UMassAmherst | Environmental Health & Safety

Fact Sheet for Air Purifiers

This fact sheet provides information on air purifiers, including the different technologies used, selection, and use. Use of air purifiers can be an important strategy for helping to improve indoor air quality (IAQ). For additional information on IAQ, please consult the EH&S guide on IAQ.

Strategies for improving IAQ

The majority of indoor air quality issues result from poor ventilation, so simply increasing ventilation can often mitigate concerns. The three most effective ways to control indoor air pollution are (in order of most to least effective):

1. ***Source Control:*** Eliminate or control the sources of pollution, for example:
    - Cleaning regularly to prevent dust accumulation
2. ***Ventilation:*** Dilute and exhaust pollutants through outdoor air ventilation, for example:
    - Increasing room air change rates by opening windows and maintaining HVAC systems
3. ***Air Cleaning:*** Remove pollutants through proven air cleaning methods, for example:
    - Using an air cleaner equipped with a HEPA filter

Using a portable air cleaner is the least effective way to clean the air, but it can be a good supplement to ventilation. If you decide to purchase a portable air cleaner, **filtering air cleaners with High Efficiency Particulate Air (HEPA) filters are recommended** because these do not emit ozone but do remove particulate matter from the air. Electronic air cleaners (e.g. ionizers) and ozone-generators are NOT recommended due to the health and safety concerns of the ozone and other potential pollutants they can emit.

Ozone-Generating Air Cleaners

Ozone is a colorless gas that is found naturally in the Earth's upper atmosphere and protects us from harmful ultraviolet solar rays, though it also can be formed at ground level. It is known to cause free-radical formation in biological systems, which damage tissues. One mechanism of damage results from ozone-olefin reactions, and another from ozone reacting with electron

donors (such as glutathione). Inhalation of relatively small amounts of ozone can cause coughing, chest pain, throat irritation, and shortness of breath.

Ozone-generating air cleaners are devices that purposefully create ozone to clean the air through chemical interactions that alter the compounds of pollutants, yet this is also the mechanism by which ozone exerts harmful health effects. Furthermore, ozone is generally ineffective in controlling indoor air pollution at lower concentrations. In other words, if the concentration of ozone in the room is high enough to be effective in cleaning the air, then it's also high enough to create an inhalation hazard for the people in the room. Additionally, ozone may even react with existing chemicals in the air to create harmful by-products (e.g. formaldehyde). **For these reasons, EH&S does not recommend the use of ozone generating or electronic air purifiers under any circumstances.**

Electronic Air Cleaners

Electronic air cleaners (including ionizers, electrostatic precipitators, hydroxyl generators, and UV light) use electric voltage to convert oxygen molecules, or other species, into their charged ionic components that inactivate airborne contaminants, in a process called bipolar ionization (BPI). The ionic components of oxygen are reactive radicals that are capable of removing hydrogen from other molecules. In the event of bipolar ionization, the positive and negative ions surround air particles, destroying present germs and pathogens, and the added mass helps the air particles to fall to the floor and get pulled into the building's air filter. However, BPI can emit ozone and other free-radical species as a by-product, and may be less effective than other cleaning technologies since charged particles in the air sometimes stick to surfaces in the room (e.g. floors and walls) rather than getting filtered away.

Filtering Air Cleaners

Filtering air cleaners pass air through a filter, where polluting particles or gases become sequestered, and return the cleaned air into a room. There is some popular controversy surrounding the extent to which air cleaners can reduce the presence of larger particles (such as pollen, house dust allergens, mold spores, and animal dander), but most of these large particles settle on surfaces in the home or office, and cannot be removed by an air cleaner unless they are disturbed and re-suspended in the air. Therefore, regular cleaning is the best way to remove larger allergens.

a. Carbon Filters

Volatile Organic Compounds (VOCs) are compounds that have a high vapor pressure and low water solubility. VOCs are emitted as gases from certain solids or liquids, many of which can be found in household materials. VOCs are generally responsible for odors. Sources of VOCs include: paints, lacquers, paint strippers, cleaning supplies, building materials and furnishings, office equipment such as copiers and printers, correction fluids, craft materials like glues and

adhesives, permanent markers, photographic solutions, cooking, pets and occupants. Carbon filters do not appreciably remove particles from the air.

b. HEPA Filters

HEPA (high efficiency particulate air [filter]) is a type of pleated mechanical air filter. This type of air filter can theoretically remove at least 99.97% of any airborne particles with a size of 0.3 microns (µm), which can include dust, pollen, mold, and bacteria. HEPA filters are rated for containment ability of 0.3 µm particles because these are the most challenging size to capture, which means that efficiency of capture for other size particles is higher than 99.97%. HEPA filters do not remove gases or VOCs from air.

