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OA REDUCTIONS CAN CUT Facility Energy Costs

A look at some of ASHRAE's fresh-air compliance standards and how properly utilizing them can save building tenants from poor IAQ issues while saving building managers/owners money.

BY MIKE WALRATH

Images courtesy of Fresh-Aire UV.

Calculating outdoor air (OA) reductions to cut commercial-building HVAC-energy costs, while still complying with acceptable indoor air quality (IAQ) codes, can be a complicated and confusing process. Luckily, some air-quality device manufacturers have developed intuitive software programs for HVAC contractors, engineers and building owners that make the OA reduction process as easy as filling out a job application.

Contractors, engineers and building owners should realize the invaluable potential these programs provide. There are literally thousands of commercial buildings throughout the nation that may be bringing in more OA than is necessary. The energy costs associated with heating, cooling and dehumidifying OA can be staggering and easily surpass thousands, if not tens of thousands of dollars annually, for most commercial facilities.

Building owners who believe they are complying with ASHRAE Standard 62.1, *Ventilation for Acceptable Indoor Air Quality*, might also be unintentionally wasting energy in the process. Introducing more OA than needed can increase energy costs from 2% to 4% up to as high as 30%.

Inaccurate OA rates can result from two widespread scenarios. The first scenario is unnecessarily conditioning OA that could be reduced legally under code allowances. The second scenario is that the service contractor or in-house maintenance department has purposely or unknowingly reduced OA too much to save energy costs, and now the building is no longer compliant under ASHRAE Standard 62.1. Worse yet, the non-compliant building's occupants could be suffering adverse effects from biological contaminants or volatile organic compounds (VOC) that are not sufficiently diluted, because of insufficient OA.

Estimating OA under ASHRAE 62.1

Generally, most buildings are designed under ASHRAE Standard 62.1, Section 6.2 "Ventilation Rate Procedure (VRP)," or Section 6.3 "Indoor Air Quality Procedure (IAQP)."

The VRP's indirect approach determines OA amounts by utilizing a cfm/sq ft and cfm/person calculation. While easy to calculate, the VRP's approach may surpass the total amount of required OA, because it is customized to a building's square footage or number of occupants rather than its specific contaminants of concern (CoC).

Instead of the VRP's indirect approach, the more direct, performance-based design of the IAQP approach provides for better accuracy as outlined in ASHRAE 62.1, Section 6.3. Instead of setting minimum OA levels as cfm/person or square-footage as does the VRP, the IAQP restricts contaminant concentrations from rising above acceptable levels. The IAQP can be applied to all system types with an OA component, but the largest impacts can be made with variable-air volume (VAV), constant-air volume (CAV) and 100% OA units.

In order to reduce a building's OA by using ASHRAE 62.1 IAQP procedure, the selected air-cleaning device methodology must have a clean-air delivery rate (CADR) that is determined via certified test methods with an ASHRAE Standard test duct. The above test rig, which tests gas-phase air-cleaning equipment under ASHRAE Standard 145.2, *Laboratory Test Method for Assessing the Performance of Gas-Phase Air Cleaning Systems: Air Cleaning Devices*, is just one of a few in the U.S. It can also be used in UV-based standardization studies including ASHRAE SPC-185.1 (inactivating airborne microbes) and SPC-185.2 (inactivating microbes on irradiated HVAC unit surfaces).

Variables and the IAQP calculation

The IAQP is a more customized approach that is potentially superior to VRP, but the challenge is the amount and complexity of required calculations due to the plethora of variables and unknowns. Key variables include the determination of the specific CoC and their concentration in suggested acceptable parts per billion (ppb) or micrograms per cubic meter ($\mu g/m^3$) threshold levels.

