Currently Available Air Cleaning Methods: Do they really work? Are they safe?

1. Ozone (sometimes called: **activated oxygen, trivalent oxygen** or **nature's air purifier**)

At certain concentrations ozone is claimed to be able to kill microorganisms and remove certain odours. While many manufacturers still market ozone generators as air cleaners for residential use, world leading health organisations (e.g. EPA, Health Canada) warn against the use of ozone for air cleaning purposes since ozone generators can be harmful to human health even when they produce only low (allegedly "safe") concentrations of ozone. It has also been proven beyond doubt by independent research that the use of ozone at safe levels is ineffective for air purification purposes. Here is a summary of the facts:

- Ozone is a well known lung irritant and can cause asthma attacks.
- Ozone does not remove particles. In order to kill microorganisms, the levels of ozone must be so high that they would also be harmful to human health. Conversely, at low levels which would be harmless to humans, ozone generators do not have any air cleaning benefit.
- If ozone is really as safe and reliable at killing microorganisms as manufacturers of ozone generators claim, why are they not recommended and used in critical hospital environments for the protection against airborne infectious microorganisms? By comparison, true HEPA filtration is recognised and recommended as the most effective means of airborne infection control (e.g. by WHO, CDC) and used in critical hospital areas worldwide. The CDC recommends HEPA filtration for the control of TB (which is one of the most infectious microorganisms known to mankind, killing thousands more people every day than the SARS virus has killed in total so far.)
- There is no independent evidence that the ozone generated by air cleaners actually kills all the microorganisms in the air that flows through it, nor the microorganisms that may have been captured inside the air cleaner.

Here are some quotes that summarise the issue regarding ozone generators:

EPA (Environmental Protection Agency):

"Conclusions:

Whether in its pure form or mixed with other chemicals, ozone can be harmful to health. *When inhaled, ozone can damage the lungs. Relatively low amounts of ozone can cause chest pain, coughing, shortness of breath and, throat irritation. It may also worsen chronic respiratory diseases such as asthma as well as compromise the ability of the body to fight respiratory infections.*

Some studies show that ozone concentrations produced by ozone generators can exceed health standards even when one follows manufacturer's instructions. *Many factors affect ozone concentrations including the amount of ozone produced by the machine(s), the size of the indoor space, the amount of material in the room with which ozone reacts, the outdoor ozone concentration, and the amount of ventilation. These factors make it difficult to control the ozone concentration in all circumstances.*

Available scientific evidence shows that, at concentrations that do not exceed public health standards, ozone is generally ineffective in controlling indoor air pollution. *The concentration of ozone would have to greatly exceed health standards to be effective in removing most indoor air contaminants. In the process of reacting with chemicals indoors, ozone can produce other chemicals that themselves can be irritating and corrosive.*

Recommendation:

The public is advised to use proven methods of controlling indoor air pollution. *These methods include eliminating or controlling pollutant sources, increasing outdoor air ventilation, and using proven methods of air cleaning."*

www.epa.gov/iaq/pubs/ozonegen.html

California Department of Health Services:

"Ozone-generating devices are being marketed to the public as a solution to indoor quality problems. Ozone generators are available in three forms: in-duct units for central air systems, portable indoor units, and personal units that are worn on the body. They are promoted as effective "air purifiers", especially to people sensitive to indoor air pollutants. ***Manufacturers often refer to the ozone as activated oxygen, trivalent oxygen or nature's air purifier to suggest that it is safe.*** *They advertise ozone's ability to oxidize indoor air pollutants and "leave only carbon dioxide, water, and breathable oxygen." However, independent studies have shown that ozone generators do* ***not*** *effectively destroy microbes, remove odor sources, or reduce indoor pollutants enough to provide any health benefits. More alarming, these devices can generate excessive levels of ozone and may contribute to eye and nose irritation or other respiratory health problems for users."*

Are Ozone-Generating Air Cleaners Safe and Effective?

