Presentation: A solar assisted air-conditioning system

V. VAKILOROAYA, R. DIBBS, Q.P. HA. ***Energy saving potential of an optimized hybrid solar-assisted air conditioning system using sequential quadratic programming.*** *Gerontechnology 2012;11(2):203;* doi:10.4017/gt.2012.11.02.329.00 **Purpose** The objective of this study is to describe a newly-developed hybrid solar-assisted air-conditioning system. We also report on its system performance that can be implemented online and that is optimized by a computationally efficient methodology for dynamic scheduling and optimal control of heating, ventilating and air-conditioning (HVAC) systems. **Method** A generalized optimization scheme was developed using sequential quadratic programming[1] along with a proposed empirical model[2] for the objective function. In this approach gradients of the Lagrangian function are used for updating the quasi-Newton matrix. The key challenge is to develop an algorithm to accurately approximate this matrix that reflects the curvature of the objective and constraints. The objective function is the compressor energy usage and optimal set-points are the superheat and sub-cool temperature[3]. A direct expansion air-conditioner combined with a vacuum solar collector was used for experimentation and data collection. The system under investigation is extensively equipped with a number of sensors and instrumentation devices for data logging and monitoring. Optimization algorithm implemented in a transient simulation software package[4], was used to solve the problem of minimizing energy consumption and predict the system set-points optimized in transient conditions. **Results & Discussion** The integrated simulation tool was validated by using the wide range of operating data obtained experimentally from the hybrid plant during summer time. The predictions from the models exhibited a good coincidence with experimental results, judged by a root mean square error of less than 10%. Experimental test results show that the daily energy saving is around 38.6% while the indoor temperature and relative humidity are within comfort ranges. The advantages of the optimal strategy lie in the fact that the optimal system operates at a higher subcool temperature and a lower unnecessary superheat temperature after storage, than in a traditional system (*Figure 1*). This results in a substantial reduction of the compressor's energy consumption, which demonstrates an improvement in the system's performance coefficient.

References

1. Sun J, Reddy A. Optimal control of building HVAC&R systems using complete simulation-based sequential quadratic programming (CSB-SQP). Building and Environment 2005;40(5):657-669; doi:10.1016/j.buildenv.2004.08.011
2. Vakiloroaya V, Zhu JG, Ha QP. Modelling and Optimisation of Direct Expansion Air Conditioning Systems for Commercial Building Energy Savings. Proceedings of the International Symposium Automation and Robotics in Construction, Seoul, Korea; 2011; pp 232-237
3. Tian J, Feng Q, Zhu R. Analysis and experimental study of MIMO control in refrigeration system. Energy Conversion and Management 2008;49(5):933-939; doi:10.1016/j.enconman.2007.10.027
4. Vakiloroaya V, Khatibi M, Ha QP, Samali B. New Integrated Hybrid Evaporative Cooling System for HVAC Energy Efficiency Improvement. Proceedings of the 4th International Symposium on System Integration IEEE/SICE, Kyoto, Japan; 2011; pp 591-596; doi:10.1109/SII.2011.6147546

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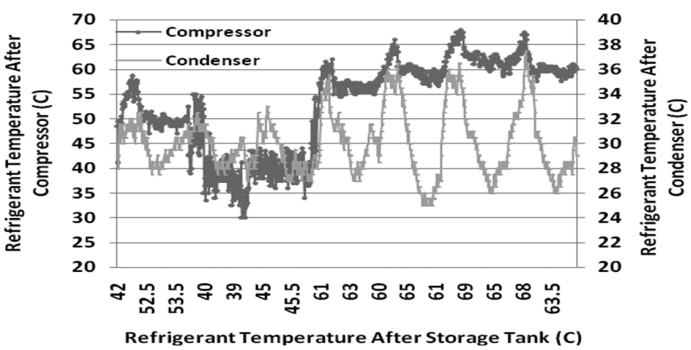

Figure 1. Temperature profiles of the new hybrid HVAC system