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An Integrated Power Generation System Design Developed between Solar Energy-Assisted Dual Absorption Cycles

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Abstract : Solar energy, with its abundant and clean features, is one of the prominent renewable energy sources in multigeneration energy systems where various outputs, especially power generation, are produced together. In the literature, concentrated solar energy systems, which are an expensive technology, are mostly used in solar power plants where medium-high capacity production outputs are achieved. In addition, although different methods have been developed and proposed for solar energy-supported integrated power generation systems by different investigators, absorption technology, which is one of the key points of the present study, has been used extensively in cooling systems in these studies. Unlike these common uses mentioned in the literature, this study designs a system in which a flat plate solar collector (FPSC), Rankine cycle, absorption heat transformer (AHT), and cooling systems (ACS) are integrated. The system proposed within the scope of this study aims to produce medium-high-capacity electricity, heating, and cooling outputs using a technique different from the literature, with lower production costs than existing systems. With the proposed integrated system design, the average production costs based on electricity, heating, and cooling load production for similar scale systems are 5-10% of the average production costs of 0.685 USD/kWh, 0.247 USD/kWh, and 0.342 USD/kWh. In the proposed integrated system design, this will be achieved by increasing the outlet temperature of the AHT and FPSC system first, expanding the high-temperature steam coming out of the absorber of the AHT system in the turbine up to the condenser temperature of the ACS system, and next directly integrating it into the evaporator of this system and then completing the AHT cycle. Through this proposed system, heating and cooling will be carried out by completing the AHT and ACS cycles, respectively, while power generation will be provided because of the expansion of the turbine. Using only a single generator in the production of these three outputs together, the costs of additional boilers and the need for a heat source are also saved. In order to demonstrate that the system proposed in this study offers a more optimum solution, the techno-economic parameters obtained based on energy, exergy, economic, and environmental analysis were compared with the parameters of similar scale systems in the literature. The design parameters of the proposed system were determined through a parametric optimization study to exceed the maximum efficiency and effectiveness and reduce the production cost rate values of the compared systems.

Keywords : solar energy, absorption technology, Rankine cycle, multigeneration energy system
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