البحث الأول

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Abstract

Molten salts are typically used as energy storage media in concentrating solar power systems for their lower costs and environmental impact. This study aims to map and optimize the performance of parabolic trough concentrators (PTCs) working with molten salt-based nanofluids (MSNFs) as heat transfer media at high temperatures. The thermal, hydraulic, energetic, and exergetic performances were analyzed and optimized using a unique framework of Monte Carlo optical simulations, computational fluid dynamics, data-drive support vector regression, particle swarm optimization, and decision-making techniques. Three molten salts (Solar Salt, Hitec, and Hitec XL) and three nanoparticle types (Al_2O_3, CuO, and SiO_2) were investigated in a broad range of volumetric concentrations (0.0–4.0%), operating Reynolds numbers (4×10^3 to 40×10^3), and temperatures (535–805 K). The results showed a maximum energy efficiency of 69.1%, achieved when using SiO_2-Hitec nanofluid (1.0%) at a Reynolds number of 40×10^4 and temperature of 535 K. The maximum achieved exergy efficiency was 70.48%, obtained using pure Hitec at a Reynolds number of 40×10^4 and temperature of 535 K. The maximum possible enhancements in energy and exergy efficiencies in the covered range are 17.0 and 42.0%, respectively. The optimal combination of energy and exergy efficiencies are ~73.1 and 69.0%, obtained using CuO-Hitec nanofluid at temperature, Reynolds number, and concentration of 535 K, 39912.98, and 0.019%, respectively. The optimum combination of percentage enhancements in energy and exergy efficiencies are 0.465 and 7.182%, respectively, which corresponds to CuO-Hitec nanofluid operating at 805 K, 32025.4, and 0.092%, respectively.