DOCKETED

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Description:	Reference articles and literature from the EPA, CARB as well as that of competing filtrations systems manufacturers.
Filer:	Mark Alatorre
Organization:	Bruce Severance
Submitter Role:	Public
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From:	G.Bruce Severance
To:	Alatorre, Mark@Energy
Subject:	CARB and EPA data on UV scrubbers
Date:	Monday, March 05, 2018 4:07:18 PM
Attachments:	aircleaners -EPA2008.pdf ozone_gen_fact_sheet-CARB 06.pdf

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Dear Mark,

Various so-called “air-purifiers” that use UV light to theoretically kill molds and purify air appear to associated with significant health hazards. It appears that the many so called “UV scrubber” devises sold for home use do not produce high enough levels of ozone and other bacteria-neutralizing agents to actually kill bacteria and they do nothing to remove particulates while exposing people to many other potentially harmful agents that are the result of chemical processes and compounds they produce:

"Reactive Oxygen Species" (ROS) of various types. If they are produced in sufficient quantities to neutralize or kill anything, these ROS molecules can also react with human cells and human tissue. Ozone is one of a group of unstable, highly reactive molecules called "Reactive Oxygen Species" ROS. If you want a sobering mass of information go to Google and type in: "Reactive oxygen species health effects." You will get thousands of hits and find that ROS are responsible for a host of diseases including cancer, heart attacks, asthma attacks and much more.

In any event, “UV-scrubbers” or “UV air-purifiers” and other in-duct "air cleaners" work on the principle of Photocatalytic Oxidation (PCO). They expose UV light to a catalyst and produce another ROS called a Hydroxyl Radical (OH). Hydroxyl Radicals differ from ozone in that they are difficult to measure. Ozone reacts with many Volatile Organic Compounds (VOC's) to create some harmful byproducts including formaldehyde and ultrafine particles. As it turns out virtually any double bond organic molecule will react with ozone to create these ultrafine particles (less than one micron). Particles this size can penetrate deep into the lungs and have been shown to create cell damage and inflammation.

Additional problems arise if there are VOC’s in the home,(most homes have them in carpet, construction adhesives, engineered wood products such as particle boards.) It is the combination of VOCs with particles resulting from the use of UV scrubbers that can cause damaging health effects.

Please reference articles and literature from the EPA, CARB as well as that of competing filtration system manufacturers that points to a body of evidence that weighs heavily against UV-emitting air cleaners in residential applications.

We probably should have inserted the attached docs into the middle of our comments to avoid confusion. Given that final revisions were submitted by Doug Tucker, I am unable to insert these now without possession of his last draft.

I appreciate you adding these to the docket as "Addendum 1 & 2 to Mitsubishi Electric US Comments".

If you do not mind, I will give Doug your direct contact information to facilitate ongoing communication on these critical issues.

Thank you for your assistance.

Sincerely,
Bruce Severance
805-268-4444
PS: Future email to me should be directed to bseverance@hvac.mea.com
(My company email is not operational at the moment).

EPA United States Environmental Protection Agency

Guide to Air Cleaners in the Home

Please Note: EPA neither certifies nor recommends particular brands of home air cleaning devices. While some home air cleaning devices may be useful in some circumstances, EPA makes no broad endorsement of their use, nor specific endorsement of any brand or model. This document describes performance characteristics associated with several types of air cleaners sold to consumers for home use. It does not discuss the effectiveness of air cleaners installed in the HVAC systems of large buildings, such as apartments, offices, schools, or public buildings.

Under Federal pesticide law, manufacturers of ozone generators must list an EPA establishment number on the packaging. This number merely identifies the facility that manufactured the product. Display of this number implies neither EPA endorsement nor that EPA has found the product to be safe or effective.

Some portable air cleaners sold in the consumer market are ENERGY STAR® qualified. Please note the following disclaimer on their packaging: "This product earned the ENERGY STAR by meeting strict energy efficiency guidelines set by EPA. EPA does not endorse any manufacturer claims of healthier indoor air from the use of this product."

