

FIVE CONCERNS OVER AIR IONIZATION FOR ENHANCING IAQ – ESPECIALLY IN SCHOOLS

Air ionization can emit dangerous ozone, lacks validation, can impair student performance, has questionable effectiveness and is unreliable

By Nick Agopian

Air-Sealed Buildings Suffer from Deficient IAQ

With buildings becoming increasingly air-sealed, a consequence is a rise in deficient indoor air quality (IAQ), which is a serious—yet often unnoticed—threat to occupant health, productivity and well-being. Deficient IAQ is especially concerning since people are indoors about 90% of the time (the elderly 95%) and the Environmental Protection Agency (EPA) found that indoor air may be two to five times, and occasionally greater than 100 times, more polluted than outdoor air. Hence the EPA ranks indoor air pollution among the top-five environmental risks to public health.¹

Deficient IAQ causes many [negative health and cognitive issues](#). On the health side, it can lead to acute problems such as allergies, headaches, coughs, asthma, skin irritations and breathing difficulties, as well as severe illnesses such as cancer, liver disease, kidney damage and nervous-system failures. It also causes cognitive impairment and sickness/absenteeism, which harms student and worker performance and costs the U.S. economy \$168 billion annually, according to the Building Ecology Research Group.²

Schools are at Particular Risk of Suffering from Deficient IAQ

At particular risk of suffering from deficient IAQ are our nation's schools due to their high occupant densities and aging facilities. Deficient IAQ can be very potent for students as the EPA found that poor-quality indoor air is one of the highest environmental threats to children's health and welfare, especially because their bodies are still developing. The EPA also found that deficient IAQ can significantly impair students' academic performance.³

Causes of Deficient IAQ

A complex array of internally generated contaminants, such as toxins, vapors, gases, chemicals and other Volatile Organic Compounds (VOCs), can build up and diminish IAQ. Contaminants are introduced in many ways, but the primary means is by being off-gassed from such sources as construction materials, furniture, fabrics, carpets, paints, sealants, finishes, cleaning supplies and even the human metabolic process that emits bioeffluents.

How do you remove indoor air contaminants? Several options exist, but one specifically that's growing in popularity—especially in schools—is of substantial concern and needs clarification. Needlepoint air ionization is asserted by some manufacturers to enhance IAQ; however, the reality is that these claims aren't independently validated and, more importantly,



Schools are at particular risk of suffering from deficient IAQ
Image courtesy of Environmental Health Perspectives (EHP)

occupant health and cognitive function can be harmed due to increased CO₂ in concert with bioeffluents and other gases.

Five Concerns Over Air Ionization for Enhancing IAQ

Air ionization is a process that's claimed to decrease indoor air contaminants by charging particles in the air and removing them through an electrostatic force. However, many concerns exist about the safety, effectiveness and reliability of this technology, and it's important to be aware of these issues—especially in schools where this technology is gaining ground. With that, below are the five reasons why air ionization is concerning when it comes to enhancing IAQ.

1. Ionization Can Emit Harmful Ozone

A study by the University of California, Irvine found that certain ionic air purifiers are capable of maintaining steady-state levels of ozone that are well in excess of the health-protective standards.⁴ In addition, Consumer Reports tested several ionization air cleaners and also found that many [emitted significant levels of ozone](#).⁵ Why is this important? Ozone inhalation can be harmful to both adults and children, and therefore its generation should be avoided indoors.

Ozone is known to have many adverse health effects. According to the EPA, breathing in ozone can result in chest pain, coughing, throat irritation, congestion, lung issues and even premature death at high levels, as well

¹ All EPA facts from this paragraph are sourced from: "Why Indoor Air Quality is Important to Schools," U.S. Environmental Protection Agency (EPA), <https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools>.

² Hal Levin, "Commercial Building Indoor Air Quality: Introduction to the Problem," Building Ecology, November 1999, <http://www.buildingecology.com/articles/commercial-building-indoor-air-quality-introduction-to-the-problem/>.

³ "How Does Indoor Air Quality Impact Student Health and Academic Performance?," U.S. Environmental Protection Agency (EPA), <https://www.epa.gov/iaq-schools/how-does-indoor-air-quality-impact-student-health-and-academic-performance>.

⁴ Nicole Britigan, Ahmad Alshawa, and Sergey A. Nizkorodov, Department of Chemistry, University of California, Irvine, CA, "Quantification of Ozone Levels in Indoor Environments Generated by Ionization and Ozonolysis Air Purifiers," May 2006 http://aerosol.chem.uci.edu/publications/Irvine/2006_Britigan_JAWMA_O3.pdf.

