Bulleiin d'Hydrogéologie No 17 (1999)
Centre d'Hydrogéologie, Université de Neuchâtel
EDITIONS PETER LANG

Geothermal project Straubing "thermal and mineral water for bathing and heating": 10 years of experience from the feasibility study to the start of operations

by Werner Jähn

Municipal technical department Straubing, Sedanstrde 10,94315 Straubing, Germany

ABSTRACT

In the city of Straubing warm water (36°C) from the southern German Malm Karst (top ca. 800 m deep) is being tapped. A small amount of the water extracted is of therapeutic quality and is being used for bathing. Heat is extracted from the largest amount of the thermal water and at 12°C this water is reinjected back into the Malm Karst through a deviated drill hole. By financing one section at a time we were able to achieve economically positive results with this project after ten years - from the feasibility study to the start of operations.

KEYWORDS

Heating, bathing, deviation drilling, economic efficiency

1. Introduction

The city of Straubing has 44.000 inhabitants and is located in Bavaria between the cities of Regensburg and Passau (Figure 1).

As far as the geology is concerned, Straubing is located on the eastern border of the southern German molasse basin. The proximity to the Danube rim fault (Donaurandbruch) offers favorable conditions for tapping thermal water from the Malm aquifer (ca. 800 – 1000 m deep), which consists of karstic lime stone and dolomite layers. This thermal water is known to have therapeutic qualities with a temperature of ca. 35 - 50°C, depending on the depth (Figure 2).

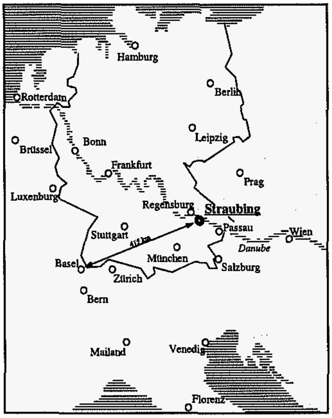

Figure 1: Location of the city of Straubing confined in Bavaria

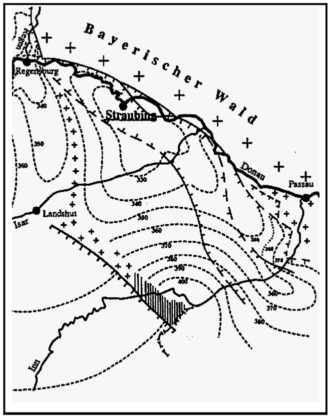

Figure 2: Equipotential lines of the free carst water

2. Utilization of geothermal heat

2.1 Foundation

In the year 1910 in the process of drilling for brown coal in Straubing, workers hit unexpectedly hot water at a depth of 800 m (and were surprised). The water gushed up out of the ground at a temperature of 30°C as high as a house and as thick as a man's arm. The drill hole was quickly closed up again. Luckily all of the records from this time were saved and can be referred to today.

In the year 1988 a feasibility study was made concerning the extraction of thermal water in the area around Straubing. It was established that the favorable prerequisites for the extraction of hot thermal water did exist in this area. *Even* the possibility of a geothermal doublet was quite promising.

In addition to this specialists anticipated that water with therapeutic quality would be found. **An** application for support in the search for thermal heat and the supply of heat to public buildings was submitted to the Commission of the European Community. The project with the working title „Thermal and Mineral Water for Bathing and Heating" was estimated at DM 20 million. Calculations of the economic efficiency of **the** project suggested a positive final outcome. This application was approved in the middle of 1989, i.e., ten years ago.

The whole project was built with a expense of ca. 22.5 Mio. DM, from its start in the year 1989 till commissioning in the middle of 1999 and with its final completion in the year

2000. A subsidy of 6 Mio. DM from the European Comunity and 2.6 Mio. DM of the Free State of Bavaria was given. The Municipal technical department had to raise 14.9 Mio. DM from its own resources.

2.2 Explotation for geothermal heat - production well

The city of Straubing instructed the Municipal technical department in 1989 to start up deep drilling to tap the thermal and mineral water in sufficient amounts so that a geothermal heat project could be started. As had been hoped, warm water (36°) in sufficient amounts (216 m^3/h) was tapped in the Malm Karst (final depth 825 m).

Scientific investigations have shown that the water is of therapeutic quality. According to the chemical composition and the temperature the water can be designated as ,,natrium chloride hydrogen carbonate thermal water containing flouride". The authorities responsible have approved the extraction of 18 m^3/h of water for bathing and 162 m^3/h for heating purposes. After use the water for bathing is allowed to flow into a drainage ditch which leads to the Danube.

