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Geothermal Potential of Mining Water in the Bílina Mines

Veronika Davídková [1]

[1] Jan Evangelista Purkyně University, Faculty of Health Studies, Pasteurova 3544/1, 400 96, Ústí nad Labem, Czech Republic

veronika.davidkova@ujep.cz

Abstract. This article is focused on utilization of geothermal potential of mining water in the Bílina Mines. The intention to explore geothermal potential in this area of interest based on consideration to use of this type of the Earth´s heat, such an alternative source of energy. Geothermal energy is cost effective, reliable and sustainable. Using of the geothermal energy leads to the production of green energy. Although geothermal energy has many advantages is not so much utilized. Geothermal energy is natural heat of the Earth, which is accessible from the surface. Economically recoverable only in places its accumulation in the anomalies. In terms of geothermal energy, the site, as part of Podkrušnohorské area, and these are to the most promising areas in the Czech Republic sections characterized by high heat flow. In article is presented research of geothermal energy at Bílina Mines, where the temperature of mining water and abundance of four hydro-geological boreholes were monitored in 2009-2010, 2011-2012 and 2018. Over 200 0000 m^3 of water is dewatered from the Bílina Mines annually. These boreholes are used for water monitoring from the mine. Due to the large amount of water pumping is area of interest interesting for using geothermal energy. Results showed that although the geothermal potential of the mine water is not so significant, there will be great potential in low-temperature energy source use for heat pumps. Heat pumps are less expensive, they do not drill deep and their installation is easier. For our case study is recommended use water-to-water heat pumps.

1. Introduction

The approaching depletion of traditional energy sources in the world, but also an effort to reduce pollutants in the atmosphere, mainly from burning fossil fuels [1], creates the need to identify and exploit new alternative sources. Geothermal energy is included to these sources. Geothermal energy is defined as heat from the Earth. It is a clean, renewable resource that provides energy around the world in a variety of applications and resources. Although areas with telltale signs like hot springs are more obvious and often the first places geothermal resources are used, the heat of the earth is available everywhere [2]. In the Czech Republic the most promising areas for using geothermal energy are the Krušnohorská and Podkrušnohorská area, which are characterized by high heat flow [3, 4, 5]. The Bílina Mines are situated in the Podkrušnohorská area.

Field research was done in the Bílína Mines. Field research conducted in measuring water temperature and abundance of four hydro-geological boreholes (Figure 1).

Figure 1. Hydro-geological borehole (own photo 2012)

2. Field research and methods

The field research was conducted in the Bílina Mines where extract coal with a high calorific value and low content of harmful substances in the Teplice – Bílina area. They supply power coal primarily to the Ledvice Power Station and other large heating plants [6]. The field research covered water temperature measurement and the abundance of four hydro-geological boreholes. These hydro-geological boreholes are used for dewatering overburden of coal seam.

The Bílina Mines are situated in the North Bohemian Brown Coal Basin. The North Bohemian Brown Coal Basin in a relict of Tertiary sedimentary basin, billed with sedimentary material mostly during the Miocene era. A brown coal seam developed in most parts of the basin, formed from layers of peat deposited in a Tertiary swamp. The body of the Bílina delta has been opened by the Bílina open cast mine in a transversal direction. Available documentation shows that the body is formed by a very tricky complex of sandy delta corpuses, layers of lacustrine clays and an entanglement of sandy fills of river beds bordered by sandy plain sediments [7]. The bottom of the Bílina Mines site is practically the lowest open point which can be reached in the Czech Republic. The Bílina surface quarry annually extracts approximately 9.5 million tons of coal during overburden extraction and removal of about 56 million cubic meters of the overlying soil [8]. Over 200 000 m3 of water is dewatered from the Bílina Mine annually [3].

As it has been already mentioned, in the context of the field research water temperature and abundance of four hydro-geological boreholes no. H9, H10 (Figure 2), H11 and RH-13 were monitored in 2009, 2010, 2011, 2012 and 2018. Each borehole had its own label. Location where boreholes are situated, is near the village Braňany. Deep boreholes are about 100 – 130 meters and they have a diameter of about 0.5 meters.

Figure 2. Hydro-geological borehole (estuary) no. H10 (own photo 2010)

The water temperature was measured by the water thermometer. Water abundance was measured using the stopwatch and a one-liter container. The water temperatures and air temperatures were monitored in 2009, 2010, 2011, 2012 and 2018 (terrain survey). All measured values are shown in the Figure 3. Results showed that air temperatures had no significant effect on the water temperature.

