Performance Analysis of Four Conceptual Designs for the Air Based Photovoltaic / Thermal Collectors

The thermal and electrical performance of different designs of air based hybrid photovoltaic/thermal collectors is investigated experimentally and theoretically. The circulating air is used to cool PV panels and to collect the absorbed energy to improve their performance. Four different collectors have been designed, manufactured and instrumented namely; double PV panels without cooling (model I), single duct double pass collector (model II), double duct single pass (model III), and single duct single pass (model IV) . Each collector consists of: channel duct, glass cover, axial fan to circulate air and two PV panel in parallel connection. The temperature of the upper and lower surfaces of PV panels, air temperature, air flow rate, air pressure drop, wind speed, solar radiation and ambient temperature were measured. The power produced by solar cells is measured also. A theoretical model has been developed for the collector model IV based on energy balance principle. The prediction of the thermal and hydraulic performance was obtained for the fourth model of PV/T collector by developing a Matlab computer program to solve the numerical model. The experimental results show that the combined efficiency of model III is higher than that of models II and IV. The pressure drop of model III is less than that of models I and IV, by (43.67% and 49%). The average percentage error between the theoretical and experimental results was 9.67%.