

ON-SITE AD

SMALL-SCALE MICROPOWER

SANDRA Sassow is a horseback rider. When going out to ride, she became aware of the manure piles near one of the stables. “I started asking if it would be possible to convert the manure into hot water for the horses,” she recalls. Eventually Sassow’s idea evolved into a containerized anaerobic digestion unit for that type of setting.

“It’s been five years from an idea on a piece of paper to where we are today,” says Sassow, CEO and cofounder with her husband Nick Sassow of SEaB Energy Ltd, based in Southampton, England. “We’ve worked with a lot of sectors along the way and although we’ve had to overcome some barriers, there has generally been a positive response to our ideas.”

The “ideas” she mentions have to do with waste and energy, portability and practicality. Nick Sassow, the product inventor side of the partnership, subsequently developed the micro anaerobic digestion technology used in the two turnkey systems the company now markets: Muckbuster®, used for manures, crop processing residues and food waste, and Flexibuster™ for food and other organic waste streams. “The term “Muckbuster” comes from our initial thoughts of using the unit in a horse stable environment,” she explains.

BASIC DIGESTION PROCESS

The basic footprint of the digester is equivalent to a 40-foot-long shipping container that is 8-feet wide and 9.5-foot tall — plus enough room at one end for access to the ramp or feed hopper for loading the unit. A gas storage bag in a separate 20-foot container is used to collect biogas. In a single 40-foot Muck-



The 40-foot Muckbuster installed at the University of Southampton Science Park receives source separated food waste and some green waste.

buster, feedstock is loaded directly into a mixing/ chopping unit where the material is macerated and mixed with some recirculated liquid digestate until it’s the consistency of thick yogurt. The system’s design is a combination of batch and a continuous flow, according to Sassow. “The front hopper is able to hold various amounts of feed,” she says. “The unit uses this as a reservoir for the continuous system behind.”

Originally, a single 40-foot box was the only option, but a new modification on the basic design allows all the necessary components to be split into two 20-foot containers instead (plus the gas storage container), providing more flexibility with the installation footprint. The design is scalable from the basic model handling around 550 lbs/day of incoming feedstock (~160 tons/year) up to the equivalent of six 40-foot containers (plus a gas storage unit), processing approximately 3 tons/day (~1,000 tons/year). Combined Heat and Power (CHP) units ranging in size from 8 kW to 65 kW accompany the digester(s).

Regulators in the United Kingdom, where SEaB’s first two units are installed, require a pasteurization phase at some point in the digestion process for operations intending to meet the qualifications of PAS 110 or the Anaerobic Digestion Quality Protocol (ADQP). Generally, this involves heating the mixture to 70°C for an hour, which has been shown to reliably inactivate indicator pathogens. The Muckbuster includes pasteurization after maceration. The mixture passes through a buffer tank and then into one of two pasteurization tanks where waste heat from the engine is used to hold the material at 70°C.

Modular anaerobic digestion units the size of a shipping container are designed for breweries, stables, housing developments, hotels and remote communities.

David Riggle

Following heat treatment, slurry is pumped into the digestion tank for a retention time of approximately two weeks. During this phase, biogas is transferred to the gas storage container and subsequently fed to the CHP unit as needed. "As we put liquid in, we also take out," explains Sassow. "The next step following digestion is dewatering.

The dewatering/liquor storage tank can retain two weeks worth of digestate before needing to be offloaded.

If the input feedstock is mostly food waste it will be 97 to 98 percent digestible material, so there may not be much solid digestate at all out the back end." The dewatering/liquor storage tank has enough space to retain two weeks worth of digestate before needing to be offloaded. The units produce a PAS 100 certified liquid digestate fertilizer that a local turf grower has been buying from one of the operating projects. SEaB is developing a liquid fertilizer for wider use, she adds.

Two projects are in operation — one at the University of Southampton Science Park in Hampshire, and the second at Lancaster Brewery in Yorkshire. A third project has recently been installed at Catherston Stud Farm in Hampshire.

