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FIVE YEARS OF EXPERIENCE IN THE OPERATION OF THE NEUSTADT-GLEWE GEOTHERMAL PROJECT

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ABSTRACT

A heat supply concept based on the use of geothermal energy was implemented in the town of Neustadt-Glewe. The Neustadt-Glewe geothermal project combines scientific research and investigations into the economic profitability and reliable supply.

A capacity of 16.4 MW_{th} is installed in the geothermal heating plant - including peripheral units - with 6.0 MW_{th} referring to geothermal.

Since 1995, the geothermal heating plant is in continuous operation. For improvement of the injectivity, soft acidising well treatment was carried out in 1998.

Thanks to geothermal energy use, the emission of CO_2 was reduced by about 3,000 tons in 1998. About 1.9 million m³ of natural gas were saved.

1. GENERAL

The town of Neustadt-Glewe is located near Schwerin, the capital of the Federal Land of Mecklenburg-West Pomerania. In 1988/1989, there were drilled two wells already for the development of a thermal water deposit in a depth of about 2,300 m.

The Federal Ministry of Research and Technology of Germany initiated in 1991 the geothermal demonstration plant for hydrogeothermal energy use based on the two wells. It supplies heat to residential buildings, commercial enterprises, and a leather processing factory. The project was co-funded by the Ministry of Trade and Commerce of the Federal Land of Mecklenburg-West Pomerania.

The construction of the geothermal plant began in 1993. In October 1994, the test operation could be started followed by continuous operation since January 1995, and in April 1995 the company Erdwaerme Neustadt-Glewe GmbH took over the entire plant which contributes by now to the stable heat supply of Neustadt-Glewe without any failure.

2. GEOLOGICAL AND WELL CONDITIONS

The geothermal wells Gt Neustadt-Glewe 1/88 and 2/89 use the Contorta sandstones (main sandstone of the Middle Rhaetian) in a depth of 2217-2274 m as productive horizon. The cooled down thermal water is reinjected in order to maintain the hydraulic pressure conditions. In addition, the highly mineralised thermal water cannot be discharged at the surface due to environmental reasons.

Table 1 gives an overview of the main well parameters.

The thermal water has a temperature of nearly 100 °C and is highly mineralised. The total mineralisation is 220 g per liter. Predominating ions are sodium with 42.2 meq%, chloride with 49.8 meq%. Calcium, magnesium, potassium and sulphate as well as traces of iron, iodine, bromium, lithium, and others are subordinated. The gas content is nearly 10 per cent, containing predominantly carbon dioxide, nitrogen and methane.

3. TECHNOLOGY OF HEAT PRODUCTION

The Neustadt-Glewe geothermal plant has three main components:

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

B. 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

C. 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 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 1.

A capacity of 16.4 MW_{th} is installed in the geothermal heating plant - including peripheral units - with 6.0 MW_{th} referring to geothermal. The speed-controlled electric submersible motor pump allows variable handling of the thermal water flow according to the required heat load.

Due to the relatively high thermal water temperature and the designed low temperature in the return pipes of the heating network, the energy of the thermal water is used in three heat exchangers for direct heat transfer. The geothermal heat is

integrated in the base and medium load. There is no need for a heat pump.
A 4.8 MW_{th} gas-fired boiler unit makes the geothermal heating plant complete. This peak-load and redundancy unit serves for reliable heat supply in case of peak loads in extreme winters, and in case of failure of the thermal water loop. Two more oil boilers with a total capacity of 5.6 MW_{th} are installed in a decentralised heating plant located in the residential area which can also be operated as peak load and redundancy unit.

4. EXPERIENCE GAINED IN THE OPERATION

For more than five years now, the geothermal plant is in operation without any major repair or failure. The materials and equipment used stands up to the extreme temperature, aggressive salt media and pressure conditions. As the injection pressure has been increasing in the course of the years, a down-hole inspection of the injection well Gt NG 2/89 was carried out in 1998. It was found out that the increase in the injection pressure was - among others - due to the sedimentation of solid material in the filter section.

The sedimented solids consist mainly of acid-soluble iron hydroxides and aragonite. That is why the pH value of the injection fluid was decreased by adding HCl above ground (soft acidising) for removal of the acid-soluble components below ground. The recipe for the adjustment of the required pH value was determined by calculation and titration.

There were added about 4,000 l of 15 % HCl (4 m³) to the thermal water over a period of two days (cumulative thermal water injection volume for this period about 1,600 m³). As a result, the injectivity index of the well Gt NG 2/89 was improved significantly.
Figure 2 shows the injection behaviour before and after soft acidising.

5. ECONOMIC RESULTS AND ENVIRONMENTAL ASPECTS

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 18.5 million DEM (9.46 million Euro) with 12.6 million DEM (6.44 million Euro) referring to the geothermal and heat production units.

