

# BIPOLAR IONIZATION

## Disinfecting the indoor air and surfaces

In ensuring the safest, most sanitized space for your guests and keeping them the most protected from the novel Coronavirus (COVID-19), bipolar ionization technology is your best option available.



## BIPOLAR IONIZATION

**AIR PURIFICATION SYSTEMS FOR DISINFECTING THE INDOOR AIR FROM VIRUSES, MICROBES, AND OTHER CONTAMINANTS**

*Varionix bipolar ionization technology has been proven to eliminate the Coronavirus (COVID-19), other viruses, microbes, and allergens. At the core of Varionix systems is bipolar ionization technology. Within an HVAC system or as a standalone unit, ionization tubes are placed. As airflow passes through the tubes, bipolar - positive and negative -ions are created that persist for up to a few minutes. In the case of a virus such as the Coronavirus, the bipolar ion clusters destroy the virus surface structure on a molecular level. As a result, the virus cannot infect, even if it enters the body. The ions also bond to dust and mold particles, break down germs and odors at their source, and break down harmful organic compounds.*

*There are three primary ways for the Coronavirus to spread - through person to person contact, by touching a surface that has the virus, and by breathing in droplets expelled by someone with the virus. The ions produced pack the occupied space. They saturate the space and go anywhere the conditioned air will go. The system can continuously disinfect the air and surfaces and offers another layer of protection against the droplets.*

## Benefits of Bipolar Ionization

Bipolar ionization provides a huge range of benefits, including:

- ✓ Reduced bacteria and viruses. Bipolar ions break the cell membrane surface of bacteria and viruses and eliminates the air born contaminants.
- ✓ Reduced dust and mold particles. Bipolar ions that bond with contaminants gain size and mass and drop to the floor, or return to the filter, making them easily cleaned from the air we breathe.
- ✓ Reduced VOCs (Volatile Organic Compounds). Bipolar ions break down toxic gasses and compounds from dangerous chemicals such as cleaning products, pesticides, paints, solvents, mold, mildew and more.
- ✓ Reduced odors. Bipolar ions break down odors at their source and eliminate them — no masking or diluting!
- ✓ Improved energy conservation guarantees you'll reduce your energy bills because you'll spend less on heating and cooling ventilated air. With our technology, you'll recycle conditioned, purified air instead.
- ✓ Reduced static electricity. Bipolar ionization naturally neutralizes the air, eliminating static charges.
- ✓ A safe, natural and environmentally friendly process. Our patented bipolar ionization technology uses no chemicals, heavy metals or mercury, and produces no harmful by-products such as ozone or ultra-violet light.

## Microbiological contamination

Microbiological contamination refers to the non-intended or accidental introduction of infectious material like viruses, bacteria, mold, and fungi into the indoor air and surfaces. The primary sources of microbial contamination being soil, air, animal feed and by-products, plant surfaces, sewage, and food processing machinery, as well as human introduced. Independent studies have shown that bipolar ionization is effective at destroying airborne biological contamination resulting in the ideal sanitary conditions. Keep in mind that this novel Coronavirus is among several other serious disease-causing strains of the virus. For example, more than 475 people have died from the MERS coronavirus (Middle East Respiratory Syndrome). The MERS strain originated in Saudi Arabia in 2012 before spreading to other countries in Middle East, Africa, Asia, and Europe. In May of 2015 there was an outbreak of MERS in Korea, the largest outbreak recorded. In 2003, another severe respiratory Coronavirus killed many people and caused several cases of the acute respiratory disease known as SARS (severe acute respiratory syndrome). In general, most coronaviruses spread in the same manner as other cold-causing viruses: via aerosols directly (infected people coughing, sneezing or touching an infected person's hands or face) or indirect contact (touching doorknobs, elevator buttons, etc. then touching your nose, eyes, or mouth). Since the virus is spread via direct and indirect contact, the continuous application of bi-polar ions emitted to ambient air by the Varionix bi-polar air cleaning system continuously disinfect both the breathing space and surfaces. It is the most effective system for continuously cleaning and decontaminating indoor air. Also, because Coronaviruses are enveloped viruses, they are easier to kill compared to naked viruses like Noroviruses. Varionix has shown significant reduction on bacteria and viruses in both laboratory and "in situ" testing. Spaces like airport terminals where travelers may carry and spread this virus should implement the Varionix bi-polar ionization air cleaning system as a step to combat the spread of illness.

