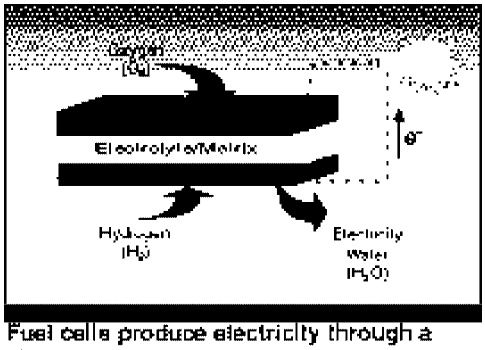
FUEL CELLS



Fuel cells produce electricity through a chemical reaction.

Like a conventional battery, a fuel cell uses two reacting chemicals separated by an electrolyte to produce an electric current. Unlike a conventional battery, a fuel cell is not charged prior to use—the chemical reactants are fed continuously to the cell to provide constant power output. The reaction takes place without combustion, requires no moving parts, and produces negligible pollution. Heat generated within the cell can be recovered via steam condensation for additional process uses.

USE IN THE WASTEWATER TREATMENT PROCESS

Although fuel cells are costly to install, they have distinct advantages in efficiency, reliability, and emissions over gas turbines or diesel generators. Fuel cells use hydrogen as a fuel source, which can be derived from methane, natural gas, or anaerobic digester gas. For wastewater treatment plants that are prohibited from expanding their cogeneration plants due to air quality restrictions, fuel cells may offer a means to utilize excess anaerobic digester gas.

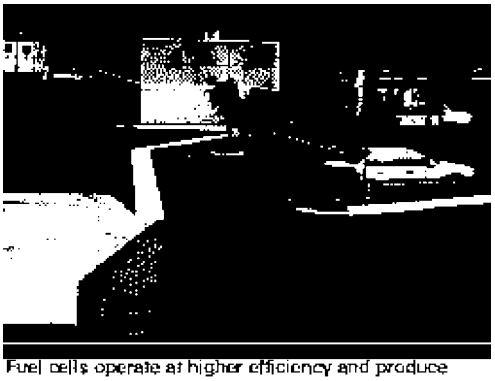
Anaerobic digester gas can also be used to fuel cogeneration engines or individual equipment, however, the gas releases sulfur compounds when burned. At plants prohibited from releasing the gas directly into the atmosphere, it must be flared. Whether burned or simply released, the environmental impacts and regulatory constraints associated with the use, storage, and disposal of anaerobic digester gas have been problematic for many plants. Using anaerobic digester gas in fuel cells circumvents these problems because the gas is neither burned nor released. The gas must be scrubbed prior to use, however, because the sulfur compounds contained in anaerobic digester gas are toxic to fuel cells.

BENEFITS

Fuel cell emissions are so clean that they are exempted from many Clean Air Act permitting requirements. Fuel cells produce carbon monoxide emissions as low as 5 parts per million and nitrogen oxide emissions of 1 part per million—well below California emissions standards for combustion engines.

Fuel cells are more efficient than the typical cogeneration systems used at wastewater treatment plants, converting 40% of the energy contained in digester gas into electricity, compared to 32% for cogeneration. They also produce considerably less nitrogen oxide and carbon monoxide emissions than diesel engine generators that operate on anaerobic digester gas. Further, fuel cells are quiet, producing minimal noise from cooling fans and pumps. They also require less upkeep: The most common fuel cell requires only a two-day annual maintenance shutdown. After about five to seven years, the fuel cell stack must be rebuilt.

PERFORMANCE HISTORY



Fuel cells operate at higher efficiency and produce less emissions and noise than combustion generators.

Fuel cells were invented well over a century ago, but the 1960's space program spurred their commercial development. NASA, seeking a lightweight, reliable source of power for its spacecraft, developed a small fuel cell that operated on liquid hydrogen and oxygen and used an alkaline electrolyte.

As of this writing, the most widely available commercial fuel cell uses phosphoric acid for an electrolyte. This fuel cell, the PC-25, is a 200-kilowatt unit developed by ONSI, a subsidiary of U.S.-based International Fuel Cells. The PC-25 has operated commercially at 75 different sites, logging over one million hours of operation with 95% availability. With anaerobic digester gas-based units now available, ONSI is working with two U.S. utilities to demonstrate the technology at wastewater treatment plants. The new model will be coupled with a gas pretreatment unit—developed jointly by ONSI and the Environmental Protection Agency's Air Pollution Prevention and Control Division--that will remove sulfur compounds from the digester gas. The PC-25's operating on anaerobic digester gas are expected to perform as well and as reliably as the natural-gas-based units. The mean time between failures for the PC-25 is about 2200 hours, compared to 500 to 750 hours for diesel cogenerators.

COST CONSIDERATIONS

As of February 1997, the limited market for fuel cells has kept the cost of fuel cells high: around $750,000 to $800,000 for both the 200-kilowatt unit and the gas processing equipment necessary for use with anaerobic digester gas. Installation costs an additional $150,000 to $200,000. This equates to as much as $5,000/kilowatt, plus operation and maintenance costs of about 1.5 cents/kilowatt hour. As the market share for fuel cells increases, costs may fall.

Financial incentives may be available to partially offset fuel cell costs. The U.S. Department of Defense offers a rebate of up to $1000/kilowatt. The Internal Revenue Service also offers a 1.5 cent/kilowatt hour tax credit or tax rebate for renewable energy sources. In some areas, emissions credits may be sold for emissions offset by a fuel cell installation.

REFERENCES

Demonstration of Fuel Cells to Recover Energy from Anaerobic Digester Gas: Phase I. Conceptual Design, Preliminary Cost, and Evaluation Study, U.S. Environmental Protection Agency, Office of Environmental Engineering and Technology Demonstration, EPA-600/R-95-034, 1995.

McDougall, A. *Fuel Cells*, New York: John Wiley & Sons, 1976.

Noyes, R. *Fuel Cells for Public Utility and Industrial Power*, Park Ridge, NJ, Noyes Data Corp., 1977.

Sanderson, G. *National Directory of Federal and State Biomass Tax Incentives and Subsidies*, U.S. Department of Energy, Tennessee Valley Authority, Southeastern Regional Biomass Energy Program, Muscle Shoals, AL, 1994.