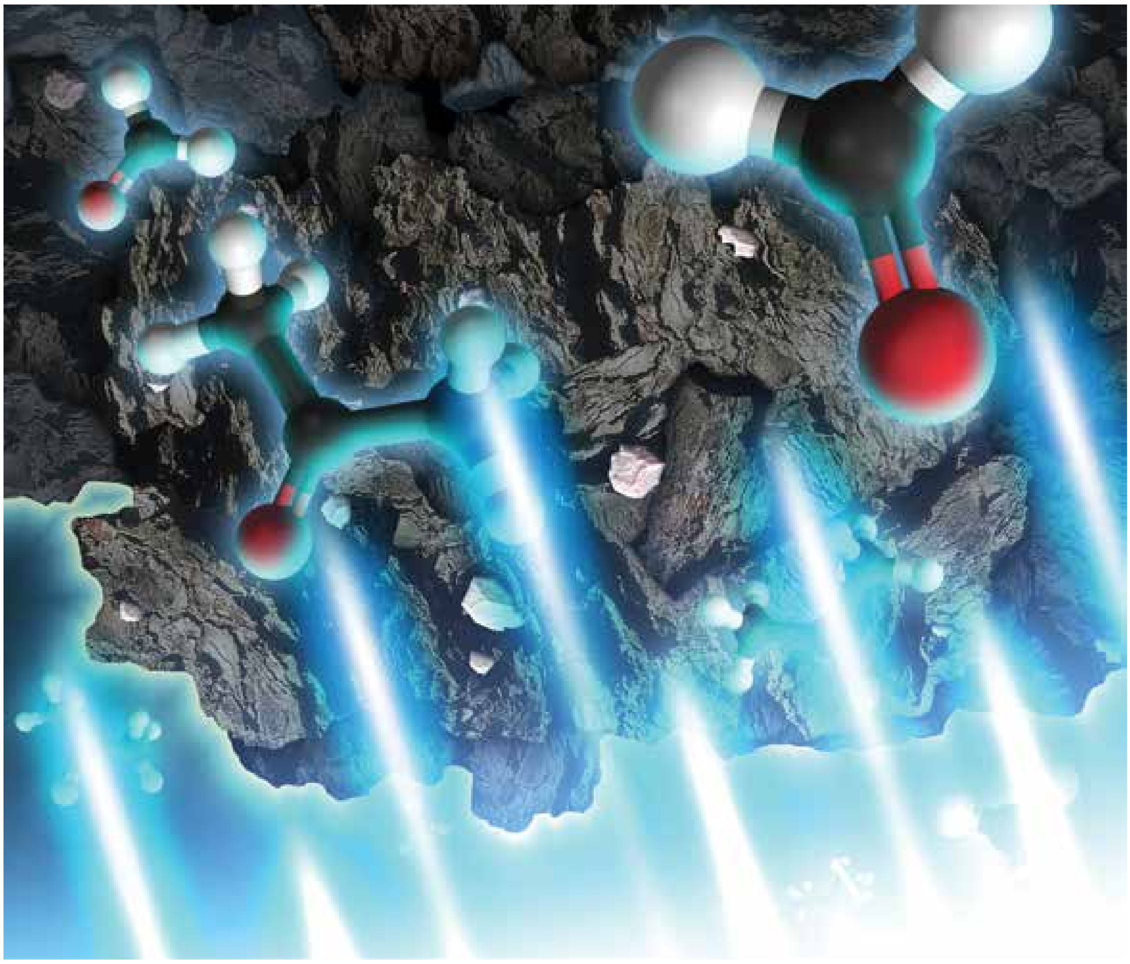
Adding even more variables to the calculations is a key component of the IAQP that allows for reduced OA levels in ASHRAE 62.1 (Appendix D) where "an air-cleaning device" can be applied to the HVAC system; whereas, the VRP does not consider air-cleaning devices.

The air-cleaning device can consist of several technologies, such as high-efficiency particulate air (HEPA) and ultra-low particulate air (ULPA) filtration; ultraviolet germicidal irradiation (UVGI) light systems; gas-phase carbon media; photocatalytic oxidation (PCO); ionization and bipolar ionization; and other methodologies. All these technologies have varying degrees of clean-air delivery rates (CADR), the type of CoC they reduce, and overall performance capabilities.

