

An ARMA Type Weather Model for Air-conditioning, Heating and Cooling Load Calculation

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ABSTRACT

In order to design the capacities of a heating, ventilating and air-conditioning (HVAC) system's elements, configuration of the building and the HVAC system for minimizing energy consumption, it is very important to know the air-conditioning, heating and cooling load of a building.

To compute the load, weather data are very important; however, what kind of weather data should be used is a difficult problem.

Conventional load calculation methods are divided into two classes, i.e., peak-load estimation and annual-load simulation. Diurnally periodic weather data are used for the peak-load estimation, but the correlation of weather elements, i.e., temperature, solar radiation, moisture contents, etc., can hardly be taken into account. Reference year weather data are used for annual-load simulation, but the results can only give the seasonal summed-up load, no information being obtained for the detailed load variations owing to the shortness of the data period.

To overcome the problem, the authors constructed an ARMA-type weather model by applying a system identification technique to the original weather data. The merits of the modeling are: (1) the statistical properties of weather data are kept in the model dynamically; (2) long-term data are reduced to a small number of parameters; (3) the characteristics of weather data can be analyzed systematically; (4) even the climate of a certain location, where a precise and/or long-term data record is not available, could be modeled if the above investigations can be made at a close location; (5) the model can be used for the stochastic heating and cooling load calculation method which was developed by the authors.

The methodology to build the model, exam-

ples of the weather model and the stochastic heating and cooling load results using the model are given, reasonable consistency being obtained with a simulated load.

1. INTRODUCTION

In order to select the components of a HVAC system and also to design an energy-efficient building and HVAC system, it is very important to know the heating and/or cooling load of the building. Numerous methods to estimate the load have been developed so far with different purposes. They can be divided into the following two classes.

(a) *Estimation of peak heating and/or cooling load.* The load is calculated under the steady or periodically steady thermal conditions with a set of fixed severe weather data. The most widely used data are the well-known TAC data proposed by ASHRAE [1, 2]. But the estimated load is usually too large to give a reasonable capacity of HVAC components. This shortcoming is mainly due to the lack of consideration of correlation between weather elements (e.g., temperature, solar radiation, humidity, etc.), continuity of severe weather conditions, and the effects of thermal properties of buildings. To overcome the shortcoming, several sets of revised TAC data which take into account the correlation were developed [1, 3]. However, these are not enough because two other important features are not considered.

(b) *Estimation of annual and/or seasonal load.* In order to estimate the energy consumption of a HVAC system, many computer codes were developed to simulate the heating and/or cooling load on an hour-by-hour basis (e.g., DOE 2, BLAST and NBSLD are well-known codes). Simplified methods are also available.