## The Technology

### Nature does it long before

Sunlight or lightning in our atmosphere constantly forms ions from the oxygen ( $O_2$ ) in the air. The ions produced here ( $O_2^-$ ) react with the air pollution, which were oxidized and neutralized. Thus, the atmosphere has its own natural cleaning process.

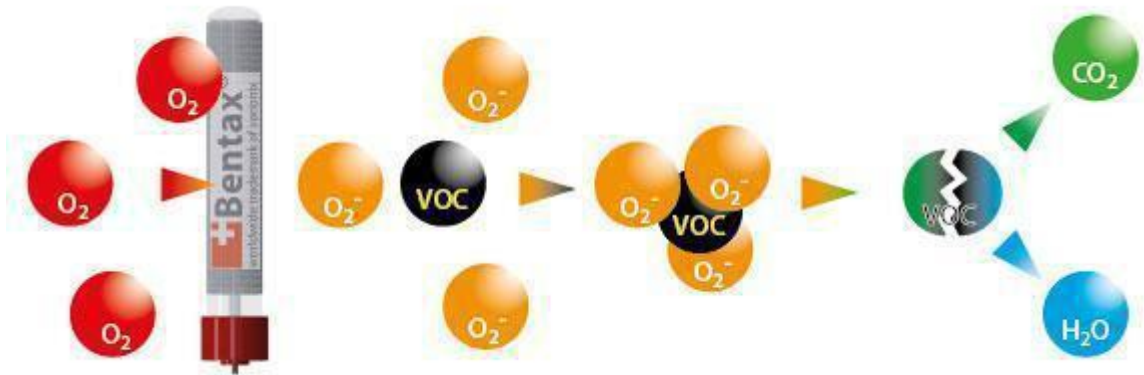
### Now We do the same

We form from this natural process and bring it controlled in each room. The oxygen ions neutralize odors, sterilize the air, reduce pollution and bring freshened air into the room.

The Varionix air purification system's bipolar ionization tube creates a tightly controlled corona discharge (DBD Dielectric Barrier Discharge). The discharge forms are non-thermal unstable gas plasma. In this plasma there are positive and negative ions, and intermediates of oxygen (atomic oxygen, oxygen ions ( $O_2^-$ ), Singlet-oxygen and ozone (the amount of ozone produced (max. 0.005ppm, when the strictest safety limit is 0.05ppm) is many times below the safety limitations and will not increase the level of ozone in the inside air).

These highly reactive intermediates lead to an immediate oxidation and destruction of organic compounds. Bacteria, mold, mildew, or other microbes will be killed and make air borne germs incapable to germinate.

The energy content in non-thermal plasma corresponds to an extremely hot gas but the actual temperature plasma is only marginally increased. This makes it possible to change volatile organic compounds (VOC) such as hydrocarbons, at best, to carbon dioxide ( $CO_2$ ) and water ( $H_2O$ ). Other compounds in the air such as  $NH_3$ ,  $H_2S$  and others can be eliminated as well.



Bipolar ionization is created when an alternating voltage source (AC) is applied to a special tube with two electrodes. When voltage is applied to the tube's electrodes an ionization field is produced around the tube. However, the ionization cannot be seen but its presence will result in freshness. Such ions occur naturally especially on mountain tops and waterfalls, where the production of both positive and negative ions purify the air. Such a system has significant commercial and industrial applications. The airflow distributes the energized ions into all spaces served by the duct system in an in-duct installation or into the application space if a standalone is used.

