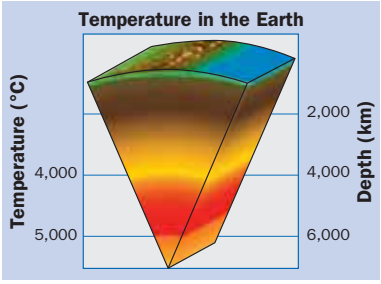
Overhaul of Geothermal Power Plants

Power from the Earth

JOB EVERSON
MARCEL DELFGAAUW
SULZER TURBO SERVICES

Geothermal energy is heat derived from the earth. The thermal energy contained in geological structures can be used directly for heating or indirectly for generating electrical energy. Depending on the type of power plant, the equipment in geothermal plants is subjected to water and steam containing corrosive impurities. Therefore, repair and maintenance of geothermal turbines is especially challenging. Recently, Sulzer Turbo Services has overhauled a number of geothermal power plants in several tectonically active regions.

It is common knowledge today, that the earth has a very hot core and a solid crust. With a maximum thickness of about 200 km, the crust, also called lithosphere, is thin compared with the earth's diameter, which is an average 6371 km (Fig. 1). In some areas of the earth, however, the crust is even thinner. In theses areas, the rock and the fluid that fills the fractures within the rock are hotter than usual, providing a source of thermal energy, which can be tapped for heating or generating electrical energy.

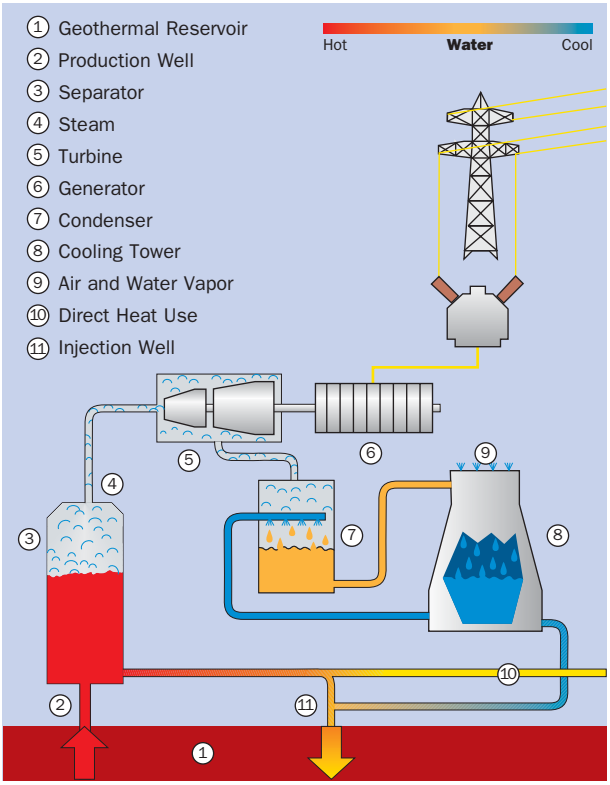


1 The earth's heat can be put to use as a source of clean energy. Sulzer Turbo Services overhauls geothermal power plants to improve their operation.

Three Principles

Geothermal power plants use 1 of the 3 common principles, dry steam, flash steam, and binary cycle, with the system depending on temperature, depth, as well as quality of the water and steam in the area. Flash steam plants are the most common type of geothermal power generation plants in operation today (Fig. 2). Due to the high pressure underground, the hot water is liquid although its temperature is above the boiling point of water at surface pressure. As the water is pumped to the surface and into the power plant, the pressure drop causes the water to vaporize, or "flash", into steam, which powers the turbine. Any water not flashed into steam is injected back into the reservoir for reuse.

2 In a flash-steam plant, steam produced directly from the geothermal reservoir drives the turbine, which therefore has to handle corrosive gases and minerals dissolved in the water from underground.



Major Overhaul in Indonesia

In early 2007, a joint venture of state owned Indonesian oil and gas and power plant companies awarded Sulzer Hickham Indonesia, a company of Sulzer Turbo Services, with a major overhaul project at one of its geothermal power plants. It was a new challenge for Sulzer Hickham Indonesia to carry out a major overhaul of a steam-turbine/generator unit including the balance-of-plant system.

