FUELS FROM BIOMASS

NEW AIDS FOR MUNICIPAL DIGESTION

MINNEAPOLIS, MN—Investigators at the Gas Research Institute (GRI, Chicago, IL) think that, when it comes to generating usable methane from municipal wastes, less can be more.

Rather than looking for the process that will produce the most methane from a given quantity of municipal solid waste (MSW, which typically consists mostly of cellulose and hemicellulose), GRI's Thomas D. Hayes and H. Ronald Isaacson decided to look for a process that would produce the cleanest and most concentrated gas. Hayes presented the team's preliminary design assessments at August's "First Symposium on Biotechnological Advances in Processing Municipal Wastes for Fuels and Chemicals," sponsored by Argonne National Laboratory in Minneapolis.

The gas produced by most current anaerobic digesters (at ambient pressures) is 55%–65% methane; the rest of the product is mostly carbon dioxide, with some hydrogen sulfide. Pipeline quality gas, on the other hand, is better than 95% dry methane at 300 psig. It typically costs $1.50–$3.00 per million Btu to clean up, concentrate, and compress gas from digesters to bring it up to pipeline quality. These processes can account for about half of the total "well-head" cost of fuel gas from wastes. Reducing or eliminating these costs could make producing methane from MSW more economically attractive than extracting gas from the ground—a proposition with profound implications for energy producers, industries that rely on hydrocarbon feedstocks, and the increasingly constrained waste-disposal industry.

Hayes and Isaacson approached the problem through a back door of sorts: they began by analyzing not methane production but carbon dioxide balance in steady-state models of anaerobic digestion.

They first looked at a pressurized system maintained at pH 8 by the addition of lime. This produced satisfactory levels of methane (90%), but the lime cost some $2.50–$3.00 per million Btu.

Finally, the designers settled on a "two-stage, pH-swing, pressure-swing digestive system."

It begins with an acid, acetogenic fermentation in a leaching bed reactor. Aerobic bacteria convert the influent organic compounds into organic acids and carbon dioxide. Most of the carbon dioxide is drawn off as a gas, but low concentrations of carbon dioxide remain dissolved in the liquid phase, along with modest concentrations of volatile acids. The liquid passes to an intermediate stage for air sparging; this step removes the remaining carbon dioxide but leaves the organic acids, which pass in turn to a holding tank where residual microbes remove any remaining dissolved oxygen.

IMAGE
UNAVAILABLE FOR
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REASONS

The mostly CO_2-free solution then flows into a packed bed reactor for anaerobic digestion into methane. The reactor's environment is alkaline and pressurized; both the pH and the pressure are maintained by microbial metabolism.

At the process's temperature and pressure (35°C and 30 psig), carbon dioxide is about 40 times more soluble in water than methane. Thus, much of the CO_2 produced in this reaction remains dissolved in the liquid phase (which is recycled back to the leaching bed for acetogenic fermentation), while the methane is released into the gas phase.

The result is 90%–95% methane at 30 psig. The concentration and purity obviate many of the cleaning processes that ordinary digester gas must undergo; and the pressure eliminates the need for one step of pre-pipeline compression.

Other processes convert more available carbon to methane than Hayes and Issacson's. Paul Smith of the University of Florida (Gainesville, FL) estimated that the process sacrifices about 10% of the methane a more direct process might produce, while some questioners at the Argonne meeting suggested that losses might run as high as 30%. Yet a 50% saving in processing costs more than justifies the sacrifices, according to Hayes.

A lot more work needs to be done before the process is proven, warns Hayes. Especially important are analyses of the influence of pressure-vessel construction costs (estimated at about $0.25 per million Btu) and the environmental effects of product gases and effluents.

—Douglas McCormick