Chances and risks of the geothermal use of mine water in Schlema / Saxony

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Abstract. The flooded mine Schlema-Alberoda, Saxony with a mined cavity of 35 million m³ and a water temperature of about 27 °C represents an important geothermal reservoir and is situated directly under the village of Schlema. Independent from the local conditions four principal possibilities how to use the warm water are applicable:

- Withdrawal of warm water from the flooded mine
- Heat extraction in the flooded mine
- Use of overflowing water prior to water treatment
- Use of treated water

Before heat mining can be realised it has to be evaluated how heat extraction changes the hydrochemical situation and the concentrations of contaminants in water respectively consequences for the treatment plant, which is going to purify the out flowing mine water.

Introduction

The flooded mine Schlema-Alberoda, Saxony with a cavity of 35 million m³ and a water temperature of about 27 °C represents an important geothermal storage and is situated directly under the village of Schlema. Recently the flooding process is in the final stage.

Due to the very deep development of the former uranium mine to a depth of about 1800 m and caused by the thermal-kinetic convection in the flooded cavities relative high temperatures are expected in the mine water permanently.

During the flooding and the period directly after the flooding high concentrations of typical contaminants like Arsenic, Uranium, and Radium will occur in the water. Therefore a treatment of 700 to 1000 m³/h of out flowing water discharging to the Zwickauer Mulde River with a temperature of 26°C is in planning.

The water filled mine cavities are spread over an area from Niederschlema to Oberschlema / Schneeberg. After flooding being completed the water surface will reach a level between 10 and 60 m below the ground surface of the village of Schlema.

Independent on the local specific conditions actually four possibilities of geothermal use of the flooding water are applicable (Fig. 1):

- Withdrawal of warm water from the flooded mine
- Heat extraction in the flooded mine
- Use of overflowing water prior to water treatment
- Use of treated water

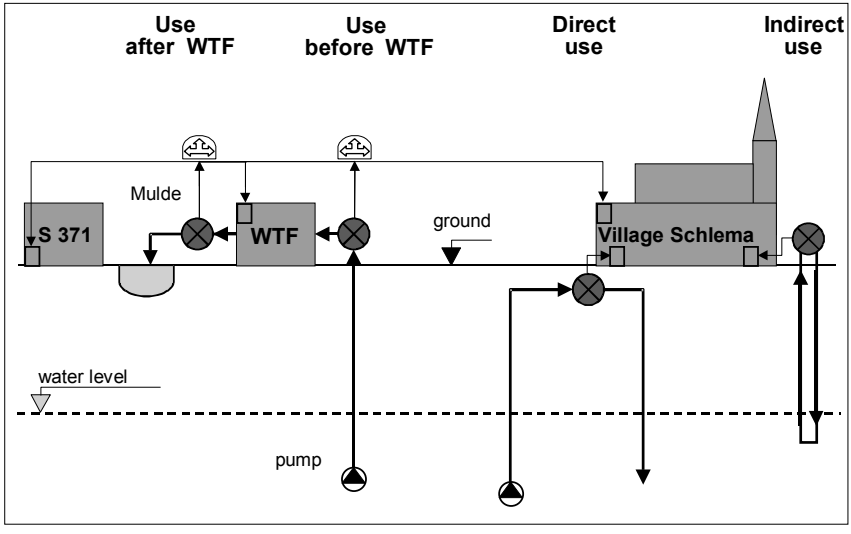

Fig. 1. Alterternative techniques of geothermal use of flooding water in the region Schlema-Alberoda (WTF- Water treatment facility)

Options of geothermal use

Direct Use in the Flooded Mine

One technique could be pumping of mine water via old shafts or boreholes to the subsurface or to the Markus-Semmler-Adit level directly towards potential consumers. In that case heat is extracted from the water by means of heat exchangers and the water is pumped back to the mine cavities. This may be an efficient form from the energetically and economically viewpoint but negative convection and hydrodynamic processes cannot be excluded. Therefore it is necessary to proof by field tests that this direct use of the geothermal potential will not lead to an additional mobilization of contaminants in the mine and in thus to a negative impact on the functionality of the water treatment plant.

Indirect Use of flooding water

The indirect use of flooding water by a heat probes installed in mining cavities via short boreholes is efficient especially if this can be realized close to the location of the consumer. Such probes consist of a tube with circulating cool water inside in a secondary circuit and warm mine water outside. By heat exchange a heat extraction of about 60 W/m is realistically. By means of a heat pump the warm water will be cooled and pumped back to the circulation tube. However, local convection processes with a negative impact at the water treatment plant can not be excluded neither.

Use of overflowing water before the water treatment

The heat use from the out flowing mine water with a temperature of about 30 °C prior to the water treatment plant is highly efficient from the energetically viewpoint. A possible negative impact on the water treatment technology depends on the degree of cooling of the mine water.

Use of treated water

Without any disadvantageous impact on the water treatment technology is the heat use of water discharge from the treatment plant. The treated water has a uniform temperature of about 26 °C. With an amount of water of 700 m³/h and cooling the treated water to 10 °C a heat power of 19 MW will be available. In this case costs are depending on the distance of the potential consumer from the water treatment plant.

Conclusions

Investigations showed that in case of direct or indirect use of mine water from the mine cavities via boreholes or old shafts the geothermal use is probably not without problems. The probability of an induction or an increase of convection streams with mobilization of contaminants from the mine is relatively high especially for parts of the mine without heat use which are not or not efficently connected with the thermal convection system in the flooded cavities. However, the volume of isolated parts of the flooded cavities as well as the amount of potential contaminants which can be mobilized are unknown. The hydraulic flow paths are unknown and therefore technical measures to prevent additional convection are not practicable. Thus without clarification the possible impact on the functionality of the water treatment plant the heat extraction from isolated areas of the flooded cavities is not recommended.

Finally the geothermal use of water both before and behind the water treatment plant is possible and is depending on the heat demand, the distance of the user to the plant, the input and output temperatures, and the efficiency of the heat exchanger.

When the water treatment plant will be closed down in 20 to 30 years after concentration of contaminants in the water have decreased to a certain level a further use of the renewable geothermal potential by direct or indirect methods is possible.

Thus the region around Schlema nowadays and in future has a great challenge to produce energy by use of natural heat from mine water very efficiently and will be very attractive for consumers and investors. It can be an example that an abandoned mining region may develop to a center of sustainable energy production.