INTERNATIONAL GEOTHERMAL DAYS
SLOVAKIA 2009
CONFERENCE & SUMMER SCHOOL

II.3

THREE YEARS OF BENEDIKT GEOTHERMAL HEATING SYSTEM - STAGE I OPERATION

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Keywords: geothermal energy, direct use, district heating, Slovenia

ABSTRACT

In spring 2004, geothermal well Be-2/03 has been drilled in the Benedikt Municipality, north-eastern Slovenia. Thermal water is classified as a CO_2-rich healing mineral water with 7.4 g/L of dissolved solids, and is suitable also for drinking, bottling and balneology. The whole project of district heating is characterized by 3.3 MW power, and annual production of 4200 MWh.

In the beginning of the year 2006 the Municipality Council decided to make a contract with the company Gejzir Consulting from Ljubljana to construct the first stage of district heating. The Benedikt Municipality is the well owner and ensured an uptake of 5 litre/sec of thermal water to Gejzir Consulting for this reason.

The first stage was built and put into testing operation in the year 2006. District heating encompasses public dwellings – the municipality building, gymnasium, primary school and kindergarten that consume 20 % of total municipality consumption. Heat station has the power of 700 kW and is foreseen to produce 600 MWh annually. Gas separator and heat exchanger are located at the production well in order to simplify the system operation. Energetically used thermal water is cooled in a nearby temporary pool.

1. INTRODUCTION

North-eastern Slovenia (Fig. 1) occupies south-westernmost extending of the Pannon-nian Basin. The most important tectonic struc-ture is a small sub-basin, termed the Mura Basin. During the past six decades the Mura Basin has been the site of intensive geological exploration for oil and gas deposits.

The Benedikt area is situated in the north-easternmost part of the Mura Basin. It is characterised by the highest recorded geother-mal gradient in Slovenia amounting to 84 °C /km in Tertiary sediments, a value which is twofold higher than the average. To tap ther-mal water having the temperature over 80 °C, deeper thermal aquifers in pre-Tertiary meta-morphic basement had to be discovered and explored.

Several thermal aquifers were tapped, but two most important occurred at depths bet-ween 1485 m and 1530 m, and 1848 m and 1857 m, respectively, where the welling stop-ped owing to a technical failure. The outflow amounts to about 100 L/s, and the tem-perature of mixed water produced from both aquifers is over 100° C. The water belongs to the sodium-bicarbonate-sulphate hydrogeo-chemical facies with approximately 7.4 g/L of total dissolved ions, and meets the demands for drinking mineral waters.

The concept of exploration and welling as realised in the Benedikt area is a novelty in Slovenia and in the neighbouring areas. In pre-Tertiary metamorphic basement assumed before as less or non potential, the existence of thermal aquifers suitable for exploitation of thermal waters and geothermal energy has been proven. Now, the inhabitants of Bene-dikt have an opportunity to benefit from this geothermal source towards sustainable, inde-pendent and environment-friendly develop-ment.

