Manure Management at Table Rock Farm, Inc. Case Study

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Contents:

Table Rock Farm's manure storage cover

Manure Management System Summary

Solid-Liquid Separator Overview

SLS Designer	PikeSide Equipment & JESS Engineering
Date Commissioned	May 2017
Expected Life	10 years
FAN screw-press separator model no.	FAN 855 Big John
Screen Sizes	0.75mm and 0.5mm screens
Separated Solids use	Stall bedding
Input vs Output	10,000-gal manure yields 10 yd^3 separated solids

Manure Storage Cover Overview

Designer	Environmental Fabrics Inc. (SC) & JESS Engineering
Date Commissioned	September 2017
Material	60 mil HDPE
Expected Life	10 yrs to accumulated solid removal – 20-year life
Dimensions	266' x 434'
Surface Area	115,444 ft^2
Biogas Treatment	Flare
Carbon Credits sold/accumulated	No

Farm Overview

- Table Rock Farm Inc. is a 1,050-cow dairy operation, owned and operated by Willard DeGloyer and Meghan Hauser, located in Castile, NY.
- Installation of the manure management system began in the summer of 2016, and was completed in October of 2017.

Why a New Manure Management System?

Many factors led Table Rock Farm to consider alternate manure management options. Two of the motives to consider a new manure management system were:

1. Pressure to reduce bedding expenses identified to the farm by Cornell's Dairy Farm Business Summary (DFBS). Table Rock participates in the DFBS each year; the DFBS compares like-sized dairies, and a trend over the last few years had shown that Table Rock's bedding costs were higher than the farm's peers, motivating them to reduce bedding costs.
2. Environmental concerns, which included reducing methane emissions along with odor concerns that are often associated with long-term manure storages, motivated the adoption of a covered manure storage system.

Anaerobic digesters, community digesters, and a shared digester system were all carefully evaluated before choosing the solid-liquid separator, covered manure storage and flare system. Although Table Rock had seen other farms succeed in using separated solids for bedding, they were initially uncomfortable with the potential adverse effects on udder health and milk quality. Once quicklime was evaluated with a reported rapid effect on pathogen reduction in the solids, and a similar system at a neighboring farm proved successful, Table Rock Farm felt lime-treated separated solids would be effective for them as well. The separation system was an easy decision given that it had a positive economic value. On the other hand, while the separated liquid storage cover and flare were appealing for environmental reasons, the NYS Climate Resilience funding was needed to make the project economically feasible.

System Overview

A single-line flow diagram for the manure management system at Table Rock Farm is shown in Figure 1. Fresh manure mixed with soiled bedding is removed from each barn with alley scrapers, and gravity fed in sub-grade channels to a storage tank located underneath a central barn. In order to help with manure flow a portion of the liquid effluent from the separation system is recycled through the sub-grade channels to maintain flow. Manure collected in the central location is agitated every 45 minutes until pumped to the SLS influent pit located within the separation facility.

The SLS influent pit contents are agitated and pumped to a pipe manifold supplying the two separators, with overflow to return to the influent pit. The gravity fed manure makes its way through one of the two parallel FAN separation systems (see Figure 2), dewatering the solids to 37-41% dry matter.

Separated solids fall directly into an inclined conveying auger, where lime is added and mixed with the solids (see Figure 3). The lime-treated solids are discharged onto an overhead conveyor belt that transports the mix to the storage area. The storage area contains three concrete bays for the solids to be stored for 24 hours before use.

The separated liquid effluent gravity flows from the bottom of the separators to an effluent pit located within the facility. Separated liquid is held here until it is gravity fed into the long-term storage, or pumped through the raw manure channels underneath the barns. The long-term storage is covered with a 60-mil high-density polyethylene (HDPE) floating impervious cover which serves both to contain the biogas produced, allowing for collection by a below-cover gas pipe system, and act as a barrier to the 34 inches of rain the region averages annually from entering the storage.

