Model of Sub-Surface Heat Rejection in Alternative Cooling Systems

E. Holzbecher [1], T. Manchester[2]

[1]German University of Technology in Oman (GUtech), Halban, Oman
[2]Univ. Utrecht, Utrecht, Netherlands

Abstract

In regions with hot climate air condition (AC) systems are one of the biggest consumers of electrical power. Power mainly stems from fossil sources. In order to reach the goal of low-carbon consumption, as agreed upon in the Paris 2015 treaty, alternative cooling systems that do not rely on fossil energy, could thus deliver a major contribution. Absorption cooling systems utilize thermal energy to produce chill. Solar and thermal energy can be employed as low grade heat sources. No fluorocarbons (as in conventional refrigerants) are used in the process. Their coefficient of performance (COP) depends strongly on a chill source, for which the sub-surface is an option. In our contribution we explore sub-surface heat rejection as part of such absorbers.
The simulation is built up on the expertise of previous COMSOL Multiphysics® models [1,2]. In contrast to former approaches we here explore and demonstrate the coupling techniques between 1D, 2D, and 3D domains, offered by COMSOL. Linear and general extrusion, as well as linear projection operators, are utilized to couple 1D pipe/borehole domains with the 2D (cross-section) or 3D domain of the surrounding ground.
The presented research was performed at German Univ. of Technology in Oman (GUtech), in connection with the Technical University of Berlin (TUB), Geoforschungszentrum Potsdam (GFZ) and the Institute of Advanced Technology Integration (IATI) Muscat (Oman), and reflects parts of a thesis handed in at Utrecht University.

Reference

[1] P. Oberdorfer et al., Comparison of Borehole Heat Exchangers (BHEs): State of the Art vs. Novel Design Approaches, COMSOL Conf., Stuttgart, Proceedings, 2011

[2] P. Oberdorfer et al., Coupling Heat Transfer in Heat Pipe Arrays with Subsurface Porous Media Flow for Long Time Predictions of Solar Rechargeable Geothermal Systems, COMSOL Conf., Milan, Proceedings, 2012

Figures used in the abstract

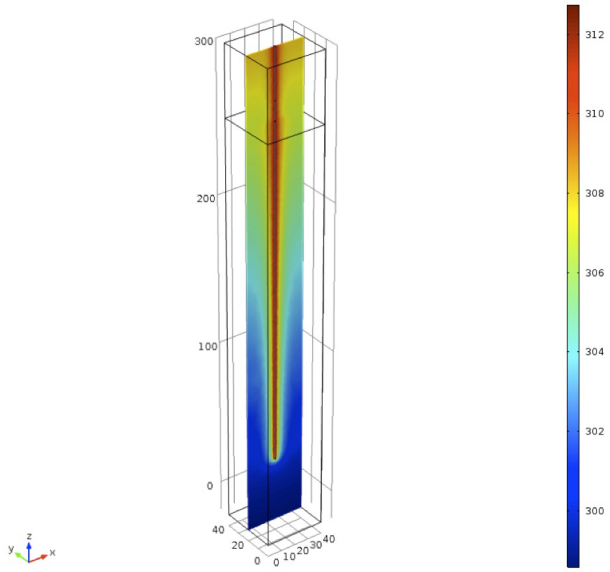

Figure 1: Simulated temperature [°K] around borehole in stagnant aquifer.

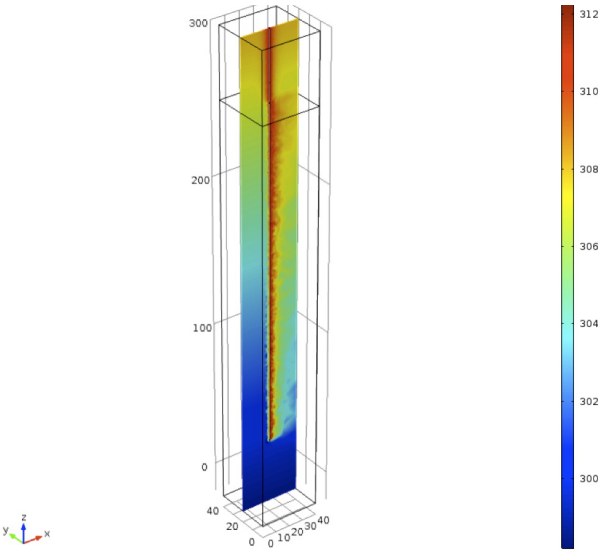

Figure 2: Simulated temperature [°K] around borehole in groundwater flow.