York State Association of Dairy and Milk Inspectors, Utica, N. Y., Sept. 22-24, 1937.

**The assistance in laboratory work rendered by Miss Muriel Kemp and Mr. Rufus Humphrey is gratefully acknowledged.

There have been great improvements in the design of can washers so that most of these faults have been corrected, but unfortunately many of the old ones are still in use. In the case of both the old and the new ones, the operator in the plant should make a careful inspection of the timing in the different steps of cleaning in the unit. The can washer is a very important factor in the sanitary control of milk, and should be given the same care and attention as any of the pasteurizing units if it is to operate efficiently.

CONTROLLING FACTORS IN DETERGENCY

A few cleaning procedures have been described that may be classified as "hit-or-miss" operations. What really are such methods of work? This report will be no attempt to tell the best way to proceed with any cleaning operation but rather to point out a few of the factors which modern discovery and invention have placed at our disposal. "Hit-or-miss" cleaning operations may be defined as those which have not been carefully planned and executed. To be successful, the plan must be well executed. This means a careful, trustworthy man either doing the work or overseeing it. A planned operation would give due consideration to five factors:

- 1—Water
- 2—Material of the equipment
- 3—The part of the process for which the equipment is used
- 4—The powder that it is proposed to use
- 5—The temperature of the cleaning solution

The composition of the water is of primary importance because in many cases of simple cleaning operations, such as washing farmers' cans, a sufficiently soft water will give satisfactory results with a very small quantity of detergent. In such cases, the use of the wrong powder may complicate the cleaning process and give less satisfactory cans than if no powder were used. Therefore, if the cleaning is to be properly done, consideration must be given to the kind and degree of hardness of the water. Some chemicals

or combinations of them will carry the hardness to a much lower point than others. For instance a water showing an original hardness of 110 p.p.m. had this same hardness reduced to 43.6 p.p.m. by the addition of ten pounds of hexametaphosphate per thousand gallons, whereas 3 pounds of hexametaphosphate brought the hardness to 22.0 p.p.m. Three pounds of hexametaphosphate plus 3 ounces of a sulphated alcohol per thousand gallons reduced the hardness to 14.0 p.p.m. Two pounds of hexametaphosphate plus 3 ounces of the sulphated alcohol reduced the hardness to 32.0 p.p.m. Three ounces of the sulphated alcohol alone per thousand gallons of water reduced the hardness to 36.0 p.p.m. It is evident that there is a delicate balance between the quantity of chemicals used and the softness attained.

This combination of softeners, and perhaps others would serve as well, has the great advantage over the commonly used chemicals in that the softening is accomplished without the formation of any precipitate. By keeping the lime salts in solution, no flakes are formed in it that may lodge on equipment and stick there in spite of rinsing. From such flakes are gradually built up lime deposits.

The material of the equipment is important because a powder that will not affect stainless steel or nickel may be very active in destroying the surface of tinned copper; not so much because of the alkaline strength, as its quality of reducing the oxygen solubility of the water. The research work of Dr. Kerr (1) of The International Tin Research and Development Council has shown that the corrosion of tin and tinned copper in solutions of sodium carbonate and sodium hydroxide at temperatures from 40° to 100° C. is largely controlled by the dissolved oxygen concentration of the solution, and only to a slight extent by temperature and concentration of alkali. The addition to the solution of a reducing agent, sodium sulphite was found to be the best, will reduce the rate of attack on the tin to nearly one-tenth. The mech-

anism of the reaction consists in the removal of dissolved oxygen from the solution whereby the sodium sulphite is converted to sulphate. Where soda ash or caustic soda was used, a ratio of one part of sodium sulphite to four parts of either alkali was found sufficient. The proportion of sulphite may be increased for exceptional conditions.

The use to which the equipment is put introduces another factor. Any milk adhering to the surface of a heater is much more difficult to remove than that found on the surface of a cooler. Between these two extremes there are various gradations of cleaning problems.

A rather difficult problem is presented in removing the deposit of milk solids from equipment used for heating milk to the pasteurizing temperature. As one method of solving this, about four years ago we started a system of circulating an acid solution containing $\frac{3}{4}$ pound of tartaric acid in 120 gallons of water. This solution was heated to from 90° to 95° F., and then circulated through the equipment for half an hour. At the end of this time, 3 pounds of trisodium phosphate were added, and the recirculation continued at a temperature of 80° to 85° F. for 15-20 minutes. The use of circulating solutions for cleaning equipment has helped considerably to standardize this part of the operation. In preparing the solution, a definite weight of the acid powder is added to a definite volume of water, and the solution is heated to a definite temperature before circulation is started. These three factors furnish the basis for standardizing any solution.

Where the milk deposit is originally hard and adheres firmly to the surface as on a heater, mechanical action is usually necessary to remove any traces of the soft residue that may remain after the solution has been circulated.

In considering the cleaning to be done, it is quite generally recognized that the character of detergent for washing cans is different from that which will give the best results on cleaning equipment, and the latter again is different from that

which will give the best results with bottles.

DESIRABLE DETERGENT QUALITIES

When selecting a powder for its detergent qualities, it is necessary to consider its power of producing *wetting, foaming, deflocculation, solution, emulsification, and lubrication*. In any successful detergent action, the majority of these qualities must be active, but in some cases a particular quality may be much more important than in others. Perhaps these qualities should be defined so that their interrelations may be more clearly understood.

Wetting (2) power is that quality in a detergent solution which enables it to squeeze in between the surface to be cleaned and the film that soils it. The condition governing this power depends largely on the interfacial tension between the liquid and the solid. When the detergent solution has completely wet the surface, that is, has formed a film between the surface and the layer of soil or contamination on it, other chemical and physical factors become active in removing the soiling layer. Frequently, slight mechanical treatment will do it. In some instances, if the surface is completely wet, the detergent will so loosen the soiling film that it may be removed by a thorough rinsing, regardless of whether these other qualities of a detergent have functioned.

