Floating geomembrane cover improves biogas collection

By Jim McMahon

As one of Canada's biggest and oldest manufacturers of corn-refined ingredients, Casco Inc. makes products that are used in industries from food and beverage to pharmaceuticals to paper manufacturing. Combined, its three Ontario-based manufacturing facilities process 4.5 million bushels of corn each month. One of its plants, located in the town of Cardinal on the St. Lawrence River, 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. Along with its high volume of production, the plant needs to process a continuing effluent of organic waste, an average of 792,000 gallons of wastewater per day. Eighty per cent of this effluent is processed through an anaerobic digester.

Casco's bulk volume fermenter (BVF), designed and built in 1988 by ADI Systems, is limited to receiving 641,000 gallons of wastewater per day, as set by the Ontario Ministry of the Environment (MOE). This effluent is generated from several areas of the plant through the wet milling process, in which various components from the exterior and interior of the kernel are mechanically and chemically separated.

A softened-kernel mixture is ground in a mill to separate the starch and gluten from the hulls. The protein, called gluten meal or corn meal, is then separated from the starch. The starch is either refined into sugar or turned into food-grade or industrial-grade starch by employing surfactants (surface active agents) to produce chemical modifications in the granules. This process accounts for ten 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 with any sugar that is rinsed out with the resins, goes out as wastewater to the BVF reactor, accounting for 70% of the plant's total effluent. Various other processes at the plant supply small volumes of effluent to the BVF.

Biogas collection

Anaerobic digestion is widely used to treat wastewater sludges and organic waste because it provides volume- and mass-reduction of the input material. Casco's raw solids are added directly into its BVF for digestion. Comparatively long retention times, typically greater than seven days, and the large physical size of the four-million-gallon bioreactor with a high volume of biomass maintained in it, work together to provide the system with inherent stability against shock conditions caused 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 sulphide, which together are labeled biogas. Although biogas-derived methane and carbon dioxide come from an organic source with a short carbon cycle, they 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 heat engines or to generate mechanical or electrical power, making anaerobic digestion a renewable energy source.

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

"Over the past two years, Casco's 20-year-old cover was getting to where it needed to be overhauled or changed," says Victor Cormier, an engineer with

Casco's 20-year-old cover prior to replacement.

Casco's new GTI floating geomembrane cover.

GTI. "It was beginning to inhibit biogas collection. Our latest cover design is significantly different from the previous cover, which fluctuated up and down with the wastewater level inside the tank. This new design is a trampoline type, with no folds and a very taut fit for better biogas collection."

Casco's new cover is made up of a one-inch layer of polyethylene foam laminated to polyethylene sheeting on the wastewater-facing side. The top layer is a non-laminated sheet of 40 mil specialty PVC (ethylene interpolymer alloy) that acts as a gas-tight barrier to keep the biogas from passing through. It also incorporates a weave design that provides maximum strength-to-weight ratios. Since this topsheet is exposed to the sun, it is equipped with advanced UV inhibitors. The polyethylene sheeting and insulation are 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.

The cover works under a vacuum, using a blower system that keeps the gases withdrawn and suctioned underneath it. The system incorporates a novel floating-beam design that creates a tent-like effect, giving extra migration paths for the biogas to follow. All panel sides of the cover are bolted down to make a gas tight seal.

Once collected, Casco's biogas is then flared, although the company is examining options for utilizing the biogas within the plant.

Importance of heat retention

The efficiency of the BVF bioreactor, i.e., its ability to maintain digestion of the continuously incoming influent, is critically dependent on keeping its temperature at 25–32 degrees C. This is particularly important in Casco's cooler, northern-climate location. Heat loss in large volumes of wastewater translates to energy loss, and lost heat must then be compensated for by adding heat. Casco supplements its BVF with heat generated from its refinery wastewater, which is intentionally heated to maintain the bioreactor's temperature.

Casco's new cover provides a heightened level of insulation to hold heat better within the reactor, and its snug fit reduces heat loss to a greater extent than the previous cover. Elimination of water evaporation, prevention of ice buildup within the reactor, and reduced sunlight penetration also help maintain proper water temperature. These factors all contribute to reducing Casco's energy consumption.

Control of a potential unplanned biogas release and its attendant odour, which is generated mainly from hydrogen sulphide, prompted Casco to move forward with the new upgraded cover. Standards set by the Ontario MOE do not allow methane to be released to the environment. Casco needed to be sure that the cover on the BVF would meet these standards. Complicating the problem was that just 150 feet from the bioreactor is a residential neighbourhood, so an unplanned methane release could present a safety hazard.

"GTI was doing regular inspections on the original cover," says Gerald Morand, process engineer and environ-

continued overleaf...

mental co-ordinator for Casco. "Their technicians advised us that the cover had become thin in a number of areas and was getting to a point where it could fail. Our technicians were no longer able to walk out on the cover to take measurements of sludge levels. Because of this and the environmental and safety implications, we made the decision to replace the cover."

A challenging cover switch

Because of the possibility of an unplanned biogas release, GTI completed the project quickly, in less than three weeks. A critical factor was the need to execute the cover switch without stopping the wastewater flow from manufacturing. The solution involved diverting some of the plant effluent away from the BVF 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 Mr. Morand. "Exposed to the air, we expected the bioreactor to have a decrease in activity, so we didn't want to overload the system. We decreased the COD going to the BVF by 55%, leaving enough influent to keep the biological activity up, but diverted the balance directly to the aerobic lagoon."

The bioreactor is located directly adjacent to the St. Lawrence River, with only 25 feet of clearance available on three sides of the system. The fourth side was space-limited by a railroad line. This posed challenges both with removing the old cover and installing the new one. GTI had to manufacture and transport the new 130 x 410-foot cover in four large, folded and rolled sections. The rolls were placed directly onto the BVF water one at a time with heavy equipment, opened and connected together using the GTI floating-beam design.

Companies that 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.

"The floating beams allowed us to connect the large cover panels together without having to weld them," Mr. Cormier continues. "We minimized the use of heat, because we didn't want to ignite the biogas. We also removed the old cover at the same time the new cover was being installed to limit the release of biogas."

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 lines. 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.

Jim McMahon is a freelance writer.
For more information,
E-mail: bms@gti.ca.