Introduction

Indoor air pollutants are unwanted, sometimes harmful materials in the air. Indoor air pollution is among the top five environmental health risks. Usually the best way to address this risk is to control or eliminate the sources of pollutants, and to ventilate a home with clean outdoor air. The ventilation method may, however, be limited by weather conditions or undesirable levels of contaminants contained in outdoor air. If these measures are insufficient, an air cleaning device may be useful. Air cleaning devices are intended to remove pollutants from indoor air. Some air cleaning devices are designed to be installed in the ductwork of a home's central heating, ventilating, and air-conditioning (HVAC) system to clean the air in the whole house. Portable room air cleaners can be used to clean the air in a single room or specific areas, but they are not intended for whole-house filtration. The following pages will provide information on different types of air cleaning devices and how they work.

Indoor Air Pollutants

Pollutants that can affect air quality in a home fall into the following categories:

- **Particulate matter** includes dust, smoke, pollen, animal dander, tobacco smoke, particles generated from combustion appliances such as cooking stoves, and particles associated with tiny organisms such as dust mites, molds, bacteria, and viruses.
- **Gaseous pollutants** come from combustion processes. Sources include gas cooking stoves, vehicle exhaust, and tobacco smoke. They also come from building materials, furnishings, and the use of products such as adhesives, paints, varnishes, cleaning products, and pesticides.

Understanding the Types of Air Cleaning Devices

Before deciding whether to use an air cleaning device, several questions should be considered:

- What types of pollutants can an air cleaner remove?
- How is the performance of an air cleaner measured?
- Will air cleaning reduce adverse health effects?
- What other factors should I consider?

These questions will be addressed in the next few pages.

What Types of Pollutants Can an Air Cleaner Remove?

There are several types of air cleaning devices available, each designed to remove certain types of pollutants.

Particle Removal

Two types of air cleaning devices can remove particles from the air—mechanical air filters and electronic air cleaners. **Mechanical air filters** remove particles by capturing them on filter materials. High efficiency particulate air (HEPA) filters are in this category. **Electronic air cleaners** such as electrostatic precipitators use a process called electrostatic attraction to trap charged particles. They draw air through an ionization section where particles obtain an electrical charge. The charged particles then accumulate on a series of flat plates called a collector that is oppositely charged. Ion generators, or ionizers, disperse charged ions into the air, similar to the electronic air cleaners but without a collector. These ions attach to airborne particles, giving them a charge so that they attach to nearby surfaces such as walls or furniture, or attach to one another and settle faster.

Gaseous Pollutant Removal

Gas-phase air filters remove gases and odors by using a material called a sorbent, such as activated carbon, which adsorbs the pollutants. These filters are typically intended to remove one or more gaseous pollutants from the airstream that passes through them. Because gas-phase filters are specific to one or a limited number of gaseous pollutants, they will not reduce concentrations of pollutants for which they were not designed. Some air cleaning devices with gas-phase filters may remove a portion of the gaseous pollutants and some of the related hazards, at least on a temporary basis. However, none are expected to remove all of the gaseous pollutants present in the air of a typical home. For example, carbon monoxide is a dangerous gaseous pollutant that is produced whenever any fuel such as gas, oil, kerosene, wood, or charcoal is burned, and it is not readily captured using currently available residential gas-phase filtration products.

Pollutant Destruction

Some air cleaners use ultraviolet (UV) light technology intended to destroy pollutants in indoor air. These air cleaners are called ultraviolet germicidal irradiation (UVGI) cleaners and photocatalytic oxidation (PCO) cleaners. Ozone generators that are sold as air cleaners intentionally produce ozone gas, a lung irritant, to destroy pollutants.

- **UVGI cleaners** use ultraviolet radiation from UV lamps that may destroy biological pollutants such as viruses, bacteria, allergens, and molds that are airborne or growing on HVAC surfaces (e.g., found on cooling coils, drain pans, or ductwork). If used, they should be applied with, but not as a replacement for, filtration systems.
- **PCO cleaners** use a UV lamp along with a substance, called a catalyst, that reacts with the light. They are intended to destroy gaseous pollutants by converting them into harmless products, but are not designed to remove particulate pollutants.
- **Ozone generators** use UV light or an electrical discharge to intentionally produce ozone. Ozone is a lung irritant that can cause adverse health effects. At concentrations that do not exceed public health standards, ozone has little effect in removing most indoor air contaminants. Thus, ozone generators are not always safe and effective in controlling indoor air pollutants. Consumers should instead use methods proven to be both safe and effective to reduce pollutant

Ozone is a lung irritant that can cause adverse health effects.

concentrations, which include eliminating or controlling pollutant sources and increasing outdoor air ventilation. Visit **www.epa.gov/iaq/pubs/ozonegen.html** for more information on ozone generators sold as air cleaners.

