Anaerobic Digestion Gets New Life on Farms

by David Riggle

Twenty years ago, the concept of farm scale anaerobic digestion was very much alive in the United States. Rising oil prices in the 1970s triggered an interest in developing alternative sources of energy, and biogas from livestock manure seemed to have real potential. The prospect of farms meeting their own energy needs - and perhaps generating enough power to sell the surplus to local utilities - was very appealing. Methods of trapping methane produced by manures in the absence of oxygen were researched and, with encouragement from federal funding, approximately 140 commercial farm scale biogas systems were constructed. According to the U.S. Department of Energy (DOE), 71 were installed at commercial swine, dairy, and caged layer farms, while another 70 digesters were constructed as university research and demonstration projects in the years between 1972 and 1982. Technologies represented in these projects included first generation covered lagoons and complete mix digesters, as well as the new plug flow digesters developed by William J. Jewell and other researchers at Cornell University in the late 1970s (see below).

ON-FARM BIOGAS TECHNOLOGY

Digesters optimize naturally occurring anaerobic bacteria to treat manure and produce biogas. They usually are covered with an airtight impermeable cover which traps the biogas for on-farm energy use. The choice of which digester to use is driven by climate and the existing (or planned) manure handling system at the facility. One of three basic options will generally be suitable for most conditions, notes the AgStar Handbook:

Covered lagoons are used with liquid manure with less than two percent solids. Generally, large lagoon volumes are required, with depths preferably greater than 14 feet. Covered lagoons generally are more compatible with flush manure systems.

Complete mix digesters are engineered tanks, above or below ground, that treat manure with a solids concentration in the range of about three to 10 percent. These structures require less land than lagoons and are heated. Complete mix digesters are compatible with combinations of scraped and flushed manure.

Plug flow digesters are engineered, heated, rectangular tanks that treat dairy manure with a range of about 11 to 13 percent total solids. The digester requires less land area than a lagoon, and can be built above ground. A plug flow digester is the most appropriate technology available for relatively high solids manure that is scraped. The system is only for ruminant manure and should not be used for swine manure, due to its monogastric manure characteristics.

Progress was being made in the field, but then the ax fell. The reduction of programs for sustainable energy projects during the 1980s, and reduced energy prices under PURPA (a program that required utilities to purchase power from independent renewable energy sources), put the nascent on-farm anaerobic digestion industry into a state of free fall.

"During the late 1970s and early 1980s, there was a lot of government money available to do these things," says Kurt Roos, program director for the U.S. EPA's AgSTAR program, which focuses on farm scale anaerobic digestion and methane recovery. "There just wasn't enough screening done of who got grant money and that helped create a history of failed projects. Some were just improperly designed for farm application using inappropriate technologies. For others that were properly designed, there was a very limited service structure in place to fix the systems if they developed problems." Regardless of the reasons, the failures contributed to the current poor technical perception of anaerobic digestion held by the livestock industry and have resulted in very limited biogas development since. In fact, by 1994, there
were only 25 commercial on-farm biogas systems still operating in the U.S., according to a DOE study, although there were at least 2,000 to 4,000 farms that could possibly benefit from the technology.

A New Approach

Over the past three years, increasing attention has been given again to on-farm anaerobic digestion systems by farmers, researchers and government officials. Interestingly, the most prominent reason has to do with a scientific reality that was barely on the horizon 20 years ago - global climate change due to methane and other human-related sources of greenhouse gases. The Clinton administration's Climate Change Action Plan, released in 1993, announced that there would be support for developing voluntary pollution prevention programs to stabilize greenhouse gas emissions to 1990 levels. One initiative to evolve from this decision was creation of the AgSTAR program within EPA and the U.S. Department of Agriculture (in cooperation with the DOE) to provide information, tools and training designed to help farmers make informed decisions about on-farm methane recovery.

