IAQ: Re-tuning Commercial Buildings

A low-cost path to improved air quality and energy efficiency.

BY SCOTT GORDON, CM

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Qualified technicians frequently use a digital manometer to take static-pressure profile readings when tracking down air-flow restrictions that have a negative impact on maintaining proper building ventilation rates.

As more companies install sophisticated energy-management and control systems to manage a wide range of building systems, the need to regularly re-tune systems, components and controls to ensure efficient operation and planned outcomes becomes increasingly more important. Among those outcomes is proper ventilation, which contributes to the health, safety and comfort of building occupants.

Ventilation is the process of supplying air to or removing air from a space for the purpose of controlling air containment levels, humidity or temperature within the space. Commonly referred to as "outside air" or "ventilation air," it is the process of diluting contaminants within a building's inside air by introducing fresh outside air into an air-handling unit to mix with the recirculated air inside. Effectively doing so requires that the proportion of outside air to inside air be closely monitored and controlled so that good IAQ can be maintained. It is important that outdoor air is introduced through a building's mechanical system, where the air can be properly filtered and conditioned to provide a comfortable and safe environment for the building occupants.

« Optimizing reset temperatures at AHUs has an energy impact all the way back to the chillers in the central plant. Here, a technician is measuring water flow through a chiller during a kw/ton efficiency test in the field.

Proper building air pressure also must be controlled to achieve high IAQ. Outdoor air leaking into a building through infiltration does not allow the AHU to properly treat the air, which can cause IAQ and comfort-related issues. Controlling building pressurization so that inside air pressure is 0.03 in. wc–0.05 in. wc higher than outside air pressure helps prevent leakage of untreated outside air into the building. Yet controlling building pressurization is not always easy and is subject to multiple factors, including weather conditions, partially connected internal spaces with various uses and the building's mechanical ventilation system, which has the potential for uneven distribution of ventilation air within the building. Uneven distribution of ventilation air is a common problem, especially with VAV systems prevalent in commercial office buildings (refer to ASHRAE Standard 62.1-2010 for additional information on this subject).

In addition to unfiltered and unconditioned outside air introducing contaminants into a building, infiltration of outdoor air as a result of poor pressurization control can result in high energy use, comfort complaints, drafts, noisy air flow, difficulty opening and closing exterior doors and, eventually, structural deterioration.

Re-tuning can be an important tool to prevent poor IAQ and building pressurization issues. Re-tuning includes reprogramming and otherwise enhancing the capability of building systems to run mechanical systems more efficiently. In most cases, the re-tuning process can be implemented through the

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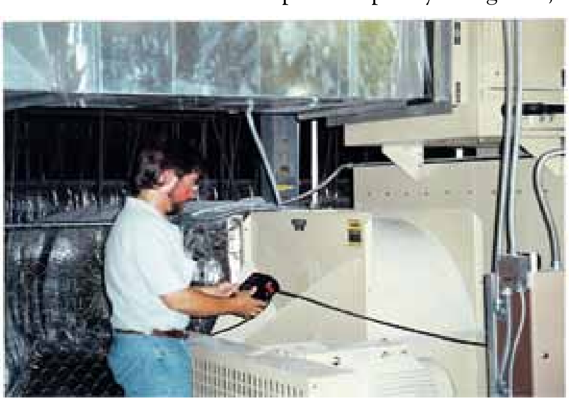
building control system at little or no cost and typically entails inexpensive repairs and identifying opportunities for operational improvements.

In the case of building pressurization, the re-tuning process checks that certain building pressurization controls are calibrated correctly and pressure sensors that monitor the indoor-outdoor pressure differential are adjusting dampers and fan speed as required to properly ventilate the building. Some common building pressurization problems discovered in the control re-tuning process are: incorrect location and calibration of pressure sensors; damper linkages that are not properly adjusted; air-flow measuring stations in need of calibration; poor tracking of supply- and return- air fans; and improperly set up air-side economizers.

Using Standard 62.1

ASHRAE Standard 62.1—Ventilation for Acceptable Indoor Air Quality—is the standard for ventilation requirements and, consequently, for re-tuning efforts with respect to ventilation systems. Standard 62.1 defines minimum breathing-zone ventilation rates for multiple occupancy categories, and provides a calculation to find the minimum intake air flow needed for different types of spaces and ventilation systems.



A technician is measuring fan performance to verify proper building ventilation rates.

Standard 62.1 was written for new construction; however, it is intended for guidance in the process of improving IAQ in existing buildings, so some elements can be applied to existing buildings. ASHRAE states that adoption of the standard as a whole for existing buildings can impose requirements that were not considered, some of which might be impractical or unreasonable. As an example, when equipment in an existing building is upgraded or replaced, the new equipment must comply with the standard. In other cases, in which the equipment is not capable of performing to the standard's requirements, it is best to get as close to the performance standards as possible. This may require working with a design engineer that is familiar with Standard 62.1.

