

# HANDLING MILKING-PARLOR WASTE

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## INTRODUCTION

Milking-parlor waste ordinarily consists of feces, urine, small amounts of wasted milk, and a large volume of wash water. The high water content makes it very tempting to consider milking-parlor waste disposal as a separate problem from that of the manure collected from other areas within a confined dairy operation. There is little debate about the way manure should be disposed of, but the same cannot be said for milking-parlor waste. Manure is spread on the land, whereas milking-parlor wastes are disposed of in a variety of ways, e.g., direct discharge, lagooning, or through septic tank systems. The study reported here was undertaken to assess the treatability of a typical milking-parlor effluent by aeration to help determine the most feasible disposal method for the watery waste.

## EXPERIMENTAL

### Composition of Milking-Parlor Waste

A survey was carried out by Mr. R.G. Gregg (agricultural engineer, Ontario Ministry of Agriculture and Food) at a typical modern Southern Ontario dairy farm milking 152 cows in a herringbone parlor with eight stalls per side. The average numbers of defecations and urinations per milking, observed during six milkings, were 23 and 4.5, respectively. Only a small proportion of the feces was removed as a solid. The bulk was flushed down the gratings at the rear of the stalls. On a daily basis approximately 1728 liters (380 imp gal) of wash water were used, 25% after the afternoon milking and 75% after the morning milking. This uneven division of water use probably reflects the milking crews' desire to finish up and get home as soon as possible after the afternoon milking. For a 625-kg (1400-lb) dairy cow a typical urination has been observed to be 1.8 liters and a

defecation 2.3 kg (3). From these figures it can be calculated that the milking-parlor waste contained 16.2 liters (2 X 4.5 X 1.8) of urine, 105.8 kg (2 X 23 X 2.3) feces, and 1728 liters (380 imp gal) of water. In the laboratory aeration experiments a milking-parlor waste was made up from feces, urine, and tap water in the same proportions as observed in the commercial parlor.

### Aeration of Milking-Parlor Waste

The aeration system, which was housed in a 25°C constant-temperature room, consisted of a 137-liter cylindrical polyethylene tank fitted with a 1.86-cm spigot drain. Air was continuously introduced into the center of the vessel 5.1 cm above the bottom via a 0.62-cm glass tube. Large air bubbles were dispersed and complete mixing was ensured by two electric stirrers with their propellers set 5.1 cm above the air source. Operation of the stirrers was controlled by time clocks so that each operated for 15 min each hour; one on the hour and the other on the half hour. Continuous operation of a single stirrer was not possible due to motor overheating and foam buildup.

The operating volume of the aeration vessel was 56 liters. Each day 14 liters of the mixed liquor were drawn off and replaced by 14 liters of freshly prepared milking-parlor waste and 2 ml of Dow Corning Antifoam H10. This procedure provided 4 d of retention within the aeration chamber. The milking-parlor waste, 600 g of feces, 130 ml of urine, and 14 liters of tap water, was forced through a 2-mm sieve before being added to the contents of the aeration vessel. Only 5.7% of the total solids present in the milking-parlor waste was retained by the 2-mm sieve. These solids, mainly undigested chopped hay, had a high COD (chemical oxygen demand) to BOD<sub>5</sub> (biological oxygen demand) ratio (27.5:1) indicating a high degree of biological stability.

Operation of the aeration system was commenced by adding 14 liters of sieved milking-parlor waste to the vessel on each of 4 consecutive days. After reaching operating volume the system was run semicontinuously on a daily put-and-take

basis for 6 d before monitoring was commenced. Aeration was continued for 12 d after the last addition of fresh waste on day 30. Analyses were carried out using standard methods except for nitrate, which was measured by the cadmium reduction method of Kamm *et al.* (5).

## RESULTS AND DISCUSSION

### Aeration Trials

Figure 1 shows the pH of the mixed liquor in the aeration vessel during the period of semicontinuous operation (days 7-30). The change in pH between the 18th and 20th days of operation had no apparent effects on the parameters being monitored, except for the nitrogen present in the system (Figures 1 and 2). It is, therefore, proposed that nitrogen content of the waste be considered separately from the other parameters measured.

The pH change from above 8 to below

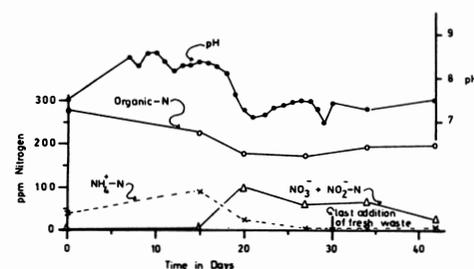


Figure 1. pH and nitrogen content of mixed liquor. (No fresh waste added after day 30.)

