United States Environmental Protection Agency

Auxiliary and Supplemental Power Fact Sheet: Microturbines

DESCRIPTION

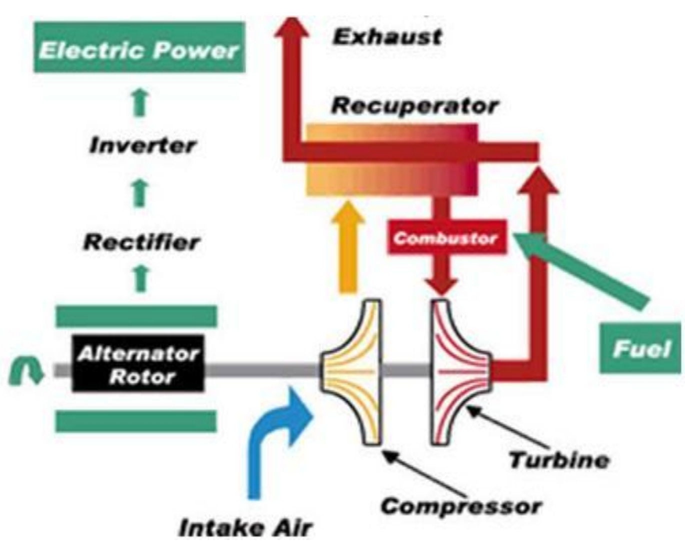
This fact sheet describes the use of microturbines as Auxiliaryand Supplemental Power Sources (ASPSs) for wastewater treatment plants (WWTPs). Microturbines are a new, innovative technology based on jet engines (more specifically the turbo charger equipment found in jet engines) that use rotational energy to generate power.

Most microturbines have four main components: compressor, combustion chamber, turbine blades, and drive shaft. The compressors operate by taking in the surrounding air at one end of the microturbine and condensing it by increasing the air's pressure and density. This air is fed into the combustion chamber where it is mixed with fuel, andthen burned. This combustion releases enormous amounts of heat energy and high-pressure exhaust gases. The exhaust gases are discharged through exhaust vents into a series of turbine fan blades that are attached to a central shaft. As the gases are discharged, they spin the turbine fans, which in turn spin the drive shaft at high speeds (100,000 revolutions per minute). The rotational energy produced by the shaft spins copper coils, which excite the electrons in the wire, producing electricity. The quantity of electricity depends on how fast the shaft can spin in the magnetic field, the strength of the magnetic field, and the quantity and arrangement of the copper coils. To produce electricity at a relatively low cost, the shaft must rotate at high speeds.

Microturbines can run on bio-gas, natural gas, propane, diesel, kerosene, methane, and other fuel sources, making them suitable for backup power in a variety of applications. Since each individual microturbine produces anywhere from 15 to 300 kilowatts (kW) of energy, they are often grouped to produce the required energy for a given application. Most microturbines are about the size of a refrigerator and have very low nitrogen oxide emissions.

ADVANTAGES & DISADVANTAGES

There are numerous advantages that make microturbines appealing. From an economic standpoint, the microturbine generators are cheaper to build and run in comparison to larger conventional gas or diesel powered generators. The technology is well understood and has been implemented in many applications throughout the U.S. They are also relatively inexpensive, easy to manufacture, and have few moving parts. These power plants can also use various types of fuels. Another advantage of microturbines is durability and reliability; they function for about 40,000 hours and require little maintenance. These systems can also be ready to operate only ten minutes after being turned on.Microturbines create a large amount of energy relative to their size. Because of their size, microturbines can be placed on site, easing security and maintenance. Microturbines have the ability to work alone or in groups. If one microturbine fails while in use, this does not necessarily mean that the entire system of microturbines will fail.



(Source: www.wastegaspower.com/images/microturbine.jpg)

From an environmental standpoint, these new machines pollute less and take up less space. The increased efficiency means that they use less fuel, which means fewer emissions into the air. Increased efficiency and less fuel also result in a lower reliance on finding the natural resources necessary to power the turbines.

One disadvantage of microturbines is a limit on the number of times they can be turned on. Microturbines also run at very high speeds and high temperatures, causing noise pollution for nearby residents and potential risks for operators and maintenance staff. It may also take several microturbines set in a series to provide enough energy to power a small WWTP.

COST

Capstone Microturbine and Ingersoll Rand are two of the larger microturbine manufacturers. Each offer different models of microturbines that depend on the power output that is needed. Based on estimates by the Gas Research Institute and National Renewable Energy Laboratory, the total plant cost varies from ~$2600/kW for a 30 kW system to ~$1800/kW for a 100kW system. Interviews with several municipalities suggested annual savings of $25,000 to $216,000 through use of microturbines over conventional gas or diesel powered engines.

CASE STUDY

The Sheboygan Regional Wastewater Treatment Plant situated in Sheboygan, Wisconsin has a permitted flow of 18.4 MGD and an average flow of 11 MGD. In 2006, as a part of Sheboygan's goal of becoming energy self-sufficient, a combined heat and power project consisting of ten 30 kW Capstone microturbines and heat recovery systems was commissioned. Using the biogas produced from the WWTP's anaerobic digesters, the microturbines produced 2300 MW of electricity annually which translates to energy cost savings of $78000. The microturbines also produced 84000 therms of heat which is equivalent to $60000 in prevailing natural gas rates. These turbines were installed at a capital cost of $300000. In 2011, the City of Sheboygan won the "Wege Small Cities Sustainability Best Practices Award" from the Great Lakes and St. Lawrence Cities Initiative for being nearly energy self sufficient.

Lancaster Water Reclamation Plant, Los Angeles County is a 15 MGD wastewater treatment facility. The facility's digester collectively produce about 200000 scf/day of biogas that is composed of 55% methane. To utilize this biogas, a 250 kW microturbine combined with a waste-heat recovery system was installed at a total cost of $720000. The net design electrical and thermal efficiency is calculated to be 51%. The annual savings from the power generation was calculated to be $225000 resulting in a payback period of just above 3 years.

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