FOOD WASTE DIGESTION AT SCIENCE PARK

The University of Southampton Science Park (USSP) is set on 45 acres of the Chilworth estate, where the Chilworth Manor Hotel and the Chilworth Arms Public House (pub) also are located. The Science Park, which houses over 50 companies employing about 900 people, in general is committed to clean technology and waste recycling. In May 2012, it entered into a partnership with SEaB Energy to install a 40-foot Muckbuster on the Science Park campus for treatment of food waste, cooking oil and the remains of alcoholic beverages collected from the hotel and pub. Green waste from the Science Park also is incorporated. Businesses in the science park are provided with food waste carts that are left outside the digester when ready for service.

"For the hotel, plate scraping and food preparation waste is separated into small (~5-gallon) bins that we supply," says Sassow. "There are no liners in these buckets, just food scraps. We collect full buckets with a tricycle that

has a caddy behind it and drop off clean ones at the same time." The collection service is provided free to the hotel in this instance. "They were helpful to us as we got set up," she adds, "so on this project, we make our money from sale of electricity to the science park."

The Chilworth Arms pub separates its food waste, some cooking oil and leftover beer and wine into tall (21-gallon) kitchen waste bins lined with plastic bags. The bags are put into yellow standard 240-litre (52-gallon) wheeled bins to distinguish them from other waste bins. "We chose yellow wheelie bins because they didn't have any other yellow bins and I wanted it to be distinct," says Sassow. On collection days, the plastic liners are lifted out and transported to the Muckbuster.

Sassow points out that for both the pub and the hotel, SEaB tried to work around the way they already did things to make it easier for them. "In general, we've found that education of the kitchen staff is a very important part of making the separation process work," she explains. "Because staff tends to change frequently, it's important to recognize the need for frequent reeducation. We've developed some posters and other signage to help with that."

The average daily input into the USSP's Muckbuster unit is calculated to be around 900 lbs. Of that amount, 772 lbs is kitchen waste combined with a varying mixture of around 44 lbs each of cooking oil, alcohol and garden waste from the grounds. The buckets or plastic bags full of feedstock are manually loaded into the macerator through the front door of the unit.

The digester produces an average of 46 m³/day of biogas, which is converted into electricity for the site using an 8 kW

The project has a projected payback period of four years for the initial investment.

CHP unit. This in turn provides a building on the grounds of the Science Park with 35 MWh/annum of electricity and supplies heat for a tenant. "There's a two-way meter," says Sassow, "and it's all used on site." Some local residents who don't have a residential food waste collection bring their organics to the digester. "We give them a bucket," she adds. "They fill it up and then bring it down to the site. We then give them a clean one to use until the next drop off." This autumn, the Science Park was planning on trying some grass and

leaves from the university with in-situ chopping of the material beforehand.

Recently, the UK's Waste and Reduction Action Programme (WRAP) posted a case study of on-site systems. It included the USSP digester, and noted that the digestate is used on the science park grounds. In addition, filtration has been installed for the hopper to reduce the smell from input waste. (See www.wrap.org.uk/on_site_treatment; case studies are listed.)

PAYBACK TIMESCALES

In terms of costs and paybacks, the WRAP case study for the USSP Muckbuster digester (processing ~150 to 160 tons/year) suggests a capital cost of \$168,000 for the unit, which includes installation. Annual operating expenses are calculated between \$10,500 to \$13,000/year over the next eight years. That amount covers maintenance at approximately \$8,000/year and annual heat, electricity and water costs of around \$2,400 to \$4,800.

The calculated amount of electricity and heat produced annually by the 8 kW CHP unit amounts to 35,481 kWh of electricity with a value of \$4,600, and 75,996 kWh of heat with a value of \$2,463. Savings on waste disposal (primarily to the hotel and pub) are expected to be around \$16,977/year. The liquid digestate and dewatered solids are valued at around \$2,239/year, and reimbursements through the UK Government's Feed-In Tariff and Renewable Heat Incentive schemes comes out to around \$8,050 and \$8,006 per year, respectively. Taken together, the project has a projected payback period of four years for the initial investment.

