

Taken from the ***Gas Turbines: An optimistic forecast*** cover story in the November/December 2009 issue of Turbomachinery International.

USING LOW-GRADE GEOTHERMAL HEAT

Geothermal energy today includes combinations of electric power generation, heating and cooling. For electricity production, there are three basic types of geothermal power plants; dry steam, flash steam, and binary cycle. Interest in binary cycles has received a boost in recent times since these systems can use less expensive, lower temperature geothermal wells. The binary cycle power cycle operates at lower temperatures of about 225°F to 360°F.

While there are a large number of heat sources at this lower temperature, the potential thermodynamic efficiency is reduced, resulting in a high capital cost per kilowatt of power generated. Consequently, there is a great incentive to modify this cycle to achieve its maximum potential efficiency. In operation, these systems transfer the heat from the hot water to a secondary working fluid, usually an organic compound (refrigerant) with a low boiling point. This cycle is often referred to as an Organic Rankine Cycle (ORC).

The advantage of this cycle is that it is not necessary to operate the system at low, sub-atmospheric pressures, and associated high volumetric flow rates through the turbine and heat exchangers. In the ORC cycle, the pressurized organic motive fluid is vaporized in an unfired boiler heated by the hot water. The vaporized motive fluid is used to drive a turbine-generator, after which it is condensed, pumped back up to the turbine inlet pressure, and again vaporized in the boiler. The cooled water is injected back into the reservoir.

GeoTek Energy, LLC, a geothermal developer, and Concepts NREC, a provider of turbomachinery systems engineering, are developing a Gravity Head Energy System (GHES), which significantly increases the overall cycle efficiency by 20% to 30%. A major contributor to the improved overall cycle efficiency of the GHES is the application of a high-performance, compact turbo expander-pumping unit installed deep within the wellbore.

The expander is driven by the high-pressure motive fluid flowing down the well by gravity that has been heated by up-flowing geothermal brine. The expander is direct coupled to a brine pump and therefore provides the required energy to pump the brine to the surface. This configuration eliminates the electrical loads associated with the motive fluid pump and the production well geothermal brine pump common to the conventional geothermal ORC system.

A special design feature of the expander pumping unit is the complete isolation between the hot brine and the motive fluid. This is critical in order to avoid crossover contamination between the two streams. Due to the downhole location of the expander pumping unit, reliability and access for maintenance are also key features to the design of the unit and overall GHES. The motive fluid discharge from the expander flows back up the well with sufficient energy to feed a surface mounted turbine-generator and produce power. The surface turbine is designed to operate at the synchronous speed of the generator. This eliminates the need for an intermediary gearbox and its associated losses, says Concepts.