COMBINED HEAT AND POWER PLANT NEUSTADT-GLEWE, GERMANY

Compiled by
John W. Lund
Geo-Heat Center

INTRODUCTION

The Neustadt-Glewe geothermal heating plant was commissioned in January 1995, supplying exclusively in direct-heat transition the base load of a district heating system amounting to a thermal output of approximately 11 MWF, thus covering the demand of a major part of the town of Neustadt-Glewe. The installed geothermal capacity is 6 MW; a gas-fired boiler unit is operated to cover the peak-load. The site of Neustadt-Glewe is characterized by the hitherto deepest wells, the highest thermal water temperature and water mineralization compared to all the other geothermal plants installed in Germany by now. In 2003, the plant was extended by a power generation unit of 210 kWe gross.

This is the first geothermal electric generation plant in Germany, and uses only 98°C (208°F) water, the lowest temperature used in the world.

Neustadt-Glewe is situated in the north German basin, between the cities of Berlin and Hamburg (Figure 1).

Figure 1. ***Location of Neustadt-Glewe.***

Since 1995, the geothermal doublet in Neustadt-Glewe provides brine at 98°C for a district heating system. The brine is produced from a 2100 to 2300 m (6890 to 7546 ft) deep sandstone aquifer. High salt contents of the brine (total dissolved solids = 227 g/L) require the use of resistant materials (e.g., titanium) for the heat exchanger equipment.

In the summer of 2003, the heating plant was extended by a binary-cycle (Organic Rankine Cycle, ORC) and in November of 2003, the first German geothermal power plant was connected to the grid, providing 210 kWe gross capacity (performance guarantee, according to Erdwãrme Kraft (2003)). A measuring scheme was installed to supervise the plant performance and to get operational data of the very low temperature ORC.

PLANT SETUP

The Neustadt-Glewe plant supplies heat and power using a parallel-series connection of power plant and heating station (Figure 2). The heating station takes priority over the power plant. The incoming mass flow rate of the brine is split and a part is fed to the power plant. The brine leaves the power plant at constant outlet temperature. The two flows, one at initial brine inlet temperature, the other at outlet temperature of the power plant, are joined upstream from the heating station. The mixing temperature should be high enough to meet the heating demand. In summertime, a minimum temperature of 73°C (165°F) is required. To meet the heating demand in wintertime, higher temperatures are necessary, amounting up to the initial brine temperature (98°C - 208°F).

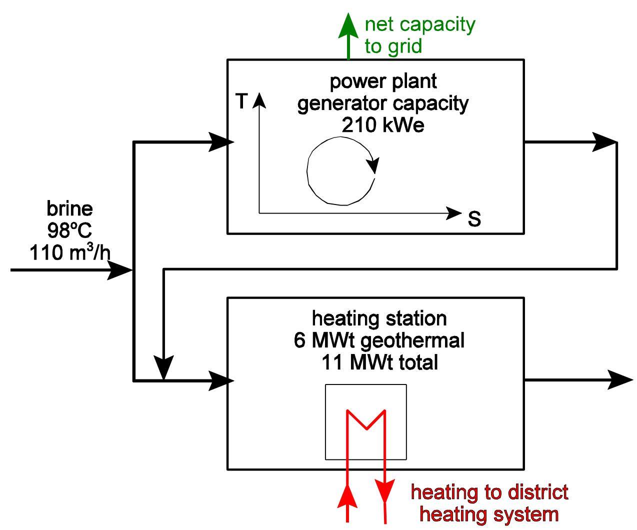

Figure 2. ***Combined heat and power supply in Neustadt-Glewe, parallel connection of power plant and heating station.***

Unlike common combined heat and power plants with combustion or the plant setup realized with the Husavik plant, heating station and power plant are competing for the brine. The power plant is fed with variable mass flow rate of the brine at constant temperature; while, the heating station is provided with a constant mass flow rate at variable temperature.

