Energy Production from Waste Using the Anaerobic Membrane Bioreactor Process

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Due to the extreme pressures imposed by a large population, limited land space and limited natural resources, Japan has often been a leader in the development of new technologies for waste management and energy production. In the late 1990s, Kubota Corporation introduced a unique form of anaerobic digestion technology that is now finding widespread application for the development of renewable energy from waste, the anaerobic membrane bioreactor, or AnMBR. This technology has also shown a great deal of promise for applications in North America, especially for the management and production of energy from food processing and biofuels production wastes.

Presently there are fourteen full-scale AnMBR installations operating or under construction in Japan, producing renewable energy in the form of bio-methane or biogas from a variety of feedstocks. Waste sources include alcohol production stillage, municipal garbage, septage, wastewater treatment plant sludge, and a variety of food processing residues and wastes. The first full-scale installation of the AnMBR process was completed in 2000 (for septage and garbage), and the first full-scale AnMBR system in the USA was constructed in 2008 for treatment of a salad dressing and BBQ sauce production wastewater.

The AnMBR process is considered to be cutting-edge technology in the field of anaerobic digestion. It is a form of high-rate anaerobic digestion process that uses a submerged membrane barrier to perform the gas-liquid-solid separation and reactor biomass retention functions. This near-absolute barrier to solids ensures efficient system operation, even under high organic loadings and intense mixing scenarios. Sine gravity settling is no longer required, higher organic loadings and mixing intensities can be employed than with other anaerobic technologies, increasing organic removals, improving biogas production, reducing system footprint and allowing for treatment of wastewaters with very high suspended solids and fats, oil and grease. The AnMBR achieves all this while maintaining the highest-quality anaerobic effluent possible. Biogas generated in the anaerobic digestion is utilized to continually clean the membranes during operation via a gas scour process and full-scale experience has shown that typical chemical cleaning intervals are 1 month to greater than 1 year.

Some of other advantages of AnMBR technology over other anaerobic systems include:

- Higher loadings due to complete retention of biomass and higher mixing/contact intensities possible
- Smaller footprint
- Superior quality, solids-free anaerobic effluent
- More stable process due to elimination of biomass loss
- Can operate at thermophilic temperatures (better removals, more biogas, reduced sludge production) yet avoids common operating problems at thermophilic temperatures (biomass loss, unstable operation)

AnMBR technology can be utilized to treat essentially any wastewater amenable to anaerobic treatment, but is most applicable to very strong, concentrated wastes, solid and semi-solid wastes and slurries, and wastewaters with poor settling characteristics, including:

- Distilleries
- Organic food waste
- Fuel and food-grade ethanol production stillages
- Food processing wastewaters
- Chemicals production
- Solids, semi-solid and slurried wastes

This paper will review the technology, present case studies of its application, and discuss its potential role in the development of renewable sources of energy from waste and in industrial wastewater treatment applications in North America.

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