

OPTIMIZATION OF POWER GENERATION FROM MODERATE TEMPERATURE GEOTHERMAL SYSTEMS - A CASE HISTORY

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ABSTRACT

Advances in binary-cycle power and submersible pump technologies over the past two decades have made electric power generation from geothermal fields in the moderate temperature range (100° to 180°C) convincingly commercial. For geothermal water in this temperature range, binary-cycle is more efficient for power conversion than flash-cycle and pumping of wells is more efficient than self flowing. The lower temperature limit of 100°C is imposed by the limits of binary-cycle technology and the upper limit of 180°C is imposed by the limits of pump technology commercially available today. This paper is a case study of optimization of net power generation from such a field at Raft River, in the State of Idaho, United States. The optimization of net generation must consider the following intertwined issues: (a) individual well productivity characteristics as controlled by near-wellbore reservoir properties, (b) maximum pumping rate possible from a well given the present state of submersible pump technology, (c) well productivity decline with time due to a combination of reservoir pressure decline and interference between wells, (d) maximum gross power available per unit water production rate given the present state of binary cycle technology, and (e) parasitic power needed for both production and injection pumps. The well productivity issue is represented by the well's productivity index as estimated from reservoir transmissivity and wellbore flow efficiency (skin factor). The change in the well's productivity index with time is computed from the solution of the partial differential equation describing transient pressure behavior in a porous medium. The effect of well interference on productivity index is taken into account by superposition of the solution in space. The well pumping issue is taken into account by estimating the pumping rate for the maximum available drawdown, which is a function of the pump characteristics and setting depth, reservoir temperature and pressure, production depth, gas content in the water, and the frictional pressure loss in the well. The parasitic power required for pumping is subtracted from the gross power available from the produced fluid to arrive at the maximum net wellhead power available from a well within realistic limits of pump-setting depth (914m) and pumping rate (220 liters per second). The proposed approach is applied to planning for development at Raft River, where 5 existing wells are planned to be worked-over for production. The maximum net wellhead power capacity available from 3 of the existing wells is shown to be 10 MW (net). For a 17 MW (net) development scenario using 5 production wells, the alternatives of maintaining power capacity by (a) make-up well drilling, (b) deepening of pump setting with time, and (c) combination of both, are examined.

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