Numerical Reservoir-Wellbore-Pipeline Simulation Model of The Geysers Geothermal Field, California, USA

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Abstract
The Geysers geothermal field, located in Lake, Sonoma, and Mendocino Counties, California is the largest developed geothermal system in the world. Electric power generation started at The Geysers in 1960 with a 12 MW (gross) plant. The total installed capacity in the field peaked in 1989 at 2,043 MW. As more and more power plants were built during the 1980s and net mass withdrawals increased, reservoir pressures at The Geysers declined, eventually resulting in steam shortfalls and declining generation levels. This net withdraw is due to the fact that geothermal power plants at The Geysers typically lose about 70 to 80% of produced mass to evaporation in cooling towers, with the balance of mass being returned to the reservoir through injection of steam condensate.

In response to this decline, field operators made modifications to the pipelines and turbines to be able to operate more efficiently at lower system pressures. Based on studies funded by the California Energy Commission that showed that injection of water from outside sources was the most effective method of managing the long-term decline in the resource, a program of augmented injection, using large volumes of treated sewage effluent, was started in the late 1990s.

This program of augmented injection has brought mass injected, more or less, into parity with mass produced, and the rate of reservoir pressure decline has been significantly reduced. Still, optimizing the distribution of augmented injection throughout the field and making corresponding adjustments to plant and pipeline facilities is a complicated process, with many interdependencies.

To aid in ongoing optimization of the field, an integrated model has been developed for the Northern California Power Agency (NCPA) that combines reservoir simulation with mathematical modeling of the wellbores, the pipelines, and the power plants. This integrated model, funded in part by the California Energy Commission, has proven very useful for evaluating the most cost-effective improvements to the combination of wells and surface facilities, and to study the benefit of increasing the volume of augmented injection.

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