

Strategies to Control Indoor Air Pollution

Source Control

Usually the most effective way to improve indoor air quality is to eliminate individual sources of pollution or to reduce their emissions. Some sources, like those that contain asbestos, can be sealed or enclosed; others, like gas stoves, can be adjusted to decrease the amount of emissions. In many cases, source control is also a more cost-efficient approach to protecting indoor air quality than increasing ventilation because increased ventilation will typically increase energy costs. For most indoor air quality problems, source control is the most effective solution.

Ventilation

Most commercial air-handling units distribute a blend of outdoor air and re-circulated indoor air. HVAC designs may also include units that introduce 100% outdoor air or that simply transfer air within the building. Uncontrolled quantities of outdoor air enter buildings through windows, doors and gaps in the exterior construction.

Thermal comfort and ventilation needs are met by supplying “conditioned” air (a blend of outdoor and re-circulated air that has been filtered, heated or cooled, and sometimes humidified or dehumidified.) Large buildings often have interior (“core”) spaces in which constant cooling is required to compensate for heat generated by occupants, equipment, and lighting, while perimeter rooms may require heating or cooling depending on outdoor conditions.

One technique for controlling odors and contaminants is to dilute them with outdoor air. Dilution can work only if there is a consistent and appropriate flow of supply air that mixes effectively with room air.

Another technique for isolating odors and contaminants is to design and operate the HVAC system so that pressure relationships between rooms are controlled. This control is accomplished by adjusting the air quantities supplied to and removed from each room. If more air is supplied to a room than is exhausted, the excess air leaks out of the space and the room is said to be under positive pressure. If less air is supplied than is exhausted, air is pulled into the space and the room is said to be under negative pressure.

A third technique is to use local exhaust systems (sometimes known as dedicated exhaust ventilation systems) to isolate and remove contaminants by maintaining negative pressure in the area around the contaminant source. Local exhaust can be linked to the operation of a particular piece of equipment (such as kitchen range) or used to treat an entire room (such as a smoking lounge or custodial closet). Air should be exhausted to the outdoors, not re-circulated, from locations that produce significant odors and high concentrations of contaminants (such as copy rooms, bathrooms, kitchens and beauty salons).

Spaces where local exhaust is used must be provided with make-up air and the local exhaust must function in coordination with the rest of the ventilation system. Under some circumstances, it may be acceptable to transfer conditioned air from relatively clean parts of a building to comparatively dirty areas and use it as make-up air for a local exhaust system. Such a transfer can achieve significant energy savings.

Air cleaning and filtration devices designed to control contaminants are found as components of HVAC systems (for example, filter boxes in ductwork) and can also be installed as independent units. The effectiveness of air cleaning depends upon proper equipment selection, installation, operation and maintenance. Caution should be used in evaluating the many new technological developments in the field of air cleaning and filtration.

One approach to lowering the concentrations of indoor air pollutants in a structure is to increase the amount of outdoor air coming indoors. Most building heating and cooling systems, including forced air heating or cooling systems, do not mechanically bring fresh air into the houses, whereas commercial buildings typically have a means to mechanically draw fresh air into the structure. ASHRAE Standard 62.2 represents the minimum requirements for residential ventilation and acceptable indoor air quality. Best or good practice may require going beyond those minima. Traditionally, residential ventilation has been provided by natural ventilation and infiltration. Sherman and Matson (1997) showed that most older buildings are leaky enough so that infiltration (air leaks from outside) alone can meet the minimum requirements of ASHRAE standard 62.2. However, houses built to new standards have substantially tighter envelopes and there is insufficient infiltration to meet even the minimum ventilation standards. Furthermore, simply meeting the minimum standard is not always sufficient to adequately dilute all contaminants.

For today's modern, single-family dwellings a whole-house mechanical ventilation system may be necessary when individuals with allergies or chemical sensitivities occupy the building or when there are unusual sources of impurities. Advanced designs of new buildings are featuring mechanical systems that bring outdoor air into the building. Some of these designs include energy-efficient heat recovery ventilators (also known as air-to-air heat exchangers). Typical total ventilations requirements are at least the larger of 7.5 CFM per person (based on Normal Occupancy) and 1 CFM per 100 square feet of floor space. The intermittent exhaust flow rates for kitchens are 100 CFM, and 50 CFM for utility rooms, bathrooms, etc. The continuous exhaust flow rate for kitchens is five air changes per hour, and 20 CFM for utility rooms, bathrooms, etc.

