THE RESULTS OF PILOT TEST IN DURKOV HYDROGEOTHERMAL STRUCTURE

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Abstract: The pilot test was held in Durkov hydrogeothermal structure during October 2000 – May 2001. The purpose of the test was to simulate the operation in real conditions, solve technical problems with scaling and corrosion and provide enough data to evaluate the reservoir properties. The results of the test and computer modelling confirmed the possible operation of reservoir for next 30 years.

Key words: geothermal energy, Kosice basin, Durkov geothermal structure, pilot test

1. Introduction

The aim of the investigation in Durkov geothermal structure is to supply the Kosice city with the ecological renewable heat energy. The planned heat output is 100 MW_t that should supply about 60 000 households in Kosice. The heat centres (four deviated geothermal wells in each) are planned with the heat exchange stations that will supply by heat pipeline Teplaren Kosice, joint stock company (heat producer in Kosice on base of fossil fuels at present).

2. Methods

For the purpose of the simulation of the operational conditions the technology (see Fig.1) was installed on site. The difference between the testing of GTD-2 and GTD-3 was that in second case the gas separator was installed as well as the manometer between separator and heat exchanger. The wells were exploited by free flow, the pressure on the wellheads was high enough to ensure the reinjection. The flowrate after flowing through separator was continually reinjected into reservoir. The automatic data recording in 5 minute intervals were done in geothermal loop - on the wellheads of production and reinjection wells (pressure, temperature and flowrate) and in secondary loop before and after heat exchanger. The flowrate in geothermal loop was measured by induction flowmeter that was due to gas content in the water incorrect. Therefore the flowrate in geothermal loop was calculated from the flowrate in secondary loop and the temperature drop in the heat exchanger. The secondary cooling water was delivered to the system from neighbouring creek and it was mechanically and chemically treated. The geothermal loop was treated against scaling and corrosion by inhibitor dosage and by electromagnetic system CALL TECH.

The pilot test was divided into two parts:

1. Free flow test of GTD-2 as production well and GTD-1 as reinjection well
2. Free flow test of GTD-3 as production well and GTD-1 as reinjection well with partly gas separation (about 40 %)

To complete test the pressure-temperature measurements in dynamic conditions, flowmeter measurements, gas separation to observe gas/water ratio and downhole sampling and surface sampling for chemical analysis were done.

Well test of GTD-2

The main aim of test was to stabilise the flowrate of the well through the technology, the test was performed on October – December 2000. Before, during and after the test the manometers were installed in wells to observe the interference between wells. The hydrodynamic test was divided into several shorter periods due to technical problems in technology, mainly in secondary loop. The secondary water because of the high content of clay was mechanically and chemically treated. The water sealed the secondary side of the heat exchanger so it had to be cleaned several times during the production. The flowrate in geothermal loop depended on the secondary water delivery. The geothermal loop was regulated and the flowrate in geothermal loop was gradually increased to operational flowrate 44 – 47,5 l/s. This flowrate corresponded to inlet pressure 1,9 – 2,0 MPa and wellhead temperature 134°C that is 4°C more than before. The temperature of reinjected water ranged between 60 – 70°C corresponding to pressure drop in heat exchanger of 0,3 MPa. The pressure in system was influenced by the pressure on the production wellhead. The plot of the data in short period is at Fig.2. The coefficient of transmissivity is ranges between $1{,}6.10^{-4}$ – $8{,}2.10^{-5}$ m^2/s and filtration coefficient $9{,}44.10^{-8}$ m/s (Jetel, 1999).

During the gas separation on surface the gas/water ratio was estimated to 25 – 26 Nm^3/m^3, while in downhole sample it was 20,7 - 21,3 Nm^3/m^3. From the chemical analyses the chemical type of water is remarkable sodium chloride type, the genetic origin of water is polygene (Bodiš et al., 1998, 1999).

Well test of GTD-3

The pilot test of GTD-3 with the heat exchanger installed in technology was done on March – May 2001. The purpose of the gas separator installation was to enable reinjection into the reinjection well GTD-1. The stabilised flow in GTD-3 with gas separation of about 40 % represented the following parameters: wellhead temperature on wellhead of GTD-3 ranged between 123,6 – 123,9 °C, the inlet pressure was 1,2 MPa, the flowrate about 50 l/s (calculated from temperature drop and flowrate on secondary loop). The temperature of reinjected water was about 70°C and reinjection pressure 0,9 – 1,0 MPa (an example see Fig. 3). During the hydrodynamic test the continual decrease of the flowrate due to scaling and two phase flow in heat exchanger was observed. The interference measurements among the wells was not successful because of manometer ripped in the well. Temperature and pressure profile in dynamic conditions was measured. The coefficient of transmissivity of Triassic dolomites is $6,3 \cdot 10^{-3} – 3,4 \cdot 10^{-4}$ m^2/s and coefficient of filtration is $8,5.10^{-6}$ m/s (Jetel, 1999).

The gas separation on the surface estimated the gas/water ratio to 23 – 25 Nm^3/m^3 and chemical analyses of the gas shows the following content of components: 98,7 vol.% CO_2, 0,3 vol.% CH_4 and 0,95 vol.% N_2. The surface technology was treated by inhibitor dosage as in case of GTD-2 test.

