Denver Technical and Poster Session Papers Questions and Comments

This is a compilation of the written questions and comments submitted to authors by attendees at the 2013 ASHRAE Annual Conference in Denver, Colorado. 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. 119, Part 2.

DE-13-008

Evolutionary Tuning of Building Models to Monthly Electrical Consumption

Aaron Garrett, PhD **Joshua New** *Member ASHRAE* **Theodore Chandler**

Ron Judkoff, Chief Architectural Engineer, NREL, Golden, CO: Regarding "metrics," the presenter only mentioned "goodness of fit" or "fitness" as a metric. It is possible to have a good fit for the wrong reasons. The NREL methodology for testing calibration procedures uses three metrics, "goodness of fit," accuracy of retrofit savings predictions, and how well the calibration method identified the "truth" input parameters.

Joshua New: We have collected metrics that show per-variable accuracy of 15% when monthly data is available and 8% with hourly data that is outside the scope of this current ASHRAE publication (is in review), but these metrics which quantify the extent to which Autotune matches "the real building" was shared in DOE Building Technology Office peer review: www1.eere.energy.gov/buildings/technologies/pdfs/emrg tech03_new_040213.pdf.

The key is that there is a set of metrics which quantify the physical realism of a tuning process, which corresponds to metric #3 from the commenter's list of methods. We shared results in the paper for metric #1, and metric #2 was not applicable since there was no retrofit to the building used in this study.

Stephen Long, Manager, Southern California Edison, Rosemead, CA: Can this approach be applied to other modelling approaches than Energy Plus?

Joshua New: Yes. Autotune was designed to be simulation engine agnostic from the beginning and can apply to any computer program which meets the 4 following criteria:

1) Takes input
2) Provides output
3) Can be run in a tractable amount of time, and
4) Has "real world" data to compare against.

This was necessary due to foreseen changes in EnergyPlus (separate story). The primary items that need to be changed to accommodate a new simulation engine is to convert the file input/output mechanisms for the simulation engine and have a running engine on a platform that runs Autotune. As an example, we converted the Office of Weatherization and Intergovernmental Programs' (OWIP) National Energy Audit Tool (NEAT), which uses a variable-degree-day method, to use Autotune in about a man-month.

While the NEAT conversion hasn't been made public, the general approach, technical details, and methods for Autotune are well-documented in 29 related publications since April 2012 (attached with links to preprint PDFs). It is ok to share my contact information if they are interested in following-up directly.

DE-13-024

Application of the Standard 62.1-2007 Indoor Air Quality Procedure to Retail Stores

Barry Bridges, PE *Life Member ASHRAE* **Neil Carlson** **David Grimsrud, PhD** *Fellow/Life Member ASHRAE* **Tony Springman, PE** *Member ASHRAE* **Scott Williams, PE** *Member ASHRAE*

Hoy Bohanon, Director of Energy Programs, Working Buildings, Winston-Salem, NC: What was the HERV rating of filters in stores? Will mixtures requirement being added to 62.1 change your conclusions?

Barry Bridges: The filters used in the stores are MERV-8 filters. Possible new requirements will affect the method of future testing. The conclusions based on the standard active at the time of the study do not change.

Michael Deru, Sr. Engineer, NREL, Golden, CO: Did you consider optimizing the ventilation rate based on the time averaged dilution of pollutants and on the energy impact? What is the optimal economizer operation to minimize energy consumption while maintaining acceptable IAQ?

Barry Bridges: We used the assumption that pollutant sources are continuous. The continuous steady-state ventilation rate minimizes average exposure to occupants in the store. (See the discussion section of the paper where the "harmonic mean" of the ventilation rate is discussed.) A performance-based ventilation approach does provide information on contaminants that could be used to further optimize timing of ventilation to take advantage of electrical demand response and other time of day energy opportunities. Daily variations in weather, occupancy, real time energy cost and contaminant concentration could be used for ongoing optimization.

