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Multi-Objective Optimization of a Solar-Powered Triple-Effect Absorption Chiller for Air-Conditioning Applications

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Abstract : In this paper, a detailed simulation model of a solar-powered triple-effect LiBr–H₂O absorption chiller is developed to supply both cooling and heating demand of a large-scale building, aiming to reduce the fossil fuel consumption and greenhouse gas emissions in building sector. TRNSYS 17 is used to simulate the performance of the system over a typical year. A combined energetic-economic-environmental analysis is conducted to determine the system annual primary energy consumption and the total cost, which are considered as two conflicting objectives. A multi-objective optimization of the system is performed using a genetic algorithm to minimize these objectives simultaneously. The optimization results show that the final optimal design of the proposed plant has a solar fraction of 72% and leads to an annual primary energy saving of 0.69 GWh and annual CO₂ emissions reduction of ~166 tonnes, as compared to a conventional HVAC system. The economics of this design, however, is not appealing without public funding, which is often the case for many renewable energy systems. The results show that a good funding policy is required in order for these technologies to achieve satisfactory payback periods within the lifetime of the plant.

Keywords : economic, environmental, multi-objective optimization, solar air-conditioning, triple-effect absorption chiller
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