Foaming (3) has been placed second in this list because it is just a physical variation of wetting quality. Foams have good wetting properties because the outside surfaces of the bubbles have higher surface tension than the inside and so flatten out against the surface of contact. Foam in a detergent solution is a valuable quality because particles of soil or dirt that are detached by the wetting may be carried away by it. Some of the best wetting agents also produce foams without the presence of soap. This statement holds true for the various sulphated and sulphonated alcohols as well as for sodium silicate of the formula $(\text{Na}_2\text{O}, 3.3\text{SiO}_2)$, (4).

Deflocculation (5) is that property of the detergent solution which disperses the film of soil or dirt into its component flakes so that it may be removed in a state of suspension. This is a most important factor because in many cases if it fails to function, the removal of the contaminating film may require special mechanical treatment. It is only when the contaminating film is broken up into small particles that it may be most readily carried away or dissolved by the detergent solution.

The solution of the soiling film depends upon the alkalinity of the detergent. Albuminous deposits are dissolved by alkalis, and fatty acids are saponified by them. In producing this change, caustic soda, on account of its hydroxyl ion and consequent high pH, is the most active; sodium silicate ranks next.

The emulsifying (6) quality in detergent solutions consists in the formation of emulsions in which water is the continuous phase and oil is the disperse one. This property is closely allied to that of wetting, and so the same agents which favor wetting also favor emulsification.

Lubrication, as the name implies, is that quality which adds slipperiness to the solution. Alkalis possess this quality in different degrees. The sulphated and sulphonated alcohols also have it. It is assumed that this quality assists the others enumerated in detergent action, but thus far no data have been obtained to determine how necessary it is to obtain satisfactory results.

BACTERIAL REMOVAL

Wetting quality is so important that a few more details which show the results

of this function are worth considering. In a test run to determine the results of improved detergency on bacterial removal, quart bottles were carefully hand-washed and twice rinsed with distilled water. Two cubic centimeters of a uniform suspension of bacteria in milk were spread over the inside of these bottles, and were allowed to dry spontaneously at room temperature for 18 hours.

The solutions for this test consisted of 2 percent preparations of the following detergents: sodium sesquicarbonate, soda ash, trisodium phosphate, sodium hydroxide, sodium hydroxide plus 10 percent of its weight as trisodium phosphate, sodium hydroxide plus 0.1 percent of its weight as sulphated alcohol, and sulphated alcohol solution alone of the same strength as the preceding.

These solutions were heated to 130° F., and 50 c.c. of each were added to a prepared bottle which was exposed to the action for 2 minutes. This somewhat low temperature was selected to avoid strong germicidal action and thus find the advantage of good detergency when the temperature of the solution happens to fall lower than it should. During the time of treatment, the bottles were rotated so that the inside would be uniformly wet by the solution. They were twice rinsed (shaken four times with each rinse) with 100 c. c. portions of sterile distilled water. The first rinse was drained out for 1 minute and the second one for 3 minutes. Then, 50 c. c. of sterile tap water were added, and the bacterial count of the bottles determined according to the official methods. The recoveries from the bottles gave the following counts:

<i>Bottles treated with</i>	<i>Bacterial Count of Bottles No. per c.c.</i>
No detergent	22,000,000
Sodium sesquicarbonate	300,000
Soda ash solution	35,000
Trisodium phosphate	14,000
Sodium hydroxide	3,100
Sodium hydroxide plus 10% of its weight as trisodium phosphate	1,600
Sodium hydroxide plus 0.1% of its weight as sulphated alcohol	500
Sulphated alcohol, weight same as above	200,000

These results show not only the influence of the temperature and pH on the germicidal quality of the solutions, but also the improved bacterial reduction when a good wetting agent is present, since living organisms are then removed in the rinse water.

The reduction due to a wetting agent is shown very clearly by the count obtained when sodium hydroxide was used. This count was reduced 84 percent by the presence of the neutral sulphated alcohol which, as a wetting agent, appears to be superior to any of the other products. The 50 percent reduction, when the caustic solution contained 10 percent trisodium phosphate, was due mostly to the addition of this latter sodium salt,

because this is known to increase the germicidal quality of sodium hydroxide, but it was also due to the improved wetting quality of the solution. Our own tests on wetting showed that this quality in a sodium hydroxide solution is much improved by the addition of 10 percent trisodium phosphate. When sulphated alcohol is used, the result is more clearly dependent on the change in wetting quality.

The preceding experiment was repeated with a different inoculum and some different products in combination. The conditions of the test were the same as those given. The recoveries from the bottles were:

<i>Bottles treated with</i>	<i>Bacterial Count of Bottles No. per c.c.</i>
No detergent	17,000,000
2% soda ash	17,600
2% soda ash + 0.1% of its weight as sulphated alcohol.....	4,000
2% sodium hydroxide	430
2% sodium hydroxide + 0.1% of its weight as sulphonated fatty acid	280
2% sodium hydroxide + 0.1% of its weight as sulphated alcohol	100
0.5% sodium hydroxide	850
0.5% sodium hydroxide + 0.1% of its weight as sulphonated fatty acid	580
0.5% sodium hydroxide + 0.1% of its weight as sulphated alcohol	280

Although the soda ash solution gave a good reduction in count, this number was reduced approximately 75 percent by the presence of 0.1 percent of its weight as sulphated alcohol.

The low count obtained when straight sodium hydroxide was used was further reduced 77 percent when the sulphated alcohol was present, but only 35 percent when the sulphonated fatty acid was used.

The 1/2 percent sodium hydroxide solutions, although not so germicidal as the 2 percent, showed a 67 percent reduction with the sulphated alcohol, and a 32 percent change with the sulphonated fatty acid.

For washing bottles, sodium hydroxide has been uniformly accepted as the best

alkali. One of the handicaps in using it in bottle washing machines has been the absence of a good method for the maintenance of the required alkali strength during the whole run. In some cases the solutions in the washers have been made up from 1 to 1 1/2 percent above the required level so that they would not be weaker than the desired percentage at the end of the run.

CONTROL OF DETERGENT STRENGTH

Two methods have been proposed for more uniform control. In larger plants, that have storage capacity for the contents of a tank-car (8,000 gallons), the use of 50 percent liquid caustic will pro-

vide a method for the uniform control of the washing solution.

