Theoretical Model of a Concentrating Parabolic Collector (FPC) with a Thermosiphon

Assumptions

- Quasi steady state
- No shading
- Ideal flow (laminar, 1D, uniform)
- Hottel Whillier Bliss equation (linearized heat loss)
- Conditions from receiver to receiver are the same

Calculations

The model was developed based on the following equations for a thermosyphon FPC from the Zerrouki paper used.

$$\varphi = N\frac{L_c}{L_{ct}}\left(\frac{d_c}{d_{ct}}\right)^4 \quad (15)$$

$$C = \frac{gN\pi A_c d_c^4\left(\frac{L_c \sin\theta}{2} + H\right)}{128 L_c (1 + \varphi)} \quad (22)$$

$$\dot{M} = C^{1/2}\left(\frac{\rho_o \beta}{\nu C_p} F' [I(\tau\alpha) - U_L(T_m - T_{amb})]\right)^{1/2} \quad (21)$$

$$T_o - T_i = \frac{A_c F'}{\dot{M} C_p}[I(\tau\alpha) - U_L(T_m - T_{amb})] \quad (19)$$

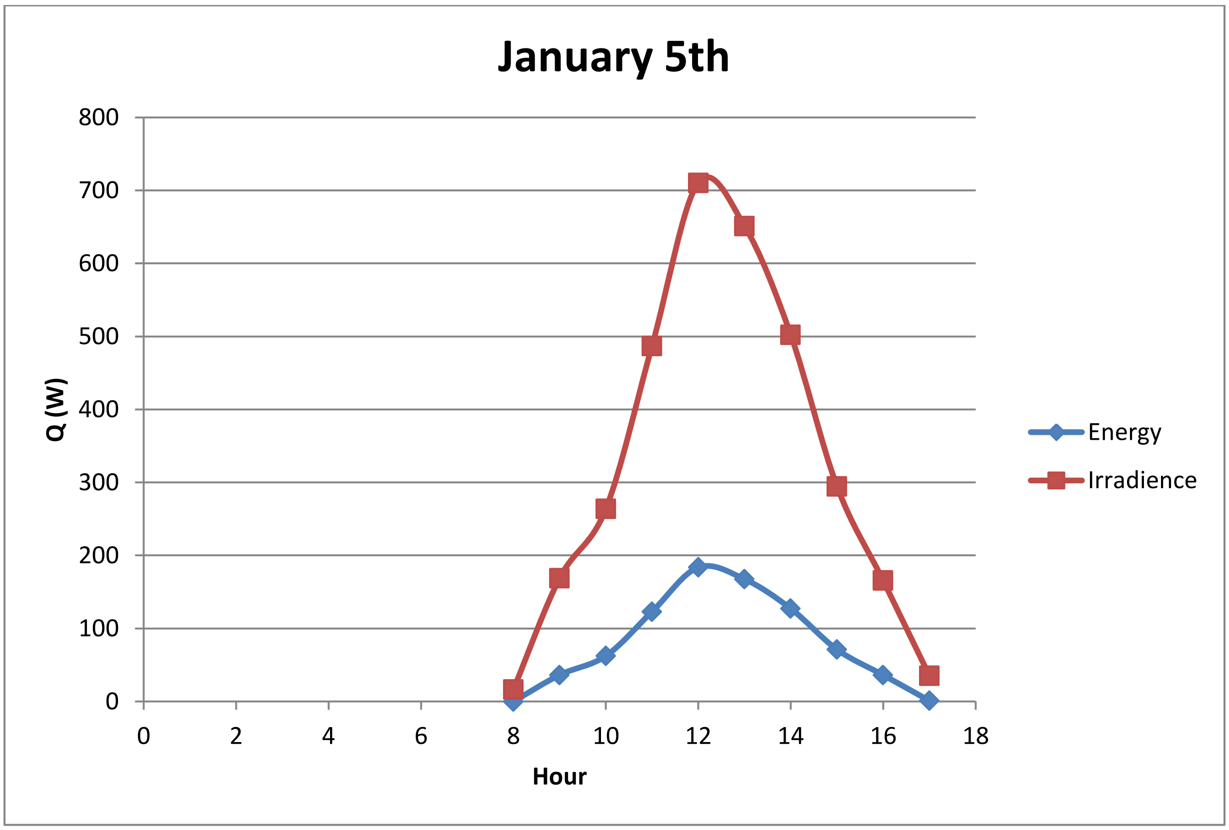
The following basic energy equation was used to find the energy into the fluid