"One of the first things we did when we started AgSTAR and began developing this next era of anaerobic digestion projects was to look at the history of all the past failures," says Roos. "For instance, the U.S. biogas experience taught us the technology is not suitable for all farms, but in certain situations, it can be a cost-effective method for treating manure and liquid waste." In addition, technical standards and specifications are under development. One standard for a covered lagoon has just been finished and two more - for complete mix and plug flow digesters - are in process, all based on successful commercial systems with track records. "What this really boils down to is some level of consumer protection," Roos notes. "It creates a common framework for everyone who wants to work in this industry and offers flexibility in expansion."

AgSTAR helps interested participants determine if anaerobic digestion makes sense for their operation. A computer software package called "FarmWare," for instance, provides a means of surveying potential sites, assessing energy options and applications, and selecting the most profitable installation. The AgSTAR Handbook, to be finalized in 1997, will complement the software by providing a comprehensive method to developing biogas systems at commercial farms. It will address issues such as technical design, odor control, vendor evaluation and financial performance.

Farmer interest in this information is picking up. "Right now, we're seeing the most activity in the biogas area since the early 1980s," Roos says. "In the first two years of the program, we had about 20 farms sign up each year. Between this year and last year, another 70 new farms have made a commitment to evaluate the options through AgSTAR." Calls to a program hotline increased from 70 in 1995 to over 400 inquiries through October, 1996. Four AgSTAR installations presently are under construction and expected to be completed by the end of the year. In 1997, Roos expects at least six or seven others to begin construction. "And that's not including what other people in the industry are doing," he says.
Cooperative Projects

One of the lessons learned from analyzing past projects is that biogas production is best suited for farms that handle large amounts of manure as a liquid, slurry or semisolid with little or no bedding added. While experience has shown that anaerobic digestion can make economic and operational sense on these kinds of individual farms (see below), another interesting way that the technology is being applied is through cooperative projects in which a number of farms take their manure to a central facility.

HOW THE SYSTEM WORKS AT LANGERWERF DAIRY

Leo and Linda Langerwerf installed a plug flow digester at their dairy with 350 milkers in 1982. “We’ve been operating it for 14 years, for better or for worse,” says Linda. “It’s kind of like a marriage. The system needs its first significant maintenance right now.” The project was initiated to take advantage of the California Department of Food and Agriculture’s low interest loan program that was available to dairies for the installation of anaerobic digesters as an alternative waste management tool. A plug flow digester was selected because the manure solids could be more easily removed and land application of the liquid manure can be incorporated as part of the irrigation system. The digester itself is installed in a greenhouse that protects it from the elements.

The Langerwerf plug flow digester measures 14 feet deep, 25 feet wide and 125 feet long. Black plastic covers the digester pit. Biogas is then collected under the plastic cover and suctioned through an underground pipeline to an engine that generates an average of 40 KW of electricity 24 hours/day, supplying all the farm needs before selling excess to the utility. As much as 30,000 cubic feet/day of biogas is recovered. The dairy scrapes manure into a mixing pit where water is added as needed to create the proper consistency before it is pumped into the digester. A series of pipes pump water through the digester to heat the manure to around 100 F, activating the methane producing bacteria.

In addition to heating the digester, enough hot water is produced for cleaning the milking parlor twice a day, and to heat the Langerwerf’s home. The final stage effluent is pumped into a solids separator and applied to the land for fertilizer. The separated solids are used for stall and calf barn bedding, and are sold for mulch to local gardeners. The entire methane recovery system adds about $68,000 per year to the dairy’s revenues.

The MEAD project in Tillamook, Oregon is a cooperative public/private venture involving the Tillamook People's Utility District (TPUD), the Soil and Water Conservation District (SWCD) and the Tillamook County Creamery Association. MEAD is planning to build a treatment facility that will process an estimated 145,000 gallons (approximately 560 tons) of manure per day from 40 or more farms with more than 10,000 head of dairy cattle. Liquid manure is expected to be taken by tanker trucks from participating farms to the treatment facility. Methane from the resulting biogas will fuel a generator, producing
electricity for TPUD customers. The remaining slurry will be dried and the solids converted to commercial fertilizer and soil amendments. Extracted liquid will be distributed to participating farmers for land application.

