MŰSZAKI FÖLDTUDOMÁNYI KÖZLEMÉNYEK

A Miskolci Egyetem Közleményei
88. kötet, 1. szám

XV. Nemzetközi Tudományos Konferencia
a Kárpát-medence ásványvizeiről

15th International Scientific Conference
on Mineral Waters of the Carpathian Basin

Miskolci Egyetemi Kiadó
2019

A kiadvány főszerkesztője:

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HU ISSN 2063-5508

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ASSESSMENT OF HEAT STORAGE CAPABILITY USING 3D HEAT TRANSPORT MODELING

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1. INTRODUCTION

Nowadays, a lot of types of heat storage, and heat extraction methods are known. These kind of extraction methods has different types of sources such as deep porous formations, karstic formations, and also landfills (FAITLI et al. 2015, 2017). This study deals with the heat storege in shallow porous conditions. Aquifer thermal energy storage (ATES) uses natural water of a saturated and permeable underground layer called aquifer as the storage medium. This type of heat storage type can have different impacts on mineral waters, and deep aquifers, and therefore we have to know the behavior of ATES systems. Thermal energy is transferred by extracting groundwater from the aquifer and by reinjecting it at a changed temperature at a separate well nearby (DINCER-ROSEN 2002). The thermal energy storage contributes significantly to improve the efficiency of energy utilization would otherwise be lost because it was available at the wrong place at the wrong time (XU et al. 2014). Also, through this energy storage method the use of fossil fuels, as well as, the emissions of greenhouse gas and air pollutants (such as CO_2, SO_x, and NO_x) could be reduced substantially (FAITLI et al. 2015).

The present study analyses the feasibility of storage hot wastewater through an aquifer thermal storage system ATES in the hydrogeological conditions of the Hungarian industrial city of Tiszaújváros, considering this heat excess resource as a likely energy source for heating systems during wintertime.

2. MODELING SECTION

The simulations use MODFLOW and MT3DS codes and have a useful life of 25 years. First, four theoretical ATES systems were modeled to figurate the groundwater and heat behavior using different operation systems described in table 1 and theoretical ideal parameters considering the ATES formation as sandy gravel unit.
After, the best two ideal models were simulated using the conditions and groundwater temperature of the test site. All the different scenarios were evaluated thro-

ugh their thermal recovery efficiency, the heat losses due to displacement by ambient groundwater flow and by dispersion and conduction.

Table 1

Details about the theoretical scenarios

Model	Mechanism
ATES-T1W	Unique well with double function, which alternates injection and production periods every 6 months.
ATES-T2W-50 m	Doublet of wells separated by 50 m, with constant injection and a production period of 6 months/year.
ATES-T2W-100 m	Doublet of wells separated by 100 m, with constant injection and a production period of 6 months/year.
ATES-T5W-50 m	System of multiple wells, four wells with a constant injection, separate 50 meters of one production well with a work period of 6 months/year.

3. RESULTS OF MODELING

The theoretical simulations ATES-T1W, ATES-T2W-50 m, ATES-T2W-100 m, and ATES-T5W-50 m experimented a heat transport velocity of 1.52 m/day, almost the half of the groundwater flow velocity and an effective thermal dispersion of 2.13 × 10-6 m^2/s.

ATES-T1W showed changes on its hydraulic head of 4.2 meters and 15 degrees in its temperature during injection and production periods, however it experimented a huge recovery efficiency between 72 and 92 percent, as well as small energy spread.

ATES-T2W-50 m showed softer differences of hydraulic head and got a decrease of two degrees of the injected temperature after ten years of work, generating a semi-steady temperature value, however it experimented less heat recovery efficiency with a maximum of 59 percent from fifth year, with more energy spread due to the bigger distance between wells.

ATES-T2W-100 m showed the softest differences of hydraulic head due to the bigger distance between wells, reason why the temperature takes more time to increase until get same values to ATES-T2W-50 m, its heat recovery efficiency is lower than the previous scenarios passing the 50 percent after eleven years and getting a maximum of 56 percent at the end.