The chart below provides a brief summary of air cleaning technologies and the pollutants they are designed to control.

AIR CLEANING TECHNOLOGIES		POLLUTANTS ADDRESSED	LIMITATIONS
Filtration	Air filters	Particles	Ineffective in removing larger particles because most settle from the air quickly and never reach filters.
	Gas-phase filters	Gases	Used much less frequently in homes than particle air filters. The lifetime for removing pollutants may be short.
Other Air Cleaners	UVGI	Biologicals	Bacterial and mold spores tend to be resistant to UV radiation and require more light or longer time of exposure, or both, to be killed.
	PCO	Gases	Application for homes is limited because currently available catalysts are ineffective in destroying gaseous pollutants from indoor air.
	Ozone generators	Particles, gases, biologicals	Sold as air cleaners, they are not always safe and effective in removing pollutants. By design they produce ozone, a lung irritant.

In addition to understanding the different types of air cleaning devices, consumers should consider their performance, as explained in the next section.

REMINDERS

HVAC
Heating, ventilating, and air-conditioning

PCO
Photocatalytic oxidation

UV
Ultraviolet

UVGI
Ultraviolet germicidal irradiation

How is the Performance of an Air Cleaner Measured?

There are different ways to measure how well air cleaning devices work, which depend on the type of device and the basic configuration. Air cleaning devices are configured either in the ductwork of HVAC systems (i.e., in-duct) or as portable air cleaners.

In-duct Particle Removal

Most **mechanical air filter**s are good at capturing larger airborne particles, such as dust, pollen, dust mite and cockroach allergens, some molds, and animal dander. However, because these particles settle rather quickly, air filters are not very good at removing them completely from indoor areas. Although human activities such as walking and vacuuming can stir up particles, most of the larger particles will resettle before an air filter can remove them.

Consumers can select a particle removal air filter by looking at its efficiency in removing airborne particles from the air stream that passes through it. This efficiency is measured by the minimum efficiency reporting value (MERV) for air filters installed in the ductwork of HVAC systems. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) developed this measurement method. MERV ratings (ranging from a low of 1 to a high of 20) also allow comparison of air filters made by different companies.

- **Flat or panel air filters** with a MERV of 1 to 4 are commonly used in residential furnaces and air conditioners. For the most part, such filters are used to protect the HVAC equipment from the buildup of unwanted materials on the surfaces such as fan motors and heating or cooling coils, and not for direct indoor air quality reasons. They have low efficiency on smaller airborne particles and medium efficiency on larger particles, as long as they remain airborne and pass through the filter. Some smaller particles found within a house include viruses, bacteria, some mold spores, a significant fraction of cat and dog allergens, and a small portion of dust mite allergens.

- **Pleated or extended surface filters**
  - Medium efficiency filters with a MERV of 5 to 13 are reasonably efficient at removing small to large airborne particles. Filters with a MERV between 7 and 13 are likely to be nearly as effective as true HEPA filters at controlling most airborne indoor particles. Medium efficiency air filters are generally less expensive than HEPA filters, and allow quieter HVAC fan operation and higher airflow rates than HEPA filters since they have less airflow resistance.
  - Higher efficiency filters with a MERV of 14 to 16, sometimes misidentified as HEPA filters, are similar in appearance to true HEPA filters, which have MERV values of 17 to 20. True HEPA filters are normally not installed in residential HVAC systems; installation of a HEPA filter in an existing HVAC system would probably require professional modification of the system. A typical residential air handling unit and the associated ductwork would not be able to accommodate such filters because of their physical dimensions and increase in airflow resistance.

    Some residential HVAC systems may not have enough fan or motor capacity to accommodate higher efficiency filters. Therefore, the HVAC manufacturer's information should be checked prior to upgrading filters to determine whether it is feasible to use more efficient filters. Specially built high performance homes may occasionally be equipped with true HEPA filters installed in a properly designed HVAC system.

Filters with a MERV between 7 and 13 are likely to be nearly as effective as true HEPA filters.

