Changes in IAQ Caused By Corona Discharge Air Cleaner

With 18 patents granted and 14 more pending, Global Plasma Solutions (GPS) is the leading manufacturer of needlepoint bipolar ionization (NPBI) systems designed for indoor air purification. As a result of the column entitled "Changes in IAQ Caused by Corona Discharge Air Cleaner," (December 2018) we have received numerous phone calls, emails and direct inquiries challenging the efficacy and viability of NPBI technology for treating indoor air. In short, the column has had the negative effect of incorrectly associating GPS' NPBI technology with all corona discharge and other ionization products. The column states "Corona discharge (sometimes labeled: ionizing, negative ion, activated oxygen, mountain fresh air, etc.) ..." The readers of *ASHRAE Journal,* and the market in general, deserve to be made aware that NPBI does not produce ozone or other listed contaminants, and that NPBI technology should not be associated with corona discharge.

NPBI is not a corona discharge technology. It should not be categorized in this manner, nor should it be associated with corona discharge and its negative side-effects. On the contrary, GPS' NPBI technology has been certified by UL 867 and UL 2998 as an ozone free technology. That is, ozone, aldehydes and ultrafine particles are not created by the application of NPBI. GPS or NPBI technology is rightfully not listed on the CARB website of Potentially Hazardous Ozone Generators Sold as Air Purifiers (https://www.arb.ca.gov/research/indoor/o3g-list.htm). In fact, NPBI is used by many cleanroom manufacturers to reduce ultra-fine particles. NPBI is successfully used in hospitals, offices, airports, schools, arenas, airplanes, veterinary offices and vivariums, to name a few applications. GPS has many third party IAQ studies proving that NPBI does not produce undesirable by-products. On the contrary, the studies show that the use of NPBI technology in conjunction with the IAQ procedure produces exceptional air quality and substantial energy savings.

Figure 1. Corona discharge tube.

While the authors highlighted several good technical points on the specific technology utilized in the testing, it does not provide sufficient detail on the differences between corona discharge and NPBI technologies. The technology and subsequent product used in the tests in the New York study are listed as a known ozone generator by the State of California. Furthermore, the same product was removed from the FEMA Trailer Study for Formaldehyde Reduction due to their high ozone output. Publishing a study from 2013 based on a known ozone producing technology does not reflect the current state of the art. The column fails to detail the differences between the technologies which has caused a lot of confusion, skepticism and concerns in the market. The column has done a great disservice to all that are dedicated to promoting the use of proven new technologies to deliver clean indoor air while delivering energy and cost savings.

Corona discharge systems have been operating since the late 1800s and were developed by Sir William Crooks. At the time they were called the "Crooks Tube," as well as cathode ray tubes. Around 1928 William Langmuir changed the name to "plasma tube." They are marketed as corona discharge tubes (CDT), or dielectric barrier discharge (DBD) systems. Many companies use CDT/DBD to generate ozone for odor control in unoccupied spaces. In short, there will be ozone when using corona CDT/DBD technology.`

Figure 1 shows an example of a CDT. There is an inner filament, a glass tube, and an outer filament,

CHEMICAL	FORMULA	Electron Volt
Xylene*	C_8H_{10}	7.89
Styrene*	C_8H_8	8.46
Methyl Ethyl Ketone*	C_3H_8O	9.52
Ammonia*	NH_3	10.07
Acetaldehyde*	CH_3CHO	10.23
Ethyl Alcohol*	C_2H_5OH	10.48
Formaldehyde*	CH_2O	10.88
Oxygen	O_2	12.07
Glass tubes require >12.07 to break down the dielectric		

* Typical contaminants of concern as contained within ASHRAE 62.1
• Electron Volt Energy greater than 12Ev, creates ozone (O_3)

CORONA DISCHARGE TUBE

Figure 2. A sample of eV potential for several compounds.

very similar to the product used in the New York classroom study. The glass is the "dielectric," or resistance to the voltage path to ground. The dielectric can be glass, quartz, mica, ceramic, or any material that has a high insulating value. For a corona discharge system to operate, the voltage and current must be high enough to breakdown the dielectric material to complete the electrical path to ground. When the power output is high enough, and the path to ground is achieved due to the dielectric breakdown, a corona discharge is formed. The corona discharge is easiest seen in darkness. It appears as a purple glow down the entire tube.

