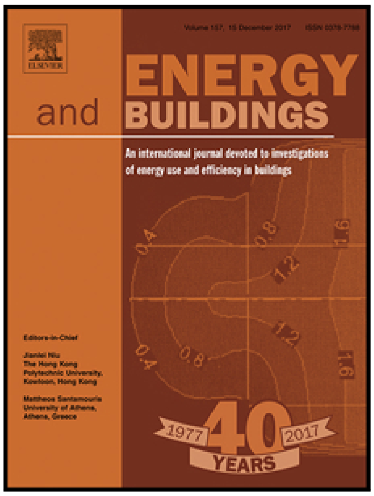
Accepted Manuscript



A Practical Approach to Chiller Plants' Optimisation

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PII: S0378-7788(17)33635-6
DOI: 10.1016/j.enbuild.2018.03.076
Reference: ENB 8462

To appear in: *Energy & Buildings*

Received date: 5 November 2017
Revised date: 8 March 2018
Accepted date: 30 March 2018

Please cite this article as: Lan Wang , Eric W.M. Lee , Richard K.K. Yuen , A Practical Approach to Chiller Plants' Optimisation, *Energy & Buildings* (2018), doi: 10.1016/j.enbuild.2018.03.076

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Abstract
Chiller plants use more than 50% of the total energy consumed by heating ventilation and air conditioning (HVAC) systems. Adjustments to the interactions between components could reduce the total power used, in the premise of helping systems to meet building thermal load targets. Studies have shown that significant power reduction can be achieved by adopting different kinds of optimisation techniques to different variables. However, it is difficult to apply these optimisation strategies into industry, as frequent simultaneous updates of different variables with large fluctuations harm the operational stability of chiller plants. In practice, making fewer and more moderate variable updates is a more practical optimisation strategy. To address this problem, this study proposes using varying searching bounds in the optimisation processes. To determine the contribution of each variable to power reduction, the effect of each optimised variable is analysed. The results show that applying varying searching bounds is an effective way to avoid frequent large fluctuations in optimised variables without sacrificing much optimisation performance. The optimisations of the condenser water mass flow rate and condenser water supplying temperature make the greater contributions to power reduction.

1. Introduction
Water-cooled chiller plants, consisting of chillers, cooling towers and condenser water pumps, consume more than 50% of the total energy used by heating and ventilation air conditioning (HVAC) systems [1]. Understanding the interactions between different components could help to reduce the amount of power used by chiller plants in the premise of meeting buildings' thermal load. For example, lowering the temperature of the condenser water supplying temperature (Tcws) can reduce the power used by a chiller compressor by reducing the lift while increasing the power requirements of the cooling tower fan. The contradictory role that Tcws plays in affecting chillers' coefficient of performance (COP) and cooling tower fans' power makes it important to find an optimum Tcws [2]. Furthermore, a lower condenser water mass flow rate (Mcw) can decrease the power used by the pump while increasing the temperature gap between the condenser water in and out chillers, which further increases the chiller's power. The contradictory role that Mcw plays in affecting chillers' COP and pumps' power demands makes determining an optimum Mcw important [3].

There are four supervisory control methods for optimising the energy efficiency of HVAC systems: model-based optimal control, hybrid optimal control, performance map-based optimal control and model-free optimal control [4]. The model-based optimal control method uses an energy model to calculate a system's energy costs in response to both environmental effects and changes in control settings. The model-based method, which does not rely on expertise, is the most frequently used method in recent studies due to its universal applicability [5]. The primary role of optimisation