Proceedings World Geothermal Congress 2005
Antalya, Turkey, 24-29 April 2005

Utilization of Geothermal Resources in Galanta – Slovak Republic

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Keywords: indirect use, cascaded uses, Galanta, Slovak Republic

ABSTRACT

Galantaterm was one of the first geothermal companies in Slovakia to utilize geothermal water for district heating and production of sanitary hot water. The company is based in the town of Galanta, in the southern part of Slovakia, in the central sedimentary depression of the Danube basin. The company operates two geothermal drillholes (FGG-2 and FGG-3), which are sited within 2 km of the central distribution station. The wells were drilled in 1983 and 1984 to depths of 2100 and 2102 m, respectively. The average wellhead temperature in FGG-2 is 78.7°C and 77.8°C in FGG-3. The geothermal water is used as base load but other energy sources, such as gas, are used in peak periods when the outside temperature goes below 0°C.

Due to its high mineralization the water cannot be used directly for space heating. The geothermal water is pumped from the wells to the Energy Centre where it heats the fresh cold water in a series of heat exchangers. The geothermal water is then cooled before it is discharged into the river Váh. The geothermal water is treated to avoid corrosion and scaling. The inhibitors used are classified as non-toxic and are added in small, environmentally harmless amounts.

Galantaterm distributes hot sanitary water and hot water for heating to 1243 flats, but the main consumer is the regional hospital, which has been using about 51% of the energy supplied by the company. The company also operates a separate gas-boiler station to provide steam to the hospital, which is used for sterilization and washing.

The main benefits of geothermal utilization in Galanta are of an economical and environmental nature. Thanks to geothermal energy, the brown coal-fired conventional boiler station in the hospital was closed. The pollution (SO_2, NO_x, CO_2) generated by the conventional boiler station has been reduced significantly.

1. INTRODUCTION

The conditions for geothermal water utilization in the Slovak Republic are excellent as indicated by the number of geothermal areas currently under exploitation within the country. According to research by the Geological Survey of the Slovak Republic, there are 26 districts with low-temperature resources, with a total heat output of 13,097 MWt.

In fourteen areas the geothermal resources are utilized for agricultural purposes such as heating greenhouses, in three areas they are used in fish farms and in six areas for space-heating,, in flats and sports halls, etc. In another thirty areas the energy is used for recreational purposes (ECB, 2002).

The most extensive use of geothermal energy in the Slovak Republic is in Trnava district, where the heat output represents 44.47 MWt. Galantaterm Ltd was set up in the town of Galanta, in Trnava district (Figure 1). The Galanta sedimentary geothermal reservoir occurs in the southern part of Slovakia in the Central Depression of the Danube Basin. The Danube basin forms the northern tip of the Pannonian Basin. Permeable aquifers in the reservoir occur in layers of sand and sandstone, which slope down to a depth of 3400 m in the centre of the depression. The depression as a whole is not fully interconnected hydrologically. These aquifers are confined by low permeability clays at the boundaries and bottom of the depression. About 34 geothermal boreholes were drilled into the Central Depression (Axelsson, 2000). Galantaterm was one of the first geothermal companies in Slovakia to utilize geothermal water for district heating and production of sanitary hot water

Figure 1: Slovakia and the location of Galanta

1. PRODUCTION OF WELLS- TECHNICAL DATA

The company operates two geothermal drillholes (FGG-2 and FGG-3), which are sited within 2 km of the central distribution station. Their utilization started in 1996. Information the geothermal wells is presented in Table 1.

Table 1: Technical data on the geothermal wells

Technical parameters	Well FGG-2	Well FGG-3
Drilled	1982-83	1984
Depth (m)	2101	2102
Casing diameter	245 mm ($9^{5/8}$ in)	245 mm ($9^{5/8}$ in)
Open section (m)	1706-2032	1731-1999
Formation	sandstone	sandstone
Temperature at the wellhead (°C)	80	77
Production from free flow (l/s)	25	25
Long-term (30 y) production (l/s)	22-23	19-20
Recommended production (l/s)	15.8	18.3

Well equipment consists of a electrical-driven submersible pump and a separation tank. The submersible pump is inserted to a depth of 100 m. Its electric motor is operated by a voltage frequency converter that automatically regulates the amount of geothermal water as required. The separation tank, with a volume of 18,000 liters, separates the suspended solids, sand and gases in the water. The wells can be regulated on-site or by remote-control.

