Steady improvements in technology, environmental pressures for cleaner water and electrical power costs are improving the anaerobic outlook.

Richard Mattocks

Thirty years ago, when I was a college student studying ways to convert manure to electricity, we speculated that the 1970s would be the decade of the innovators, the 1980s for the launch of operating projects, and the 1990s when the mainstream adopted the technology. Now I think our predictions for the mainstream were ten to 15 years premature — but it is happening!

During the 1990s, the AgSTAR program successfully promoted use of manure digesters by supporting construction of more than a dozen systems throughout the continental United States. AgSTAR is a joint program of the U.S. Environmental Protection Agency, Department of Energy, and Department of Agriculture. The objective was for those interested in digesters to have the opportunity to inspect systems. The current focus on digester technology is likely the result of this program which evolved from building systems to educating about them.

Clearly, a major change in perspective has taken place from viewing production of electricity from a waste product as a “gee-whiz” element to increased recognition of this power approach as a way to support a heavily strained power grid system. Perhaps an even more compelling reason for increased acceptance of manure digesters is their ability to reduce pollutants and odor risks associated with manure. A summary analysis of a system operating on a Minnesota dairy farm cited these expected benefits of an anaerobic digester: Odor control; Generation of electricity; Thermal energy production; Potential increase in value of manure as fertilizer; Pathogen reduction; Weed seed reduction; and Greenhouse gas reduction.

As costs of fuel increase — and odor complaints from neighbors mount — animal production facilities are looking for ways to shave costs by generating their own electricity and reduce dependence on propane/natural gas to heat process water.

MARKET SHIFT

Digestion systems are attracting investors in animal production facilities and those industries which sell to animal producers. But, with few exceptions, the utility industry has been slow to value the manure digester biogas fueled engine generator concept. In past years, objections were based on unreliable performance and variable production outputs. Now these technical problems have been overcome.

Today, the utility objections are not based on technical issues. When an application for a strip mall to be connected to the grid arrives on the same day as an application for a dairy scheme for self-generation with biogas, utility personnel give priority to projects which result in more revenue. While this is understandable historically and in the short run, increasingly utilities are finding themselves short of capacity to supply power, particularly in the rural reaches. Line upgrades of tens of thousands of dollars per mile are not unusual. And when found short of capacity, the utility will face generator installation costs of $1,000 to $3,000/kW to build new generation plants.

Distributed generation is on the mind of all utilities today. That generation must still be fueled. Contrary to the vagaries of wind and rainfall (for hydro) or the tripling of the cost of natural gas, manure is an ab-
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DEVELOPMENT of at least four more animal waste processing facilities — using the same litter-to-energy-to-organic fertilizer technology as one under construction for Virginia’s poultry industry — was jointly announced by DukeSolutions of Charlotte, North Carolina, and Harmony Products of Chesapeake, Virginia. Planned for completion by late 2001, estimated construction costs for four new plants in the Southeast and Midwest is $26 million. When completed, the plants will sell energy to industrial customers in the form of steam produced by gasification of animal litter. DukeSolutions and Harmony Products will share ownership with Renewable Energy Corp. Ltd. of Sydney, Australia. The utility will focus on the waste-to-energy technology, while Harmony Products will operate the plants and market the fertilizer.

“Biomass-to-energy-to-fertilizer is a strategic alternative. Some see a ton of poultry litter and see negative environmental consequences and costs. We see a business plan and a tremendous opportunity,” says Keith Butler, chief operating officer of DukeSolutions. “Each ton of litter processed equals about $100 in revenue in terms of fertilizer and energy. Each of these new plants could process up to 100,000 tons annually or enough energy to heat 15,000 homes.”

Currently under construction, the first plant to be built by the two companies in Harrisonburg, Virginia is scheduled for completion later this year. Feedstocks to be processed will include litter and manure from poultry growers. For additional details, contact Rick with (DukeSolutions) at (704) 373-6611; or Vernon Meachem (Harmony Products) at (757) 523-2849.
Biogas output at the Haubenschild Farm is considerably higher than original projections.

The system paid itself off in five years with reductions in lagoon cleanout costs, and less propane and electric bills. That was back when electric rates were relatively low; he hasn't even tried to figure the savings to the farm now that electric rates have skyrocketed in California.

Interest in his system has greatly increased in the past six to eight months. Langerwerf doesn't have an electric bill to speak of, and the utility is actually paying him for his surplus power. "Dairy farmers are coming by to see the system, as well as government employees who are helping farms meet regulations." He tells them that he always will have manure to produce electricity.

Year in and year out, the generator has been producing power. With 320 cows, he is generating 40 kW, 24 hours a day from an estimated 24,000 cubic feet of biogas per day. Langerwerf Dairy is on its first rebuild of its second engine. Since start-up, the engines have operated about 94 percent of the time, processing over 200 million cubic feet of biogas. (See BioCycle, July, 1999 for additional information.)

