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Study and Effects of Negative Air Ions on Atmosphere

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Abstract

The paper deals with the effects of ionization of air where people suffer various subjective sorts of discomfort such as headache, insomnia, fatigue, nervousness, joint aches, high blood pressure, which decrease work productivity. It has been recognised that these discomforts appear when there is a higher number of positive ions in the air .The positive ions prevail in industrial areas and densely populated places (housing estates, busy downtown sections, etc.) and enclosed rooms, which means in the places where we spend most of our lives. Various health effects are associated with or directly caused by respirable airborne particles and microbial agents. To reduce the human exposure to these indoor pollutants, numerous techniques have been developed over the years. One of the causes is presented especially by artificial materials which surround us (PVC flooring, synthetic carpets, and plastic windows), modern appliances (printers, copy machines, fluorescent lamps, TV sets, LD monitors, mobile phones , chemical cleaning agents, polluted air and cigarette smoke. The worst "enemy" of ionization is air conditioning which creates un-natural, artificial environment destroying natural microclimate by destroying all negative ions [4]. In normal, unfiltered air, air ions are molecular clusters consisting of about 10 neutral gas molecules around a charged oxygen, water, or nitrogen molecule. These are called small air ions. Small air ions are relatively mobile and soon encounter ions of the opposite polarity or a grounded surface, at which point they lose their charge and become neutral molecules again. Small air ions have a life span of a few seconds to a few minutes in clean air.

Under the right conditions, these ions attach to particles or other large molecular clusters in the air, resulting in large air ions. The relative proportion of small and large air ions present generally depends on the cleanliness of the air. Large quantities of particulate matter or aerosols in the air lead to a depletion of small air ions.

1. Introduction

Negative ions have positive effects on humans and they are said to be air vitamins. Their presence is highest especially in the nature after a storm, in caves, in the forest, near waterfalls, at a sea coast, etc. Negative ions are a significant and important source of energy for a human

body. They support the immune system and mental well-being. Thanks to them we feel happy, relaxed and we can breathe easy. This results in good mood, better work productivity, and peaceful sleep [1].

As the favourable impact of light negative ions on man and their body has been proved, there is an effort to ensure such an environment where the concentration of negative ions in the living space approaches the maximum of their concentration in the natural, unpolluted environment. This aim can be achieved by building our dwellings from suitable natural materials or by modification of our existing dwellings and work spaces [3].

The use of air ionizers is recommended in most published static control programs, but those documents contain little explanation of the physics of the air ionization process or of the effects of using ionizers in the manufacturing environment. Because marshalling air ions for static control purposes is important in many industries, this article attempts to fill in the missing information for users of air ionization technology.

Ionization has been used to clean the air in an internal environment by reducing dust particles and aerosols from volatile organic substances [6]. Ions also have antibacterial effects and may decrease the amount of microorganisms and allergens in the air [8]. Investigated negative ion concentrations at various room humidity levels and at various distances from the ionization source. The ion life cycle was approximately 100 s. The undesirable effects related to air ionization include excessive electrostatic discharge and charge of objects, dust accumulation on surfaces in a room resulting in the need of regular cleaning[10].Another side effect of the ionization process is ozone (O3) emissions [11]. Several techniques for changing the ambient air's burden of ions are effective for controlling static charge on insulating materials. The air ionization has been incorporated into commercial air purification devices manufactured by Ionair, Inc. (Midland, MI, USA), Sharp Corporation (Osaka, Japan), Topway Electronic Factory Company (Guangzhou, China), Wein Products, Inc. (Los Angeles, CA, USA) and other companies. Most of the ionic air purifiers, including unipolar ion emitters, have been originally designed to reduce the exposure to all types of aerosol particles, irrespective of their biological properties. Since viable airborne bacteria represent a specific hazard, it is important to determine the physical and biological efficiencies of ionic air purifiers against these air contaminants. The physical efficiency of ionic air purifiers represents their ability to reduce the concentration of bacterial particles in the air, whereas the biological (bactericidal) efficiency represents their ability to reduce the microbial viability by inactivating viable microorganisms that remain airborne.

