Referencer

Weholite became an innovative biogas reactor

Uponors rolle

- Weholite tank for bioreactor applications

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Farms have great potential for biogas production, but poor profitability has hindered the construction of biogas plants, especially on smaller farms. A new type of biogas reactor developed by Jyväskylä-based BGC Nordic offers a cost-effective, reliable solution even for medium-sized farms with 1–2 milking robots. This innovative solution, which is scalable even for industrial use, utilizes the layered structure of the Weholite tube, which ensures smooth, efficient heat transfer and stable operation for the reactor.
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“The potential of biogas has been discussed in Finland for decades, but its utilization remains limited,” notes Henri Viiru, one of the three partners at BGC Nordic Oy, founded in 2020.
The largest source of raw material for biogas is agricultural biomass, such as manure and grass. However, the construction of smaller farm-based plants in particular has been hampered by poor profitability. For example, of Valio’s more than 3,000 contract farms, only a few dozen utilize biogas.
The new type of biogas reactor developed by BGC Nordic provides a cost-effective, reliable solution even for medium-sized farms with 1–2 milking robots, or approximately 50–70 dairy cows.
– With heat and electricity produced from biogas, farms can even become completely energy self-sufficient. This is of great significance both for farm profitability and for the transition from fossil fuels to renewable energy.
The government supports biogas plant projects with a 50% investment subsidy.
– However, the payback period must be reasonable so that people dare to make the investment.
BGC Nordic began its development work based on the needs of farms, but the reactor innovation can also be widely scaled up for industrial use and wastewater treatment. A national patent has already been obtained for the solution, and international patenting is underway.
– Our absolute goal is to make this an international export product.

Numerous advantages of plastic
According to Viiru, the main problems with biogas reactors in the past have been poor heat transfer to the biomass and sedimentation, i.e., the buildup of material on the reactor walls.
– Poor heat transfer results in an unstable process. Material buildup on the walls, in turn, means that the reactor must be shut

down for cleaning. After a shutdown, it takes several months before production returns to normal levels.
BGC Nordic spent over four years on product development for its biogas reactor and built various test reactors and prototypes. From the outset, it was clear that the reactor would be made of plastic.
– Plastic offers significant advantages. Sediment does not accumulate on the smooth material, it has good heat and chemical resistance, and there is no risk of corrosion.
BGC Nordic's solution is a so-called plug-flow reactor, which offers advantages over a traditional fully mixed slurry reactor, including precise control of feed retention time.
– Feedstocks, such as manure and grass, move forward through the reactor in a ''plug'' and remain for exactly the designed duration. Production is efficient, and the precisely processed mass prevents methane emissions.

A New Application for Weholite
In the fall of 2022, BGC Nordic contacted Uponor and proposed a collaboration.
– It was extremely important to us that they were genuinely interested in moving the development project forward.
Uponor has decades of experience in demanding plastic construction and certainly the best expertise in multilayer pipes, on which our own idea is based.
Uponor has been manufacturing layered Weholite pipes for over 40 years. These pipes, which can reach diameters of up to 3.5 meters and are manufactured by spiral welding polyethylene or polypropylene profiles, can be custom-sized and equipped for a wide variety of applications. In addition to piping systems, Weholite is used to manufacture, among other things, special wells and various tank solutions such as alkalization plants, equalization tanks, and stormwater and chemical storage tanks.
''The bioreactor is a completely new application for Weholite, so there was a lot to consider and figure out, starting with the choice of materials,'' says Sales Manager Tom Karnela of Uponor.
Product Manager Sakari Mänty explains that the design process involved resolving numerous issues related to usability and maintainability, among other things.
– We certainly spent over 100, if not 200, hours on strength calculations alone.
He cites as an example the flange connection located at one end of the reactor, which connects the mixer—which extends through the entire tank—to the flange. The connection had to withstand torsional stress comparable to a 5,000-kilogram load at the end of a 1.5-meter-long arm.
''A challenging but very interesting project,'' Mänty sums up.

Heat management at the core
– In the biogas process, the temperature is constantly quite high, so the material's heat resistance is put to the test. At first, it seemed that the only option would be polypropylene, which is highly resistant to high temperatures. However, research revealed a suitable grade of polyethylene capable of withstanding remarkably high temperatures. Compared to polypropylene, its advantages included easier machinability, Mänty explains.
Henri Viiru points out that temperature control is the most critical aspect of the biogas process.
– This utilizes the layered structure of Weholite. Heating water circulates within the honeycomb structure between the inner and outer walls of the Weholite pipe, causing the entire frame to function as a heat exchanger. The temperature remains constant, and the methane-producing bacteria break down the biomass efficiently.
Thanks to effective heat management, the reactor can be operated not only in the conventional mesophilic temperature range (40°C) but also in the thermophilic range. In this case, the temperature rises above 50 degrees Celsius, causing the biomass to break down more quickly.
– Raw biogas contains an average of 60 percent methane and the rest is carbon dioxide. Hydrogen can also be added to the reactor, which increases the methane content to as much as 90 percent, Viiru explains.

The results have exceeded expectations
The Paavola dairy farm in Karstula was selected as the pilot site for the biogas reactor, and the unit was delivered there in the fall of 2023.
Made from a 3-meter-diameter Weholite pipe, the reactor has a volume of 77 cubic meters and a length of 11 meters.
''Initially, the reactor is run solely on slurry so that we can collect enough data from this.'' So far, the yield and feed processing speed have exceeded expectations. The long periods of freezing weather early this year also went smoothly, says Henri Viiru.
In early summer 2024, the plan is to add dry matter—specifically grass—to the reactor to enhance the process, and during the summer, the facility will also transition to thermophilic digestion.
– After this, the plant's energy production will double to an annual level of approximately 500 MWh, at which point the farm will be well on its way to self-sufficiency in heat and electricity production.

According to Viiru, slurry alone can produce slightly more than half of the energy needs on farms like Paavola, which have a single milking robot. On larger farms with 2–3 robots, energy self-sufficiency can also be achieved using only slurry, and dry matter may not be needed in the process at all.
‘‘Compared to a traditional fully mixed slurry reactor, we can produce gas about 2.5 times more efficiently. The payback period for the investment is estimated at 5–8 years,’’ says Viiru.

Projektfakta:

Location	Færdiggørelse
Karstula, Finland	2023
Bygningstype	Product systems
Land- & skovbrug	Wells, Well system

Partnere

Country: Finland
Location: Karstula
Year of completion: 2023
Project type: Customized solutions
Uponor systems installed: Weholite tank for bioreactor use

Designer: BGC Nordic Oy and Uponor
Developer: BGC Nordic Oy

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