[…] However, it is ***not effective in air*** *as a biocide (i.e. killer of bacteria and fungi), except at extremely high, unsafe levels. […] A number of independent studies have concluded that safe levels of ozone do not effectively oxidize air pollutants or improve indoor air quality.*

Recent Actions

[…] The Federal Trade Commission (FTC) filed suit against the industry's leading manufacturer for violating their 1995 consent order with FTC. The 1995 order required that ozone generator manufacturers halt their practice of making unsupported, misleading health claims about the ability of their products to remove indoor air pollutants and prevent or relieve allergies, asthma and other conditions."

www.cal-iaq.org/o3_fact.htm

For further information on this topic visit the following websites:

www.hc-sc.gc.ca/ehp/ehd/catalogue/psb_pubs/ozone_qa.htm
www.baq1.com/hozone.html

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2. Ionization

An ionizer is a device that disperses negatively (and/or positively) charged ions into the air. These ions attach to particles in the air, giving them a negative (or positive) charge so that the particles may attach to nearby surfaces such as walls or furniture, or attach to one another and settle out of the air.

Limitations of this method:

- The particles are not actually removed, but adhere to surfaces causing black walls and curtains. Since the largest surface in an inhabited room is offered by the human lung, this is also a likely surface where the charged particles can become lodged. Obviously this can cause severe short- and long-term health problems.
- As the particles loose their charge over time, this allows the particles to become airborne again.
- Ionizers do not filter gases or odours and many ionizers also produce harmful ozone as a by-product.

EPA (Environmental Protection Agency):

"In recent experiments, ionizers were found to be less effective in removing particles of dust, tobacco smoke, pollen or fungal spores than either high efficiency particle filters or electrostatic precipitators." (Shaughnessy et al., 1994; Pierce, et al., 1996).

www.epa.gov/iaq/pubs/ozonegen.html

3. Electrostatic/Electronic Air Cleaners (Precipitators)

(please refer to **www.engr.psu.edu/ae/wjk/electro.html** for a useful summary of this air cleaning method)

Shortcomings:

- Need to be serviced regularly.
- Maximum efficiency ca. 95%, which decreases from the very first moment of use, sometimes to below 20%.
- Do not remove odours or gases.
- No evidence that they effectively control microorganisms.
- Not effective for larger airborne particles (e.g. allergens).

4. UV Light

Some air cleaners offer UV-light as an additional air cleaning stage. Although UV light has been shown to kill microorganisms at a certain wavelength and after a certain exposure time and light intensity, UV light is **NOT** a reliable way to sterilize the air. Also there is no scientific evidence that shows that UV light provides a benefit to a HEPA air cleaner.

- UV lamps create an increased health-risk, a disposal problem and added expense. The real reason why some manufacturers like to include UV lamps in their HEPA air purifiers is not their desire to increase the system's efficiency, nor can they guarantee that the germs will actually be killed reliably by their UV lamps. The UV lamps are included because the manufacturer can make more money with replacement parts (for safety reasons, UV lights must be changed at least at yearly intervals).
- UV light does not remove odours or gases.
- Many health organisations warn health-care institutions not to use UV light for germicidal purposes due to their unreliability and because of the false sense of security which UV lamps create.

CDC (US Centres for Disease Control and Prevention):

"The use of UV lamps and HEPA filtration in one single unit would not be expected to have any infection control benefits not provided by the use of the HEPA filter alone." ***www.cdc.gov/mmwr/preview/mmwrhtml/00035909.htm***

OSEH (Occupational Safety & Environmental Health Dept.) of Michigan University:

"The University of Michigan no longer supports the use of ultraviolet germicidal irradiation (UVGI) […]

UVGI lends little to product sterility or personal safety in research settings, and has caused numerous hazardous exposures to employees while creating an expensive disposal problem.