There is no standard measurement for the effectiveness of **electronic air cleaners**. While they may remove small particles, they may be ineffective in removing large particles. Electronic air cleaners can produce ozone—a lung irritant. The amount of ozone produced varies among models. Electronic air cleaners may also produce ultrafine particles resulting from reaction of ozone with indoor chemicals such as those coming from household cleaning products, air fresheners, certain paints, wood flooring, or carpets. Ultrafine particles may be linked with adverse health effects in some sensitive populations.

REMINDERS

ASHRAE
American Society of Heating, Refrigerating and Air-Conditioning Engineers

HEPA
High efficiency particulate air

HVAC
Heating, ventilating, and air-conditioning

MERV
Minimum efficiency reporting value

In-duct Gaseous Pollutant Removal

Although there is no standard measurement for the effectiveness of gas-phase air filters, ASHRAE is developing a standard method to be used in choosing gas-phase filters installed in home HVAC systems. Gas-phase filters are much less commonly used in homes than particle air filters. The useful lifetime of gas-phase filters can be short because the filter material can quickly become overloaded and may need to be replaced often. There is also concern that, when full, these filters may release trapped pollutants back into the air. Finally, a properly designed and built gas-phase filtration system would be unlikely to fit in a typical home HVAC system or portable air cleaner.

In-duct Pollutant Destruction

There is no standard measurement for the effectiveness of UVGI cleaners. Typical UVGI cleaners used in homes have limited effectiveness in killing bacteria and molds. Effective destruction of some viruses and most mold and bacterial spores usually requires much higher UV exposure than is provided in a typical home unit. Furthermore, dead mold spores can still produce allergic reactions, so UVGI cleaners may not be effective in reducing allergy and asthma symptoms.

UVGI cleaners may not reduce allergy or asthma symptoms.

There is no standard measurement for the effectiveness of PCO cleaners. The use of PCO cleaners in homes is limited because currently available catalysts are ineffective in destroying gaseous pollutants from indoor air. Some PCO cleaners fail to destroy pollutants completely and instead produce new indoor pollutants that may cause irritation of the eyes, throat, and nose.

Portable Air Cleaners

Portable air cleaners generally contain a fan to circulate the air and use one or more of the air cleaning devices discussed above. Portable air cleaners may be moved from room to room and used when continuous and localized air cleaning is needed. They may be an option if a home is not equipped with a central HVAC system or forced air heating system.

Portable air cleaners can be evaluated by their effectiveness in reducing airborne pollutants. This effectiveness is measured by the clean air delivery rate (CADR) developed by the Association of Home Appliance Manufacturers (AHAM). The CADR is a measure of a portable air cleaner's delivery of contaminant-free air, expressed in cubic feet per minute. For example, if an air cleaner has a CADR of 250 for dust particles, it may reduce dust particle levels to the same concentration as would be achieved by adding 250 cubic feet of clean air each minute. While a portable air cleaner may not achieve its rated CADR under all circumstances, the CADR value does allow comparison across different portable air cleaners.

Many of the portable air cleaners tested by AHAM have moderate to large CADR ratings for small particles. However, for typical room sizes, most portable air cleaners currently on the market do not have high enough CADR values to effectively remove large particles such as pollen, dust mite, and cockroach allergens. Some portable air cleaners using electronic air cleaners might produce ozone, which is a lung irritant. AHAM has a portable air cleaner certification program, and provides a complete listing of all certified cleaners with their CADR values on its Web site at **www.cadr.org**.

REMINDERS

AHAM
Association of Home Appliance Manufacturers

CADR
Clean air delivery rate

ASHRAE
American Society of Heating, Refrigerating and Air-Conditioning Engineers

HVAC
Heating, ventilating, and air-conditioning

PCO
Photocatalytic oxidation

UV
Ultraviolet

UVGI
Ultraviolet germicidal irradiation

REMINDERS

PCO
Photocatalytic oxidation

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Ultraviolet germicidal irradiation

Will Air Cleaning Reduce Adverse Health Effects?

