Enhanced Transient Modeling of Hybrid Photovoltaic Air (PVT) Module

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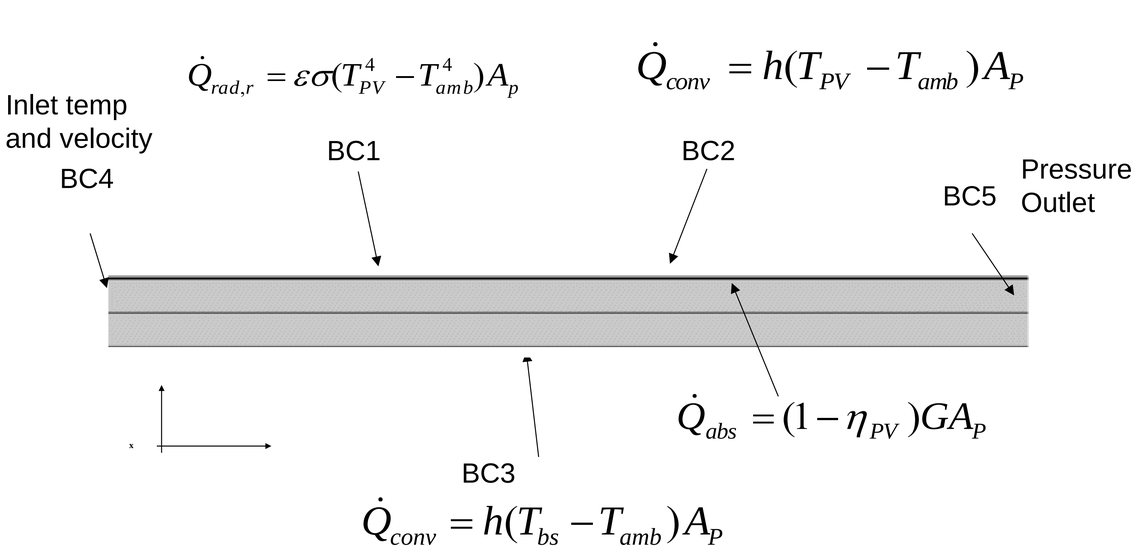
Abstract:

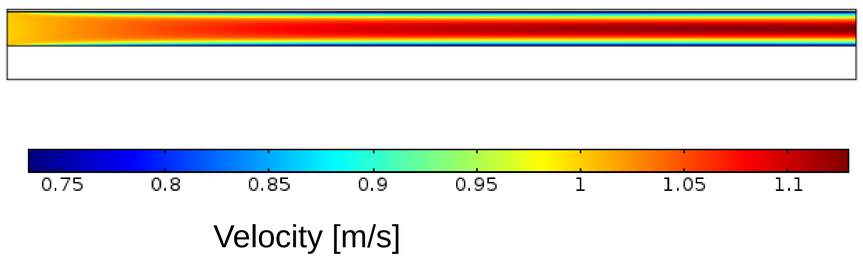
2D transient heat conduction model was created in COMSOL Multiphysics to study the performance of photovoltaic-thermal (PVT) water system. The model captures the variation of important environmental and system parameters such as outside temperature, solar irradiation, air velocity and temperature. The model has a good agreement with experimental data for the Photovoltaic cell temperature, air temperature inside the air channels and back surface temperature.