The equipment which I have seen consists of a vertical tank 36 inches high and 14 inches in diameter. It holds approximately 36 gallons or 1 gallon per inch of height. In this particular case, it was planned to add 1 gallon of the 50 percent caustic solution per hour. This is equivalent to an addition of 50 pounds

of caustic per eight hour day. The equipment gives a satisfactory method of maintaining uniform strength of solution in the bottle washer.

Just recently I have been helping to perfect a new method of control which gives every promise of being one solution to this problem. It has the great advantage of being equally applicable for both large and small bottling plants.

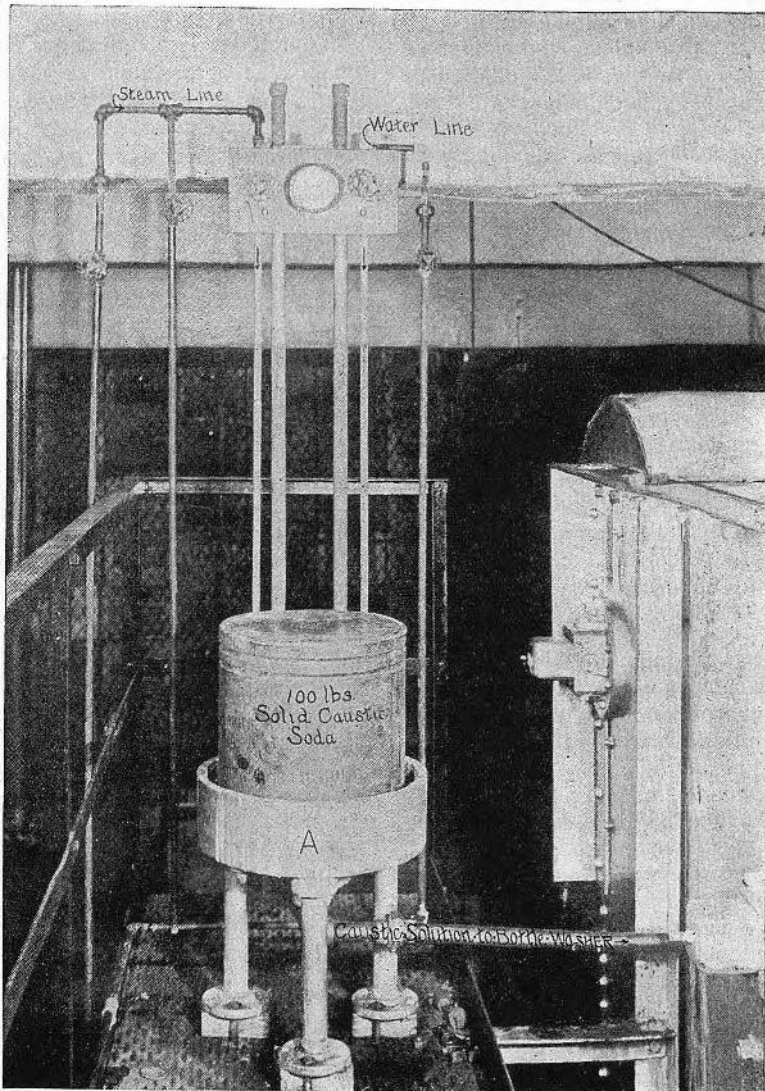


Figure 1. Assembly for Control of Detergent Strength

Briefly it consists of inverting a 100-pound can of solid caustic on a low table and dissolving the alkali by blowing steam on it, and then washing this strong caustic solution into the bottle washer by a small stream of water which flows from the outer edge of the table toward the center.

Figure 1 illustrates the apparatus used for this purpose.

The circular table "A" is 13½ inches in diameter, and 1 foot high. Centered on it is a ring 9¼ inches in diameter which rises ½ inch above the surface. It is triangular in cross-section. Within the ring are centered 12 ¼-inch holes to drain off the solution into the tank of the bottle washer. In the middle of the ring rises a mushroom cap under the top of which are a number of small holes for the entrance of the steam. The valve on the steam line has a pointer and a dial so that it may be readily set to the same opening on succeeding days. The water line is also controlled by a valve with the same device.

It is seen that this method has two great advantages. It practically removes all danger of caustic burns for the workmen, since the only time that the solid caustic is exposed is just before the can is inverted on the table and then only a 4½-inch friction disk is removed from the middle of the top. The second advantage is that it furnishes a good means for the uniform addition of caustic solution to the bottle washer during the period of the run. As an example of the control which this apparatus gives, the following table, showing the strength of solution in the tank receiving the addition, is of interest:

<i>Time</i>	<i>Caustic Alkalinity %</i>
11:20	2.11
12:00	2.21
2:00	2.48
4:00	2.21
6:00	2.48
7:30	2.24

Although these results were obtained on only the fifth run with this apparatus,

it is evident that good control has been established.

A still better picture of the excellence of control obtained by this method may be seen from the percentage strength of the solutions in four tanks of this machine. The samples for these determinations were taken at the end of the day's run.

	<i>Caustic Alkalinity %</i>
Tank 1	2.24
" 2	2.14
" 3	2.14
" 4	2.05

STERILIZATION

Sterilization is a process that is subject to scientific determination. It has been possible to set limits of time and temperature or strength to attain it. The problem has been further simplified by the regulations of the various boards of health in which they have defined the degrees and duration of treatment that they approve for this purpose.

The agents available in sterilizing are steam, hot water, and chlorine. In order to avoid the "hit-or-miss" classification, each must be used on the equipment and under the conditions where it gives the best results. The treatment must be very thoroughly done.

In sterilizing cans, steam has always been used. It fits in so well with the other mechanical steps in producing a clean, sterile, dry can that there is no question about its being the best agent. However, most satisfactory results are obtained when the can is given a sterile rinse with water at from 190° to 200° F., then a blast of dry steam, and finally a flash treatment with high speed, filtered, sterile air at 250° F. These three steps insure a sterile, dry can. If it is not entirely dry, the procedure cannot be considered satisfactory.