Dennis Stanke, Staff Applications Engineer, Trane, La Crosse, WI: If you measured OA flow rate indirectly (by measuring CO_2 for instance), then you can't really deduce how much OA flow the intake requires or contributes.

Barry Bridges: We have observed that the building is pressurized to about 0.02 in. except for short durations at neutral pressure. In this case, determining the ventilation rate from CO_2 concentrations (when all sources are accounted for) is appropriate. In addition, test and balance reports and on-site verification of outside airflow taken during the test period were used to validate ventilation airflow.

Marwa Zaatari, Student, University of Texas at Austin, Austin, TX: Filtration will not solve the problem of high indoor $PM_{2.5}$ concentration if we have high infiltration and high outdoor $PM_{2.5}$ concentration.

Barry Bridges: We agree. Infiltration is unfiltered air. Our experience in this group of stores found in three different regions of the country (MN, FL, MD) that outdoor $PM_{2.5}$ concentrations are the dominant source of the $PM_{2.5}$ that is measured in the stores. As noted in the response to Stanke, the mechanical ventilation is operated to provide a neutral to slight positive pressure-mitigating infiltration.

DE-13-025 (RP-1597)

Optimized Control of Automatic Windows for Energy Savings and Occupant Comfort

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Shanti Pless, PE
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Charlie Curciga, Scientist, LBNL, Berkeley, CA: Does your study take into consideration energy savings resulting from reduced need of centralized ventilation through fan power savings?

Ryan Tanner: Yes, this study does take into consideration energy savings from reduced need of centralized ventilation. In fact, the main take-home message is that energy savings are best achieved when the centralized ventilation system is coupled to the natural ventilation system in what we call an "interlock" system. Often there is no coordination between automatic windows and mechanical ventilation; when there is coordination, one can save fan energy by reducing ventilation rates when windows are open and natural ventilation is in effect.

Kimberly Barker, Principal Application Engineer, Siemens, Buffalo Grove, IL: Besides the recommendation to interlock windows with VAV (mech coding), what benefit does monthly reset provide for other climate areas? Is there an additional strategy that could be applied? Does this need further study?

Ryan Tanner: Unfortunately, this study did not include investigations with other climate areas, and there is certainly room for more study. The best set of control setpoints presented in this study are specific to the Golden, CO, climate, and to the RSF building, which has a unique combination of features described in the paper. A different strategy that works in many naturally ventilated buildings is to compare indoor and outdoor conditions, rather than just relying on outdoor conditions as in the RSF. A simple control strategy that will work year-round (and will change with the weather) is to open windows when outdoor conditions fall within the ASHRAE Standard 55-2010 adaptive comfort envelope and to close windows when indoor conditions are approaching the boundaries of the comfort envelope. For anyone curious about what benefit a monthly reset might provide in other climate areas, a simple analysis of a climate file will provide some insight into the potential benefits of natural ventilation. For example, summing the hours in each month when outdoor conditions fall within the ASHRAE Standard 55-2010 comfort envelope will indicate how many hours are potential natural ventilation hours, and summing the hours when outdoor conditions are cooler, but not too cold or too humid, will indicate how many hours have potential for natural cooling.

DE-13-029

Method to Compute the Enthalpy Difference of a Liquid Stream in the Absence of an EoS-based Function

K.J. Schultz, PhD
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Phillip Johnson, Director of Engineering, McQuay International, Staunton, VA: A well written and useful paper for the industry; thanks for this contribution! I don't quite understand the author's comment in footnote 1, since the net capacity used by AHRI Standard 550/590-2011 for published chiller ratings does not give credit for higher capacity with higher pressure drop. It is the gross capacity that includes an additive term in the evaporator due to pressure drop (and a subtractive term in the condenser). This $\Delta P/\rho$ term is intended to more closely capture the total heat exchanged between water and refrigerant in order to provide for a more accurate energy balance. It is still a simplification of the thermodynamics, but it avoids the complexity of requiring enthalpy values at the inlet and outlet. Considering the pressure drop due to frictional losses as a source of heat generation, it is somewhat intuitive to think of the net capacity in an evaporator as what is available for useful cooling of a building load or process load. Considering different evaporator designs with varying frictional losses, but equal net capacity and equal temperature change, as the frictional losses increase the gross capacity increases in order to dissipate the additional energy losses from the water to the refrigerant, but the end user of the cooled fluid receives no additional benefit or cooling capacity. The penalty for higher frictional losses is reflected in a system analysis as increased pumping energy.

