Numerical Simulation of Temperature and Stress Fields in the Rock Heating Experiment

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Abstract

The presented work is motivated by realization phase of rock heating experiment in underground, testing the rock properties for geothermal application, energy storage, or spent nuclear fuel disposal. The experiment is of meter scale, with heater installed in large bore hole from end of a tunnel, with months to years duration. The geometry of the model was imported from the scanning of the real tunnel. The heater is fixed to the rock face with the geopolymer and the rest of the bore hole is filled by the isolation material. The dimensions of the used heater, its fixing and isolation are fully parametrized. The modeled process is the unsteady heat conduction in 3D, then the results are used as the input for thermal expansion. In COMSOL, we used the Heat Transfer Module (particularly, heat transfer in solids with convective cooling inside the tunnel) and the Structural Mechanics Module, both with parametrized material properties. The objective of the work was to predict the temperature distribution and induced mechanical stresses in the area close to the heater, where several testing boreholes with mechanical and temperature sensors will be located. We made several parametric studies with various types of heater fixing, various heat parameter of used geopolymer and isolation. The largest mechanical loading emerges on heater-geopolymer-rock interfaces, but the general shape of the temperature and stress field outside the borehole are mostly influenced by the properties of the rock.