

RINSING MILK RESIDUES FROM STAINLESS STEEL, GLASS, AND TYGON PIPELINES WITH COLD AND WARM WATER

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(Received for publication October 20, 1963)

Because the dairy industry deals with highly perishable food products which are excellent foods for microorganisms as well as man, an early interest developed in the cleaning and sanitizing of milk-contact surfaces. Today the dairy industry is recognized as the leader in the field of in-place cleaning. Recommendations for rinsing—the first step in an over-all cleaning procedure—usually state that it should be done by flushing the pipeline or parts with cold or warm water until it runs clear. This unfortunately gives little idea as to the amount of water required to flush out a given length of pipeline. There are two different kinds of operations involved in rinsing and in detergent circulation. The loose adhering film of milk can be flushed out with cold or warm water. The hard film or soil deposits which cannot be removed by water during rinsing are taken care of by the circulation of detergents. Although there are numerous references dealing with the effectiveness of various circulation cleaning methods, there are no data available in the literature concerning rinsing alone.

In this study laboratory experiments were conducted to gain information on the comparative amounts of rinse water needed per foot of length and per square foot of inside surface area of stainless steel, glass, and Tygon pipelines under similar conditions of slope and at two different water temperatures. In all cases a slope of 1 inch per 10 feet of length of pipeline was kept constant. The total lengths of the several pipelines were different. The study dealt with the rinsing of skim milk, whole milk, ice-cream mix, and heavy cream from stainless steel pipes. Only skim milk and whole milk were used in the glass and Tygon pipelines.

The rinsing was done by a batch method as well as by continuous pumping. Two different temperatures of water were used: cold water varying from 38 to 58 F and warm water at a constant temperature of 110 F. Water of 7 grain hardness from Cornell University water supply was used throughout the study. All products on which rinsing studies were made were cold. The setup of a pipeline was such that most of it was in the form of straight lengths with elbows used where necessary to form return bends. One Tygon line located at a commercial dairy

farm was coiled on a vertical circular rack during rinsing.

EXPERIMENTAL

Forced Circulation Rinsing

Milk products for soiling the pipeline were placed in a stainless steel tank and were then recirculated through the pipeline for 15 min by a 1/4-hp sanitary centrifugal pump. All connecting pipe to the recirculation unit was of 1/2-inch stainless steel. The discharge line from the pump contained a sanitary diaphragm valve used for regulating the flow in the pipes. After soiling, a pipeline was disconnected from the circulating unit and allowed to drain free of liquid. The pump and tank were washed thoroughly before being reconnected for circulation of rinse water. This procedure insured that only milk residues from the pipeline itself would appear in the rinse-water effluent which was sampled at 5-sec intervals during the test. Sampling time began when water first started to discharge to waste from the pipeline. The quantity of water required to fill each line was known and has been included in the tabulated values of water required for rinsing. Blank samples were obtained from the water in the circulation tank and rinsing was considered complete when a rinse sample appeared the same as the blank by means of spectrophotometer analysis.

Batch Rinsing

After draining the pipeline free of milk product, it was filled completely with rinse water. One minute later the batch of rinse water was drained into a milk can, a representative sample taken, and the entire process repeated until the transmission of the sample reached that of the blank.

After each test the entire system was cleaned by an appropriate CIP procedure, sanitized, and allowed to air dry before reuse. Residual water was removed from the Tygon line by a dart forced through it by compressed air.

Analytical Method

In 1913 Kober (1) recommended the use of 3% sulfosalicylic acid as a good precipitating agent in the nephelometric determination of casein, globulin, and albumin. A modification of the test was used

in this study to detect traces of milk remaining in the rinse water. Fat globules in the rinse water caused some turbidity. However, greater turbidity and hence greater sensitivity was obtained by precipitating the protein with sulfosalicylic acid.