The ability to remove particles, including microorganisms, is not, in itself, an indication of the ability of an air cleaning device to reduce adverse health effects from indoor pollutants. The use of air cleaning devices may help to reduce levels of smaller airborne allergens or particles. However, air cleaners may not reduce adverse health effects in sensitive population such as children, the elderly, and people with asthma and allergies. For example, the evidence is weak that air cleaning devices are effective in reducing asthma symptoms associated with small particles that remain in the air, such as those from some airborne cat dander and dust mite allergens. Larger particles, which may contain allergens, settle rapidly before they can be removed by filtration, so effective allergen control measures require washing sheets weekly, frequent vacuuming of carpets and furniture, and dusting and cleaning of hard surfaces. (For more on allergen control, visit **www.epa.gov/asthma.**) There are no studies to date linking gas-phase filtration, UVGI, and PCO systems in homes to reduced health symptoms in sensitive populations.

Additional Factors to Consider

When making decisions about using air cleaning devices, consumers should also consider:

- **Installation:** In-duct air cleaning devices have certain installation requirements that must be met, such as sufficient access for inspection during use, repairs, or maintenance.
- **Major Costs:** These include the initial purchase, maintenance (such as cleaning or replacing filters and parts), and operation (such as electricity).
- **Odors:** Air cleaning devices designed for particle removal are incapable of controlling gases and some odors. The odor and many of the carcinogenic gas-phase pollutants from tobacco smoke will still remain.
- **Soiling of Walls and Other Surfaces**: Ion generators generally are not designed to remove the charged particles that they generate from the air. These particles may deposit on room surfaces, soiling walls and other surfaces.
- **Noise:** Noise may be a problem with portable air cleaners containing a fan. Portable air cleaners without a fan are typically much less effective than units with a fan.

Conclusion

Indoor air pollution is among the top five environmental health risks. The best way to address this risk is to control or eliminate the sources of pollutants, and to ventilate a home with clean outdoor air. The ventilation method may, however, be limited by weather conditions or undesirable levels of contaminants in outdoor air. If these measures are insufficient, an air cleaning device may be useful. While air cleaning devices may help to control the levels of airborne allergens, particles, or, in some cases, gaseous pollutants in a home, they may not decrease adverse health effects from indoor air pollutants.

Additional Information

More in-depth analysis of air cleaners is available in the EPA technical document *Residential Air Cleaners: A Summary of Available Information (Second Edition)*, EPA 402-F-08-005, May 2008.
Web site: **www.epa.gov/iaq/pubs/residair.html**

An electronic copy of this brochure, EPA 402-F-08-004, is available at **www.epa.gov/iaq/pdfs/aircleaners.pdf**

For additional hard copies of this brochure and other EPA indoor air publications, contact:

National Service Center for Environmental Publications (NSCEP)
P.O. Box 42419
Cincinnati, OH 42419
phone: (800) 490-9198
fax: (301) 604-3408
Web site: **www.epa.gov/nscep**

Office of Air and Radiation
Indoor Environments Division
(6609J)

EPA - 402-F-08-004
May 2008

Fact Sheet

California Environmental Protection Agency
Air Resources Board

March 2006

Beware of Ozone-generating Indoor "Air Purifiers"

Some devices that are advertised as "air purifiers" or air cleaners purposely emit large amounts of ozone, the main component of smog! Not only are such ozone generators ineffective at cleaning indoor air, but breathing ozone poses serious health risks. This fact sheet discusses these health risks and provides effective, alternative solutions to indoor air quality problems. Further details, including a list of brands and models of ozone generators, can be obtained at: http://www.arb.ca.gov/research/indoor/ozone.htm. The Air Resources Board recommends that ozone generators not be used.

What are ozone-generating air cleaners?

Some indoor "air purifiers" or air cleaners emit ozone, a major component of outdoor smog, either intentionally or as a by-product of their design. Those that intentionally emit ozone are often called "ozone generators," and are the focus of this fact sheet. Manufacturers sometimes inappropriately refer to ozone as "activated oxygen," "super oxygenated" or "energized oxygen," implying that ozone is a healthy kind of oxygen. Because ozone reacts with some other molecules, manufacturers claim that the ozone produced by these devices can purify the air and remove airborne particles, chemicals, mold, viruses, bacteria, and odors. However, ozone is not effective at cleaning the air except at extremely high, unsafe ozone levels, and then it is only partially effective.

Common ozone generators

Ionizers and electrostatic precipitators are other types of air cleaners that emit ozone, but do so as a by-product of their design and function. These devices are designed to electrically charge particles and remove them from the air; ozone is released through the charging process. These devices typically emit less ozone than ozone generators.

What is ozone?