ATES-T5W-50 m showed the same hydraulic differences of ATES-T2W-50 m due to their same distance between wells, however the temperature takes more time to increases until get the same difference of ATES-T2W-50 m due to heat plume must travel 50 meters towards all directions, its heat recovery efficiency is lower than all the previous scenarios, it didn’t reach the 50 percent in all the working life, getting a maximum of 44 percent at the end. Also, this scenario may have more economical cost due to the quantity of wells comparing with the previous scenarios. *Figure 1* gives a better understanding of the heat pathway in each scenario.

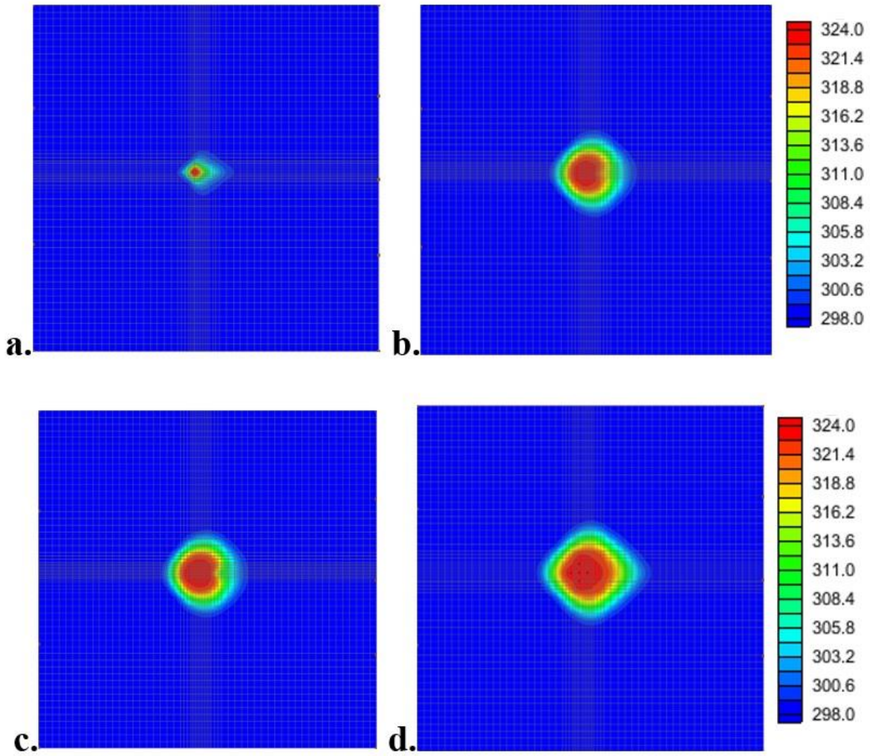

Figure 1: *Heat plume after 20 years of operation of*
a) ATES-T1W
b) ATES-T2W-50 m
c) ATES-T2W-100 m, and
d) ATES-T5W-50 m

ATES-T1W and ATES-T2W-50 m got the highest values of heat recovery efficiency, reason why they were simulated using the hydrogeological conditions of Tiszaújváros.

The models ATES-R1W and ATES-R2W-50 m showed less heat recovery efficiency with real hydrogeological conditions, with a heat transport velocity of 1.6 m/day, and the effective thermal dispersion was 2.09 × 10-6 m^2/s during the heat transport process.

ATES-R1W despite having big shifts in the groundwater temperature between injection and production periods, it experiments a huge increase in the recovery efficiency from 74 to 85 percent during a period five years, after it increases mildly until getting a maximum of 89 percent. ATES-R2W-50 m had a brief increasing of heat recovery efficiency during the first four years from almost 8 to 42 percent. After this period, the heat recovery increase mildly over time until get a maximum of 55 percent, besides, the system beats the 50 percent of efficiency since the eighth year. The overall fluctuation in heat recovery efficiency of theoretical and in site models can be visualized in *Figure 2*.