The milk can is an important factor in the production of clean, low count, normally flavored milk. Such milk can only be carried in a clean, practically sterile can. In order to obtain such cans, the washer itself should be given a frequent,

careful inspection to see that it is clean and in good mechanical condition.

In sterilizing any apparatus with steam, the regulations usually stipulate that all surfaces must be exposed to live steam under pressure for not less than 2 minutes. This is a minimum requirement.

When recorder bulbs are in the equipment during live steam sterilization, it has been found in some cases that the accuracy of the instrument is reduced. In such instances, if the bulb is placed in the unit when the steam is turned off, the recorder will generally show a temperature of from 200° to 210° F. and will remain above 190° F. for 5 minutes. This gives a satisfactory result.

If hot water is used, the regulations generally require that the recorded temperature must not be less than 180° F., and the period of exposure 2 minutes or longer (again a minimum requirement). In practice, the temperature of the water is frequently raised to between 190° and 200° F. with a jet of steam. Although the water has this high temperature, it may cool before reaching some parts of the system so that the recorder in those parts will show only 180° F. In such cases, the water is circulated for 15 minutes—a good margin of safety for sterilization. Special treatment may be given certain units, like filters, which may be steamed for half an hour.

The choice between steam and hot water as a sterilizing medium may be determined by the hardness of the water. Hot water sterilization with a hard water will frequently leave a white calcium deposit on the equipment.

When chlorine solution is circulated, the regulations generally require that it shall leave the last unit with at least 100 p.p.m. of available chlorine and the exposure shall last for not less than 2 minutes. If the equipment is properly cleaned, 105 p.p.m. is usually sufficient at the start.

When the solution is sprayed, it must leave the units with at least 250 p.p.m. of available chlorine. Five parts per million above this quantity is usually sufficient at the start. In this case the ex-

posure should be continued for at least 5 minutes. The latter treatment is especially favored for tank trucks and coolers.

Chlorine solutions are gaining in favor as sterilizing agents so the future will see improvements to promote this quality. One step in this direction may be made by the addition of 1/10th percent of sulphated alcohol to the solution to increase its wetting power. This product reduces only slightly the available chlorine but increases the wetting quality, so that the solution when sprayed will form a film even on a greasy surface. The pH of a chlorine solution is one of the most important factors in determining its germicidal quality.

The equipment must be drained very completely when chlorine solutions are used. Some of the first milk must be wasted or the chlorine treatment may be followed by a hot water rinse to avoid any development of oxidized flavor. This hazard has been explained to us in previous meetings by Drs. Dahlberg and Carpenter (7).

In order to complete the efficiency of chlorine sterilization, the industry needs a simple, accurate method for determining the strength of these solutions, one with which the ordinary plant worker and farmer can obtain accurate results.

Orthotolidine is a good reagent in the hands of the chemist, and those who are accurate and have a good eye for shades of color, but for many it is not satisfactory.

A small test set has been devised which is based on the regular laboratory method of liberating iodine with the solution of available chlorine, and then determining the quantity of the former with a solution of sodium thiosulphate. Each drop of the latter equals 10 p.p.m. of available chlorine. The method is accurate but complex for the average worker.

The test papers that have been on the market now for about three years have the great advantage of simplicity and are satisfactory for a rough approximation of chlorine strength if all the testing conditions are heeded. These depend on the liberation of iodine and its reaction with

starch to form a blue color whose intensity is a rough measure of the concentration of chlorine.

Chlorine is such a powerful reagent that while we want to use a sufficient strength for satisfactory sterilization, at the same time it is highly desirable to avoid using an excess. For this reason it is to be hoped that research will be continued so that a method may be devised that will more nearly meet our needs.

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Second Conference on Sanitation of Paper Milk Containers

Reported by Dr. R. S. Breed, *Chairman*,

*With a Supplementary Note on
Sanitary Inspection and Control at Pulp and Paper Mills.
New York Agricultural Experiment Station
Geneva, New York, May 2, 1938.*

As a result of rapid and interesting developments in the use of paper milk containers during the past year, it was considered advisable to hold a second conference to discuss problems of sanitation involved in the manufacture and use of single service paper containers for milk and cream. This meeting took place on May 2nd, 1938, at the New York Agricultural Experiment Station, Geneva, New York. A report of progress made during the year was given by Dr. J. R. Sanborn of the Geneva Experiment Station. Statements pertaining to various aspects of the work were made by Dr. John W. Rice of Bucknell University who is to be associated during the summer months with Dr. Sanborn in research work at the Geneva Station, Mr. J. C. Marquardt of the Geneva Station, Dr. F. W. Tanner of the University of Illinois, Urbana, Illinois, Mr. S. Abraham in charge of milk inspection work for New York City and Mr. W. D. Tiedeman, Chief of the Bureau of Sanitation, of the New York State Department of Health.

About one hundred persons attended the conference, representing the following manufacturers of paper containers, American Can Company, Bensen Corporation, Dixie-Vortex Company, Ex-Cell-O Corporation, the Lily-Tulip Cup Corporation, Mono Service Company, the Reed Container Company and the Sealright Company; also manufacturers of paper board used in making these containers; makers of milk bottle caps, paper cups, secretaries of interested paper, pulp and container associations, milk dealers using paper containers, dairy machinery manufacturers, and representatives from federal, state and municipal health groups. The purpose of the conference was to encourage a free discussion between responsible health authorities and representatives of the industry, in order that both satisfactory and unsatisfactory practices in the handling and use of containers of this type would be revealed, and that plans could be made for correcting any undesirable conditions that have developed during the rapid introduction of

these containers, particularly in the metropolitan area of New York City.

