TEXAS WATER RESOURCES INSTITUTE
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New Technologies

Evaluating Technologies for Reducing Nutrients in Dairy Effluent

The Geotube® Dewatering System

Project Background

The Texas State Soil and Water Conservation Board, Texas Cooperative Extension, and the Texas Water Resources Institute are collaborating to demonstrate and evaluate technologies aimed at reducing phosphorus by an average of 50% from dairy lagoon effluent applied to waste application fields in the North Bosque and Leon River Watersheds. In 2005, they evaluated the Geotube® de-watering system on a 2000-head lactating cow open-lot dairy in the Leon River watershed.

Geotube® System Overview

The Geotube® dewatering system was demonstrated by the Miratech Division of Ten Cate Nicolon and General Chemical Corporation. The technology (Fig. 1) uses large porous tubes made from heavy-duty synthetic fabric that trap solids and allow water to escape.

Lagoon effluent is pumped into the tubes (Fig. 2) after alum and a polymer are added to bind and precipitate phosphorus. As the liquid leaves the porous tubes, it returns to the lagoon or is used for irrigation. Once the tubes are dried, the solids can be hauled off.

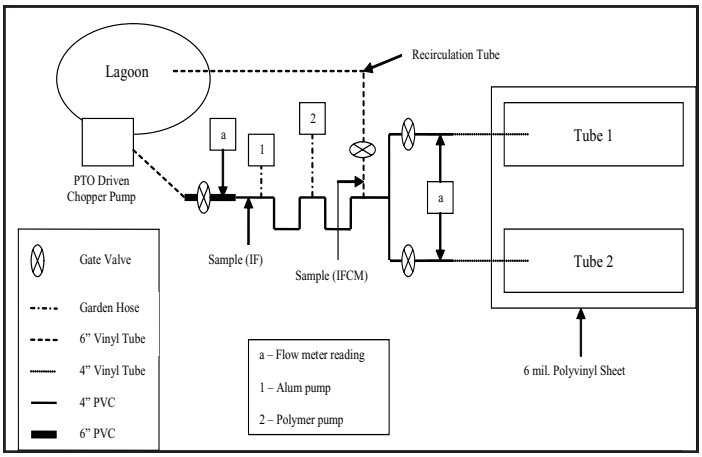

Figure 1: Geotube® dewatering system schematic (not to scale)

Geotube® System Configuration

Manure from the milking parlor at the demonstration dairy was flushed into the primary lagoon. Prior to treatment, the lagoon was agitated using a PTO-driven chopper pump (Fig. 3) for a minimum of 2 hours prior to pumping the well mixed raw effluent to the tubes.

Fig. 2: Filled Geotubes®

To prevent erosion and groundwater contamination, an impervious 6 millimeter polyethylene sheet was placed under the tubes and a felt-like fabric was laid on the down gradient end of each tube.

Raw lagoon effluent was pumped at approximately 400 gallons per minute into the Geotube® after alum and polymer are added. Once the Geotubes® were filled to a height of approximately 5 feet with the mixture of slurry and chemical (Fig. 2), pumping ceased and they were allowed to dewater for 6 months. The large geotextile filtration tubes retain the solids and allow the liquid to weep from the pores in the fabric (Fig. 5).

After the tubes are sufficiently dewatered, the residuals within the tubes (Fig. 4) are disposed of off-site.

Fig. 3 (top): Chopper pump mixing the lagoon
Fig. 4 (bottom): Residual solids in dewatered Geotube®

Results

The effectiveness of the Geotube® System was evaluated based on liquid samples collected on March 30 as the Geotubes® were being filled and April 6, 2005 after filling was completed (Fig. 5). Residual solids samples were collected on October 3, 2005 (Fig. 4). Hence, the results should be considered a snapshot of the performance of this system at the time of the sampling events.

Concentrations of liquid analytes varied little between the two sampling events indicating that the chopper pump effectively mixed the influent as it was pumped into the system. Average concentrations of nutrients and metals in the effluent from the tubes varied substantially from one sampling event to the other. It is possible that amounts of these analytes in the effluent fluctuated as the tubes continued to dewater for 6 months after the second pumping event.

