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A computational model for performance prediction of a hybrid PV/T module

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Objectives

1. Develop and validate a mathematical model for a PV/T system

2. Compare new model to previous model against experimental data by Tiwari & Sodha (2006)

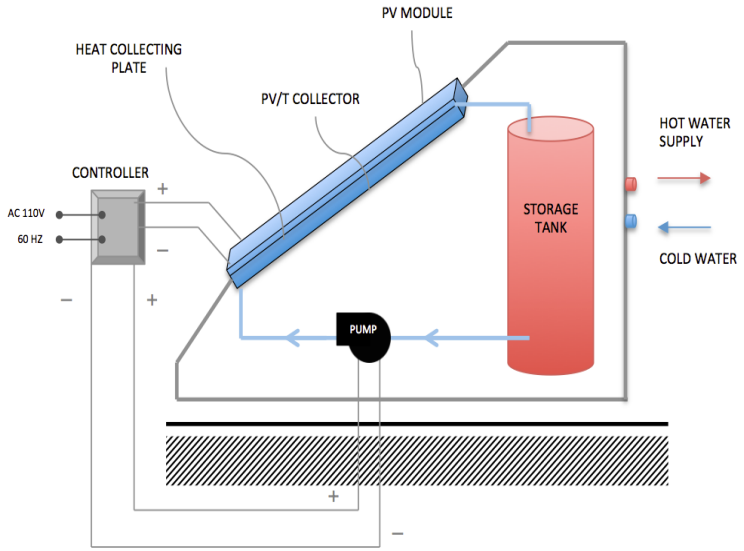


Figure 1. Schematic diagram of PV/T system

Methodology

- Apply a one-dimensional (1D) heat conduction mathematical model
- Solve the equations using MATLAB™
- Incorporate the improvements to the mathematical model
- Validate the 1D model using previously published PV/T data

Mathematical Model

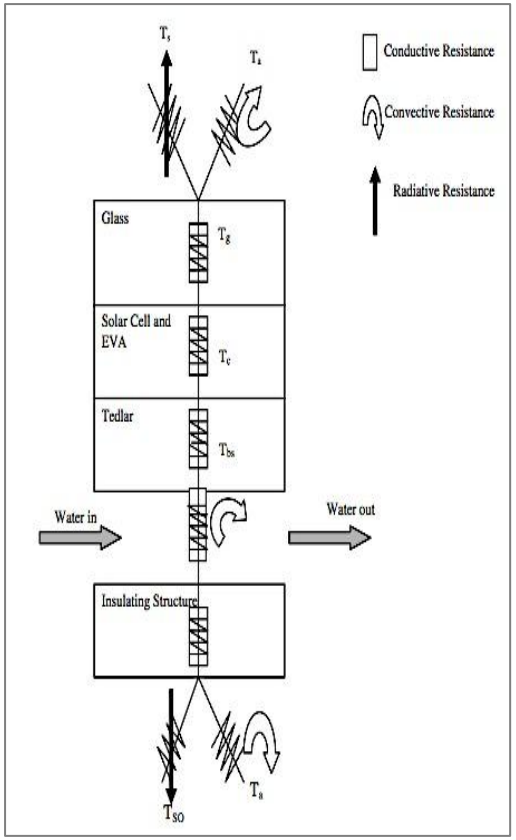


Figure 2. Thermal resistance circuit diagram for PV/T water collector

The energy balance was applied for each of the components that makes up the PV/T panel.

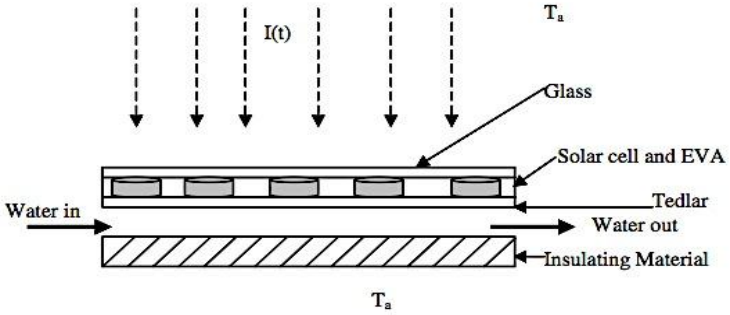


Figure 3. Cross-sectional view of PV/T

(a) $$F'\left[h_{p1}h_{p2}(\alpha\tau)I(t)-U_L(T_f-T_a)bdx=\frac{\dot{m}}{n}C_w\frac{dT_f}{dx}bdx\right]$$

(b) $$t_g\left[a_cI(t)b_c+(1-b_c)a_TI(t)\right]bdx=$$
$$bdx\left[U_t(T_c-T_a)+U_T(T_c-T_{bs})\right]+bdx\,h_ct_gI(t)b_c$$

$$R_{si}=L_{si}/K_{si}$$

$$T_{sky}=0.0522T_{amb}^{1.5}$$

$$h_{rad}=\varepsilon_g\sigma\left(T_{sky}+T_c\right)\left(T_{sky}^2+T_c^2\right)$$