According to Gregory Booth, MEAD project manager, bids have been received and a decision on a specific developer will be made in the near future. Construction is expected to begin soon, with start-up projected for the Fall of 1998. "This really got started in 1989, but we didn't get funding to start on any scale until 1993, with most of the development money coming from EPA's Region 10 office," says Booth. The Oregon Department of Energy also provided financial assistance and Oregon State University horticultural researchers have been involved in developing fertilizer products using a 300 gallon digester.

As part of the same overall project, the Craven farm - an 800 cow dairy on the far end of TPUD's electric service territory, and a partner in the AgSTAR program - has just completed construction of a plug flow digester. "Most of the other dairies here are within a short distance of the central plant," says Booth. "If we're going to have a digester at a single dairy, they are the very largest one and it made sense to do it there." The Craven farm will serve as a pilot facility for further work with products beyond the energy that will be sold to TPUD. "The economics here really depend on creating a high quality potting soil business," Booth adds. "Having more material available from the Craven farm before the central digester comes on line will be a big help for future market development."

Nutrient Management in New York

Two of the biggest reasons farmers are becoming interested in anaerobic digestion are odor control and water quality. To comply with the federal Clean Water Act, farmers are being required to develop nutrient management plans that specify what steps they are taking to control nonpoint source pollution of surface and ground water. In New York State, the Agricultural Management Practices Catalogue describes methods (such as composting) farmers can use to address these concerns in a variety of different circumstances. Anaerobic digestion was formally approved as an acceptable nutrient management practice for the first time in April, 1996. This will enable a farmer interested in biogas to apply for some of the $2.1 million in state funds available for implementing the designated agricultural practices. "We haven't funded any anaerobic systems yet, but they are approved," says Rich Lewis of the New York State Soil and Water Conservation Committee. "The money is made available through a competitive grant process, so if a farmer wants a digester as part of his manure management system, then that would compete against other projects and technologies. Cost-effectiveness would be a big factor."

Also in New York, Jewell and Peter E. Wright at Cornell are completing a study of a potential centralized system south of Rochester in an area where there are approximately 30,000 cows within a 10-mile radius. "We've not been focusing on anaerobic digestion for a number of years," Jewell says, "but research has recently been diverting back into the area in a comprehensive and intensive way." This project, financed through AgSTAR, is examining the economic and technical feasibility of collecting manure from dairies and deodorizing it with anaerobic digestion, producing energy and returning the digested manure to participating farmers. "At this stage, the study is 90 percent complete, and under certain scenarios, results look positive," notes Jewell. A report is expected to be completed by March, 1997 that will be available through the U.S. Natural Resource Conservation Service.

Having seen the shortcomings of the industry in its earlier days, one of Jewell's main concerns with the present renewed interest in anaerobic digestion is that there are relatively few commercial providers of digester systems. "There were maybe six or seven major companies and 40 or 50 consultants who made a living in the field, and that's just not there now," he notes.

In an ideal scenario, Jewell says he can envision a delivery system in which a supplier sets up a digestion system and the farmer would then pay for the service and the maintenance, but not be required to get involved in operations. The commercial provider could service a number of farms in a given area, with
everyone aiming for 90 to 100 percent waste reduction and utilization of as many by-products as possible, including electricity, digested solids and effluent.

"The whole idea is to commercialize projects and allow a broader biogas and coproduct industry to develop," says Roos. To help this move along, AgSTAR is holding two workshops in Raleigh, North Carolina in February and March, 1997. "We hope that a lot of private sector people come and look at anaerobic digestion as a possible way of expanding their businesses, or expanding the equipment and services they sell," he says. For more information, contact AgSTAR, US EPA Atmospheric Pollution Prevention Division, 401 M Street SW (6202J), Washington, DC 20460.