The Danish Hydrocarbon
Research and Technology Centre

Title: A Coupled THM Simulation for Hydraulically Fractured Geothermal Reservoirs

Author: Hedda S. Vik

Type: MSc Thesis

Institute: DTU Chemical Engineering

Abstract

Geothermal energy is one of the most promising renewable energy resources in the world. Geothermal energy has the potential to provide 3% of electricity and 5% of heating with respect to the global demand by 2050 (Pandey et al., 2014). Low reservoir permeability in many deep geothermal systems is a common challenge for heat exploitation. In Enhanced Geothermal System (EGS), hydraulic fracturing is used to increase the permeability within the geothermal reservoir by creating conductive flow pathways.

This work investigates, through numerical modelling, the heat production from a multiple parallel horizontal fractures EGS. A fully coupled thermo-hydro-mechanical (THM) finite element model (FEM) is used to reconstruct the behaviour of the EGS. The model accounts for heat transfer in fractures and the rock matrix, mechanical deformation of the matrix, and fluid flow within the fractures and rock matrix. The effects of fracture spacing, reservoir temperature gradient and mechanical properties of the rock matrix on the net energy production are investigated. The present model results show that the matrix deformation significantly increases the interactions between the two neighbouring fractures. For a system of two parallel disk-shaped fractures with a diameter of 1000 m, the mechanical interactions can be considerable when the fracture spacing reduces to 750 m and below. The optimal spacing, corresponding to the maximum heat production, varies between 150 m and 300 m, depending on the mechanical properties of the matrix. For the case of rigid medium, it has already been shown that the thermal interactions disappear when the spacing between two neighbouring fractures increases to 80 m and above (Wu et al., 2016). Therefore, the mechanical interactions are far more important than the thermal interactions between two fractures.

The results of this study can be used to minimise negative interference of fractures aiming at improving energy production efficiency.