



Simulating heat transfer for geothermal energy and heat storage in a flooded legacy coal mine in Liège (Belgium)

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Groundwater in flooded legacy coal mines can be used for heat and cold production and storage in combination with heating and cooling networks. In the Walloon Region of Belgium, three cases are currently being investigated with the financial support of the Recovery Plan (Walloon Government, SPW Energy) to assess the potential of mining geothermal pilot projects in Liège, Charleroi, and Mons. The case of Liège is detailed here. The heat and cold users/producers to be connected were identified as well as their demand profiles. The model of the mine reservoir was elaborated by digitizing and conceptualizing the geometry of the interconnected galleries, shafts, and extracted coal panels of the flooded mine in the fractured Westphalian formations. The mine reservoir must be described as realistically as possible to ensure the reliability and robustness of the results and its behavior under defined exploitation scenarios. For the simulation of the groundwater flow coupled to heat transfer, the 3D highly heterogeneous rock domain is complemented with discrete 1D and 2D elements representing mine galleries and panels respectively. Feflow© is used to allow temperature-dependent density and viscosity, in a complex 3D heterogeneous domain. The system concept foresees using a reversible heat pump and a geothermal doublet. Hot water is pumped in the deepest parts of the open network, and cold water is re-injected in the shallower parts (galleries or fractured rocks). A seasonal inversion is planned to cool the buildings during summer. The main challenge to design the whole geothermal project and to assess its future efficiency and impact is the uncertainties inherent to such a highly heterogeneous underground reservoir. They can impact the simulation results of short-, mid-, and long-term temperature evolution in pumping and injection zones. This case study highlights the importance of relying on modeling approaches using detailed mine data to provide reliable predictions.

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