The data on heat production in 1998 given in Table 2 allow 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 optimisation 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 m³ of natural gas were saved. In the course of the by now four years of operation, there did not occur any failures affecting the environment. The emission data are given in Figure 3.

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position of depth of the aquifer	2 217 ... 2 274 m
stratigraphy	Keuper / Rhaetian (Contorta)
temperature gradient	4.06 K/100 m
thickness of sandstone layer	60 m
effective porosity	22 %
permeability	0.5 - 0.8 x 10^{12} m²
aquifer temperature	98 °C (2.223 m)
number of wells	2
distance between the wells	1,350 m
productivity	183 m³ / (h · MPa)
injectivity	265 m³ / (h · MPa)
temperature at the well head	95-97 °C
mineralisation of the brine	220 g/l

Table 1. Main geological and well parameters

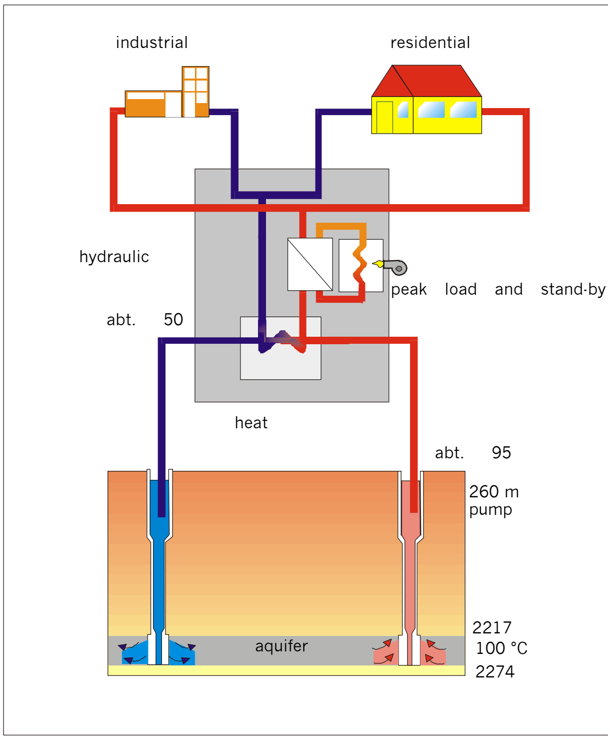

Figure 1: Principle scheme of the thermal water loop

heat production:	
total	15,900 MWh
thereof geothermal	15,042 MWh
primary energy sources 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 %
GHP - Geothermal Heating Plant	

