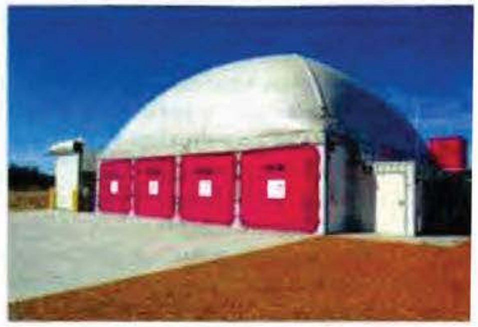
Anaerobic digestion (AD) technology has become a viable alternative method for disposal of the food scrap portion of the solid waste stream. Although long established and popular in Europe, AD technology has been slow to catch on in the United States. This has been mostly a result of low U.S. tipping fees relative to those in Europe. The European Union also effectively banned the disposal of organic wastes in landfills over a decade ago. The purpose of this article is to provide an overview of the basics of the technology, attributes of some popular systems, and factors that are critical and desirable when integrating AD into a community.



Know Your AD

A survey of the different anaerobic digestion technologies at work in U.S. installations.

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Background

AD has been used in the U.S. wastewater treatment industry for decades, in the processing and treatment of raw liquid sludge. The process uses naturally occurring microorganisms in a series of bio-chemical reactions to decompose the organic fraction of the waste in an oxygen-free atmosphere, usually conducted inside a tank. Anaerobic digestion produces two desirable by-products from the bio-chemical process: biogas with a high methane content, and a low solids digested sludge.

This liquid-based (or "wet") technology was the first to be adapted to include food scraps along with other more traditional liquid feedstock including manure and fats, oils and grease (FOG). And although there are several plants of this type successfully operating in the United States, the focus of this article is on anaerobic digesters that have been developed to process a feedstock (i.e., food scraps and green waste) that are considered "dry."

Composting is another method to process food scraps that is more widespread in the United States than AD. However, the basic attributes of an AD system, as opposed to aerobic composting of food scraps include:

- Production of renewable energy
- Reduction in the footprint of the main plant site
- Significant reduction of odor nuisance potential of the plant
- Reduction of CO2 emissions
- Consistent high quality of treatment

Fig. 1 (LEFT): Zero Waste Energy (SMARTFERM) dry anaerobic digester for Monterey (Calif.) Regional Waste Management District.
Photo courtesy of MRWMD and Zero Waste Energy.

Fig. 2 (TOP): Combined Heat and Power Plant, BIOFerm Digester, Oshkosh, Wis.
Photo courtesy of BIOFerm and the University of Wisconsin.

Fig. 3 (RIGHT): Zero Waste Energy (KOMPOFERM System) Material Recovery Facility and Dry Anaerobic Digester for the City of San Jose, Calif. (shown in full article only)
Photo courtesy of Zero Waste Energy and the City of San Jose.

Fig. 4 (BOTTOM): EISENMANN High solids dry digester, Cremona, Italy.
Photo courtesy of EISENMANN Corporation.

Operating U.S. Systems

It was not until the Europeans adapted AD for use with mixed feedstocks with much higher solids content – up to 50 percent – that the technology became viable for use on municipal solid waste. Several European companies have established U.S. offices and technical representatives, including but not limited to, Eggersmann Group, Organic Waste Systems (OWS), EISENMANN Corporation (EISENMANN) and Viessmann. Several U.S. universities as well are conducting research and have teamed with private U.S. companies to introduce adaptations of AD technology that work with food scraps.

Viessmann's waste company, BIOFerm Energy Systems, has an operating plant in Oshkosh, Wis., that started in 2011 and processes about 6,000 tons annually of food scraps from the University of Wisconsin campus (Fig. 1). Eggersmann Group, represented in the U.S. by Zero Waste Energy LLC (ZWE),has a plant, based on their SMARTFERM technology in Monterey, Calif., that started operation in early 2013 and at the time was processing about 300 tons per month of food waste and green waste (Fig. 2). ZWE also recently completed a plant in San Jose, Calif., based on their KOMPOFERM technology system, that is operational and designed for a capacity of 90,000 tons annually of commercial organics (Fig. 3). OWS has several U.S. plants in the planning stages. These however are by no means the only companies active; several other companies have plants in the planning, permitting or construction phases.