The geothermal water is transported from both wells to the Energy Centre in an insulated steel pipeline. Because of the high mineralization of the geothermal water it cannot be used directly for space heating. The Energy Centre is a heat exchanger station, distribution and gas-boiler station. The Energy Centre distributes sanitary hot water and hot water for heating to 1243 flats and the regional hospital.

Table 2: Series of plate heat exchangers

LEVELS	System	**Use**	In/out fluid temp.	Out-put of heat	Output of heat from geother-mal water	Code of system
1	Hos-pital 90/70 °C	Radiator and hot tap water	90/70 °C	2731 kW	1800 kW	HX-1
2	Flats 77/52 °C	Radiator	77/52 °C	6500 kW	4000 kW	HX-2
3	Hos-pital 52/42 °C	Ceiling and panel heating	52/42 °C	2744 kW	2300 kW	HX-3
			Pre-heat 42 °C	810 kW	810 kW	HX-5
4	Flats	Hot tap water	Post-heat 78 °C	1551 kW	1551 kW	HX-4

The geothermal water heats the treated circulation water in a series of plate heat exchangers (Table 2; Figure 2). The heat exchanger station comprises three different closed-loop heating systems and one two-level sanitary hot water system. On level 1 the circulation water is distributed to heat exchangers located in the hospital.

The capacity of the exchangers is controlled by the output temperature of the heat exchanger systems and by the outside temperature. When the outside temperature goes below 0°C the geothermal energy is insufficient and a reserve heating source is used, in this case gas. The gas boiler station comprises four 2.5 MW boilers. Before the geothermal water was used these boilers were used to heat the flats.

The maximum temperature of the geothermal discharge water when it leaves the Energy Centre is 42°C. It is piped for 7.2 km to the river Váh. Before draining into the river the waste geothermal water mixes with the percolation water and cools to acceptable levels. The average temperature of the water when discharged into the river is 11.2°C (the maximum measured during the summer was 16.5°C).

The company also operates a separate gas boiler station to provide steam to the hospital for technological uses such as sterilization and washing.

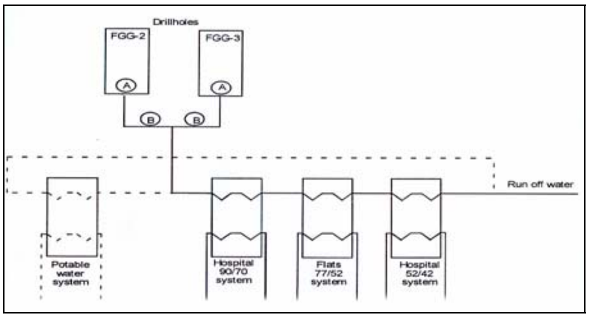

Figure 2. Wells FGG-2 and FGG-3 and the heat exchanger center

The geothermal water is treated to avoid corrosion and scaling in the processing equipment. Degassing occurs in the well and as the water looses carbon dioxide (CO_2) and it becomes supersaturated with calcium carbonate, which causes the scaling. Injection of a chemical scale inhibitor into the well is common practice throughout the world (Orkustofnun, 1994). The inhibitors are classified as non-toxic and are added in small, environmentally harmless amounts. Corrosion/scaling coupons are used to monitor the influence of the inhibitors. The coupons are of the same material as the pipelines, i.e. steel no. 11 373, and are inserted close to the wellhead as well as in the geothermal pipeline at the Energy Centre.

2. ENERGY SYSTEM CONTROL

The entire geothermal system is computer-controlled and the technical data monitored automatically. The heating system is organised on two levels.

1) Every item of equipment (wells, pumps and heat exchangers in the Energy Centre and in the hospital) is operated by an individual automatic controller.

2) The automated control system makes it possible to monitor all process conditions remotely and change the operating parameters of individual items of equipment to meet the requirements of the Energy Centre.