Table 2. 1998 heat production

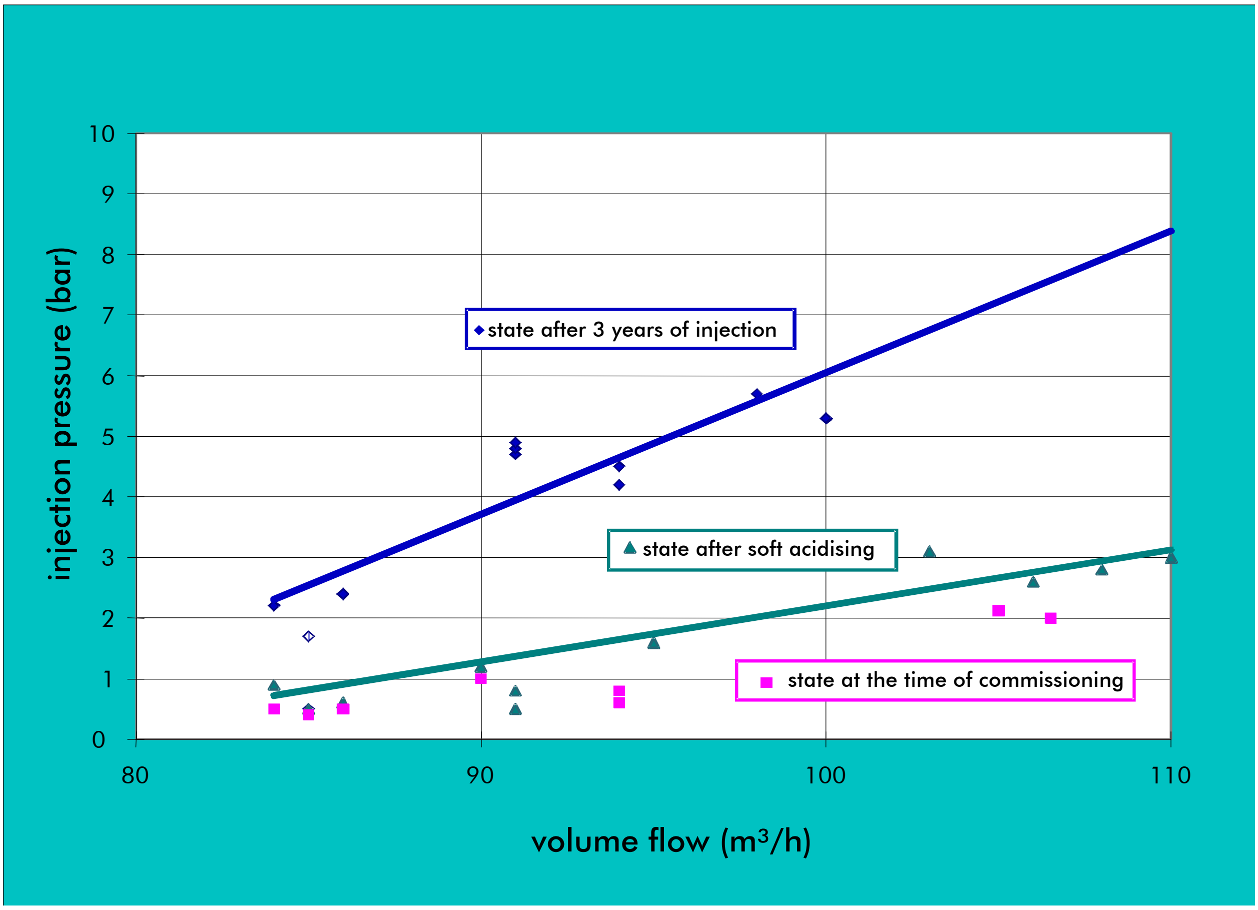

Figure 2: Injection behaviour before and after soft acidising

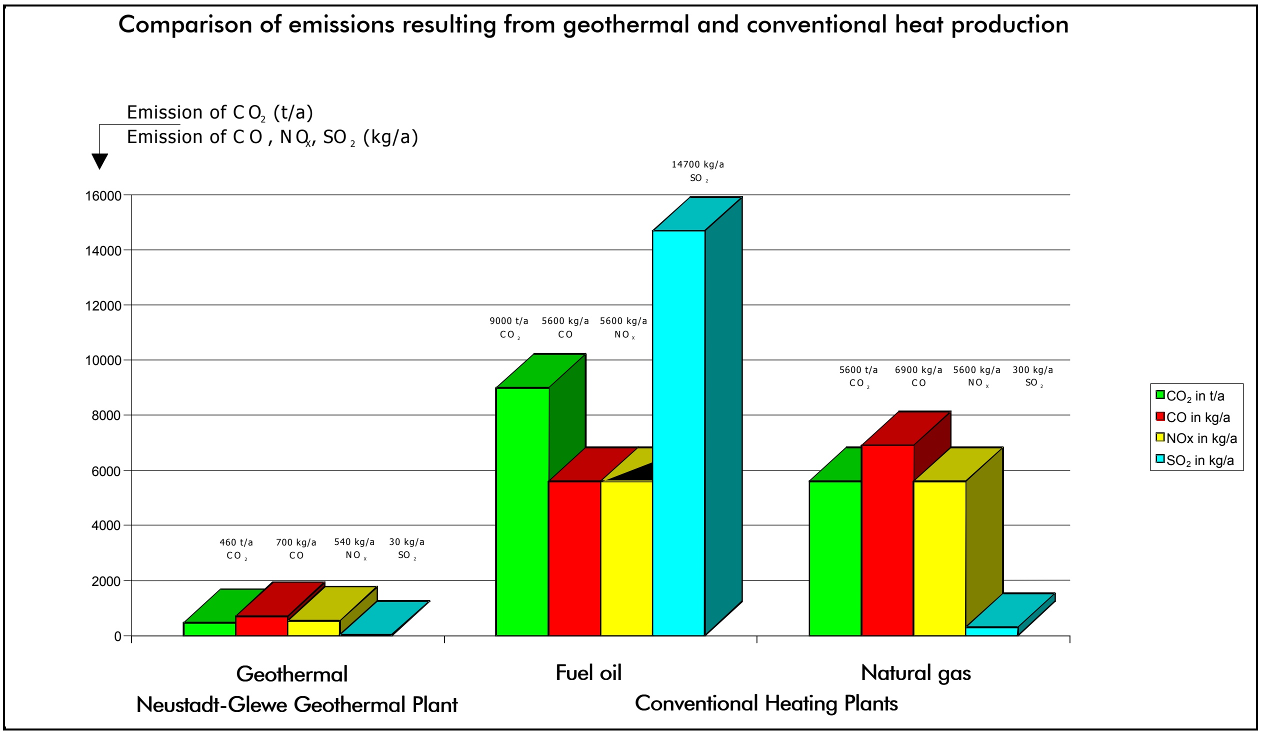

Figure 3: Comparison of emission resulting from geothermal and conventional heat production