However, any discussion of neutralizing static charge on insulators in a static control program, as here, will deal primarily with the production and effects of small air ions.

Respirable airborne particles, including airborne dust, microbial agents and aeroallergens, may cause adverse health effects, such as asthma, allergic diseases and airborne infections [2]. Although health effects associated with biological aerosols have been of a special concern for decades, recent outbreaks of emerging infections as well as the growing concern about bioterrorism have drawn additional attention to the development of control methods against indoor air pollutants, particularly against viable bacterial cells and spores.

It was felt that at this time the basic problem were of greater importance in order to bring some order and restraint into the prevailing chaotic conditions. It was obvious to all participants that the practical results of the meeting exceeded all expectations but that much work still remains to be done before air ionization achieves full recognition and undivided scientific support.

2. Air Ionization Concept

There is necessity to bring some focus into air ionization concept before experimental design behind the air ionization.

The word *ion*, derived from a Greek verb suggesting motion, has the sense of "a traveler." The term was first used to de-scribe the effects observed when electrical currents were passed through various solutions ; molecules in the solutions would dissociate and migrate that is, travel to electrodes of opposite polarity. A theory advanced by the Swedish researcher S. A. Arrhenius that the migrating ions were electrically charged atoms was substantiated by the later discovery of the electron and its nature.

Ions are defined as atoms or molecules that have lost or gained electrons. (Electrons are the only easily available charge carriers.) When an atom or molecule has an equal number of electrons and protons it is electrically balanced, or neutral. If an electron is lost, the atom or molecule becomes positively charged and is a positive ion. Gaining an electron makes it a negative ion.

What is called an *air ion*, or a charged air molecule, is really no such thing. Air is a mixture of gases, including nitrogen, oxygen, carbon dioxide, water vapor, and other trace gases, any one or more of which may be ionized. Sometimes a di-atomic gas molecule, such as nitrogen or oxygen, will gain or lose the electron. Sometimes it will be a more complex gas such as carbon dioxide. In any case, when molecules of one or more of the gases in air gain or lose electrons, the result is conventionally called air ions.

In normal, unfiltered air, air ions are molecular clusters consisting of about 10 neutral gas molecules around a charged oxygen, water, or nitrogen molecule. These are called small air ions. Small air ions are relatively mobile and soon encounter ions of the opposite polarity or a grounded surface, at which point they lose their charge and become neutral molecules again. Small air ions have a life span of a few seconds to a few minutes in clean air.

Under the right conditions, these ions attach to particles or other large molecular clusters in the air, resulting in large air ions. The relative proportion of small and large air ions present generally depends on the cleanliness of the air. Large quantities of particulate matter or aerosols in the air lead to a depletion of small air ions.

However, any discussion of neutralizing static charge on insulators in a static control program, as here, will deal primarily with the production and effects of small air ions. The atmosphere surrounding us is constantly ionized. The sources of the ionization energy affect the Earth continuously and, therefore, electrically neutral air does not practically exist. The source of energy activating ionization of air is electromagnetic radiation (space radiation, solar ultraviolet radiation, and gamma radiation of radioactive materials) [7].

We encounter ions practically all the time and everywhere, because they are an inseparable part of the atmosphere which surrounds us everywhere. In the air there are ions of two polarities, that is the positive one cations and the negative one anions. The way they influence us depends on their mutual ratio.

At the end of the nineteenth and the beginning of the twentieth century many physicists discovered that independent discharging of the charged electroscope is caused by conductive particles ions in the air atmosphere. Gas molecules are electrically neutral in normal conditions. A certain amount of energy is needed for air ionization to occur [9]. This minimum amount of energy is identified as ionization energy. When the ionization energy is reached, non-elastic collisions of formerly neutral particles occur. These collisions cause one or more electrons to separate from the orbital atom course, thus forming pairs of electrically charged particles. These electrically charged particles carry a negative charge, and the remaining atoms carry a positive charge [5]. Therefore, in natural ionization a pair of electrically charged particles, with each particle having the opposite charge is always formed.