Unlike most air purification systems, Varionix seeks out particulates and contaminants, including molds, bacteria, and germs and does not wait for pollutants to find their way into the filter within the air handler. Instead charged ions go to the contaminants in the space where you breathe, just as in nature, and do so in a continuous fashion and with continuous disinfection.

These positively and negatively charged ions effects on dust particles, allergens, VOC's, odors, and bacteria, viruses, molds and mold spores. VOC's or gaseous chemical off gasses typically cause odors and irritations.

Bipolar ions break down hydrocarbon chains that make up these complex compounds into immeasurable levels of carbon dioxide and water vapor. On micro-organisms like bacteria, virus and molds, bipolar ions will interrupt the reproductive ability of these organisms so rather than colony forming units (cfu) increasing and spreading and expanding, they shrink away and lessen the chance of infection.

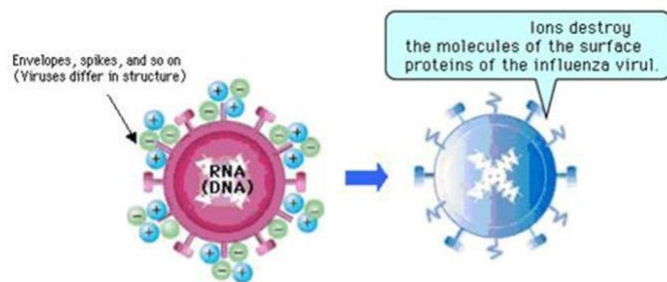
## The Effect of Bipolar Ionization on micro-organisms:

The negative and positive ions that are generated by Bipolar Ionization are designed to treat and allow energy imparted by the ions to transform ordinary oxygen into Reactive Oxygen Species (ROS), Superoxides, Peroxides, and Hydroxyls. These ions have the property of clustering around micro- particles, and thus, they surround harmful substances such as airborne mold, viruses, bacteria and allergens. At that point, a chemical reaction occurs on the cell membrane surface, and they are transformed into OH radicals, which are powerfully active (Standard Oxidation Potential [V]=2.81 for OH vs H<sub>2</sub>O<sub>2</sub>=1.78 and O<sub>2</sub>=1.23) and because they are unstable, they rob the harmful substance of a hydrogen atom (H). The result is that they are inactivated by severing the protein on cell membrane, which causes the opening of holes, thusly destroying the entity. The OH radicals instantly bond with the removed hydrogen(H), forming water vapor (H<sub>2</sub>O) which returns to the air. It is most important to note that bipolar ionization kills microbes without damaging DNA (therefore it does not cause cancer) in the interior of cells and unlike other physical and chemical agents, such as UV light, radioactivity and use of caustic chemicals, Bipolar Ionization is totally green, and it does not adversely affect the environment in any way.

See the figures below, which pictorially help explain this process:

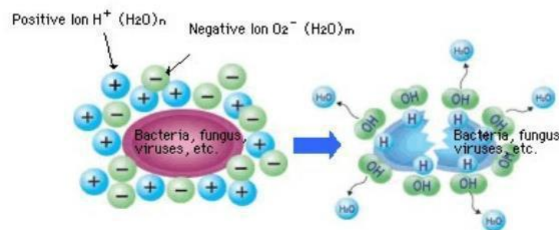
### Mechanism for Inactivating Airborne Virus

The positive (H<sup>+</sup>) and negative (O<sub>2</sub><sup>-</sup>) ions surround the hemagglutinin (surface proteins that form on organisms and trigger infections) and change into highly reactive OH groups called hydroxyl radicals (\*OH). These take a hydrogen molecule from the hemagglutinin and change into water (H<sub>2</sub>O). The ions destroy the virus surface structure, for example its envelopes and spikes, on a molecular level. As a result, the virus cannot infect even if it enters the body.



### Mechanism for Inactivating Bacteria, Fungi

The positive (H<sup>+</sup>) and negative (O<sub>2</sub><sup>-</sup>) ions cluster together on the surface of airborne mold, bacteria, or fungi, causing a chemical reaction that results in the creation of highly reactive OH groups called hydroxyl radicals (\*OH). The hydroxyl radical will take a hydrogen molecule from the cell wall of an airborne mold, bacteria or fungi particle.