Origin of the elements in the water

During the tests the geothermal water samples were taken, we had a group of 21 analyses. The TDS of the water ranges between 30 – 31 mg/l, the chemical type of the water is NaCl and according to isotopic analyses the origin of the water is polygene – marinogene and petrogene. There were done the correlation and factor analyses , the results are as following:

- Tide correlation among macro elements (Na, K, Cl, Br, SO_4) confirm the marinogene and halogene origin of the water
- Tide correlation between I – HPO_4 shows their common origin i.e. form the organic matter of the sea water
- Correlation between As – Pb shows the origin of As in polymetalic mineralisation of neovolcanic rocks (other correlation exclude the origin of As in organic matter, marinogene and carbonates)
- Tide relation among Sb, Zn and HCO_3 shows their origin in carbonatic rocks
- The origin of Mn and Fe is from neovolcanic sediments or neovolcanic rocks

The data obtained during the well test were used for reservoir modelling by TOUGH 2 that confirmed the operation in demanded conditions (production temperature 125°C, reinjection temperature 60°C, flowrate 60 l/s) for the next 30 years.

Conclusions

The aim of the pilot test was to simulate the operational conditions, find solutions to geothermal water continual reinjection, solving problems with technological properties of the water and create the reliable computer model of reservoir conditions.

The test confirmed that the production and reinjection is available by free flow, the maximum temperature reached on the wellhead (GTD-2) was 134°C with wellhead pressure 2,0 MPa, the flowrate 44 – 48 l/s (calculated from secondary loop flowrate and temperature drop in heat exchanger), the stabilised parameters of GTD-3 are as following T_{wh} 123°C, P_{wh} 1,3 MPa, flowrate 33-46 l/s, temperature of reinjected water 65°C, the reservoir of geothermal water is in Triassic dolomites with the bottom conglomerates of Karpatian sediments, the gas / water ratio according to surface gas separation is 23 – 25 Nm^3/m^3, TDS of the water is 30 – 31 g/l and the computer modelling confirmed the 30 years operation of the reservoir.

The results of the test verified the possibility of the construction of Kosice heating system on the base of geothermal energy.

References

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Figure 2: Hydrodynamic test on GTD-2 - geothermal loop (5th - 13th December 2001)

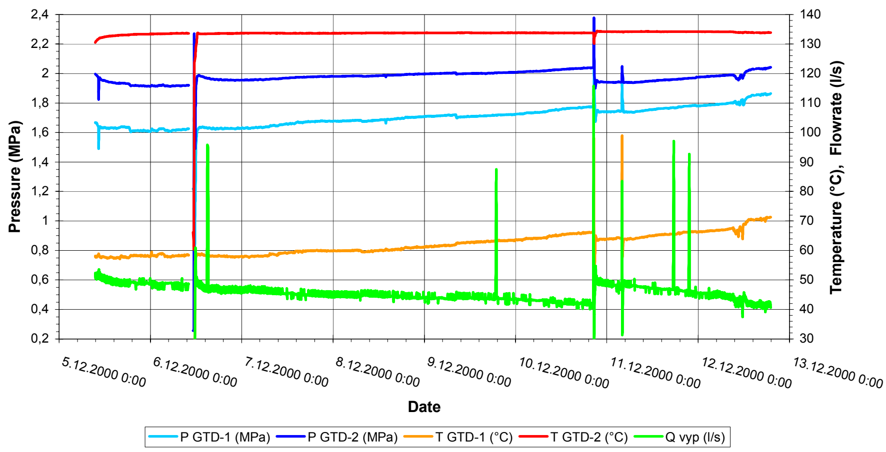

Figure 3: Hydrodynamic test on GTD-3 - geothermal loop (17th - 27th March 2001)

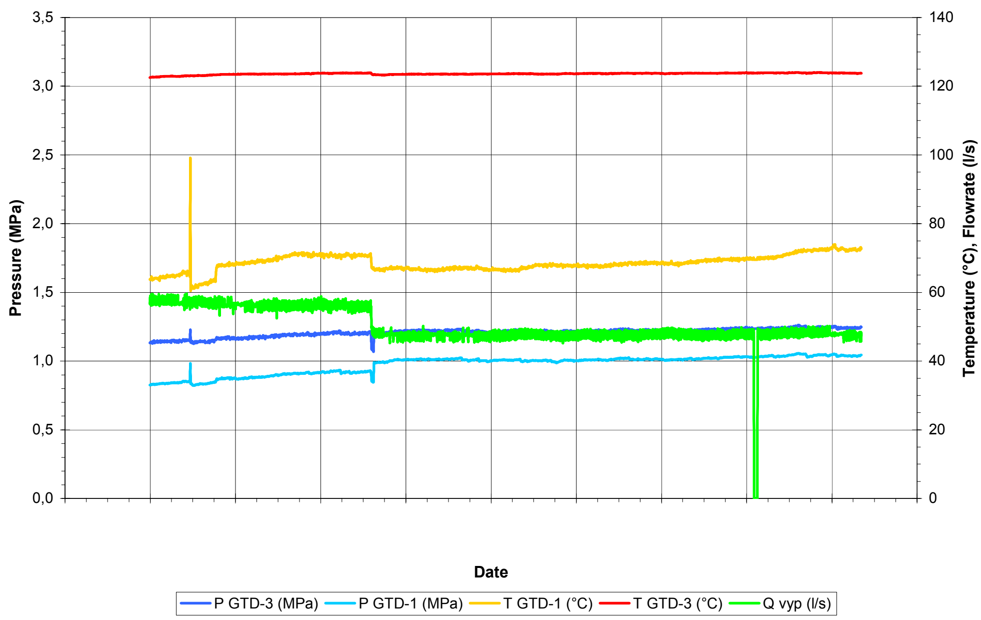

Fig. 1.

Figure 1: Scheme of the surface technology for the well test of GTD-3