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Working with ANSI/ASHRAE Standard 62-1989

The author addresses four questions that have arisen regarding ASHRAE's new ventilation standard

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ASHRAE *Standard 62-1989, Ventilation for Acceptable Indoor Air Quality*, has been endorsed by the American National Standards Institute along with Addenda 62a to the standard.[1] This addenda modified the specifications for particulate matter and radon gas to be consistent with changes promulgated by the U.S. Environmental Protection Agency. It also updated certain references with respect to duct construction, making them easier to find.

Now that *Standard 62-1989* is beginning to be used, several questions that have arisen deserve explanation:

- How can the energy implications of the increase in the minimum ventilating rate from 5 to 15 cfm (2.5 to 7.5 L/s) per occupant be justified?
- Does the standard limit supply duct relative humidity to 70%?
- Does the standard require continuous ventilation in restrooms?
- How can residential ventilating rate of 0.35 ach be assured?

Minimum ventilating rate

Enclosed spaces occupied by people must be ventilated to replace the oxygen consumed and to dilute contaminants in the air. Of these two requirements, dilution of contaminants requires more air than replacement of oxygen. It is necessary then to determine which contaminants are most critical and how they should be controlled.

Some contaminants (such as products of combustion) may be captured at the source and exhausted. Particulate matter may be removed by filtration. However, many gases and vapors must be controlled by dilution. This is especially true of the bioeffluents that humans produce. Of these, carbon dioxide (CO_2) is the chief bioeffluent; most others can be classified as odorous compounds.

Appendix D of *Standard 62* presents a derivation and curves showing the amount of dilution air needed to control the CO_2 concentration under various conditions. The question then is: What is the acceptable CO_2 concentration?

Both occupant-generated odors and the CO_2 generation rate are functions of the number of occupants present and their activities. Thus, CO_2 concentration may be used as a surrogate for odor.

Measurements of the odor level versus ventilating rate were made at the John B. Pierce Laboratory, Yale University and the Technical University of Denmark.[2] Three different groups of people were studied. The data confirmed that 7.5 L/s (15 cfm) of outdoor air per person was needed to dilute the odor in the room to a concentration that 80% of the visitors entering the space from an odor-free environment would find acceptable. *Figure 1* shows these data.

When writing *Standard 62-1989*, ASHRAE SPC 62-1981R found this evidence persuasive and set the minimum ventilating rate at 7.5 L/s (15 cfm) of outdoor air per occupant.

This decision was reinforced by two other findings. First, studies of occupant response in rooms where the outdoor air flow

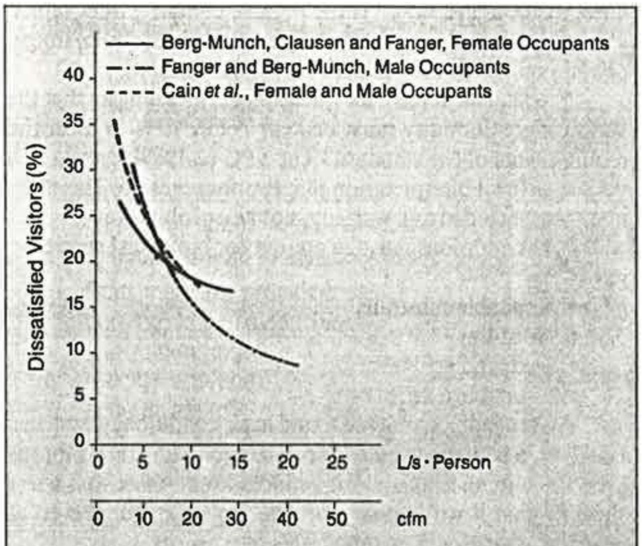

Figure 1. Odor acceptance of visitors to a room.

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rate was controlled by the room CO_2 level[3] showed that, at a CO_2 level of 1,600 ppm, the occupants felt warmer (as much as 2°C), their hands and feet felt warmer with respect to their bodies, they felt there was less air motion even though this was a constant volume system and they felt the atmosphere was stuffier.

This CO_2 level would be realized with a ventilating rate of about 5 L/s (10 cfm) of outdoor air per occupant. No negative response to CO_2 was found when the CO_2 was decreased to 1,000 ppm by increasing the outdoor air flow rate to 7.5 L/s (15 cfm) per occupant.

The second bit of supporting evidence for this minimum ventilating rate came from a study of the incidence of respiratory disease among U.S. Army recruits in new, energy conserving barracks versus those housed in older, loosely constructed buildings.[4] This four-year study found that infection rates were 40% to 100% higher in the new barracks.

