The flex-microturbine for biomass gases: An update

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Background

FlexEnergy, together with its partner, Capstone Turbine Corporation, has been developing the Flex-Microturbine™ for the last four years. FlexEnergy has contracts with NREL through the DOE's Small Modular Biopower Project and with the California Energy Commission (CEC) through its Small/Scale Modular Biomass Power Initiative under the PIER Program. Now that funds are available, development is proceeding much more rapidly. This paper provides an update on progress.

The Technological Breakthrough

The most important technical breakthrough for the Flex-Microturbine is its ability to accept very low Btu gases at atmospheric pressure. The Flex-Microturbine will run on gases as low as 20 Btu/cubic foot (180 kcal/cubic meter) or two percent the strength of natural gas, with no loss of output. This remarkable potential is achieved by mixing the fuel and air prior to compression. The mixture is then compressed and heated, followed by catalytic combustion whereupon the hot gases will flow through the turbine to produce power. In fact, at full load, the air-gas mixture must be diluted so that its fuel content is no more than 13 Btu/scf. This weak mixture is well below the concentration necessary to support continuous combustion. The Flex-Microturbine therefore uses catalytic combustion, borrowing from technologies developed for the "destruction" of hydrocarbons from automotive and industrial exhaust. The Capstone C30 microturbine power plant has been commercially available for over two years, and shipments are now in the thousands. Rather than start from scratch, it was decided to adapt the Flex-Microturbine from the commercial C30 Capstone turbine, with a capacity of 30 kW. While this approach created some early design challenges, it will greatly accelerate the commercialization process. The Capstone assembly line could be modified to build the Flex-Microturbine, and current sales and marketing strategies could also be expanded to include the Flex-Microturbine. Many of the early design challenges have now been resolved, and Proof-of-concept testing is anticipated in the second quarter of 2001.

With air bearings and no lube oil or cooling water, catalytic combustion and extremely low NOx, the Flex-Microturbine is rugged, long-lasting and environmentally one of the cleanest means of generating electricity, cleaner even than modern large power plants.

The Market

The wide-ranging fuel-flexibility of the Flex-Microturbine creates unique biomass opportunities. While it will run on natural gas, diluted, as above, to 13 Btu/scf, there are large quantities of low-energy biomass gases that form naturally. Most of it is widely dispersed, difficult to collect and expensive to transport. Methane from biomass is the second largest cause of global warming after carbon dioxide from power plants and automobiles. Methane emissions occur from animals, their manure, landfills, swamps, and water treatment facilities. Much of this methane is in concentrations too low for most traditional machines. These occurrences are well suited to the Flex-Microturbine. The Flex-Microturbine could be installed locally, collecting locally generated gases. For example, old landfills generate gas with methane content of less than five percent (50 btu/scf). A Flex-Microturbine is the only engine that can run on such gas.

Solid biomass, such as wood waste, nutshells, corncobs etc., is also widespread, but dispersed and expensive to transport. Wood and wood-waste is also a potential source of fuel that can be converted to biomass gas, generally called Producer Gas, around 150 to 200 Btu/scf and generally at pressures just

above atmospheric. All the above gases must be further diluted to 13 btu/scf before they can be used in the Flex-Microturbine. The Flex-Microturbine reverses the traditional approach to biomass gasification and use: instead of attempting higher pressures and higher concentrations, low pressure and low concentration will suffice.

The first prototypes will be for a manure digester, a landfill and a portable unit for consuming forest residues in Lake Tahoe and other western forests where trees are dead or dying. A pre-commercial system will be run on gasified nutshells from a pecan processing plant in Arizona. Another unit is being considered to run on direct animal emissions in a totally enclosed dairy feedlot in Iowa. It is hoped that these diverse demonstrations will jump-start the market for the Flex-Microturbine.

Current Status

The Flex-Microturbine will be completing the Proof-of-Concept testing in the second quarter of 2001, and the three prototype systems (for manure digester gas, landfill gas and Producer Gas) are expected to be in operation about one year later. Proof-of-Concept testing will be performed on methane-based fuels and also on hydrogen and carbon monoxide based fuels that are the basic constituents of Producer Gas. The Proof-of-Concept will demonstrate the feasibility of running on very low-energy fuel gases. It is anticipated that by the time of the conference, significant results from Proof-of-Concept testing will be available.