Health authorities were requested to state clearly what precautions they felt should be taken in the manufacture and use of containers of this type. Dr. Sanborn reported that through the development of a disintegration technic, he had been able to make between 500 and 1,000 bacteriological analyses of samples of paper board, the histories of which were known. All mills manufacturing board for milk containers use virgin mechanical or chemical pulp. Processes of manufacture when this work started were found to yield a board which gave an average bacterial count of less than 500 colonies per gram of disintegrated paper. In following the production of six mills in a routine way during the period from May 1937 to April 1938, it was found that two of the mills were able to keep nearly all counts under 100 colonies per gram, and samples were often practically bacteria free. There is some indication that board made during the spring and fall may show higher counts due to the fact that control of microorganisms in water supplies and in mill systems may be less effective then than at other times in the year. However, these data are not yet sufficient to reveal what can be accomplished when the various mills give attention to the matter of producing consistently a low count paper board. Dr. Sanborn stated that some mills are not in a position to guarantee a paper board that will regularly yield bacteriological counts of less than 500 per gram.

The persons present at the May second conference appreciated the desirability of holding to a minimum all human contact with paper and containers until the finished container filled with milk reaches the consumer. Various reports indicated that definite progress is being made along

these lines. It was evident that manufacturers realize the importance of handling the paper, paper blanks, and finished containers as aseptically as possible. They also realize the value of packing prefabricated containers in such a way that the milk dealer who receives them will regard the containers as sterilized packages. Careless handling and misuse of paper blanks and fabricated containers in milk bottling plants were reported by the health authorities present. Suggestions were made pertaining to the sterilization of containers just before filling with milk. The use of toxic substances of any sort in the paper, moisture-proofing materials, adhesives, or other materials used in the manufacture of the container could not be allowed under any circumstances.

The conference again brought out differences in viewpoint among public health authorities as to methods of achieving the highest possible sanitary quality in both prefabricated containers and those that are filled with milk immediately after paraffining. There are so many mechanical and sanitary difficulties involved in providing sterile containers in milk plants that health authorities are requiring that more careful attention be paid to sanitary conditions involving the storage, handling, and filling of containers in the average milk plant.

As a result of suggestions that have been received during the year, mimeographed sheets were prepared suggesting amendments to the Principles of Sanitation which were drawn up at the previous conference held on July 12, 1937 (1). Preliminary drafts of a model ordinance for cities were distributed for discussion.

Those interested may secure copies of the various publications and mimeographed sheets that were available at the meeting, on application to the Geneva Experiment Station.

Supplementary Note on Sanitary Inspection and Control at Pulp and Paper Mills.

In response to a general request from health groups represented at the second conference on paper milk containers that some sort of an official inspection be es-

tablished of mills making board for food containers, the technical directors from a number of interested mills met at the New York State Agricultural Experiment

Station on May 16, 1938, to consider a program for meeting sanitary requirements. The paper manufacturers present requested sanitary inspections of their mills and authorized Dr. R. S. Breed and Dr. J. R. Sanborn to organize and conduct a preliminary program of inspection and control. A group of about a dozen mills have requested that Dr. Sanborn undertake a preliminary inspection to determine how adequately they are prepared to meet the type of regulation that was suggested at the conference of May 2, 1938. The suggestions covered general sanitation at these pulp and paper mills, including control measures that would keep persons suffering from contagious diseases from contact with paper-making operations; proper purification of water supplies; and handling of pulp and paper so as to maintain low bacterial counts in the pulp before it reaches the drier rolls and in the finished product.

The purpose of these preliminary inspections is to insure the production of

paper that is sufficiently bacteria-free and clean to meet the rigid requirements necessary for the packaging of perishable foods. These procedures, incidentally, are also helpful in general mill operation and production. Inspections are based upon a guide for a systematic sanitary survey, tentatively approved by the pulp and paper and public health groups.

In several cases, the present summer inspection will follow up previous inspections made last year. Through the cooperation of mills that have had the opportunity to make improvements and corrections, it has been possible for this Station to secure complete records of the sanitary condition of milk container board production. Satisfactory bacteriological analysis of many samples of board has been made possible through the development at this Station of a disintegration method previously described. (2). The technic for determining the bacterial content of container board consists of repulping the board in sterile water by

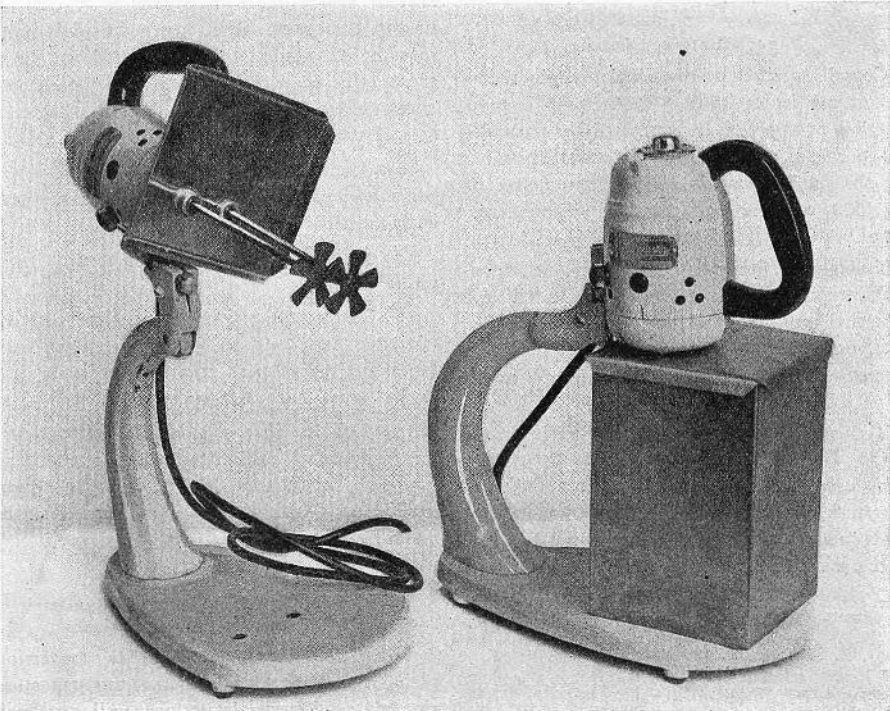


Figure 1—Apparatus for Paper Board Disintegration

means of a sterilized beating device (Fig. 1) and plating the resulting pulp suspension according to standard bacteriological procedures. Various cooperating laboratories are investigating the bacteriological contamination of paper board, using disintegration procedures. The results obtained are showing interesting correlations and considerable agreement.

