Swimming Pools as Heat Sinks for Air Conditioners

Key Benefits of Technology

- Compared to standard residential air-conditioning, using swimming pools as thermal sinks could save roughly 25% on peak cooling power and 30% of overall cooling energy.
- In Western climates, when space cooling and pool heating occur concurrently, heat rejected from cooling equipment will directly displace pool heating energy.

Background

In California, where electric utilities experience their peak power demand in the summer, space cooling accounts for 29% of total peak power demand and approximately 40% of residential peak demand. This occurs in part because the COP for traditional air-cooled vapor-compression cooling equipment diminishes significantly at high outdoor temperatures, such that equipment efficiency can be at its worst when cooling demand is greatest.

For this reason, a large fraction of cooling research has focused on techniques to reduce heat sink temperatures, and reduce the required temperature differences between the refrigerant and the source and sink. For example, rejecting condenser heat to water instead of air reduces the temperature difference that is needed for adequate heat transfer; air cooled condensers typically require a refrigerant temperature that is 35°C higher than condenser inlet air, while exchange with water only needs a 20°C temperature difference.

Thus, the efficiency of vapor compression air conditioning can be improved significantly by rejecting condenser heat to a swimming pool, rather than to ambient air.

Key Research Objectives

Through a combination of theoretical analysis, field research, and collaboration with industry, utilities, and end users, WCEC will:

- Develop modeling tools to accurately predict the temperature response of a pool given mechanical thermal loading.
- Develop guidelines for the most appropriate application of pool-coupled heat pumps.
- Provide industry and utilities with reliable design recommendations and energy savings predictions for cost effective systems.

Research

WCEC collaborated with Geremia Pools to monitor a pool-coupled heat pump system installed in Sacramento. The pool was instrumented to measure temperatures and thermal heat transfer, and data from the 2010 cooling season was compared to results from a first-principals model developed by the WCEC. Results indicate that the model is very accurate; hourly predictions over approximately 8 months in the 2010 cooling season compare well to measured values with an R-squared value of 0.993 and a maximum error of 1.6°C. During the test there were 2322 kBTUs of heating loads extracted from the pool from 4/15/10 – 5/31/10, 8452 kBTUs of cooling loads delivered to the pool from 6/1/10 – 10/19/10, and 4840 kBTUs of heating loads extracted from the pool from 10/20/10 – 12/12/10. The model development is outlined in a publication in the January, 2011, edition of Building and Environment Journal and a second publication is being drafted on the results of the feasibility analysis.

FOR MORE INFORMATION:

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Laboratory Results
Preliminary results suggest that using a swimming pool as a heat sink can realistically reduce air conditioning energy use by 30% and peak demand by 25%. WCEC is currently developing a tool to assist contractors with the sizing of pools to meet the required loads from an air conditioner.

Field Results
Model predictions of hourly pool temperature matched well with measured results further validating the model with the influence of external heat loads. This gives confidence for using the model to accurately predict energy savings and pool temperatures during the cooling season.

Comparison of predicted values to measurements of Geremia’s pool-coupled heat pump for several months in the 2010 cooling season.

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