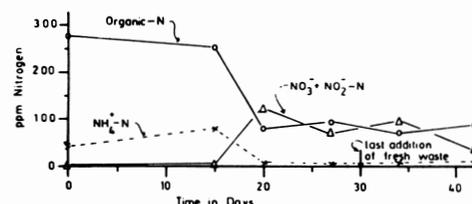


Figure 2. Nitrogen content of clarified effluent (1 h settling) of actively nitrifying mixed liquor.

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**TABLE I ANALYSES OF AERATED MILKING-PARLOR WASTE**

	Milking-parlor waste		Clarified effluent
	Mixed liquor		
	Prenitri-fication	Nitri-fication	
pH	7.6	8.4	7.4
Total N, ppm	338	319	190
BOD <sub>5</sub> , ppm	1600	1700	200
COD, ppm	7600	6200	1300
Total solids, ppm	4500	3300	1900
Vol solids, ppm	3220	2200	872
COD/BOD <sub>5</sub>	4.76	3.65	7.5
TS/VS	1.40	1.50	2.15

7.5 corresponded almost exactly with the appearance of oxidized nitrogen in the waste (Figure 1). The change in composition must have reflected the establishment of a significant and active nitrifying population. The difference of 19 ppm of nitrogen between the mixed liquor before nitrification and the input waste (Table I) was probably accounted for by the volatilization of NH<sub>3</sub>. In support of this, it was observed that the aeration unit had a strong ammoniacal odor until the fall in pH occurred. After nitrification had commenced, denitrification during the periods of no stirring probably accounted for the increased loss of total nitrogen (76 ppm, Table I). The nitrogen loss of 22.5% reported here was appreciably less than the 52% observed by Edwards and Robinson (1). This is explained by the fact that the present system was over-aerated, which led to the accumulation of oxidized nitrogen; even during the periods when the stirrers were not operating, the biochemical oxygen demand was largely satisfied by dissolved gaseous oxygen and not by NO<sub>3</sub><sup>-</sup>-oxygen.

A comparison of the analysis of the input waste and the nitrifying mixed liquor indicates that 4 d of aeration did not dramatically alter the pollution potential of the material. The very much higher COD/BOD<sub>5</sub> ratio of the mixed liquor, however, is an indication of the higher biological stability of the treated waste. Aeration did markedly improve the settleability of the milking-parlor waste. In 1 h the nitrifying mixed liquor separated into two distinct layers, the larger, 90% of the mixed liquor volume, a clarified effluent, and the remainder, a sludge of approximately 0.5% solids. The decreased COD/BOD<sub>5</sub> ratio and increased TS/VS ratio of the clarified effluent compared with the nitrifying mixed liquor suggests that the materials that settled out were largely biologically inert.

Although settling removed almost 25% of the total nitrogen present in the nitrifying mixed liquor, perhaps the only valid justification for settling is the removal of turbidity. From Figures 1 and 2 it can be seen that this nitrogen is mainly organic nitrogen and probably unavailable as little change was produced when aeration was continued for 12 d after the addition of fresh waste ceased. A similar observation was made for COD, BOD<sub>5</sub>, and total solids, which suggests that for practical purposes the treatment limit achievable by simple aeration had been reached in 4 d or fewer.

The clarified effluent, although much more acceptable than the raw waste, is not of a quality suitable for discharge into a water course (Table I). Requirements vary slightly in different areas but generally a BOD<sub>5</sub> of less than 20 ppm is required. It must, therefore, be concluded that aeration is not a suitable treatment to permit the direct discharge of milking-parlor waste to a water course.

#### Alternatives to Aeration

The question still remains, what should be done with milking-parlor waste? This liquid waste, more than 99% water, but of high pollutional strength, must be disposed of, or better still, utilized without creating either a public health or a pollution hazard.

A milking herd of 150 cows produces about 400 imp gal (1820 liters) of milking-parlor waste per day with a solids content near 4500 ppm, volatile solids near 3000 ppm, a BOD<sub>5</sub> near 1600 ppm, and a nitrogen content near 340 ppm. Domestic sewage, by comparison, has a solids content near 1000 ppm, volatile solids near 600 ppm, a BOD<sub>5</sub> near 350 ppm, and a nitrogen content near 60 ppm (2, 4).

