School HVAC

Standard 62 IAQ Procedure

Reduced Outdoor Air For Auditorium

By Peter F. Johnson, Member ASHRAE

If you don’t use the air purification option in the IAQ Procedure in ANSI/ASHRAE Standard 62.1-2004, *Ventilation for Acceptable Indoor Air Quality*, you may miss out on a non-traditional but cost-effective design that reduces heating, cooling loads, duct sizes and first costs.

The IAQ design option results in outdoor air (OA) reductions for most commercial spaces down to 5 cfm (2.4 L/s) OA per person, and are based at full occupancy 24/7. When gas cleaning technology is used with high-efficiency filters, you use less energy and have a healthy and more comfortable space.

In Ohio, Brunswick School officials were planning a new auditorium in 1998 and wanted the best IAQ with reduced OA. They also required the air-handling systems use the least amount of energy for heating and cooling the space.

In 1999 the air-handling system’s design was based on the ANSI/ASHRAE Standard 62-1999, *Ventilation for Acceptable Indoor Air Quality*, IAQ procedure that combined the use of gas-phase cleaning and high-efficiency particulate filters for reduced OA. For greatest savings, an energy recovery unit (wheel) was added for energy recovery of the exhaust air.

This project was designed as an architectural showcase. It is a one-story insulated brick building with a built-up insulated metal deck roof with single ply membrane and rooftop units.

The Ohio Building Code (OBC) Section 403.2, “Mechanical Ventilation,” requires designers to use Standard 62. The code has the option to use 15 cfm/person (7 L/s per person) of OA to be supplied per the standard’s Ventilation Rate Procedure. Or, you may use Standard 62 to calculate the required outside air with air-cleaning systems to clean gasses, vapors and improve the job of removing particulates. In 1999,

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the OBC did not allow a “design reduction in OA on a three-hour occupancy rule.”

Several types of gas-phase technologies (chemical cleaning) are available. The two methods considered were bipolar ionization vs. packed bed granular activated carbon media. Bipolar ionization was selected as the more cost effective of the two because its annual maintenance cost is low. The bipolar cleaning section is combined with a high-efficiency particulate phase filter to complete the air-cleaning system.

This project’s OA requirement was reduced from 15 cfm to 7.5 cfm (7 L/s to 3.5 L/s) per person using chemical cleaning. This level of OA only required 80% filtration efficiency (MERV 11) for particle removal. Based on the maximum occupant density of 1,000 people, the IAQ program requires calculations of the concentration for all chemical contaminants to be below acceptable limits. Contaminants generated by occupants, odors contributed from the building and undesirable fumes in the outdoor air are all handled with this design.

Software was used to quickly run zone-by-zone calculations of the chemical concentrations of all contaminants. This software program is based on ASHRAE formulas. It offers the option to consider different systems’ performance and efficiency. It then models the level of cleaning for the type of system chosen in each zone. In a few minutes, a best combination of variables can be obtained to satisfy code.

Energy Efficiency

More than a 50% reduction in outside air was achieved vs. the original design’s potential outcome. As a direct result, substantially smaller cooling and heating systems were used, and smaller airflows and ductwork were needed. A 27-ton (95 kW) cooling load reduction was achieved (from 71 tons down to 44 tons [250 kW to 155 kW]). For heating, the load reduction was 1,194 MBtu/h (350 kW) reduced down to 261 MBtu/h (76.5 kW), which is a net 931 MBtu/h (273 kW) reduction in heating. These figures include the energy reduction from an energy recovery wheel unit on the reduced OA flow (Figure 1). This site does not separately meter utilities to this building. Therefore, energy savings calculations are based on the projected utility costs (Figures 2 and 3).

With the IAQ procedure and reduced OA, the $9,268 project utility costs are reduced to $8,541, a $727 annual energy reduction with chemical cleaning and energy recovery. This low amount is due to the short number of hours the system operates, i.e., two times per week for three hours occupied at 80% and six hours Monday through Friday at 3% occupancy.

A major equipment supplier’s modeling program was used to compare standard rooftop units based on the Ventilation Rate Procedure vs. the IAQ Procedure with energy recovery ventilators.

Indoor Air Quality and Thermal Comfort

It doesn’t matter if odors come from inside the building from people, furniture, cleaning chemicals or from the outside. The supply air to the space always is controlled for odors, mold and particle removal. IAQ is improved simply because ventilation with high efficiency (MERV 11) and chemical cleaning for reduced OA vs. low efficiency filters (MERV 5)
and more OA (as would have been in the standard design) is a cleaner environment.

