



# IONIZATION WHITE PAPER

**NEGATIVE ION GENERATION:****What is it? What are its benefits? What are its applications?**

**The Need for Clean Air** – Since, most people spend the vast majority of their daily lives indoors (about 90%) and since indoor air pollution is at least 25 times worse than outdoor air, indoor air quality is critical for health-conscious employees, customers and tenants. Indoor air pollution is among the top five environmental health risks. The sources of airborne gaseous organic compounds include tobacco smoke, building materials and furnishings, as well as products including paints, dyes, deodorizers, cleaning chemicals, adhesives and pesticides. The indoor air quality of most homes and commercial buildings lack the proper “electrical” balance needed to provide a healthy and clean environment. The desire to build “airtight” homes and buildings in an effort to reduce energy consumption has also drastically reduced the quality of the air inside these facilities. In addition, most homes and buildings are located in urban environments consisting of asphalt and concrete streets and parking areas, combined with densely packed buildings. As a result of this and other factors, the air in urban areas is not “electrically” balanced enough to provide good outside air quality.

Microbes, including bacteria, mold and virus, are airborne and can cause sickness in buildings with inadequate ventilation and or air cleaning equipment. Influenza, SARS and COVID-19 have all been shown to be spread via airborne droplets.

Most particles including dust, pollen, smoke, animal dander, odors, and chemical fumes, have a positive charge. Current homes and buildings are built with energy loss reduction in mind. This means buildings generally have an inadequate number of negative ions in the air. In addition, fluorescent lights, computer screens, plasma and LCD TVs, ventilation systems and newer building materials and fabrics contain a high concentration of positive ions.

Scientific studies have shown that positive ions can lead to tiredness, fatigue and irritability and that an increase in negative ions, in an indoor environment, can produce reductions in seasonal depression, asthma, allergic reactions, fatigue, moodiness and headaches.

**Types of Air Cleaners** – There are multiple types of air cleaning devices available for home and commercial use. The following is a list of the more common air cleaning devices along with some advantages and disadvantages of each.

**1. Bi-Polar Ion Generators** – iAIRE utilizes Needle Point Bi-Polar Ionization (“NPBI”) to create positively and negatively charged ions. NPBI uses needles to create electrodes made from carbon fiber to produce the positively and negatively charged ions. NPBI is not the same technology as corona discharge ionization. NPBI does not create ozone in measurable amounts. The negative ions produced by this type of air cleaner attract positively charged particles (pollutants etc.), causing them to fall to the floor and become inert. Negative ion generators use high voltage to create negative ions (particles with one or more extra electrons). These devices do not have tubes or filters, so they are much easier to maintain. Since the positive ions generated by these devices play a smaller part in the actual cleaning of the air, the focus of this paper will be on the negatively charged ions.

**2. HEPA Air Filters** – High Efficiency Particle Arresting (HEPA) filters are made of paper or polymer which are densely packed to reduce the air flow and stop particles from entering the air stream. HEPA filters are often used in hospital or clean room environments. They are not well suited for homes or commercial spaces due to the limitation of air flow that results from these filters. HEPA filters need to be changed quite often due to their construction and restrictive air flow properties.

**3. Electrostatic Air Cleaners** – These devices used charged plates to attract positively charged particles as they move through the air. These are generally designed for small areas and can clean only a small volume of air. These devices do not have filters, but they do have plates that need to be cleaned periodically.

**4. Ultraviolet (UV) Air Cleaners** - UV light is an effective way to kill bacteria, viruses and mold on surfaces; however, typical UV systems used in a home have a very limited effectiveness in killing airborne contaminants. Killing these pathogens in a home requires a much higher UV exposure than a typical home unit

can generate. In addition, these devices do not remove gases, odors or particles from the air. A filter is required in conjunction with the UV lamp to provide additional air cleaning. UV tubes are expensive and need to be replaced periodically. Environmentally speaking, UV tubes are made of glass and can be hazardous to handle.

**5. Ozone Air Cleaners** - Ozone is an unstable molecule of three Oxygen atoms (O<sub>3</sub>). It can be generated by an electrical process. Ozone can be an effective way of eliminating odors, chemicals and mold, although too much ozone can be a health hazard.

