Breaking Down Geomembrane Cover Benefits

By Jim McMahon

Casco Inc. is all about processing of corn products. As one of Canada's biggest and oldest manufacturers of corn-refined ingredients such as sweeteners, starches, oil and animal feed, its products are used in over 60 industries from food and beverage to pharmaceuticals to paper manufacturing and animal nutrition. Combined, its three manufacturing facilities, located in Ontario, process 4.5 million bushels of corn each month.

One of its plants, located in the town of Cardinal, directly on the St. Lawrence River and 50 miles south of Ottawa, is among the most automated corn wet milling facilities in the industry. Opened in 1858, and processing 70 million pounds of corn monthly, the facility manufactures high fructose corn syrup, glucose, specialty starches and corn oil for Canadian and U.S. markets.

Along with the Cardinal facility's high-volume of corn processing production — it runs 24 hours, seven days a week — is the plant's need to process a continuing effluent of organic waste. A total average volume of 792,000 gallons (106,000 cubic feet) of wastewater per day enters its treatment facility. Eighty percent of this effluent is first processed through its anaerobic digester.

Wastewater Generation From Casco's Corn Processing

Casco's BVF (bulk volume fermenter) was designed and built in 1988 by ADI Systems. It is limited to receiving 641,000 gallons (85,000 cubic feet) of wastewater per day, as specified by the Ministry of the Environment (MOE), the agency responsible for setting wastewater standards in Ontario. This effluent is generated from several areas of the plant through a process referred to as wet milling, where various components from the exterior and interior the kernel are mechanically and chemically separated.

Essentially, a softened-kernel mixture is ground in a mill to separate the starch and gluten from the hulls. The hulls are then used as animal feed. The protein, also called gluten meal or corn meal, is separated from the starch. There is very little effluent from this stage because most of the water gets recirculated to minimize loss of the starch or gluten.

The starch, now separated, is either refined into sugar, or turned into a food-grade or industrial-grade starch — a starch slurry is introduced into several process streams where various surfactants (surface active agents) produce chemical modifications to the physical properties of the granules to meet requirements for different grades of starch. The processing of the starch accounts for 10 percent of the wastewater effluent going into the BVF.

During the conversion process for changing the starch to sugar, ion exchange resins are employed requiring the use of hydrochloric acid and caustic for regeneration. The initial regeneration flow, along and any sugar that is rinsed out with the resins, goes out as wastewater to the BVF reactor. Subsequent rinses that have a COD (Chemical Oxygen Demand) of less than 1,000 ppm, are diverted to the plant's aerobic basin of the waste treatment plant. The sugar refinery is the biggest supplier of wastewater to the system accounting for 70 percent of the plant's total effluent. Various other processes of the plant supply trace volumes of effluent to the BVF.

Floating Geomembrane Cover Streamlines BVF Biogas Collection

Anaerobic digestion is a process where microorganisms break down biodegradable material in the absence of oxygen, used widely to treat wastewater sludges and organic waste because it provides volume and mass reduction of the input material. At Casco, raw solids are added directly to the BVF bioreactor, where they are digested, minimizing waste sludge handling. Comparatively long retention times — typically greater than seven days, and the large physical size of the bioreactor (in excess of 4 million gallons) with a high volume of biomass maintained in it, work together to provide the system with inherent stability against shock conditions, such as by organics and solids loading, and temperature and pH fluctuations.

The biological breakdown of organic matter in the absence of oxygen gives off primarily methane, but also carbon dioxide and some traces of hydrogen sulfide, which altogether is labeled biogas. Although biogas-derived methane and carbon dioxide come from an organic source with a short carbon cycle, they do still contribute to increasing atmospheric greenhouse gas concentrations. This is diminished, however, when biogas is combusted. This energy release allows biogas to be used as a fuel to run any type of heat engine, or to generate either mechanical or electrical power. In essence, anaerobic digestion is a renewable energy source which converts wastewater to a methane- and carbon dioxide-rich biogas suitable for energy production, replacing fossil fuels.

