Air purifier

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An **air purifier** is a device which removes contaminants from the air in a room. These devices are commonly marketed as being beneficial to allergy sufferers and asthmatics, and at reducing or eliminating second-hand tobacco smoke. The commercially graded air purifiers are manufactured as either small stand-alone units or larger units that can be affixed to an air handler unit (AHU) or to an HVAC unit found in the medical, industrial, and commercial industries. Air purifiers may also be used in industry to remove impurities such as CO_2 from air before processing. Pressure swing adsorbers or other adsorption techniques are typically used for this.

A Sharp FU-888SV Plasmacluster air purifier.

The same air purifier, cover removed.

Contents

Use and benefits of purifiers

Dust, pollen, pet dander, mold spores, and dust mite feces can act as allergens, triggering allergies in sensitive people. Smoke particles and volatile organic compounds (VOCs) can pose a risk to health. Exposure to various components such as VOCs increases the likelihood of experiencing symptoms of sick building syndrome.[1] Air purifiers are becoming increasingly capable of capturing a greater number of bacterial, virus, and DNA damaging particulates.

Purifying techniques

Several different processes of varying effectiveness can be used to purify air.

- Thermodynamic sterilization (TSS) - This technology uses heat sterilization via a ceramic core with micro capillaries, which are heated to 200 °C (392 °F). It is claimed that 99.9% of microbiological particles - bacteria, viruses, dust mite allergens, mold and fungus spores - are incinerated.[2] The air passes through the ceramic core by the natural process of air convection, and is then cooled using heat transfer plates and released. TSS is not a filtering technology, as it does not trap or remove particles.[3] TSS is claimed not to emit harmful by-products (although the byproducts of partial thermal decomposition are not addressed) and also reduces the concentration of ozone in the atmosphere.[4]
- Ultraviolet germicidal irradiation - UVGI can be used to sterilize air that passes UV lamps via forced air. Air purification UVGI systems can be freestanding units with shielded UV lamps that use a fan to force air past the UV light. Other systems are installed in forced air systems so that the circulation for the premises moves micro-organisms past the lamps. Key to this form of sterilization is placement of the UV lamps and a good filtration system to remove the dead micro-organisms. For example, forced air systems by design impede line-of-sight, thus creating areas of the environment that will be shaded from the UV light. However, a UV lamp placed at the

coils and drainpan of cooling system will keep micro-organisms from forming in these naturally damp places. The most effective method for treating the air rather than the coils is in-line duct systems, these systems are placed in the center of the duct and parallel to the air flow.

- Filter - based purification traps airborne particles by size exclusion. Air is forced through a filter and particles are physically captured by the filter.

  High-efficiency particulate arrestance (HEPA) filters remove at most 99.97% of 0.3-micrometer particles and are usually more effective at removing larger particles. HEPA purifiers, which filter all the air going into a clean room, must be arranged so that no air bypasses the HEPA filter. In dusty environments, a HEPA filter may follow an easily cleaned conventional filter (prefilter) which removes coarser impurities so that the HEPA filter needs cleaning or replacing less frequently. HEPA filters do not generate ozone or harmful byproducts in course of operation.

  Filter HVAC at MERV 14 or above are rated to remove airborne particles of 0.3 micrometers or larger. A high efficiency MERV 14 filter has a capture rate of at least 75% for particles between 0.3 to 1.0 micrometers. Although the capture rate of a MERV filter is lower than that of a HEPA filter, a central air system can move significantly more air in the same period of time. Using a high-grade MERV filter can be more effective than using a high-powered HEPA machine at a fraction of the initial capital expenditure. Unfortunately, most furnace filters are slid in place without an airtight seal, which allows air to pass around the filters. This problem is worse for the higher-efficiency MERV filters because of the increase in air resistance. Higher-efficiency MERV filters are usually denser and increase air resistance in the central system, requiring a greater air pressure drop and consequently increasing energy costs.

