MILK and FOOD SANITATION

A COMPARISON OF THE SCRUNBBING EFFICIENCY OF FOUR TYPES OF DAIRY EQUIPMENT BRUSHES

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Dairy plant personnel have different opinions as to the best types of brushes to use in cleaning dairy equipment. Many workers prefer stiff-bristled brushes for cleaning jobs and softer brushes for surfaces that have been exposed to cold products only. Most of the brushes used in dairy plants are made from either nylon or bassine fibers that are embedded in a wood or composition stock. The length of the handle and the size and shape of the brush depend on the personal preference of the operator for the cleaning job to be done. Since there were so many differences of opinions on the relative value of brushes, it was believed that a contribution could be made to some of the cleaning problems if means were devised for measuring the scrubbing efficiency of the different types of brushes.

A review of the literature revealed that very little information is available on the scrubbing efficiency of dairy equipment brushes or methods for their evaluation. Fowler stated that nylon brushes were very effective for dairy plant cleaning and Myrick remarked that the bristles were very serviceable and virtually impervious to water.

If the scrubbing efficiency of brushes is to be evaluated properly, it is necessary to have a machine that will uniformly subject each brush to conditions that are similar to those found on soiled dairy equipment. Also a standard method of preparing a soiled metal surface and of measuring the cleaned or scrubbed area must be developed. Johnson and Roland prepared a milk film on stainless steel tubes by letting the milk flow through them. As the milk was circulated through the tubes, it was heated to 143°F by a hot water (180°F) jacket surrounding each tube. Domingo developed a method for measuring the efficiency of a cleaning process by staining the soil with a fluorescent material. He could observe the effectiveness of the cleaning procedure by exposing the surface to filtered ultraviolet light and noting the amount of fluorescence.

This study is concerned with (1) the development of a machine for uniform manipulation of the brushes, (2) the preparation of a standard milk-soil, and (3) a procedure for measuring the cleaned area for the purpose of evaluating the scrubbing efficiency of the different type dairy brushes.

EXPERIMENTAL

Development of a Brush Scrubbing Machine

The brush-scrubbing machine that was developed is shown in figure 1. An electric motor was the source of power. The speed of the motor was reduced by means of gears until the large wheel of the machine revolved at 52 rpm. The length of the stroke was 22 inches. The soiled container was fastened in a stationary position. The container had three sides that could be coated with milksoil during each preparation. This enabled the operator to test either three brushes on one preparation or one brush three times.

Metal weights of four, six, and eight pounds were used to test the individual brushes. If weights heavier than eight pounds were used, the soft bristles flattened out so that only the sides were used for scrubbing. On the other hand, weights less than four pounds resulted in very little scrubbing. The weights were fastened to that portion of the brush directly above the bristles on the short-handled brushes and near the tip of the handle on the long-handled brush.

Preparation of a Milk-Soiled Surface

The equipment shown in figure 2 was used in the preparation of a milk-soiled surface. The outside jacket of the cheese vat was filled with water and then drained immediately. (Temperature of water was approximately 80°F.) This was done in order to obtain a uniform temperature in the cheese vat, so that each batch of milk washed out the same heat treatment. The small vat was then filled with water and heated to 204°F with steam. This temperature was held for five minutes, so as to insure an even temperature of the vat. Reconstituted milk made from non-fat dry milk solids (9 percent total solids) was adjusted to 50°F, poured into the milk can, and then siphoned into the cheese vat in approximately 10 minutes. The agitator was started, and the milk heated to 150°F by holding the water in the small vat at 204°F. When the milk reached 150°F it was held for ten minutes. This temperature was maintained by lowering the temperature of the water in the small vat by simultaneously siphoning off the hot water and running in cooler water. After the ten-minute holding period, the milk was cooled to 140°F by siphoning off the warmer water and running cooler water into the small vat. When the milk temperature reached 140°F, the small vat containing the water was removed from the milk, placed on its end for three minutes, and then rinsed with two quarts of 120°F water. The soiled surface was then ready for use. An illustration of the milk-soiled surface is shown in figure 3.

