Cornell University

Manure Management Program

www.manuremanagement.cornell.edu

PRO-DAIRY

Anaerobic Digestion at Emerling Farm, Inc.: Case Study

Dept. of Biological and Environmental Engineering, Cornell University

Curt Gooch, P.E. and Jennifer Pronto
February 2008

Contents:

Anaerobic digestion overview

Digester type	Plug-Flow
Digester designer	RCM Digesters, Inc.
Influent	Raw manure
Stall bedding material	Separated manure solids
Number of cows	1,100 dairy cows
Rumensin® usage	
Dimensions (width, length, height)	
Cover material	Soft top (Hypalon 45)
Design temperature	100°F
Estimated total loading rate	48,000 gallons per day
Treatment volume	1.2 x 10^6 gallons
Estimated hydraulic retention time	20 days
Solid-liquid separator	Yes; separated manure solids used for stall bedding
Biogas utilization	Caterpillar engine with 230-kW generator
Carbon credits sold/accumulated	No
Monitoring results to date	No; currently being monitored with ASERTTI protocol

Farm overview

- Emerling Farm, Inc. in Perry, NY is a second and third generation family farm operated by John and Betty Emerling and Mike and Elizabeth Emerling. The farm was started in 1960 with 25 cows.
- Presently the farm houses 1,100 total dairy cows in two east/west oriented 6-row freestall barns, with plans to grow the business to 1,500 cows via internal growth
- Cows are milked three times a day in a double 20 parallel parlor
- The farm raises forage crops on 2,400 acres of land
- The farm selected a plug-flow digester over a mixed digester due to the reduced capital and maintenance costs
- The farm received funding from the New York State Energy and Development Authority (NYSERDA) as well as from the United States Department of Agriculture (USDA)

Considerable time was spent identifying, investigating, and responding to multiple financial grant opportunities. After receiving grant funds from several sources, digester construction started in Spring 2005 with commissioning in Summer 2006.

Why the digester?

Unlike most other dairy farms in NYS that have constructed an anaerobic digester, the primary reason Emerling's chose to construct a digester was to offset electrical power cost. The two six-row freestall barns are outfitted with cow cooling fans located off the feeding area and the freestall rows. Additionally, a previous generation freestall barn located across the road is now used to house replacements and is tunnel-ventilated throughout the rest of the year. Fan electrical loads along with the electrical demands of cooling milk create significant costs, and thus the farm desired to reduce their annual cost of power.

Additional benefits of the anaerobic digester include: reduction of odor emissions, preservation of nutrients in treated manure for use by field crops, and reduction of risk for run-off and leaching of nutrients (when properly applied to land with a growing crop in accordance with the governing Comprehensive Nutrient Management Plan (CNMP)).

