Abstract:

Operating temperature of densely packed concentrator photovoltaic (CPV) system under high concentration of solar irradiance is vital as it affects the solar-to-electrical conversion efficiency. Excessive thermal energy generated during the operation may degrade or even damage the solar cells. Besides, non-uniform distribution of temperature across the solar cells causes “current matching” problem, where the cell operated at the highest temperature will limit the conversion efficiency of the whole string. In this study, three-dimensional computational fluid dynamics (CFD) simulations were employed to investigate the effect of different inlet and outlet arrangements, fin designs and flow parameters on cooling performance of cooling block in achieving lower and more uniform CPV temperature. The simulated result was validated with measured result, and a good agreement between both results was observed. From the simulation, it was found that under the same volumetric flow rate, different inlet/outlet arrangements could lead to a change in a maximum temperature difference of up to 4.4 K and a standard deviation...
difference of 0.74 K. This study also examined the effects of fin arrangement. It was determined that the number of splitting between fins could result in a CPV maximum temperature difference of 0.4 to 3 K depending on the inlet and outlet arrangement. In terms of fin geometry, fin width had a more significant effect on cooling performance compare to fin height.