Choosing the appropriate filter for a room

What is a Clean Air Delivery Rate?

Air cleaning units have air volume limitations which are identified by a "Clean Air Delivery Rate" (CADR). A CADR is the cubic feet per minute (CFM) of air that has had all the particles of a given size distribution removed. CADR indicates the volume of filtered air an air cleaner delivers per unit time, with three separate scores for smoke, pollen and dust, which represent different particle sizes. The higher the CADR number for each pollutant, the faster the unit filters the air for pollutants of a particular size range.

Room Size

The Association of Home Appliance Manufacturers (AHAM) recommends that the CADR of your air cleaner is equal to at least two-thirds of the room's area. For example, a room with 120 square feet (10 ft by 12 ft) should have an air cleaner with a smoke CADR of at least 80. If your ceilings are higher than 8 feet, an air cleaner rated for a larger room will be necessary.

Particle Size

A carbon filter is the most appropriate unit for cleaning gaseous VOCs out of the air, such as when new furniture is off-gassing. However, if you notice an odor in a room, please contact EH&S first for an evaluation. The best course of action is to eliminate and control the odor's source, and EH&S can perform an assessment to do that and develop a remediation plan.

HEPA filters are better for cleaning particles out of the air. The diameter specification of 0.3 microns responds to the worst case, or most penetrating particle size (MPPS). Particles that are larger or smaller are trapped with even higher efficiency. Using the worst case particle size results in the worst case efficiency rating (i.e. 99.97% or better for all particle sizes). Minimum Efficiency Reporting Values, or MERVs, report a filter's ability to capture larger particles between 0.3 and 10 microns (µm). **EH&S recommends HEPA filters for particles and aerosols.**

MERV Rating	Average Particle Size Efficiency in Microns
1-4	3.0 - 10.0 less than 20%
6	3.0 - 10.0 49.9%
8	3.0 - 10.0 84.9%
10	1.0 - 3.0 50% - 64.9%, 3.0 - 10.0 85% or greater
12	1.0 - 3.0 80% - 89.9%, 3.0 - 10.0 90% or greater
14	0.3 - 1.0 75% - 84%, 1.0 - 3.0 90% or greater
16	0.3 - 1.0 75% or greater

Care and Maintenance

All filters need regular replacement as specified by the manufacturer in the product user manual. If a filter is dirty and overloaded, it will not work well. With proper care and upkeep, the portable air cleaner will continue to function properly and filter the air. Consider purchasing replacement filters with the air cleaner. Carbon filters can passively absorbs VOCs from the air, so please ensure these remain sealed until installed in the unit to prolong their lifetime.

Do indoor plants clean the air?

According to the EPA, there is currently no evidence to suggest that a reasonable number of houseplants would be effective in removing significant amounts of pollutants from indoor air. Indoor houseplants should not be over-watered because overly damp soil may promote the growth of microorganisms which can affect allergic individuals.

For more information:

EPA's Guide to Air Cleaners in the Home https://www.epa.gov/sites/production/files/2018-07/documents/guide_to_air_cleaners_in_the_home_2nd_edition.pdf

EPA Indoor Air Quality website www.epa.gov/indoor-air-quality-iaq

Association of Home Appliance Manufacturers (AHAM) https://www.aham.org/

Other Sources

Pryor, W. A. (1994, November). *Mechanisms of radical formation from reactions of ozone with target molecules in the lung*. Free radical biology & medicine. Retrieved December 6, 2021, from https://pubmed.ncbi.nlm.nih.gov/7835752/.

The FSG Blog. (2020, September 4). *How bipolar ionization inactivates airborne pathogens and viruses in facilities*. FSG Electric & Lighting. Retrieved December 6, 2021, from https://fsg.com/bipolar-ionization-inactivate-pathogens-viruses-facilities/.