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PROGRESS: Digester is Center of Michigan Manure System

Integrated manure management systems provide new opportunities for dairy producers.

Integrated manure management systems that reduce nutrients and possibly eliminate pathogens in the manure stream will change the way dairy farmers handle manure on the farm. What was once a relatively simple task of hauling and spreading manure on farm fields is evolving into a highly sophisticated process involving treatment and other operations that grant farmers flexibility and generate the potential for new profit centers.

Michigan State University researchers in the Department of Biosystems & Agricultural Engineering have been at the forefront of developing manure management systems in this country. The first component they developed for dairy farms was a sand-manure separator that took sand used for bedding out of the manure. Removing the sand allowed more flexibility in manure handling. And because the separator also rinses the sand, farmers can reuse it.

“Michigan dairy farmers have identified manure management as one of the most important challenges they face today and expect to face in the future,” says William Bickert, professor of Biosystems & Agricultural Engineering. “We are continuing to look at new ways to help farmers meet these challenges.”

A component of the integrated manure management system being investigated by MSU researchers is a fixed-film anaerobic digester that is used to convert the biomass into an energy source. The fixed-film digester has the advantage of a shorter retention time -- four days compared with 21 or more days in a plug flow system -- requiring a substantially smaller digester volume, so the digester can be built for less cost.

“Unlike the plug flow systems operating in Michigan 20 years ago, the fixed-film digesters offer new opportunities for treating animal manure, especially manure streams with higher moisture contents,” Bickert says. “When used in conjunction with other manure treatment processes, the digester reduces odors and pathogens, generates energy and sets the stage for removing nutrients from the manure stream.”

In spring 2004, Bickert and his colleagues in the MSU Department of Biosystems & Agricultural Engineering will install the first anaerobic digester on a Michigan dairy farm in 20 years.

Funding for the digester comes from the Animal Agriculture Initiative and the Michigan Biomass Energy Program. In addition, Wirth and Fedewa Construction and MPC Cashway Lumber have provided a building for laboratory equipment and instrumentation. Green Meadow Farms is providing facilities and assistance with construction.

The digester will be one component of a complete integrated manure management system installed on the mid-Michigan dairy farm. If the trial is successful, researchers expect to see more digesters in place around the state.

“Anaerobic digestion is the cornerstone of an integrated manure management system in which successive treatments may lead to a zero effluent discharge manure system,” Bickert states. “For example, phosphorus separation technologies and other innovative manure treatments benefit from the stable and consistent effluent stream produced by an anaerobic digester.”

The anaerobic digester also has the capability of destroying pathogens such as E. coli and Salmonella that may be present in the manure.

How the system works:

The first step in the process is the removal of sand and grit from the manure. The digesters used in the past were unable to handle manure with sand in it. The development of the sand-manure separator makes the digester a viable concept again.“We have used some new science along with age-old technology to develop a system that we hope will benefit today’s dairy farmers,” Bickert says. “We are going well beyond generating methane.”

From the sand separator, the manure stream travels on through a grit removal system that removes fine sand and grit particles, further reducing problems in the digester. Once the grit is removed, the manure stream goes through a grinder, then through a heat exchanger and then to the anaerobic digester.

“Through this process, all the biosolids in the manure will be included in the digestion process, increasing biogas production and reducing the stream of unprocessed biosolids,” Bickert explains.

The liquid and biosolids leaving the digester will then pass through a struvite reactor, where the phosphorus is removed in a sludge that can then be land applied or composted. The sludge and resulting compost can be sold as a fertilizer. (The struvite reactor is being constructed with a grant from the National Center for Manure and Wastewater Management.)
The liquid leaving the struvite reactor, with very low concentrations of biosolids and nutrients, will then be directed to a constructed wetland.

“The wetland effluent may be used for irrigating crops, for flushing in the barn or for other purposes, if disinfected,” Bickert says.

Evaluating the results:

A team of researchers from the departments of Biosystems & Agricultural Engineering and Civil and Environmental Engineering will evaluate the integrated manure management system at each step in the process. Samples from each process will be collected and tested to determine the effectiveness of the complete system.

Jim Wallace, a graduate student in biosystems engineering, is studying the use of an anaerobic membrane as a part of the system to determine the impact on digester efficiency and on reduction of pathogens.

Already the researchers have conducted hundreds of experiments in the lab, evaluating various manure characteristics. These research trials will be beneficial when designing individual farm systems.

“Integrated manure management systems can be tailored to individual farms, depending on the needs and goals of the operation,” says Dana Kirk, graduate assistant in biosystems engineering. “Individual farm operations may not need every possible treatment component but may

implement those that are useful on their farm.”
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