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Hydrogeotherrnal energy use – The example of the Neustadt-Glewe geothermal plant, Germany

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ABSTRACT

Germany has a considerable hydrogeothermal potential which is available for the environmentally sustainable and resources saving production of heat.

The example of the Neustadt-Glewe Geothermal Plant in the north east German Federal Land of Mecklenburg-West Pomerania is one more proof of the principle feasibility of energy production using highly saline deep waters as heat source. Since the end of 1995, operation of the Geothermal Plant goes off smoothly which confirms the correctness of the selected technical and technological solutions.

KEYWORDS

Geothermal resource, heat production, geothermal plant, Germany

1. Introduction

The development of hydrogeothermal resources offers the possibility of heat supply in the MW capacity range at any time of the day independently of the season.

At present, the installed capacity of the 17 hydrogeothermal plants operated in Germany amounts to about 50.5 MW_{th} with the Mecklenburg-West Pomeranian Geothermal Heating Plants having a capacity of 39 MW_{th} (table 1).

2. The project history

In Neustadt-Glewe which is situated 20 km south of Schwerin, the capital of the Federal Land Mecklenburg-West Pomerania, there was built a demonstration plant for

hydrogeothermal energy use which supplies heat to residential buildings, commercial enterprises and a leather processing plant.

The project includes re-use of two wells which were drilled already in 1988/1989 and proved the occurrence of almost 100 "C hot thermal brine in a depth of about 2,200 m usable for heat production.

Table 1: Characteristics of the NE German geothermal heating plants

	Neubrandenburg		Waren (Müritz)		Neustadt-Glewe	
Installed capacity, total	16.44	MW_{th}	6.2	MW_{th}	16.4	MW_{th}
thereof geothermal	3.85	MW_{th}	1.6	MW_{th}	6.5	MW_{th}
Heat demand, present	12.50	MW_{th}	5.2	MW_{th}	8.7	MW_{th}
future	15.50	MW_{th}			11.1	MW_{th}
Heat supply, total	45000	MWh/a	13400	MWh/a	15700	MWh/a
thereof geothermal	27 900	MWh/a = 62%	8 500	MWh/a = 63%	14600	MWh/a = 93 %

Against the background :o maintain the geothermal know-how accumulated in NE

number of wells	2
temperature at the well head	97 °C
production rate	40 to 120 m^3/h
mineralisation	220 g/l
internal distance between the wells	1,350 m
thermal water pipeline	1,780 m long, glass-fiber reinforced plastic tubes

For erection and operation of the geothermal plant there was founded the company Erdwarme Neustadt-Glewe GmbH. The shareholders are the Municipality of Neustadt-Glewe (47 %), Westmecklenburgische Energieversorgung AG/WEMAG (West-Mecklenburgian Energy Supplying Enterprise) (40 %), GTN - Geothermie Neubrandenburg GmbH (8 %) and Norddeutsche Ledenverk GmbH (North German Leather Processing Factory) (5 %). In January 1995, continuous trial operation was started, and in April 1995 the company Erdwarme Neustadt-Glewe GmbH took over the entire plant.

3. Geological conditions

In the course of the past geological ages , up to 5,000 m thick sedimentary rocks could deposit in NE Germany. For hydrogeothermal heat recovery, the porous sandstone layers containing thermal brine and occurring in a depth between 1,000 and 3,000 m are important.

Depending on the position of depth of the aquifer concerned and according to the temperature gradient of 3 to 3.5 K/100 m, the thermal brines have a temperature between 40 °C and 100 °C (table 3).

In the Neustadt-Glewe region, the temperature gradient is 4.06 K/100 m.

Table 3: Geological parameters

depth of the aquifer	2,216 to 2,248 m
stratigraphy	Keuper / Rhaetian (Contorta)
thickness of sandstone layer	67 m
effective porosity	25.6 % (acc. to well logging)
permeability	0.3 - 1 x 10^{12} m
aquifer temperature	98 °C
productivity	183 m^3 / (h · MPa)
injectivity	265 m^3 / (h · MPa)

The geothermal wells Gt Neustadt-Glewe 1/88 and 2/89 proved three sandstone aquifers for potential geothermal heat utilisation. Based on the higher formation temperature and the good petrophysical and hydrodynamic characteristics, the Contorta sandstones (main sandstone of the Middle Rhaetian) were selected as productive horizon. The thermal water is highly mineralised. The table 4 gives a survey of the essential ion shares. The predominating cation is sodium with 42.2 mval%.

Among the anions, chloride dominates with 49.8 mval %. Subordinated are calcium, magnesium, potassium and sulphate as well as traces of iron, iodine, bromide, lithium and others.

Table 4: Chemical characteristics of the thermal brine

Ions	mg / l	mval%
K+	950	0.32
Na+	73,000	42.14
Ca++	8,670	5.74
Mg++	1,600	1.75
NH_4+	81	0.06
Fe	>50	
Cl-	133,000	49.77
Br-	400	0.07
I-	6	0.00
SO_4-	515	0.14
HCO_3	25	0.01

total mineralisation	218 g/l
pH	4.7
density	1,147 kg/m^3

4. Technology of heat production

The Neustadt-Glewe Geothermal Plant has three working points:

- Production well with filter house containing the control unit of the electric submersible motor pump, balancing tank, coarse filter unit, nitrogen system, slop pit.
- 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 principle of geothermal energy use is shown in Figure 1.

