AN ALTERNATIVE AND MODULAR APPROACH TO ENHANCED GEOTHERMAL SYSTEMS

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ABSTRACT

This paper describes a low-risk, low-cost and modular alternative to the conventional Hot Dry Rock or Enhanced Geothermal Systems (EGS). In this approach, which we have named the Earth Energy Extraction System ("Triple-E" System), the injected fluid is allowed to get preheated in the injection wellbore before reaching the reservoir; this preheating is achieved through injection in ultra-slim diameter wells (2.5 to 7.5cm) and by keeping the rate of injection very low (on the order of 10 liters per second). The injected fluid then heats up further as it travels to the production well through pores and fractures in the rock. The injection wells are terminated close to and at a shallower level than the top of the productive interval in the production well. This approach avoids the two main technical limitations associated with conventional EGS: (a) creating a significant reservoir volume by artificial fracturing; and (b) fluid loss control. This approach reduces dependence on the occurrence of natural permeability that limits the scope of conventional geothermal technology. The risk of cooling of the production well by short-circuiting of injected water, a common concern in both EGS and conventional geothermal projects, is significantly reduced by preheating of the injected water. A single Triple-E module consists of a central production well with an adequate casing diameter to accommodate a submersible pump, and surrounded by several ultra-slim injection holes of a special low-cost design; the injection holes are sited a few hundred meters from the production well and are deviated towards it. A large project would consist of multiple adjacent modules. The permeability around the bottom of the production well should improve with time due to spontaneous fracturing or fracture extension associated with thermal contraction of rock. If needed, one of several commercially available techniques can be used to stimulate the permeability of the rock in the immediate vicinity of the well bottom. Unlike a conventional EGS, the main purpose of stimulation here is to make the production well flow at a commercial rate rather than creating and sustaining an artificially fractured reservoir of substantial extent. The injection holes reach this permeable zone around the bottom of the production well and are completed a few tens of meters to a few hundred meters above the bottom of the production well to minimize any fluid loss below the production zone by gravity drainage. The pressure sink around the production well will actually create the potential for fluid gain into the system. The technical feasibility of the concept has been confirmed by analysis of heat transfer between the injection holes and the surrounding rock, and heat transfer in the reservoir between the rock and the injected fluid in pores and fractures. Optimization of the process through modeling is in progress, and will be reported in due course.
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