Measurement of turbidity or the light transmittance was used as the basis of distinction between clear water and a sample containing milk. The instrument used to measure light transmittance was a Coleman spectrophotometer at 600 $m\mu$ wavelength and at 35 $m\mu$ band width. The sensitivity of the test in terms of ppm of product was determined by comparing the percentage transmission of various known dilutions of skim milk, whole milk, ice-cream mix, and heavy cream to that of a water blank. The lowest detectable concentration of a product was the one just giving 100% transmission when compared to the water blank. The procedure followed for skim, whole milk,

TABLE 1. LOWEST CONCENTRATION OF MILK PRODUCT DETECTABLE BY SPECTROPHOTOMETER TEST

| Product | Concentration ppm |
|--|-------------------|
| Skim milk (pasteurized) | 150 |
| Whole milk (pasteurized, homogenized) | 100 |
| Ice-cream mix (Pasteurized, homogenized) | 20 |
| Heavy cream (pasteurized) | 45 |

and ice-cream mix was: mix 5 ml of known diluted sample with 5 ml of 3% sulfosalicylic acid. The blank sample was given a similar treatment. With heavy cream, 10 ml of diluted sample were mixed with 1 ml of 3% sulfosalicylic acid. Table 1 shows the lowest detectable concentration in water of each of the milk products.

TABLE 2. FLOWING WATER RINSE OF 88.9 FEET OF 1 1/2-INCH STAINLESS STEEL PIPE (CAPACITY = 6.7 GAL, TOTAL INSIDE SURFACE = 32.8 FT²)

| Product | Temp. of rinse water | Flow rate of water gal/min | Time required for rinsing (sec) | Average amount of water needed (gal) | Amount of water per foot length of pipeline (gal) | Amount of water per ft ² area of inside wall of pipeline (gal) | Ratio of cold to warm water |
|------------------------|----------------------|----------------------------|---------------------------------|--------------------------------------|---|---|-----------------------------|
| Skim milk | 42 | 11.7 | 30 | 12.6 | 0.14 | 0.38 | 1.13 |
| | 110 | 10.4 | 25 | 11.1 | 0.12 | 0.34 | |
| Homogenized whole milk | 58 | 10.8 | 60 | 17.5 | 0.20 | 0.53 | 1.32 |
| | 110 | 10.4 | 37 | 13.1 | 0.15 | 0.40 | |
| Plain ice-cream mix | 58 | 12.3 | 120 | 31.3 | 0.35 | 0.96 | 1.71 |
| | 110 | 10.7 | 65 | 18.3 | 0.21 | 0.55 | |
| Heavy cream | 38 | 11.9 | 609 | 126.7 | 1.42 | 3.86 | 4.73 |
| | 110 | 11.7 | 102 | 26.6 | 0.30 | 0.81 | |

TABLE 3. BATCH RINSING OF 86.9 FEET OF 1 1/2-INCH STAINLESS STEEL PIPE (CAPACITY = 6.8 GAL, TOTAL INSIDE SURFACE = 31.9 FT²)

| Product | Temp. of rinse water (°F) | Number of rinsings required | Total amount water needed (gal) | Amount water per foot length of pipeline (gal) | Amount water per ft ² inside area (gal) | Ratio cold to warm water |
|---|---------------------------|-----------------------------|---------------------------------|--|--|--------------------------|
| Pasteurized skim milk | 47 | 3 | 20.4 | 0.23 | 0.64 | 1.50 |
| | 110 | 2 | 13.6 | 0.16 | 0.43 | |
| Pasteurized homogenized whole milk | 59 | 3 | 20.4 | 0.23 | 0.64 | 1.50 |
| | 110 | 2 | 13.6 | 0.16 | 0.43 | |
| Pasteurized homogenized plain ice-cream mix | 48 | 5 | 34.0 | 0.39 | 1.06 | 1.67 |
| | 110 | 3 | 20.4 | 0.23 | 0.64 | |
| Pasteurized heavy cream | 42 | 7 | 47.6 | 0.55 | 1.49 | 2.33 |
| | 110 | 3 | 20.4 | 0.23 | 0.64 | |