3. CHEMISTRY OF GEOTHERMAL WATER AND MONITORING SYSTEM

The geothermal waters in wells FGG-2 and FGG-3 in Galanta are of the sodium-bicarbonate type with a total mineralization of 4900 - 5900 mg/l. The source waters have fairly stable chemical properties. The water from wells FGG-2 and FGG-3 is rich in chlorides (Cl- content from 300 to 900 mg/l), while the sulfate content is higher than in the resources in the Central Depression of the Danube Basin (Franko et al., 1995). Fe content is lower than 1 mg/l, which makes it suitable from a technological point of view.

The chemical composition of the geothermal waters from wells FGG-2 and FGG-3 is very similar. Well FGG-3 has higher contents of total dissolved solids and chlorides and lower sulphate contents. The monthly water monitoring program includes determination of::

1) pH/ temperature of pH 6) Cl^-

2) CO_2 7) Total dissolved solids at 105°C

3) H_2S 8) Conductivity/ temp. of conductivity

4) SiO_2 9) Gas/ water ratio

5) SO_4^- 10) Dissolved oxygen

A total analysis of the geothermal water is performed twice a year (in winter and summer) when samples are also collected for gas analyses. Sampling takes place at the wellhead. Flow rate, wellhead pressure, water levels, and water temperatures are monitored in each well by a computerized monitoring system. The results are important for all reservoir model calculations.

Measurements of gas content indicate that it is very variable and may range from 0.096 to 0.39 m^3 per m^3 of fluid(Fendek, 2000). The major gas components are carbon dioxide, nitrogen and methane. The H_2S content is very low, at 3- 5 mg/l. Gases are collected and analyzed twice a year by Slovak Gas Company.

The discharged water is monitored monthly in the vicinity of the river Váh, following environmental regulations.

The quality of the water circulating in the Energy Centre is monitored weekly at three locations. Circulation water is treated cold water. The cold water is first filtered and then purified in a treatment plant (NaCl, Na_3PO_4, Na_2SO_3). Monitoring of the circulation water guarantees the quality of the water distributed to the consumers. The cold water is monitored before and after adding the chemicals so as to minimize the quantity of chemicals used and, subsequently, the operating costs.

The composition of the water coming from the gas boiler at the hospital is monitored every day at four locations. These tests are done in accordance with the technical specifications of the boiler operators and Slovak Technical Standards.

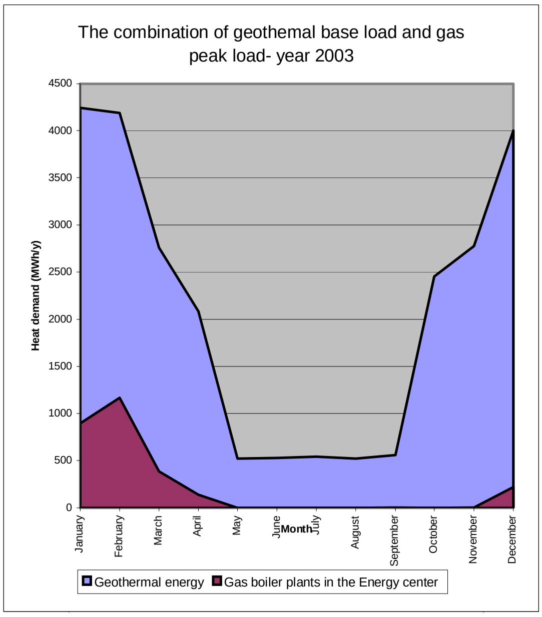

Figure 3. The combination of geothermal base load and gas peak load for the year 2003

4. ENERGY PRODUCTION

In 2003 the company produced 29,210 MWh of energy, 22,355 MWh of which was generated from geothermal water (8212 MWh from well FGG-2 and 14143 MWh from well FGG-3), and 6855 MWh from gas. In addition to this, 4048 MWh were generated from gas to produce the steam required for sterilization at the hospital. The combination of geothermal base load and gas peak load is shown in Figure 3. This figure does not include the gas from the gas boiler station.

The water discharged from each well between 1997 and 2003 is shown in Figure 4.