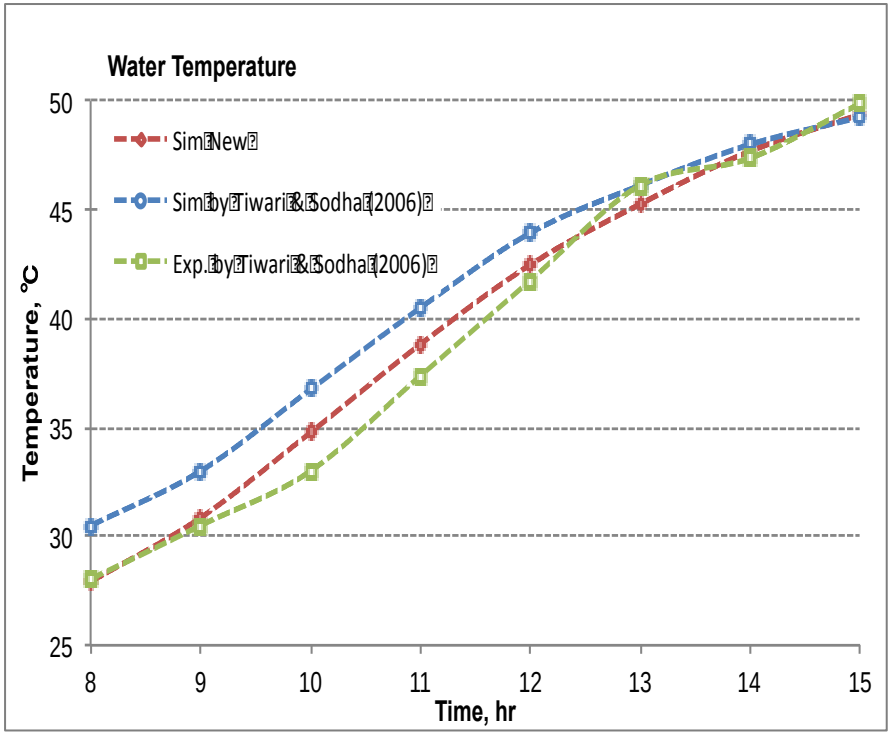
$$U_e=\frac{(U/A)_{edge}}{A_c}$$

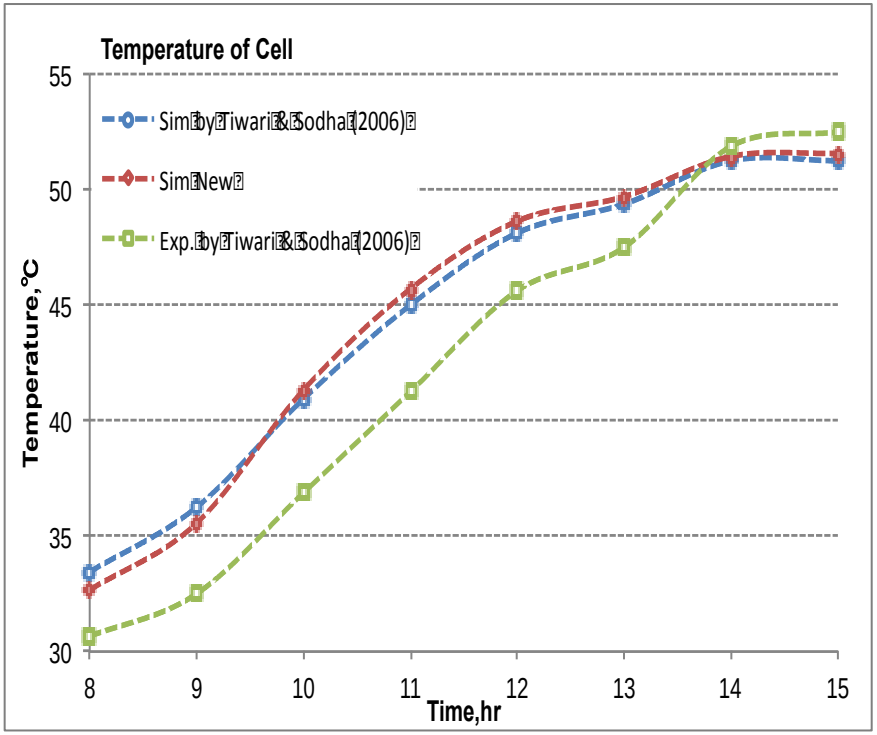
Figure 4. Improvements made to old model

Results

The root mean square percentage error for the water temperature is 2.48%, which is lower than the previously reported 5.87%.

The root mean square deviation for the cell temperature is 6.94%, which is better than the previously reported 7.22% by others.





Conclusion

- An improved mathematical thermal model for the PV/T collector has been developed
- The simulation results of the model are in good agreement with available experimental measurements.