Pressure differential sensors are across the sets of filters to alert the building management system when units are dirty and need changing. Both sets of filters have long, useful lives because of the low number of operating hours. At the start of the job, air balancing was performed without any difficulty on this innovative approach. Ceiling air supply and underfloor return air openings are used. This design allows for a high ventilation efficiency to be used in calculation. To be conservative, we used 0.8 ventilation efficiency. In addition there is less noise. One hardly hears the air movement.

Moisture, mold and humidity in the space are easier to control with reduced OA. No HVAC complaints have been made about system operation during the last four years.

Local building inspectors and commissioning agents had not seen another project with reduced OA design based on the IAQ Procedure. We expected they would have questions about acceptable CO₂ levels. A Standard 62-1999 Interpretation answered most of their questions. Still, field verification of the common chemicals was important for verifying compliance.

Testing was done with high quality, calibrated portable test equipment to verify that concentration levels are below ASHRAE limits. CO₂ was below 2,000 ppm (max CO₂ was 5,000 ppm) and ammonia was below 2 ppm—the odor threshold level of ammonia. Ammonia was one of the challenging chemicals in designing controls in this space. All chemical concentrations are dealt with

Advertisement formerly in this space.
and are below odor or exposure levels. The key was the amount of OA, the chemical cleaning and level of filtration.

Innovation

The IAQ Procedure allows for a large OA reduction and resulting energy savings. Although the IAQ Procedure has been available since 1981, it has been tedious to calculate all the zone-by-zone chemical calculations to verify compliance with the standard. With new software from a manufacturer, project designers can quickly model the zone’s performance and calculate all chemical concentrations. System optimization can be done easily by applying the IAQ strategy for reduced OA and its associated energy saving. Calculations take only a few minutes per zone. The filtration efficiency needed also is displayed to show the necessary level of MERV filters to install.

Operation and Maintenance

Operationally, total airflow was decreased, reducing noise and improving auditorium aesthetics. Site personnel are pleased with the operation of the chemical cleaning system and that it is simple to maintain.

Filter changes are routine and scheduled when the air-handling units show a pressure drop across the filters. With the IAQ design and the high efficiency filters, the final filters are changed out about every two years. This design has not been a major extra cost or labor requirement on the site.

Bipolar ionization was selected over granular activated carbon design because of significantly less operating costs, i.e., no media change out required. In addition, a reduced air pressure drop occurs with bipolar design over carbon media. Bipolar required less fan horsepower. Bipolar has less than 0.1 in. w.g. (25 Pa) of static drop with bipolar tubes vs. 0.8 in. w.g. (200 Pa) with carbon.

The bipolar tubes work on gases and do not collect dirt. Therefore, there is less maintenance. The tubes have 30,000 hours of operational life before needing to be tested. Replacement is simple and only takes a few minutes each. A remote panel monitors if a failure occurs in the system.

Cost Effectiveness

Bipolar was the least expensive design. This project came in with lower capital equipment cost with the air cleaning strategy than the standard rooftop design. The chemical cleaning strategy allowed smaller rooftop units to be selected with the resulting lower electrical consumption.

Although the chemical cleaning units needed slightly larger horsepower fan motors with the higher efficiency filters, overall the site benefited with better IAQ, which resulted in less exhaust air. The net result is smaller duct sizes and chiller size that contributed to more first cost savings. A $60,000 savings in first costs was achieved with the bipolar chemical cleaning and reduced size of the energy recovery ventilator over a standard rooftop design.

Recognition

The Ohio School Facility Commission (OSFC) has recognized the value of the

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Ventilation Rate Procedure vs. IAQ Procedure

Original Plan per Ventilation Procedure

Designed in 1999, three air-handling units required a total of 15,000 cfm (7079 L/s) outside air with 30% DS filters (MERV 5).

Optimized per IAQ Procedure

With the use of bipolar ionization and 80% DS filters (MERV 11), the outside air is reduced to 7,500 cfm (3540 L/s). Enthalpy wheel energy recovery systems were added to save additional energy.

Benefit

The added cost of the bipolar ionization and MERV 11 filtration was less than the cost of the larger heating and cooling load per the standard design. The net result was a lower total air-handling unit cost. The annual energy savings are an added benefit where the client’s electrical and gas costs are reduced based on the operation of smaller equipment.
IAQ Procedure for reduced OA designs using the chemical air cleaning approach. In April 2004, OSFC incorporated the IAQ design option into their master Ohio School Design Manual, Section 15722 for “Chemical Air Cleaning.” The Brunswick School project was the first of this design in Ohio. This project and others helped state engineers see the value of the IAQ Procedure.

Summary

More projects should consider using the Standard 62.1-2004 IAQ Procedure because of the reduced energy, improved environment and ease of maintenance. Do not wait until you have a problem space to apply the IAQ Procedure, or before utility costs force you to look for more savings options.

References