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Second law evaluation and environmental analysis of biomass-fired power plant hybridized with geothermal energy

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Abstract

Two novel configurations for hybridization of geothermal and biomass energies are proposed and analyzed in this paper. In the first system (named Configuration 1) geothermal heat is employed for feed water heating, while in second one (named Configuration 2) the geothermal energy is employed for steam generation to be entered into the low pressure steam turbine stage. The method of hybridization of geothermal and biomass resources in this paper is quite different than the schemes proposed in previous researches. Another unique feature of the proposed hybrid configurations is the ability of utilizing geothermal resources with various temperature level. In order to assess the feasibility of proposed systems and to compare their performance, detailed simulation models are made based on the first and second laws. Also, the systems' performances are evaluated from the environmental perspective using three exergo-environmental factors. In addition, the optimal operating conditions of the systems are determined with respect to the maximum exergy efficiency. For a wide range of practical operating conditions it is found that, the proposed Configuration 2 outperforms the Configuration 1 due to the direct steam injection into the law-pressure turbine in the former. Under the optimal operation, it yields 8.65 % higher exergy efficiency as well as 12.5% lower environmental damage effectiveness compared to Configuration 1. Also it is concluded that, the gasification and combustion processes own more than 55% of overall exergy destruction in both systems.