The outdoor air flow rates were not measured directly, but from the conditions reported and a knowledge of differences in building construction over the past 40 years, the older barracks probably had infiltration rates of 7.5 L/s (15 cfm) per occupant or higher. In contrast, the new barracks were ventilated by infiltration at a rate of 2.5 L/s (5 cfm) per occupant or lower. Clearly, low ventilation rates (especially during epidemic periods) increase the spread of infection.

While concern for energy is important, the SPC 62-1981R concluded that health and comfort considerations should take precedence.

Supply duct humidity

Sections 5.11 and 5.12 of *Standard 62* warn of the potential for microbial contamination when relative humidities exceed 60%. Section 5.12 says, "If the relative humidity in occupied spaces and low-velocity ducts and plenums exceeds 70%, fungal contamination (mold, mildew, etc.) can occur."

This statement has been questioned. Does it mean that the supply duct humidity must be kept below 70% to meet the requirements of the standard? The SPC 62-1989R agreed in a vote of official interpretation that the answer is no. The statement was included as a warning, not as a prohibition.

Four conditions must be present for biological species to grow:

- A suitable substrate;
- Moisture;
- Seed; and
- A suitable temperature.

These conditions may be found in air-conditioning systems. However, a bare metal duct is not a suitable substrate. Fibrous glass duct lining is treated with a biocide and must pass a test showing that it will not support the growth of fungi even at relative humidities in excess of 90%.[5]

When dirt collects on either metal or fibrous glass, the dirt provides an acceptable substrate for fungi. Thus, one strategy is to keep the ducts as clean as possible.

The relative humidity downstream of a cooling coil is always above 90%, and usually very near 100%. Spray may also blow off the coil to dampen the duct directly downstream of the coil. Subcooling the air to dehumidify it and then reheating is no longer acceptable because of the energy penalty.

Two strategies that can be used instead are desiccant dehumidification and face-and-bypass reheating. However, both have some energy penalty. Desiccant dehumidification is well understood and is sometimes used.

Cold water or ice storage systems offer a possibility for lower supply duct humidity without an energy cost penalty. If water is chilled and/or ice is made during off-peak periods at reduced electric rates, the coil can be operated at a lower temperature.

Part of the recirculated air can then bypass the coil and be added to the supply downstream of the coil. The bypassed air then reheats the saturated air leaving the coil and, thus, the supply air's relative humidity is reduced.

A third strategy is to keep spores normally present in the outdoor air out of the system. Effective filters upstream of the cooling coil can do this. The improved heat transfer from a coil kept continuously clean can offset the filters' cost.

It would appear that most air-conditioning systems have a potential for microbiological contamination, yet the number of cases is quite small. This leads to the speculation that the coil, in condensing water from the air, also acts as an effective filter in removing both dirt and spores from the air.

As this particulate matter passes through the region where the air is saturated and water droplets form, the particles act as nuclei for the condensing water droplets. The particles are then effectively washed from the air. (It is well-known that people who suffer from hay fever find relief in air-conditioned buildings because of the reduction in pollen.)

Steps are now underway to measure the air cleaning effectiveness of a wet coil. If this phenomenon has any practical effect on odors or other gases, it is possible that some reduction in the outdoor air flow rate could be justified during cooling operations.

Restroom ventilation

SPC 62-1981R also responded to a request for official interpretation of the requirements for restroom ventilation. The question was: Must restroom exhaust be constant? The answer was: No, it can be interrupted under the terms of Section 6.1.3.4 (Intermittent or Variable Occupancy).

The objective is to continue ventilation for sufficient time after use of the room to assure adequate dilution of odors so that they do not migrate into adjoining spaces. The standard specifies 25 L/s (50 cfm) per water closet or urinal and recommends mechanical exhaust with no recirculation. Transfer air from adjoining spaces usually supplies the ventilation.

In small restrooms, the interval between uses may be long enough to consider intermittent operation of the exhaust fan. The fan must have a delay on its switch (perhaps interlocked with a light switch) to assure a proper afterrun. This required afterrun of the exhaust fan may be determined from Figure 5 of *Standard 62-1989*.

Figure 5 (entitled Required Lead Time) was designed to reduce the concentration of a contaminant in a space to 3% of its initial value. Thus, if the exhaust fan operates for the time specified in Figure 5 after use of the room, the concentration of contaminants will be only 3% of that when the room is in use, and the room will be essentially odor-free. The exhaust fan then can be turned off until the next use of the room.