In order that the milk-soil produced by the above procedure would be uniform from day to day, one source of non-fat dry milk solids was used. Furthermore when one batch of reconstituted milk had been used a total of four times, it was discarded and a new batch prepared.

Measurement of the Cleaned Area

The senses of sight and touch supported by observations with a Mineralight were used to determine when the surface was clean. If

1Published with the approval of the Director of Research, North Carolina Agricultural Experiment Station, Raleigh, as paper No. 453 of the Journal Series.

2Bassine fibers are coarse, dark-colored and stiff, commonly used in brushes.—Editor.

3Mineralight is an apparatus which generates a long wave ultraviolet for detection of milkstone, fats, and other fluorescent surface soils. Manufactured by Klenzades Products, Inc., Beloit, Wisconsin.

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The surface appeared to be clean by observation and feeling, it was rinsed and examined under ultraviolet light. If no fluorescent material remained, the cleaned area was measured and the time recorded. If the area was not clean to sight and touch after each scrubbing period, the scrubbing was continued until it was. Figure 4 shows how the measurement of the area was determined. The area measured in this figure was approximately 3½ inches by 20 inches.

**Selection of Brushes**

After observing the different types of brushes used in dairy plants, the four types shown in figure 5 were selected. These brushes varied in type of fiber (nylon or bassine), length of fiber, size of brush, and length of handle.

Since different types of brushes hold varying amounts of washing solution, and this may affect their scrubbing efficiency, it was desirable to determine the volume retained by the bristles when each brush was used. Brush No. 1, when submerged in a pail of washing solution, delivered approximately 140 ml; brush No. 2 delivered 140 ml; brush No. 3 delivered 50 ml; and brush No. 4 delivered 30 ml. This procedure showed that brushes made from bassine fibers had a greater solution-carrying ability than the nylon brushes. This was also true when the comparison was made on the basis of the approximate cubic content of the bristles. However, the short-bristled nylon brush transported almost twice as much solution per cubic inch of brush bristles as the long-bristled nylon brush.

**Measurement of the Scrubbing Efficiency**

After the types of brushes had been selected, approximately eight of each were secured so that more than one brush of each type could be used in the test. The individual brushes were chosen at random from the supply available.

The weight was attached to the brush and the brush was fastened to the metal rod. Then the soiled surface was positioned. A predetermined amount of cleaning solution (as determined by procedure cited above) was poured on the surface of the vat in the path.
Figure 5. Types of brushes used. No. 1—long-handled bassine fiber. No. 2—short-handled bassine fiber. No. 3—short-handled, short-bristled nylon fiber. No. 4—short-handled, long-bristled nylon fiber.

of the brush as the motor was started. At the end of 30 seconds or 26 strokes, the area was examined. If the surface was clean, it was measured and the data recorded. If the area was not clean, the process was repeated.

Four types of brushes were tested. A new brush was used for each of the different weights. The trials were repeated eight times on each brush with each weight. The averaged results are shown in table 1.

The amount of weight applied affected the performance of the different brushes. The long-handled bassine brush did not scrub efficiently when four pounds pressure was applied but did satisfactorily when larger weights were used. This was as expected because the leverage involved was such that a much greater weight must be applied at the end of a long handle to get the same pressure on the bristles as on a short-handled brush. In this instance, none of the weights used caused a spreading or flattening of the bristles.

The short-handled bassine brush did best with the 8-pound weight and poorest with the 6-pound weight. The bristles maintained a proper scrubbing position with the 4-pound weight but began to flatten considerably when the 6-pound weight was applied. When the 8-pound weight was used, the bristles were flattened completely and the weight was so heavy that scrubbing was effected only by the sides of the bristles. It is doubtful whether this latter condition would occur in dairy plant cleaning unless the brushes were badly worn or water-soaked.

The long-bristled nylon brush scrubbed best with six pounds pressure. Apparently, four pounds of pressure was not enough and eight pounds was so much that the bristles were flattened.