The water used for beating purposes (which need only be cooled down), must be reinjected into the same aquifer (Malm) for hydrogeological reasons. This will guarantee that resources are. preserved. Under these conditions the Municipal technical department were able to begin working on a comprehensive plan. This was developed so that one section at a time was financed.

2.3 Comprehensiveplan

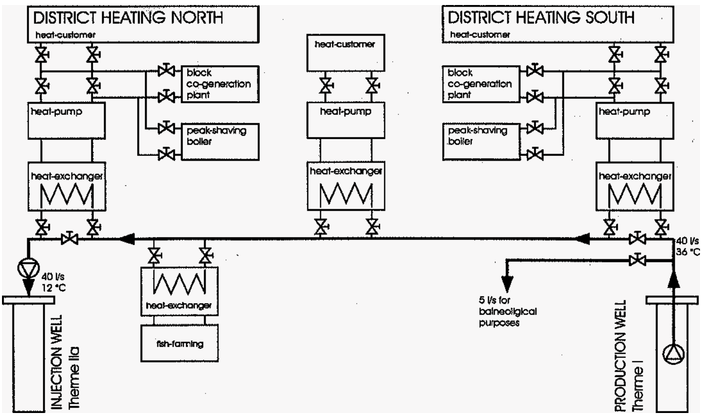

Figure 3: Overview to the close-range-district heating system with energy houses

From the location of the production well, the thermal water is to be conducted to potential large-scale heat consumers - here in particular we mean bathing facilities, public buildings and residential areas - by means of a single-pipe system.

The thermal water should also be conducted to construction areas and agricultural facilities, as well as to a fish **farm.**

For hydrogeological reasons the reinjection drilling must be located an adequate distance from the production well so that the thermal water itself does not cool down (doublet method).

Taking this aspect into consideration, the location of the reinjection drilling was selected near the Danube, ca. two kilometers distant from the production well.

On its way from the production well (Therme I) to the reinjection well (Therme IIa), the heat is extracted from the thermal water by means of heat pumps.

The thermal and mineral water that has been cooled down to ca. 12°C must be reinjected into the same aquifer, the Malm (Figure **3).**

Evaluations of the economic efficiency were carried out and the conclusion was that the project would have a chance of realisation if **there** were sufficient heat consumers, additional **use** as water for bathing and generous financial support.

2.4 Use for bathing

Since 1992 **the** thermal and mineral water has been used for bathing. By feeding the thermal water from Therme **I** into the nearby indoor and outdoor swimming pool facility AQUAtherm, 72,750 m³ of natural **gas** can be saved annually.

Another positive effect resulting from feeding thermal and mineral water into all eleven pools at AQUAtherm is that an amount of 44,150 m3 of drinking water quality can be saved.

In the year 1992 the reinjection hole was drilled at a depth of 885 m. There were great difficulties at this depth due to the reinjection rate and after extensive hydrogeological considerations and negotiations, especially of a financial nature, it wasn't **until** 1996 that deviation drilling was started. This step was supposed to guarantee an adequate reinjection rate and low operating costs.

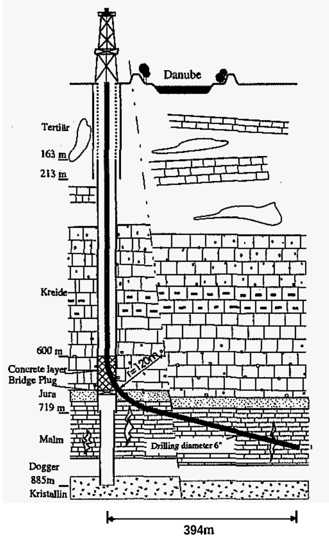

Figure 4: Deviation drilling, reinjection well IIa

2.5 Reinjection well

Deviation drilling (Therme IIa) in this form was a completely new development for the supply of water and was generously supported by the Bavarian State. At a depth of 600 m a deflecting wedge was inserted which caused the boring bit to be deviated by 77" (Figure 4). The direction north-northeast was chosen, in order to remain near the historical site of 1910 mentioned in the beginning, so that better penetrability of the rock could **be** expected.

After a deviated borehole 487 m long was drilled, the planned reinjection rate of **40** l/s was attained.

Finally at the end of 1996 the geothermic project could **be** advanced further.

