Comparative numerical study on the effect of fin orientation on the photovoltaic/thermal (PV/T) system performance

Abstract

The thermal performance of a photovoltaic (PV) system is highly influenced by cooling its surface temperature. In this study, a series of cooling modules are developed, including fin turbulators within a serpentine channel placed on the rear side of a photovoltaic/thermal (PV/T) system. These modules are designed to effectively cool the PV/T system, ensuring uniform temperature distribution and enhancing the system efficiency. The study examines fins at four different angles within the serpentine channel, namely 30°, 45°, 60°, and 90° The water was employed as a cooling fluid in the study, operated under laminar flow conditions, with five Reynolds number values, ranging from 250 to 1250 with 250 increment. Every PV/T system has 108 fins with an area of 600 mm2 for each. Numerical simulations were conducted to predict the flow fields resulting from each fin configuration in the serpentine channel. The electrical and thermal efficiency of the PV/T collector was evaluated for the fin configuration with better thermal performance. Results showed that fins oriented with 30° provided the best thermal performance, while fins at 90° orientation achieved maximum heat transfer coefficient. Moreover, the electrical efficiency of the proposed PV/T system could be improved by 0.8 % to 1.5 % compared to a standard PV/T system. In addition, the PV/T system demonstrated a remarkable thermal efficiency of up to 59 % at 90° fin orientation.

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