LAGOONS FOR FARM WASTES

George L. Pratt, James C. Converse, Richard L. Witz, Robert G. Butler and Jesse L. Parsons

Some of the first lagoons for farm wastes were put into service in North Dakota in 1960. A few of these lagoons are still in operation. They can be used to indicate how such disposal systems can be expected to perform in the kind of climate found in North Dakota.

The first lagoons installed were designed to receive all solid and liquid wastes from livestock buildings. Most systems were used in hog production facilities. In many of the systems the building floors were cleaned with water so the wastes were diluted before they entered the lagoon. In other systems wastes were collected under slatted floors before they were drained into the lagoons. In some barns the wastes were conveyed through gutters by mechanical gutter cleaners. In the latter two systems wastes in the lagoons were undiluted. Some lagoons received wastes on alternate days. In other cases intervals between loadings ranged up to several weeks.

Dr. Pratt is professor, Converse is former graduate research assistant (now graduate assistant at the University of Illinois, Urbana), Witz is professor, Department of Agricultural Engineering, Butler is professor, Department of Civil Engineering, and Dr. Parsons is professor and chairman, Department of Bacteriology.

Solids Accumulate

Seven years of experience shows that reduction of solids in livestock waste lagoons generally occurs at a slow rate in North Dakota. Reports from users indicate that buildup of solids may be a major problem in lagoon management. While lagoons are frozen, low temperatures retard the activity of the micro-organisms that decompose wastes. Decomposition in the summer is often not adequate to break down the winter accumulation of solids. It has been found necessary to drain some lagoons and remove the accumulated solids at least once a year to keep them in service.