The power required to breakdown most dielectrics exceeds 12.07eV (electron volts). Every gas has an electron volt potential. Figure 2 shows a sample of eV potential for several compounds. Oxygen has a potential of 12.07eV. When the power input is greater than 12.07eV, ozone is created as oxygen is ionized. Understanding the relationship of power to eV is critical when designing air purification systems to produce the desired effect, while avoiding the formation of ozone and

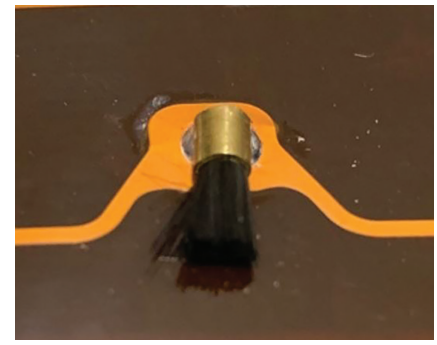

Figure 3. NPBI electrode.

other by-products. NPBI is uniquely different from corona discharge systems. NPBI does not use a dielectric. It does not produce ozone. The power output is controlled to less than 12.07eV.

NPBI electrodes, or "needles," are made from carbon fiber (Figure 3), titanium, silver, gold, stainless steel, and other corrosion resistant conductive materials. As you can see from the Figure 3, the electrodes are attached to the flexible circuit and there is no dielectric.

NPBI has been used for particle reduction, odor control, pathogen control and static electricity control for more than 10 years. The production of unwanted by-products, including ozone, associated with corona discharge air cleaners are avoided when using NPBI. The newer NPBI technology should NOT be associated with corona discharge. This should be made clear to all, especially the readers of the *ASHRAE Journal*.

Charlie Waddell, Associate Member ASHRAE, Chief Technology Officer, Global Plasma Solutions, Savannah, Ga.

Editor's Note: The authors of the column responded after print deadlines. Their response is below.

The Authors Respond

Mr. Waddell, Global Plasma Solutions, Inc., (GPS) asks New York State Department of Health (Department) to distinguish needlepoint bipolar ionization (NPBI) from corona discharge air cleaners. The letter suggests that GPS customers have negatively and incorrectly associated NPBI with corona discharge and ionization.

Mr. Waddell offers GPS patents, UL certifications and general information to support his assertions that NPBI does not produce ozone or other contaminants and should not be associated with corona discharge.

The Department's column described the methods used to measure the changes in indoor air quality caused by operating a corona discharge air cleaner in a classroom ventilation unit. The study demonstrated that the air cleaner failed to meet the requirements of International Mechanical Code Section 403.2 (2010) because the study measured increased indoor ozone levels, ultra-fine particle counts and aldehyde concentrations.

For the purposes of this study, the Department designed an approach to evaluate regulatory compliance in New York. However, the Department's approach could be adapted by others to compare different air cleaner technologies and devices. Mr. Waddell's assertions about NPBI air cleaners could be tested and compared against other ionization air cleaners following the methods described in the column.

Mr. Waddell asserts that NPBI should not be associated with ionization products. However, patents for Global Plasma Solutions include patents for "ion generation devices." No differentiation between NPBI and ion generation can occur when their patents don't make that distinction.

Mr. Waddell offers that NPBI technology has been certified by UL 867, *Standard for Electrostatic Air Cleaners* and UL 2998, *Environmental Claim Procedure for Zero Ozone Emissions from Air Cleaners*. Ozone is one component of the mixture of reactive oxygen species (ROS) formed by ionization in air. Our study design measured ozone concentrations, but the scientific literature clearly establishes that a mixture of ROS is formed by ionization in air. GPS manufactures ion generation devices, which must form ROS to perform "air purification": ROS react with volatile organic chemicals, forming ultra-fine particles and aldehydes, as was shown in our study.

Mr. Waddell states their units are used for particle reduction, without mention of what metric (particle, count, size or mass) or what test was used to establish that. The UL 867 standard was referenced in the letter, but that standard addresses electrical issues, and it is the Department's understanding from the UL website, that it is not for air cleaners to remove particles other than dust. The Department's study did not measure dust, it measured ultra-fine particles. Ultra-fine particles are not in the particle fraction designated as dust.

The Department acknowledges that "clean air" is a subjective assessment. However, the study demonstrated increases in the concentrations of the analytes measured when the air cleaner was operating.Further increases occurred when the outdoor air supply rate was reduced below that required by the mechanical code. The Department's interpretation of the observed increases in the analytes measured when the unit was operated, and a decrease in those concentrations when the unit was off, is that, rather than removing pollutants, air quality was degraded when it operated, and it worsened when there was a reduction in the outdoor air delivery rate.

Advances in outdoor and indoor air cleaning technology to mitigate known and emerging contaminants of concern is a shared challenge for industry, academia and health agencies. It requires careful attention to all potential air quality impacts, and recognition of conditions outside of the laboratory to achieve methods which deliver a healthful indoor environment and protect public health.

There are no industry standards or guidelines to distinguish NPBI from other corona discharge air cleaners. Any comparisons of the effects on indoor air quality of different air-cleaning technologies should be based on data collected following the methods used in our study. The Department hopes manufacturers and researchers will reference our column in the Journal when they are tasked with evaluating changes in indoor air quality caused by ionizing air cleaners.

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