Using COMSOL To Create A Closed Loop Geothermal System

Jessica S. Rosenberg[1], Josh Thomas[1], Sergei Yushanov[1], Kyle Koppenhoefer[1]

[1]AltaSim Technologies, Worthington, OH, United States

Abstract

Closed loop geothermal systems (CLGS) are continuous energy systems that rely on the earth's constant temperature deep beneath the surface. Pipes, filled with liquid, are drilled down deep into the earth and heated by hot rocks as they run horizontally underground. The heat from the pipes, converts some of the liquid into steam, and the pipe filled with this mixture rises back to ground level and can be used as an energy source, after which the fluid is cooled, and the process is repeated. CLGS require maintenance only every 25-30 years, but drawbacks such as limited resources have created a need to further study under what conditions CLGS can be maintained in. COMSOL's Nonisothermal Pipe Flow interface is well positioned to answer such questions, where a 3D model of a pipe can be represented as simple edges leading to faster meshing and run times. In this case, we used analytical functions to create the apparent heat capacity with latent heat of a water, steam mixture, and interpolation functions to ramp up and down the wall thickness and thermal conductivity respectfully on the pipe section leading from the underground part to the surface. We also created a 3D section of a short part of the pipe to model the phase transition in detail. The simulations' results led to a better understanding of different pipe conditions needed, and in particular how much insulation would be necessary to create steam at the outlet.