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MODELING THE PAUZHETSKY GEOTHERMAL FIELD, KAMCHATKA, RUSSIA

The Pauzhetsky geothermal field has been developed since 1966, when a 5 MWe power plant was put into operation. The first reservoir engineering study of this field conducted by V.M. Sugrobov (1965) revealed a liquid dominated reservoir with layer type tuffs formed at 170-190^{o}C, with hot springs discharges at 31 kg/s. The lumped parameter model by V.M. Sugrobov (1976) yielded 460 kg/s lateral high temperature outflow from the Kambalny ridge into the geothermal reservoir. Nevertheless, the initial 10 years of the exploitation at 160-190 kg/s shows gradual temperature decline and chloride dilutions of the production wells located near the natural discharge area, so new exploration wells were drilled, and exploitation gradually shifted away from the natural discharge area until 200-220^{o}C were reached. Wells were drilled into central upflow zone located 1.5-2.0 km southeast from the old production field (V.A. Yampolsky, 1976). The drop in temperatures and enthalpies continued, while total flow rate reached 220-260 kg/s between 1975 and 2005. The forward TOUGH2 modeling study of the field conducted by A.V. Kiryukhin and V.A. Yampolsky (2004) yielded the following estimates of principal parameters: (1) An upflow rate of 220 kg/s with an enthalpy of 830-920 kJ/kg, (2) a permeability-thickness of 70 D*m in the central part of the field, and a compressibility of 5.0 10^{-7} Pa^{-1}, (3) a fracture spacing of 162 m and fracture/matrix ratio of 0.1 for the dual-porosity model, and (4) the existence of constant pressure boundaries.

The sustainable capacity of the Pauzhetsky field became a critical question for power plant reconstruction, new binary technology implementation and possible extraction of Li, Rb, Cs and B from geothermal fluids, hence a more detailed calibration study of the reservoir parameters was performed. In this study, iTOUGH2 was used for parameter estimation. The current numerical model (mesh has 424 elements (294 active)) represents a 3-layer system (caprock, reservoir of 500-m thickness, base rock) with an interior upflow zone and external constant pressure recharge-discharge boundaries.

For the iTOUGH2 natural state modeling, calibration data include 70 points (2 natural discharge rates, 16 reservoir pressures at -250 m.a.s.l., 52 reservoir vertically averaged temperatures). The different quality of the calibration points was expressed by specifying appropriate standard deviations. Preliminary estimates of the principal parameters are: (1) permeability-thickness of 41 D*m in the central part of the field, and (2) an upflow rate of 41 kg/s with an enthalpy of 950-1050 kJ/kg.

Modeling of the exploitation phase using iTOUGH2 is still on-going. The principal parameters to be estimated include: (1) the field permeability-thickness in the central part of the field, (2) reservoir compressibility, and (3) reservoir fracture spacing. Model calibration will be followed by an analysis of the sustainable capacity of the Pauzhetsky field and update of the thermal-hydrodynamic-chemical (TOUGHREACT based) model of reservoir (Kiryukhin et al, 2004)..