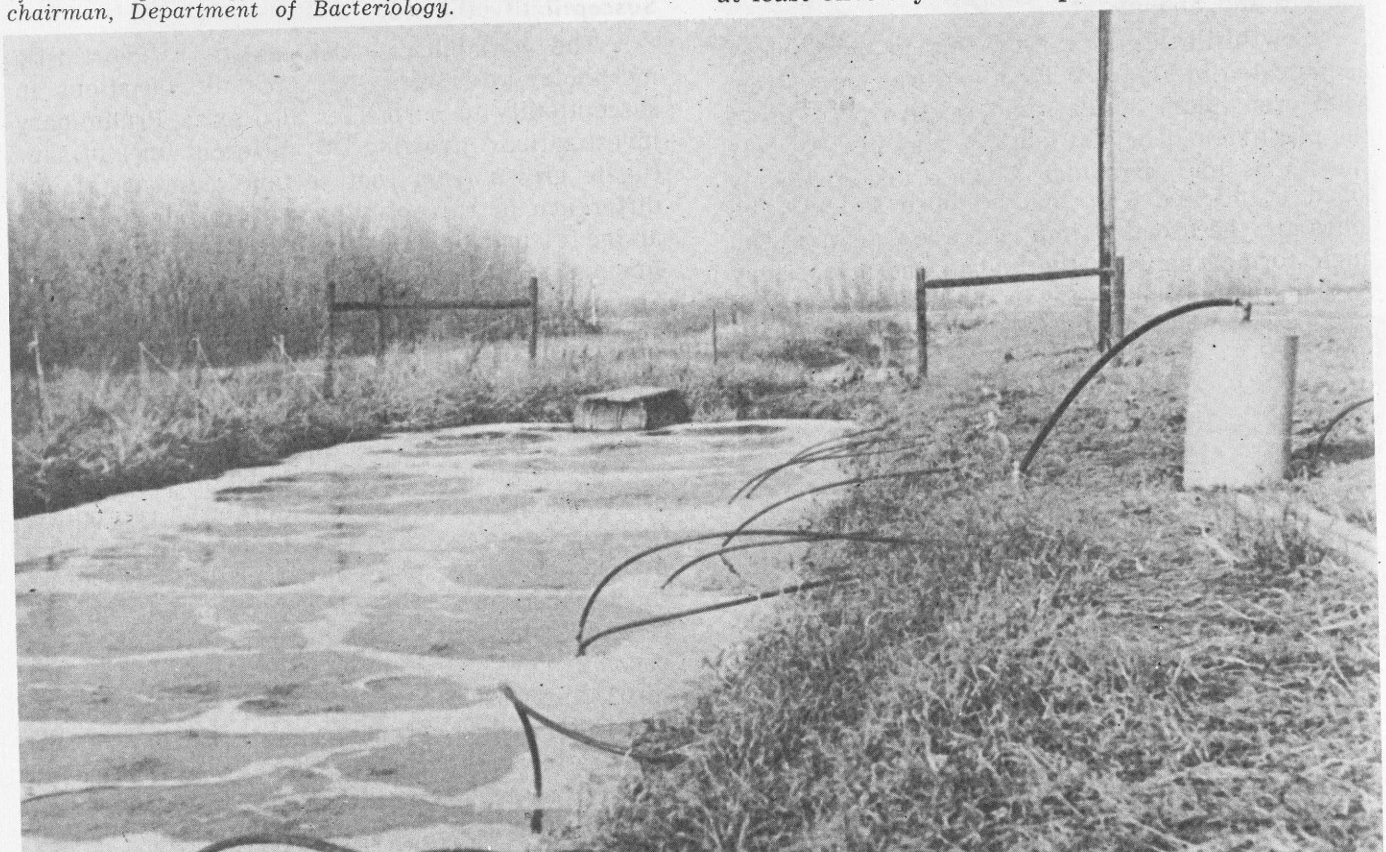

Figure 1. High volume aeration of test lagoon.

A second problem is the odor generated by the lagoons in the summer. These odors can be partially controlled by enlarging the lagoons, aerating them or adding chemicals to the wastes.

Research at North Dakota State University has been directed toward modifications needed to help overcome some of the limitations associated with existing farm lagoons. A test system was designed to serve a hog barn. It includes a lagoon that receives waste water from a settling tank placed between the hog house and the lagoon. The barn floor is cleaned by flushing with water. Solids collect in the settling tank and are pumped and hauled away in slurry form in tank wagons. The lagoon is used to treat the water overflow from the settling tank. This eliminates the need for transporting to fields the large volume of water mixed with the wastes during the washing process.

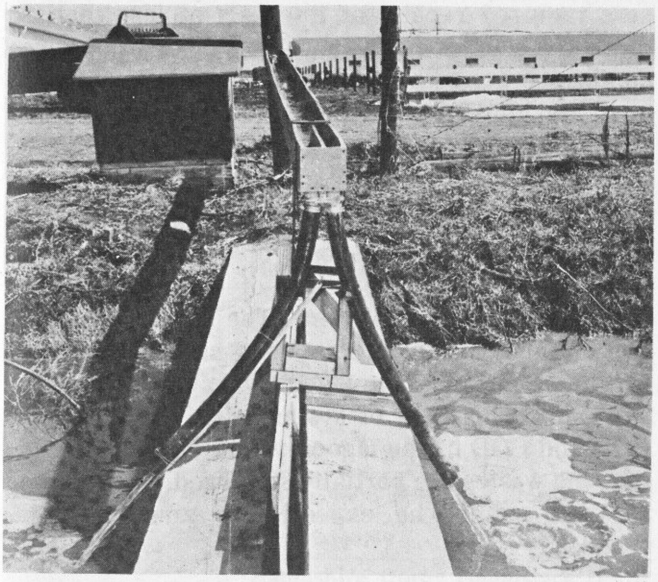

Figure 2. Trough used to divide liquid manure influent to test lagoons at North Dakota State University.

Figure 3. Tubing used in low and high volume subsurface aeration.

The barn associated with the experimental lagoon is divided into 34 pens, each 8 feet by 10½ feet. The lagoon that receives the water from the settling tank is 200 feet long and 20 feet wide. The average depth is about 3.25 feet and the maximum depth is 6.5 feet. The bottom of the lagoon has a parabolic shape. The lagoon has an estimated capacity of 13,000 cubic feet. The test lagoon is illustrated in Figures 1 and 2.

Method Evaluated

A system designed to evaluate the benefits of low volume aeration was installed in this lagoon. The lagoon was divided into two chambers, each 20 feet wide and 100 feet long, with a plywood divider. Material coming into the lagoon (influent) was divided into two equal parts for delivery to the two compartments. One compartment was aerated with about 3.75 cubic feet of air per minute and the second compartment was unaerated. Air was delivered to the lagoon from a ½ hp air compressor through 200 feet of aeration tubing. The tubing is illustrated in Figures 3 and 4. The objective of the low volume aeration test was to determine if the slow mixing action would reduce odors and help increase the rate of reduction of the solids in the lagoon.

