INTERNATIONAL ASSOCIATION OF MUSEUM FACILITY ADMINISTRATORS

PAPYRUS

VOL. 17, NO. 3 WINTER 2016–2017

What I Learned — the 26th IAMFA Conference

Networked Lighting-Control Systems

The Greenest Building

Trends in Indoor Air Quality

Waste Management at the Smithsonian

When Fire and Smoke Dampers Fail

Trends in Indoor Air Quality

By Robert F. Goodfellow

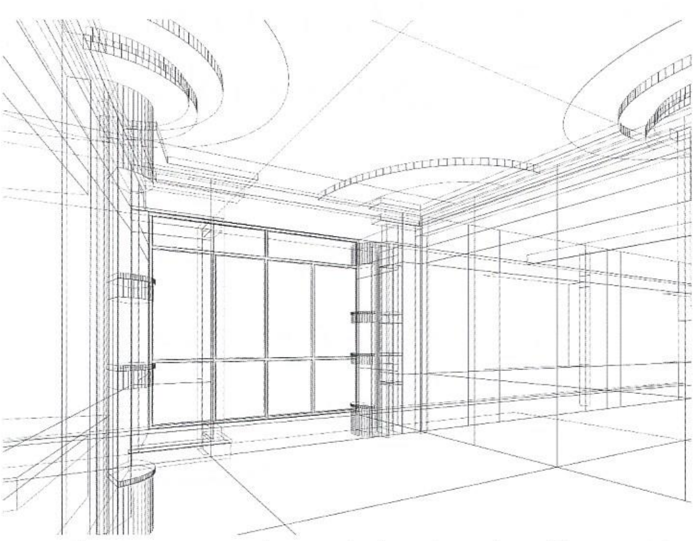
Indoor air quality (IAQ) initiatives in Museums have been on the rise in recent years. Many result from an interest in lowering operating costs, protecting valuable collections, or a need to correct issues related to specific airborne contaminants.

The Most Common IAQ Problems

The IAQ problems that generally get the most attention are those involving complaints from staff and visitors. These issues can be further exacerbated by allergic reactions and health issues.

Indoor air contaminants can either originate within a building or be drawn in from the *outdoors*. Sources of indoor air contamination include polluted outdoor air, underground sources (e.g., radon, pesticides, sewer leaks), and a variety of indoor sources (e.g., people, equipment, furnishings, and housekeeping supplies). And pollutants can vary with time of day, such as only when floor stripping is done, or during rush-hour traffic.

Today, the most common IAQ problems involve outdoor contaminants infiltrating the building with outdoor air. Perhaps the most common issue involves vehicle emissions, which can be problematic when the building is located in a metropolitan area, or near heavily traveled roads or highways. Emissions from vehicles and internal combustion engines produce a variety of chemicals, many of which are toxic, including hydrocarbons, carbon monoxide, methane, nitrogen oxides, sulfur dioxide, volatile organic compounds, ozone, and particulate matter in the form of soot. These substances can have a detrimental and corrosive effect on museum collections and archives.



A good IAQ strategy can improve indoor air quality while protecting collections, reducing energy consumption, and lowering building operating costs.

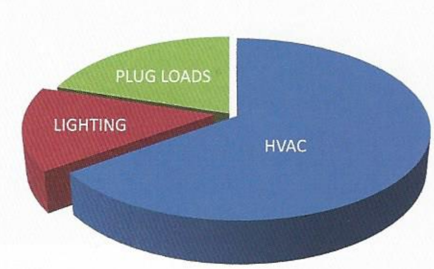
Historically, more outside ventilation air has commonly been used to dilute airborne contaminants. This strategy was especially common when smoking was common indoors. Over the years, however, with the ban on smoking indoors and the use of low-VOC-emitting furniture and building materials, airborne particle and odor contaminants are much more apt to enter a building through fresh-air intakes. To cope with these issues, designers and facility managers have found that high-efficiency, ozone-free air-cleaning systems can be incorporated into HVAC systems, not only to clean incoming fresh air, but also to keep indoor air at contaminant levels below outdoor levels.