## History and scientific studies

Air ionization has a long history of varied applications. In one published review article on the ionization of air for removal of *noxious effluvia*, a presentation of recent developments in the application of controllable air ionization processes that apply dielectric-barrier discharge devices to generate non-thermal plasmas have led to applications for chemical and biological decontamination in indoor environments (8). These include significant reductions in airborne microbes (mold, bacteria, and fungi), neutralization of odors, and reduction of VOCs. Also, removal of very fine particulates (PM<sub>x</sub>) is also enhanced by air ionization. The physics and chemistry of air ionization, and its utility for contributing to significant improvements in indoor air are discussed in detail (8).

The efficacy of bipolar ionization technology against a wide variety of pathogens was confirmed through collaborative research (9). Efficacy in inhibiting of airborne target substances noted below was verified by exposing those organisms to an ion concentration of at least 3000 ions/cm<sup>3</sup>. Effective kill was achieved in seconds to minutes dependent upon the microbe, the exposure time, and the concentration of ions. Studies have shown that a more rapid kill-time can be achieved by increasing concentration of ions. For example, Sharp Corporation studies in collaboration with Retroscreen Virology Ltd demonstrated that the highly pathogenic H5N1 avian influenza virus could be inactivated by 99.9% in ten minutes using a high bipolar ion concentration of 50,000 ions/cm<sup>3</sup> (10). Sharp has also shown that reduction by 99% could be achieved in ten minutes at a concentration of 7000 ions/cm<sup>3</sup> (10). It is very important to understand that during actual real-time in-use conditions, bipolar ionization systems perform in a continuous steady fashion with continuous disinfection so that large bolus concentrations are unnecessary for effectiveness.

The results of a series of studies are summarized in the chart below:

John Oxford's Efficacy of Bi-Polar Ionization on Various Pathogens		
Target Substance	Species	Testing and Verification Organization
Fungi	Cladosporium (black mold, mildew)	Ishikawa Health Service Association Universitätsklinikums Lübeck University Clinic (Germany) (proliferation control effect) CT&T (Professor Gerhard Artmann, Aachen University of Applied Sciences)
	Penicillium, Aspergillus	Universitätsklinikums Lübeck University Clinic (Germany) (proliferation control effect)
	Aspergillus, Penicillium (two species), Stachybotrys, Alternaria, Mucorales	CT&T (Professor Gerhard Artmann, Aachen University of Applied Sciences)
Bacteria	Coliform bacteria (E. Coli)	Ishikawa Health Service Association
	E. coli, Staphylococcus (aureus), Candida	Shanghai Municipal Center for Disease Control and Prevention, China
	Bacillus subtilis	Kitasato Research Center of Environmental Sciences CT&T (Professor Gerhard Artmann, Aachen University of Applied Sciences)
	MRSA (methicillin-resistant Staphylococcus aureus)	Kitasato Research Center of Environmental Sciences Kitasato Institute Medical Center Hospital
	Pseudomonas, Enterococcus, Staphylococcus	Universitätsklinikums Lübeck University Clinic (Germany) (proliferation control effect)
	Enterococcus, Staphylococcus, Sarcina, Micrococcus	CT&T (Professor Gerhard Artmann, Aachen University of Applied Sciences)
	Viruses	H1N1 influenza virus
H5N1 avian influenza virus		Retroscreen Virology, Ltd.
Coxsackie virus (summer colds)		Kitasato Research Center of Environmental Sciences
Polio Virus		Kitasato Research Center of Environmental Sciences
Corona Virus		Kitasato Institute Medical Center Hospital
Allergens		Mite allergens (dead bodies and feces)
	Pollen	Hiroshima University

Air ionization, although historically well documented and technologically well advanced, is just now entering the field of treatment of specific targets in indoor environments, which directly affect the IAQ!

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