This work follows on a validation report that was submitted in October 2018. In that validation exercise, it was concluded that the models respect basic thermodynamic laws and that they show expected behavior. In the present exercise, two weeks of in-field measured data were used in order to determine whether the modeled results are representative of real world results.

Meteorological data consisting of ambient temperature, ambient humidity, total solar radiation on the horizontal, and wind speed at half-hour intervals for a period starting September 16 and ending October 1. Collector inlet temperature, outlet temperature, and flowrate were provided at one-minute intervals for the same period.

A TRNSYS model was constructed consisting of a weather data reading component, a solar radiation processor (to turn the total horizontal solar radiation into beam, diffuse, and ground reflected radiation on the collector slope), and a solar collector (Type817). Type817 was fed the measured meteorological data as well as the measured inlet temperature and flow rate. The simulated and measured outlet temperatures were then compared. Figure 1 below shows the results of one of the two weeks.

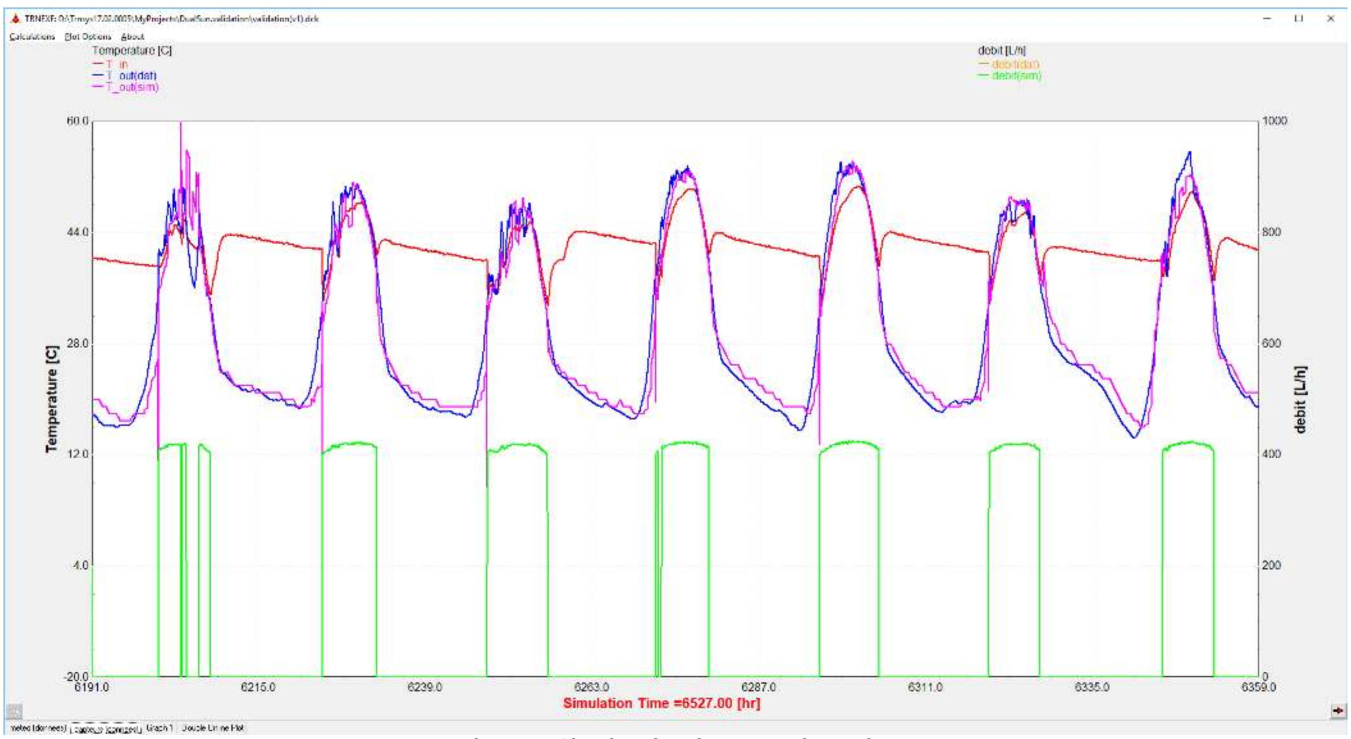

Figure 1: Simulated and Measured Results

In the plot above, the red line is the measured inlet temperature and the green line is the measured flow rate. The blue line indicates the measured collector outlet temperature while the pink line shows the simulated result.

The numerical values of measured and simulated outlet temperature when there is collector flow were used in an error regression analysis. The table below summarizes the results of that analysis. Points when there is no collector flow were not included in the analysis for two reasons. First and more simply, the model does not need to do a very good job of predicting the collector temperature at night when there is no flow through it. Second, when fluid is not moving through the collector, the collector's measured outlet temperature can be heavily influenced by the specific location of the temperature sensor, and the collector's construction and geometry. As such, the measured temperature can be subject to very localized and installation specific circumstances. Such circumstances cannot be very accurately modeled so the no-flow data points are excluded so as not to unfairly disadvantage the model.

Description	**Value**	**Units**
Number of points analyzed	5846	[-]
Root mean squared error (RMSE)	2.17	[C]
Percentage of points within one RMSE deviation	58.9	[%]
Percentage of points within two RMSE deviations	71.5	[%]
Observed mean	45.2	[C]
Total sum of squares	184587	[-]
Regression sum of squares	194640	[-]
Residual sum of squares	27402	[-]
Coefficient of determination (R^2 value)	0.851	[-]

Discussion:

The greatest source of unknowns in the simulation comes from the algorithms used to compute the components of solar radiation (beam, diffuse, and ground reflected) based on knowledge of the total solar radiation on the horizontal. With only this one known value, the algorithm must make some guesses as to whether a given hour was evenly overcast or whether it was clear for part of the hour and cloudy for the rest. Either situation can result in the same total radiation for the hour but each has a significantly different ratio of beam to diffuse radiation. The algorithm uses ambient temperature and humidity to assist in its assumption.

The coefficient of determination of the regression analysis is 0.85. A value of 1 would indicate perfect agreement between measured and simulated results. It is unfortunately not possible to know how much of the difference between 0.85 and 1.0 can be attributed to uncertainty in the solar radiation algorithms and how much should be attributed to the model of the collector. The point is worth mentioning but is somewhat moot given that a coefficient of determination of 0.85 is quite acceptable.

Conclusions:

It can be concluded that Type817's simulated results match measured results well and that it can be used to predict collector performance with good accuracy.

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