Abstract

In the present thesis, the performance evaluation of inverted absorber semi-transparent photovoltaic thermal air collector (SPVT-AC) system has been studied. The parametric evaluation of hourly/monthly performance at the constant mass flow rate with varying the packing factor (PF) of the PV module has been studied. It has been shown that at constant mass flow rate with the increase in packing factor from 0.222 to 0.89 there is a 4°C rise in temperature for the constant of solar cell count. On the basis of present study, it has also been shown that annual exergy for fully covered inverted absorber semi-transparent photovoltaic thermal air collector (SPVT-AC) system is higher by 24.45%, in comparison to the partially covered inverted absorber semi-transparent photovoltaic thermal air collector (SPVT-AC) system.

Annual electrical energy comparison of inverted absorber semi-transparent photovoltaic thermal double pass double exposure air collector (SPVT-DPDE-AC) system has been studied and the results showed that the outcome is higher by 68% and 41.9% in comparison to single pass double exposure (SPDE) system, for $\beta=0.22$ and $\beta=.89$ respectively. It has also been shown that the fully covered system ($\beta=.89$) annual thermal energy for double pass double exposure (DPDE) system is 6% lower in comparison to single pass single exposure (SPDE) system. As a result, the electrical efficiency of double pass double exposure (DPDE) system has increased in comparison to single pass double exposure (SPDE) system. Conclusively it has been found that the double pass double exposure (DPDE) system is the most viable option of higher electrical and overall exergy gain.

At constant collection temperature, the performance analysis of a fully covered inverted absorber semi-transparent photovoltaic thermal collector system (SPVT-AC) system has been studied for single/double pass with single/double exposure. It has been found that, if daily
collection temperature requirement increases from $40^\circ\text{C}$ to $50^\circ\text{C}$ then the corresponding electrical energies reduce from 0.8 to 0.4 kWh respectively. With the help of other results, we concluded that fully covered inverted absorber semi-transparent photovoltaic double pass doubly exposure air collector (SPVT-DPDE-AC) system is most suitable option for better annual, electrical and exergy gain.

The comparative performance analysis based on packing factor variation between both single pass double-exposed (SPDE) system and double pass double-exposed (DPDE) system has been evaluated. Here it has been observed that annual electrical energy for double pass double exposure inverted absorber semitransparent photovoltaic air collector system for packing factor coefficient ($\beta$) =0.22 is 68% higher and for $\beta$=.89 it is 49.1% higher in comparison with single pass double exposure inverted absorber semitransparent photovoltaic air collector (SPDE-SPVT-AC) system, respectively. Further performance analysis for fully covered system has been compared based on constant collection temperature between single and double exposure systems.

The performance analysis for different material solar cells, at constant collection temperature, for both single and double-exposed SPVT-AC systems has been studied. Based on observation, it has been concluded that an annual electrical energy of inverted absorber semitransparent photovoltaic air collector (SPVT-AC) system for double pass double exposure is 14.5% higher in comparison with single pass single exposure (SPSE) configuration and 49.1% higher in comparison with single pass double exposure (SPDE) configuration for c-Si PV module.

Energy matrices, carbon credit earned, life-cycle analysis of double pass double-exposed system have also been evaluated. Based on study, it has been concluded that c-Si based PV module(monocrystalline silicon-based solar cells) has shown best performance for thermal energy and exergy gain which is around 2 times higher than the gain obtained for amorphous
thin film-based solar cells. It has also been shown that CO₂ mitigation and carbon credit earned has been found to be maximum for (c-Si) Crystalline silicon PV module and minimum for (CIGS) Copper Indium Gallium Selenide PV module.