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RESOURCE DEVELOPMENT

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The resource assessment techniques utilized in geothermal reservoir engineering are a combination derived from the disciplines of groundwater hydrology and petroleum engineering. As the geothermal industry has developed, these techniques have been modified to take into account phenomena normally ignored in aquifer management and oilfield practice. Details of multiphase flow and heat transfer need to be incorporated into the geothermal reservoir engineer's repertoire. The purpose of this presentation is to (1) comment on how several established groundwater and petroleum reservoir engineering techniques (reservoir modeling and wellbore flow simulation) are currently utilized in the geothermal industry to speed the development of large and small prospects, and (2) suggest areas where future government-funded research might be directed in order to assist the geothermal industry in the development of geothermal resources.

Mathematical models of wellbore flow have been used to extend our understanding and make predictions on well productivity, heat loss, and the relationship of temperature to pressure in a flowing and flashing well. Examples of satisfactory fits of theory to experiment in a well with very high salinity (200,000 ppm TDS) and high concentration of CO_2 will be presented. Suggestions for improvements to currently available wellbore flow models will be made.

Sophisticated numerical simulators have been used to predict reservoir performance and compare resource output as a function of well placement and development scenarios. Unfortunately, such studies have not increased the utilities or investors confidence in a reservoir's ability to deliver its estimated reserves. This has resulted in a reassessment of field development plan and a subsequent emphasis on stepwise, modular development rather than a large scale, all-at-once exploitation of a geothermal resource. As an example, various development scenarios of the East Mesa field will be presented along with advantages and disadvantages of each approach. Recommendations for future studies of resource development will also be given.

In comparison to the development of a large geothermal resource such as East Mesa, the smaller, low temperature geothermal resources capable of only direct heat utilization rather than electric power generation present an interesting challenge. The reason for the interest is that the nature of the flow of the hot water is incompletely understood and must be inferred from a combination of subsurface geology and well test data. This, in turn, leads to questions of delicately balancing resource recharge with production and reinjection. An example of a small resource, along with the reservoir parameters needed for well-test design and resource assessment, will be given. Recommendations for future studies regarding the exploitation of small geothermal resources will also be presented.

Concluding remarks will deal with the present versus future role of the geothermal reservoir engineer in evaluating and predicting reservoir performance. Emphasis will be on recommendations that can put the credibility of the geothermal reservoir engineer on a level equal to that given to reservoir engineers in the petroleum industry. The useful role that government funding can play is raising the credibility of the geothermal reservoir engineer. The point will be raised that funding efforts need to be increased in the areas of field studies and case histories, development of high temperature well logging instrumentation, and evaluation of materials capable of withstanding geothermal conditions.

* This is only a summary of the actual presentation.