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

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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 1½-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 mμ wavelength and at 35 mμ 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, 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 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

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 ft² 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 ft² 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 ft² inside	Ratio cold to warm water
1½" stainless steel Length – 88.93' Inside surface – 32.80 ft²	Skim milk	Cold Warm	0.38 0.34	1.13
	Homogenized whole milk	Cold Warm	0.53 0.40	1.32
1 1/2" glass Length – 45.67' Inside surface – 18.0 ft²	Skim milk	Cold Warm	0.46 0.40	1.15
	Homogenized whole milk	Cold Warm	0.63 0.45	1.40
Tygon – 5/8" Length – 85' Inside surface – 13.9 ft²	Skim milk	Cold Warm	0.15 0.13	1.14
	Raw whole milk	Cold Warm	0.15 0.13	1.14
Same Tygon line except dart pushed through before rinsing	Skim milk	Cold Warm	0.09 0.09	1
	Raw whole milk	Cold Warm	0.09 0.09	1
3/4" Tygon – Length – 120' Condition – coiled Inside surface area = 23.6 ft²	Raw whole milk	Cold	0.15	

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 ft² inside	Ratio cold to warm water
1½" stainless steel Length – 86.93' Surface area – 31.97 ft²	Skim milk	Cold Warm	0.64 0.43	1.5
	Homogenized whole milk	Cold Warm	0.64 0.43	1.5
1½" glass Length – 45' Surface area – 17.7 ft²	Skim milk	Cold Warm	0.43 0.43	1
	Homogenized whole milk	Cold Warm	0.43 0.43	1
5/8" Tygon Length – 85' Surface area – 13.9 ft²	Skim milk	Cold Warm	0.14 0.14	1
	Raw whole milk	Cold Warm	0.14 0.14	1

REFERENCES

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