Thermal and Thermo-hydraulic Performance of Finned Double-Pass Solar Air Collector Utilizing Cylindrical Capsules Nano-Enhanced PCM

ABSTRACT

Double-pass solar air collector with a finned absorber and nano-enhanced PCM in the lower channel is one of the significant and attractive designs proposed to improve the performance. This research paper presents a novel mathematical model of steady-state equilibrium equations created and developed for two air streams: the glass cover, absorber plate, fins, nanoenhanced PCM capsules, and back plate. The influence of various operating parameters on thermal and thermo-hydraulic performance was presented and discussed. The simulations were conducted at air mass flow rates from 0.02 kg/s through 0.06 kg/s and solar irradiance levels ranging from 475 W/m2 to 1000 W/m2 . The proposed collector has an optimal energy efficiency of 80%, an exergy efficiency of 18.2% at solar irradiance of 1000 W/m2, and a mass flow rate of 0.06 kg/s. The minimum and maximum improvement potentials for solar irradiance levels of 475–1000 W/m2 at an ambient temperature of 298 K are 163– 237 W. The proposed collector's best findings in the current study are 1.0 m in length and a width of roughly 0.3 m for air mass flow rates of 0.02-0.06 kg/s.