2.6 Connecting pipe

The connecting pipe between both thermal drillholes was laid taking economical factors into consideration. Insulated **HDPE** pipelines DN 200 PN 10 were used. The pipeline route in urban conditions was very carefully established. Pipes for bathing water, heating, gas and water were laid in the same ditch section by section along with the cable tube equipment for electric supply lines. The connecting pipeline for thermal water was started in 1997 and completed by the middle of 1998.

2.7 Heat consumers

A significant factor was that customers were found after it was evident that the successful **use** of geothermal heat was a certainty. Among these heat consumers are public institutions such as schools, retirement homes, the museum and the city hall. The local heating network already in place in the south and north were included in the project.

It wasn't until there were enough heat consumers standing by that the two machine houses for production drilling and reinjection drilling were constructed. A third heating station could **be** set up in the downtown area in the future (for example, a large thermal bath facility with health resort). The **use** of geothermal heat for fish farms has already **been** planned (Figure **3).**

2.8 Heat extraction

For economical reasons, heat extraction **takes** place in both of the machine houses near the thermal wells. At first it was planned to place the heat pumps along the connecting pipe on the demand of the heat consumer.

At Therme I 4500 kW is produced by three electrically operated heat pumps. The heat pumps raise the temperature from 36°C to 70°C.

In order to achieve a high number of hours of **use** annually with a reasonable degree of effectiveness, **three** heat pumps were installed with 1 MW each in a modular design. They can **be** used step by step. Thus it is guaranteed that the highest possible share of geothermic heat is fed into the local heating network at any time.

Two gas boilers with a combined output of 1600 kW were installed. Together with the existing block co-generation plant in AQUAtherm which has an output of 1285 kW, in the future the customers will be supplied with beat. Geothermal heat will replace decentralized boilers in the future (Figure 5).

At Therme IIa two electrically operated heat pumps were installed with a total of 1500 kW and a gas boiler producing 900 kW was set up. Together with the existing block heating power plant in city hall with an output of 686 kW, customers are supplied with beat. Here too when the geothermal heat equipment starts up operations, the decentralized gas boilers will be shut down (Figure 6).

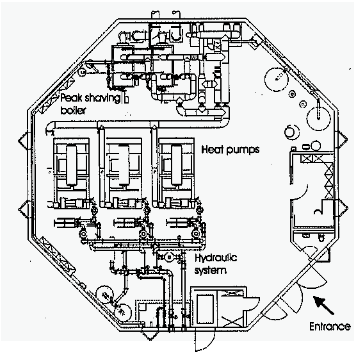

Figure 5: Scheme of machine house Therme I

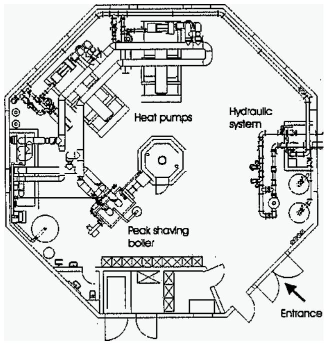

Figure 6: Scheme of machine house Therme II

3. Economical aspects of the total project

It is most difficult to achieve a suitable balance between the costs and the profit when a geothermal project is involved. Initially there are high investment costs. Afterwards you can hook up the heat consumers step-by-step and start earning money.

Evaluations of the economic efficiency were carried out and the conclusion was that the project would have a chance if there were sufficient heat consumers, additional use as water for bathing and generous financial support. Nevertheless there must be a guarantee that even in the future the prices of heat that are calculated and applied will be equivalent to the current average beat costs in Germany (at the moment 83 DM/MWh). In order to cover costs for operation over the medium-term, at least 90 DM/MWh would have to be realized.

However, the liberalized energy market doesn't orient itself according to the production costs, but rather only according to the comparative price, which in turn is oriented on oil, the leader of the market. This will especially hamper local environmental projects, which are dedicated to renewable energy sources.

A compulsory point for the geothermal project in Straubing is the double use for bathing and heating. It is to be hoped that we can continue to keep our financial goal of delivering thermal and mineral water to our own AQUAtherm for only 7.50 DM/m³.

What is needed over the medium-term is a large-scale heat consumer willing to pay 14.00 DM/m³ for therapeutic water at a temperature of 36°C.

But if you observe the trends in German health and bathing facilities, it does not look very promising.

4. Closing remarks / perspectives

Whenever you are speaking to experts about geothermal heat, there is hope that this heating method will gain in significance for ecological reasons in the future.

These projects are getting more expensive to launch, however, and using geothermal heat from the interior of the earth is becoming increasingly difficult for economical reasons.

In the application we made in 1989, we advocated the environmentally-friendly production of energy from geothermal heat. Actually an original consideration is finally bearing fruit.