Introduction

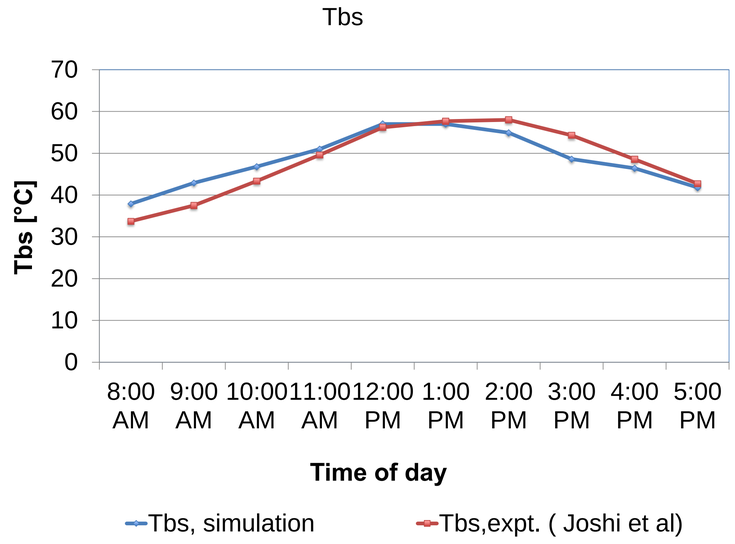
Solar photovoltaic/thermal units which are also known as hybrid photovoltaic/thermal (PV/T or PVT) solar units are systems that could simultaneously produce solar photovoltaic energy and thermal energy. Due to transient nature of several environmental and system parameters, an enhanced model which incorporate these variations has been studied in this paper. The performance of a hybrid photovoltaic-thermal model is evaluated by utilizing COMSOL 4.4 Multiphysics software and the results are validated against experimental data by Joshi et al [1].



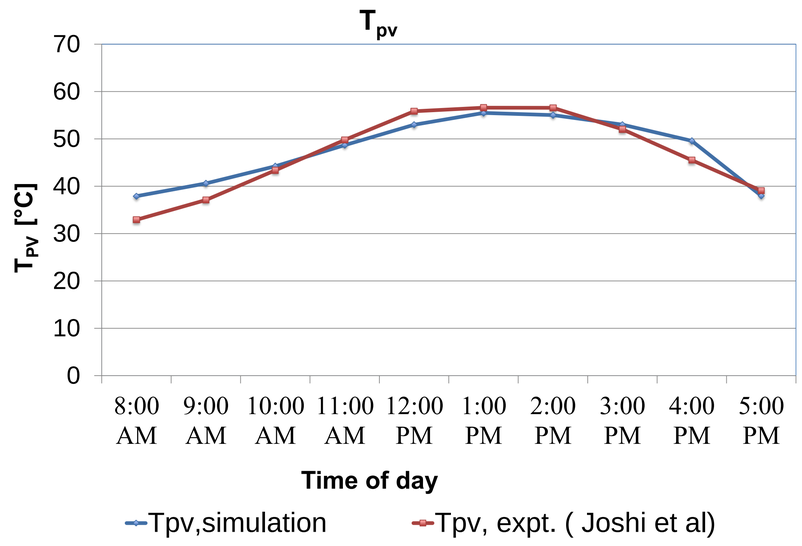
$$\dot{Q}_{net} = \dot{Q}_{abs} - \dot{Q}_{rad,r} - \dot{Q}_{conv}$$



Velocity of air inside the air duct



Simulated Back surface temperature (Tbs) compared with experimental data



Simulated PV cell temperature (T_{pv}) compared with experimental data

Results

The average percentile error between simulation result and experimental data is around 4%. Taking into consideration an inherent error in experimental observation, it could be inferred that the simulation has a very good agreement with experimental data. Similarly, the back surface temperature of PVT module is simulated and values are compared against experimental data.

Conclusion

In this study, an enhanced transient Photovoltaic thermal (PVT) model is developed which takes into consideration the variation of environmental and system parameters with time. The simulated model is compared against experimental data and good agreement was obtained. Thus, the model could be useful to perform parametric analysis of PVT design as well as testing the performance of PVT design in different environmental and system conditions

References

[1] Joshi, A.S., Tiwari, A., Tiwari, G.N., Dincer, I., Reddy, B.V., Performance evaluation of a hybrid photovoltaic thermal (PV/T) (glass-to-glass) system, *Int. J. Therm. Sci*. **48** 154–164(2009)