Clearing the Air
by Ted Fitzemeyer

Specifying the right air filters to protect occupant health and ensure HVAC system efficiency

Air filters traditionally have been used in commercial and institutional facilities to filter particles such as dust and pollen from the air, usually to protect HVAC coils. Today, however, air filters are used more often to effectively treat indoor air quality (IAQ) problems and to help organizations minimize energy use.
The challenge for maintenance and engineering managers is to match available filters to their facilities' needs to ensure proper IAQ - for occupant health and comfort - and to ensure efficient HVAC system operation.

Identifying the target

There are two types of airborne contaminants targeted by air filters:

- Particles are filtered by traditional paper or fiberglass filters. Filter efficiency governs the size of particles that are filtered.
- Gases are filtered by absorbers, such as carbon, and filter media is available to filter most know contaminants.

The role of air filters is central to HVAC system operation. When an IAQ problem occurs, among the first places checked are the HVAC system's filters and the ventilation capacity of outdoor air, or ventilation rate. And when designing an HVAC system, a good place to start is with the calculation of appropriate air filtration and ventilation rates intended to meet facility needs.
Determining appropriate air filter requirements early in the system design process will serve as a guide in selecting the correct HVAC system, since some systems are not capable of using all filter types.
For example, terminal units, such as fan coil units, do not have many filter options, while large commercial air handlers offer a range of choices. Selecting the appropriate air filter application can help to eliminate many long term IAQ problems.

Ventilation codes and standards

Most state building codes either are based on or refer to ASHRAE's Ventilation for Acceptable Indoor Air ASHRAE 62-1989. This standard, which includes a table that lists space types and the amount of outdoor air required for acceptable IAQ, is based on three basic assumptions:

- There is enough outside air to dilute internally generated air contaminants, given the normal building contaminants.
- There is acceptable, clean outdoor air.
- Supply air to the rooms achieves 100 percent mixing or ventilation effectiveness.

These three conditions, however, rarely occur in the real world. Typically, the best air mixing achieves a ventilation effective rate of no more than 80 percent because much of the mixing occurs above occupants' heads and leaves the room through the return register.

Real-world testing has shown that 80 percent of office buildings exhibit normal building contaminants, while the other 20 percent showed unacceptable levels of contaminants.
Often, new and renovated buildings have an unacceptably high level of volatile organic compounds (VOC) resulting from off-gassing from new furniture, rugs or contaminants from office equipment, such as copy machines.
Also, outdoor air in many urban areas is not considered acceptable. The best source for checking the local air quality is a state or regional office of the U.S. Environmental Protection Agency, which can provide general air quality information about a geographic area.
For a specific locale, consider local contaminant sources, such as street traffic, and exhaust from neighboring buildings and from within the building. Often, the location of a building's air intake is determined by architectural constraints and is not necessarily the best location for accessing acceptable outdoor air.
Generally, these air intake sites work 90 percent of the time but a change in wind direction or an idling truck parked in the wrong place for too long can generate temporarily unacceptable outdoor air. Buildings near to airports and highways require special attention, since the average outdoor pollution level may be acceptable but intermittently become unacceptable.

IAQ guidelines

To achieve indoor air levels suitable for human comfort, particles larger than 0.3 micron must be kept to a minimum, since they have an adverse effect on the human respiratory system. So, the first goal of a good IAQ filtration system should be to remove a majority of the 0.3 micron particles from the space.
The minimum initial filter efficiency should be a 60 percent efficient filter at 0.3 microns. The equivalent ASHRAE 52-76 rating would be a high-efficiency 90-95 filter, which has an initial 0.3 micron rating of 75 percent and a weighted average efficiency of 87 percent. A less conservative selection would be an ASHRAE 52- 76 high-efficiency 80-85 filter, which has an initial 0.3 micron efficiency of 50 percent and a weighted average efficiency of 68 percent.
The most common particulate filters for HVAC systems are pleated panel filters, rigid box filters, and bag filters. The filter media is typically fiberglass, synthetic or a cotton/synthetic blends.
Gas-phase filters are used to filter inorganic materials, such as VOCs and ozone, from both re-circulated and outdoor air. These filters usually are made of a carbon- based product treated with various chemical compounds to increase its ability to filter different types of contaminants.
Gas-phase filters provide a practical, cost-effective way of reducing VOCs and cleaning unacceptable outdoor air. The newest generation of gas-phase filters on the market provide longer filter life, lower initial pressure drop and lower overall cost of ownership than their predecessors.

Industry trends

The air filter industry has witnessed a number of new developments in recent years, such as the introduction of environmentally friendly filters. When they are discarded, these filters break down more easily in landfills. Many of these new filters have no metallic parts, making them easier to incinerate and contributing to a lower total cost of ownership for facilities.
Also, the use of new pleated media in filters reduces their initial pressure drop, which permits the use of lower horsepower fans and extends filter life.
Since filter loading is determined by the pressure drop across the filter, a lower initial pressure drop will extend the time required between filter changes, reducing the overall life cycle cost of the filters.
Maintenance and engineering managers should consider using all of the available filtration technologies to ensure a healthy building. A good design will allow for additional filtration to be added easily, should a facility's-built conditions be worse than predicted in the design phase.

New System? New Filter Considerations

When designing a new HVAC system, managers should consider the following guidelines:

- Select filters with a minimal initial 0. 3-micron efficiency of 60 percent.
- Use a gas-phase filter recommended for IAQ applications where VOCs are suspected.
- Use a medium- to high-efficiency gas-phase adsorber where unacceptable outdoor air is suspected.
- Ensure filter housings have a minimal amount of bypass leakage.
- Design using ASHRAE 62-1989 ventilation rates. Base the minimum outside air on a variable air volume system calculated on these rates or use a demand ventilation system.
- Use a system capable of varying flow to accommodate filter loading when using high-efficiency filters. Design systems that can be upgraded with gas-phase filters and higher-efficiency filters where practical. This step will require a system that can sustain higher static pressures and that has a filter box designed to accept the appreciable weight and size of gas-phase filters.
- Design the filter's face velocity to increase filter life - typically 500 feet per minute maximum.
- Consider using rigid filters. They are best for variable air volume (VAV) systems because they do not collapse when air flow is reduced, as a bag filter might. Rigid filters are also ideal when the HVAC system shuts down at night, since bags can deflate, allowing collected contaminants to break off and re-enter the system. Bag filters are best suited for continuous operational systems that have a constant volume or little variation in air flow.

Using a combination of particulate filters, gas-phase adsorbers and good ventilation practices will provide a healthy and comfortable building environment.

Ted Fitzemeyer, P.E., is president/principal at Fitzemeyer & Tocci Associates Inc., a Massachusetts engineering firm specializing in mechanical and electrical engineering, design and construction management services for heating, ventilation and airconditioning (HVAC), plumbing fire protection and electrical systems in both new building construction and renovation programs. This article appeared previously in the May 1999 issue of Maintenance Solutions.

First published in the BOA Magazine, November 2000