Changes in IAQ Caused By Corona Discharge Air Cleaner

The IEQ Applications column entitled "Changes in IAQ Caused By Corona Discharge Air Cleaner," published in the December 2018 *ASHRAE Journal*, in my opinion has multiple challenges with the test methods employed, presentation of results, and conclusions reached by the New York State Department of Education.

First, there are multiple means of generating ions that result in varying levels of ozone. Most manufacturers can provide documentation regarding the level of ozone their particular technology generates. The authors of this article do not mention which manufacturer's product they tested or the level of ozone the device generates.

Second, the authors do not state whether they collected data for ozone, relative humidity, temperature, VOCs, aldehydes, and acetone from the outdoor air during the testing. For this reason, it is impossible to determine whether outdoor pollutant sources active during the testing time period could have impacted the results.

Third, technology exists that would allow for counting of ion levels in the space. Manufacturers of these devices typically will indicate what the ion level needs to be to have a meaningful impact on contaminants. Ion levels were not measured before or during the test, in the space or outdoors, and the authors appear to have assumed the corona device tested was creating a level of ions that could impact the contaminants being monitored. Without this information it is impossible to determine if the device was operating as intended by the manufacturer.

Fourth, most of the technologies used to generate ions are not known for creating any contaminants other than ozone. The authors do not state this fact, and yet contaminants other than ozone were measured to have increased when the device was turned on. Assuming the device did not generate those other contaminants, what caused them to increase? This is an unanswered question.

Finally, CARB has two standards: a one-hour average of 0.09 ppm (90 ppb) and an annual average of 0.07 ppm (70 ppb). The ozone levels reported during all test conditions are below these levels (maximum of 34.8 ppb and minimum of 15 ppb). However, the authors left readers with the impression that the device had created unacceptable levels of ozone in the space.

Having implemented bipolar ionization in multiple facilities throughout my career and having been involved in pre- and post-installation IAQ testing, I can attest to the effectiveness of bipolar ionization when properly designed and implemented. In my opinion, ASHRAE and the authors have done a disservice by reporting on a poorly designed and executed test. There are multiple manufacturers and industry experts who could have assisted and supported the authors in their pursuit of trying to

understand this type of technology and the meaningful benefits it can provide.

Ellis G. Guiles, P.E., Member ASHRAE, Wayne, Pa.

The Authors Respond

We thank Mr. Guiles for his comments. Our article describes a method of measuring the changes in indoor air quality caused by corona discharge. The study was designed and executed in collaboration with the manufacturer of the air cleaner. New York State Education Department (NYSED) requested the study and New York State Department of Health (NYSDOH) executed the air monitoring, sampling and analysis of the indoor air quality. The vendor and manufacturer installed the corona discharge air cleaner in the classroom unit ventilator and made all the adjustments for each phase of the study.

Mr. Guiles argues the configuration of the corona discharge affects the emission of ozone. Ozone is one of the reactive oxygen species (ROS) that may be formed by corona discharge in air; other ROS include hydroxyl radical and superoxide anion. The relative proportions of the different ROS may be varied by changing the configuration of the corona discharge, but we leave it to others to demonstrate a corona discharge that won't form any ROS in air. As noted in our article, the manufacturer's marketing literature stated this system does not form ozone.

Mr. Guiles questions whether the outdoor air conditions influenced the indoor air quality (IAQ).

There are no significant sources of aldehydes or acetone in this suburban location. Winter concentrations of ozone are very low and daytime levels may increase when ozone is formed by sunlight, but Figure 1 shows the concentration of indoor ozone rose during the nighttime period when the corona discharge was turned on. This study was internally controlled so that we compared the IAQ when the air cleaner was operating against conditions when it was turned off. Table 1 and Figure 1 clearly show that indoor air contamination increased when the air cleaner was operating compared to when it was turned off.

Mr. Guiles suggests that ion levels should have been monitored to validate the operation of the corona discharge system. The manufacturer and vendor were engaged throughout this study and at no time did they suggest their air cleaner was faulty, nor did they recommend measuring the ion levels.

However, if ion levels were elevated when the corona discharge was operating that would have been interpreted as another increase in the indoor air contamination.

We are dismayed by Mr. Guiles' assertions that: 1) corona discharge doesn't create any contaminants other than ozone, and 2) there are no mechanisms for the formation of indoor air contaminants. We cited two papers to provide readers with excellent summaries of corona discharge and indoor ozone chemistry (Goldman at al. 1985 and Weschler 2000). Those two papers reference some of the many scientific and technical publications that describe in detail corona discharge and reactions in indoor air. This column described the methods that we designed to measure the contaminants that are well-known to form during these processes.

Mr. Guiles refers to the California Air Resources Board (CARB) Ambient Air Quality Standards for ozone, which is an outdoor air standard, not an indoor air standard. The more applicable CARB regulations, those for ozone emissions for portable indoor air cleaning devices, were not relevant to our evaluation of the corona discharge air cleaner. The vendor claimed their system would satisfy the requirements for the Exception in Mechanical Code 403.2. No numerical standards for any specific air contaminant apply in the Exception. Our study demonstrated that indoor air contaminants increase when the corona discharge is operating in the ventilation system. NYSED used this data to respond to the vendor's claims. This air cleaner system, installed and operated by the manufacturer in a classroom, does not comply with the requirements of Mechanical Code 403.2.

Finally, Mr. Guiles attests "to the effectiveness of bipolar ionization when properly designed and implemented," but did not share the IAQ parameters upon which this experience is based. In broad terms, we concur that properly designed, installed and operated corona discharge air cleaners may be appropriate in some settings. This study describes a method for evaluating air cleaning systems when they are installed in ventilation systems to establish whether they meet indoor air quality requirements for specific settings, in this case a school.

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