Assessment of Geothermal Well Productivity Improvement Technologies: an Overview from the DEEPEGs Project

Mariane PETER-BORIE1, Annick LOSCHETTER1, Julie MAURY1 & the DEEPEGs Team
1BRGM, Orléans, FRANCE

Introduction

In some contexts, it is not possible to extract the Earth’s thermal energy economically without implementing technological solutions (merged under the term “Enhanced/Engineered Geothermal System”, EGS) to increase the injectivity/productivity of the wells.

To demonstrate the EGS technology, two deep geothermal wells were drilled in Iceland and in France, in different geological contexts. A part of the scientific program of the H2020-DEEPEGs project is dedicated to the assessment of the EGS technology on these wells by numerical simulations and focused on:

- Hydraulic Stimulation
- Chemical Stimulation

The assessment of these technologies are reported in the deliverable 4.7 (Peter-Borie et al., 2020).

Chemical Stimulation

- Matrix acidizing, performed below fracturing rate and pressure. Acid flows through the matrix with reactions taking place in existing pores and natural fractures
- Fracture acidizing, performed above fracturing rate and pressure. Etching of the created fractures provides well stimulation, not just damage removal.

Hydraulic Stimulation

- Hydrofracturing: new tensile fractures are generated; propping is necessary to keep the new fractures opened
- Thermal stimulation: stress due to differential contractions/dilatations
- Thermal shearing: shearing of pre-existing fractures after widening/reopening by thermal contraction and fluid expansion

Numerical simulations of hydraulic stimulation:

Approach: Discrete Fracture Network (DFN)
Considered physic: Hydro-Mechanical (HM)
Software: 3DEC ©Itasca

Results: Irreversible aperture gain. Implementation of the new apertures in a Hydro-Thermal code to estimate the injectivity/productivity gain

Numerical simulations of Thermal fracturing:

Approach: Discrete Element Method (DEM)
Considered physic: Thermo-Mechanic (TM)
Software: PFC2D ©Itasca

Results: New discontinuities in the rock mass or in the sealing resulting in a whole permeability increase implementation of the new apertures in a hydro-thermal code to estimate the injectivity/productivity gain

Multilateral well configurations

One or more secondary wells issuing from a first well

Numerical simulations:

Approach: Discrete Fracture Network (DFN)

Considered physic: Thermo-Hydraulic (TH)
Software: ComPASS (CHARMS research project ANR-16-CE06-0009)

Process:

- Numerical model of the reservoir (DFN + porous media) & well trajectory
- Simulation of the injection/test production tests

Results: Injection/Produtivity index, cooled area by injection, overpressure in the reservoir

Conclusion

Numerous EGS technologies are available: multilaterals wells, hydraulic, thermal and/or chemical stimulations. All of these can be combined to reach the targeted production rate.

In the DEEPEGs project, these technologies were assessed and tested on two demonstrators, in different geological contexts in Iceland and in France. The technology and the induced process of the injectivity/productivity increase depends on the context: in the super-hot Icelandic context thermal stimulation appears to be relevant, whereas in the French faulted-reservoir, multilateral well configuration is a promising technology to increase the injectivity index. In both cases, an upstream assessment of the potential of each technology would lead to design the well to optimize their efficiency. The assessment of these technologies are reported in the deliverable 4.7 (Peter-Borie et al., 2020).

References

Peter-Borie M. et al. (2020) Deliverable 4.7, DEEPEGs project - Synthetic report with feedbacks of implemented method on site: Reykjanes and Vendenheim EGS demonstrators