The entire procedure of paper disintegration for bacteriological examination is undergoing intensive investigation and standardization, so that conditions of sample collection and testing may be uniform at all laboratories. In disintegration processes, we are working toward the utilization of stainless steel equipment throughout. For example, in the case of

the method previously described, sterile stainless steel covers for stainless steel churning jars have replaced the sterile, single service, paper board covers originally employed.

Pulp and paper mills are deriving considerable benefit from a knowledge of the bacterial content of various runs of board. This information enables a mill to meet sanitary requirements and to employ control measures effectively. Paper container manufacturers and public health laboratories are also finding disintegration methods useful in determining quality.

- (1) Report of Proceedings published in *The Milk Sanitarian*, 6, No. 9, September 1937.
 (2) *American Journal of Public Health*, 28, 576 (1938).

Paper Containers for Milk
Principles of Sanitation to be Observed in
Their Manufacture and Use.*

ITEM I

Paper Container Stock

Containers shall be made from virgin chemical or mechanical pulp. Virgin pulp is pulp that has not previously been used for commercial purposes. Board prior to moisture-proofing shall not at any time have a count exceeding 500 colonies per gram of disintegrated board.**

Unless used immediately after manufacture, container board shall be wrapped, sealed and protected until used. When used, the outside sheet on rolls or the top and bottom sheets of sheeted stock shall be discarded in all cases.

PUBLIC HEALTH REASONS

(a) The use of stock which has previously been used for commercial purposes (secondary stock, is not consistent with standards of food quality. Even if secondary pulp is completely sterilized during recovery, its miscellane-

ous content of foreign matter and dirt render it unsuitable for use in milk container stock.

(b) Contamination of rolls of paper, or sheeted stock occurs most readily at ends or on top or bottom sheets, hence the advisability of complete wrapping protection and sealing of these rolls or packs. Discarding the outside sheets of rolls or top and bottom sheets of sheeted stock, is a desirable precaution.

SATISFACTORY COMPLIANCE: For the above reasons, this item shall be deemed to have been satisfied when:

(a) Mills produce container board from virgin pulps.

(b) Mills require personal cleanliness among operators and consistently practice plant sanitation for the purpose of producing board low in dirt count and free from slime spots.

(c) Rolls or sheeted stock are wrapped immediately after manufacture in strong, clean wrappers, or utilized before there is opportunity for contamination from dust, dirt, or handling.

ITEM 2.

Process of Conversion — Where Stock Is Made Directly Into Containers

When container board reaches conversion plant, it shall be considered that this paper has received a bactericidal treatment. All stock and containers shall be handled mechanically so

* As revised at a Conference held at Geneva, N. Y., May 2, 1938. Originally prepared by J. R. Sanborn, M. W. Yale and R. S. Breed.

** Further research has shown that this is a feasible and rather lenient standard. Certainly, board should not give a count of more than 100 colonies per gram where milk or milk products come in direct contact with uncoated papers.

far as possible. Following fabrication, until final sealing in milk plant, container surfaces with which milk or milk products come in contact shall be protected from contamination. This shall be done through the use of mechanical equipment, careful handling, sealed sanitary shipping cases, or a closure for each container.

PUBLIC HEALTH REASONS: Human handling of container board increases opportunity for contamination which is reflected in the numbers and types of microorganisms present in waxed containers. If stock in conversion and milk plants is not protected from contamination, the value of germicidal treatment and sanitary precautions at pulp and paper mills will be partly or entirely nullified. Moisture-proof treatment may not completely sterilize containers. The chief purpose of the latter treatment is to render containers uniformly non-absorbent. Fortunately the same process may act as a secondary line of defense against contamination with microorganisms.

SATISFACTORY COMPLIANCE: This item shall be deemed to have been satisfied when:

(a) Paper direct from pulp and paper mill is unwrapped in conversion plant close to mechanically-fed machine and sheets exposed to unavoidable manual contact are discarded.

(b) Entire conversion process, methods of packing and shipping are conducted in such manner as to protect container from contamination, particularly human contact contamination.

ITEM 3

Process of Conversion Where Container is Performed in a Collapsed or Nested State Before Final Sealing

Throughout the processes of printing, folding, sealing, adhesive application, or packing prior to shipment to milk plant, all stock and containers shall, as far as feasible, be handled mechanically and be suitably wrapped or packaged before shipping.

Packaged container stock at milk plant shall be kept in a clean, dry place and opened only for immediate use. Where it is necessary to form or manipulate containers, all surfaces with which milk or milk products may come in contact, shall be protected from human handling.

PUBLIC HEALTH REASONS: It is important that, during intermediate stages in conversion

processes, manual contacts with container board be reduced to a minimum. In order to guard against promiscuous handling and exposure to dirt, it is advisable to keep board not in actual use, packaged and sealed. Fabrication, printing and sealing of containers should be conducted in such manner as to protect them from contamination.

SATISFACTORY COMPLIANCE: This item shall be deemed to have been satisfied when:

(a) Plants for printing, folding, sealing, and packing containers or other operations prior to delivery to milk plants, handle container board mechanically so far as possible and, at the conclusion of the operations, package the stock in suitable wrappers, cartons, or tubes.

(b) Milk plants protect packaged containers and contents from injury or abuse and complete fabrication, filling, and sealing of containers in such manner as to protect them from contamination.

ITEM 4

Moisture-Proofing

Moisture-proofing of containers shall be accomplished by means of fully refined paraffin wax or other suitable materials which are odorless, tasteless and non-toxic. The operation of paraffining machines shall be supervised by competent persons.

PUBLIC HEALTH REASONS: Fully refined paraffin is the only grade acceptable to and consistent with food uses. It is of fundamental importance that containers be rendered completely non-absorbent by machines that operate properly and that the moisture-proofing material be odorless, tasteless and non-poisonous.

