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Innovative dairy fuels green energy microturbines with manure

By Jim Crouse

Digester plant at den Dulk Dairy in Ravenna, Michigan. Waste methane gas from the anaerobic digester fuels a microturbine that produces 30-kilowatts of clean, green electricity and 45-kilowatts of thermal energy used for building heat.

Seven gallons of milk isn't the only thing an average dairy cow produces each day. It's the "other output," about 10-and-a-half gallons of manure a day that some progressive dairy farmers are using to fuel on-site power for their facilities.

For several years, the den Dulk Dairy in Ravenna, Michigan has converted manure from 1,000 of its cows into 30 kilowatts of clean, green electricity produced by microturbines. In addition, heat from the microturbines is captured and reused to heat the farm's 700-square-foot concrete liquid/solid separator building.

The energy system at den Dulk is called a Combined Heat and Power system (CHP) because electricity and heat are produced at the same time from one fuel source. A CHP system fueled by biogas significantly increases energy efficiencies of an on-site power plant—from about 30% to more than 80% when microturbine technology is incorporated. The result is a significant reduction in energy costs.

At farms, landfills, and wastewater treatment plants around the world, methane gas is a by-product of day-to-day processes. Unfortunately, the methane gas oftentimes is flared or, worse yet, vented directly into the atmosphere. Methane has a greenhouse-gas impact on the atmosphere 21 times that of carbon dioxide. Flaring methane completely wastes its energy value. An ideal environmental solution is to use these waste gases to generate renewable power.

This is exactly what the team at den Dulk Dairy is doing. At the dairy, manure is first pumped through an external heat exchanger that heats the material to 100° F, then sends it to a 47-foot-tall, 48-foot wide digester tank. The external heat exchanger actually runs off a portion of the biogas created by the process. The digester at den Dulk is an anaerobic digester, which uses no oxygen in the process. The digester features a continuous stir-tank reactor that mixes the heated manure to break it down, thereby creating biogas.

The anaerobic digester at den Dulk Dairy has several innovative features including equipment to remove toxic hydrogen sulfide from the biogas, pumps built in the digester tank foundation (so that any sediment build-up can be removed without emptying the tank), and separate units for easy operation and maintenance functions. Because microturbines can run on a variety of fuel types—from liquid, natural gas to diesel fuel, as well as biogas—they were the natural choice to create electricity from the biogas.

The Combined Heat and Power system at den Dulk Dairy contains a low-emission microturbine that produces 30 kilowatts of continuous power, and 45 kilowatts of thermal power. In addition, the system features a 2.8 million BTU boiler. Heat exhaust from the microturbine is either pushed directly to the digester or delivered to a heat exchanger that warms hot glycol. The glycol provides heat throughout the plant, just as the boiler does.

Previously waste from den Dulk, which is home to 3,000 cows and produces 155 million pounds of manure a year, was stored on-site and eventually spread on farm fields across West Michigan. Environmentalists and state regulators say such storage practices cause environmental problems with runoff into rivers and streams.

Microturbine systems, which can range in size from 30 kilowatts up to five megawatts, can be specifically designed to operate on biogas such as methane produced from manure, food waste, landfills, and wastewater treatment plants. Although such biogas fuels contain useable energy, unfortunately, they also have low-energy density and are usually contaminated with other gases, such as hydrogen sulfide.

Microturbines make system design easier than traditional generating technologies because they operate on a wide range of fuel types, automatically adjust to changing energy densities over time, and accept high levels of

contaminants such as hydrogen sulfide. The microturbine installed at den Dulk Dairy can accept hydrogen sulfide levels as high as 70,000 parts per million. In addition to being clean burning and efficient, microturbines are known for their reliability since they have only one moving part, and have air-bearing technology that does not require any lubricants or coolants. Because of the lack of moving parts and lubricants, maintenance is much less than traditional reciprocating engines. Once a year, a filter change occurs that takes less than six hours to complete. In addition, after every 40,000 hours of runtime, the engine is exchanged, which takes two technicians less than six hours to complete.

This project is being conducted with the Michigan Alternative and Renewable Energy Center and was funded with a $1 million grant from the Michigan Public Service Commission. The den Dulk farm contributed $1.2 million for the site preparation required to host the biodigester.

Digesters, especially those that incorporate microturbine technology in a Combined Heat and Power application, are the future of the agriculture industry. Not only can digesters become a distributed generator of electric and thermal power from their waste stream, but they also help farms continue to manage their waste stream in an environmentally responsible manner.

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