Introduction

Growing concern about the adverse effects of poor indoor air quality is driving the market for indoor air cleaning devices in the United States. These devices operate using a variety of technologies that claim to remove particulate matter, odors, and other pollutants. These technology types include simple air filters specially treated with activated carbon or zeolite, ultraviolet-photocatalytic oxidation (UV-PCO), ozone oxidation, air ionization (plasma decomposition), and botanical air cleaning.

But how effective are these devices really? Consumer Reports and the Association of Home Appliance Manufacturers periodically evaluate the effectiveness of these devices for removing particulate matter. Information about these evaluations can be found on the Internet websites provided in the "More Information" section of this brochure. However, no one had evaluated these devices for removing other pollutants, until now. A study that recently concluded at Syracuse University evaluated the effectiveness of 12 commercially available air cleaning devices for removing chemical pollutants, like formaldehyde and toluene, from indoor air. These chemicals, which can be found in many household cleaning products and building materials, are known as volatile organic compounds (VOCs). Some VOCs are a concern because of links to cancer and other health problems.

Figure 1. Building Energy and Environmental Systems Laboratory at Syracuse University.

Each of the 12 portable air cleaners was tested in Syracuse University's air quality research chamber (shown in Figure 1). During the test, 16 different VOCs commonly found in a home or office were introduced into the chamber. Each air cleaner operated for a 12-hour period. Throughout the test period, VOC levels were measured, and ozone emissions, power consumption, and noise levels were monitored for each device.

Results

No single air cleaning device removed all VOCs from indoor air, but some technologies worked better than others.

Figure 2 shows how effectively each of the tested technology types removed four representative VOCs. These four compounds typify the physical and chemical characteristics of the 16 test VOCs.

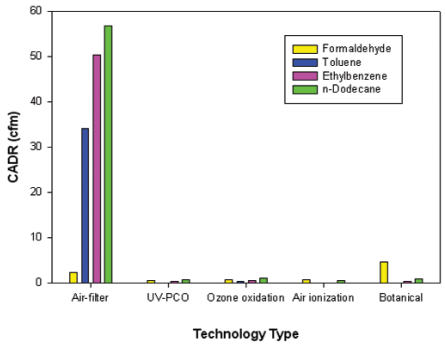

Figure 2. VOC removal effectiveness among technology types. The performances of seven units are averaged together for air-filters, and two units are averaged for UV-PCO. Only one unit was tested for each of the ozone oxidation, air ionization, and botanical technologies.

The effectiveness of each air cleaner is represented by its "clean air delivery rate" (CADR) for each VOC in cubic feet per minute (cfm). Cleaners with high CADR values are the most effective at removing pollutants. This figure shows that, on average, filter-based devices performed better than the others.

This figure also reveals that none of the tested air cleaners were effective at removing formaldehyde.

Effective VOC removal differs between similar products.

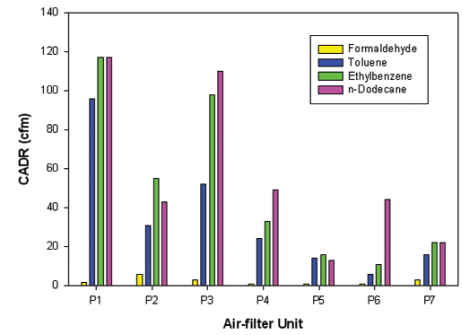

Figure 3. Differences in VOC removal among the 7 tested air-filter units.

While filter-based units were found to be more effective than other technologies, performance differences were observed from product-to-product depending on their designs. Figure 3 illustrates that the performance between filter-based cleaners can vary by nearly a factor of 10 in the case of toluene.

Noise levels vary by technology.

In general, the tested ionization, ozone oxidation, and UV-PCO cleaners were very quiet. The noise produced by the filter-based cleaners varied greatly depending on the operating speed of the fan. When operating on their lowest speed, the filter-based cleaners were quiet. However, when operating at their highest speed, these cleaners were almost as loud as a window air conditioner.

Operation can be costly.
Energy costs vary by product. The most effective filter-based product can cost as little as $70 in electricity per year to operate while an average performing filter-based product can cost more than $300 per year, assuming the products were used 24 hours a day. Further, replacement filters for different units vary from about $30 to $150 per year.

Ozone production can pose health risks.
Ionization and ozone generator devices produce ozone, a known respiratory irritant, either intentionally for air cleaning purposes or as a byproduct. If used in rooms without sufficient ventilation, ozone levels can accumulate to levels that exceed established guidelines for human health and safety.

SUMMARY

If a homeowner believes they have an indoor air quality problem, they should first identify the type and source of the pollutant that needs to be treated. If the problem cannot be addressed by removing or controlling the source of the pollutant, a homeowner could try using an air cleaning product. If VOCs need to be removed, it appears that air cleaners with specially treated filters work the best. While these filter-based air cleaners can remove a variety of VOCs, no tested product removed every pollutant. In some situations, a homeowner may have to rely on ventilation to remove certain VOCs, like formaldehyde.

While ionization air cleaning devices appear to be very popular, based on unit sales, this study did not find them to be effective in removing VOCs. UV-PCO air cleaners, which are just becoming available to consumers, were also found to be ineffective at removing VOCs.

Ozone generators should not be purchased for residential air cleaning purposes. Use of these products in areas with low ventilation rates can result in adverse health consequences from exposure to high concentrations of ozone.

Overall, it seems that the best way to deal with common VOCs is to control the source by looking for ways to reduce their levels in the home.

More Information

Consumer Reports Product Evaluations
http://www.consumerreports.org

Air Cleaners and Testing by the Association of Home Appliance Manufacturers
http://www.cadr.org/

VOCs and Indoor Pollutants from the U.S. Environmental Protection Agency
http://www.epa.gov/iaq/voc.html

Health effects of specific VOCs or hazardous substances from the Agency for Toxic Substances and Disease Registry
http://www.atsdr.odc.gov/toxfaq.html

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Effectiveness of Portable Room Air Cleaners for Removing Volatile Organic Compounds (VOCs) from Indoor Air