VARIATIONS IN TEMPERATURE OF FARM BULK TANK MILK AT TIME OF PICK UP[1]

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Summary

A study was made of the temperature of bulk tank milk at the time of pick up. The study included 534 Grade A producers from routes of 29 bulk tank haulers, with 22 brands of tanks ranging in age from <1 to >10 yr. Actual temperatures of milk at the time of pick up ranged from 0 to 12.8C (32 to 55 F). Differences were observed in the temperature of the top layer of milk before agitation and the blend temperature after agitation. Butterfat particles and ice were observed in approximately 8% and 2% of the tanks, respectively.

Approximately 6% of the bulk tank thermometers were either broken or out of order. About 20% of the tank thermometers' readings did not check within ± 3F of those of a test thermometer. The majority of the bulk tank haulers did not carry or use a test thermometer to check the temperature of the milk.

Proper cooling and storage of raw milk is recognized as an essential prerequisite to the production of high quality dairy products. The widespread use of farm bulk tanks during the past decade has resulted in more efficient cooling and storage of milk. They undoubtedly have contributed to a general improvement in the quality of milk.

A bulk tank must be properly designed, sized and operated in order to meet basic cooling requirements. Recommended standards for performance have been formulated by the 3-A Sanitary Standards Committees on farm milk cooling and holding tanks *(3)*. Problems associated with malfunctioning of the bulk tank as a result of aging have been discussed by Atherton *(1)*. Quality problems observed in bulk tank milk in recent years apparently can be attributed to inefficient cooling of tank milk *(2, 4, 5)*.

This study was undertaken to obtain information on the temperature of farm bulk tank milk at the time of pick up, the accuracy of farm bulk tank thermometers, and the practices of haulers with respect to temperature measurements.

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Experimental Procedure

State and local sanitarians and fieldmen from major dairy companies and producer cooperatives collected the information used in this study. They obtained these data by riding with the bulk hauler or by meeting him at the individual farms. Observations were made and recorded on: the bulk tank hauler's temperature readings, the actual tank thermometer reading before and after agitation, and the temperature of the top layer of milk before and after agitation measured with a test (± 1 F) thermometer. The test thermometer readings were made within the top 6-inch layer of milk. Also, information on the characteristics of the bulk tank and other facts pertinent to the pick up were recorded. Information was obtained on 534 Grade A producers from routes of 29 bulk tank haulers from July to November 1965.

Results and Discussion

Twenty-two brands of bulk tanks, ranging in age from <1 to >10 yr, were included in the study. The average age was 6.6 (± 2.6) yr. Approximately half of the tanks were of the ice bank type and half of the direct expansion type. The average capacity of the tanks was 265 (± 155) gal. Almost all of the tanks had automatic agitators, with either one or two speeds. Over 80% of the pick ups were on an every-other-day basis.

Temperature Readings

A comparison of the hauler's with the sanitarian's or fieldman's temperature readings taken before and after agitation of the milk is summarized in Table 1.

The results reveal that fewer than 20% of the haulers carried or used a test thermometer. A majority of the haulers made their temperature observations after agitation; however, some made temperature observations both before and after agitation. Although the number of observations was not consistent, the average temperature readings indicate that the tank

TABLE 1. COMPARISON OF TEMPERATURE READINGS MADE BY HAULER AND SANITARIAN OR FIELDMAN ON BULK TANK MILK

Temperature reading	Temperature taken	No. observations	Ave. temp.	Std. dev.
By hauler				
Tank thermometers	Before agitation	149	37.85	4.23
Tank thermometers	After agitation	228	39.20	4.50
Hauler thermometers	Before agitation	68	38.91	5.74
Hauler thermometers	After agitation	102	39.21	4.56
By sanitarian or fieldman				
Tank thermometers	Before agitation	377	38.18	3.52
Tank thermometers	After agitation	502	38.51	3.92
Test thermometers	Before agitation	397	38.95	3.93
Test thermometers	After agitation	534	38.73	3.43

TABLE 2. EFFECT OF STRATIFICATION ON TEMPERATURE OF BULK TANK MILK AS REVEALED BY READINGS BEFORE AND AFTER AGITATION[a]

Difference in temperature taken before and after agitation	Observations No.	%
Tank thermometer		
Temp. before agitation >3 F higher than temperature after agitation	7	1.8
Temp. before agitation 2 to 3 F higher than temperature after agitation	36	9.7
Temp. before agitation within ± 1 F of temperature after agitation	312	83.2
Temp. before agitation 2 to 3 F lower than temperature after agitation	13	3.5
Temp. before agitation >3 F lower than temperature after agitation	7	1.8
Test thermometer		
Temp. before agitation >3 F higher than temperature after agitation	25	6.3
Temp. before agitation 2 to 3 F higher than temperature after agitation	40	10.1
Temp. before agitation within ± 1 F of temperature after agitation	318	80.1
Temp. before agitation 2 to 3 F lower than temperature after agitation	14	3.5
Temp. before agitation >3 F lower than temperature after agitation	0	0.0

[a]All readings taken by sanitarians or fieldmen.

thermometer readings were lower than the test thermometer readings. Differences in the average temperature readings before and after agitation indicate variations in the uniformity of temperature throughout the body of milk.

Effect of Stratification on Temperature

The effect of stratification on the temperature of bulk tank milk as revealed by the temperature readings taken before and after agitation is summarized in Table 2. The results show that no measurable differences in temperature before and after agitation were present in over 80% of the tanks. Data obtained with the test thermometers indicate that the top layer of the milk was higher than the blend temperature after agitation by >3 F and 2 to 3 F in approximately 6 and 10% of the tanks, respectively. These results indicate that stratification could be a significant cause of quality problems in bulk tank milk. The temperature of the top layer of milk was lower than the blend temperature in less than 4% of the tanks, and in no case was the temperature more than 3 F lower.

Accuracy of Tank Thermometers

Approximately 6% of the bulk tank thermometers were either broken or out of order. Table 3 shows a comparison of tank thermometer readings with those of a test thermometer. The results reveal that less than 50% o the tank thermometer readings were within ± 1 F of the test thermometer readings. Approximately 20% were inaccurate by more than ± 3 F. It is believed that tank thermometers should be accurate to ± 2 F at 50 F *(3)*.

TABLE 3. ACCURACY OF BULK TANK THERMOMETERS IN COMPARISON WITH READINGS TAKEN WITH TEST THERMOMETERS[a]

Temperature readings[b]	Observations No.	%
Tank thermometer >3 F higher than test thermometer	46	9.2
Tank thermometer 1 to 3 F higher than test thermometer	74	14.7
Tank thermometer within ± 1 F of test thermometer	234	46.6
Tank thermometer 1 to 3 F lower than test thermometer	91	18.1
Tank thermometer >3 F lower than test thermometer	57	11.4

[a]All readings taken by sanitarians or fieldmen.
[b]All readings taken after agitation.

Based on the results reported here, a significant number of bulk tank thermometers do not meet accuracy recommendations. Such thermometer inaccuracies as observed in this study could be a source of confusion and/or false security to producers and to bulk tank haulers, resulting in quality problems.

Butterfat and Ice Particles

Butterfat particles were observed in 43 and ice in 12 tanks. Both butterfat and ice particles were observed in 3 tanks. These observations, indeed, indicate improper functioning of the bulk tank cooling system. Of the 43 tanks containing butterfat particles, 25 were of the direct-expansion and 18 of the ice bank type. Of the 12 tanks with ice, 11 were of the direct-expansion and 1 was of the ice bank type. All of the tanks which contained both butterfat particles and ice were of the direct-expansion type.

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