As a case in point, designers for a metropolitan museum in Philadelphia, Pennsylvania, housing one of the most valuable art collections in the world, took extra precautions to remove ultrafine particles and gas-phase contaminants from outdoor ventilation air, in addition to indoor air. Polarized-media air cleaners and activated-carbon matrix systems were carefully monitored for performance. After one year of operation a core analysis was conducted to determine the remaining capacity of the carbon. This analysis determined that unanticipated high levels of hydrogen sulfide had been collected in the carbon. Further investigation revealed that the hydrogen sulfide had been off-gassed from dumpsters at a nearby grocery store.

Cost Savings

Although good IAQ has real, tangible benefits, applications for better IAQ are still largely cost-driven. So where are potential savings for designers and facility managers who implement these applications?

Energy costs present the largest opportunity. HVAC accounts for about half of the energy used in commercial buildings, making HVAC systems a good target for cost reductions and savings within a facility's annual operating budget. In new buildings, according to the U.S. Department of Energy, adopting energy-efficient design and technologies—in HVAC and other areas—can cut future energy costs by as much as 50%. And in existing buildings, renovations that replace older systems with more efficient



Typically HVAC systems dominate building energy consumption.

*HVAC – Universal Abbreviation of Heating, Ventilation and Air Conditioning.

technology can yield savings of up to 30%. With respect to only IAQ and the filtration component of an HVAC system, significant operational savings can be found through reduced fan horsepower from lower static pressure. Additional substantial savings are available from lower ventilation air requirements and lower maintenance costs through longer service intervals.

Air-filtration systems alone can reduce a building's total energy footprint by 5-10%. Historically, increasing filter efficiency has meant increasing energy and operating costs, because it takes more fan horsepower to push air through denser, more efficient filter media. The denser the filter media, the higher the resistance in static pressure. A low static pressure also corresponds directly to lower brake horsepower. Since brake horsepower drives fan energy, lower static pressure corresponds directly to energy savings. Today, the technology exists to increase filter efficiency with very low resistance in static pressure, without compromising dust-holding capacity.

System Design Benefits

ASHRAE Standard 90.1 sets allowances for brake horsepower, based upon system type and application. While these allowances can often be difficult to meet with traditional high-efficiency passive filtration, newer advanced air cleaners can help to meet them. Lowering static pressure is one of the most effective and measurable ways to immediately reduce the total energy used by the HVAC system. Active field-electronic air cleaners offer relatively low resistance. In some cases, there can be midlife pressure-drop savings of up to $1^1/_2$ inches versus passive, mechanical filters. This allows fans to be designed and selected with lower brake horsepower requirements and potentially less operational energy consumption.

Reducing Ventilation Air

A reduction in ventilation air can reduce the heating and cooling required to condition incoming fresh air. Fine-tuning ventilation air requirements can have a big impact on energy consumption, particularly in situations where ventilation rates were based on consistently high average occupancy. ANSI/ASHRAE Standard 62, which is the basis for many local mechanical codes, provides three alternative procedures for determining minimum outdoor airflow rates: the ventilation rate procedure, the natural ventilation procedure, and IAQ procedure. The first two are prescriptive methods that are easy to calculate. The IAQ procedure is more complex and based on performance criteria. It allows HVAC system designers and operators to reduce outdoor air when it has been determined that the air inside the space is clean enough.

In a typical building with no smoking and no unusual contaminant sources, outdoor air levels can often be reduced from 13 to 16 cfm/person to between 7.5 and 10 cfm/person. Such a reduction can yield significant operational savings (in addition to better IAQ). For example, in a small building with a 60-ton rooftop unit, annual savings on utility costs alone can be expected in the range of $3,000 to $12,000, depending on the geographical location of the building (hot humid climates have the greatest costs/savings), utility rates, and hours of operation.