- Activated carbon is a porous material that can adsorb volatile chemicals on a molecular basis, but does not remove larger particles. The adsorption process when using activated carbon must reach equilibrium thus it may be difficult to completely remove contaminants.[5] Activated carbon is merely a process of changing contaminants from a gaseous phase to a solid phase, when aggravated or disturbed contaminants can be regenerated in indoor air sources.[6] Activated carbon can be used at room temperature and has a long history of commercial use. It is normally used in conjunction with other filter technology, especially with HEPA. Other materials can also absorb chemicals, but at higher cost.
- Polarized-media electronic air cleaners use active electronically enhanced media to combine elements of both electronic air cleaners and passive mechanical filters. Most polarized-media electronic air cleaners convert 24-volt current to safe DC voltage to establish the polarized electric field. Airborne particles become polarized as they pass through the electric field and adhere to a disposable fiber media pad. Ultra-fine particles (UFPs) that are not collected on their initial pass through the media pad are polarized and agglomerate to other particles, odor and VOC molecules and are collected on subsequent passes. The efficiency of polarized-media electronic air cleaners increases as they load, providing high-efficiency filtration, with air resistance typically equal to or less than passive filters. Polarized-media technology is non-ionizing, which means no ozone is produced.
- Photocatalytic oxidation (PCO) is an emerging technology in the HVAC industry.[7] In addition to the prospect of Indoor Air Quality (IAQ) benefits, it has the added potential for limiting the introduction of unconditioned air to the building space, thereby presenting an opportunity to achieve energy savings over previous prescriptive designs. As of May 2009[8][9] there was no more disputable concern raised by the Lawrence Berkeley National Laboratory data that PCO may significantly increase the amount of formaldehyde in real indoor environments.[10] As with other advanced technologies, sound engineering principles and practices should be employed by the HVAC designer to ensure proper application of the technology. Photocatalytic oxidation systems are able to completely oxidize and degrade organic contaminants. For example, Volatile Organic Compounds found low concentrations within a few hundred ppmv or less are the most likely to be completely oxidized.[5](PCO) uses short-wave ultraviolet light (UVC), commonly used for sterilization, to energize the catalyst (usually titanium dioxide (TiO_2)[11]) and oxidize bacteria and viruses.[12] PCO in-duct units can be mounted to an existing forced-air HVAC system. PCO is not a filtering technology, as it does not trap or remove particles. It is sometimes coupled with other filtering technologies for air purification. UV sterilization bulbs must be replaced about once a year; manufacturers may require periodic replacement as a condition of warranty. Photocatalytic Oxidation systems often have high commercial costs.[5]

A related technology relevant to air purification is photoelectrochemical oxidation (PECO) Photoelectrochemical oxidation. While technically a type of PCO, PECO involves electrochemical interactions among the catalyst material and reactive species (e.g., through emplacement of cathodic materials) to improve quantum efficiency; in this way, it is possible to use lower energy UVA radiation as the light source and yet achieve improved effectiveness.[13]

- Ionizer purifiers use charged electrical surfaces or needles to generate electrically charged air or gas ions. These ions attach to airborne particles which are then electrostatically attracted to a charged collector plate. This mechanism produces trace amounts of ozone and other oxidants as by-products.[1] Most ionizers produce less than 0.05 ppm of ozone, an industrial safety standard. There are two major subdivisions: the fanless ionizer and fan-based ionizer. Fanless ionizers are noiseless and use little power, but are less efficient at air purification. Fan-based ionizers clean and distribute air much faster. Permanently mounted home and industrial ionizer purifiers are called electrostatic precipitators.
- Immobilized cell technology removes microfine particulate matter from the air by attracting charged particulates to a bio-reactive mass, or bioreactor, which enzymatically renders them inert.
- Ozone generators are designed to produce ozone, and are sometimes sold as whole house air cleaners. Unlike ionizers, ozone generators are intended to produce significant amounts of ozone, a strong oxidant gas which can oxidize many other chemicals. The only safe use of ozone generators is in unoccupied rooms, utilising "shock treatment" commercial ozone generators that produce over 3000 mg of ozone per hour. Restoration contractors use these types of ozone generators to remove smoke odors after fire damage, musty smells after flooding, mold (including toxic molds), and the stench caused by decaying flesh which cannot be removed by bleach or anything else except for ozone. However, it is not healthy to breathe ozone gas, and one should use extreme caution when buying a room air purifier that also produces ozone.[14]
- Titanium dioxide (TiO_2) technology - nanoparticles of TiO_2, together with calcium carbonate to neutralize any acidic gasses that may be adsorbed, is mixed into slightly porous paint. Photocatalysis initiates the decomposition of airborne contaminants at the surface.[15]