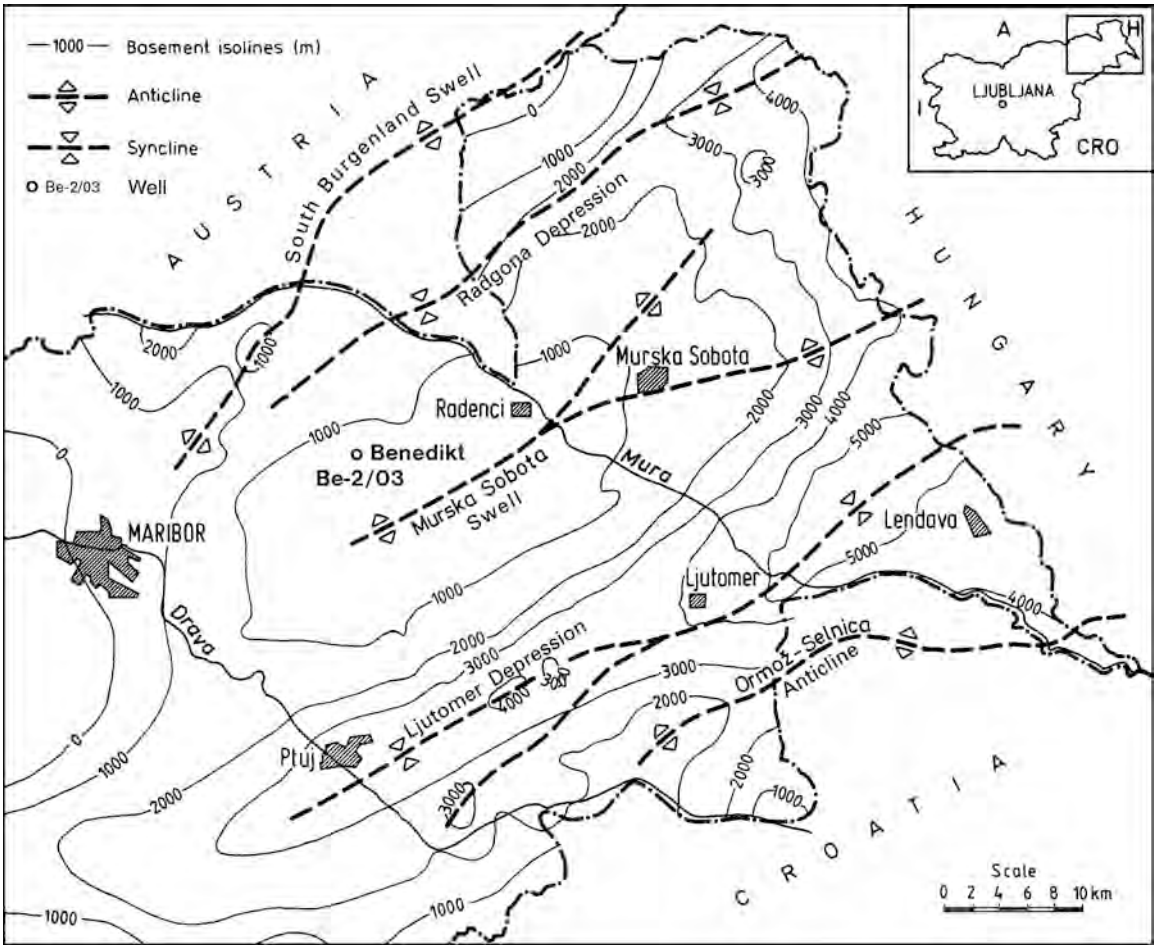

Fig. 1. The most important tectonic structures in the Mura Basin and geographic position of Benedikt (modified after Kralj 2001).

2. ENERGY SITUATION IN THE TOWN OF BENEDIKT

The town of Benedikt has a little more than 1000 inhabitants. Average annual energy consumption amounts to 6.060 kW per person. The structure of fuels and consumption balance of primary energents used for heat production (for space heating and sanitary water) that existed prior to the introduction of geothermal energy source is shown in Table 1. At heat production, various pollutants are released into the environment. According to the energents consumed, annual impact to the environment is shown in Table 2.

3. THE CONSTRUCTION OF GEOTHERMAL DISTRICT HEATING SYSTEM – STAGE I

3.1 Scope and objectives of the project

The project's Stage I aim was to complete the boiler room in the multipurpose hall so that the heating system is equipped to operate either by geothermal energy from the well, or by the existing boiler inside the existing boiler room with a power of 400 kW.

The operation is automatic, for thermal water heat exchange at geothermal well side and distribution to the boiler room, as well as in the existing boiler room. Preparation of thermal water is achieved by a degasifier, a heat exchanger, frequency modulated pumps and pipelines connecting the well and the boiler house. The system construction at the geothermal well is shown in Figure 2. The new constructions must fulfil heat demands and the regulatory body conditions.