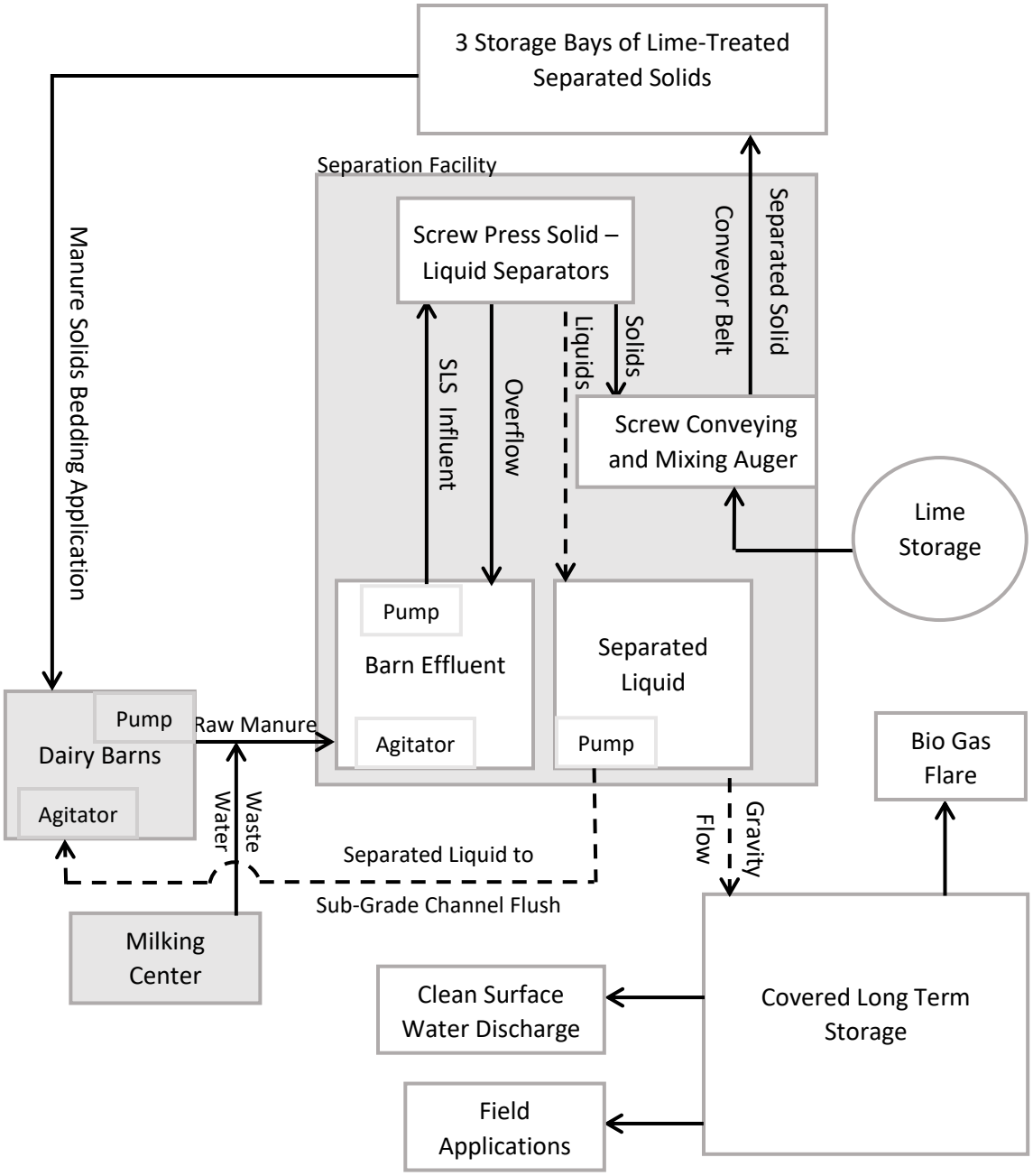

Figure 1. Table Rock Farm's Manure Management System Process Flow Diagram

Figure 2. Two parallel FAN screw-press solid liquid separators (SLS)

Figure 3. Inclined, conveying lime auger system to automate the lime addition process.

