ETHANOL plants are finding new ways to use anaerobic digestion to improve energy and process efficiency. BioCycle recently spoke to three midwestern ethanol facilities to understand how deploying anaerobic digestion is expected to lower costs, reduce carbon footprints and improve plant operations.

A by-product of fermentation and distillation at a typical corn ethanol plant is stillage, a mixture of corn solids and water. Centrifuges separate the stillage into thin stillage, composed of water and dissolved solids, and wet cake (distillers grains). Generally, a portion of the thin stillage (backset) is recycled to the front of the ethanol process as makeup water to the cook/slurry tanks. The backset reduces the quantity of fresh water required by the cooking process and contains nutrients for fermentation.

Evaporators thicken the remaining thin stillage into syrup. The syrup, containing 25 to 50 percent solids, is either sold separately or mixed with the distillers grains and dried to produce DDGS (distiller dried grains with solubles), which is sold into animal feed markets.

UNITED ETHANOL, LLC

In Milton, Wisconsin, United Ethanol LLC is working with EISENMANN Corporation (Eisemann) to integrate a closed-loop anaerobic digestion process into its 50-MMgy ethanol plant. The system will improve the quality of recycled process streams and replace 25 to 30 percent of the natural gas used at the facility with biogas.

The BIOGAS-TS is a two-stage methanogenic digestion system composed of two primary digesters and one secondary digester. A portion of the backset, about 120 gallons/minute, and some of the syrup will be fed to the digester. Total hydraulic residence time is approximately 25 to 30 days.

Digestate is recycled back through the fermentation process. Recycling the digestate means there is no external sludge, solids blowdown, or discharge stream. “This is a total closed-loop integrated process digester,” explains John McDowell, Eisemann sales engineer. The digester also reduces the fermentation inhibitors, such as acetic acid, in the backset to near zero, adds Howard Hohl, Manager at Eisemann. Fine organic solids that are digestible but not fermentable are also significantly reduced, increasing fermentation capacity. The plant ethanol capacity could be increased as much as 500,000 gallons to 2-MMgy.

From a process standpoint, anaerobic digestion consumes some of the thin stillage and syrup. “It reduces our evaporator bottlenecks, alleviates and assists in reducing our dryer load and it eliminates a syrup load-out that we have at the plant,” explains Alan Jentz of United Cooperative, the managing member of United Ethanol. “It does all that while offsetting our natural gas consumption at the plant.”

Both the thin stillage and the syrup are rich in organics. United Ethanol will convert a portion of these energy rich organics into biogas by integrating the BIOGAS-TS system into its ethanol process “Estimates place expected biogas production at a rate of 1,250-scfm with an energy content above 40-million BTUs per hour,” McDowell says. Biogas will be dried and used to fuel a 1,500-hp steam boiler specifically designed to handle the gas. The new biogas boiler will offset an equivalent amount of steam produced today by the plant’s existing natural gas fired boilers.

The estimated $6.75 million project is funded in part by a $2.25 million low-interest loan awarded through the 2009 American Recovery and Reinvestment Act. The company is financing the remaining cost. Payback for the system is estimated at four years. While the price of natural gas is a significant component of the payback calculation it is not the only consideration, Jentz says. “The reduction of fermentation inhibitors and the other operational benefits enhances the payback.”

Permitting for the plant is underway and should be completed shortly. Jentz expects the digester to be operational sometime between fall 2011 and January 2012.

POET’S DIGESTER PILOT

Sioux Falls-based POET (Poet) is testing anaerobic digestion technology at its pilot-scale cellulosic ethanol plant in Scotland, South Dakota. The technology will be deployed to fuel Project Liberty, the company’s first commercial-scale cellulosic ethanol plant, located adjacent to Poet’s corn ethanol facility in Emmetsburg, Iowa.

