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Anaerobic Digestion at Sunny Knoll Farms, Inc.: Case Study

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Contents:

Anaerobic digestion overview

Digester type	Plug-Flow
Digester designer	RCM Digesters, Inc.
Date Commissioned	2006
Influent	Raw manure, food waste (sugar-based syrup)
Stall bedding material	Sawdust
Number of cows	1,500 lactating, 490 heifers
Rumensin® usage	Yes; all lactating cows
Dimensions (width, length, height)	34’-4" x 190’-8"x 16’
Cover material	Soft top (Hypalon 45)
Design temperature	100°F
Estimated total loading rate	33,000 gallons per day
Treatment volume	780,000 gallons
Estimated hydraulic retention time	18 days
Solid-liquid separator	No
Biogas utilization	Caterpillar engine with 230-kW generator
Carbon credits sold/accumulated	Not currently, farm is planning to
Monitoring results to date	No; Currently being monitored with ASERTTI protocol

Farm overview

- Sunny Knoll Farms, Inc. in Wyoming County, (Perry, NY) is a third generation family farm owned by Don Butler and his three sons, Eric, Scott and Jason
- The farm houses 1,500 dairy cows in three 6-row freestall barns
- Cows are milked three times a day in a double-24 herringbone parlor
- Milk production is 25,500 lbs. on a rolling herd basis
- All lactating cows are fed Rumensin®
- Manure is spread on a land base of 2,000 acres, used to raise forage crops
- Freestalls consist of mattresses bedded with green sawdust/shavings
- At this time, the farm does not plan to switch to post-digested separated manure solids for bedding, since they do not have, and do not plan to install, a solid-liquid separator
- The farm spent considerable time identifying, investigating, and responding to multiple financial grant opportunities. After successfully receiving a cost-share from NYSERDA (through the Town of Perry) and USDA, construction of a plug-flow digester started in August 2005 and was completed in July 2006

Why the digester?