The particles that are formed are not stable, and they connect with neutral charges or molecules, forming a complex of up to 30 molecules; these molecules are reasonably stable and are called light positive and negative ions. The process of light positive and negative ion formation occurs in a fraction of a second. The scheme of ion particle formation is illustrated in Fig.1.

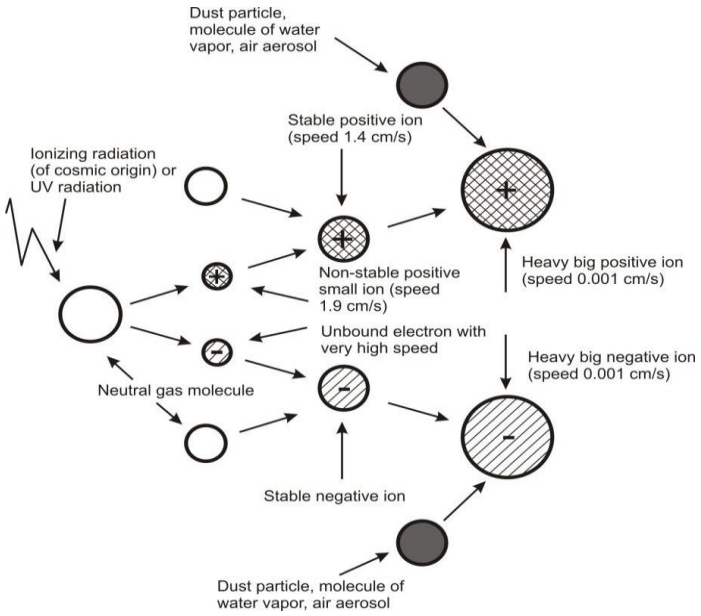

Figure.1 The principle of ion particle formation in the atmosphere

3. Atmospheric Electricity

The study of general electrical properties of the atmosphere, both under normal conditions and at the time of discharge (i.e., a lightning), is called atmospheric electricity.

Atmospheric Electricity is due to following factors:

a) When evaporation takes place from the surface of water of the seas and the rivers, the water vapours which go up are positively charged thereby leaving the water behind as negatively charged.

b) Ultraviolet Radiations, cosmic rays and radioactive rays (from radioactive sources) cause the ionization of the atmosphere.

c) The ions produced in the atmosphere bring about further ionization by collisions. The electrified region of the atmosphere (extending from 80 km to about 300 km above the earth's surface) is called ionosphere.

Water vapours present in the atmosphere condense on the ions forming charged water drops. When thsese large number of drops combine, a cloud is formed which may either be negatively charged or positively charged? Whenever a charged cloud comes near the surface of the Earth or when two oppositively charged clouds come together, these are neutrelised and lightning takes place.

Alpha Ionization Alpha ionizers utilize a nuclear source, polonium 210, which is an alpha particle emitter. The alpha particle, a helium nucleus, collides with air molecules, knock-ing out electrons over a travel distance of about 3 cm. Gas molecules that lose electrons become positive ions. The dislodged electrons do not exist freely for very long before they are captured by neutral gas molecules, forming negative ions (see Figure 2).

Alpha ionizers always produce balanced quantities of positive and negative ions. Each electron knocked out leaves behind a positive ion and, when captured, creates a negative ion. This is advantageous in certain applications involving extremely ESD-sensitive components. Equal numbers of positive and negative ions means that the ionizer is always balanced to 0 V and neutralizes everything in the work area to zero.

Alpha ionization is used commercially for applications involving explosive or flammable environments, or in applications requiring precise balance of ionization. The process is expensive because alpha ionizers lose half their strength every 143 days (the half-life of a radioactive source). Usually they must be replaced annually. Although alpha ionizers have more than a 25-year record of safety, they are subject to government regulation. Anything radioactive makes people nervous. For these reasons, alpha ionization use is not as widespread as that of corona ionization.

