Renewable Energy-Water Nexus: Optimal Design of an Integrated System including a Single Flash Geothermal Plant, Kalina Cycle and Reverse Osmosis Desalination Unit

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Abstract

This paper addresses the optimization of a dual-purpose desalination system based on a geothermal flash cycle, Kalina cycle, and a reverse osmosis seawater desalination plant. A nonlinear mathematical programming (NLP) optimization is developed and implemented in GAMS – general algebraic modeling system – which is a high-level modeling environment widely used in Process System Engineering PSE. CONOPT, which is a derivate-based optimization algorithm, is used as an NLP solver. Also, dynamic-link libraries (DLLs) are developed and implemented in the programming code C with the aim of rigorously calculating the thermodynamic properties of all process streams. The DLLs are systematically called from the GAMS environment. In addition, a solution strategy has been developed to facilitate model convergence. In this approach, several models are sequentially solved, starting with the simplest model progressing to solving a more complex model. As a result, the optimal sizing and operating conditions of all process units are simultaneously obtained. Finally, a sensitivity analysis of the key model parameters, electrical power, and freshwater demands on the optimization criterion is discussed. The proposed mathematical model is a powerful decision-making tool for the design and synthesis of integrated geothermal power and desalination processes, which can be used as either a simulator or an optimizer, depending on the number of freedom degrees specified by the user.

Key words: geothermal energy; combined cycle power plant; desalination system; optimization