Microturbines: A New Source of Reliable Electricity

A new type of electrical generator, called a microturbine, is sized to fit the electricity and heating needs of typical commercial buildings and industrial plants. This new technology provides efficient energy for a variety of applications and can be placed in or near facilities that need a reliable and efficient source for electricity and heat.

Introduction

Commercial and industrial energy consumers have a better option for purchasing electrical power. A new class of electrical generator, called a microturbine, is designed to help satisfy a facility’s power needs by producing economical power at the point of use.

What Is a Microturbine?

A microturbine is a small gas-turbine engine that drives an electrical generator. It provides electrical power directly to a local facility for long periods of time and with very low emissions. It burns a variety of fuels, such as natural gas or diesel, to produce the same kind of electricity provided by a utility electrical grid (50 or 60 Hz). Because the gas turbine engine has relatively few moving parts, it is quite reliable and can operate for a long time with little in the way of maintenance (typically 8,000 hours or more).

Unlike gen-sets, microturbines produce very low emissions as they burn fuel. For example, NOx emissions are below nine ppm when burning natural gas. This is more than 10 times less than gen-sets and similar to emissions from modern central power plants with special exhaust treatment. Microturbines are also relatively quiet – around 75 dbA measured at one meter.

How Is the PowerWorks Microturbine Different?

Ingersoll-Rand’s PowerWorks microturbine was designed to meet the same standards found in commercial equipment, such as chillers, boilers and furnaces. PowerWorks engines have been designed from the ground up to provide the reliability, long-life and high performance required in the rigorous environment of the plant floor or utility room.

At the core of PowerWorks systems is a rugged turbocharger-based design. Industrial-quality components are used in each system to achieve a design life of 80,000 hours, approximately 10 years under typical around-the-clock operating conditions. This includes an essential component to engine efficiency, the recuperator. As shown in Figure 1, the recuperator recovers heat from the exhaust of the power turbine, which is then used to preheat incoming air.

Designed and manufactured in our own facilities, IR’s breakthrough technology recuperator withstands repeated engine cycling and allows the engine to reach full power quickly. The operating benefits of the IR recuperator technology have been recognized by other organizations seeking to maximize engine performance and efficiency. For example, Northrop-Grumman has incorporated the Ingersoll-Rand recuperator into the WR21 engine program, an advanced 20 megawatt ship propulsion system for the United States’ and British navies.

“Derived from military applications where performance requirements are very challeng-
ing, the IR recuperator technology is exceptional,” said Steven I. Freedman, an energy systems expert and former executive scientist at the Gas Research Institute (now the Gas Technology Institute). “Combining the recuperator with the other design features, Ingersoll-Rand has created a unique microturbine line that offers performance versatility and reliability that extends beyond simply generating electricity.”

Once preheated by the recuperator, the PowerWorks system uses its patented dry low-NOx combustor to produce the hot gases that drive its turbines. The combustor is designed to easily meet stringent environmental regulations, such as California emission standards.

PowerWorks connects directly to the electrical distribution system of a facility to provide high quality electricity. As shown in the cycle diagram, the distinctive free power turbine configuration allows PowerWorks systems to use reliable rotating generators to produce electricity (Figure 2). This same technology is used by utilities to produce power for the grid and it allows PowerWorks systems to similarly provide clean, reliable power.

Many commercial buildings and industrial facilities are not supplied by the high-pressure natural gas typically required by microturbines. Therefore, a fuel gas booster is required. PowerWorks systems can incorporate a fully integrated booster based on IR’s in-house screw compressor technology. Already used in thousands of critical industrial applications, this highly reliable, proven technology actually offers a design life well beyond the 80,000 hours targeted for PowerWorks microturbines.

The PowerWorks microturbine can be uniquely placed either inside or near a facility since it is qualified for indoor use.

**How Are Microturbines Used?**

The PowerWorks’ industrial quality allows the microturbine to work 24/7 for long periods with low maintenance. This can quickly make the PowerWorks microturbine the least expensive electricity-generating option over the life of the machine for a facility. PowerWorks is an excellent fit for continuous duty applications that are typically found in cogeneration opportunities.

With a hot water heat exchanger fully integrated into its exhaust system, useful heat is easily extracted from PowerWorks microturbines. This built-in cogeneration ability allows overall system efficiencies to approach 80 percent depending on the temperature of the inlet water.

Facilities can use this heat in a variety of ways, including space heating, domestic hot water, and process heating.
of ways. In suitable climates, the hot water can reduce building heating fuel use by providing space heating. Since the PowerWorks water heat exchanger is rated for potable water use, the PowerWorks system can supply domestic hot water directly. The hot water can also be used in conjunction with other heat-driven devices such as absorption chillers or desiccant wheels used for dehumidification. In the latter case, the heat provided by the microturbine helps regenerate the desiccant wheel by driving out the captured moisture.

Of course, the 400°F (200°C) exhaust from the microturbine can also be used directly in some applications. Since the gas turbine engine’s emissions are so low, the exhaust is relatively clean. And due to the design of the PowerWorks engine, the exhaust still contains plenty of oxygen and can support follow-up burners to further raise temperature.

Designed to help satisfy electric power needs by producing electricity at the point of consumption, the PowerWorks microturbine comprises a versatile design that not only generates electricity for base consumption, but also supports peak shaving applications. This allows facilities to avoid peak charges, or even minimize punitive charges associated with tariffs, such as interruptible rates.

Example Applications
The following site installations represent good examples of how the PowerWorks microturbine can benefit a variety of domestic and industrial applications:

- A PowerWorks 70 kW microturbine provides grid-parallel electricity to a 90,000-square-foot public ice-skating facility in Southern California containing two ice rinks – an NHL-sized rink and an Olympic-sized rink. Built-in heat recovery also provides hot water to regenerate the desiccant wheels used to dehumidify the facility, which improves ice quality and occupant comfort. In addition, the hot water is available for other facility requirements, including ice melting, domestic hot water, and the ice-resurfacing machine.

- A 60,000-square-foot community center and skilled nursing facility located in the State of New York is using an IR PowerWorks microturbine to generate most of the facility’s domestic hot water needs. The 70 kW microturbine was installed as a complementary power source to help reduce the center’s use of electricity from the public grid. As a result, they are currently saving significant amounts on both electric-utility costs and hot-water energy costs.

- A PowerWorks microturbine is providing electric power and process heat for an oil refinery in Pennsylvania. The 70 kilowatts of electrical power produced by the generator help to offset the facility’s base load, and heat captured from the integrated heat-recovery system preheats the feed water for process boilers. This highly effective cogeneration application is currently achieving over 70 percent overall efficiency.

- A commercial greenhouse in Colorado has a rather unique application of the PowerWorks 70 kW microturbine. In addition to providing base-load electricity for the facility, the PowerWorks cogeneration heat-recovery system preheats the water that is used to water plants. Studies have shown that preheating ground water to temperatures around 60°F to 70°F (15°C to 21°C) accelerates the growth of greenhouse plants (as opposed to using the unheated cold water). The greenhouse consumes at least 90,000 gallons (24,000 liters) of ground water each day, and the PowerWorks microturbine makes a significant contribution in heating the water to substantially reduce the amount of natural gas used by the boilers.

Conclusion
PowerWorks microturbines are part of Ingersoll Rand’s Independent Power Sector, which focuses on identifying, developing and marketing alternative-power and energy-management solutions. Unlike gen-sets, microturbines produce very low emissions as they burn fuel. For example, NOx emissions are below 9 ppm when burning natural gas.