⁵ "New Concerns about Ionizing Air Cleaners," Consumer Reports, May 2005, <http://www.arb.ca.gov/research/indoor/cr-05-2005.pdf>.

as worsen bronchitis, emphysema and asthma.⁶ Also, according to a study by Columbia and Rutgers Universities, high doses of ozone can cause a transformation in animal cells similar to cancer.⁷

Furthermore, ozone's harmful effects are magnified when it dissipates indoors and creates more invisible contaminants. For example, when ozone reacts with the terpenes in lemon- and pine-scented cleaning products and air fresheners, it creates formaldehyde—an extremely potent carcinogen—as well as other irritants and ultra-fine particles that are hard to filter and can penetrate deep into a person's lungs.⁸

2. Ionization's Validation Falls Short

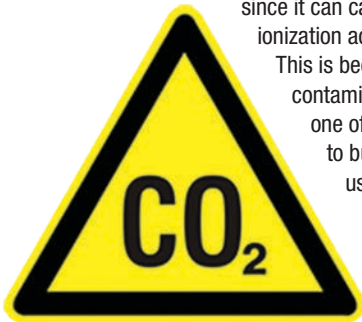
Ionization manufacturers say they meet the IAQ requirements as outlined in ASHRAE's Indoor Air Quality Procedure (IAQP) from Section 6.2 of Standard 62, but this threshold falls short. IAQP is inadequate for ensuring acceptable IAQ because it only considers a minimal list of contaminants (thus leaving many in the air), the odor test it uses is subjective, ongoing building-system vigilance is required and clear guidelines for meeting acceptable IAQ aren't provided.⁹

Moreover, the International Mechanical Code requires that the registered design professional demonstrate that an engineered ventilation system, such as ionization, will prevent the maximum concentration of contaminants from exceeding that obtainable by the rate of outdoor air ventilation determined in accordance with the minimum ventilation rates in the code.

3. Ionization Causes CO₂ Buildup and Impaired Student Performance

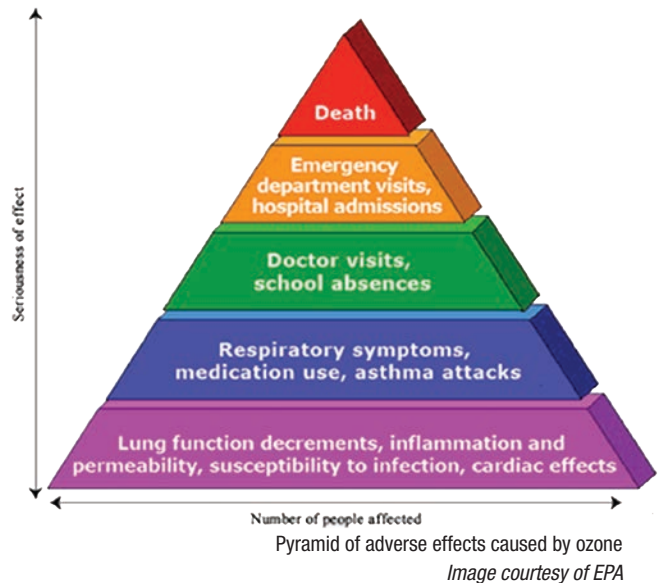
A contaminant not included in the IAQP list is carbon dioxide (CO₂), which can [negatively impact cognitive abilities and decision-making](#), according to the Harvard School of Public Health and the Lawrence Berkeley National Laboratory.¹⁰ Of particular alarm is that cognitive impairment was observed at CO₂ levels commonly found inside homes, offices and schools. These studies have prompted many organizations to take action in order to remove CO₂ from indoor spaces.

We now know that too much CO₂ in an indoor space should be avoided since it can cause cognitive impairment, yet air ionization actually increases CO₂ levels indoors. This is because air ionization breaks down contaminants into different compounds, one of which being CO₂, thus causing it to build up. In addition, air ionization uses the IAQP as its IAQ guideline, but the IAQP doesn't even include CO₂ as a contaminant, so it's not addressed.



CO₂ can negatively impact cognitive abilities and decision-making

Image source: San Diego Hydroponics and Organics



How does this relate to impaired student performance? Many schools have recently installed air-ionization systems, which means that CO₂ levels are rising inside classrooms and potentially causing cognitive impairment in students. To make matters worse, schools are at a disadvantage when it comes to CO₂ buildup due to their high occupant densities, which results in more CO₂ being exhaled, and outdated infrastructures that are ineffective in removing stale indoor air.

Further, children are more vulnerable than adults to the adverse effects of breathing in CO₂, as well as all indoor air contaminants. For example, the World Health Organization found that children inhale more pollutants per kilogram of body weight than do adults, and because children's airways are narrower, irritation means greater obstruction.¹¹ What's more, children's immune systems are less developed and provide a weaker defense against contaminants.

