

論文要旨

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論文題名	STUDY ON PERFORMANCES OF GEOTHERMAL WELL IN THE WATER-DOMINATED AND STEAM-WATER TWO-PHASE RESERVOIRS 熱水型および蒸気・水二相型貯留層の地熱坑井の挙動に関する研究		

論文内容の要旨

The increase in electricity demand is one of the major energy problems in the developing countries where fuel resources are not produced. This leads to an effort of searching and developing various alternative energies including geothermal energy that is clean, renewable and still abundant in resources. In the course of geothermal reservoir development, qualitative evaluation of well productivity as well as reservoir productivity is one of the most important information for designing appropriate and proper development scenarios of the field. For this purpose, a method should be developed for reliable evaluation of well performances that include well characteristics representing relation between steam water flow rate and pressure at the wellhead. Well performances are affected by reservoir and wellbore conditions, thus the effects of these conditions must be systematically evaluated. This study includes numerical and field studies for qualitative evaluation of performances of geothermal well in the water-dominated and steam-water two-phase reservoirs. The objectives are to develop a wellbore model coupled with a radial reservoir flow and to make reliable and practical prediction of well performances under various reservoir and wellbore conditions that can be encountered during the development of geothermal reservoir.

This dissertation consists of six chapters. **Chapter 1** describes background of study, literature review, and objectives of study.

Chapter 2 discusses the numerical analysis of well characteristics under steady state. A coupled wellbore simulator with a reservoir flow was developed and used to evaluate the effects of specified wellbore and reservoir conditions. For the steam-water two-phase conditions in the reservoir, total flowrate at the wellhead shows gradual decrease with an increase of wellhead pressure whereas the flowrate decrease quickly with an increase in wellhead pressure for the wellbore in the water dominated reservoir. Initial water saturation that qualitatively characterize two-phase reservoir was examined in the range from 0.1 to 0.8 and resulted slight differences in steam flowrate in relatively low wellhead pressure range.

Chapter 3 deals with the numerical simulation of well performances for the fluid containing CO₂ and the presence of calcite scale formed on wellbore surface. Effects of CO₂ concentration in the deep water on the well performances were examined for 0.5 and 1.0 wt% of

CO₂ with reference to no CO₂ in the water of same temperature. The presence of CO₂ in the liquid geothermal water increases the saturation pressure compared to the pure water, and then resulted in the movement of flashing depth downward by 300 m for 1wt % of CO₂ compared with that of pure water. Assuming a homogeneous deposit of scale along the wellbore above flashing depth, deposited length and diameter was estimated by fitting the measured flow rate and wellhead pressure from the literature.

Chapter 4 covers the continuous measurement of steam and water flow rates at a production well of the Hatchobaru geothermal field with a newly developed measurement system to evaluate and understand the unsteady state behaviors of well characteristics. The duration of wellhead valve operation for controlling flowrate affected the flow stabilization in wellbore. Quick valve operation causes longer period of stabilization and produces impulse response of flowrate soon after the valve operation stopped. The fluid flow required about 7 min to stabilize for closing valve operation, while it needed longer than 20 min to reach the stable condition for opening valve operation.

Chapter 5 contains the numerical study on unsteady state behaviors of well performances. This chapter emphasizes the changes of the well characteristics with time caused by controlling mass flow rate at wellhead. For a given wellbore and reservoir condition, the step change in flow rate produces a sharp decrease in wellhead pressure. While linear changes in flow rate show gradual decreases. The time required for the wellhead pressure to stabilize is faster for linear change rather than step change in the flow rate.

Finally, **Chapter 6** gives summary and future works.