Air Handler

As air is circulated through the structure via heating, ventilating, and/or air conditioning (HVAC) systems, particulate matter will accumulate inside the system where, especially in cooling systems, they serve as medium for bacteria and fungal growth. The dispersion of microbes such as bacteria, virus, mold, and fungus can be the source of sickness to exposed occupants in the climate-controlled area. For example, Legionella pneumophila has been found to exist in such an environment and has been linked to Legionnaire's disease. Other microbes may contribute to "sick building" or "sick building" syndrome. Many people are also allergic to the molds and fungus entrained in the dwelling's ventilation system as the air passes over contaminated condensate drain water and wet evaporator cooling coils. **For this reason, it is very important that evaporator coils be cleaned and disinfected at least once per cooling season and the condensate pan be cleaned to minimize the breeding of bacteria, virus, mold and fungus, which can be entrained into the conditioned air and carried throughout the building.**

Air Filtration

There are many types and sizes of air cleaners on the market, ranging from relatively inexpensive tabletop models to sophisticated and expensive whole-building systems. Some air cleaners are highly effective at particle removal, while others, including most tabletop models, are much less so. Air cleaners are generally not designed to remove gaseous pollutants.

The effectiveness of an air cleaner depends on how well it collects pollutants from indoor air (expressed as a percentage efficiency rate) and how much air it draws through the cleaning or filtering element (expressed in cubic feet per minute). A very efficient collector with a low air-circulation rate will not be effective, nor will a cleaner with a high air-circulation rate with a less efficient collector. The long-term performance of any air cleaner depends on maintaining it according to the manufacturer's directions.

At present, EPA does not recommend using air cleaners to reduce levels of radon and its decay products. The effectiveness of these devices is uncertain because they only partially remove the radon decay products and do not diminish the amount of radon entering the building. EPA plans additional research into whether air cleaners are, or could become, a reliable means of reducing the health risk from radon.

Types of air cleaners or air filtration include

- Mechanical filters, including, the typical furnace or AC filter.
- Electronic air cleaners (for example, electrostatic precipitators) which trap charged particles using an electrical field.
- Ion generators that act by charging the particles in a room. The charged particles are then attracted to walls, floors, draperies, etc., or a charged collector.
- "Hybrid" devices, which contain two or more of the particle removal devices discussed above.

Mechanical Filtration

There are essentially two methods to purify or filter the air, mechanical filtration and electrostatic filtration. With mechanical filtration, a filter permits air to pass through a porous, typically fiber-like, material that essentially blocks the path and ideally captures these particles. Since the pores between fibers are typically larger than the airborne particles the filter relies on the random chance that the particle will get caught on a fiber. If the thickness of the filter is increased or the pores are made smaller through the use of a tighter fiber weave, then the resistance to the passage of air increases, thereby increasing the pressure loss, reducing the airflow and ultimately decreasing the system's cooling capacity and efficiency.

An alternate method designed for the purpose of increasing particulate removal efficiency without decreasing pore size or increasing fiber density is electrostatic attraction. Active electrostatic filters, commonly referred to as electronic air filters, impart a high-voltage charge between plates and any charged particles passing through are electrostatically withdrawn from the passing air and captured on the charged collection plate. This type of electrostatic system (discussed in the next subsection) normally suffers from a rapid decrease in performance as the collection plate becomes dirty and therefore insulated.

To alleviate the need for an applied voltage but still obtain the advantages of electrostatic dust removal, passive electrostatic systems have been developed. A passive electrostatic system relies on dielectric (non-conducting) fibers that harbor electrostatic charges produced from air friction as the air is drawn through the filter. Air passing through dielectric fibers generates friction that induces a static charge that builds up to become substantial enough to draw out any passing charged particles, namely dust. This is the principal behind electrostatic filters used in HVAC systems. The passive electrostatic filter behaves similarly to active electrostatic filters whereby dust is drawn from the air and attracted to the fibers by electrostatic forces this time without the need for external electrical power. Typically, because of their high cost, this type of passive electrostatic filter is cleaned and reused rather than discarded when dirty. However, by their nature, these filters are difficult to get perfectly clean and their performance degrades after the first use. There are also disposable electrostatic filters, however, in most cases, a careful inspection of the package will reveal that these disposable filters are not fabricated from 100% electrostatic fibers but instead only contain some electrostatic fibers, thereby making their effectiveness questionable.

