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Use of Controlled Fractures in Enhanced Geothermal Systems

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Enhanced geothermal systems (EGS) are typically tight and naturally fractured like unconventional oil and gas (UOG) reservoirs, so the leading technology being evaluated for their commercial development is also multistage fractured horizontal wells (MFHW). The state-of-the-art approach of thermal recovery from EGS involves injecting cold water into a multiply fractured horizontal/deviated well and producing hot water from a parallel well above the injector, as in the ongoing Utah FORGE project. Considering the negligible control on hydraulic fracture size and orientation, the actual injection and production wells may not intersect planar and bi-wing hydraulic fractures in the ideal and optimum configurations they are simulated. This, coupled with the well-known risk of short-circuiting certain parts of the fracture network, could result in lower heat recovery from the field compared to the simulated MFHW recoveries. To address this problem, we present an alternative technology that employs unique configurations of mechanically cut fractures to recover heat efficiently from all parts of hot rocks in the subsurface. The precise control over these fractures'location, size, orientation, and conductivity facilitates the design of suitable configurations of intersecting fractures.

This paper presents high-resolution numerical studies of thermal recovery from both MFHW and the proposed approach. We simulated several cases with and without stochastic natural fractures to evaluate the performance of these technologies in such systems. To facilitate a reasonable comparison between the MFHW and the proposed technology, we ensure that the total fracture surface area is the same. The results from the natural stochastic fracture systems studied indicates that the contribution of natural fractures to heat recovery is minimal in the proposed approach. This is due to the flexibility in designing the mechanically cut fractures to avoid being short-circuited by large natural fractures or faults known to be present in the subsurface. We simulated several cases, including one based on the published model parameters of the Utah FORGE project. All these simulation results show that the proposed approach can recover 50% to 140% more thermal energy than the state-of-the-art approach based on MFHW.

The temperature profiles after simulating 50 years of thermal recovery show that the precise control over the location of the fractures allows the reliable and efficient recovery of heat from all parts of the EGS, which could be the key to their commercial development. Finally, the control over the location, size, orientation, and aperture of the mechanically cut fractures provides more reliability in comparing the system modeled to the actual EGS in the subsurface. In contrast, the actual MFHW system could be much less efficient than the simulated system because of the lack of control over the hydraulic fractures' size, orientation, and geometry. There is also no guarantee that the injection and production wells will intersect all the hydraulic fractures.

Participation

In-Person

References

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