Ozone is a molecule composed of three oxygen atoms. It is a highly reactive, unstable, toxic gas. Ground level ozone is a major component of photochemical smog that plagues larger cities during the summertime. There is also a layer of ozone high up in the atmosphere, called stratospheric ozone, that protects us by reducing the amount of ultraviolet light entering the earth's atmosphere. This beneficial ozone layer should not be confused with the harmful ozone that occurs at ground level.

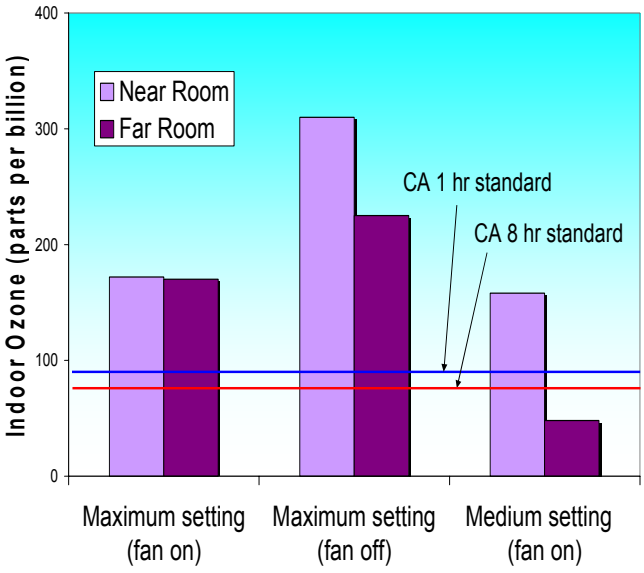
What are the adverse health effects from exposure to ozone?

Buyers of ozone generators may not be aware that ozone can harm the cells in the lungs and respiratory airways. Exposure to ozone irritates and inflames the lining of the respiratory system. It causes symptoms including coughing, chest tightness, and shortness of breath. In persons with asthma, ozone can worsen asthma symptoms, and one study indicates that ozone may contribute to the development of asthma. Ozone impairs breathing. Elevated exposures to ozone can cause permanent lung damage, and repeated exposure can even increase the risk of dying among persons already in poor health.

Persons especially vulnerable include children and those who suffer from asthma or other respiratory diseases, including the elderly. Due to the health hazards of ozone, California has worked aggressively for decades to reduce outdoor ozone levels, with considerable success. For more information on the health effects of ozone, visit http://www.arb.ca.gov/research/aaqs/caaqs/ozone/ozone.htm. In addition to its impacts on health, ozone can also damage materials such as rubber, fabrics, plastics and other indoor furnishings.

How much ozone do ozone generators produce?

Studies have shown that ozone generators can produce indoor ozone levels several times the state outdoor health standard of 90 parts per billion (ppb) for one hour, as well as the eight hour standard of 70 ppb. In one experiment, a level of 300 ppb was measured in a house after 1-2 hours of ozone generator use.[1] As shown, indoor ozone levels were about twice the health standard levels when the ozone generator was set on the maximum setting and the central fan was either on or off. Ozone levels were almost twice the health standard levels in the near room even when the device was set to a medium setting. These concentrations are equal to, or worse than, a first stage smog alert. It is clear that the ozone concentrations produced by these devices can easily exceed health-protective standards.



Are ozone generators effective at cleaning air?

Some devices are marketed with advertising claims that they will kill viruses, bacteria, mold and other biological contaminants, and remove chemical contaminants and odors. However, studies have shown that, when ozone concentrations are below the health standards, it does not effectively remove biological contaminants. Ozone also does not remove particles (e.g. dust and pollen) from the air, including the particles responsible for most allergies. Research also shows that ozone generated by air purifiers does little to remove chemical pollutants. In fact, ozone has been found to react with existing chemicals in the air to create other toxic pollutants, most notably formaldehyde and ultrafine particles.

Some consumers purchase air purifiers to eradicate odors. Evidence shows that ozone concentrations below the health standards are not effective in removing many odor-causing chemicals. Ozone is also known to deaden one's sense of smell. Not only does this disguise rather than eliminate odors, it can also have the dangerous effect of decreasing a person's ability to detect high ozone levels.

Unlike the situation in air, ozone can be used successfully to purify water in some applications. This is so because high levels of ozone can be used in the water, most of the ozone reacts in the water, and people typically are not present when the ozone is used.