The Casco Cardinal plant has used a geomembrane cover on its BVF bioreactor since it became operational in 1988. In October 2008, however, Casco upgraded to an improved-design floating, insulated geomembrane cover with a streamlined capability to collect biogas. The cover captures and reclaims all of the biogas from the treatment process that is going on inside the anaerobic tank. Without a cover, the biogas would be released to the atmosphere. Designed, built and installed by Geomembrane Technologies Inc. (GTI), this new geomembrane cover is collecting an average of 236,000 cubic feet of biogas per day from the BVF bioreactor at a 65 percent methane concentration.

"Over the past two years, Casco's cover was getting to the point where it needed to be revamped or changed," says Victor Cormier, Engineer and Casco Project Manager for GTI. "As the previous cover aged over the 20 years that it had been in place, it began to have issues inhibiting biogas collection. Our latest floating geomembrane cover system is significantly different from the previous cover. The prior cover fluctuated up and down with the wastewater level inside the tank. The new-design GTI cover system is a trampoline type, it has no folds and the material is quite taut."

Casco's new floating and insulated geomembrane cover is made up of a one-inch layer of polyethylene foam laminated to polyethylene sheeting on the bottom (wastewater facing) side. The top layer is a non-laminated sheet of 40 mil specialty PVC (Ethylene Interpolymer Alloy) that acts as a gastight barrier to keep the biogas from passing through. It also incorporates a highly specialized weave design that provides maximum strength-to-weight ratios. Since this topsheet is exposed to the sun, it is also equipped with advanced UV inhibitors.

The cover's polyethylene sheeting and insulation is not meant to be gastight, it is specially perforated to allow the biogas to pass through and become trapped by the top layer. This design has exceptional seam strength, extreme puncture and tear resistance, low thermal expansion and contraction properties, a wide range of chemical resistance, high flexibility, and dimensional stability under high loads and temperature fluctuations, making it ideal for anaerobic bioreactor floating cover applications.

The geomembrane cover lays on the surface of the bioreactor, which provides buoyancy for the cover system. It works under a vacuum, using a blower system which keeps the gases withdrawn and suctioned underneath the cover. The system incorporates a novel floating-beam design which not only assists in the initial deployment of the cover panels over large bioreactors (such as at Casco), but it also creates a tent-like effect giving extra migration paths for the biogas to follow. The beams themselves are hollow molded plastic, but they are also biogas-tight. Aluminum angles are bolted down to all panel sides of the cover to make a gastight seal, and a very strong connection so the panels maintain a constant vacuum.

Not all cover designs work this efficiently, however. Polyethylene topsheets, for example, typically have a poor coefficient of expansion and contraction. When it gets cold the material contracts, and when it gets warm it expands. Over time, this growing and shrinking will contort the shape of the cover, creating a series of hills and valleys that will inhibit biogas migration and collection, not to mention creating ponds of rainwater. GTI's cover system has overcome these deficiencies.

Once the biogas is collected, several options are available to the plant including disposal of the gas in a flare, or use as a fuel to provide process heat or to generate electricity. Biogas must be very clean to reach pipeline quality, and must be of the correct composition. Carbon dioxide, water, hydrogen sulfide and particulates must be removed before it can be used for heating or electrical generation. The Casco plant is currently flaring the gas, and is examining options for utilizing the biogas within the plant.

A customized control system for the gas collection and management uses a PLC in communication with SCADA (Supervisory Control And Data Acquisition) control software with a PC operator interface. The software trends operational data, and Casco operators can remotely monitor and control the system.

Improving BVF Heat Retention

The efficiency of the BVF bioreactor — its ability to maintain digestion of the continuously incoming influent and its commensurate production of biogas — is critically dependent upon keeping the temperature of the BFV reactor at 25 to 32 degrees C. This is particularly important in cooler, northern climates, such as Casco's location.

Heat loss in large volumes of wastewater translates to energy loss, and this lost heat must then be compensated for by adding heat. Casco has supplemented its BVF reactor with heat generated from its refinery wastewater, which has been intentionally heated to maintain the bioreactor's temperature.

Its new GTI geomembrane cover design provides a heightened level of insulation material to better hold heat within the reactor, and its snug fit reduces heat loss to a greater extent than the previous cover. Additionally, elimination of water evaporation and increased prevention of sunlight penetration improve maintenance of appropriate water temperatures. Minimizing heat loss, as well as preventing potential ice build-up in the BVF, has decreased Casco's energy consumption and reduced its operating costs.