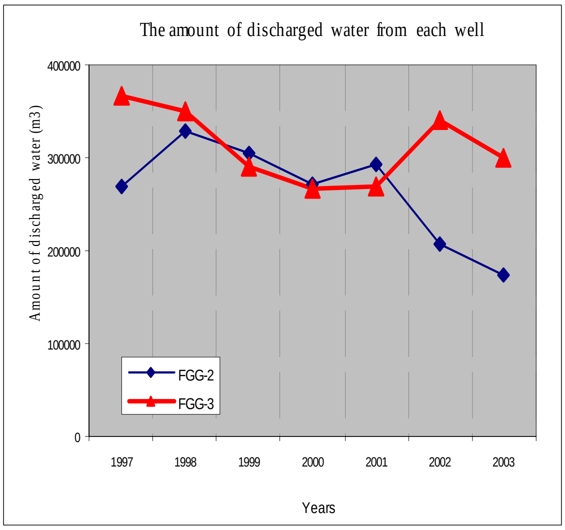

Figure 4: Geothermal water discharged between 1997 and 2003

5. REINJECTION

Fluid reinjection is currently carried out in a number of geothermal fields throughout the world. The objectives are to get rid of the waste water from geothermal power plants, as well as to maintain pressure in the reservoirs and recharge them. It is highly recommended that reinjection become part of the future management of the Galanta geothermal reservoir (Axelsson, 2000).

Cooling of the production wells could be avoided by careful siting of the injection wells. Reinjection into sandstone reservoirs has met with limited success at the locations where it has been attempted. During many sandstone reinjection tests the efficiency of the injection wells decreases very rapidly. The solution to sandstone reinjection was found in Thisted, Denmark, where the reinjection water is kept completely oxygen-free as well as passed through very fine filters (Mahler, 1998). The Thisted solution for sandstone reinjection should be considered as a solution to potential problems with future sandstone reinjection in Galanta.

6. ENVIRONMENTAL ASPECTS

The main benefits of geothermal utilization in Galanta are of economical and environmental character. For example, geothermal heating and water led to the closure of the conventional boiler plant fired by brown coal used in the hospital.. The pollution (CO, NO_x, SO_2,, C and solids) produced by the conventional boiler station has thus been reduced significantly. The most conspicuous results in the reduction of emissions were achieved at the start-up of operations in 1997. Since then, the amount of emissions has been the result of particular operational circumstances.

The trend in emissions of CO, NO_x, SO_2, C and solids (in tons) from 1995 to 2003 is shown in Figure 5. This figure does not include the emissions from the separate gas boiler station.

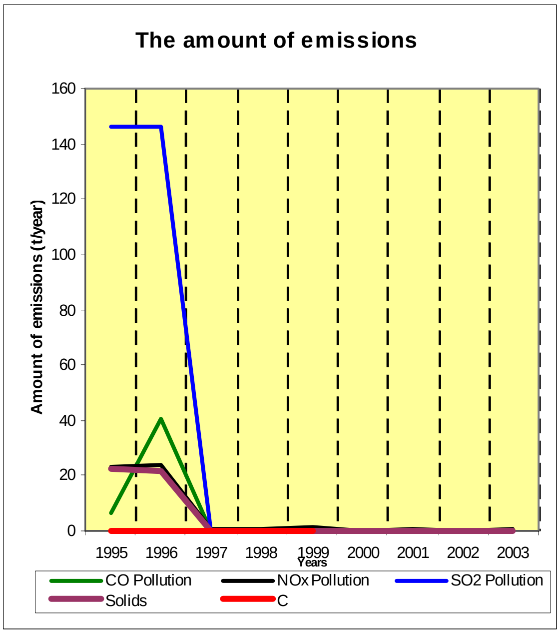

Figure 5: The amount of emissions during the period 1997-2003

Although Galantaterm has still been releasing emissions the charge for emissions has increased significantly. Whereas in the year 1995 the environmental fee paid was 187200 SK= 4605 €, by 2003 the total charge for emissions was 1500 SK= 38 €.

7. CONCLUSION

The paper gives an overview of the utilization of geothermal water in Galanta. The main objective of the heating project in Galanta was to reduce the emissions from burning solid fuels and gas.

There is still much to do in both the company Galantaterm and in the Slovak Republic, such as determine the optimal reinjection strategy in order to increase output, convince the public of the positive effects of integration with green energy, avoiding waste of geothermal water (discharging geothermal water contrasts with the principle of sustainable energy production).

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