TABLE 4. CONTINUOUS FLOW RINSING OF STAINLESS STEEL, GLASS, AND TYGON PIPELINES

| Pipeline | Product | Temp. of water | Gal water per ft ² inside | Ratio cold to warm water |
|--|------------------------|----------------|--------------------------------------|--------------------------|
| 1½" stainless steel Length - 88.93' Inside surface - 32.80 ft ² | Skim milk | Cold | 0.38 | 1.13 |
| | | Warm | 0.34 | |
| 1 1/2" glass Length - 45.67' Inside surface - 18.0 ft ² | Skim milk | Cold | 0.46 | 1.15 |
| | | Warm | 0.40 | |
| Homogenized whole milk | Homogenized whole milk | Cold | 0.53 | 1.32 |
| | | Warm | 0.40 | |
| Tygon - 5/8" Length - 85' Inside surface - 13.9 ft ² | Skim milk | Cold | 0.15 | 1.14 |
| | | Warm | 0.13 | |
| Raw whole milk | Raw whole milk | Cold | 0.15 | 1.14 |
| | | Warm | 0.13 | |
| Same Tygon line except dart pushed through before rinsing | Skim milk | Cold | 0.09 | 1 |
| | | Warm | 0.09 | |
| Raw whole milk | Raw whole milk | Cold | 0.09 | 1 |
| | | Warm | 0.09 | |
| 3/4" Tygon - Length - 120' Condition - coiled Inside surface area = 23.6 ft ² | Raw whole milk | Cold | 0.15 | |
| | | Warm | | |

RESULTS AND CONCLUSIONS

Table 2 shows the results of rinsing a 1½-inch stainless steel line with flowing cold and warm water. Results of rinsing by the batch method are given in Table 3.

Similar experiments using only skim milk and whole milk were conducted on lines of 1½-inch glass pipe, and 5/8-inch and 3/4-inch Tygon tubing. The results, along with those for the stainless steel pipe with the same products, are summarized in Tables 4 and 5.

The amount of water, either warm or cold, required to rinse milk-solids residues from a drained pipeline increased with the total solids content of the dairy product that had been in the line. The data show that the amount of fat is more important than the amount of solids-not-fat and that the condition of the fat is also important in determining the amount of water required. The required amount of cold water increased significantly with the fat content of the dairy product. With warm water rinsing, the increase with the fat content was considerably less.

On the basis of each square foot of surface area, Tygon required the least rinse water, followed by glass and stainless steel which required comparable amounts. Pushing a dart through the plastic line before rinsing permitted thorough rinsing with about one-half the usual amount of water.

TABLE 5. BATCH RINSING OF STAINLESS STEEL, GLASS, AND TYGON PIPELINES

| Pipeline | Product | Temp. of water | Gal water per ft ² inside | Ratio cold to warm water |
|---|------------------------|----------------|--------------------------------------|--------------------------|
| 1½" stainless steel Length - 86.93' Surface area - 31.97 ft ² | Skim milk | Cold | 0.64 | 1.5 |
| | | Warm | 0.43 | |
| Homogenized whole milk | Homogenized whole milk | Cold | 0.64 | 1.5 |
| | | Warm | 0.43 | |
| 1½" glass Length - 45' Surface area - 17.7 ft ² | Skim milk | Cold | 0.43 | 1 |
| | | Warm | 0.43 | |
| Homogenized whole milk | Homogenized whole milk | Cold | 0.43 | 1 |
| | | Warm | 0.43 | |
| 5/8" Tygon Length - 85' Surface area - 13.9 ft ² | Skim milk | Cold | 0.14 | 1 |
| | | Warm | 0.14 | |
| Raw whole milk | Raw whole milk | Cold | 0.14 | 1 |
| | | Warm | 0.14 | |

REFERENCES

1. Kober, P. A. Nephelometric determination of proteins, casein, globulin and albumin in milk. *J. Amer. Chem. Soc.* 35:290 and 1585. 1913.