The following equipment was installed:

Geothermal water preparation for exploit-ation:

Plateau with a fence for degasifier positioning, and a fence around geothermal well,

Degasifier with appurtenant pipeline connec-tions and valves,

Geothermal water – water heat exchanger of the district heating system,
Pipeline connection of the heat exchanger and temporary cooling pool,
Temporary cooling pool,
Cooling pool – creek pipeline connection,
Exploitation well – boiler house pipeline connection,
Pumps in the district heating system,
District heating system is composed of:
Heat exchanger,
District heating system pumps,
Pipeline connections and valves inside the boiler room,
District heating network pipelines with connections to the buildings,
Heat stations for separate buildings,
Return pipeline from the boiler house to the heat exchanger at the geothermal well, with a connection to the heat exchanger,
Water preparation system for the district heating system, and
Necessary civil engineering works for the district heating pipeline and temporary cooling pool construction.

Table 1: Consumption structure of energents used for heating.

	Before	After geoth. h.
	MWh/a	
Coal	82	82
Wood	1.756	1.756
Extra light oil	1.627	1.027
Electric power	279	280
LPG	455	455
Geoth. en.		600
Altogether	4.199	4.200

Table 2: Annual emission of pollutants related to heat production in the town of Benedikt

	Before	After geoth. h.
	t/a	
SO_2	1,1	1,0
NO_x	0,6	0,5
CO	39,7	33,1
Dust	0,6	0,5
C_xH_y	6,5	5,2
CO_2	1.172,3	968,2

3.2 Technical data

Stage I comprises the connection of public buildings with a heat demand of 700 kW, and total energy consumption of 600 MW_{th}/yr.

Heat exchanger parameters with heat ex-change potential of 700 kW are:

T_{geo} –inlet = 80ºC
T_{geo} – outlet = 45ºC
Q_{geo} = 5 liter/s
$T_{d.h.}$ – inlet = 70ºC
$T_{d.h.}$ outlet = 42ºC
$Q_{d.h.}$ = 6,0 liter/s
dt log = 7.6ºC

Temperature control of the district heating system water inlet and return is attained by frequency modulated pumps which assure dt =30ºC, regardless of the heat consumption in building heating system, in the boiler house inlet and return distribution headers.

The water from the district heating is the same as in the boiler house, what means that we have a direct system of district heating in a chain: heat exchanger – pipeline to boiler house frequency modulated pumps – distribution header at the boiler house – a pump for each building pipeline to the building – radiators – pipeline to the boiler house – boiler house collector of return water – pipeline to the heat exchanger and then back to the boiler house.

The Stage I. of district heating system is constructed and designed in such a manner that can cover not just the present demands, but also the demands of the following stages. At this stage of the project only 20% of the whole heat demand is installed in the main system pipelines and boiler house.

Heat exchanger is designed for Stage I with an extension possibility to cover heat demands of all four stages of the district heating system expansion by installation of additional plates to the heat exchanger.

The use of thermal water for the purpose of heating and connection to the boiler room is not suitable because of high content of total dissolved solids. Therefore a heat exchanger with degasifier was installed close to the well.

On side of geothermal well there is sufficient over pressure of the geothermal water to prevail over pressure drop through degasifier and heat exchanger. Therefore there is no necessity for pump installation inside geothermal well.

4. TREE YEARS OF OPERATION

During the three-year operation no injury occurred that would not be repaired in warranty. Two minor troubles were managed in this way and they did not influence the functioning of heating system. One circu-lation pump has been replaced, and the frequency regulation in the main circulation pump has been fixed.

5. CONCLUSION

Benedikt Municipality has extremely positive experience with the use of geother-mal energy. For this reason, the municipality desires to use their own geothermal source to solve the energy demand and supply in the area. With construction of this district heating system the heating power will amount to about 3,3 MW with annual heat demand of 4200 MWh. The Stage I having the capacity of 700 kW is constructed in such manner that allows an expansion keeping the foreseen reserves for the following project phases.