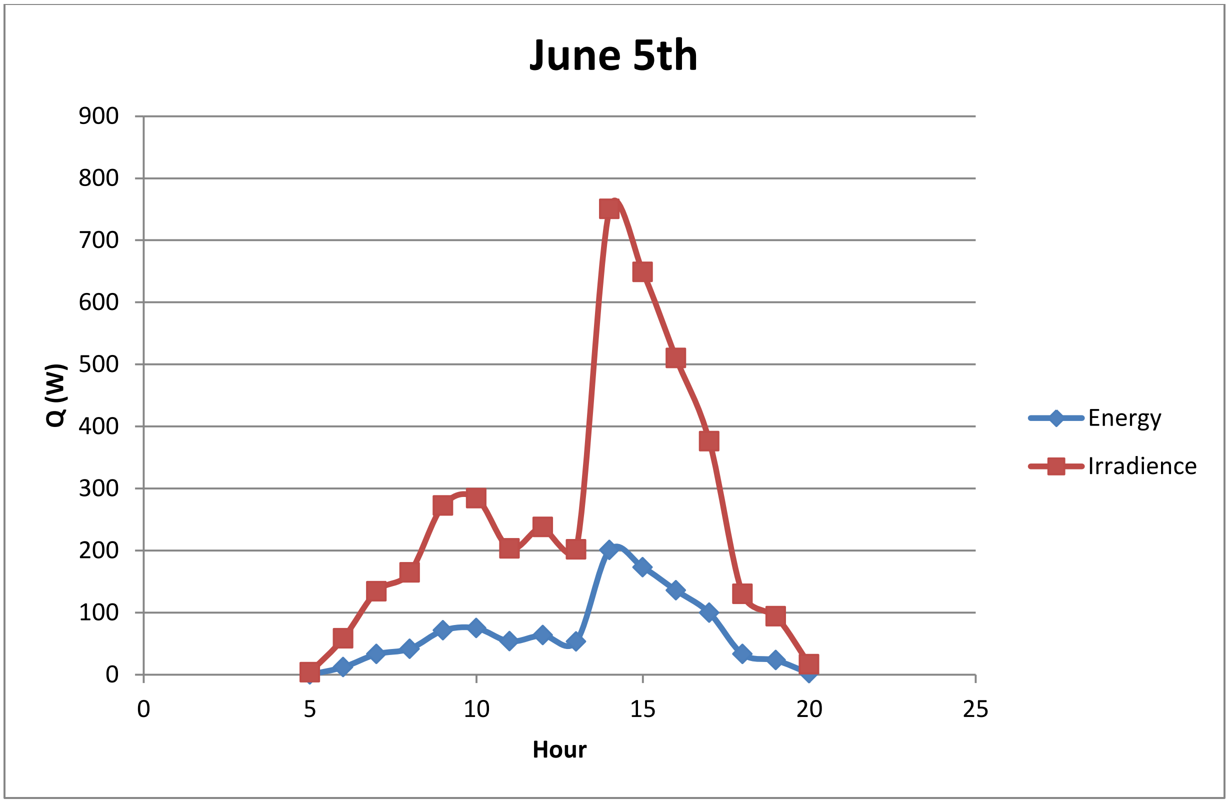
$$Q = \dot{m} * C_P * N * \Delta T$$

Equations for relating a CPC collector to the Hottel Whillier Bliss equation were taken from Solar Engineering of Thermal Processes 3rd edition.

Sample Days

Using the model developed we predicted the energy added to the system for January 5th and June 5th resulting in the following plots.





Conclusion

Date	5 January	5 June
Total Daily Irradiance (W)	3,675	4,557
Total Energy Input to Still (W)	808.5	1070.5
Efficiency	22%	23%

Using this model we predict a usable energy input to the solar still even during the winter in Rochester. The efficiency over the year stays somewhat constant.