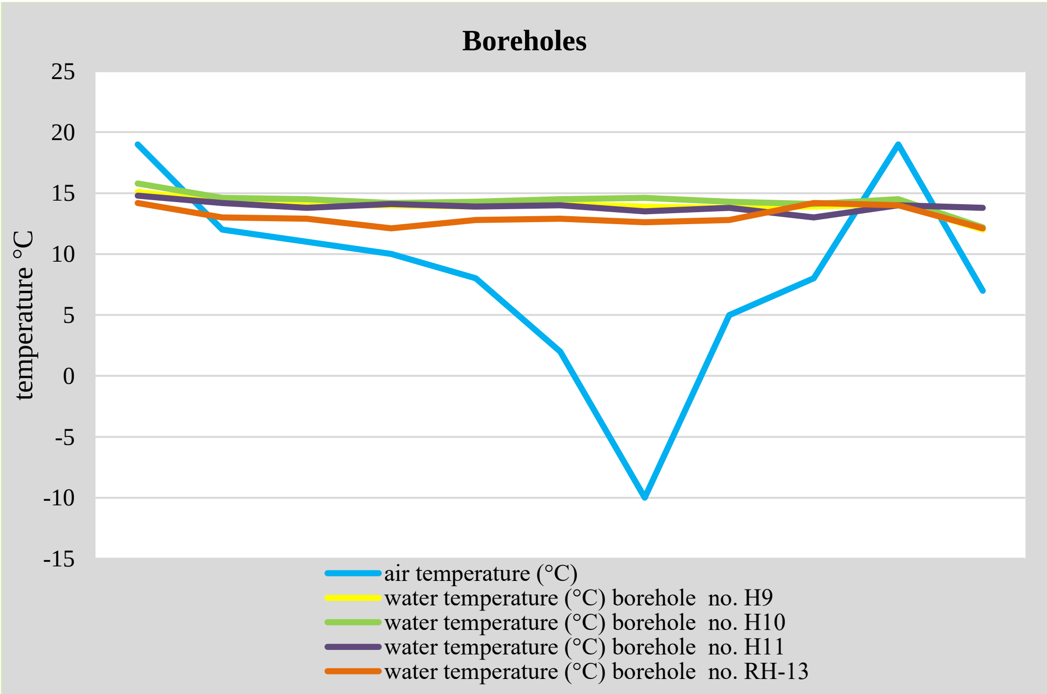

Figure 3. Boreholes

Theoretical calculations of the thermal power transferred by the water (Figure 4.) were made using the following formula:

$$Q = m \cdot c \cdot \Delta t \quad (1)$$

The meaning of the variables indicating the physical units:

Q [kW]	thermal power/capacity when taken from the borehole
m [l/s]	temperature potential (abundance)
$c = 4{,}186\ kJ \cdot kg^{-1} \cdot K^{-1}$	water specific heat capacity
$\Delta t = 5$ [°C]	suitable temperature for a heat pump

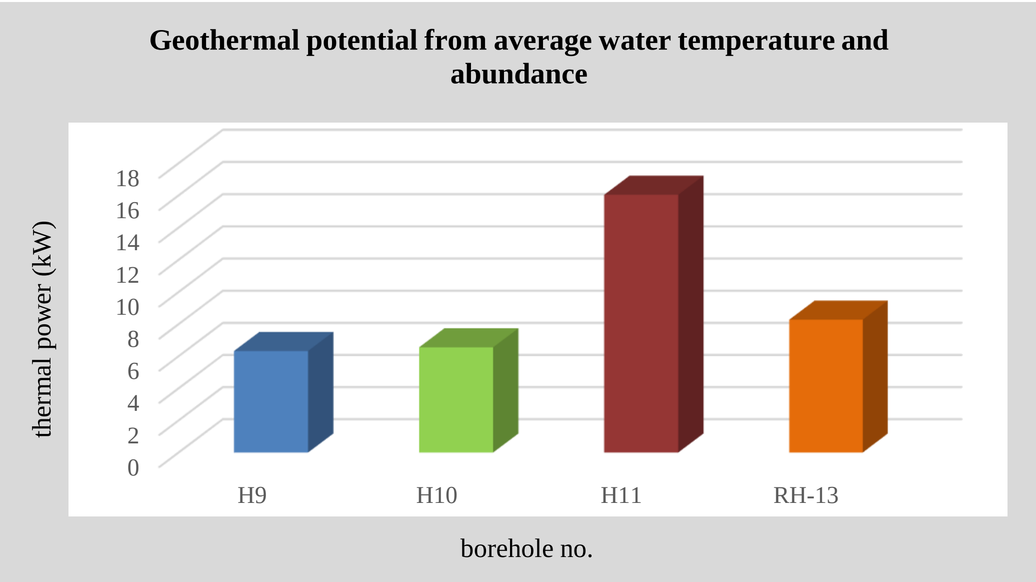

Figure 4. Geothermal potential

3. Results and discussions

In 2010 where only two boreholes (no. H10 and H9) where there was opportunity to conduct measuring. In 2012 there were four boreholes. In 2018 the number of boreholes changed as mining work progressed. For each borehole the thermal loss affected by distance from the estuary of the borehole is indicated. The thermal heat at the estuary of the borehole is in the range of 3 – 5 °C. The average temperature of water was 13.8 °C. According to the average temperature of water and its thermal loss is water temperature at the bottom of borehole about 20 °C. In 2011 was measured water temperature at the bottom of the Bílina Mines and reached 20 °C. The authors Bejšovec [9] and Blažková [10] noted that in the central region (i.e. the Bílina Mines) of the North Bohemian Brown Coal Basin had the largest quantity of hot water in the range of 20 – 25 °C. The author Myslil [11] noted that many low-temperature hydrothermal sources (<90 °C) called thermal water with a temperature of approximately 25 – 72 °C are situated in the Czech Republic.

4. Conclusion

The field research shows the presence of low-temperature hydrothermal sources in the Bílina Mines. Theoretical calculations of the thermal power transferred by the water analysed geothermal potential of hydro-geological boreholes. Total geothermal potential from average water temperature and abundance from four hydro-geological boreholes was measured about 37.21 kW. Although the geothermal potential of the mine water is not so significant, there will be great potential in low-temperature energy source use for water-to-water heat pumps. The great potential is in the amount of pumped water from the Bílina Mines. In the surrounding of the Bílina Mines is situated village Braňany where it would be possible to use this system. Currently mine water flows only into the water recipient.

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