The application of an Exergy radial outflow turbine (ROT) in Organic Rankine Cycle (ORC) systems is used to exploit geothermal heat sources, as well as recover biomass and waste heat in power generation and gas compressor applications.

The Importance Of Recovery

by **Roberta Prandi**

Exergy uses radial outflow technology to recover heat for energy

Exergy S.p.A., an Italian subsidiary of the Maccaferri Industrial Group, develops and produces Organic Rankine Cycle (ORC) systems usign its patented radial outflow turbine (ROT) technology.

This technology is particularly suited for the exploitation of geothermal heat sources, which represents 90% of the company's installed and in-construction portfolio of 255 MW. It is also used for biomass and waste heat recovery in power generation and gas compression stations.

The company explained that the ROT is capable of converting the energy contained in the ORC fluid into mechanical power, with a higher efficiency than competing technologies on the market, such as axial and radial inflow turbines.

Exergy's CEO, Claudio Spadacini, developed this system and explained how he came up with the idea. "At the beginning of the year 2000, it became clear that there was a gap in the ORC market for a turbine that could utilize lower quality heat sources and convert it into energy," he said. "Steam turbines were not always the most efficient, flexible and economic solution."

With the impression that the market was waiting for some innovation and technology improvement, Spadacini started working on a new solution, which is the application of a ROT to ORC systems.

"This technology had been developed in the early 20th century by Ljungstrom and Parsons to expand steam," Spadacini said. "Back then, the choice to use the radial outflow turbine with water steam demonstrated serious limitations with steam processing and was deemed not suitable.

"Thus, no significant development of such turbines followed, and they were phased out for steam applications by axial turbines."

Spadacini's experience with steam turbines and Rankine systems allowed him to start evaluating the application of a ROT — similar to Ljungstrom turbines — to the ORC.

"While all existing ORCs worldwide have been based on turbomachinery employing axial or radial inflow turbines, the radial outflow turbine showed many unique characteristics when applied to ORCs, resulting in high ORC engine efficiency," Spadacini said. "The high efficiency of the machine is combined with better overall cycle efficiency as a result of higher pressure ratio and volumetric ratio."

Spadacini added that he introduced and tested for years this new alterna-

An Organic Rankine Cycle (ORC) installation by Italian specialist Exergy for waste heat recovery.

tive to conventional ORC and, in 2009, his vision was realized when the ROT launched into the marketplace. Exergy's ORC plants are available for powers between 300 kW and 100 MW. According to Exergy, ORC is the best solution when the enthalpy level of the heat source is low or when the size of the application is too small for a steam power plant.

ORC advantages are based on the differing thermodynamic properties of the single organic fluid. The fluid is chosen to best fit the heat source, obtaining higher efficiencies. Fluids more commonly used are pentanes and refrigerants — all usually having high market availability. The system also rarely needs refilling.

In comparison with heat recovery systems using steam turbines, ORC is suitable for lower-temperature applications. The low turbine rotation and speed, together with the absence of a liquid phase during expansion, lead to a reliable and long-lasting expander with lower cost compared to a steam turbine, said Exergy.

The system is compact and automated, with no need for an operator, and is ideal for a cycling operation, especially with fast starts and stops.

Other advantages of a ROT include the possibility of having multiple pressure admissions on a single disk, while having two pressures on a single wheel represents a cost-effective solution.

Being that it is directly coupled to the generator, the turbine rotates at low speed with minimum turbulence and no need for a gearbox, with higher reliability and maximum efficiency, said Exergy; in addition to that, the outward movement of the fluid minimizes 3-D effects.

The company also added that a large increase in volumetric flow is achieved without the need for extreme changes in blade height, and the volumetric flow matches with the cross section across the radius.

The ROT design requires no partial admission and allows for less tip leakage and disk friction losses. All these, combined with the low-speed rotation, create less vibration with a longer life of the bearings, said the company.

Exergy recently landed a follow-up agreement for the second phase of a geothermal project for Karadeniz Holding in Turkey. Regarding future strategies, Spadacini said, "We will continue to develop our business to grow worldwide. The global market for heat recovery and biomass applications is an important target for us develop."