Based on numerous scientific studies, ionization is the best method to ensure a healthy indoor air quality for employees, tenants and customers since ionization is effective in killing virus, bacteria, mold and mildew and removing odors from smoke and other Volatile Organic Compounds (VOC). Ionization is also the most versatile air cleaning method as ions generated in an HVAC unit travel through the building ductwork into the areas of the building where contaminants reside. Ionization units can also be placed directly into the air vents providing clean air into a particular space which is difficult with all other air cleaning technologies. This is very important as people spread harmful particulates which may never pass through HEPA filters, UV cleaners or electrostatic filters.

**What are Negative Ions?** – As noted above, negative ions are electrically charged particles that have extra electrons. Air quality contaminants are positively charged particles. When these contaminants are in the presence of negative ions, the contaminants are neutralized electrically causing the particles to fall to the floor or other surfaces, cleansing the air where humans breathe. In order to keep the indoor air negatively charged, negative ions need to be constantly generated in the normal air flow path.

Peer reviewed technical studies have shown that ionization was effective during the SARS outbreak and then during the MERS epidemic. The new Covid-19 virus is only about 0.1 Micron in size while a HEPA filter stops particles most effectively that are greater than 0.3 Micron. In addition, a new study from Japan indicates that a person is 20 times more likely to get Covid-19 from indoor airborne contact as compared to outdoor exposure. Studies have also shown that Covid-19 is an enveloped virus which is easier to kill with ionization unlike “naked” viruses like noroviruses. The Covid-19 virus is neutralized when ionization disrupts protein in the cell membrane.

While negative ion generators and ozone generators operate in a similar fashion, they are not the same device. Ozone generators are designed to attract an extra oxygen atom that attaches to an O<sub>2</sub> molecule, creating an O<sub>3</sub> molecule. This process is accomplished using a UV light or a corona discharge tube. A Negative Ion Generator creates negatively charged ions using voltage to electrically charge the passing air flow. As a result, only non-measurable amounts of Ozone are produced.

Negative ions and Ozone perform different functions in cleaning the air. Ozone can eliminate odors and some pollutants, but also creates a distinct odor in high concentrations. Negative ions can remove pollen, dust and mold; as well as improve a person's attitude and is completely odorless.

Excessive Ozone levels can be harmful to your health, however excessive Negative Ionization is not at all dangerous and is beneficial to a person's well-being.

**Benefits of Negative Ion Generation** –The following are some of the many benefits that are associated with the introduction of negative ions to an indoor environment:

- Elimination of microbes such as Virus and Bacteria.
- Reduction of pollen levels
- Elimination of mold spores
- Reduction of dust and dust mite levels
- Elimination of smoke
- Reduction of hay fever and asthma symptoms
- Mood improvement
- Improvement in depression and seasonal affective disorder symptoms
- Improvement in chronic fatigue symptoms
- Reduction in household odors
- Reduction in chemical odors from materials or fabrics

Negative Ion Generators can purify indoor air by causing contaminants such as dust, pollen, animal dander, mold spores and bacteria to be neutralized electrically. Negative ionization causes these particles to be attracted to each other and ball up; falling to the floor or other surfaces where they disintegrate to be cleaned up by the normal cleaning process. Ionized air does not have to pass through a filter to perform this action.

The Ion Generator only needs to be installed in normal ductwork in a home or building to continually treat the inside air. The introduction of negative ions in this fashion will eliminate a lot of the floating contaminants in the air like the dust you see in a ray of sunshine. The ability to improve a person's mood or reduce seasonal disorders by the introduction of negative ions in the air is certainly a positive side benefit.

**Integration with Ventilation** - Recent studies by ASHRAE and others have shown the necessity for bringing in outside air to a building. This is particularly important as current HVAC equipment is built to allow little outside air to come into a building. The use of dynamic outside air control in addition to ionization can provide a building with an additional level of indoor air quality security.

**Commercial Applications** – The following are some of the better applications for negative ion generators in commercial environments due to the nature of the problems associated with these environments:

- Hospitals • Veterinary offices
- Convention centers and arenas • Nursing Homes
- Schools • Churches and synagogues
- Animal feeding and processing plants • Doctor’s offices
- Shopping malls • Jails
- Laboratories • Casinos
- Restaurants and food preparation areas • Museums

**Independent Laboratory Testing** – Recently, negative ionization has been tested by independent, accredited laboratories to determine the effectiveness of ionization in eliminating a variety of airborne pathogens, including Corona Virus. The results are below:

Independent Laboratory Tests			
<p><b>Human Coronavirus</b></p> <p>Incubation Period - 60 Minutes</p> <p>Rate of Reduction - 90.0%</p> <p>Surrogate for Human Coronavirus SARS-CoV-2, actual strain tested was Human Coronavirus 229E</p> <p></p>	<p><b>Legionella</b></p> <p>Incubation Period - 30Minutes</p> <p>Rate of Reduction - 99.7%</p> <p></p>	<p><b>E.coli</b></p> <p>Incubation Period - 15 Minutes</p> <p>Rate of Reduction - 99.6%</p> <p></p>	<p><b>Tuberculosis</b></p> <p>Incubation Period - 60 Minutes</p> <p>Rate of Reduction - 69.0%</p> <p></p>
<p><b>Staphylococcus</b></p> <p>Incubation Period - 30Minutes</p> <p>Rate of Reduction - 96.2%</p> <p></p>	<p><b>Norovirus</b></p> <p>Incubation Period - 30Minutes</p> <p>Rate of Reduction - 93.5%</p> <p>Surrogate for Norovirus, actual strain tested was Feline Calicivirus, ATCC VR-782, Strain F-9</p> <p></p>	<p><b>Clostridium Difficile</b></p> <p>Incubation Period - 30Minutes</p> <p>Rate of Reduction - 86.8%</p> <p></p>	<p><b>MRSA</b></p> <p>Incubation Period - 30Minutes</p> <p>Rate of Reduction - 96.2%</p> <p></p>

**Clinical Studies** – The following are a few brief examples of the various clinical studies that have been done on the effects of negative ions in an indoor environment.

- 1. Influenza A** - By the use of a modified ionizer device the researchers describe the effective prevention of airborne transmitted influenza A (strain Panama 99) virus infection between animals and inactivation of virus (>97%). Hagbom M, Nordgren J, Nybom R, Hedlund KO, Wigzell H, Svensson L. Ionizing air affects influenza virus infectivity and prevents airborne transmission. Scientific reports. 2015 Jun 23;5:11431.
- 2. Tuberculosis transmission** - Negative air ionization was used to prevent tuberculosis transmission. Escombe AR, Moore DA, Gilman RH, Navincopa M, Ticona E, Mitchell B, Noakes C, Martínez C, Sheen P, Ramirez R, Quino W. PLoS medication. 2009 Tue 17;6(3):e1000043
- 3. Porcine Virus removal** - Effectiveness of Negative Air Ionization in Removing Airborne Porcine Reproductive and Respiratory Syndrome Virus (PRRSV). In 10th International Livestock Environment Symposium (ILES X) 2018 (p. 1). American Society of Agricultural and Biological Engineers.
- 4. Negative ions effect on Virus** - The effect of corona discharge-generated ions on the filtration of aerosolized bacteriophage MS2 was studied. Recirculated air in HVAC systems used for indoor air quality control in buildings can contain a considerable number of viable bioaerosol particles due to the limited efficiency of the filters installed in these systems. In this study, the researchers investigated - using aerosolized bacterial cells, bacterial and fungal spores, and virus-carrying particles - a novel idea of enhancing the performance of a low-efficiency HVAC filter utilizing continuous emission of unipolar ions in the filter vicinity. <https://www.ncbi.nlm.nih.gov/pubmed/18333990> Use of corona discharge-generated air ions for filtration of aerosolized virus and inactivation of filtered virus. Journal of Aerosol Science. 2017 May 1;107:31-4

5. **Negative ions used to remove aerosol virus** - Park CI. Effectiveness of negative air ionization for removing viral bioaerosols in an enclosed space. Canadian Society for Bioengineering 2017.
6. **Negative ionization in Hospitals** - In recent years there has been renewed interest in the use of air ionizers to control the spread of infection in hospitals and a number of researchers have investigated the biocidal action of ions in both air and nitrogen. By comparison, the physical action of air ions on bacterial dissemination and deposition has largely been ignored. However, there is clinical evidence that air ions might play an important role in preventing the transmission of Acinetobacter infection. Although the reasons for this are unclear, it is hypothesized that a physical effect may be responsible: the production of air ions may negatively charge items of plastic medical equipment so that they repel, rather than attract, airborne bacteria. By negatively charging both particles in the air and items of plastic equipment, the ionizers minimize electrostatic deposition on these items. In so doing they may help to interrupt the transmission of Acinetobacter infection in certain healthcare settings such as intensive care units. 17. Simon J Shepherd, Clive B Beggs, Caroline F Smith, Kevin G Kerr, Catherine J Noakes & P Andrew Sleight BMC Infectious Diseases volume 10, Article number: 92 (2010) Abstract
7. **Newcastle Disease Virus** - In many cases, dust will carry microorganisms that cause infections. In a 1994 study, it was determined that negative ionization can reduce the incidence of infections in poultry houses. (Mitchell, B.W. a. D. J. K. (1994). "Effect of negative air ionization on air borne transmission of Newcastle disease virus." Avian Diseases 38: 725- 732.)
8. **SAD** – A study was conducted on the reaction of participants suffering from Seasonal Affective Disorder to high levels of negative ions. The results showed that the treatment was effective in reducing the symptoms of the disease. Click hyperlink below to see the study.<http://www.chronotherapeutics.org/docs/term/Terman%202006%20AJP.pdf>
9. **Dental Clinics** – A study of dental clinics in 1990 found that Colony Forming Units in the air were reduced by over 30% when subjected to continuous negative ions. (Gabbay, J. (1990). "Effect of ionization on microbial air pollution in the dental clinic." Environ. Res. 52(1): 99)

