A Parametric Study of CO_2 Plume Geothermal System in Deep Saline Aquifers

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Abstract

Carbon dioxide (CO_2) geological storage in various underground formations in order to reduce greenhouse gas commissions into the atmosphere and achieve net-zero carbon emission policies has received increasing attention. The single-purpose CO_2 geological storage, however, is quite expensive in large-scale engineering applications. Extracting CO_2 plume geothermal (CPG) energy in deep saline aquifers with utilizing CO_2 as a heat transmission working fluid while permanent storing CO_2 there to enhance its economics could be a good practical solution. Some parameters of the CO_2 plume geothermal system have significant impacts on the complex process of extracting energy. This paper focuses on analyzing effects of some key reservoir and operational parameters on geothermal energy extraction performance. In this parametric numerical simulation study, considering the influence of the coupled model of wellbore flow and reservoir flow in the CO_2 plume geothermal system in a deep saline aquifer with CO_2 as the working fluid, a series simulations are performed on a synthetic deep saline formation with a horizontal CO_2 injection well and a horizontal production well to extract heat. The analysis parameters include formation parameters, such as, formation property heterogeneity, permeability anisotropy, initial formation temperature and geothermal gradient, and the operational parameters, such as, well spacing, horizontal section lengths of injection and production wells, vertical positions of those two wells in the formation , injection and production rates, etc. Based on the simulation results, the sensitivity study is further conducted. The study results show that the permeability of the aquifer has a significant impact on the heat extraction rate and the operating time of the production system. The heterogeneity of the aquifer could greatly advance the initial CO_2 production time, resulting in a premature and rapid drop in the temperature of the produced fluid. The well spacing is another important factor affecting the heat extraction rate. The larger well spacing increases the maximum amount of geothermal resource and the heat exchange time between the heat transfer fluid and the reservoir, weakening the influence of heat loss on the heat extraction rate. The other analysis parameters have different extent impacts on the heat extraction rate. All results and conclusions can be used for selecting aquifer location of CO_2 plume geothermal system and optimizing operational parameters. It is the first time that the sensitivity evaluation of reservoir and operational parameters to the CO_2 plume geothermal system with horizontal injection and production wells in a deep saline aquifer is carried out. All results and conclusions can be used for selecting aquifer location of CO_2 plume geothermal system and optimizing operational parameters.