SATISFACTORY COMPLIANCE: This item shall be deemed to have been satisfied if the purpose and quality of the treatments described above are strictly maintained.

ITEM 5

Adhesives

Container board should be sealed by means of non-fermentable adhesives, preferably synthetic thermoplastic materials. Adhesives having starchy or casein bases must resist decomposition, dissolution, and leaching, and not contaminate the contents of containers with microorganisms.

PUBLIC HEALTH REASONS: Adhesives are as a class notoriously susceptible to decomposition

by microorganisms. Some of these highly perishable materials, such as animal glue, are obviously not suitable for use in food containers. A number of adhesives, represented by products employing starchy or casein bases, while ordinarily fermentable, may be produced in forms or grades which are non-odorous, resistant to moisture, and unsuitable for the development of microorganisms.

SATISFACTORY COMPLIANCE: In accord with the above account, this item shall be deemed to have been satisfied if:

(a) Rapidly drying adhesives having starchy or casein bases which resist fermentation are used to form liquid-tight joints; these adhesives do not contaminate containers with microorganisms.

(b) Adhesives employed be of synthetic thermoplastic types.

ITEM 6 Germicides

Germicidal and bacteriostatic agents that are toxic to human beings or that affect milk in any way, as in taste, odor or nutritional qualities shall not be used in board, adhesives, or moisture-proofing materials for milk containers.

PUBLIC HEALTH REASONS: Substances introduced into materials of which containers are composed, which might conceivably exert preservative or antiseptic effects may affect the nutritional value of milk and be instrumental in producing off-flavors or odors. In some cases injurious effects on human beings from the use of such antiseptics have been demonstrated. It is necessary that substances of this class for use with containers be free of any toxic associations.

SATISFACTORY COMPLIANCE: This item shall be deemed to have been satisfied when:

(a) No germicidal or bacteriostatic agents are used unless they have been shown to be non-toxic and without effect on milk through the use of physical, chemical and biological tests, supported by clinical evidence.

ITEM 7 Handling of Paraffin

Paraffin in the solid state shall be shipped and stored in cool, clean, dry places, protected from dirt and isolated from odorous materials.

Paraffin in the liquid state shall be kept, at all times, in clean and sanitary containers. Waxing machines and baths shall be cleaned at regular intervals unless cleaning devices such as continuous filtration, are employed. In no case shall freshly prepared, new paraffin be introduced into used paraffin which has become discolored, oxidized or dirty. Odorous substances such as ordinary kerosene and gasoline shall not be used on or about conversion machines.

PUBLIC HEALTH REASONS: Paraffin absorbs odors and for the sake of milk quality it is advisable that special storage facilities be provided, which will also protect wax from promiscuous handling and exposure to dirt.

Due to the susceptibility of heated paraffin to oxidation, a well-regulated program of paraffin utilization should be followed to avoid over-heating, prevent contamination of new paraffin with partly oxidized wax and to eliminate the possibility of coating or impregnation of containers with discolored, dirty or oxidized wax.

SATISFACTORY COMPLIANCE: This item shall be deemed to have been satisfied if:

(a) Slabs of paraffin are shipped and stored in clean, cool, dry places and removed from storage only as required for coating or impregnation bath.

(b) Paraffin for coating, impregnation or storage is held at temperatures and for periods of time which will not impart flavors or odors to paraffin or milk.

(c) Molten paraffin is held in clean sanitary containers.

(d) Paraffin bath or tank is cleaned by continuous filtration or at regular intervals depending on such evidences of deterioration as discoloration and presence of dirt or fiber.

(e) The possibility of mixing new paraffin with a product that is unfit for use is avoided.

ITEM 8 Shipping Cases and Storage for Containers*

Cases for shipping empty containers shall be constructed of board or wrapping designed to adequately protect containers from injury or abuse due to tearing or breaking. Containers shall be stored in sealed, dry, unbroken cases, in a dry, vermin-proof location. Partly empty shipping cases of prefabricated

containers shall be resealed, rewrapped, or otherwise protected from contamination during storage. Except during filling operations, empty containers shall not be exposed at any time.

PUBLIC HEALTH REASONS: Damage to shipping cases frequently exposes containers to conditions which may result in serious contamination from dirt, wetting and human contact.

SATISFACTORY COMPLIANCE: This item shall be deemed to have been satisfied when:

(a) Shipping cases are well enough constructed and sealed to resist the handling they receive in transit without injury.

(b) Containers are stored at all times in sealed cases in places having dry floors and where there is no washing down of the floors while cartons are in storage.

ITEM 9

Cartons for Shipping Filled Containers

Only clean cartons shall be used for shipping filled containers. Returned carriers shall be handled or stored so as not to become wet, dirty, or damaged before again being used.

PUBLIC HEALTH REASONS: The re-use of shipping cartons may easily become a menace to milk quality and health. The abuse of these boxes arises from lack of care in handling and storing returned cartons. They may be carelessly thrown aside, allowed to become wet, dirty and mildewed. The packing of new containers of fresh milk in abused cartons is a practice which should not be allowed as it may cause addition of organisms and dirt.

SATISFACTORY COMPLIANCE: This item shall be deemed to have been satisfied when:

(a) New paper cartons are used for single delivery to retailer.

(b) Milk plant has adequate and dry storage facilities for returned cartons and uses only neat and clean, uninjured boxes.

ITEM 10

Examination of Containers

By any method of manufacture, treatment, or handling employed, the final test of sterility and cleanliness shall be freedom from bacteria, chemical reagents, and other foreign matter.

PUBLIC HEALTH REASONS: Consideration of possible sources of contamination during container manufacture, renders it advisable to reduce to a minimum the number of organisms present. While the likelihood of contamination by disease organisms is slight, bacteriological control of plant sanitation is necessary.

SATISFACTORY COMPLIANCE: This item shall be deemed to have been satisfied when:

(a) The average bacterial content of containers does not exceed 50 colonies per container.

