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Anaerobic Digestion at Twin Birch Farm: Case Study (Update)

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Contents:

Twin Birch Farm anaerobic digester and biogas utilization building (foreground).

Anaerobic digestion (AD) overview

Digester type	Plug-flow
Digester designer	AnAerobics/Twin Birch Farms
Date commissioned	2003
Date upgraded	2012
Influent	Raw Manure
Stall bedding material	Post-digested separated solids
Number of cows	1270
Rumensin® usage	Intermittently
Dimensions (L × W × D)	140 × 40 × 14 ft.
Cover material	Concrete hard-top
Design temperature	100°F
Estimated total loading rate	~30,000 gal. per day
Treatment volume	586,500 gal
Estimated hydraulic retention time	20 days
Liquid-solid separation	Yes
Biogas utilization	Guascor 225 kW; biogas fired boiler
Carbon credits sold/accumulated	No
Monitoring results available	No

Farm overview

- Twin Birch Farm, owned by Dirk Young, is located in Cayuga County, New York
- The farm milks 1,270 Holstein cows.
  - The AD system was commissioned in 2003 (See: Anaerobic Digestion at Twin Birch Farm: Case Study) with several equipment upgrades made on an ongoing basis and a new biogas utilization system added in 2012.

Why the digester?

Twin Birch Farm built their AD system for energy savings, to prevent the environmental and soil compaction impacts of daily manure spreading, and to avoid odor issues associated with long-term manure storage. System upgrades were made in 2012 to replace corroded equipment, reduce biogas leaks, replace the microturbine system with an internal combustion engine to reduce maintenance and improve overall energy generation system performance.

Digester system

System and process description

The AD system has several subsystems (see Figure 1.) including:

- Manure collection
- Anaerobic digestion with external shell and tube heat exchanger
- Digester effluent solid-liquid separation
- Separated solids handling for use as bedding
- Transfer system for separated liquid effluent to remote long-term storage
- Hydrogen sulfide biotrickling filter (scrubber)

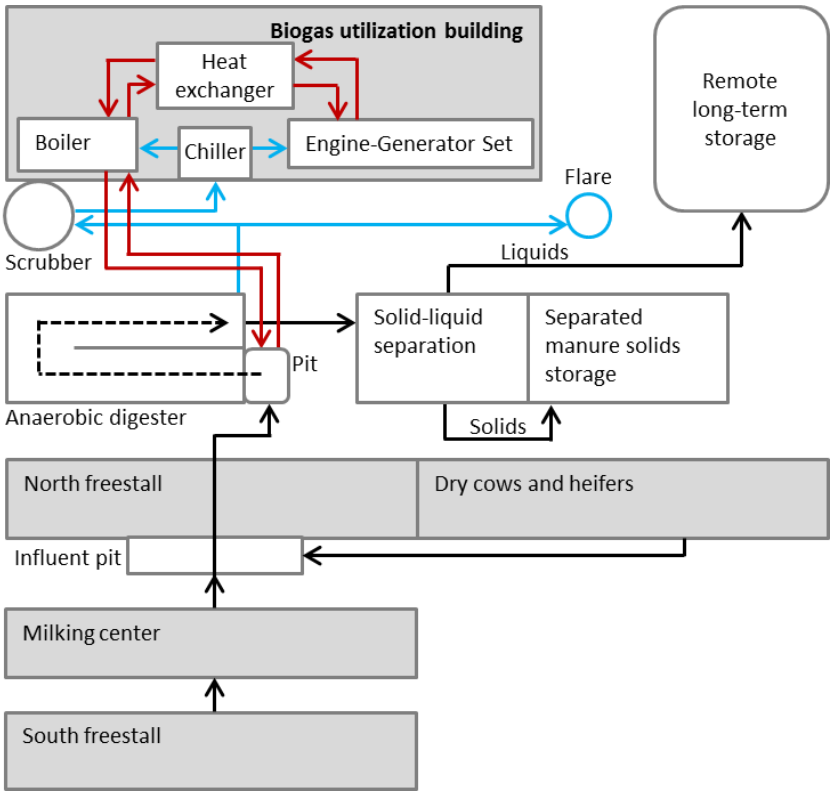

Figure 1. Schematic of Twin Birch Farms waste management, anaerobic digester, combined heat and power generation and usage systems. Flows for organics/wastes are in black, biogas is in blue, and recovered heat is in red.