Corrosive Steam

The geothermal power plant is situated on the island of Java on a beautiful plateau at around 2 500 m above sea level. This power plant was commissioned in 1998 and went into commercial operation in 2002. With 1 steam-turbine/generator unit, it can provide 60 MW of electrical power. Steam (450 t/h) collected from 4 active well pads drives the double-flow condensing-type steam turbine, which operates under high cyclic stress. For long periods, it is exposed to wet steam, which contains corrosive gasses. Hard scale deposits are frequently found during casing opening. Sulzer Turbo Services inspected the steam-turbine rotor using a borescope to determine its condition prior to performing the major overhaul. Additionally, the steam-path parts, i.e., nozzles, diaphragms, and blades, showed signs of erosion and corrosion.

On site, the Sulzer Hickham Indonesia crew prepared the steam-turbine rotor and 1 of the 2 very large hot-well pumps to be transported to the workshops for the scheduled 60-day in-shop repair. The main scope of work for the shop repair comprised of blade replacements as well as welding repairs of nozzles and diaphragms on both the drive and non-drive ends of stages 1, 2, and 3.

While the rotor repair was ongoing, the site crew continued the major overhaul of the balance-of-plant system, i.e., rock muffler, various valves, steam-purifier installation, generator unit, condenser, various pumps and motors, and ejectors complete with all electrical installation and instrumentation to be checked, calibrated, and tested.

Increased Performance

To remove the generator rotor from the casing for the first complete inspection since its installation, the generator-building roofs had to be dismantled, work made difficult by the rainy season with frequent hard rain, storms, and damp conditions. During the inspection of the generator rotor, Sulzer found that the oil-seal areas and the exciter ring had undergone significant radial rubbing, which required machining repair on site, another challenge for Sulzer Hickham Indonesia. Reassembly of the steam-turbine unit took 24 days including commissioning. The unit is now running smoothly with vibration levels one-fifth of those before the overhaul. It can now produce 45 MW with a steam supply of 300 t/h, whereas preshutdown it produced 40 MW with 400 t/h steam.

3 Hard scale deposit behind the turbine inlet nozzle.

Fire and Ice

Iceland is an island of 103 000 km^2, consisting mainly of lava. The majority of the 313 000 inhabitants lives in the area of the capital Reykjavik.

In Iceland, there are 2 main sources of energy: geothermal energy and hydro power. Geothermal heat is one of Iceland's greatest natural resources. Ninety percent of the homes use geothermal heating and the capital has been enjoying this valuable power source for more than 60 years. Due to the abundance of naturally hot water, central heating and warm water are rather inexpensive.

There are 4 major geothermal power plants on Iceland:

- Nesjavellir (180 MW electrical power, 300 MW of heating water)
- Svartsengi (75 MW electrical power, 80 MW of heating water)
- Krafla Landsvirkjun (60 MW electrical power)
- Hellisheidi (124 MW electrical power)

In the Hellisheidi power plant, additional 90 MW of electrical power will take up operation in 2008, and in 2009, the production of heated water will start.

Successful Repair

Sulzer Repco, a Dutch company of Sulzer Turbo Services, has started serving the Icelandic geothermal market in 2007. In February 2007, experts of Sulzer Turbo Services visited the Nesjavellir geothermal power plant, Iceland's largest, with 6 low-pressure steam turbines of 30 MW each.

Because of the far-from-optimum steam conditions (195 °C, 14 bar) in this plant, erosion is a serious problem. During the visit, the Sulzer specialists evaluated a welding repair job on 8 complete diaphragms. Due to the broad experience of Sulzer Repco with this kind of work, the clients placed an order for the welding repair, which already has been finished successfully. As of early 2008, Sulzer Repco has a 30-MW steam turbine rotor and diaphragms from the Nesjavellir plant under repair.

4 Nesjavellir geothermal power plant in Iceland.

5 Erosion on the diaphragm caused by steam from the underground reservoir.

Further Opportunities

After this first work for geothermal plants in Iceland, Sulzer Turbo Services has received requests for several quotations some of which have already lead to further orders. As all geothermal power plants on Iceland and many worldwide are facing more or less the same erosion problem, the division expects that its services will be in increasing demand in this market. ◀

Contact

Sulzer Turbo Services
Sue Hudson
Zürcherstrasse 12
8401 Winterthur
Switzerland
Phone +41 52 262 34 44
Fax +41 52 262 00 45
sue.hudson@sulzer.com