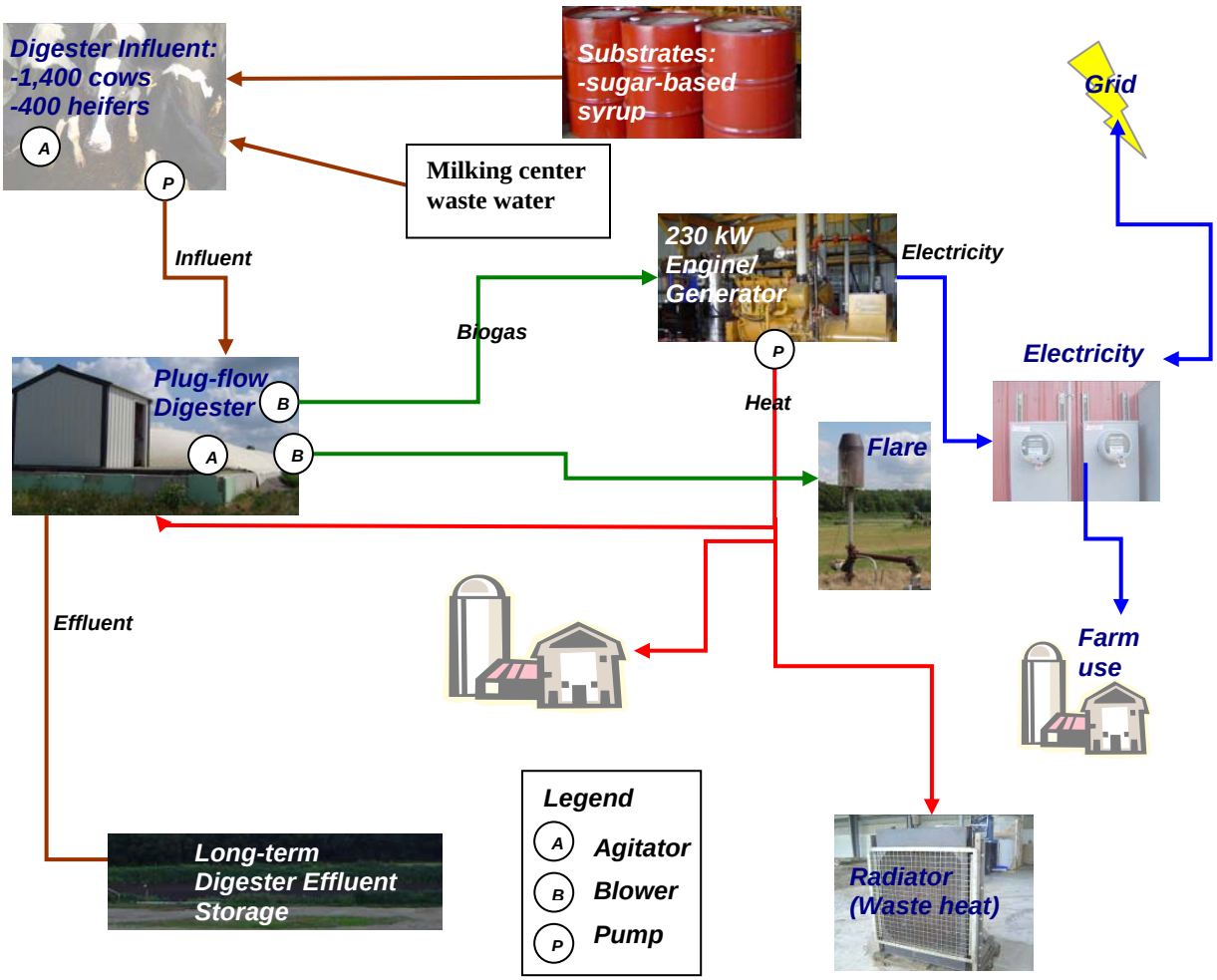
Unlike most other dairy farms in NYS that have constructed an anaerobic digester, Sunny Knoll's primary reason for anaerobic digestion was to offset electrical power cost. The three 6-row freestall barns are outfitted with cow cooling fans located above the feeding area and the freestall rows. Fan electrical loads along with the electrical demands of cooling milk are significant, thus the farm desired to reduce their annual cost of power. Farm odor was not a significant issue for this farm; however, a proactive approach was taken to reduce farm odors associated with spreading manure on crop fields by implementing anaerobic digestion.

An additional benefit of the anaerobic digester is the preservation of nutrients in treated manure. The risk of run-off and nutrient leaching are drastically reduced when manure is properly applied to crop land in accordance with a governing Comprehensive Nutrient Management Plan (CNMP).

Digester System

System and process description

The plug-flow digester, designed by RCM Digesters, Inc. consists of a below-grade insulated concrete tank with inside dimensions of 34'- 4" wide x 190'-8" long x 16' deep, covered with a flexible, non-insulated membrane cover. With a working volume of 784,500 gallons and an estimated influent volume of 33,000 gallons, based on manure from 1,500 dairy animals, the estimated hydraulic retention time is 18 days. The digester, influent pit and support building were constructed by hired Pro-Construction contractors.



Liquids and solids process description

Currently the digester processes barn effluent (composed of manure from 1,500 cows [lactating and dry], manure from 490 heifers [15 months of age and older]), milking center wastewater, and about 5,000-10,000 gallons per week of a sugar-based corn syrup product. Occasionally, the farm allows some manure to bypass the digester and to be input directly to the lagoon (approximately once or twice per week).

A skid-steer is used to push manure and soiled bedding to centrally located manure drops in each barn, where it then flows by gravity to the digester influent pit. The digester is fed three times per day, each time for a one hour period, with a 7.5-Hp J. Houle & Fils, Inc. piston pump. A 7.5-Hp J. Houle & Fils, Inc. impeller agitator is used to blend the influent tank contents for 20 minutes prior to feeding the digester.

As of March 2009, the farm installed a 17 Hp Bauer submersible pump to provide agitation within the digester vessel. The mixer was installed half way down from each end, on the side of the digester. The mixer is run for 30 minutes following each feeding, for a total daily run time of 1.5 hours. If desired, the angle and direction of the mixer can be changed in the future.