The power plant is a simple Organic Rankine Cycle (ORC) using n-Perfluorpentane (C_5F_{12}) as working fluid. An additional pump was installed in the geothermal loop to ontrol the mass flow rate fed to the power plant and to overcome the pressure losses of the brine in the heat exchanging equipment of the power plant. Parasitic loads in the plant include all pumps (brine pump, feed pump 10 kW, cooling water pump in cooling circuit, 15 kW), the ventilators in the cooling tower (16 kW), the cooling water pump in the well and several dosing pumps in the make-up system for the cooling water. Only the downhole pump in the production well is not included in the parasitic loads. The generator capacity and the parasitic loads are recorded as well. However, the parasitic loads are only measured as total sum.

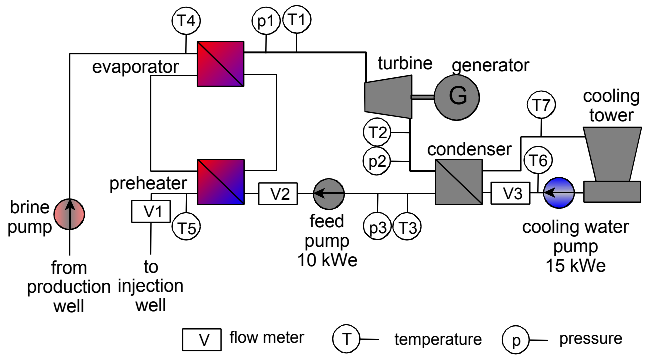

Figure 3. Schematic setup of Neustadt-Glewe power plant with positions of measuring equipment installed in the plant.

The setup of the plant is shown schematically in Figure 3. The figure includes the positions of the measuring equipment installed by GeoForschungsZentrum (GFZ) of Potsdam. In total, three pressure valves, seven temperature valves and three flow meters are allowed to setup the complete energy balance of the plant as well as analysis of single components (e.g., the turbine). The outside temperature is recorded as well.

Figures 4 and 5 show the power station and the ORC turbine and condenser.

Figure 5. ORC-turbine with new condenser.

THE DISTRICT HEATING SYSTEM

The Neustadt-Glewe geothermal heat plant has three main components.

- Production well with speed-controlled electric submersible motor pump (depth 260 m - 850 ft) and filter house containing the control unit of the motor pump, balancing tank, coarse filter unit, nitrogen system, leakage system.

Figure 4. Entire geothermal power station.

- Geothermal heating plant with heat exchanger, peak load gas boiler, various equipment for the heating network water, process instrumentation and control system, control room, office rooms, demonstration hall.
- Injection well with filter house containing the injection pump (not in use), balancing tank, fine filter unit, nitrogen system, slop pit, slop collector.

The thermal water pipe is 1,780-m (5,840-ft) long and connects the wells with the heating plant.

Specific materials such as glass-fiber reinforced plastic tubes, resin-lined steel tube parts and measures such as inertisation by means of nitrogen loading were applied for protection from corrosion and precipitation.

The principle of geothermal energy use at the Neustadt-Glewe site is shown in Figure 6.

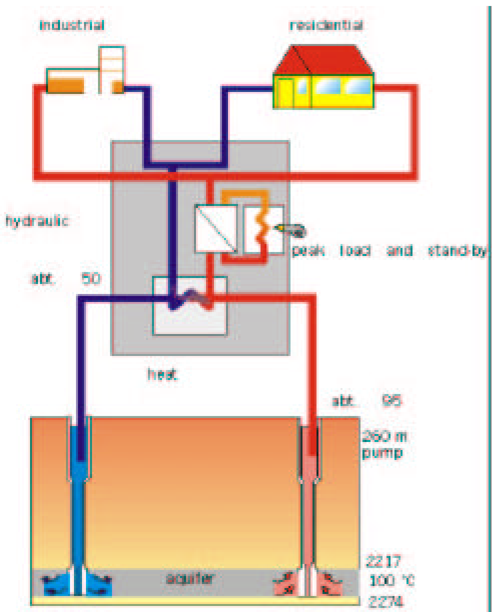

Figure 6. ***Schematic of the thermal water loop,.***

ECONOMIC AND ENVIRONMENTAL ASPECTS

The Heat Plant

The expenditures on the project including the purchase of the oil boiler unit in the residential area and the district heat supply system, as well as its extension or rehabilitation, amounted to € 9.45 million ($11.4 million) with € 6.44 million ($7.7 million) referring to the geothermal and heat production units.

