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THE WHEY TO RENEWABLE ENERGY

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Looking for ways to better manage their waste streams, a cheese plant will install an anaerobic treatment system that also will service a nearby ice cream cone factory. Biogas generated will offset heat and power costs.

Diane Greer

WHEN Tom Wilson with the Pennsylvania State University Cooperative Extension set out to study the feasibility of a community-based anaerobic digester in Mercer County, he initially analyzed processing manure collected from area dairies and food wastes gathered from the local college, nearby prisons and industrial food processors. But the economics of transporting the materials just did not make sense, Wilson explains.

But what did make sense, after further investigations, was an anaerobic treatment system to process food wastes at the local cheese plant operated by John Koller and Sons. The facility - the Fairview Swiss Cheese plant - is located in Fredonia, Pennsylvania and produces nine million pounds of Swiss cheese a year.

Making cheese produces substantial quantities of organic waste. “The by-product of the cheese making process, which is the cheese whey, is always an issue,” says Richard Koller, president of John Koller and Sons. “What do you do with it? Where do you get rid of it?” Protein in the whey, the most valuable component, is removed and sold as an additive for food products and animal feeds. What remains is lactose permeate, also known as whey permeate. The lactose permeate can be dried and sold, but the cost of the equipment and the energy required to process it exceeds the revenue generated.

Currently, whey waste is disposed on fields as fertilizers. “But as you increase your volumes, you need more field space,” Koller says. “The DEP [Pennsylvania Department of Environmental Protection] is concerned with it.” Application is limited to certain locations to prevent nutrient overloading of fields. Runoff and odors are also a concern.

WASTE SYNERGIES

In addition to the waste from the cheese plant, the anaerobic treatment system that will be installed at Koller's facility will process wastewater from the Joy Cone Company, a manufacturer of ice cream cones. The Cooperative Extension hooked up the two businesses. Joy Cone was facing problems with wastes containing high levels of BOD (biological oxygen demand) going into the municipal sewer system and was looking for ways to clean up the waste and avoid paying surcharges, Koller explains.

Testing of the Joy Cone waste showed it to be rich in sugars. “Their volume is not as great as mine, but the sugars that it had in it for the volume will generate a sufficient amount of methane to benefit my project,” Koller says.

Joy Cone produces 10,000 to 12,000 gallons of wastewater a week. When combined with the wastes from Koller, which include whey from the cheese making process and wastewater from cleaning equipment, the treatment system will process close to 50,000 gallons a day.

The feasibility study showed that Joy Cone could send the waste to Koller, pay for the transportation and a tipping fee and still save money over other pretreatment options, Wilson says. Final details on the financial arrangement between Koller and Joy Cone were not disclosed.

TREATMENT VERSUS DIGESTION

Ecovation is installing a Mobilized Film Technology (MFT) anaerobic treatment system at Fairview. The company distinguishes its system, which performs anaerobic treatment, from anaerobic digestion. “We are going after liquid waste streams where the solids are already solubilized,” explains Sarah Ploss, Vice President of marketing for Ecovation, based in Victor, New York. “Anaerobic digestion, on the other hand, deals with solids like cow manure.”

Since the MFT only processes liquid waste streams, the system skips the hydrolysis step in anaerobic digestion, which dissolves particulate matter into solution by breaking down solids into volatile acids. Eliminating hydrolysis results in a two-step process to produce

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biogas. First, acid-forming microbes in the tank break down the solubles in the waste stream into fatty acids. Then bacteria, called methane formers, convert the acids to methane gas and carbon dioxide.

Eliminating the hydrolysis step also speeds up the process considerably, explains Bob Cummings, CTO and Senior Vice President of engineering at Ecovation. “Once the solids are in solution, it is just a bacteria numbers game. The more bacteria you have, the faster you can go.”

MFT technology is able to mobilize tremendous concentrations of bacteria within the reactor by using a medium of tiny inert particles of silica oxide, basically a mason sand type material. The microbes attach to the sand particles arranged in a trough at the bottom of the reactor. “The bacteria we use work at higher rates attached to the medium than they do in solution,” Cummings explains. The small particles maximize the surface area supporting microbial growth in the reactor, thereby maximizing the number of bacteria. Nozzles at the bottom of the tank send the wastewater up through the trough of sand with the attached bacteria. The nozzles fire sequentially to optimize the upflow of wastewater through the medium. The system results in high organic loading rates and treatment efficiencies that reduce retention times. In the Fairview installation, retention times are estimated at one to two days, Cummings says.

A control system, referred to as the PLC, utilizes sensors in the MFT tank to monitor alkalinity. If pH levels drop below a certain level, the system slows the pumps feeding the reactor. This allows the methane formers, which convert the fatty acids into methane, to “catch-up,” Cummings explains. “The PLC controls the loading to the reactor in such a way that the environment around the bacteria is always optimal, thereby we grow the bacteria faster and you maintain the highest rates - pH control is the key.”

Net flow rates of wastewater vary through the course of the day depending on the cheese making process. To accommodate the varying rates, the treatment system employs an equalization tank at the beginning of the process that stores the wastewater and controls the flow to the digester. Wastewater from the equalization tank flows into a preconditioning tank, with a retention time of 10 to 20 minutes, where it is heated to 35°C and treated with nitrogen.