Ken Shultz: Thanks for the comment. I agree entirely. The footnote was meant to convey an admittedly nontechnical rationale (as a way to be brief) for not using the "gross" capacity to rate a chiller, instead using the "net" capacity as defined in AHRI 550/590-2011. Your comment clarifies my footnote in a much more technical manner. The calculation of gross capacity in AHRI 550/590-2011 is an example of a formulation that neglects the small adjustment of $1 - T\alpha_P$ in the $\Delta P/\rho$ term in Equations 13 and 14. As shown in the paper, this has little consequence when the chilled fluid is water.

DE-13-038

A Novel Building Component Hybrid Vacuum Glazing—A Modelling And Experimental Validation

Yueping Fang, PhD
Farid Arya
Trevor J. Hyde, PhD
Neil Hewitt, PhD

Kelly Kissock, Professor, University of Dayton, Dayton, OH: Why is U dependent on whether vacuum is on warm or cold side?

Yueping Fang: This is due to two main reasons. (1) As the convection within the air gap strongly depends on the air temperature within the air gap, the thermal transmittance across the air gap is different when it is facing the warm or cold side ambient. This results in the U-factor of the total hybrid vacuum glazing being affected by the setting direction. (2) This is also due to greater thermal resistance of the vacuum gap compared to the air gap. When the vacuum gap is positioned on the warm side, the heat transfer through the glazing is reduced.

M. Mohammed Shah, Consultant, Redding, CT: Did you consider using vacuum glazing for all three glass plates?

Yueping Fang: Yes, that is triple vacuum glazing, which has been theoretically and experimentally investigated, whose thermal performance is clearly better than HVG. Please see references Fang et al. 2010a and Arya et al. 2012.

David McCowen, Marketing Executive, SEMCO Energy, Negaunee, MI: What problem was caused by the "temperature induced stress" that resulted in the need for the third (hybrid) sheet of glass?

Yueping Fang: The rate of expansion of the two glass sheets of a vacuum glazing is different due to the difference in temperature from the warm and cold ambient air. This causes stress (i.e., temperature-induced stress) within the vacuum glazing system as the edges of the two glass sheets have been bonded rigidly by an edge seal. Although it has been prove that a well-designed vacuum glazing can sustain this stress, after applying the third glass pane with an air gap, the temperature difference between the two glass sheets of the vacuum glazing is reduced, leading to the temperature-induced stress being reduced.

DE-13-039

Corrosion of Embedded Metals in Wood: An Overview of Recent Research with Implications for Building Moisture Design

Samuel L. Zelinka, PhD

Kelly Kissock, Professor, University of Dayton, Dayton, OH: If galvanized nails corrode faster than steel nails, why use galvanized nails?

Samuel L. Zelinka: The corrosion rate is just one design consideration. When iron corrodes, it releases iron ions into the wood which break down the cellulose through a Fenton reaction and weakens the wood surrounding the nail (so called "nail sickness"). Zinc ions (from the corroded galvanized fasteners) do not break down cellulose.

DE-13-041

Simplified Model for Ground Heat Transfer from Slab-on-Grade Buildings

Kelly Kissock, PhD, PE *Member ASHRAE* **Abinesh Selvacanabady** **Narendran Raghavan**

Joel Neymark, J. Neymark & Associates, Golden, CO: Were you able to compare your model to example results for any of the cases in the IEA BESTEST slab-on-grade model tests? (See NREL publications database, Neymark et al. 2008, 2009.)

Kelly Kissock: Unfortunately, we were not aware of the IEA BESTEST slab-on-grade model tests at the time of publication. Future work will compare our results with the IEA data and possibly use the data to refine our models.