Numerical Modeling of the High-Temperature Geothermal System of Amatitlan, Guatemala

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ABSTRACT

Using the conceptual model (Lima et al., 1996) of the Amatitlan geothermal system as a guide, a 14 by 10 km numerical model was set up with five layers and a total of 1,220 grid blocks. The number of grid blocks varies from layer to layer, with finer resolution in the two production layers. Boundary blocks for conductive heat transfer, heat and mass recharge, shallow discharge, and deep regional fluid flow were added to the model as appropriate. With an inflow of hot fluid (336°C) at a rate of 450 tones per hour, an inflow of cool fluid (50°C) at a rate of 620 tons per hour and permeabilities varying from 1.5 to 50 md, the initial state temperatures on all five levels were well matched by the numerical model. The initial state results indicate that highest permeability is present to the southeast of the productive wells, suggesting that considerable additional production potential exists in this area. A two-phase region exists in the upper levels of the reservoir and in the outflow plume; the latter is consistent with the presence of fumaroles along the shoreline of Lago de Amatitlan.

To further calibrate the numerical model, enthalpy and pressure data collected during tests of wells AMF-1 and -2 were matched, primarily by varying reservoir storage capacity. Good matches to the observed data were obtained for both wells, although sharp transients could not be matched. Modeling proceeded to the prediction stage under two scenarios: production of 12 and 25 MW (gross) for 30 years. 100% injection of separated water and condensate was assumed to take place in the vicinity of well AMF-3 in both cases. The results show an increase in enthalpy caused by expansion of the two-phase zone during the first year of production, followed by an enthalpy decline as reservoir liquid begins to migrate toward the production area. The two existing production wells (AMF-1 and -2) are predicted to be capable of maintaining output in the 12 MW case throughout the 30-year project life. Three additional wells, located southeast of the existing wells were added for the 25 MW case. Assuming that these three wells are productive, the five wells are predicted to be capable of maintaining output during the project life. Predictions of future enthalpy trends must be viewed with caution as they depend strongly on the actual extent of the natural two-phase zone, which is unknown at present.

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