The short-bristled nylon brush scrubbed satisfactorily with each weight but did best when eight pounds was used. None of the weights caused the bristles to flatten so they remained in their most effective scrubbing position. It is believed that this brush would have a much longer life than the others tested because their bristles were forced out of their proper position and made to scrub from the sides.

The brushes varied in the amount of surface which was in contact with the soiled area. Therefore, it was thought that some comparison should be made of the scrubbing efficiency based on the actual contact surfaces. The results are presented in table 2.

The short-bristled nylon brush proved to be approximately twice as effective in scrubbing efficiency as any of the other brushes when compared on the basis of its size. The other types varied in their relationship to each other depending on the weights used and it would be done about the basis to select.
Scrubbing Efficiency

**Table 1**—A Comparison of the Vat Areas Cleaned by Four Types of Brushes Using Lead Weights Weighing 4, 6, and 8 Pounds

<table>
<thead>
<tr>
<th>Type</th>
<th>Area cleaned per minute using a 4-pound weight</th>
<th>Area cleaned per minute using a 6-pound weight</th>
<th>Area cleaned per minute using an 8-pound weight</th>
<th>Averaged areas cleaned per minute by all weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bassine</td>
<td>35.25 sq. in.</td>
<td>73.70 sq. in.</td>
<td>74.06 sq. in.</td>
<td>57.14 sq. in.</td>
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<tr>
<td>(long handled)</td>
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<tr>
<td>2. Bassine</td>
<td>32.10 sq. in.</td>
<td>64.67 sq. in.</td>
<td>65.05 sq. in.</td>
<td>50.84 sq. in.</td>
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<tr>
<td>(short handled)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3. Nylon</td>
<td>50.05 sq. in.</td>
<td>59.34 sq. in.</td>
<td>59.65 sq. in.</td>
<td>54.96 sq. in.</td>
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<tr>
<td>(long bristle)</td>
<td></td>
<td></td>
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<tr>
<td>4. Nylon</td>
<td>61.46 sq. in.</td>
<td>72.83 sq. in.</td>
<td>73.31 sq. in.</td>
<td>66.65 sq. in.</td>
</tr>
<tr>
<td>(short bristle)</td>
<td></td>
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**Table 2**—A Comparison of Vat Areas Cleaned Per Square Inch of Brush Area Applied for Four Types of Brushes Using 4, 6, and 8-Pound Lead Weights

<table>
<thead>
<tr>
<th>Type</th>
<th>Brush area</th>
<th>4-pound weight</th>
<th>6-pound weight</th>
<th>8-pound weight</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bassine</td>
<td>5.00 sq. in.</td>
<td>1.35 sq. in.</td>
<td>2.44 sq. in.</td>
<td>3.24 sq. in.</td>
<td>2.07 sq. in.</td>
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<tr>
<td>(long handled)</td>
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<tr>
<td>2. Bassine</td>
<td>5.24 sq. in.</td>
<td>2.31 sq. in.</td>
<td>3.49 sq. in.</td>
<td>4.48 sq. in.</td>
<td>3.50 sq. in.</td>
</tr>
<tr>
<td>(short handled)</td>
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</tr>
<tr>
<td>3. Nylon</td>
<td>5.94 sq. in.</td>
<td>2.01 sq. in.</td>
<td>3.17 sq. in.</td>
<td>4.21 sq. in.</td>
<td>3.16 sq. in.</td>
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<tr>
<td>(long bristle)</td>
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<tr>
<td>4. Nylon</td>
<td>6.88 sq. in.</td>
<td>4.13 sq. in.</td>
<td>5.39 sq. in.</td>
<td>6.60 sq. in.</td>
<td>4.31 sq. in.</td>
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<tr>
<td>(short bristle)</td>
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Summary

1. A method was developed for measuring the scrubbing efficiency of dairy equipment brushes.
2. The bassine-bristled brushes carried about twice as much cleaning solution as the nylon-bristled brushes.
3. The amount of pressure exerted on the different type brushes affected their scrubbing efficiency.
4. The short-bristled nylon brush cleaned the largest area per square inch of brush area when comparisons were made on a heavily-soiled area.

Cooperation

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References