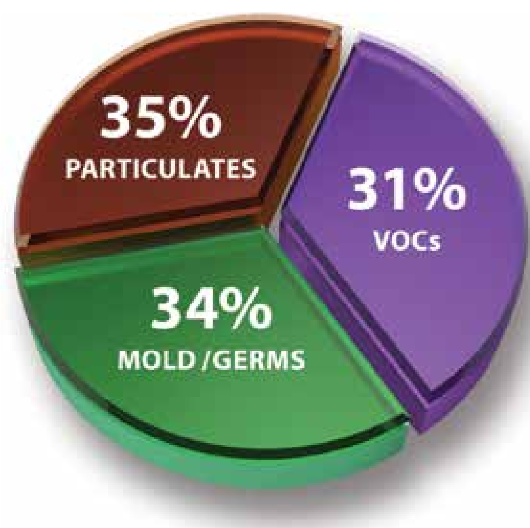
These technologies can be categorized into two groups: 1. systems that operate inside a space, such as an HVAC system near a coil or in a duct; or 2. systems that distribute some type of air-cleaning residual into an occupied area. The first method is preferred, because the process of minimizing particulates, biological microbes, VOCs or a combination of them is accomplished remotely from the breathing zone. In other words, the airstream flows through the devices and is cleaned of targeted CoC while flowing through the HVAC system. The second method is not preferred because it distributes potentially harmful airborne oxidizers into the breathing zone.

Incidentally, the aforementioned breathing zone is yet another variable that consists of an area 3 ft to 6 ft above the floor. Areas above and below the breathing zone are not typically a major concern.

In order to arrive at a reduced percentage of OA, the building's specific CoC types, their concentrations and the



» Gas-phase carbon media adsorbs and holds gaseous contaminants, then a UV light activates the titanium-oxide-infused media to create a chemical process called photocatalytic oxidation, which purifies and converts the adsorbed contaminants into harmless H_2O and CO_2 molecules. This process qualifies as an air-cleaning device that allows contractors, engineers and building owners to save commercial building energy by reducing OA under the guidance of ASHRAE's 62.1 IAQP procedure.



The Center for Disease Control and Prevention (Atlanta, GA) breaks the typical building's airborne contaminants into three categories in this pie chart: particulates, volatile organic compounds and mold/germs.

allowable regulatory amounts must be determined and included in IAQP calculations.