Economics

The total capital cost the SLS system and manure storage cover was approximately $1,000,000. A breakdown of the total cost is:

- Two parallel solid-liquid separators along with electric service: $250,000
- Site and concrete work: $70,000
- Building for separator, and separated solid storage (doors with automated openers, mixing pit, effluent pit, vertical wet well pump, effluent pump from separator to storage, feeder pump from pit to separator, mixing auger, mixer pump): $192,000
- Additional building aspects (railings around separators, gutter, lighting, safety equipment, ventilation, plumbing): $16,000
- Lime system (21-ton storage, auger, conveyor belt): $35,000
- Long-term storage cover: $430,000
- Engineering: $7,000

Estimated Annual Operation Costs

- Quicklime at a 5.5% by mass ratio: $70,000
- Replacement screens for SLS: $30,000
- Labor and maintenance/repair costs: $7,000

Other

- Depreciation: $30,000
- Interest on investment: $30,000

Grants Received

- Table Rock participated in the pilot round of the New York State Department of Agriculture and Markets and Soil and Water Conservation Committee's Climate Resilient Farming Program.
- 70% of the cost of the cover system ($380,000) was covered by the grant and funds were distributed through the local Soil and Water Conservation District office.

Costs were reduced on sawdust, manure hauling, and field lime, while also having the potential to sell excess bedding materials. These reduced costs and returns were greater than the farms added costs and reduced returns.

Benefits of the System

Table Rock Farm reported several advantages to the new manure management system including:

1.) Higher milk production
2.) Decreased sematic cell count
3.) Improved cow comfort
    - cow lying times have increased
    - standing bouts have decreased
4.) Odor control
5.) Cost savings on manure hauling through diverting the 34" of annual precipitation
6.) Decreased greenhouse gas emissions

The most notable benefit from the new manure management system has been the use of recovered manure solids as bedding. This has allowed the farm to cut costs on sawdust and even improved the quality of their bedding. Table Rock has sampled their recovered manure solid bedding and sent it out for bacterial counts. The results show that the bacteria count on the solids is comparable to that found in the previously applied sawdust.

Lessons and Considerations

<u>Facilities and Design</u>

- The solid storage area should have excellent ventilation for the employees retrieving stockpiled bedding. Odor and gases were initially very harsh and required the farm to install ridge fans to increase ventilation improving the work environment for employees.
- The solid storage area should be designed with a large enough space to comfortably handle equipment inside the structure.
- A larger SLS influent pit allows for easier management of the system. Initially, Table Rock thought it would be best to have the SLS influent pit and effluent pit the same size but from experience would instead recommend making the SLS influent pit larger to allow for filling without worry.
- Set up the system to take manure and parlor waste but exclude bunk silage leachate where possible. Table Rock's system includes significant amounts of leachate, and in heavy rainfalls has caused the system to run much longer than the typical day to keep the additional water from overfilling the SLS influent pit.
- It was also recommended by the farm, and their designer to have the SLS influent and effluent pits on the inside of the separator building for the ease of system maintenance.

<u>Flare Related</u>

- The flare does not run continuously in the colder months, as biogas production naturally slows when the temperature of the long-term storage drops. Table Rock

Farm has been running the flare approximately every 3 days, and from this found it is necessary to install and ensure proper function of an automatic lighting system for the flare.

Mixing of Lime into Manure Solids

Table Rock Farm designed their own system to mix quicklime into the manure solids immediately following separation. There have been a number revisions and considerations to this aspect of the system the farm noted including:

- When exposed to moisture, quicklime has the potential to corrode through various materials [3]. Aluminum and many non-reinforced plastics are not suggested for use with lime due to the known material incompatibilities. It is recommended to use corrosion resistant metals that can withstand the abrasive and caustic properties of lime [5].
- Quicklime can only be stored for limited amounts of time before quality decreases, and clumping due to humidity occurs [2]. Table Rock Farm has struggled to control the clumping of lime due to humidity, forcing them to purchase quicklime biweekly.
- Quicklime's reaction with water releases heat which may ignite combustible materials in specific instances [3]. Table Rock Farm has witnessed the smoldering of lime-treated manure solids in the storage area. Smoldering of manure solids can be caused by manure solid moisture content between 20 and 50%, combined with the pressure produced by stacking at heights greater than 7 feet [1], and the heat produced by the exothermic reaction taking place between the lime and moisture within the recycled manure solids.

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