LANCASTER MICROBREWERY

In February 2013, SEaB Energy installed a Flexibuster unit at the Lancaster Microbrewery in the north of England. The brewery has been making beer since 2005. According to recent profile in a local Lancaster paper, it currently employs around 32 people, including five brewers and is operating at two-thirds of its capacity, producing 3.9 million pints of beer per year.

Instead of mixed food waste, the brewery has a single feedstock for anaerobic digestion: around 1,200 tons/year of spent grain and hops from the brewing process. It comes to the digester as wet, sticky grain. Each load is carried by forklift to the feed hopper of the digester. Since the spent grains are



of such a fine consistency, there's no need for maceration on this unit. Otherwise, the process is very similar to the one described for the Southampton Science Park hotel and pub wastes. At present, the brewery is sending the digester around 550 lbs/day of grain.

"On this project, we're still trying to optimize the process," says Sassow. "It's been a bit of a struggle to balance the system and keep the bugs happy. So far, the biggest issue has been pH. It gets down to around 5.0 and so is very acidic. We're looking at the whole process because although we know what to do to balance it, we're not sure if the cost of a pH-balancing additive will keep it economical for them over the longer term. We are also considering using other waste available in the same industrial park where the brewery is located to scale the size of

the system." Currently, a "seed feedstock," usually manure, is being added to get the system going.

Another operational challenge, adds Sassow, is the beer is brewed in batches, so the spent grain and hops are fed into the digester over a period of three days. "The longer the material sits, the more physical and chemical changes take place, not all of which are helpful. We're also testing to see if there's something in the feedstock itself that is affecting the bacterial population in the digester."



The Lancaster Microbrewery is anaerobically digesting its spent grain and hops from the brewing process.

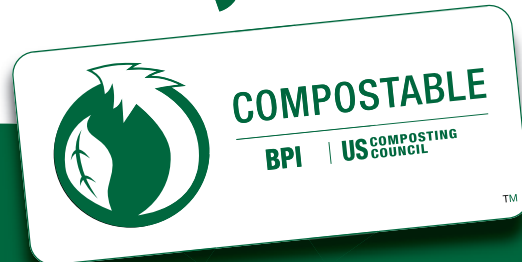
RURAL AND COMMUNITY APPLICATIONS

The anaerobic digestion technology has potential applicability in a wide variety of situations — especially in remote and rural locations. This target niche has attracted attention from organizations outside of the traditional waste management industry. For instance, in 2012 SEaB Energy was selected from over 500 applicants by the NASA-backed sustainability initiative, 'LAUNCH: Beyond Waste,' as a provider of a global technology that could help address climate change.

Earlier this year, the company was one of the winners in the 2013 (U.S.) Defense Energy Technology Challenge (DETC) that looks for "...innovative energy solutions to increase the safety of its troops, lower energy costs, and reduce its reliance on foreign energy supplies." Winners made presentations in September at the annual Asia Pacific Clean Energy Summit in Hawaii. In addition to the treatment of a variety of wastes to generate energy, the feature of interest in this competition is that the system is housed in a transportable container, "enabling it to be easily delivered and installed anywhere in the world," according to DETC.

"Deploying a Muckbuster unit to rural communities provides them with a self-generating supply of power," says Sassow. "The communities can place all of their organic waste, including septic waste, into the unit. It produces power, and the resulting fertilizer can feed their crops to increase the yield and save money on buying commercial fertilizer. Additionally, the unit can be moved around on short notice and can be taken to disaster sites for emergency power and be set up and ready to use in a matters of hours." She adds that they can be delivered with portable toilets that could be emptied into the digester, "bringing sanitation and power to a disaster zone." ■

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