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Predicting the life-cycle performance of an EGS by numerical simulation

G. Blöcher, G. Zimmermann, I. Moeck, W. Brandt, and E. Huenges

Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences, Telegrafenberg, D-14473 Potsdam, phone: +49 331 288 1414, eMail: bloech@gfz-potsdam.de

Enhanced geothermal systems (EGS) are engineered reservoirs that have been created to extract economical amounts of heat from low permeability and/or porosity geothermal resources. Reservoir engineering requires a comprehensive data base of reservoir parameters to perform reservoir simulations and it implies reservoir characterisation, production enhancement through stimulation techniques and assurance of the resource-sustainability.
This study addresses the hydro-thermal (HT) conditions of the geothermal research doublet E GrSk03/90 and Gt GrSk04/05 at the drill site Gross Schoenebeck (north of Berlin, Germany). The first well Gross Schoenebeck E GrSk3/90 was tested to investigate scenarios of enhancing productivity of thermal fluid recovery from the underground. In order to complete the doublet system a second well Gt GrSk4/05 with a true vertical depth of -4198 m has been finished in 2007, followed by three stimulation treatments to enhance productivity. In order to increase the apparent thickness of the reservoir horizon, the new well is inclined in the reservoir section by 48° and was drilled in the direction of the minimum horizontal stress (Sh=288° azimuth) for optimum hydraulic fracture alignment in relation to the stimulated pre-existing well EGrSk3/90. Hence the orientation of the fractures will be 18° azimuth in the direction of the maximum horizontal stress. The reservoir is located at 4100-4300 m depth within the Lower Permian of the North East German Basin. According to the continental geothermal gradient, the reservoir temperature increases from 138°C to 147°C from top to bottom. In order to get evidence of the hydraulic-thermal (HT) behaviour of the geothermal reservoir during the time of geothermal power production a 3D model was developed. This model includes coupling of various petrophysical parameters: specifically, temperature dependent heat conductivity and heat capacity are considered. The porosity and hydraulic conductivity of the rock matrix and fractures were determined by laboratory and field experiments. We present the predicted temperature change during 30 years life-cycle due to continuous injection of 70°C cold water /after serving as the heat source for a ORC power cycle) with a flow rate of 75m^3/h.