Bulbs still in use will be removed and disposed as they fail over the next two years. Actually they effectively fail in 6 months, but appear to still be working (no visual indication of failure)." ***www.umich.edu/~oseh/UVbulb.pdf***

5. Photocatalytic Oxidation (PCO)

This new technology for the filtration of gases is still in its infancy. No residential air cleaner manufacturer (irrespective of their claims) has yet managed to develop a system which uses this method effectively to remove gaseous contaminants as effectively as granular activated carbon (GAC). In order to work effectively, PCO air cleaners would become very expensive and would still not be as effective as GAC in removing gaseous pollutants. In a publication comparing the cost-effectiveness of activated carbon with PCO at removing Volatile Organic Compounds, the EPA writes:

"The analysis shows that, […] the PCO unit would have an installed cost of 10 times greater, and an annual cost almost 7 times greater, than the GAC unit. It also suggests that PCO costs cannot be likely be reduced by a factor greater than 2 to 4, solely by improvements in the POC system configuration and reductions in unit component costs." ***www.epa.gov/appcdwww/iemb/cost.htm***

"Even with reductions by a factor of 2 to 4, POC would still be sufficiently expensive such that it would not likely be widely accepted for general indoor air applications." ***www.epa.gov/appcdwww/iemb/insideiaq/ss98.pdf***

6. (True) HEPA filtration

High Efficiency Particulate Air (HEPA) filters, formerly called high-efficiency particulate arrestors, were originally developed during World War II to prevent discharge of radiactive particles from nuclear reactor facility exhausts. Due to their extraordinarily high filtration efficiency, HEPA filters have since become a vital technology in industrial, medical, and military clean rooms.

The filtering media of a HEPA filter is made of submicronic glass fibers in a thickness and texture very similar to blotter paper. A HEPA filter has been traditionally been defined as having a minimum particle removal efficiency of 99.97% for all particles of 0.3 micron and larger. In the words of the American Lung Association, to qualify as a "true" HEPA, the filter must allow no more than 3 particles out of 10'000 to penetrate the filtration media.

It is important to note that the mere use of a 99.97% efficient HEPA filter in an air cleaner does not automatically guarantee that the air cleaner's actual efficiency is also 99.97%. In fact for most so-called HEPA air cleaners this is not the case. Badly pleated filters, leakage around the edges of the filter material or between the filter element and the housing often result in actual efficiencies between 50 - 95%. So instead of allowing only 3 particles out of 10'000 to come out of the air cleaner, these systems permit between 500 and 5'000 particles to be contained in the "cleaned" air stream.

The U.S. Centers for Disease Control and Prevention (CDC) therefore recommend:

> *"Manufacturers of room-air cleaning equipment should provide documentation of the HEPA filter efficiency..."*
>
> ***CDC Recommendations and Reports, Vol. 43, No. RR-13, p. 81***

Such documentation must come in the form of an independent test report, such as an efficiency classification in accordance with an internationally accepted HEPA filter test norm (e.g. European Norm EN1822) which tests HEPA filters within the air cleaner housing, or a certificate that shows that the complete air cleaner has been tested and certified individually and has actually achieved the 99.97% efficiency for particles greater or equal to 0.3 micron.

7. Synthetic HEPA, non-true HEPA filtration

In an effort to cash in on the high-performance image of true HEPA filters, some air cleaner manufacturers have introduced so-called "HEPA-type" filters. Such filters are less expensive, but also hugely less efficient than true HEPA filters. On this point, the American Lung Association warns:

> *"[…] recently, filters made in the same physical style [as true HEPA filters] using less efficient filter paper are being referred to as HEPA filters or "HEPA-type" filters. Their actual efficiency may be 55% or less at 0.3 microns."*
>
> ***http://www.lungusa.org/pub/cleaners/air_clean_chap3.html***

The use of the word "HEPA" in conjunction with less efficient air cleaners is designed to mislead potential buyers into believing that the system can provide the same filtration efficiency as a true HEPA filter. Such practices are misleading (at best) and can be even harmful when it comes to health issues of allergy sufferers or if the system is to be used for airborne infection control.

IMPORTANT NOTE:
The publication of air cleaner efficiency claims that cannot actually be achieved by the system or are known to be wrong, may amount to "false advertising" and can give rise to legal actions against the person or organisation publishing or perpetuating such false claims.