Mainstream's PuraClean™ Filter Spray has been demonstrated to be an alternative to electrostatic filters, and can be applied to ordinary disposable filters. PuraClean Filter Spray creates a passive low-cost electrostatic filter from an ordinary low-cost disposable filter. In this way the low-cost filter could be disposed instead of cleaned. PuraClean is a liquid formulation, which, after application to an ordinary non-electrostatic filter (such as a metallic filter, disposable spun-glass filter, or foam filter), will produce a dielectric filter surface (insulating surface) and transform an ordinary filter into a passive electrostatic filter.

The only true measure of a filter's effectiveness is the Minimum Efficiency Reporting Value (MERV). Most filters are labeled with a MERV rating number, which measures a filter's ability to trap particles ranging in size from 3.0 microns to 10.0 microns. Residential filters commonly have MERV ratings of 1-12. The higher the MERV rating, the more efficient the filter is and the more particles it can filter.

- A MERV rating of 6 means the filter is 35% to 50% minimum efficient at capturing the measured particles.
- A MERV rating of 8 means the filter is 70% to 85% minimum efficient at capturing the measured particles.
- A MERV rating of 11 means the filter is 85% to 95% minimum efficient at capturing the measured particles.
- MERV is an industry standard rating, so it can be used to compare filters made by different companies.

When sprayed on typical disposable filters, PuraClean™ Filter Spray demonstrates an increase of up to 300% in particle capture, *with no significant increase in pressure drop*. **In ASHRAE 52.2 testing, the MERV rating of non-electrostatic filters improved dramatically over all size ranges by using PuraClean, see Figure 1.** PuraClean's technology garners these dramatic results by converting non-electrostatic surfaces into electrostatic surfaces. A more efficient filter also means the evaporator coil will stay cleaner, which translates into improved energy efficiency and improved cooling capacity.

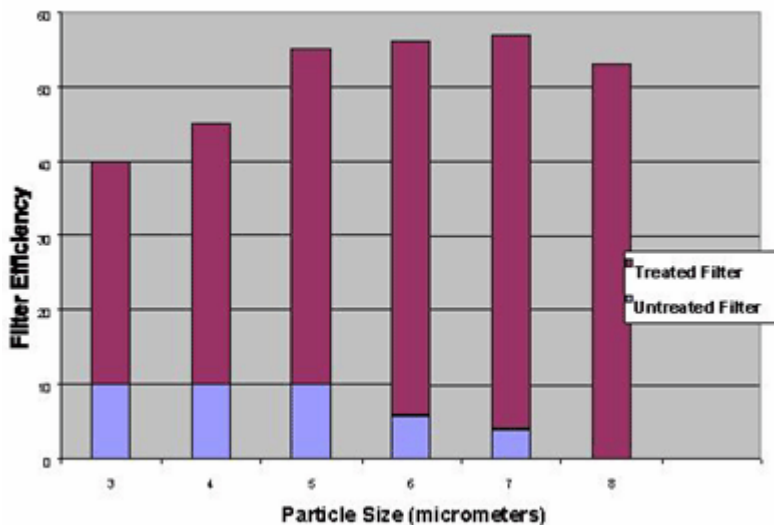


Figure 1. PuraClean Improvements to Filter Efficiency
 (Based on Independent Laboratory
 test data using the ASHRAE 52.2 test Procedure)

Electronic Air Cleaners

There are a number of companies that offer Electronic Air Cleaners. These devices have a positively or negatively charged grid that charges the contaminants in the air and an oppositely charged or grounded collection surface to which the contaminants are attracted. These filters have very good initial filtration effectiveness and very little pressure drop, but the filtration efficiency decreases rapidly due to build-up on the collection plate, which essentially insulates the collection plate and stops the filtration. Also, as the collection plate becomes insulated, the charged contaminants are then attracted to other grounded surfaces, such as walls, ceilings, furniture, etc., thereby causing staining of these surfaces

