



Unlocking the power in waste

Although yet to be commercial, improved anaerobic treatment of liquid waste promises lucrative returns

By C.G. STEINER

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 typically reduce the energy costs incurred in wastewater treatment by one third to one half. But this only represents the tip of the iceberg.

Traditional anaerobic treatment, frequently called 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.

The operation of anaerobic digesters require very close attention as the continuous 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 first phase intermediates into mostly methane gas (methanogenesis). Sulphur compounds, if present, are reduced to hydrogen sulphide gas. First-phase biological digestion is optimised in a pH range

of 5.0 to 6.0, at an oxidation/reduction potential (ORP) of -200 to -300mV, whereas the second phase is optimised 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, however, resulting process efficiency will enhance overall system performance and reduce the total size of the anaerobic digestion equipment.

Other improvements available are:

- Utilising 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 population.
- Employing thermophilic bacteria at

59°C metabolises organics at four times the rate of mesophilic bacteria, permitting a further size reduction in digestion equipment as well as the associated hydraulic residence time.

- Staged treatment which increases process efficiency.

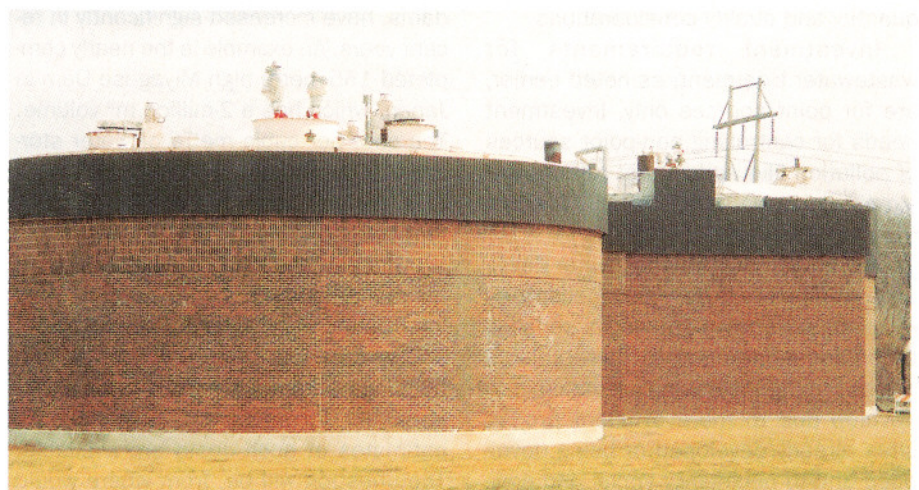
- Flow recirculation to further increase process efficiency by reducing the size of the required reactor vessel.

- Process controls and instrumentation to achieve environmental conditions that permit the several biological reactions to be optimised rather than obstructed.

- The addition of essential micro-nutrients to permit the sophisticated anaerobic biology to reach its ultimate effectiveness.

Conventional anaerobic treatment has been commercially practised for the last 60 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 to diminish methane production. The remedy has always been to raise the pH to favour the methanogenic methane producing biology. In so doing, the higher pH also sup-



Single-phase anaerobic digesters to process municipal sanitary wastewater sludge



presses the performance of 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 the two-phase treatment and is rapidly becoming the dominant process of anaerobic treatment.

Although process refinement is far from over, most existing CHR plants can still 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 programme 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 which capitalise on the process improvements available are capable of treating five to ten times more waste, on an organic loading basis, than a usual CHR vessel.

The Optimised Anaerobic Treatment (OAT) technology by WaterSmart Environmental in the US 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 represents 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 programme, a country's wastes can become an asset rather than a burden on the world's already polluted rivers, lakes and aquifers. ♠

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