Discussions for the Technical Papers from the 2018 ASHRAE Winter Conference in Chicago, Illinois

This is a compilation of the written questions and comments submitted to authors by attendees at the 2018 ASHRAE Winter Conference in Chicago, Illinois. All authors were given the opportunity to respond.

The questions/comments and authors' responses are published with the papers in the hardbound volume of *ASHRAE Transactions*, Vol. 124, Part 1.

CH-18-004

Modeling Variable-Airflow Parallel Fan-Powered Terminal Units with a Mass and Energy Balance Approach

Peng Yin, PhD
Associate Member ASHRAE

Dennis L. O'Neal, PhD, PE
Fellow/Life Member ASHRAE

Lixing Gu, Florida Solar Energy Center, Cocoa, FL: Is the model approach the same as the real practice?

Peng Yin: The control and operating sequences were derived based on the information provided by equipment manufacturers. Yes, they are the same as the operations in real buildings.

Steven Carlson, Principal, XRG Analytics, LLC, Evansville, WI: Since you have included leakage factors in parallel boxes as a real-world adjustment, why not also consider the real-world adjustment for series boxes to include secondary air filter loading and setup/operation errors in minimum and maximum ECM speed in coordination with primary air damper modulation?

Peng Yin: To investigate the impact of different factors, such as primary air leakage in parallel units and air filter loading, on the performance of fan-powered terminal units, we need measured data either from field or laboratory testing. For the leakage modeling, we have laboratory data to support our results. However, we do not have data on secondary air filter loading or setup/operation errors in minimum and maximum ECM speed. The realistic performance issues you mentioned may be topics for future studies.

CH-18-005

Modeling and Testing of a Single-Speed DX Air-Conditioning System

Nabil Nassif, PhD, PE
Member ASHRAE

Lixing Gu, Florida Solar Energy Center, Cocoa, FL: Your model improvements are based on testing data from a single 3 ton AC. Many manufacturers provide performance data. Did you compare your model to their performance data for accuracy?

Nabil Nassif: The model was only evaluated against actual data collected from lab setting experiments performed under various conditions. We did not compare the results with manufacturers' data. I agree this additional testing and comparison could be useful . We appreciate your comment, and this will be considered in the future model improvement work.

Craig Messmer, Vice President of Engineering, Unico, Arnold, MO: Excellent paper. I hope it leads to a generic algorithm.

Nabil Nassif: Thank for your great note. As planned, we will perform additional testing on various DX unit types and sizes that will lead to a generic algorithm.

Steven Carlson, Principal, XRG Analytics, LLC, Evansville, WI: Does your modeling approach and learning data set include the loss of latent capacity when a DX coil cycle is at part load?

Nabil Nassif: It does not include DX coil cycle at part load. The model was tested by running the DX unit continuously. We will certainly look into this in the future testing. Thank you for your comment.

Cool Roof Use in Commercial Buildings in the United States: An Energy Cost Analysis

Thomas J. Taylor, PhD

Christian Hartwig

Larry Spielvogel, L.G. Spielvogel, Inc., Bala Cynwyd, PA: This paper does not begin to cover many important issues regarding involving energy use and cost in commercial buildings with cool roofs. It looks mainly at the external impact on cool roofs, not how those external factors affect the heating and cooling energy use, electric demand, and energy cost. It uses oversimplified assumptions and computer modeling to make their case. The conclusion that "For every examined city, spanning climate zones 1 through 7, modeling predicts energy savings will be achieved by converting from a dark, absorptive roof membrane to a highly reflective cool roof" is not supported.

The authors do not consider the tremendous variations in both the architecture and the engineering that exist in commercial buildings. While the paper does not say so, it assumes that all roofs are over both heated and cooled spaces and that there are no ceiling plenums, return air, or other influences on the air temperatures or velocities below the roof deck. No consideration is given to the wide variety of HVAC systems and equipment used and their range of energy performance. How much of the roof area in commercial buildings is over spaces that are not cooled or even heated? It also assumes that every roof is over a cooled space and that space is cooled all the time. Such assumptions do not reflect reality.

The authors assume that heating and cooling energy use is proportional to heating and cooling degree-days or roof surface temperatures without any analysis or supporting measurements. No consideration is given to the presence of snow, ice, water, or solar collectors. Most published degree-days are determined to be at a balance-point temperature of 65°F (18.3°C), and that is not applicable to most all commercial buildings, nor are night or weekend setback or shutoff temperatures considered. Adding demand charges to average energy costs is incorrect, since average energy costs already include demand charges.

The paper incorrectly assumes that all buildings are heated with natural gas and cooled with electricity, and that the roof performance directly influences and always sets the peak electric demand in every building every month. The paper does not consider that almost all commercial buildings are intermittently occupied, and they are at least partially self-heating by virtue of their internal heat gains. It assumes that all buildings have or will have the insulation levels required by the 2015 International Energy Conservation Code (IECC). Currently, only a fraction of 1% of all buildings at best even have or will have this much roof insulation.

Virtually none of the content of this paper or the references shows measured energy data in common commercial buildings to support and confirm the conclusions in this or any other competent peer-reviewed papers. The authors claim, "Modeling results must always be validated with experimental or real-world data," yet, unbiased peer-reviewed data are not provided for any number of commercial buildings.

Therefore, contrary to the authors' conclusions, the assumptions and conclusions in this paper are not relevant for most buildings. If the conclusions in this paper had any merit, they would have been readily adopted in building energy codes and standards long ago. They are not.

Thomas J. Taylor and Christian Hartwig: The authors recognize the tremendous variations that exist in both the architecture and engineering existing in commercial buildings. These variations obviously affect the total overall energy efficiency of such buildings. The goal of the study was to use previously well-validated models to more closely examine the contribution of the roof assembly as a building envelope component to the energy balance within that envelope. Thus, heat flux into and from the envelope is considered, but not what occurs within the envelope. Strategies to compensate in whatever way necessary for the total building were beyond the scope of this work.

The study indicates that cool roofs reduce net annual heat flux into buildings for all cities examined. Thus, regardless of location, the energy load on the building interior is reduced through the use of cool roofing. As noted, the highest levels of insulation, required by the 2015 International Energy Conservation Code (IECC) were assumed. There has been much industry discussion as to whether or not high levels of insulation would negate any effect of roof reflectivity, and this study suggests that is not the case. Therefore, as the 2015 IECC insulation levels become adopted, the work indicates that it would not reduce the case for using reflective roofing. It also should be noted that states are adopting the 2015 IECC at varying rates. As is well known, model energy codes take time to be promulgated and incorporated into building regulations.

As to the occupancy patterns of commercial buildings and the degree to which internal operations affect energy loads, the first points made above similarly apply. The study clearly states that the goal is to examine the roof's contribution to energy load and efficiency as a part of the building envelope. Finally, the use of cool roofing has been required by many cities and states. It has been broadly recognized that cool roofing leads to improved energy efficiency. What has been questioned is the impact of cool roofing in northern areas, as detailed in the review section. This modeling study indicates that there isn't a significant heating penalty due to the use of cool roofs in the north, even when high levels of insulation are assumed. As with any study based on modeling, next steps should include actual experimental validation as made clear by the authors.