A CASE STUDY

The Possibilities of Receiving Geothermic Energy from the Tunnels of the Deep Mine of Recsk

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A modern ore mine, originally planned to excavate considerable quantities of minerals, closed down in the phase of preparations, for economic and other reasons. The two vertical shafts run down to a depth of 1200 m. They are located 1200 m away from each other, and each is 8 m in diameter. Two horizontal tunnels connect the two shafts, at 700 and 900 m depths. The warm water (52 °C), pouring into the mine had to be continually drained out. When it was finally decoded to close down the mine, the pumps stopped and the warm water fully filled up the mine. The quantity of water is estimated at 300,000 m^3. A major development project is going to take place at the Parádfürdo Spa, only a few hundred meters from the mine.

How would it be possible to make use of the heat of the water in the mine?

A Brief Historical Background:

Modern mining in the Mátra mountains commenced in 1767, and they found ancient mines, ruined shafts around Vörösvárhegy and Gyöngyösoroszi. The re-cultivation of the mines around Parádfürdo began during the decade after 1767.

At the end of the 1700s, they hoped to find copper and silver, and the plans included the construction of an ore-crusher in order to produce powder suitable for melting.

A more intensive development of ore mining started after World War II. The prospect holes ran down into the mesosoic stones to an avegare depth of 900 m below the sea level.

Two shafts were drilled down to a depth of 1,200 m. Their diameter is 8 m. They are connected by transporting tunnels at 700 and 900 m. These tunnels were constructed in 1980. Since that time, works were suspended because of economic difficulties. An annual sum of HuF 150-400 has been spent on maintenance. Further research has also been suspended.

During the construction, high temperatures have been measured. At the bottom of the shafts temperature exceeded 52 °C. Large amounts of water poured in, and the water was found to contain high concentrations of calcium-carbonate, and the precipitation of aragonite was also significant. According to reliable calculations, the amount of water in the mine is now in excess of 300,000 m^3.

This is the situation for which the author is proposing a solution.

As the depth of the shafts is more then 1,000 m, and they are fully flooded with water, a significant quantity of water is to be calculated with. Similarly large is the quantity of thermal energy. The density and value of geothermic streams in the area is highly advantageous–presumably because of the heat conductivity of the volcanic rocks–so this large amount of water represent a high amount of thermal energy. It is a high reserve of thermal energy, the exploitation of which does not require any damage of, or even interference with the environment. Heat-pumping appers to be the most suitable solution.

There are, however, a number of factors to be examined and clarified preliminarily: the first is the temperature in the different tunnels and shafts. The question of replacement: is there going to be replacement after the heat has been pumped out? Is there a point of balance, when there is a permanent and economical heat pumping and adequate replacement of the energy extracted.

It is, therefore, necessary to carry out further research as I have mentioned before. The calculations are to include temperatures at different depths, heat replacement, quantitive measurements, chemical and hydro-chemical analyses and other tests.

A new concept is to be developed, based upon these calculations, in order to find the ways of the economical exploitation of this special form of hydrothermal energy. As tourism is expected to increase in the Mátra Mountains–especially in the Parád Valley–in the future, a vegetable garden and orchard appear to be a good way of making use of the thermal energy. There are free areas in the valley, excellent for agricultural cultivation. There may also be other ways of utilisation (including even the generation of electric power) and plans are to be prepared for several alternatives. The existing buildings in a good state of repair may also be utilized (e.g. growing mushrooms etc.).

In Hungary, the district heating company of Harkány is the only organization that uses readily available geo-thermal energy for heating. The used thermal water of the spa, otherwise simply drained into the sewer, although the temperature of the water is still 30°C or even higher. The daily quantity utilized is 6,000 m^3, the energy utilized through the heat pump is a total of 6 MW, delivered to the hospital, hotels, restaurants and other users who use it as heating or as hot water in their systems.

Unfortunately, there are 3,000 wells closed and sealed in Hungary the thermal energy of which is utilizable. Still, these resources are unused. (The total quantity of thermal energy theoretically available in Hungary is 200,000 MW/h. If we only consider 100 MW/h at 30° C water temperature, this is a quantity of energy that makes a medium-sized power station unnecessary.

