THERMAL IMPACT EVALUATION OF AN OPEN LOOP HEAT PUMP SYSTEM: INTEGRATED APPROACH WITH PROJECT DATA, NUMERICAL MODELING AND GROUNDWATER MONITORING

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One of the crucial aspects about open loop low enthalpy geothermal applications is thermal impact estimation, already required from the first step of the hydrogeological study. But, without any monitoring dataset available, ante operam numerical model can't be calibrated with a consistent series of field observations and so it won't be initially able to reach an adequate reliability level. Therefore, the following groundwater monitoring period, maintained during the experimental operation of the geothermal system, is fundamental to relevantly improve the numerical model efficiency, adding new experimental information to the existing database.
The heat transport simulation is always more often requested from public authorities to authorize an initial experimental testing period of the pilot geothermal plant. At the same time, the model is used to support plant design and engineering, defining optimized values of pumping and reinjection rates and finding the best placement of the wells. Moreover, the case study experience confirmed the importance of following model calibration, used with a bilateral approach in order to enhance forecast performance and to test initial assumptions validity.
Case study heat pump system consists of a single couple of pumping and injection wells, together with a monitoring network of 4 piezometers drilled to a depth of about 40 m from ground level, at different distances from the reinjection point. Well screens intercept a 25-30 m thick confined aquifer, composed by highly permeable sandy gravel with hydraulic conductivity values in the range of 1E-03 m/s. After initial investigations, including several pumping tests to estimate aquifer hydraulic properties, experimental monitoring of thermal impact started in March 2013; so actually about 4 years of groundwater level and temperature data series have been collected.
During the first period of heat pump system activity, the numerical simulation realized with FEFLOW-DHI responded correctly to temperature trends measured in monitoring wells, confirming the accuracy of model setup and allowing an effective thermal parameters calibration. After a model update with more recent temperature observations, a comparison between calculated and observed values suggested the necessity of further investigations to confirm the offsite hydrogeological properties, specially relating to larger scale groundwater flow direction. Then a new monitoring well was drilled near the calculated heat plume centerline, to verify the revised simulation scenario; after a short monitoring period, the new measured temperature trend confirmed model hypothesis and a better representation of real thermal impact has been obtained.

References

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