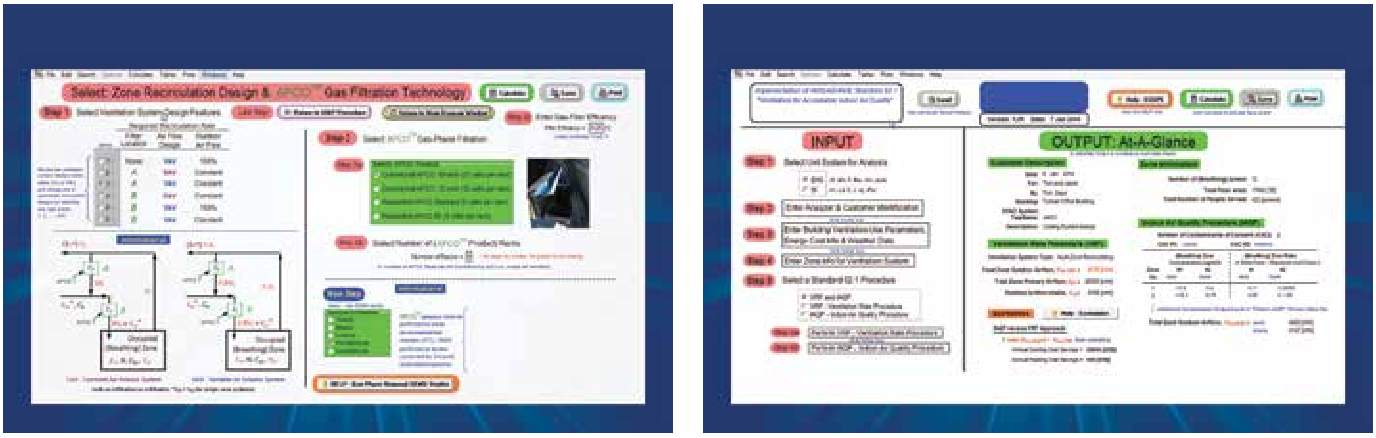
CoC identification and concentration, as allowed by IAQP, can be accomplished either through: site testing, which in most cases is cost prohibitive; or by using peer-reviewed literature written by industry experts spotlighting emission strengths for people (mg/min-person) and for building materials (µg/m^3-h) for these CoC. Typically, there are approximately 15 major contaminants identified as harmful if breathed long-term. Many cognitive authorities have identified the common CoC, such as the Lawrence Berkeley National Laboratory, Richmond, CA, which is one of many IAQP provision-approved organizations. Some of the most common inorganic CoC are carbon monoxide, nitrogen dioxide and ozone; whereas common organic CoC are formaldehyde, dichloromethane, trichloroethylene and acetaldehyde.

Once CoC are established, the CADR of the selected air cleaning methodology as per each CoC is applied. The CADRs are typically performed by a third-party air cleaning equipment measurement and testing specialist under ASHRAE test standards, such as ASHRAE 145.2 *Test Method for Assessing the Performance of Gas Phase Air Cleaning Equipment*, which is for gas-phase equipment.

Making IAQP easy

ASHRAE's IAQP has been used less for commercial-building OA reduction, because few contractors, building owners or engineers want to spend the time and money to determine all the variables and then calculate with complicated algorithms.

Therefore, particular air-cleaning device manufacturers have recently developed software that provides a database of



^ Software programs introduced by air-cleaning device manufacturers have made the process of calculating ASHRAE 62.1 IAQP procedure for estimating outdoor air in commercial buildings as easy as filling out a job application.

^ A simulated airstream microbe inactivation in an ASHRAE Standard 52.2-certified environmental duct test chamber by the third-party IAQ device test facility in Airmid Healthgroup AHG (Dublin, Ireland). Contractors, engineers and building owners relying on air-cleaning devices to help reduce their outdoor air and subsequent energy savings under ASHRAE 62.1 IAQP allowance in commercial buildings should make sure their chosen air-cleaning equipment provides what the vendor claims via third-party test results.

pre-gathered information, such as peer-reviewed CoC typically found in buildings, for example.

These software programs simplify the IAQP application to easily filling in prompts, clicking pull-down menus and selecting radio buttons with strong graphical user interfaces. CoC types, CoC concentrations, regulatory agency CoC exposure limits and a host of other difficult-to-determine variables are already integrated into the software. Easily determined fixed values, such as building zones, occupancies, floor area, ceiling height and supply/return ductwork locations are input by the applicant. The software then calculates the potential OA reduction under the allowances of IAQP provisions.

Furthermore, some software programs account for all the regulatory CoC exposure limits required by organizations, such as the Environmental Protection Agency (EPA), Occupational Safety & Health Administration (OSHA) and other authorities recognized by the IAQP. Some of these authorities further disseminate CoC requirements into exposure limits such as one-hour, eight-hour and chronic exposures.

Besides calculations, software programs also suggest intuitive choices in their OA design capacity. For example, if the ratio of a particular zone's CoC concentration divided by the regulatory exposure limit surpasses 1.00, then the software can recommend additional air-cleaning capacity or more OA. Some software also allows the selection of a different regulatory agency with a different CoC exposure limit, as long as it is IAQP provision-approved. For example, the California Air Resource Board (CARB) and the Center for Disease Control and Prevention (CDC)—two of the cognitive authorities recognized by the IAQP—have different formaldehyde exposure limits, but the IAQP does not recommend one over the other.