Self-Cleaning Electronic Air Filters

As discussed above, it is well known that the use of a positively or negatively charged grid can charge the contaminants in the air and cause these particles to be attached to an object of the opposite or grounded (neutral) polarity. Also, as stated above, these systems have always been burdened with the problem of cleaning a filter, collection surface or collection tray. The Mainstream Self-Cleaning Electronic Filter solves this problem because the "grounded collection plate" is actually a grounded water surface, which is continually refreshed as condensate drains from the condensate pan. This is also advantageous since the grounding "surface" or body of water has a larger volume to collect dust/particulates than just a metal plate. This water stream is a result of the normal condensation of water in the evaporator section of an operating air conditioning unit or the excess water flow from a humidifier unit of a forced air heating system. For the humidifier, this flow is necessary to prevent calcium and other mineral deposits from accumulating on the humidifier surfaces. In either case, this water would normally be discarded anyway, so the Mainstream Self-Cleaning Electronic Filter advantageously uses this condensed or excess water before it is discarded. This self-cleaning air cleaner is typically located anywhere below the evaporator drain pan (or humidifier outlet), so that gravity can be used to force the flow of water through the self-cleaning air cleaner. It

also contains an overflow safety switch to prevent flooding, and operates off the 24 VDC control circuit.

Aside from a traditional filter's lack of efficiency, another problem occurs when dust material accumulates on the filter--it serves as a food source for xeroscopic bacteria or fungi. With this self-cleaning configuration, the dust materials are continually swept from the system, leaving no food to support growth. The device also creates small amounts of ozone in the water, which serves to disinfect the condensate water flow and keep the condensate drain line clear.

Houseplants

Over the past few years, there has been some publicity suggesting that houseplants have been shown to reduce levels of some chemicals in laboratory experiments. There is currently no evidence, however, that a reasonable number of houseplants remove significant quantities of pollutants in buildings and offices. Indoor houseplants should not be over-watered because overly damp soil may promote the growth of microorganisms that may affect allergic individuals.

Prevent dirt from entering the HVAC system:

Use PuraClean Filter Spray on all HVAC filters and change air filters frequently. Filters must be changed monthly, even more frequently if they are severely loaded up with contaminates during monthly filter replacements. Any contaminates removed from the conditioned air by the filter are being kept out of your family's lungs! PuraClean treated filters are capable of removing mold spores, in addition to dust mites and bacteria.

Removing moisture is the first line of defense, and a clean environment, provided by good filtration is the second line of defense. Improved filtration will also minimize the amount of dusting needed in the building. Of course, no filtration of any type will remove harmful gasses, such as carbon monoxide, or are effective at removing radon from the air.

Prevent Air Ducts From Getting Wet

Moisture should not be present in ducts. Controlling moisture is the most effective way to prevent biological growth in air ducts.

Moisture can enter the duct system through leaks or if the system has been improperly installed or serviced. Research suggests that condensation (which occurs when a surface temperature is lower than the dew point temperature of the surrounding air) on or near cooling coils of air conditioning units is a major factor in moisture contamination of the system. The presence of condensation or high relative humidity is an important indicator of the potential for mold growth on any type of duct. Controlling moisture can often be difficult, but here are some steps to take:

- Promptly and properly repair any leaks or water damage. Discard any wet insulation or fiber duct board; it cannot be effectively dried. Treat replacement material and all adjacent duct board or insulation with QwikTreat® Porous Duct Sealant with Biocide.

- Pay particular attention to cooling coils, which are designed to remove water from the air and can be a major source of moisture contamination of the system, leading to mold growth. If mold is present, clean the hard surfaces of the air handler and the evaporator coils with QwikTreat® MoldStop™ Hard Surface Disinfectant. Make sure the condensate pan drains properly. The presence of substantial standing water and/or debris indicates a problem requiring immediate attention. Check any insulation near cooling coils for wet spots. Treat all drain pans with QwikTreat® Pan Tablets and consider installing a QwikTreat Dispenser.
- Ensure all ducts are properly sealed and insulated in all non-air-conditioned spaces (e.g., attics and crawl spaces). This will help to prevent moisture due to condensation from accumulating on the duct work or entering the system. To prevent water condensation, the cooling system and associated duct work must be properly insulated.
- Verify that the AC unit is operating properly. Humidity must be maintained below 55% (ideally 30% to 50%). If humidity is a problem, consider having a dehumidifier or Mainstream Humidity Control Board installed. The Mainstream Humidity Control Board allows the existing Central AC unit to dehumidify the building without the conditioned space becoming too cold.