Technology Overview

Although all of the established vendor systems are based on the same basic bio-chemical process, there are some significant design and operating variations between systems. In a "dry" system the truly low solids content materials are limited in quantity so that the feedstock mixture is dry enough that it can be managed as a solid material. This has resulted in other design options for the container where the food scrap is processed. In the systems from BIOFerm, ZWE (SMARTFERM), and Eisenmann, wastes in bulk are placed in long, rectangular chambers usually constructed of reinforced concrete. The Eisenmann system, however, also uses stainless steel tubular vessels (Fig. 4).

The Viessmann dry technology is based on bulk feedstock being loaded into a pile inside the unit with a front end loader. Feedstock can be ground up but this step is not necessary. Heat is applied with a convection system in the walls and floor. Leachate is continuously collected in a large underground storage tank, heated and sprayed over the pile with header pipe to hasten decomposition. Biogas is collected in a flexible membrane holder located above the chamber

Takeaways

- "Dry" anaerobic digestion (AD) technologies are designed specifically to accept food scrap and yard waste feedstocks, whereas "wet" AD was developed for liquid waste with some capacity for food waste.
- The chief dry AD technologies are differentiated through their use of a vertical flow digester, a static pile (heap) digester or a horizontal flow digester.
- An initial feasibility study is recommended for any company or community mulling an AD application.

and then piped to a combined heat and power (CHP) plant.

The KOMPOFERM system is unique in that it has the flexibility to integrate several waste processing technologies, if desired, for the production of refined materials and multiple energy sources to serve a a variety of markets and to meet restrictions on the landfilling of residual materials, if required. The components of the system include; automated mechanical pre-processing (i.e., bulk separation of inerts), fine separation of recyclables, production of refuse-derived fuel (RDF), aerobic composting, a wet digestion element and a dry AD process.

The SMARTFERM dry technology is based on the KOMPOFERM dry anaerobic element process, but is optimized for compact, smaller scale applications. In a general sense, the SMARTFERM system design resembles the Viessmann system.

The Eisenmann technology applied to food scraps is based on a horizontal flow model that consists of the processing chamber fitted with a mixing element. Feedstock is first reduced to less than 1-1/2 inch size. Liquid – usually leachate generated from the process – is added and the mixture is fed into the digester and slowly pushed through it by a paddle system fixed to an axle turned by an electric motor. The axle runs the length of the vessel. Similar to the Viesmann technology, heat is supplied by convection from a piping system in the walls. Leachate is collected at the end of the chamber in a separate tank and may be recycled back to the pile or sent to a secondary digester where additional biogas is produced. Biogas generated from the processes can be sent directly to a CHP plant. The input of the energy from the continuous mixing action has the potential for relatively high biogas production.

In the OWS system, a unique vertical system, waste is ground up to about 1-1/2 inch, injected with steam, and pumped using a high pressure unit (not unlike a concrete pump) into an elevated steel silo tank where the decomposition takes place. The processed waste moves downward in a compact mass by gravity (Figs. 5 and 6). Digestate is drawn off the bottom of the digester and some of that diverted back to the mixing pump to seed incoming feedstock. The OWS system's design, combining a high solids tolerance with the weight of the waste providing a high degree of contact, has the potential for higher biogas production.

Fig. 5: Organic Waste Systems (OWS) dry anaerobic digester under construction, Bourg-en-Bresse, France.
Photo courtesy of OWS.

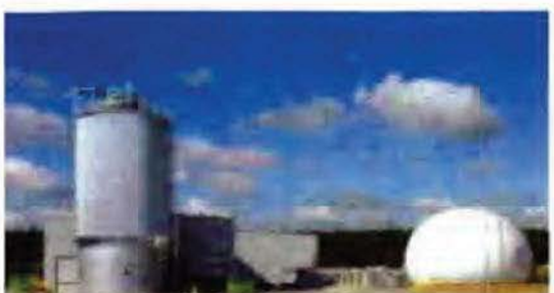

Fig. 6: Organic Waste Systems (OWS) dry anaerobic digester, Leszno, Poland.
Photo courtesy of OWS.

Closing

Any community or company interested in AD technology should consider conducting an initial feasibility study. This would include an economic pro-forma of one or more representative systems. Plants will vary in capital and operating costs, complexity of operation, energy outputs and the level of technical service provided by the vendor. The initial reports clearly indicate that the dry AD systems up and running in the U.S. are working well. However, also visiting operating plants can provide a wealth of key details and better understanding that diagrams and pictures alone cannot convey, and should also be high on the list when evaluating different systems and vendors. ■

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Read the vastly expanded version of this article online at http://bit.ly/1aOMJxb for detailed breakdowns of the three AD types, an AD FAQ, and discussion of the economics of implementing AD.

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