Liquids and solids process description

The AD system treats manure from 1,270 dairy animals, bred heifers, some beef cattle, milk house wastewater, and spent bedding. The influent is pumped from a centralized collection pit to a pre-digestion pit. In this 20 ft. × 20 ft. pit, sand and gravel are allowed to settle and the influent is heated.

The digester is a below-grade, rectangular insulated concrete tank, with a concrete hard top. The system has a hairpin design with impeller mixers used for in-vessel agitation. The influent is pumped into the digester for 3 minutes every 15 minutes (4 times per hour). A shell and tube heating system is used to pre-heat influent. The loading rate is ~ 30,000 gal. of manure a day depending on manure production. Hydraulic retention time is ~ 20 day. A blower, controlled by pressure sensors and a variable frequency drive, is used to keep the headspace of the AD system equal to atmosphere to minimize biogas leaks.

Digested effluent is pumped to a FAN screw-press, solid-liquid separator with liquid effluent pumped by a 160 HP centrifugal pump to an earthen long-term storage ~7,500 ft. away and 220 ft. upslope. Separated solids are stacked in a roofed area and either used for freestall bedding, sold or recycled to the land base.

Biogas Utilization

Combined heat and power generation

The biogas goes through an American Biogas Condition, LLC designed H_2S scrubber and multi-step dewatering process prior to use. The biogas is used to power a Guascor 225 engine generator set (capacity factor of 96%, Figure 2.) and a WL-90 Columbia boiler (1,260,000 Btu per hr). Heat recovered from the engine exhaust and generate by the boiler are used to heat the digester. Electricity is net-metered with NYSEG.

Figure 2. The engine-generator set at Twin Birch Farms.

Economics

Costs

The total capital cost of the original AD system was over $1,300,000 (Gooch & Pronto, 2008). The cost of the 2012 upgrades (replacement of microturbines with internal combustion engine, installation of an aftermarket hydrogen sulfide scrubber and demisting system, new boiler, and new biogas chillers) was nearly $500,000.

Typical annual operating costs are estimated to be in ~ $20,000.

Incentives

NYSERDA provided capital cost sharing.

Income & Savings

The AD has resulted in multiple farm savings.

- Reduction in electricity cost (based on a long-term average of $0.07 per kWh): $130,000
- Reduction in water heating cost (based on current oil prices): $10,000
- Other hard to quantify (non-tangibles) include the significant reduction in farm odor and surface water quality impacts.

Lessons Learned

There were many difficulties Twin Birch Farm had to overcome in order to successfully operate their AD system and efficiently utilize the generated biogas. These include problems with the initial AD system design, the use of a hardtop to contain biogas, the heating system and the use of microturbines. These obstacles and the lessons learned are discussed in detail in an earlier case study (Gooch & Pronto, 2008).

One of the obstacles outlined in the earlier case study were issues associated with pressurizing gas and efficiently operating the microturbines. The farm has since switched to a Guascor internal combustion engine and notes much lower maintenance problems. As high pressure gases are no longer needed and biogas leaks from the hardtop digester were still creating odor problems, an automated blower was installed to keep the biogas headspace at zero pressure.

Another perpetual issue the farm has dealt with while operating their digester has been biogas-induced corrosion. As part of recent updates, the farm has begun to replace metal plumbing on the 'wet' side of the coolers and scrubbers with plastic, noting that even 316 stainless fittings have corroded.

Contact Information

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References

Gooch, C. & Pronto, J. 2008. Anaerobic digestion at Twin Birch Farm: Case Study. http://www.manuremanagement.cornell.edu/Pages/General_Docs/Case_Studies/TwinBirch_case_study.pdf