Interdependencies between physical, design and operational parameters in a two doublet configuration for direct use geothermal heat

Alexandros Daniilidis[a], Hamid Nick[b], David Bruhn[a,c]

a. Delft University of Techology, Stewinweg 1, Delft 2628CN, The Netherlands

b. Technical University of Denmark, 2800 Kgs. Lyngby, Denmark

c. GFZ German Research Centre for Geosciences, Telegrafenberg, Potsdam, Germany

a.daniilidis@tudelft.nl

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ABSTRACT

The increase of renewable energy supply is a main objective at several levels of governance. Geothermal energy has a substantial potential for supplying renewable heat for direct-uses. Nonetheless, high upfront costs and marginal profits can hamper the development of deep, direct-use geothermal energy projects (Daniilidis et al., 2017). Therefore, the necessity arises to improve energy extraction and economic output. Understanding the options for this improvement requires a systematic analysis of this complex system.

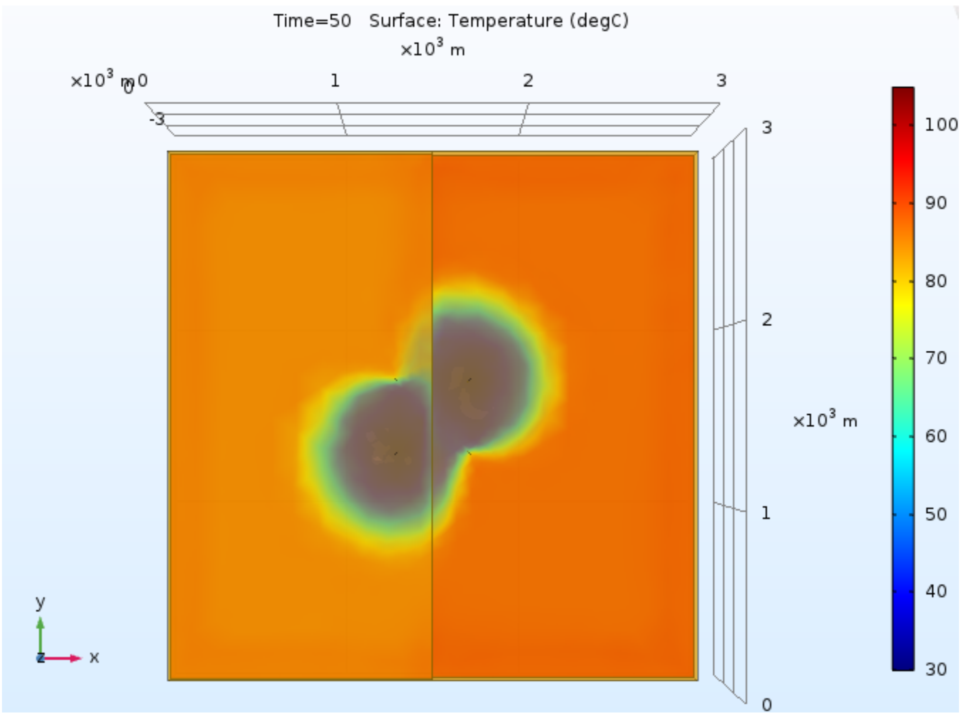

Figure 1. Top view of domain temperature after 50 years of production for one parameter combination

The interference between doublets was found to be beneficial when injector and producer wells of adjacent doublets are alternating and the Net Present Value (NPV) is improved when doublet spacing equals well spacing(Cees J.L. Willems et al., 2017). Moreover, reducing well spacing allows for more doublets to be installed within the same license area (C. J.L. Willems et al., 2017).

In this work we present a synthetic Hydraulic-Thermal (HT) model using the Finite Element Method (FEM). The model includes two doublets separated by a fault. The reservoir part has a thickness of 150m and comprises of three layers with equal thickness and different flow properties. Basement and overburden impermeable layers with a minimum thickness of 250m provide conductive recharge to the reservoir. A range of well spacing and placement, layered reservoir and fault flow properties, as well as fault throw parameters are considered in the analysis. The parameter space is selected to be representative of direct use geothermal systems in conduction dominated geological settings (Moeck, 2014). All parameter combinations are simulated for 50 years.

The cold front breakthrough is monitored separately for each doublet, while different thresholds for the cold front definition are also considered. Additionally the total produced energy and the NPV are evaluated for each doublet and the system overall. The insights from this analysis improve the understanding of interdependencies between physical and operational parameters with respect to produced energy and economic output. Results from the synthetic models can serve as guidelines to reducing the considered options in full scale field models.

REFERENCES

Daniilidis, A., Alpsoy, B., Herber, R., 2017. Impact of technical and economic uncertainties on the economic performance of a deep geothermal heat system. Renew. Energy 114, 805–816. https://doi.org/10.1016/j.renene.2017.07.090

Moeck, I.S., 2014. Catalog of geothermal play types based on geologic controls. Renew. Sustain. Energy Rev. 37, 867–882. https://doi.org/http://dx.doi.org/10.1016/j.rser.2014.05.032

Willems, C.J.L., Nick, H.M., Goense, T., Bruhn, D.F., 2017. The impact of reduction of doublet well spacing on the Net Present Value and the life time of fluvial Hot Sedimentary Aquifer doublets. Geothermics 68, 54–66. https://doi.org/10.1016/j.geothermics.2017.02.008

Willems, C.J.L., Nick, H.M., Weltje, G.J., Bruhn, D.F., 2017. An evaluation of interferences in heat production from low enthalpy geothermal doublets systems. Energy 135, 500–512. https://doi.org/10.1016/j.energy.2017.06.129