Unlocking the Power in Waste

C. G. Steiner

WaterSmart Environmental, Inc

Shawnee Mission, Kansas

Article reprinted from Asian Water magazine, October 1999

Bacteria play a vital role in converting waste to energy. The same bacteria that produce methane at the landfill are used in the anaerobic treatment process to treat wastewater. Sadly, only a few thrifty municipal treatment plants are converting their digester gas (biogas containing 65-70% methane) into energy. Those that do are typically reducing their total wastewater treatment plant energy costs by one third to one half. But this only represents but the tip of the iceberg.

Traditional anaerobic treatment, frequently referred to as conventional high rate (CHR) treatment, is extremely inefficient at producing methane gas. It consists of a single vessel suspended growth digester at about 35 C (95 F).

The operation of anaerobic digesters requires very close attention as the continuing adjustment of pH and alkalinity is process demanding. This is because two independent biological steps, or phases, are occurring simultaneously within a single fermentation or digestion vessel.

In the first phase *hydrolytic* and *acidogenic* bacteria convert dispersed and dissolved organics into aldehydes, alcohols, acids, and carbon dioxide (acetogenesis). In the second phase, methanogenic bacteria convert the 1st phase intermediates into mostly methane gas (methanogenesis). Sulfur compounds, if present, are reduced to hydrogen sulfide gas. The first phase biological digestion is optimized in a pH range of 5.0 to 6.0 at an ORP (oxidation/reduction potential) of -200 to -300mV whereas the second phase is optimized in a pH range of 7.2 to 8.2 at an ORP of -400 to -450mV. When both phases occur in a single vessel at a single pH and ORP an anaerobic reactor always operates way below process efficiency.

Improvements to the Old

By isolating the independent biological phases, resulting process efficiency will enhance overall system performance and reduce the total size of the anaerobic digestion equipment.

Other significant improvements available are:

- Utilizing attached growth rather than suspended growth bacteria. This modification greatly decreases the total reactor size because of the inherent ability to accommodate up to a five-fold increase in active bacteria.
- Employing thermophilic bacteria at 59°C (138.2°F) metabolizes organics at four times the rate of mesophilic bacteria, permitting a further size reduction in digestion equipment as well as the associated HRT (hydraulic residence time).
- Staged treatment that increases process efficiency.
- Flow recirculation to further increase process efficiency by reducing the size of the required reactor vessel.
- Process controls and instrumentation to achieve environmental conditions that permit the several biological reactions to be optimized rather than obstructed, and
- The addition of essential micronutrients to permit the sophisticated anaerobic biology to reach its ultimate and remarkable effectiveness.

Conventional anaerobic treatment has been commercially practiced for the last sixty years. Process improvements have been slow to develop and unimpressive. Researchers and anaerobic treatment equipment manufacturers worldwide have been consistently troubled by the complexity of the biology as several reactions always occur simultaneously.

Research reports frequently cite plant start-up problems associated with the lowering of the pH so as to diminish methane production. The remedy was always to raise the pH to favor the methanogenic methane producing biology. In so doing, the higher pH also suppressed the performance of the several acidogenic reactions.

Phase Isolation for Efficiency

Both reactions work entirely without restraint when they are separated from each other and permitted to function at their individually preferred pH and ORP. This method is referred to as **two-phase treatment** and looks to rapidly become the dominant process of anaerobic treatment.

Although process refinement is far from over, most existing CHR plants can be upgraded to take advantage of the several process improvements available to achieve levels of treatment efficiency thought unattainable until now.

Therefore, although energy from waste can indeed be achieved using CHR technology, any such program would likely be as unsuccessful as the landfill methane gas-to-energy or municipal-solid-waste-to-energy efforts.

Elevating waste-to-energy technology to a successful commercial operation with a positive return on investment is, however, now possible. Anaerobic treatment digesters that capitalize on the process improvements available are capable of treating five to ten times more wastes, on an organic loading basis, than a usual CHR vessel.

The Optimised Anaerobic Treatment (OAT™) technology by WaterSmart Environmental in the IS is an example of a wastewater treatment process that operates on the principle of phase isolation. It is also based on the use of fixed growth biology and the use of thermophilic bacteria.

The OAT™ represent one of the first wastewater treatment processes with a positive return on investment that makes its acquisition economically justifiable in Asia. Virtually all organic wastes can be biologically treated with the OAT™ process to generate energy in the form of methane or electricity.

Since all countries produce renewable wastes, all can benefit from the conversion of wastes into energy. Energy-scarce Korea, for example, must pay about US$0.38/kWh, nearly five times the rates in Europe and the US. By adopting such a program a country's wastes become an asset rather than a burden on the world's already polluted rivers, lakes, and aquifers.

C. G. Steiner is the president of WaterSmart Environmental, Inc. For information about the anaerobic treatment technology discussed in this article, call WaterSmart at 913-897-2727 or write to Post Office Box 26346, Shawnee Mission, Kansas USA 66225-6346.