The data on heat production in 1998 given in Table 1 allows a view of the economic situation. By the end of 1998, more than 1,300 households, 20 trade consumers and one industrial enterprise have been supplied with environment-friendly heat by the geothermal plant.

Present activities are concentrated on the optimization of the individual sections of the plant, more rational primary energy use and extension of the supply network through the connection of more heat consumers.

In Neustadt-Glewe, the emission of CO_2 was reduced by about 2,700 tons in 1997. About 1.7 million m^3 (60 million ft^3) of natural gas were saved. In the course of the by now (1999) four years of operation, there did not occur any failures affecting the environment.

Table 1. **1998 Heat Production**

Heat Production	
Total	15,900 MWh
That of which is geothermal	15,042 MWh
Primary Energy Source Used	
Fuel Oil	0%
Natural Gas	5%
Geothermal	95%
Percentage of the Cost Depending on Consumption	
Purchase of Gas	25%
Purchase of Fuel Oil	0%
Power - GHP	45%
Power - District Heat Supply	30%

The Power Plant

In Germany, electricity generation from geothermal heat has only since March 2000 been government-funded under the so-called Renewable Energies Act. Electricity from wind, sun, biomass and hydros have already enjoyed this privilege since 1990. The change in legislation aroused the interest in the use of geothermal energy for power production.

Bewag Aktiengesellschaft & Co. of Berlin developed ORC geothermal power plants with the following key features:

- Wet cooling towers reducing own consumption to 18-20%.
- Cogeneration because the sale of heat would increase revenues.

Bewag then looked for a project to put the know-how to good account. The geothermal power plant in Neustadt-Glewe, a little town with 8000 inhabitants located 200 km (125 miles) northwest of Berlin, lent itself well for this purpose.

The high share of geothermal heat in the overall heat volume supplied to the town of Neustadt-Glewe implied that space capacity was available for other uses (electricity generation) in the summer months and inter-seasonal periods. In addition, the smoothly operating Neustadt-Glewe geothermal plant was not subject to any geological risks, and also the operational risk inherent in the small innovative ORC plant was limited.

Another crucial factor for the project was that this 200-kWe project could be implemented within the financial framework of the originally planned 125-kWd project with air cooling towers , i.e., of € 800,000 ($960,000) capital costs, out of which € 400,000 ($480,000) were grant-funded. The final costs of the project then amounted to € 950,000 ($1.14 million).

ACKNOWLEDGMENTS

Material for this article was edited from the following:

Broßmann, Egbert and Marc Koch, 2005. "First Experience with the Geothermal Power Plant in Neustadt-Glewe (Germany)," *Proceedings, World Geothermal Congress 2005*, Turkey, International Geothermal Association.

Erdwärmekraft, GbR, 2003. www.erdwaerme-kraft.de.

Köhler, S., 2005. "Analysis of the Combined Heat and Power Plant Neustadt-Glewe," *Proceedings, World Geothermal Congress 2005*, Turkey, International Geothermal Association.

Menzel, Heiner; Seibt, Peter and Tosten Kellner, 2000. "Five Years of Experience in the Operation of the Neustadt-Glewe Geothermal Project," *Proceedings, World Geothermal Congress 2000*, Japan, International Geothermal Association.

Seibt, Peter; Kabus, Frank and Peer Hoth, 2005. "The Neustadt-Glewe Geothermal Power Plant - Practical Experience in the Reinjection of Cooled Thermal Waters into Sandstone Aquifers," *Proceedings, World Geothermal Congress 2005*, Turkey, International Geothermal Association.

ERRATA

In the last issue of the *GHC Quarterly Bulletin* (Vol. 26, No. 1 - March 2005), an incorrect graph was printed for Figure 5, page 5 of the article in "Greenhouse Heating with Geothermal Heat Pump Systems" by Andrew Chiasson. The correct graph is reproduced here and can be found on our website at http:/geoheat.oit.edu/bulletin/bull26-1/art2.pdf, where the correct version also appears.