Digester System

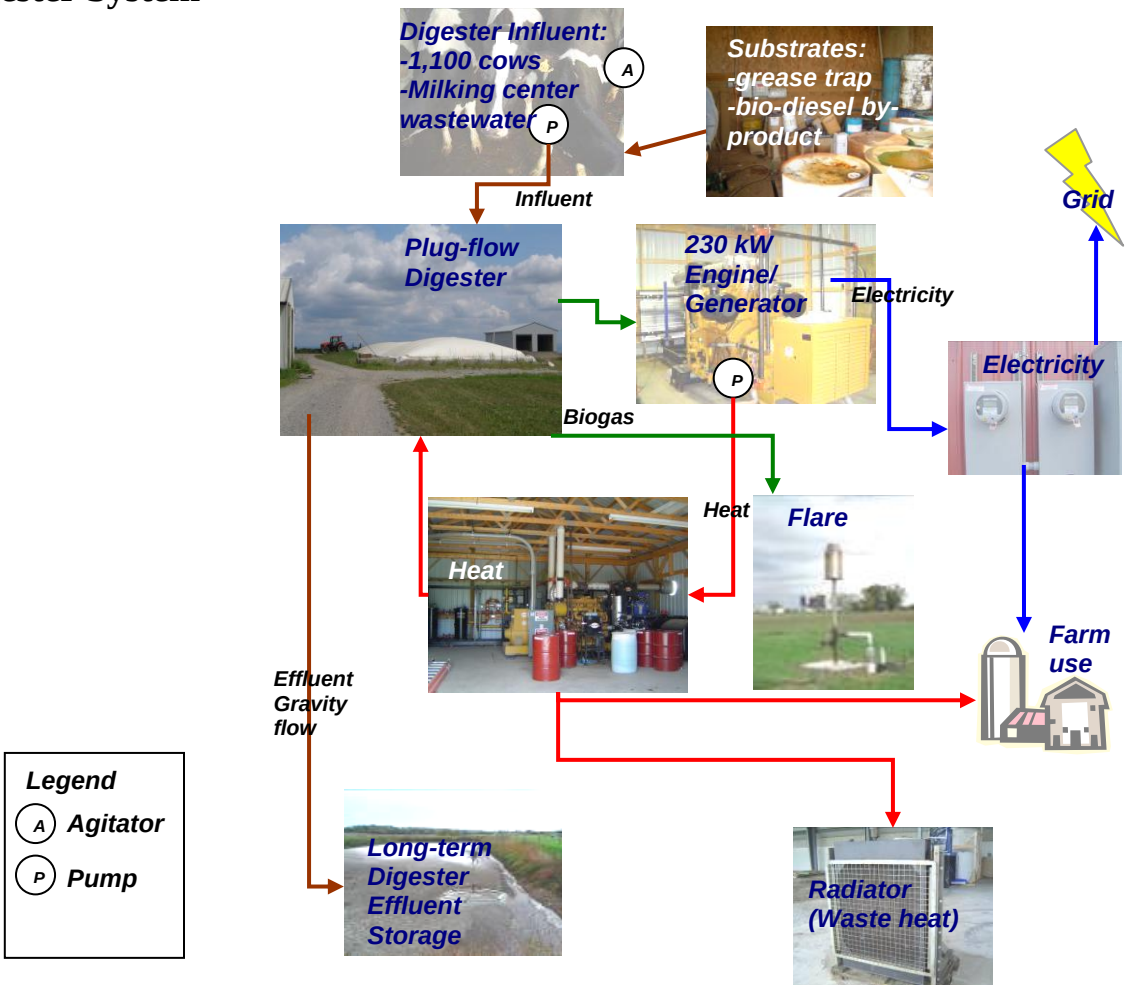

Figure 1. Flow diagram for the manure treatment system at Emerling Farms

System and process description

A 1.2 million-gallon plug-flow anaerobic digester with a design hydraulic retention time of approximately 20 days, based on manure from 1,100 dairy animals, was designed by RCM Digesters, Inc. The cast-in-place concrete digester, pre-digestion substrate holding tanks and support buildings were constructed by hired contractors.

Liquids and solids process description

Currently, the digester processes 48,000 gallons per day of barn effluent (composed of manure from 1,100 cows [lactating and dry], manure from 100 heifers [15 months of age and older]), and milking center wastewater. Freestalls are bedded with separated manure solids. Manure and soiled bedding are conveyed by alley scrapers to centrally located manure drops with a gravity flow system leading to the influent pit. A pump station, located on the south end of the north freestall barn's gravity flow system, transfers manure to the north end of the south barn's gravity flow system, where it flows by gravity to the anaerobic digester influent pit, located on the south side of the southern freestall barn. Contents of the influent pit are transferred to the digester

every 20 minutes for a five minute period with a J. Houle&Fils Vertical piston pump. An impeller agitator is used to blend the influent tank contents on a timed schedule.

The digester system was designed to utilize gravity flow for transport of digester effluent to the farm's 8.5 million gallon earthen storage. Solids passing through the digester have caused problems with the gravity flow system and thus a PTO-driven centrifugal pump is used for effluent transfer. Digester effluent is now transferred to a screw-press solid-liquid separator (SLS), installed in January 2008. Separated liquid effluent flows by gravity to the existing long-term storage and separated manure solids are currently being used for freestall bedding on a trial basis.

Material from long-term storage (digester effluent + rainwater) is recycled to the farm's land base following their CNMP. During the summer of 2008, hayfields were top dressed with stored manure; this has not been possible for the last ten years due to significant odor emissions.

Heat and electricity generation

An electric blower is used to transfer biogas through a pipe from the digester to the biogas utilization building where it is used to fire a 230-kW Caterpillar GT379 engine-generator set. The engine-generator set was procured from Martin Machinery and consists of a remanufactured engine with a spark ignition system. Martin Machinery guarantees a 180-kW output with this set when biogas is the fuel source. Surplus biogas is burned by a flare.

Generated power is used on-farm and excess is sold to the New York State Electric and Gas (NYSEG) grid 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 flare.

Engine oil changes are performed after every 500 hours of operation to reduce damage of the engine from the corrosive hydrogen sulfide component of biogas. Forty gallons of oil are used for each change.

Heat recovered from the engine is primarily used to maintain target digester operating temperature of 100°F and also for heating milking center wash water. Excess heat is dispersed to the atmosphere by a heat dump radiator.

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 • Conversion of nutrients from organic to inorganic form, allowing them to be readily utilized 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 anaerobic digester system should have been completely designed and laid out prior to starting construction. Engineering design was an ongoing process that resulted in construction delays that could have been avoided.

A complete mixed digester should have been chosen in lieu of a plug-flow digester. Formation of a crust within the digester has caused problems with the system. It is thought that the addition of restaurant grease trap waste will help reduce crust build up; the farm adds about 10 gallons per day. They also add similar volumes of a byproduct from a bio-diesel plant from time to time.

Two smaller engine-generator sets should have been chosen instead of one larger unit. Some of the engine-generator set maintenance requires down time and consequently results in the need to procure power from the local utility and increases the farm's stand-by demand charge.

Who to Contact

- Mike Emerling, Emerling Farms, Inc.
  Phone: 585-237-2548, E-mail: emerling246@hotmail.com
- Curt Gooch, Dairy Housing and Waste Treatment Engineer, PRO-DAIRY Program, Cornell University. Phone: 607-255-2088, E-mail: cag26@cornell.edu

Acknowledgements

The authors would like to thank the New York State Energy Research and Development Authority (NYSERDA) for funding in support of this work. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of NYSERDA or the State of New York, and reflect the best professional judgment of the authors based on information available as of the publication date. Reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it. Further, Cornell University, NYSERDA and the State of New York make no warranties or representations, expressed or implied, as to the fitness for particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed, or referred to in this publication. Cornell University, NYSERDA and the State of New York make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this publication.