Corona Ionization Corona ionizers use strong electric fields created by applying high voltage to a sharp ionizing point to move the electrons. Due to the decay of trace ra-dioactive elements in soil and air, a few free electrons are always present in the atmosphere. Creation of a high positive electric field accelerates these electrons toward the ionizing point. They collide with air molecules and knock out more electrons on the way, leaving behind many molecules that have lost electrons and become positive ions in a high positive electric field. This field repels them from the ionizing point, presumably toward the area where they are needed for charge neutralization. Similarly, a negative electric field sends free electrons away from the ionizer point into collisions with gas molecules that generate more free electrons that are captured by neutral gas molecules near the ionizing point. The negative ions created are repelled by the negative electric field. Corona ionization generally does not provide the intrinsic balance of ion polarities that alpha ionization does. Methods do exist, however, to ensure that closely matched quantities of positive and negative ions are delivered to the work area despite differences in ion mobilities and ion production rates for each polarity. Also, some ionizers include monitoring and feedback capabilities to provide adequate long- term stability of the ion balance in the work area. Ion balance is important because an imbalance in the ionizer can induce voltages on isolated conductors, an outcome just the opposite of that for which the ionizer's use is intended.

The Ionization Standard Ionizer balance, or offset voltage.

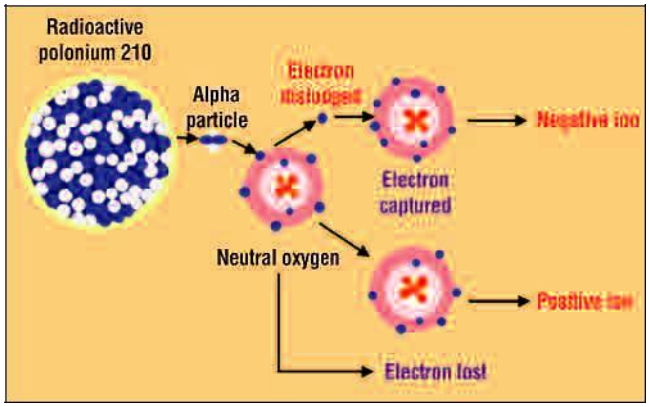

Figure 2. In alpha ionization, polonium 10 collides with air molecules and knocks out electrons

4. Selecting Methods Associated With Air Ionizations

The ESD sensitivity of the product being protected generally determines the type of ionization that is best to use. The more sensitive the product, the more precise must be the ionizer's ability to maintain balance and long-term stability in ion production. However, problems such as particle attraction to charged surfaces and ESD-related equipment difficulties can be solved by almost any commercially available air ionizer. Solving these problems does not require ionizer balance to better than a few hundred volts, as measured with the CPM.

Selecting an ionizer may involve consideration of several other issues as well. These include available airflow, distance from the ionizer to the work area, and the cleanroom compatibility of the ionizer.

Several methods of corona ionization are available to create and deliver bipolar ionized air to the work area. These methods differ mainly in whether high voltage ac, dc, or pulsed dc current is used to create ions.

Ac Ionization In alternating current technology, high voltage is applied to a number of closely spaced emitter points that cycle negative and positive at the line frequency of 50 or 60 Hz. Ionization efficiency is low because the points remain above the ionization threshold voltage for each polarity only a small percentage of the time.

Ac technology is widely used in ionization bars that control static charge on low and medium speed moving material webs. It is used also with ionizing blowers and blowoff gun devices. In electronics manufacturing, ac ionizers are commonly employed to protect components during assembly. Because of their dependence on the power line, with its often unbalanced and noisy characteristics, ac ionizers are rarely used in applications requiring precision balance (within ±15 V) and because of the high ion currents necessary to make up for high levels of ion

recombination, particle levels associated with ac ionizers usually make them unsuitable for cleanroom applications.

