RP1014

IMPACT OF ENERGY EFFICIENCY POOL PUMPS ON PEAK DEMAND, ENERGY COSTS AND CARBON REDUCION

Research Question

How does a solar pool heating system contribute towards the total energy consumption of a residential swimming pool system?

What can be done to improve the energy efficiency of a solar pool heating system?

What are the associated impacts on pool thermal conditions?

Figure 1 Residential solar pool heating system.

Methodology

The experiment was performed on an existing solar pool heating system in Sydney. A data acquisition system was installed to measure the key system parameters. The solar collector and the pool were modelled in TRNSYS and were both validated against the experimental data. The system performance and energy saving potentials under various scenarios were simulated and evaluated using the experimentally validated models. This project is currently completed.

Results

TRNSYS Model Verifications

The results presented in Table 1 and Figure 2 indicate a good fit of the modelled data against the experimental data.

Table 1 Statistical analysis results of the steady state collector and pool model.

	MBE	Cv-RMSE	R^2
$\dot{Q}_u$	-2.50%	8.4%	97.0%
T_{out}	-0.50%	1.8%	98.6%
T_{pool}	-0.36%	0.6%	98.7%

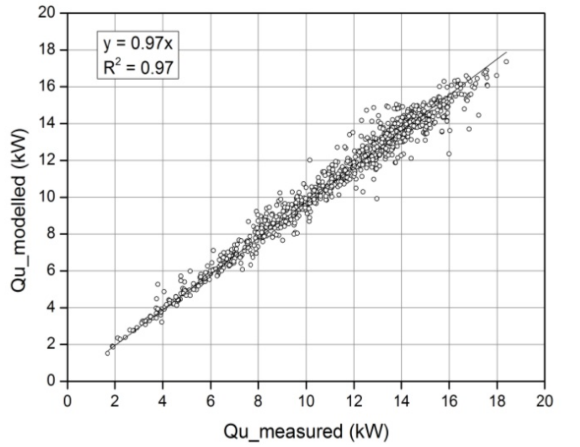

Figure 2 Plot of modelled rate of heat output of the solar collector against the experimental data.

Simulation of the solar pool heating system under lower flow conditions

Figure 3 shows the average daily pool temperature and pump energy use for the pump running under low speed (with the valve partially throttled) and the high speed (BAU case). Running the solar pool heating system at lower flow rates results in 70% energy savings, without actually changing the average pool temperature.

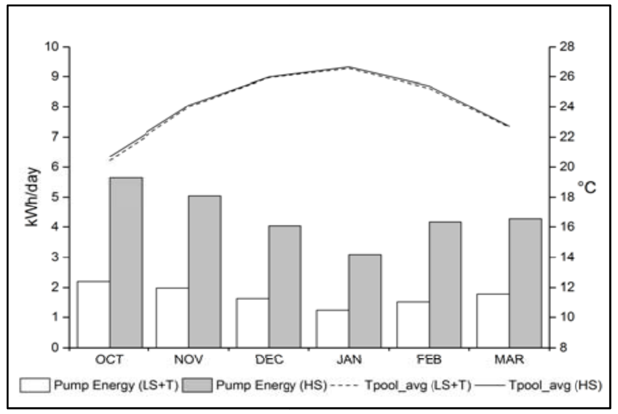

Figure 3 Daily average pool temperature and pump energy under low pump speed plus throttled (LS+T), and high pump speed (HS) from OCT to MAR.

With the operation of the solar pool heating system, approximately 50 days have an average pool temperature above 26 °C which indicates a longer swimming season (Figure 4). It is important to see that operating the system at a lower flow results in a similar pool temperature distribution to the BAU high-speed case.

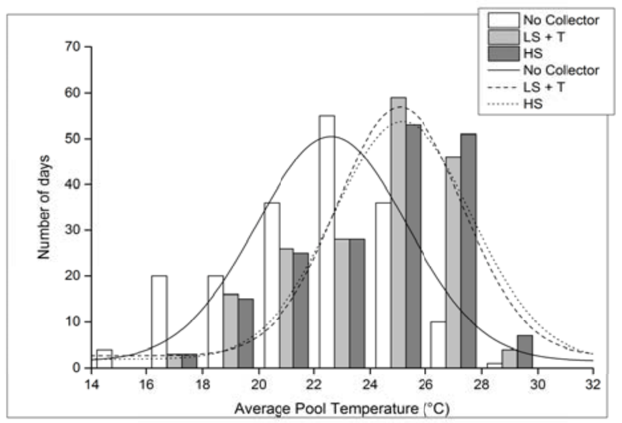

Figure 4 Histogram of the average pool temperature with no collector heating, under low pump speed plus throttled (LS+T), and high pump speed (HS) from OCT to MAR.

Conclusions

The collector and pool model has achieved excellent agreement with the experimental data. Operating solar pool heating systems under lower flow rates achieves 70% pump energy reduction and an improvement of system COP by 2.5 times for the entire swimming season. For lower flow operations, the slightly lower thermal output and extra system running time can be compensated for by increasing the collector area.

Anticipated impacts

Approximately 90% of the heated swimming pools in Australia are installed with solar pool heating. This energy efficiency retrofit alone has the potential to save approximately 210 GWh of electricity per annum. This corresponds to ~150 kilotonnes of carbon emission abatement and $52.5 million dollars of savings per annum (assuming $0.25/kWh). The amount of electricity reduction represents 10% of the total projected electricity usage of Australian residential swimming pools in 2016.

Further information

For further information, please go to the CRCLCL website:
http://www.lowcarbonlivingcrc.com.au/

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