**10. Bacterial Aerosols** – A burns and plastic surgery unit was able to significantly reduce the amount of airborne bacterial aerosols using negative ion generation. (Makela, P., J. Ojajarvi, et al. (1979). “Studies on the effects of ionization on bacterial aerosols in a burns and plastic surgery unit.” J. Hyg. 83: 199-206.)

**11. Mood** - “Negative ions increase the flow of oxygen to the brain; resulting in higher alertness, decreased drowsiness, and more mental energy,” says Pierce J. Howard, PhD, author of *The Owner’s Manual for the Brain: Everyday Applications from Mind Brain Research* and director of research at the Center for Applied Cognitive Sciences in Charlotte, N.C. “They also may protect against germs in the air, resulting in decreased irritation due to inhaling various particles that make you sneeze, cough, or have a throat irritation.

**12. Human Body** – An article in *Economy Daily News* - January 30, 2002 indicated that negative ions 1: Strengthen the functions of autonomic nerves, 2: Reinforces collagen (tissues that are resilient and tension related), 3: Improves the permeability of the cell’s prototype plasma membranes (improves metabolism) 4: Strengthens the body’s immune system.

**13. Longevity** – An article by John Heinerman, Ph. D on Negative ion regeneration for youthfulness and longevity suggests that negative ions neutralize pollutants and provide positive effects on health to:

- a. Stimulate the reticuloendothelial system, a group of defense cells in our bodies that marshal our resistance to disease.
- b. Act on our capacity to absorb and utilize oxygen. Negative ions in the bloodstream accelerate the delivery of oxygen to our cells and tissues.
- c. Speed up oxidation of serotonin (5-hydroxytryptamine) in the blood. This is well known to have far reaching effects on mood, pain relief and sexual drive.

**14. Asthma** - At the University of Pennsylvania's Graduate Hospital and at Northeastern and Frankford hospitals in Philadelphia, Dr. Kornblueh administered negative-ion treatments to patients suffering from hay fever or bronchial asthma. Over 60 percent have experienced partial to total relief.

**15. Burn Pain** - Dr. Kornblueh also studied brain-wave patterns and found evidence that negative ions tranquilized people in severe pain. Now, burn cases at Northeastern are immediately put in a windowless, ion conditioned room. Patients are left in the room for 30 minutes. The treatment is repeated three times for a full day. In 85 percent of the cases, no pain deadening narcotics are needed. Burns dry out faster; heal faster and with less scarring. They also reduce the need for skin-grafting.

**16. Airborne Allergens** - Experiments by Dr. Albert P. Krueger and Dr. Richard F. Smith at the University of California have shown how ionization affects those sensitive to airborne allergens. Bronchial tubes and trachea, or windpipe, are lined with tiny filaments called cilia. The cilia normally maintain a whip like motion of about 900 beats a minute. Together with mucus, they keep our air passages free of dust and pollen. Krueger and Smith exposed tracheal tissue to negative ions, found that the ciliary beat was speeded up 1200 a minute and that mucus flow was increased. Doses of positive ions produced the opposite effect: ciliary beats slowed to 600 a minute or less; the flow of mucus dropped.

**17. Cigarette Smoke** - In experiments involving cigarette smoke, Drs. Krueger and Smith also discovered that cigarette smoke slows down the cilia and impairs their ability to clear foreign and possibly carcinogenic (cancer-inducing), substances from the lungs. Positive ions, administered along with cigarette smoke, lowered the ciliary beat as before, but from three to ten times faster than in normal air. Negative ions however, counteracted the effects of the smoke.