A distinguished expert of heat pumps claims that the natural replacement of water between -300 and -700 m is approximately 1,5 m^3/min, that is, 90 m^3/h. The estimated temperature is min. 40ºC. The heat extracted through cooling the water down to 5ºC is 3,600 kW, to which we may add 700 kW of electric performance, and the total thus comes to cca. 4300 kW. This is sufficient to heat 1,000 hotel rooms.

A condition of this simple solution is whether they allow to extract a quantity of 25 l/sec of this water and pour it into the reservoir.

Unfortunatly, this solution is hardly feasible because of environmental issues. According to the manager, Mr. Hajdú, it is possible to extract a significant quantity of thermal energy from the mine without draining or pumping out the water. For this, it is enought to extract the heat through the wall of the mine. The expert's opinion of Dr. Lenkey (Department of Geophysics, Eötvös University, Budapest), has also been requested. Dr. Lenkey asserts the following about the quantities of heat extractable through the geo-thermic streams: ”Is extracted heat energy replaced? The amount of extracted heat, considering a density of ge-thermic streams of 0,11 $Wm^{2,}$ per definitum, 0,4 kJ/1 m^2/h. The *extracted heat energy* is therefore replaceable on 9 x 106 m^2 (3 km x 3 km = 9 km^2). As the heat energy is extracted on a small area, along the 2 km between the two shafts, it is clear that the connection to the 2 geo-thermic streams is only able to replenish a small part of the energy extracted. (At the calculation above it is supposed that the entire heat stream density is devoted to heating, which is obviously untrue.) As the heat is not replenished from an extarnal source (geo-thermal streams), the system is going to extract the heat from the direct environment, and the environment is going to cool down.

As heat conduction is a slow process, the heat is replaced from the remote points of the environment very slowly only. Consequently, the environment rapidly cools down to the temperature of the re-circulated water.”

Dr. Lenkey–convincingly–underpins his statement with the model of a temperature space, perpendicular to the horizontal pane, and comes to the conclusion that the temperature of the environment of a linear source drops rapidly.

The deep bore no. 11/a at Mátraderecske, producing water of 38 ºC from a depth of 900 m, deserves attention. There is hardly any depression observed during the replenishment of the water. The temperature of the soil at 900 m is + 52 ºC, and at 700 m it is + 46ºC.

L. Lenkey also finds it possible that during a period of 1 year we are able to extract a quantity of thermal energy equal to 1,000 kW/h, as the temperature would only drop below 10 ºC after a year. *If the same quantity is not extracted during one year, then–in the author's opinion–a smaller extracted quantity extends the period considerably*. It is especially successful of we are able to solve the problem of circulating the water between the shafts and the environment. (Some experts believe that the more the soil cools down, the stream of the heat accelerates. The author does not share this opinion. This is related to the geological relations of the area, endoterm etc. processes.)

In Switzerland, Germany and the U.S.A. heat pumping from deep probes has been used for heating where there is no subsoil water in sufficient quantities. Heat is extracted from holes of 50-100 m depth and 110-133 mm diameter. The working medium in the pipes is water mixed with anti-frost liquid. The temperature is 0– -3 ºC. The extractable thermo-energy is, depending on the humidity and conductivity of the soil is the following (DIN standard):

1. Porous soil at high water output	100 W/m
2. Solid rock with good conductivity	80 W/m
3. Solid rock with medium conductivity	55 W/m
4. Dry subsoil with poor conductivity	30 W/m

If more than one bor is used fro extracting thermo-energy, the distance between the bores should not be smaller than 5 m. The rocks at Recsk are porous, with a high amount of water streaming through them. In that area, 2 pieces of shafts, 100 m deep each, are sufficient for extracting 19 kW heat energy in the long run, enough for a dwelling house that requires a total of 25 kW of energy. The mass of land necessary for this is 10 m x 100 m of rock, of which only the conductive heat is used. The more the rock cools down, the faster the heat will stream there.

As a summary we find it justified to declare that there is a realistic possibility for the economical extraction of the thermal energy stored in the area concerned. It is, naturally, necessary to clarify a number of further technical, theoretical and practical issues and to conduct a number of further measurements, and it is also necessary to prepare a feasibility study.

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