UNIVERSITI TEKNOLOGI MARA

THE DOCTORAL RESEARCH ABSTRACTS

Volume: 9, Issue 9 April 2016

NINTH ISSUE

INSTITUTE of GRADUATE STUDIES

IGS Biannual Publication

14

Name : Hasila Jarimi

Title : Design and Performance Analysis of A Single Pass Bi-Fluid Photovoltaic/Thermal (PV/T) Solar Collector With Fins

Supervisor : Associate Prof. Dr. Mohd Nazari Abu Bakar **(MS)**
Associate Prof. Dr. Mahmod Othman **(CS)**
Associate Prof. Dr. Mahadzir Hj. Din **(CS)**

The research on photovoltaic/thermal (PV/T) solar collector tends to focus on either water or air as the working fluid. Thus this study aims to investigate the feasibility of incorporating two types of working fluid (air and water) under the same PV/T solar collector. In addition to the electricity generated, this type of collector enables the production of thermal energy in the form of heated air and water. The use of both fluids (bi-fluid) also creates a greater range of thermal applications and offers options in which three modes of fluid operation namely: the air mode, the water mode, and the simultaneous mode (air and water) can be produced depending on the energy needs and applications. To investigate this type of collector, an improved design of a single pass PV/T solar collector which integrates both water and air as the working fluids (bi-fluid) into the system with the commercially available PV module as the thermal absorber was designed and fabricated. Heat transfer enhancement technique to the air flow has been introduced with the use of a series of low-cost fins. To test the fabricated collector, test-rig facilities were fabricated for indoor and outdoor testing with calibrated and reliable data acquisition tools were set-up. The performance of a PV/T solar collector is strongly influenced by the environmental factors, operating conditions and design parameters of the collector. Therefore mathematical modelling is crucial in order to predict the collector performance for further energy optimization purposes. In this study, when both fluids are operated simultaneously, 2-D steady-state analysis is used in modelling the performance of the designed collector. Thus energy balance equations using finite difference method were developed and solved using the inverse matrix solution procedure, with the Newton Raphson iteration implemented to compute the unknown temperature nodes using MATLAB. Even though the model was developed for the simultaneous mode of fluid operation, it can be implemented for the independent mode by setting the mass flow rate of one of the fluids at stagnant condition (0 kg/s). Experimental studies were conducted to analyse the collector performance for both thermal and electrical characteristics. The total efficiency of the PV/T design was computed by considering the 'primary energy saving efficiency' for both indoor and outdoor testing. For the independent mode, at average wind speed of 1 m/s, air and water mass flow rate ranging from 0.0074-0.09 kg/s, and 0.0017 – 0.0265 kg/s respectively, the experimentally obtained primary energy saving efficiency for air and water are ranging from 34.87% to 72.59%; and 41.35% to 64.79% respectively. Meanwhile for the simultaneous mode of fluid operation, higher range of primary energy saving efficiency was computed such that when air and water is fixed at flow rate of 0.0262 kg/s and 0.0066 kg/s respectively, the computed efficiency are ranging from 64.02% to 77.90%; and 64.01% to 77.03% respectively. The developed model was then validated against the experimental results by conducting error analysis using the mean absolute percentage error (MAPE), and root mean squared percentage deviation (RMSD) methods. From the analysis, the theoretical and experimental results are concluded to be in good agreement and hence the model is proven valid. Using the validated model, parametric studies were conducted. To conclude, this study has significant contributions to the knowledge of PV/T technology in which the computer simulation and experimental results have proven the feasibilities of integrating both fluids into the same collector.