Consider an IAQP-based OA design example consisting of a building with one air handler serving 10 zones with 15 CoC (in each zone). Such a design consists of 150 ratios, where a ratio is the concentration of the CoC divided by the exposure limit. Once calculated with the IAQP software, if one (or more) of the 150 ratios is above 1.00, then that CoC is not in compliance with the IAQP. However, as mentioned earlier, the software allows the user to apply other regulatory authority's exposure limits or add additional filtration, which, when considered in the calculation, may lower the previously non-compliant ratio(s) below 1.00. In so doing, the new ventilation system design solution becomes compliant with the IAQP.

Ozone Watch in Air-cleaning Devices

Air cleaning devices producing a byproduct, such as ozone, are currently being reviewed by a number of organizations. The document "Oxidants and the Pathogenesis of Lung Diseases," sponsored by the National Institute of Health (NIH), Research Triangle Park, NC, makes a direct correlation between ozone exposure and lung diseases.

According to authors Jonathan Ciencewicki, Ph.D., Shweta Trivedi, Ph.D., and Steven R. Kleeberger, Ph.D., "many air pollutants exert their major effect by causing oxidative stress in cells and tissues that they contact. Gaseous pollutants including O3 (and other pollutants too numerous to name) are known to form ROS (reactive oxygen species)."

The NIH paper also asserts that an ROS byproduct, such as ozone, should not be distributed throughout an occupied zone, because it can contribute to breathing issues, such as asthma, chronic obstructive pulmonary disease (COPD), acute respiratory distress syndrome (ARDS) and others.

The EPA has also stated a position on ozone in its document "Ozone Generators that are Sold as Air Cleaners." In the document, the EPA states that "the concentration of ozone would have to greatly exceed health standards to be effective in removing most indoor air contaminants. In the process of reacting with other chemicals indoors, ozone can produce other chemicals that themselves can be irritating and corrosive."

On another front, ASHRAE expects to release a position statement in 2015 that reports on various health issues, of which one of the concerns will be ozone-producing devices.

Software solution documentation, which is mandated by the IAQP, is also invaluable because it verifies each zone's CoC reduction, which can serve as a proof of compliancy if any liability issues occur against the building's OA policy. Post-IAQP application evaluations are as difficult to compile as pre-application CoC tests. However, IAQP does recommend evaluating the results by questioning occupants for any adverse symptoms from the OA reduction. If software was originally used, then the modification to remedy occupant complaints can be easy as selecting a few different radio dials.

Choosing an air-cleaning device

The key to substantial energy savings via the IAQP depends heavily on the use of an air-cleaning device. Like any HVAC category, not all products have equal performance specifications. Therefore, engineers, contractors and building owners should be wary of air-cleaning product vendors' efficacy and performance claims. Therefore air-cleaning product specifications should be substantiated by a third-party tested CADR that is certified under ASHRAE 145.2.

Static pressure increases due to the filtration method's inherent air-flow resistance and subsequent fan energy increases, such as those associated with HEPA, ULPA and gas-phase carbon-media beds, may create a trade-off that diminishes the total efficacy of the reduced OA energy-consumption process. The IAQP equations provide an efficiency factor for air cleaners, but the VRP does not. Therefore, air-cleaning systems that minimally raise static pressure, such as UV lamps for microbial CoC disinfection and/or gas-phase carbon-media matrixes (versus more restrictive gas-phase media beds) will help retain the energy savings gained through OA reduction.

With the dozens of complicated variables to consider, using IAQP-calculating software can be invaluable in a quest to compliantly reduce a building's OA for energy savings. As more industry members discover the value of the IAQP and its ease of implementation via software programs, more commercial buildings will experience significant energy savings via code-compliant OA reductions.

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