Traditionally, isolated habitations (summer cottages, country houses, farms, etc.), have been serviced by septic tank sewage disposal systems. The sewage flow per person is usually considered to be about 50 imp gal (225 liters) per day. Therefore, a day's milking-parlor waste is equivalent in volume to eight person's sewage but in strength is equivalent to approximately four times that number.

Septic tank systems generally have a retention time of 48 h so the milking parlor under consideration would require a 1000-imp gal (4546-liter) tank. The solids from a domestic sewage septic tank have to be removed about every 2 yr (8). Assuming that solids breakdown to the same degree, then the milking-parlor septic tank would have to be pumped out every 6 mo because of its higher solids load.

The operating pH of a septic tank is usually between 5 and 6 (4). This pH is low enough to cause milk to clot. Therefore, if waste milk gets into the milking-parlor waste, as it does particularly during outbreaks of mastitis, then both the tank and the disposal bed can be expected to become plugged with clotted milk. Just such a failure of a septic tank disposal system occurred in 1971 at the University of Guelph's Dairy Experimental Station at Elora, Ontario. Although a septic tank system is quite capable of handling the volume of waste from a milking parlor, it is unlikely that it can cope with the high strength of, and wasted milk in, milking-parlor effluents. Furthermore, as shown below, the use of a septic tank for this purpose would release nitrogen into soil at a higher rate per acre than is the recommended practice for Ontario.

Another common procedure for handling liquid wastes is lagooning. For a lagoon to remain aerobic and relatively odor-free, the depth should not exceed 1 m and a loading rate of less than 2 lb (0.8 kg) of BOD<sub>5</sub> per 1000 ft<sup>2</sup> (97.64 kg/ha) surface area per day should be used (4). A retention time of about 40 d is advisable for wastes that can be treated in this way for release to surface waters, but in the case of milking-parlor waste, it is unlikely that effluents would be acceptable for surface water discharge. Thus, a lagoon would have to be considered as an odor-controlling storage facility and sized accordingly. Periodically the contents would be pumped out for spreading by tanker, spray, or furrow irrigation. In Ontario the recommended maximum rate of application of nitrogen for disposal is 300 lb/acre (336 kg/ha) (7). If all the milking-parlor waste produced throughout the year in the unit under study were spray-irrigated, 1.5 acres (0.61 ha) of land would be required so as not to exceed this value. The area would receive about 4 inches of waste per year.

#### CONCLUSION

It is concluded that aeration, followed by surface water discharge, and septic tank disposal are unacceptable practices for disposal of milking-parlor waste in Ontario. Storage in an aerobic lagoon combined with spray or furrow irrigation is a feasible alternative but is hampered by the winter conditions prevailing in the province, which obviate winter irrigation and lead to odorous conditions in spring. Finally, where the manure is already being handled as a liquid, the most satisfactory alternative would appear to be combining the milking-parlor waste with the manure. A dairy cow produces about 45 liters (1.6 ft<sup>3</sup>) of feces and

urine per day but only contributes about 14 liters (0.5 ft<sup>3</sup>) of milking-parlor waste. The liquid manure storage capacity recommended in the Canadian Code for Farm Buildings 1970 (6) is 66 liters (2.2 ft<sup>3</sup>) per cow per day, which includes a 40% dilution factor. It would therefore be possible to incorporate the milking-parlor waste (about 30% of the manure produced) into properly sized storage systems without increasing volume requirements. Equipment requirements would be simplified and the watery milking-parlor waste would tend to improve the handling characteristics of the manure.

Combination of milking-parlor waste and liquid manure is recommended in Clause 1.3.2.4. (1) of the Canadian Code for Farm Buildings 1970 (6) where liquid storage is available. However, the Code recommends that a sedimentation tank and underground disposal field be used for milking-parlor waste where manure is being handled as a solid. This system, essentially a septic tank, is subject to the shortcomings outlined above. Lagooning, followed by irrigation or tanker spreading, should prove much more satisfactory.

#### SUMMARY

Four days' aeration of milking-parlor

waste produced a clarified effluent with a BOD<sub>5</sub> (biological oxygen demand) of 200 parts per million, nitrogen content of 200 parts per million, and a total solids content of 1900 parts per million. This effluent is not of a sufficiently high standard for direct discharge into a water course. Septic tank disposal, lagooning, and spray irrigation of milking-parlor wastes are discussed. It is concluded that milking-parlor waste should be combined with liquid dairy manure for disposal when circumstances permit. If manure is being handled as a solid then milking-parlor waste should be lagooned and applied to land by irrigation or spreading.

#### ACKNOWLEDGEMENTS

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