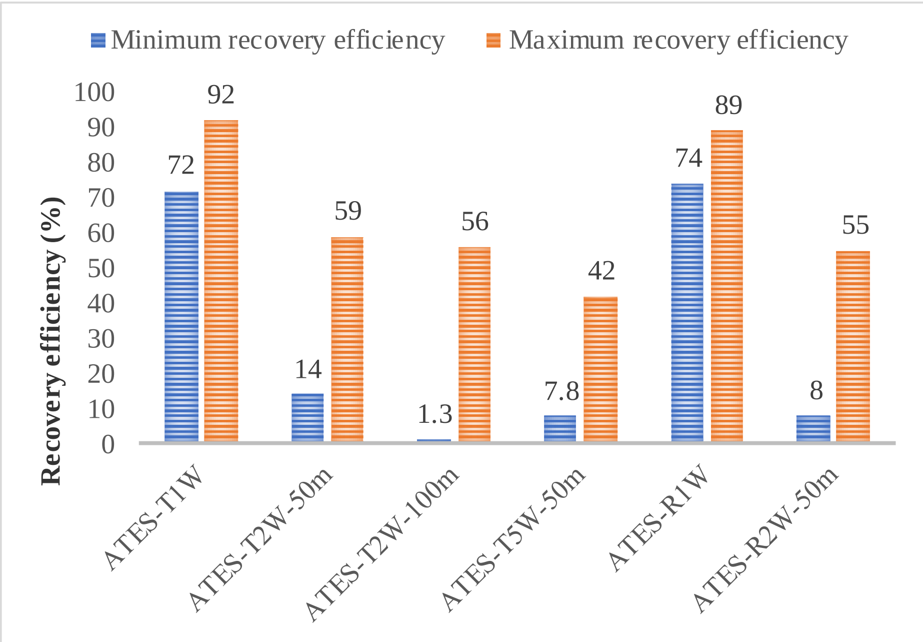

Figure 2: *Variation of heat recovery efficiency of the modeled scenarios*

4. CONCLUSIONS

The theoretical simulations ATES-T1W, ATES-T2W-50 m, ATES-T2W-100 m, and ATES-T5W-50 m developed using ideal conditions and different wells systems allowed knowing how the injected hot water and heat are displaced in the aquifer matrix, showing a radial spread in all the cases. Also, the models detailed that the locations and quantity of the wells have a huge effect on the heat recovery efficiency during its underground storage.

The research demonstrates theoretically a capacity of more than fifty percent of heat recovery capacity in Tiszaújváros through 3D-modelling and using an aquifer thermal storage system, which is enough to be tested in laboratory scale. The research became a good point of reference to other similar projects, considering the large amount of excess heat sources in Hungary, which are generally hot wastewater, and which could be a potential source of energy to provide heating, instead of non-renewable energy like natural gas, allowing to decrease the pollutant emissions and global warming.

ACKNOWLEDGEMENT

The described study was carried out as part of the EFOP-3.6.1-16-2016-00011 *Younger and Renewing University – Innovative Knowledge City – institutional development of the University of Miskolc aiming at intelligent specialization* project implemented in the framework of the Szechenyi 2020 program. The realization of this project is supported by the European Union, co-financed by the European Social Fund.

REFERENCES

DINCER, I.–ROSEN, M. (2002): *Thermal Energy Storage: Systems and Applications*. New York, John Wiley & Sons.

FAITLI, J.–ERDÉLYI, A.–KONTRA, J.–MAGYAR, T.–VÁRFALVI, J.–MURÁNYI, A. (2015): Pilot Scale Decomposition Heat Extraction and Utilization System Built into the "Gyál Municipal Solid Waste Landfill" CISA Publisher, Paper: 262, 12.

FAITLI, J.–MAGYAR, T.–ROMENDA, R.–ERDÉLYI, A.–BOLDIZSÁR, CS. (2017): *Laying the Foundation for Engineering Heat Management of Waste Landfills*. Nova Science Publishers, 215–244.

XU, J.–WANG, R.–LI, Y. (2014): A review of available technologies for seasonal thermal energy storage. *Solar Energy*, 103, 610–638.

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Példányszám: 141
TNRT – 2019 – 200 – ME