
Technical Report

Date: 05/12/2020

Subject: Ozone & ROS-Generating Air Cleaners

Scope

Overview: Air purification technologies with potential to create hazardous by-products

Background

Non-mechanical air cleaners

Many commercial air purifiers utilize electrostatic components to enact vapor and particulate removal. These functions include ultraviolet light (UVGI), photocatalytic oxidation (UV-PCO), ionizers/plasma, and ozone generation. The high-energy local environments within these air cleaners excite molecules in incoming air, causing a myriad of chemical transformations. Airborne reactive oxygen species (ROSs), which include peroxides, ozone (O₃), free radicals, and **ions** (e.g. hydroxyl OH⁻), are important by-products of these processes. These compounds are aggressively reactive, and contribute to gas phase and biological cleaning efficacy of air cleaners that are not based on physical barriers. However, this same potent reactivity of airborne ROSs can foster harmful health impacts on humans and animals in spaces utilizes these kinds of cleaning technologies. As such, it is helpful to overview studies impacts of ROSs generated by air purification devices.

ROS health effects

Most ROSs like free radicals portray relatively short lifespans (seconds-minutes). However, the longer half-lives of peroxides and ozone in particular allow these molecules to accumulate in spaces. Ozone generating air purifiers in fact rely on this to encourage reactions with airborne contaminants. However, peer-reviewed studies including one from UC Irvine have found even a few milligrams of O₃ accumulation per hour can foster room concentrations above public health limits.¹ Especially in spaces with poor ventilation, air purifiers enacting electrostatic processes can easily generate unsafe levels of harmful compounds even if they claim relatively low generation rates of these by-products.

ROSs have also been found to generate a variety of health concerns. For instance, an *in vivo* study by the Japanese National Institute of Health observed how virucidal/bactericidal ionizing air purifier technology fostered genetic damage in subject lungs—a side-effect that would be difficult to directly diagnose, but can entail long-term consequences.² Importantly, even though ozone concentrations below 25ppb from the device were well below regulatory limits, parallel spontaneous generation of superoxide and hydroxyl radicals from the air cleaning process enacted these degenerative effects.

Independent stances on ROS-generating devices

The U.S. Environmental Protection Agency (EPA) provides a detailed review of ozone cleaning technology, available for free online.³ The document elucidates the numerous health detriments of ozone exposure, provides several examples of how airborne ozone generators can be ineffective in indoor air cleaning, and shares insight onto how ozone air cleaners can generate unpredictable hazards, even when devices are used according to manufacturer recommendations.

The ASHRAE Position Document on Filtration and Air Cleaning⁴ asserts that any air cleaning device utilizing electricity as part of its cleaning mechanism can release ozone. The document also provides several academic references elucidating health effects of ozone. Furthermore, ASHRAE offers precautionary guidance against ozone emitters—recommending non-ROS producing air treatment methods as safer alternatives.

Summary

Especially when air cleaners are employed to improve and assure human health in treated spaces, it is important to scrutinize whether or not they can bolster negative health impacts as well. Presently available information in academic literature and regulatory overviews strongly suggest ozone and ROS-generating devices can introduce health hazards while treating indoor air. Additionally, claims of ozone's effectiveness for indoor air cleaning are dubious, based on evidence highlighted by the EPA and ASHRAE in their independent reviews. Air cleaning devices such as Purashield which utilize physical and chemical filtration mediums can be regarded as safer alternatives, since they do not release any airborne by-products into the environment.

References

- 1) University of California - Irvine. "Indoor Air Purifiers That Produce Even Small Amounts of Ozone May Be Risky For Health." ScienceDaily. *ScienceDaily*, 2006. <www.sciencedaily.com/releases/2006/05/060509235740.htm>.
- 2) *J. Toxicol. Sci.* **2010**, 35(6), 929-933
- 3) Ozone Generators that are Sold and Air Cleaners. U.S. Environmental Protection Agency. Accessed May 11th, 2020. <<https://www.epa.gov/indoor-air-quality-iaq/ozone-generators-are-sold-air-cleaners#ozone-health>>.
- 4) ASHRAE Position Document on Filtration and Air Cleaning. ASHRAE **2015**