Digester effluent flows by gravity to the farm's 9 million-gallon earthen storage. Stored material (digester effluent + rainwater) is spread on the farm's land base following their CNMP. The farm does not plan to install a solid-liquid separator, because they are concerned with possible negative affects of reduced organic matter returned to the fields.

Electrical power and heat generation

An electric blower, located in the biogas utilization building, is used to pressurize biogas prior to use in a 230-kW Caterpillar G379 engine-generator set. The engine-generator set was procured from Martin Machinery and consists of a remanufactured engine with a spark ignition system. The farm indicated that Martin Machinery guarantees a 180-kW output with this engine set when biogas is the fuel source. Engine oil changes are performed after every 700 hours of operation with Mobil Guard 450 to reduce damage to the engine from the corrosive hydrogen sulfide component of biogas. Fifty-five gallons of oil are used for each change, and 1.5 to 2 gallons are consumed by the engine every day.

Generated power is used on-farm and excess is sold to NYSEG under the provisions of the New York State net metering law (see Fact Sheet No. NM-1). Excess biogas is automatically routed to and burned by a gravity flare.

On average 185-kW to 195-kW are generated by the engine when run on biogas. Engine combustion heat is captured and primarily used to heat digester influent to 100°F and to maintain digester operating temperature. Secondary heat is also used to heat milking center wash water and to heat the newly constructed shop building adjacent to the digester and biogas utilization building. Excess heat is dispersed to the atmosphere with a heat dump radiator.

Economics

The itemized capital costs for the anaerobic digestion system are shown in the table below. Digester miscellaneous cost items include: construction supplies and materials, employee travel, and shipping charges for equipment and materials.

	Cost ($)
Digester -Site Work -Engineering design -Concrete digester (Including cover, concrete, and heating pipes) -Misc. ***Subtotal***	*40,000* *105,000* *350,000* *27,000* *522,000*
Energy conversion -Engine-generator set -Electrical wiring and control systems and plumbing -Biogas utilization building ***Subtotal***	*380,000* *145,000* *30,000* *555,000*
Family labor	*7,500*
TOTAL	**1,084,500**

The farm received funding from the New York State Energy and Development Authority (NYSRDA) totaling $414,000, as well as from the United States Department of Agriculture (USDA) totaling $95,000. This represents 48 percent of the initial capital costs. The initial estimation for project cost was $900,000. In the middle of the project the cost of copper increased significantly, accounting for a portion of the higher final project total.

Benefits and Considerations

Benefits	**Considerations**
• Odor control • Potential revenue from: 1) Value-added products 2) Reduction of purchased energy 3) Sales of excess energy 4) Efficient use of biogas production 5) Carbon credit sales • Nutrient conversion, allowing use by plants as a natural fertilizer, if effluent is spread at an appropriate time • Pathogen reduction	• Possible high initial capital and/or high operating costs • Long and tedious contracts with the local utility; may require special equipment for interconnection • Dedicated management of the digestion system • Careful attention to equipment maintenance and safety issues due to the characteristics of raw biogas

Lessons Learned

The farm reported that the following lessons were learned as a result of constructing and operating their anaerobic digester.

The entire anaerobic digester system should be completely designed and laid out prior to starting construction – especially the electrical components of the system. Engineering design was an ongoing process that resulted in construction delays that could have been avoided.

One difficulty noted by the farm during the construction process, was the repeated delay and mistakes in ordering of parts and materials. Too much of one part would be sent while there was not enough of another. This issue lies more with the companies providing supplies, but farms should be cognizant to choose reliable companies to furnish parts.

One major benefit the farm observes is the decrease in solids in the lagoon over time. Formerly, the sawdust used as a bedding material had posed several problems in the lagoon, but the farm now perceives most of the lagoon material to be liquid.

The farm believes there should always be a setup to bypass material from the digester to be sent directly to the lagoon, should problems arise with the digestion system.

Who to Contact

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