4. Ionization's Filtration Effectiveness is Questionable

On top of the concerns already mentioned above over air ionization, another one is the fact that its filtration effectiveness is questionable at best. For example, Consumer Reports looked at five ionizing air cleaners, and after conducting months of testing and expert investigation into their ability to remove dust, cigarette smoke and pollen, all five models were found to do [a poor job of cleaning the air](#).¹²

5. Ionization Systems are Unreliable and Prone to Malfunctioning

A final concern over air ionization is that these systems were shown to be unreliable and prone to malfunctioning. This was demonstrated in a study by Purdue University's School of Mechanical Engineering and Birk Nanotechnology Center showing that as air molecules are ionized, positive ions impact the cathode surface and typically force an electron to be released, thus degrading system performance over time.¹³

⁶ "Ground Level Ozone, Health Effects," U.S. Environmental Protection Agency (EPA), <http://www3.epa.gov/ozonepollution/health.html>.

⁷ "Tests on Animals Show Ozone May Cause Cancer," New York Times, October 26, 1986, <http://www.nytimes.com/1986/10/26/us/tests-on-animals-show-ozone-may-cause-cancer.html>.

⁸ "New Concerns about Ionizing Air Cleaners," Consumer Reports, May 2005, <http://www.arb.ca.gov/research/indoor/cr-05-2005.pdf>.

⁹ "Indoor Air Quality: A Guide to Understanding ASHRAE Standard 62-2001," Trane, 2002, <https://www.trane.com/commercial/Uploads/PDF/520-ISS-APG001-EN.pdf>.

¹⁰ Joe Romm, "Exclusive: Elevated CO₂ Levels Directly Affect Human Cognition, New Harvard Study Shows," Climate Progress, October 26, 2015, <http://thinkprogress.org/climate/2015/10/26/3714853/carbon-dioxide-impair-brain/>.

¹¹ "Children's Health and the Environment," World Health Organization (WHO), July 2008, http://www.who.int/ceh/capacity/Indoor_Air_Pollution.pdf.

¹² "Consumer Reports Investigates Ionizing Air Cleaners: Five Models are not Recommended; Some Can Create Significant Levels of Potentially Harmful Indoor Ozone," Consumer Reports, May 2005, <http://www.consumerreports.org/content/Pressroom/Presseng/PDF/eng0505cln.pdf>.

¹³ MS Peterson, W Zhang, TS Fisher and SV Garimella, "Low-voltage ionization of air with carbon-based materials," School of Mechanical Engineering and Birk Nanotechnology Center, Purdue University, September 2, 2005, <http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1050&context=nanopub>.

Ventilation is the Best Option for Enhancing IAQ

What's the best way to provide cleaner and healthier indoor air?

The answer is more and better ventilation. As long as enough fresh outdoor air is coming in and stale indoor air is exhausted out, the indoor space will enjoy high-quality air. In fact, the Occupational Safety and Health Administration (OSHA) found that inadequate ventilation is the number one cause of deficient IAQ in workplaces.¹⁴

Ventilation's critical role in achieving high-quality indoor air is underscored in ASHRAE's other, more comprehensive, IAQ guideline – the Ventilation Rate Procedure (VRP) from Section 6.1 of Standard 62. As opposed to the IAQP, the VRP focuses on ventilation as the best way to dilute indoor air contaminants. The VRP clearly dictates both the quantity and quality of ventilation air, and because it's so prescriptive, is the top choice for the majority of building designers.

Boost Energy Efficiency & Savings with Energy Recovery Ventilation

Energy recovery ventilation takes the effectiveness of ventilation one step further by enhancing IAQ both energy-efficiently and cost-effectively. This ventilation technology optimizes energy efficiency by preconditioning the outside air coming in with the otherwise-wasted heat and humidity of the exhaust air going out. The result is [reduced HVAC loads](#), minimized carbon footprints and [significant annual energy savings](#) generated over the long-term.

Additionally, energy recovery ventilation is the perfect complement to increasingly [air-sealed homes and buildings](#). The goal of air-sealing methodologies is to boost energy efficiency by reducing air leaks, but as we know, this decreased ventilation can lead to deficient IAQ. With energy recovery ventilation, the energy efficiency obtained through air sealing is maintained and cleaner and healthier indoor air is provided.

In Sum

With deficient IAQ on the rise, one option to reduce indoor air contaminants that should be avoided—especially in schools—is air ionization since it can emit dangerous ozone, lacks validation, can impair student performance, has questionable effectiveness and is unreliable. The best option for enhancing IAQ is energy recovery ventilation, which provides cleaner and healthier indoor air, optimizes energy efficiency, reduces HVAC loads and generates significant long-term savings.

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¹⁴ "Indoor Air Quality, Frequently Asked Questions," Occupational Safety & Health Administration (OSHA), <https://www.osha.gov/SLTC/indoorairquality/faqs.html>.