During the cheese making process, most of the nitrogen is drawn from the solution. “There is no nitrogen in the wastewater, so we usually need to add back a little nitrogen to allow the bacteria to grow,” Cummings says. “We are literally making a balanced diet that is all up to temperature prior to feeding it to the reactor.”

PROCESS BY-PRODUCTS

Liquid effluent is removed from the top of the tank and fed into two existing aerobic sequencing batch wastewater treatment systems. The added wastewater from the Joy Cone Company will not be a problem for the aerobic systems since the anaerobic process will have removed approximately 95 percent of the BOD, Koller says. “We will finish polishing the water in our aerobic treatment plant and then discharge it to the creek.” Solids still need to be disposed, but the volume is less after the digestion process.

The current plan is to dispose of the solids in a landfill. Testing and new permits would be required to land apply the solids. “Even the DEP told me that it would be simpler to take it to a landfill,” Koller says. “You do not have to do the testing or go through the permit process. So if DEP says to take it to a landfill, it is less work for them and less work and expense for me.”

Wilson hopes that over time a new set of permits will be obtained to allow land application of the treated wastes. The system is expected to generate 40 million cubic feet of biogas a year, equivalent to 28 million cubic feet of natural gas. Biogas from the reactor will be cleaned to remove sulfides and sent through a chiller to take out the water vapor.

The current plan is to utilize the biogas to fire a combined heat and power system (CHP). The generator will produce electricity for internal use and sale to the power grid. Heat produced by the generator will be captured to heat wastewater for the anaerobic treatment system and produce hot water for various process energy requirements, thereby reducing fuel oil usage, Koller says.

REDUCING ENERGY COSTS

Installing an anaerobic treatment system at Fairview will substantially reduce Koller's energy costs. Making cheese is an energy intensive process, Wilson explains. Heat is required to pasteurize the milk and process it into curds and whey. “The entire process is highly automated requiring a lot of electricity and a lot of fuel oil to make steam,” Wilson says. “The system gives Koller some security in his long-term energy costs.” Pricing caps are expected to come off electricity in the near future, which will cause electricity costs to increase by 40 to 50 percent.

Pennsylvania's new net metering laws, which govern how utilities compensate customers who generate their own power, provide a real opportunity for projects to move forward that might not otherwise make economic sense, Wilson adds. Prior to the new rules, electricity generation was limited to 200 KW and companies could only generate power for onsite usage. Under the new rules, sites can generate up to 3 MW of power to offset their current power usage and sell any excess to the grid.

Utilities are required to purchase electricity produced to offset a customer's current electricity usage at retail rates. Any electricity produced over a facility's current usage is sold at the wholesale rate or whatever rate the company negotiates with the power company, Wilson explains.

In Koller's case, the project would still be viable even without net metering, but the biogas would only be used to offset fuel oil purchases to generate steam as opposed to firing a CHP system. “It would not be as efficient a use of the gas,” Wilson explains. “We have uses here for both heat and electricity. So the question was how do we match and maximize the production of biogas to benefit John Koller and Sons.”

GRANTS REDUCE PAYBACK PERIOD

The total cost for the system is about $2.2 million, Koller says. Two grants, a $370,000 Energy Harvest Grant from the DEP and a $500,000 9006 Renewable Energy grant from the USDA will help pay for the system. To qualify for the Energy Harvest Grants, projects had to simultaneously reduce or supplement the use of conventional energy sources and lead to improvements in water quality. The grants are also intended to promote and build markets for renewable energy technologies.

The Energy Harvest grant was done in conjunction with Penn State which charged a small fee for handling the grant. "I also gave them the right to use the system for any educational purpose they want," Koller explains.

"The grants are really important to enabling these projects to go forward," Wilson says. Without them, payback was estimated at around 15 years. But Koller believes he would still move forward with the system even without the grants. "The alternative was to install a system to convert the whey permeate into a powder for sale. I would have invested the same amount of money, the operating expense would have been ten times greater and I would not have generated as much revenue."

Payback for the system, taking into account the grants, is estimated at less than five years. The payback period will change as the utility company increases its electricity rates. Any increase in rates will increase the amount of revenue earned by volume of electricity generated in excess of the plant's requirement, Koller explains. Koller will absorb the remainder of the costs for the system. He is talking to Citizens Bank about financing arrangements and also looking into a state low-interest loan.

In addition to extra revenue from the sale of electricity, Koller will sell renewable energy certificates (RECs) generated by producing electricity from the biogas. Under Pennsylvania's Renewable Portfolio Standard, a utility or electric distribution company supplying retail electric customers must supply 18 percent of its power from alternative energy sources by 2020. Compliance can be achieved by purchase of RECs from alternative energy source generators, such as Koller.

One company has already contacted Koller about purchasing his RECs. "They wanted to buy them in advance, give me a deposit ahead of time and said they would purchase them for a 20-year period," he says. "They gave me a number that is a lot more than I had anticipated and I thought well, that is only the first offer." Koller is starting to research other companies interested in purchasing the certificates. "Hopefully people will come to me," Koller adds. "The other option is my local utility might be interested in buying them, since they have to have so many to meet their state mandate."

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