Consumer concerns

Other aspects of air cleaners are hazardous gaseous by-products, noise level, frequency of filter replacement, electrical consumption, and visual appeal. Ozone production is typical for air ionizing purifiers. Although high concentration of ozone is dangerous, most air ionizers produce low amounts (< 0.05 ppm). The noise level of a purifier can be obtained through a customer service department and is usually reported in decibels (dB). The noise levels for most purifiers are low compared to many other home appliances. Frequency of filter replacement and electrical consumption are the major operation costs for any purifier. There are many types of filters; some can be cleaned by water, by hand or by vacuum cleaner, while others need to be replaced every few months or years. In the United States, some purifiers are certified as Energy Star and are energy efficient.

HEPA technology is used in portable air purifiers as it removes common airborne allergens. The US Department of Energy has requirements manufacturers must pass to meet HEPA requirements. The HEPA specification requires removal of at least 99.97% of 0.3 micrometers airborne pollutants. Products that claim to be "HEPA-type", "HEPA-like", or "99% HEPA" do not satisfy these requirements and may not have been tested in independent laboratories.

Air purifiers may be rated on: CADR(Clean Air Delivery Rate); efficient area coverage; air changes per hour; the clean air delivery rate, which determines how well air has been purified; energy usage; and the cost of the replacement filters. Two other important factors to consider are the length that the filters are expected to last (measured in months or years) and the noise produced (measured in decibels) by the various settings that the purifier runs on. This information is available from most manufacturers.

Potential ozone hazards

As with other health-related appliances, there is controversy surrounding the claims of certain companies, especially involving ionic air purifiers. Many air purifiers generate some ozone, an energetic allotrope of three oxygen atoms, and in the presence of humidity, small amounts of NO_x. Because of the nature of the ionization process, ionic air purifiers tend to generate the most ozone. This is a serious concern, because ozone is a criteria air pollutant regulated by health-related US federal and state standards. In a controlled experiment, in many cases, ozone concentrations were well in excess of public and/or industrial safety levels established by US Environmental Protection Agency, particularly in poorly ventilated rooms.[16]

Ozone can damage the lungs, causing chest pain, coughing, shortness of breath and throat irritation. It can also worsen chronic respiratory diseases such as asthma and compromise the ability of the body to fight respiratory infections—even in healthy people. People who have asthma and allergy are most prone to the adverse effects of high levels of ozone.[17] For example, increasing ozone concentrations to unsafe levels can increase the risk of asthma attacks.

Due to the below average performance and potential health risks, Consumer Reports has advised against using ozone producing air purifiers.[18] IQAir, the educational partner of the American Lung Association, has been a leading industry voice against ozone-producing air cleaning technology.[19]

Ozone generators used for shock treatments (unoccupied rooms) which are needed by smoke, mold, and odor remediation contractors as well as crime scene cleanup companies to oxidize and permanently remove smoke, mold, and odor damage are considered a valuable and effective tool when used correctly for commercial and industrial purposes. However, there is a growing body of evidence that these machines can produce undesirable by-products.[20]

In September 2007, the California Air Resources Board announced a ban of indoor air cleaning devices which produce ozone above a legal limit. This law, which took effect in 2010, requires testing and certification of all types of indoor air cleaning devices to verify that they do not emit excessive ozone.[21][22]

See also

- Air filter
- Air ioniser
- Air sanitizer
- Electrostatic precipitator
- HEPA
- Nose filter
- Ozone generator

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External links

- CADR.org (http://www.cadr.org/) Information on Clean Air Delivery Rate by AHAM
- EPA report on indoor air quality (http://www.epa.gov/iaq/pubs/insidest.html)
- DOE HEPA Filter Standards (http://homer.ornl.gov/nuclearsafety/ns/techstds/tsdrafts/doe-std-3020-yr.pdf) HEPA filter specifications for DOE contractors
- Potera, C. (2011), Wood-Burning Stoves Get Help from HEPA Filters (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3080954/) US National Institutes of Health

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