Why are ozone generators still on the market?

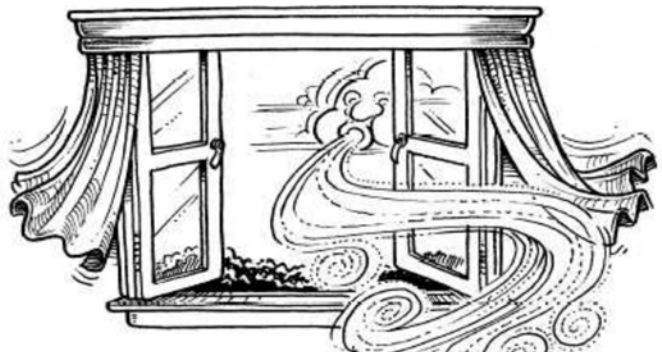
If ozone generators are ineffective at removing air pollutants, and they pose major health risks to users, why do they continue to be sold? The unfortunate answer is that misleading advertising by manufacturers is very effective, and no government agency has the authority to fully regulate these devices. Thus, ARB is actively working to educate professionals and the public about the dangers of using ozone generators.

What does the Air Resources Board recommend?

We strongly advise against the use of ozone generators in occupied spaces. Other governmental agencies agree with this advice.[2,3] A current list of ozone generators is available at: http://www.arb.ca.gov/research/indoor/o3g-list.htm.

Instead of using an air cleaner, consumers are encouraged to first eliminate or reduce indoor pollution sources and to ventilate well with outdoor air. The most effective method of controlling indoor air pollution is through prevention: eliminating pollution at its source. To minimize the release of pollutants indoors:

- carefully follow directions on consumer products such as cleaning agents, paints, and glues;
- properly maintain and operate gas- and wood-burning appliances;
- restrict smoking to outdoor areas;
- purchase building materials and wood furniture that do not emit formaldehyde;
- use candles and incense sparingly, if at all; and
- clean frequently and thoroughly to prevent dust and mold build-up.



Use plenty of ventilation: be sure there is adequate airflow to/from the outdoors. This can be achieved by opening windows, using exhaust fans near pollutant sources (e.g. above gas stoves), and increasing airflow through the use of mechanical ventilation systems. If your home is equipped with a central forced air system, you should also consider upgrading the filter.

If I still need an air cleaner, how do I find a good one?

In some cases, air cleaners may be beneficial. Types of air cleaners include filters (including High Efficiency Particulate Air or "HEPA" filters), electrostatic precipitators, ionizers, and hybrid models. For help in selecting a good air cleaner, see our Fact Sheet entitled "Air Cleaning Devices for the Home – Frequently Asked Questions," February 2005, available by calling the telephone number shown below, or online at: http://www.arb.ca.gov/research/indoor/aircleaners.htm. Additional information can be obtained by reviewing rankings of effectiveness published by manufacturers (see the Association of Home Appliance Manufacturers website at http://www.cadr.org, and reports by other reviewers such as Consumers Union (http://www.consumerreports.org).

For more information:

California Air Resources Board
Research Division
Indoor Air Quality Program
P. O. Box 2815
Sacramento, CA 95812
(916) 322-8282 (indoor information message line)

Indoor air quality guidelines are available at:
http://www.arb.ca.gov/research/indoor/indoor.htm

If you would like to receive periodic updates and information about air cleaners and indoor air quality, please sign up for our email list serve at: http://www.arb.ca.gov/listserv/listserv.php.

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[1] Mason, MA *et al.*, (2000), "Characterization of ozone emissions from air cleaners equipped with ozone generators and sensor and feedback control circuitry." In: Engineering Solutions to Indoor Air Quality Programs Symposium, Research Triangle Park, NC. VIP-98, AWMA, July, pgs 254-269.

[2] U.S. Environmental Protection Agency (EPA; 2005), Fact Sheet: "Ozone Generators that are Sold as Air Cleaners: An Assessment of Effectiveness and Health Consequences." (http://www.epa.gov/iaq/pubs/ozonegen.html).

[3] California Department of Health Services, (1997), Press release: "State Issues Warning About Ozone Air Cleaning Devices." April, #27-97, Sacramento. http://www.applications.dhs.ca.gov/pressreleases/store/pressreleases/27-97.html.