Steady State Dc Ionization High voltage of both polarities is continuously applied to pairs of positive and negative emitter points in standard direct current technology; thus, the efficiency of ion production is better than that of ac ionizers. Because lower operating currents can be used, steady state dc ionizers are more applicable to cleanroom use. The availability of separate positive and negative high voltage supplies makes it possible to employ various schemes for monitoring and feed back control of ion balance to better than ±5 V. Steady state dc ionizers can be used in high airflow rooms and in high speed web applications. This technology is also applied in ionizing blowers, ionizing bars, and blowoff gun devices. In addition, it has wide application for controlling static charge in room systems, on work surfaces and flow hoods, and in equipment at the point of use.

Pulsed Dc Ionization Positive and negative high voltage currents to the emitter points are alternately turned on and off in pulsed systems, creating clouds of positive and negative ions that mix together in the work area. The result is a dramatic lowering of the recombination rate. This allows ionizers to be placed on the ceilings of rooms 5 m high or higher.

Pulsed dc ionizers are used in rooms with low airflow and are the most common type of ionizer employed in cleanrooms and laminar flow hoods. The advantage of this type of ionizer is its flexibility and versatility, as cycle timing can be adjusted to the specific airflow conditions. Since the polarity of the ionizer output varies with the cycle timing, a voltage swing is produced that must be limited in order to protect ESD-sensitive devices.

The Effects of Air Ionization

Whenever something is to be added to the air people breathe, the natural response is to ask what effects it may have. Since the 18th century, scientists have been pursuing this question with respect to what are now called charged air molecules. Research on the effects of air ions on all sorts of biological systems conducted through the 20th century found that these included the killing of microorganisms, the stimulation of plant growth, and the shift of chemical levels in the blood and brains of animals. Both adding ions to the normal environment and removing those affected biological systems.

Investigations into the effects of air ions on human beings have followed from the anecdotal evidence that naturally occurring air ions do affect human activity. Certain hot dry winds, for example, cause a shift in the balance of positive to negative air ions, to which increases in illness and the alteration of mood have been attributed.

Despite an absence of true double blind clinical trials, several conclusions regarding the effects of small air ions on people have been reached. One is that not all people notice or react to

changes in the level of air ions. More important, for those who are affected, a decrease in the air ion level is more significant than an increase or a shift in the ratio of positive to negative ions.

Few human technological activities lead to an increase in air ions. Most activities cause depletion. Industrial air pollution, stray electrical fields, and ventilation ducts are some factors that effectively strip air ions from the environment. Such ion depletion can cause sleepiness, attention deficit, discomfort, and headaches, effects that artificially increasing air ion levels has been reported to reverse. Ion generators have been used to mitigate these problems. However, there is no general agree-ment that employing these devices to restore or increase environmental levels of air ions has beneficial health effects. Studies have shown, on the other hand, that for certain tasks, and worker performance improves in an ionized environment, particularly relative to an ion depleted work area. People whose performance or moods are affected by ion levels seem to prefer a negatively ionized environment.

One thing is common to all studies of the effects of air ions on people: no researcher has reported any adverse effects from even high concentrations of balanced or monopolar negative ionization.

5. Findings Related to Air Ionization and Atmospheric Electricity

a) At the earth's surface there exists an electric field of strength 100 V/m which is directed vertically downward all over the Earth. The strength of this field decreases gradually with height and at about 50 km from earth's surface, it becomes negligible. But the potential goes on increasing with height.

b) The entire negative charge will be neutralised in few minutes.

c) The atmosphere remains charged due to thunderstorm and lightning which occur all over earth.

6. Conclusions

It is necessary to supply the negative ions for healthier and more natural environment. Negative ions are essential for cleaning the air and for improving our health. The higher their concentration in the air, the cleaner is the air and higher is the oxygen concentration in our body.

Human beings have evolved in an ion rich environment, essential for their health. But since the industrial revolution, air pollution and the use of concrete to build cities have drastically reduced the air ion concentration in cities and industrial areas.In our indoor environment, synthetic material, electrical equipmemts, like computers and TV, cigarette smoke and air conditioning systems also quickly neutralized the negative air ions. Maximum strength of the persons regularily working with computers are suffering of headache, memory trouble and

concentration problem. The depletion of negative air ions in the air not only weakens our body defence but also drastically reduce the air quality.

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