Results from the three sampling events showed that the Geotube® dewatering system was highly effective in reducing phosphorus from dairy lagoon effluent (Table 1). The average separation efficiency for soluble phosphorus and total phosphorus were 88% and 97% respectively; well above the 50% reduction goal set by the TMDLs. This system was also successful in filtering solids from the lagoon effluent as indicated by the 95% separation efficiency observed for total solids.

Table 1: Separation efficiency for measured treated effluent constituents

Parameter	Separation Efficiency
Solids	
• Total Solids (TS)	95%
• Total Fixed Solids (TFS)	91%
Nutrients	
• Soluble phosphorus (SRP)	88%
• Total phosphorus (TP)	97%
• Total Kjeldahl Nitrogen (TKN)	85%
• Potassium (K)	48%
Metals	
• Calcium (Ca)	91%
• Magnesium (Mg)	65%
• Sodium (Na)	26%
• Manganese (Mn)	94%
• Iron (Fe)	99%
• Copper (Cu)	99%

Separation efficiency (Table 1) for most analytes was very high, indicating that the Geotube® dewatering system was effective in reducing solids, most nutrients, and metals in the dairy lagoon effluent.

Table 1 shows that the system effectively removed very high percentages of soluble phosphorus, total phosphorus, and total Kjeldahl nitrogen. The reduction of soluble phosphorus was attributed to the addition of the positively charged aluminum in alum binding to the negatively charged ortho-phosphorus (soluble phosphorus) rendering most of it insoluble.

Because of the high solubility of potassium, the system was only moderately successful in removing it from the influent. High percent reductions were also seen for calcium, manganese, iron, and copper.

This system was not effective in reducing sodium from the dairy lagoon effluent and only moderately effective in removing magnesium; however, for all other metals, the Geotubes® functioned as an effective filter.

Economics

It was estimated that ten 45 feet by 232 feet Geotubes®, used in conjunction with 15,000 gallons of alum and 600 gallons of polymer, will treat an estimated 1.9 million gallons of effluent from this lagoon. Estimated costs could be about $90,000 to dewater and contain 15+ year old nutrients in the Geotubes® from the primary lagoon. If consideration is allowed for costs per year (total cost divided by years of accumulated nutrients: $90,000/15 years), the real costs amount to about $6,000 per year, or $3 per cow per year. This cost estimate does not include residual solids removal and will likely vary depending on the size of the dairy and number of cows.

Fig. 5: Sampling collection from a Geotube®

When compared to conventional sludge treatment methods, Geotubes® costs are slightly higher. Using a 15-year treatment increment would result in conventional cost ranging between $0.32 and $2.03 per cow while using Geotubes® would cost $3 per cow.

Conclusions

Results from the three sampling events showed that the Geotube® dewatering system was highly effective in reducing P from dairy lagoon effluent. The average separation efficiency for SRP and TP were 88% and 97% respectively, which is well above the goal of 50% reduction set by the TMDLs. This system was also successful in filtering TS from the lagoon effluent with 95% separation efficiency.

Although this system was effective in removing P and other constituents from the dairy lagoon effluent, it was not an optimized system and must be optimized before it could be implemented as a best management practice for animal waste pollution control. To optimize the system, exact flow rates of lagoon effluent, alum, and polymer must be determined and maintained.

Remaining Issues

Maintaining a constant flow rate was an issue for this system. Because gate valves were used to control flow, solids in the lagoon clogged the valves over time, steadily reducing the flow of effluent to the tubes. As a result, the valves had to be frequently opened completely and then readjusted for the desired flow rate. Modifying the type of valves used or controlling the flow rate using a variable speed pump could solve this problem.

Another issue associated with the use of Geotubes® is disposal of the residual solids. It could be difficult and potentially costly to dispose of this by product due to rising shipping cost. Commercial composters may be willing to purchase these solids and defray some of the associated costs.

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