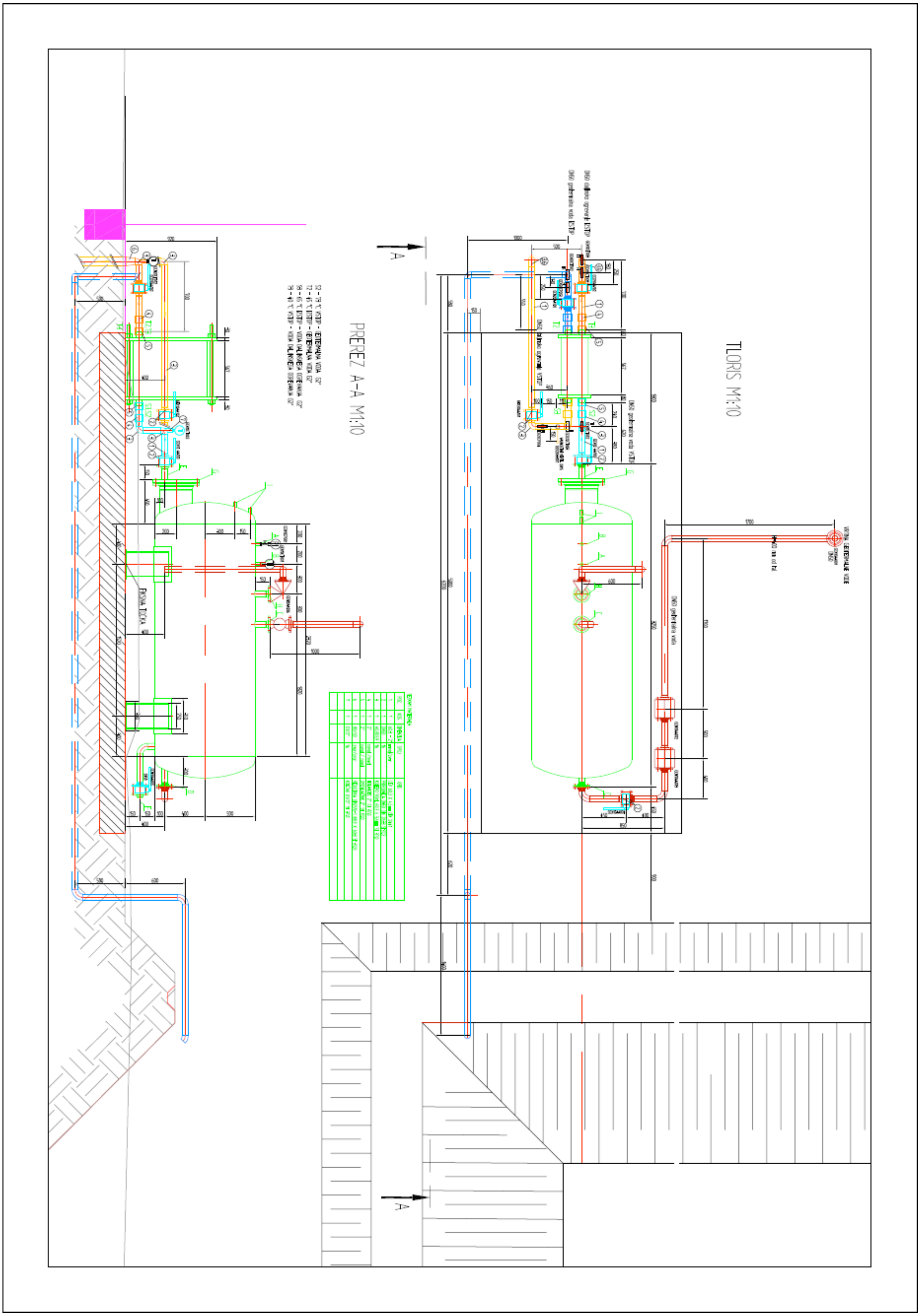

Fig. 2: District heating system at geothermal well with geothermal water preparation and heat exchanger station.