ITEM 11

Quarantined Residences

The delivery of milk or milk products to and the collection of milk and milk-products containers from quarantined residences shall be subject to the special requirements of the health officer. It is recommended and urged that single service containers be used for retail delivery of milk and milk products under these circumstances. In case of wholesale delivery, to hospitals, etc., caring for infectious diseases carrier cartons as well as individual containers should be destroyed.

* Regulations governing construction of milk plants so as to limit the operations of opening shipping cases, storing, and filling the containers to definite rooms, should be adopted where feasible.

Mastitis IX. The maintenance of a herd free from mastitis. *G. J. Hucken and E. S. Harrison. New York State Agricultural Experiment Station Technical Bulletin No. 246 (1937).*

Three experimental herds including a total of 271 cows were divided as follows: one herd contained no animals which were discharging demonstrable streptococci, another herd contained a moderate number of infected animals, and a third herd contained a large percentage. The herd with moderate infection was divided into a section which was milked in order of increasing infection, and into another section which was milked in no particular order or arrangement of segregation of the infected animals.

In the first herd, 11 percent of the total cows developed infection, and in the second and third herds 30 percent each. The percentage of new infections as evidenced by the appearance of streptococci in the fore-milk was proportionately decreased as the amount of the in-

fection in the herd decreased, but it was impossible to keep the first herd (which was clean to start with) permanently free from cows which discharged streptococci in their milk.

By milking the infected cows last, the authors found no reduction in the incidence of mastitis streptococci in the milk or the possibility of reducing the spread of infection.

With regard to the streptococcic infection of the milk of heifers upon initial freshening, the authors showed that the conditions of the udder of the dam appeared to affect only moderately the possibility of infection in the heifer, but that when there was high incidence of infection in the barn, there was a more or less proportionate infection in the first lactation milk of heifers. From a practical standpoint these observations indicate that care should be taken to determine the source of replacement heifers and the amount of infection in the herd from which they have originated.

J. H. SHRADER.

The California Association of Dairy and Milk Inspectors headed by the following officers, Mr. E. P. Bernard, Milk Inspector, San Jose, California, *President*, and Mr. Chas Brinkley, Milk Inspector, City Health Department, Los Angeles, California, *Secretary*, will hold their annual convention at Santa Barbara, Calif., in September, 1938.

Dr. R. P. Gingerich, Supervising Market Milk Specialist, State Department of Agricul-

ture, Los Angeles, California, Dr. E. K. Roberts, San Diego County Health Department, Dr. Floyd Wilcox, Chief Milk Inspector, Los Angeles County Health Department, Mr. Mark Howlett, Jr., Chief Milk Inspector, Los Angeles City Health Department, and Mr. Max A. Heinzman, Chief Inspector, Ventura County Health Department participated in a discussion on Milk and Dairy Inspection at the School of Government, on June 22nd, 1938 at the University of Southern California.

NEXT ANNUAL MEETING

The Twenty-seventh Annual Meeting of the International Association of Milk Sanitarians will be held in Cleveland, Ohio, October 19, 20 and 21, 1938, with headquarters at The Allerton.

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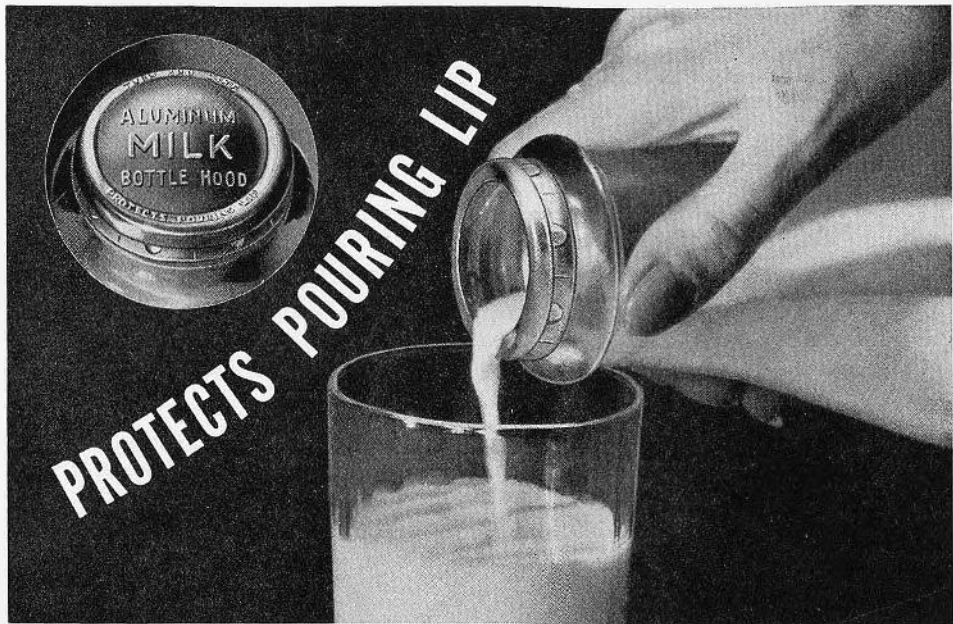
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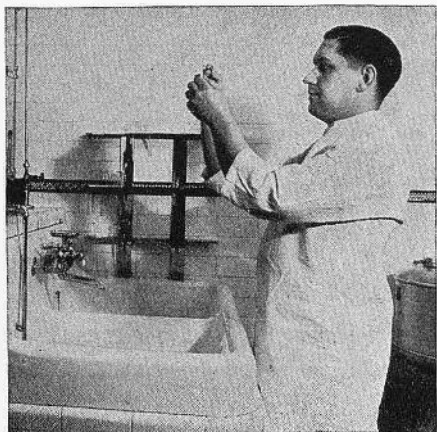
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PUBLIC INTEREST

Carrying the message of Sealtest to the general public has brought about a far-flung interest in the scientific supervision of dairy products and ice creams. The thoughtful family-heads are looking for this type of assurance in the products they buy. Consequently, in the publication and radio messages continuously set before this public, the benefits of a supervision brought about by co-operation of Sealtest representatives with milk sanitarians is stressed in territories served by Sealtest member-companies.

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