There are several methods of calculating the volume of outdoor air that enters an air-handling unit, including use of the building-automation system. By using the BAS and calibrated averaging temperature sensors for mixed and return-air streams and an accurate outdoor-air temperature sensor in a good location, the percentage of outdoor air can be calculated. The following formula can be programmed into the BAS to continually monitor the percentage of outdoor air for each AHU:

$$\%\ \text{outdoor air} = \frac{\text{mixed air db} - \text{indoor air db}}{\text{outdoor air db} - \text{indoor air db}}$$

Another method employs air-flow measuring stations in a process known as volumetric fan tracking. As an example, if the air handler is supplying air flow at 20,000 cfm and the return fan is returning air at 15,000 cfm, the differential of 5,000 cfm represents the volume of outside air coming into a building and mixing with the return air. This measurement method requires that air-flow measurement stations be located in the inlet of the supply-air and return-air fans. An air-flow measuring station also can be located in the outside-

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›› **The AHU was not able to handle the additional cooling and heating load from the outdoor air, so the outdoor air intake was blocked off, laying the foundation for a building to have IAQ problems.**

air intake louver/damper assembly, where the station can directly measure and control the proper amount of ventilation air into the building.

Additional strategies

A number of re-tuning strategies can be used individually or in combination to optimize building ventilation systems. The first strategy involves making certain the air volume matches Standard 62.1 requirements with respect to the building type, space use and occupancy. This strategy requires the building owners and engineer to understand the building occupancy schedule and to determine whether the proper amount of outside air is entering the building to match the building occupancy, and then make the necessary adjustments to the air handler to ensure that proper ventilation is occurring.

A second strategy—demand-controlled ventilation—is a control strategy that monitors the level of CO_2 inside a building. As the occupancy rate increases, the CO_2 level rises as well, indicating that more outside air is required. A combination of occupancy and CO_2 sensors throughout the building control the outside air dampers to bring in more outside air as necessary. In the re-tuning process, technicians use a handheld CO_2 meter to calibrate sensors to ensure their proper operation and identify areas that are potentially under- or over-ventilated.

Due to their low cost, occupancy sensors are often used instead of CO_2 sensors in small areas such as offices. These sensors can be used to turn off lights and place VAV boxes in the unoccupied mode, while triggering the control sequence of resetting ventilation air volume down at the air-handling unit level.

Another strategy that is simple to implement and has the potential to generate significant savings involves keeping outdoor air dampers closed in the early morning as the building warms up or cools down, depending on the time of year. This process can occur before a building is occupied and, therefore, during a time when ventilation is not required. Dampers can be opened slowly as building occupants begin to arrive, saving 10–15 hours a week of having to bring in outside air, cool/warm it and dehumidify/humidify the air. The potential energy savings make it important to check damper operation as part of the re-tuning process.

Finally, the re-tuning process can be helpful in making sure that exhaust fans are interlocked with the associated air handlers. In cases where fans are not interlocked, exhaust fans continue to run, even when air handlers are shut off. The result is a building that receives no outside air for ventilation purposes, even as negative pressure is created, providing opportunities for unfiltered and unconditioned air to enter the building through cracks around doors and door thresholds, windows and weather stripping.

Efficiency/cost savings

Re-tuning should not be limited to strategies for ventilation optimization. In addition to IAQ, the re-tuning process also can impact energy-efficiency goals and cost savings, as the following measures indicate:

- → **Optimized scheduling:** Adjusting equipment start/stop times so that morning warm-up/cool-down periods are no longer than necessary can contribute to additional energy savings. Schedules can be created or adjusted to match building occupancy.
- → **Unoccupied hour setback:** During the heating season, lowering the zone temperature setpoint when the building is unoccupied can result in energy savings. The size of the savings depends upon a number of factors, including the number of heating hours and temperature each year (weather bin data); the extent of setback in terms of time and degrees; the thermal efficiency of the building envelope (U-value); and energy consumption without setbacks. Although savings also can be associated with the cooling season, savings at this time of year will likely be less due to a lower temperature difference between indoor and outdoor air.
- → **Supply-air temperature reset:** Paying close attention to supply-air temperature as part of the re-tuning process can significantly impact energy costs. That is because supply-air temperatures are the most important control parameter for air-handling units, and have a direct energy impact all the way back to the chiller and boiler at the central plant. If the supply-air temperature is too low, the terminal boxes must reheat the over-cooled air before sending it to each zone. If the supply-air temperature is too high, the zone(s) may lose comfort and humidity control. Adjustments to the supply-air temperature should be made so that the temperatures run as high as possible, while still meeting the cooling needs of the zone.
- → **Discharge static-pressure reset:** Most VAV systems operate at a fixed static-pressure setpoint, regardless of the load on the air-handling unit. However, it should be noted that higher-than-required discharge static pressure causes high noise levels in VAV boxes or diffusers and puts an extra load on the AHU. In addition, wear on the fan and belts increases, as does the cost of energy to operate the fan. Re-tuning can prevent some of these negative and costly side effects associated with high discharge static pressure, by providing an opportunity to reset (lower) the pressure as the building load falls below full design conditions.
- → **Improve economizer operation and control:** The economizer should control the supply-air temperature by modulating the outdoor air damper when the temperature outside is lower than the supply-air temperature setpoint. However, economizer control often is implemented to maintain discharge-air temperature at 55°F—a control strategy that is far from optimum. This can be improved by integrating economizer operation with supply-air temperature reset. This action will increase the number of hours each year that the air-handling unit can operate in the economizer mode and conserve energy associated with reheating the air.

As these measures indicate, re-tuning offers building owners the opportunity to examine a number of control strategies within a building to identify operational problems and ensure optimal building performance. By having their facilities re-tuned and making adjustments to poorly tuned or underutilized systems, building owners are better positioned to help facilities meet energy-efficiency goals and satisfy the comfort and safety requirements of building occupants.

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