Averting an Unplanned Biogas Release

Control of an unplanned biogas release and its attendant odor — which is generated mainly by hydrogen sulfide — prompted Casco to move forward with the new upgraded geomembrane cover.

Standards set by the Ontario Ministry of the Environment do not allow any methane to be released to the environment from Casco's BVF wastewater treatment. From an operating perspective, the company needed to have certainty that the GTI cover on the BVF would meet these standards. Complicating the problem is that just 150 feet from the bioreactor is a residential neighborhood. If a less durable cover released a concentrated cloud of methane, that cloud could drift over to the neighborhood and present a serious safety hazard if inhaled, and even more serious if it were to ignite, however unlikely.

"GTI had been doing regular inspections for us as part of their service on the original cover," says Gerald Morand, Process Engineer and Environmental Coordinator for Casco. "Their technicians advised us that the cover had become quite thin in a number of areas, and that it was getting to an imminent point where it could fail. That is when we made the decision to replace it. In addition to the serious environmental and neighborhood safety implications, our operators were now limited from walking out onto the cover to measure the sludge levels. We deemed that the condition of the cover made it unsafe to take these measurements."

Challenging Cover Switch

Aside from a very tight deadline required to replace the cover because of the possibility of an unplanned, and potentially dangerous biogas release — the GTI design, manufacturing and installation team was required to complete the project in less than three weeks — a critical factor was the need to execute the Casco cover switch while still operating the plant. This meant that the wastewater flow from manufacturing could not stop. The solution implemented was to divert some of the plant effluent away from the BVF bioreactor to the aerobic lagoon while the work was in progress.

“We were concerned with the activity of the BVF unit while the cover was off,” continues Morand. “Because the bioreactor runs anaerobically, when it is exposed to the air we expected it to have a decrease in activity, so we did not want to overload the system. If we could decrease the COD going to the BVF it would not put too much of a strain on the system while it was exposed to the atmosphere, yet still allow it to have some nutrients so that the biological activity would remain active. We cut the wastewater volume to the BVF by 55 percent, and we overloaded the aerobic lagoon intentionally during the project to reduce the biogases in the digester while we had the cover off.”

Because the bioreactor is located directly adjacent to the St. Lawrence River, only 25 feet of clearance was available on three sides of the system. The fourth side is bordered by the plant’s operating railroad line, again minimizing available space. This posed challenges with both removing the old cover and installing the new one. To remedy this, GTI manufactured and transported the 130-foot by 410-foot new cover in four large sections, which were folded and rolled. The rolls were placed directly onto the BVF water, one at a time, opened and connected together using the GTI floating-beam design.

“The floating beams allowed us to connect the large cover panels together without having to weld them,” Cormier continues. “We minimized the use of heat, because we did not want to ignite the biogas. The more we could do mechanically to fasten the large floating panels together without the use of electrical tools or heat, the safer the installation.”

“GTI used a combination of a large cane, fork lifts and dump trucks to help maneuver the cover sections,” explains Cormier. “While we were removing pieces of the old cover, we were simultaneously installing sections of the new cover to limit the reactor exposure to air and reduce the amount of odor coming off the wastewater. Usually, we remove the old cover, and install the new one by pulling one off while we are pulling on the other. In this case, because there was too limited space, so we had to design, build and install the new cover differently.”

Casco’s new GTI floating geomembrane cover is not only successfully retaining the digester’s biogas odors, and delivering a very efficient system for the collection and management of biogas, it is also providing a strong surface to safely support foot traffic. “We are quite happy with GTI, and felt comfortable working with their team,” Morand says. “They had the most intimate knowledge of our system and situation. The entire project went smoothly.”

“Companies are looking for both wastewater and freshwater cover systems that are environmentally proven, energy efficient and essentially maintenance free,” says Hollis Cole, President and CEO of GTI. “This requires extensive research and development into new techniques and products, and a commitment to quality and performance. Floating, insulated geomembrane covers represent the most advanced level of this technology, especially when applied to anaerobic wastewater systems."

Inevitably, manufacturers with anaerobic wastewater bioreactors will gravitate to more energy-efficient cover systems to maximize biogas collection and usage, streamline their operations and improve their bottom line. Those companies that do upgrade to the latest cover technology will find themselves in a better competitive position, particularly as energy costs continue to escalate and become an increasingly critical factor in plant operations.