When completed in 2012, Project Liberty will produce 25-MMgy of cellulosic ethanol from the corn cobs, leaves and husks left over from corn harvesting. “Our anaerobic digestion technology is
really part of our cellulosic ethanol production process,” explains Dave Bushong, general manager at the POET Research Center in Scotland.

POET produces cellulosic ethanol using enzymatic hydrolysis, which employs enzymes to breakdown cellulose and hemicelluloses, complex carbohydrates found in cellulosic materials, into fermentable sugars. As with standard grain-based ethanol, these sugars are fermented to produce ethanol.

Typically by-products from conventional corn-based ethanol facilities are processed into DDGS for sale into feed markets. This is not an option with the wastes from the cellulosic process. Instead, after distillation, the remaining materials are fed directly into the digester. “We convert about 65 percent of the raw material into [cellulosic] ethanol, leaving 35 percent,” Bushong says. “We need to extract some value from that and

Vertically, the cellulosic wastes with waste streams from the starch [corn ethanol] plant have been considered, he adds. “But those streams have value as a feed product. So it is not economically advantageous.”

Digesting cellulosic wastes is now producing between five to seven cubic feet of biogas per pound of COD (chemical oxygen demand) consumed at the pilot plant. Poet estimates the production digester will generate about 2,500,000 MMBtu’s of biogas annually. This is enough biogas to replace all the natural gas required by the boilers generating steam for the cellulosic plant as well as the adjoining starch (corn ethanol) plant.

Prior to use in the boilers, hydrogen sulfide (H2S) and moisture will be removed from the gas. Digestate from the process is dewatered using screw presses. The water is recycled back to the front-end of the process. The company is exploring commercial outlets for the solids. Construction of Project Liberty is scheduled to start this summer and the plant is expected to be operational by early 2012.

AG Processing, Inc.

In Hastings, Nebraska, Ag Processing Inc. (AGP) recently received a $275,000 grant from the Nebraska Energy Office to offset natural gas usage with biogas. The grant, plus $50,000 of AGP’s funds, enabled installation of piping to capture and transfer biogas produced by the company’s anaerobic digesters. The piped biogas will replace some of the natural gas now used to fuel the regenerative thermal oxidizer (RTO) at the facility’s 52-MMgy ethanol plant.

AGP is a farmer-owned cooperative that procures, processes, markets and transports grain and grain products. The cooperative operates nine soybean processing plants, three vegetable oil refineries, two soy biodiesel plants and the ethanol facility in Hastings. Collocated at the Hastings complex is a soybean processing plant and a vegetable oil refinery.

AGP’s digester is a bulk volume fermenter (BVF®) made by ADI Systems Inc. It processes wastewater from the complex’s corn and soy processing plants. The ADI-BVF is a low-rate treatment system that can process wastewater with high suspended solids concentrations and variable flows and/or characteristics. Average retention time for AGP’s digester is about 12 days.

Over the past few years, operation of the digester has been optimized to meet the increased demands of the processing plants, which are sending more wastewater to the system. “We looked in closer detail at the operational parameters of the biological system as far as pH, temperature, metal requirements and nutrients,” explains Darcy Ehmann, director, corn/biodiesel operations for AGP. “Optimizing digester operations increased the volume of potential biogas production to the point where it became economical to capture and use it in the process. Biogas produced by the system ranges from 120-scfm to 300-scfm. Currently the gas is flared.

Upgrades included installing an underground transfer line from the positive-displacement blower, which transfers the biogas from the digester to the process area housing the plant’s RTO. The RTO controls emissions in exhaust from the ethanol plant’s DDGS dryers. It consists of five chambers, used one at a time, to treat the exhaust. The chambers are designed to absorb heat from the exhaust and use the captured heat to preheat the next chamber in line to treat the exhaust. “Using the biogas in the RTO is a ‘good fit,’” Ehmann says. Construction of the transfer line is complete. Ehmann expects the system will be commissioned and brought online during the second quarter of 2011.

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