The random conditions of heat production are as follows:

- In the production well, the inflow section is open, so that from the hydrodynamical point of view there exist very favourable blower stream conditions.
- In injection well, the reservoir section is lined with a wired screen filter. In addition a section above the filter is perforated.
- Resulting fiom the productivity of the production well and the injectivity of the injection well, the thermal water flow may be adapted to the heat demand of the customer, varying from 40 to 120 m^3/h.

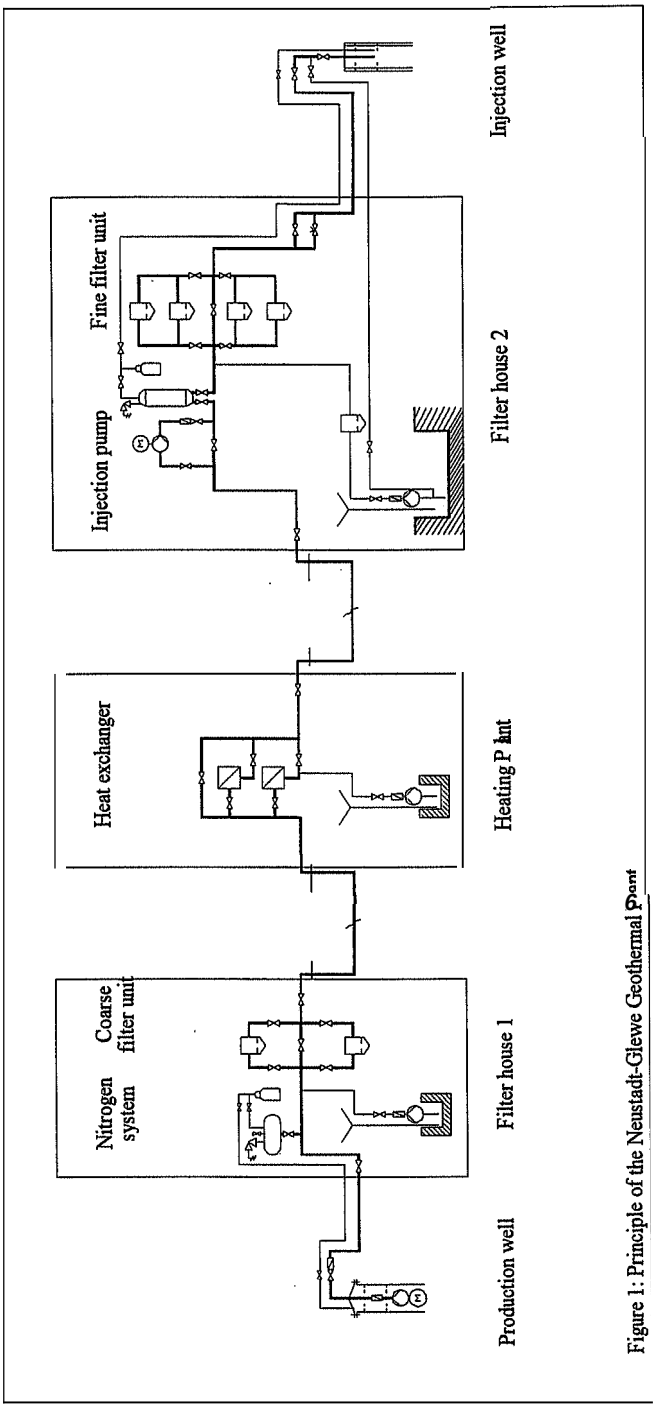

Figure 1: Principle of the Neustadt-Glewe Geothermal Plant

- **A** speed-controlled electric submersible motor pump is used allowing variable handling of the thermal water flow according to the required heat load.
- Due to the relatively high thermal water temperature and the dimensioned low temperature in the return pipes of the heating network, the energy of the thermal water is used in direct heat exchange and the geothermal heat is integrated in the base- and medium load. The use of a heat pump was dispensed with.
- **A** 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.

Specific materials such as glass-fiber reinforced plastic tubes, resin-lined steel tube parts and other measures such as inertisation by means of nitrogen loading were applied for protection from corrosion. The heating plant has three heat exchangers for direct heat transfer. Optionally, there may be integrated in the complex of base- and medium load system. The future heat demand, but also the level of the energy prices and in particular the relations among the produced power and the used fuels will mainly influence this decision.

5. Economic results

The data on heat production in 1998 given in table ***5*** allow a view of the economic situation.

*Table **5:** Heat production in 1998*

Heat production, total	15,739 MWh
thereof geothermal	14,637 MWh
Primary energy sources used:	
fuel oil	0 %
natural gas	7 %
geothermal	93 %
Percentage of the cost depending on consumption:	
purchase of gas	25 %
purchase of fuel oil	0 %
power-GHP	44 %
power - district heat supply	31 %
Cost depending on consumption / annual average	12.78 DM/MWh
of geothermal	(1.28 DPf/kWh)

By the end of 1998, more than 1,300 households, 20 trade consumers and one industrial enterprise have been supplied with heat by the geothermal heating plant.

6. The environmental aspect

Geothermal plants offer a significant potential for the reduction of pollutant emissions, in particular those of CO_2, CO, NO_x, SO_4.

In Neustadt-Glewe, the emission of CO_2 was reduced by about 2,700 tons in 1998. About 1.7 million m^3 of natural gas were saved.

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