MORE INCOME, LESS COAL

"The darn manure is getting to be worth about as much as the milk," was Dennis Haubenschild's message to the participants at a recent dairy show where he described performance of a heated plug-flow anaerobic digester for managing dairy manure at his 1,000 acre Princeton, Minnesota dairy.

Haubenschild Dairy has nearly eliminated propane purchases, recovering hot water from the cogeneration system for process needs and floor heat. The farm has had many visitors who want to see how manure biogas electrical generation systems can add revenue to a financially strapped industry. "While we may net $0.40 to $0.50/cow/day in milk after all expenses, we are receiving something over $.25/cow in electricity sales and savings," says Haubenschild, who also estimates that "with the amount of energy we're generating (using on the farm as well as selling to the utility), we're replacing the equivalent of 35 tons/month of coal." Plus there's a reduction in use of petroleum-based fertilizers because of nitrogen in the digestate spread on farm fields.

Recently The Minnesota Project issued a final report on the Haubenschild Farms anaerobic digester which included this information: The digester is a covered 350,000-gallon concrete tank installed in the ground, with suspended heating pipes to heat the manure inside the digester where bacteria breaks down the manure, creating methane. A 135-kilowatt engine-generator set is fueled with methane captured from the digester. The hot water to heat the digester is recovered from the engine-generator's cooling jacket and exhaust muffler. Barn floor space is also heated with the recovered heat. The digested, odor reduced effluent flows to a lined storage pond, where it is kept until it can be injected or broadcast spread on fields for crop production.

Since it started, the digester has been processing manure from 420 to 430 dairy cows, which is about half of its total design capacity. The Haubenschild Farms are planning on expanding to 900 cows by summer, 2001. According to Carl Nelson and John Lamb of The Minnesota Project, "since start-up in fall of 1999, the biogas output of the digester has steadily increased from about 30,000 cubic feet/day to about 65,000 cubic feet/day by May, 2000. This output is considerably higher than original projections. Sale of electricity generated is an important..."
HOW ON-FARM DIGESTERS PRODUCE ENERGY

TODAY’S complete-mix digesters can handle manures with TS (total solids) concentrations of three to ten percent, and generally can handle substantial manure volumes. The reactor is a large, vertical, poured concrete or steel circular container. The manure is collected in a mixing pit by either a gravity flow or pump system. If needed, the TS concentration can be diluted, and the manure can be preheated before it is introduced to the digester reactor.

The manure is deliberately mixed within the digester reactor. The mixing process creates a homogeneous substrate that prevents the formation of a surface crust and keeps solids in suspension. Mixing and heating improve digester efficiency. Complete-mix digesters operate at either the mesophilic or thermophilic temperatures range, with a hydraulic retention time (HRT) as brief as ten to 20 days.

A fixed cover is placed over the complete-mix digester to maintain anaerobic conditions and to trap the methane-rich biogas produced. The methane is removed from the digester, processed, and transported to the site of end-use application. The most common application for methane produced by the digestion process is electricity generation using a modified internal combustion engine. Both the digester and the mixing pit are heated with waste heat from the engine cooling system.

Complete-mix digester volumes range considerably from about 3,500 to 70,000 cubic feet. This represents daily capacities of about 25,000-500,000 gallons of manure/digester. Larger volumes are usually handled by multiple digesters.

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benefit of the project. Before the digester was built, Haubenschild Farms entered into a power purchase contract proposed by the local electric cooperative, East Central Energy, who greeted the project with enthusiasm and offered Haubenschild Farms a very favorable contract. By January, 2000, enough electricity was being produced to provide all the electric needs on-farm, plus enough surplus electricity to power about 45 average homes.”

APPROPRIATE DIGESTER TECHNOLOGY AND EVALUATION TOOLS

There is one last significant trend: the recent upsurge in manure digester designers claiming expertise in knowing what is needed on the farms. Enthusiasm is a desired characteristic in any endeavor. A grasp of reality based on hands-on experience is also essential. There is a risk of return to the system failures of the 1970s and early 1980s. As is often heard: “Experts are coming out of the woodwork.” The industry continues to develop and final solutions are not in place. Thinking innovators will continue to develop new approaches. The animal industry and its neighbors will continue to benefit. Initiative is good but it should be recognized as such.

Two important principles should not be overlooked in digester designs: (1) First order of business on the farm is production of animal products; the digester is secondary, and (2) Projects that generate revenue command more management attention and respect than those which lose money or are dependent on free money.

The purchasers of these technologies, as well as their lenders/investors and the surrounding community, have a right to know when a technology to be provided is established, being demonstrated or under development. The risk to achieving success can be associated accordingly. Opportunities for success are greatest when the technology provider can provide the mass and energy balance of the proposed system and can demonstrate first-hand experience at the proposed scale and with the same type of feedstock.

Richard Mattocks and his company, Environomics, are based in Riverdale, New York; phone (718) 884-6740 or visit www.waste2profits.com. Mattocks will be one of the speakers at a session on anaerobic digestion at the 31st Annual BioCycle National Conference, May 21-23, 2001 in St. Paul, Minnesota. See pages 15-17 of this issue for complete program and registration information.