It should be recognized that this intermittent operation is practical only in small restrooms. The specified afterrun is likely to be about 15 minutes. Larger restrooms will have more frequent use. If a building is unoccupied at night, however, then interruption of the restroom exhaust is practical.

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Restrooms must be kept clean. No amount of ventilation can control odors in a dirty room. The objective is to make certain that there is a flow of air from adjoining spaces to the restroom and outdoors so that any odors from the room are carried away from adjoining spaces.

Residential ventilation

Residential ventilation must depend on some cooperation from the occupants. From an engineering viewpoint, it would be desirable to make a residence as tight as possible and dependent on a mechanical system.

Mechanical ventilating systems are commonly used in Sweden and have also been used in Canada and France. Some people in the United States recommend that a separate ASHRAE standard be written for residential ventilation, and that it mandate or strongly recommend the use of mechanical ventilation in residences. This presents several challenges.

Sweden and Canada are characterized as cold climates. France varies from relatively cold in the northern and Alpine regions to mild in the Mediterranean area. This narrows the climate with which a mechanical system must deal. In contrast, climates in the United States range from arctic (Alaska) to tropical (Hawaii).

The economics and technical considerations of using mechanical ventilation are more attractive in cold climates. Very tight construction with mechanical ventilation is of dubious value in mild climates (such as San Diego) and of unknown value in tropical climates.

ASHRAE Standard 119-1988, Air Leakage Performance for Detached Single-Family Residential Buildings, has attempted to divide the United States and Canada into regions of equivalent weather. It is not known if this division or some other grouping could function successfully for the use of mechanical ventilation.

Reliability is also an unknown factor. To be successful, a residential ventilating system should be able to operate for many years (perhaps 20) with a minimum of maintenance, as gas-fired furnaces do now. Homeowners cannot be depended on to service a ventilating system unless it stops working. This implies the need for a safety device to sound an alarm if the ventilating system fails. While a sail switch may be adequate, its reliability must be proven, and any standard specifying mechanical ventilation for residential use must include specifications for safety devices.

The alternative to mechanical ventilation is passive ventilation through infiltration and open windows. We have always depended on this, but now there is technology for making a house so tight that infiltration is inadequate. When a tight house is coupled with large and powerful exhaust fans, vented combustion systems (furnaces) sometimes fail to properly exhaust their products of combustion.

As a result, each year a few people die of asphyxiation from inhaling products of combustion. The solution is to enable a house to "breathe" at a level that provides needed ventilation without excessive energy consumption. *Standard 62-1989* specifies a nominal infiltration rate of 0.35 ach. This is presumed to be at an outdoor/indoor pressure difference of about 0.016 in. water (4 Pa).

Typically constructed homes will experience a 4 Pa pressure difference with about 5 mph wind velocity and a 20°F (11°C) indoor/outdoor temperature difference. Occupants tend to open windows when the weather is mild and infiltration may be less than 0.35 ach. *ASHRAE Standard 136* is being developed to specify means for determining air change rates.

Residential ventilation presents a paradox. We do not have adequate or widely used mechanical systems. We do not know how to specify construction well enough to assure adequate infiltration without getting too much. *ASHRAE Standard 119-1988* specifies acceptable air leakage rates for detached single family residences, but it does not say how this is to be achieved. Yet there are relatively few serious problems. The whole subject of residential ventilation needs further development.

Summary

ANSI/ASHRAE Standard 62-1989 is in force and is being used. It seems to be able to address most issues. However, care must be exercised when material is taken out of context and various features of the standard or cautions are ignored. ■

References

1. ASHRAE. 1989. *ANSI/ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality*. Including *ANSI/ASHRAE Addendum 62a-1990*. Atlanta, Georgia.

2. Berg-Munch, B., *et al.* 1984. "Ventilation requirements for the control of body odor in spaces occupied by women." *Environment International*. Vol. 12 (1986), pp. 195-199.

3. Janssen, J., *et al.* 1982. "Ventilation for control of indoor air quality: A case study." *Environment International*. Vol. 8, pp. 487-496.

4. Brundage, *et al.* 1988. "Energy-efficient buildings pose higher risk of respiratory infections: Study." *Journal of the American Medical Association*. April 8.

5. SMACNA. 1979. *Fibrous Glass Duct Construction*. 5th edition. Vienna, Virginia: Sheet Metal and Air-Conditioning Contractors National Association.