About 2,000 gallons of wastes were added per day to each of the two compartments of the lagoon. The Biochemical Oxygen Demand (BOD) of this waste was about 1,300 milligrams per liter (mg/1)*. Data were recorded from April 12 to July 1, 1967. Data for the sample taken at the end of the test

Figure 4. Aeration tubing attached to mats for use in high volume aeration tests.

period are recorded in Table 1. Laboratory tests were run in duplicate and averaged. COD is the abbreviation for the term Chemical Oxygen Demand.

A statistical analysis of the test data in Table 1 indicated that no differences existed between the aerated and control compartments. The BOD values of about 200 mg/1 recorded for both compartments are much lower than the value of 1,300 mg/1 measured in the influent. Either lagoon compartment therefore lowered the BOD of the wastes effectively. No measurements of dissolved oxygen were taken in either compartment, but the presence of odors indicated that anaerobic conditions existed in each. Low volume aeration apparently was of little value.

Second Test

The effects of high volume aeration were evaluated in a second test in the same two lagoon compartments that were used for the low volume aeration tests. A gasoline powered air compressor delivered 35 cubic feet of air per minute to one compartment of the lagoon through 1,260 feet of aeration tubing. Data were recorded from August 24 to November 12. Here again about 4,000 gallons of waste per day flowed from the settling tank and were divided equally between the two lagoon compartments.

Data for the sample taken at the end of the test period are recorded in Table 2. Laboratory tests were run in duplicate and averaged. The table indicates that both lagoon compartments improved the quality of the waste water. Significant differences existed, however, in the BOD values as well as the COD values. Less organic material was in solution in the aerated compartment than in the control. The reduction of organic matter achieved with high aeration demonstrates the efficiency of aerobic reduction as compared with anaerobic reduction.

Table 1. Data taken at end of low aeration test period.

	Aerated Compartment	Control Compartment
Total Solids (mg/1)	1701	1706
Organic Matter (mg/1)	758	741
Suspended Solids (mg/1)	307	285
BOD (mg/1)	207	197
COD (mg/1)	1153	1150

*Quantities are reported in units of milligrams of material per liter of sample. One mg/1 is equal to one part per million (ppm) by weight.

Table 2. Data taken at end of high aeration test period.

	Aerated Compartment	Control Compartment	Influent
Total solids (mg/1)	1876	1915	3614
Organic matter (mg/1)	674	723	2184
Suspended solids (mg/1)	105	114	1253
BOD (mg/1)	62	130	1156
COD (mg/1)	441	590	3903
Dissolved oxygen (mg/1)	3.7	0	——

Odor Reduced

Dissolved oxygen was found in the water of the aerated lagoon, while none was found in the control compartment. More odor was apparent from the control compartment that from the aerated compartment. The aeration apparently reduced odor. During some parts of the year lagoons may overflow. The aeration improved the quality of the discharge water, but probably not enough for delivery to public waterways.

Several piston type air compressors were evaluated as aerating devices for farm lagoons. During the test period, gasoline powered compressors required repairs at intervals of less than 30 days. Experience has shown that electric powered compressors can be expected to operate continuously for longer periods, but probably not for more than one year.

In North Dakota, lagoons are serving very well as a means of managing overflow water from settling tanks. Subsoil disposal of such waste water often is impractical because of low permeability characteristics of many soils. The lagoon is a satisfactory alternative. It has been shown that high volume areation of the lagoons can effectively control odor. This type of system also will lower the BOD and COD of the lagoon water, which indicates that the wastes are partially stabilized. Low volume aeration cannot be expected to give these responses.

SUMMARY

Lagoons may provide an easier method of handling farm wastes. Both aerated and unaerated lagoons effectively disposed of wastes, research indicates, but existing lagoon systems require modifications to overcome shortcomings. High volume aeration reduced the odors and waste material faster than in untreated lagoons. Low volume aeration proved of little value in the NDSU tests. The principles of the lagoon system studied at NDSU may apply to any type of farming operation.

LITERATURE CITED

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