
Dan Int-Hout

High Performance Air-Distribution Systems

BY DAN INT-HOUT, FELLOW ASHRAE

ASHRAE recently established several multidisciplinary task groups (MTG) and challenged them to integrate ideas from across a number of technical committees (TC) and other interest groups. Members of the MTGs represent their corresponding committees, not themselves, which is a unique policy in ASHRAE. Additionally, members are recertified annually by the chair of the TC they represent.

As a technical activities committee member and section head for these MTGs, I am kept abreast of all their activities. One of the MTG's, Energy Efficient Air Systems (EAS), is tasked with coordinating the "activities of related ASHRAE technical and standards committees to facilitate development of packages of tools, technology, and guidelines related to the design, operation, and retrofit of energy-efficient air-handling systems in new and existing non-residential buildings." They recently circulated a draft document for comment to several TCs, which contains both research needs and concepts for high-efficiency air systems.

As I have mentioned in previous columns, the results of ASHRAE Research Project 1515, which measured occupant comfort, system operation, and total energy use, showed the viability of VAV operation in large open office spaces. It also showed that actual interior loads are quite a bit lower than what most engineers have been designing toward. While the Energy Efficient Air Systems MTG is looking at a number of issues related to the performance of the air handler fans and supply ductwork, there is no doubt that the delivery of variable airflow to a space, with properly selected air outlets, will provide an acceptable environment, even with airflow rates as low as the ASHRAE minimum ventilation rate.

Given that we can maintain an acceptable environment at these low airflow rates, we need to look at managing humidity at the same time. Tighter building envelopes make it easier, but systems need to be designed to manage both ventilation and humidity without subcooling, which seems to be the greatest problem of most interior offices.

As was shown in RP1515, setting the minimum airflow rate too high can cause interior system temperatures to drop far enough to drive the controls into heating mode. This, combined with the (often code required) dead-band, will result in a system that attempts to maintain a setpoint several degrees below optimum. Other studies conducted in California have shown that today's digital controls and VAV box inlet probes have the capability of maintaining very low flow rates. Moreover, digital controls are easily programmed with heating airflow rates high enough to ensure that the ceiling diffusers can properly mix warmer air and avoid stratification.

ASHRAE Standard 90.1.has an addendum that allows higher reheat airflows. Up to 50% of the cooling maximum airflow is allowed if the controls start at 20% and use variable volume heating while limiting discharge temperatures to prevent stratification. As I have mentioned, repeatedly it seems, discharging very hot air at the ceiling is a big "no-no." When this occurs, ASHRAE Standard 62.1 requires increased ventilation; it is also unlikely that ASHRAE Standard 55's vertical temperature stratification limits will be met.

A factor that is often ignored, which can be a very important energy saver, is proper use of economizer systems. Non-VAV systems are seldom able to take advantage of the real benefits of properly managed economizer operation. The minimum ventilation rate is also no longer considered a "constant."

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Standard 62.1 identifies three minimum ventilation rates. "Off" is when the space is unoccupied. This may mean a room is locked, but some school districts consider a classroom that not scheduled for class to be considered "off." The second state is "unoccupied," which typically requires 0.05 cfm/ft^2 (2.54 L/s·m^2) ventilation to take care of carpeting and other sources of potential VOCs. "Occupied" means that both the minimum space ventilation and the minimum occupant ventilation are to be maintained.

The consequence of this is that many types of spaces will have a dynamic ventilation rate, implying a moveable damper on the ventilation supply duct to the zone. With a VAV system, of course, this is a part of the design. For other systems, such as a water source heat pump, fan coil, variable refrigerant flow, or even chilled beams, engineers will need to consider how to accomplish this. Placing a moveable damper on the ventilation supply, allows one to manage economizer operation. Of course, pressure independent flow management (using a flow measurement technique) will be required if one is to maintain true flow rate control. Again, this is already a part of any VAV system.

Fan-powered VAV boxes, which have been in use for many years, have never been properly accounted for in energy models. ASHRAE and AHRI conducted a joint research program to determine whole system energy response for both series and parallel fan boxes as well as standard and electrically commutated motors (ECM). The output of this study has been made available to ASHRAE; AHRI is sponsoring a research project to incorporate these models into the energy calculation programs to better predict energy savings of different strategies.

With a proper combination of diffuser selection and variable volume series-flow fan boxes (which make ECM motors accurate, efficient, and practical), it promises to be an extremely efficient system. When combined with sensible cooling coils on the fan boxes (usually on the induction inlet to minimize pressure loss), one may consider eliminating the conventional air handler altogether and relying on the dedicated outdoor air system (DOAS) unit for economizer, ventilation, and humidity control.

Stay tuned as the Energy Efficient Air Systems MTG develops research projects and design recommendations with the goal of making VAV systems truly energy efficient, meeting ventilation standards, and providing occupant comfort. ■

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