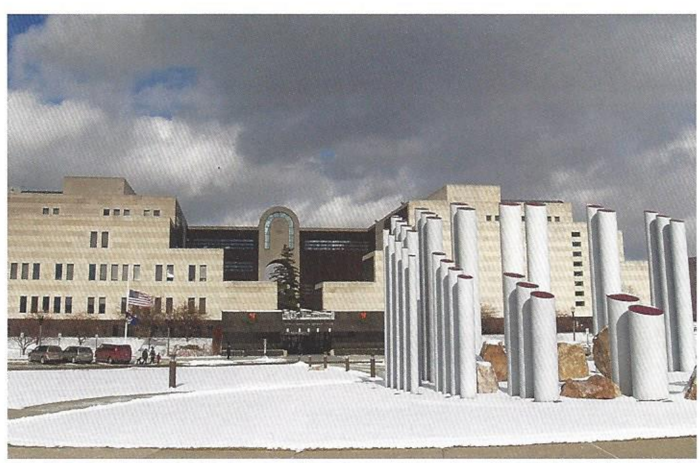
The other benefit to this approach is that outdoor ventilation air does not inadvertently create indoor air-quality issues. As discussed, in many urban environments, outdoor air is usually more polluted than indoor air. For example, in the monitoring of black carbon and ultra-fine particle levels (<.1 micron in size) inside and outside an 11-story building in a 2010 Washington, D.C. study, the (clean) indoor levels were 92-99% lower than those outdoors. Bringing dirty outdoor air indoors does not improve IAQ, whereas cleaning and re-using the indoor air does.

And lastly, reduced outside air can also have a favorable impact on equipment selection, sometimes translating into smaller equipment. This can have the net effect of essentially paying for the filtration system on the project.

Maintenance Advantages

Maintenance costs present yet another area for savings. Maintenance costs include time, labor, ordering, handling, storage, and filter disposal costs, in addition to materials. High-efficiency air-cleaning systems such as polarized-media filters offer very high dust-holding capacities that are capable of extending change-out intervals from every several *months* to every several *years*.

As a case in point, polarized-media electronic air cleaners were installed throughout ASHRAE Headquarters in Atlanta, Georgia, as part of a massive renovation. The building serves as a "living lab" where system performance and air quality are carefully monitored and tracked. The filter media in the air cleaners were not replaced for over five years, during which static pressures never exceeded the recommended change-out criteria of clean static pressure × 2.



COURTESY ANDREW MCFARLANE

During a recent renovation, designers at the Michigan Library and Historical Center were able to achieve precise environmental control, while also reducing ongoing operation costs with a state-of-the-art air-cleaning system.

Other Trends

The benefits of a good IAQ strategy, such as cost savings and increased health and productivity, have caused many people to recognize the importance of IAQ. Comprehensive energy audits are increasingly popular. Because most energy audits target the HVAC mechanical system, IAQ is getting increased attention. The same can be said for sustainability. HVAC and filtration are recognized as key areas for reducing carbon footprints and reducing waste. IAQ is also an area of emphasis in green building certifications. For example, filtration systems achieving MERV 13 or better can earn a LEED® point for IEQ Credit 3.0. Reducing HVAC Energy can qualify for a LEED point under EA Credit 1.0. Points may be available in other areas as well.


Polarized-media electronic air cleaners.

Although cost controls may typically steer facility managers toward low-cost options, particularly as it relates to filtration, the presence of sustainability initiatives can indicate a broader goal. Increasingly, sustainability initiatives have been trumping cost initiatives. In some cases, a high-efficiency filtration system can pay for itself in less than two years. As mentioned previously, fan horsepower and system static pressure greatly affect energy consumption. Filter-replacement costs and length of maintenance intervals influence ongoing operational costs. These costs can be reviewed to determine the return on investment (ROI).

Whether your goals involve providing a contaminant-free environment to protect valuable collections, or reducing facility operating costs, improving your IAQ is a good idea. Studies have shown that better indoor air quality improves health, well-being, and productivity. Today's air-cleaning systems can do that, while reducing energy consumption and lowering operating costs at the same time.

Robert F. Goodfellow is Vice-President of Marketing with Dynamic Air Quality Solutions, and an indoor air quality professional with over 25 years' experience in the heating, ventilation, air conditioning and refrigeration industry. Dynamic Air Quality Solutions is active in a wide variety of sectors in addition to museums, including schools, healthcare, data centers, and office buildings. He can be reached at rgoodfellow@DynamicAQS.com.