mks Ion Systems

Technical Note

Air Ion Distribution Methods:
Corona, Alpha, and Photoelectric

Three Common Methods

In high tech and industrial manufacturing environments, static charge can be a serious threat to product yield and equipment processes. Static can destroy product or render it unusable, or lock up machinery or software. There are many methods for reducing or preventing static charge problems when using conductive or static-dissipative materials that can be connected to ground. Only air ionization eliminates static charge and insulators and isolated conductors that cannot be grounded.

The power distribution methods used to create air ions vary in efficiency and appropriateness for each application. Three common methods are used in commercial air ionizers:

- Corona
- Alpha
- Photoelectric

Each method generates air ions with corona ionization the most commonly used method, particularly in cleanrooms. Each of the three methods are discussed below.

Corona Ionization

AC (alternating current) and DC (direct current) high voltage is used to generate corona ionization. To create corona ionization, the high voltage is applied to a sharp emitter point or a small diameter emitter wire, resulting in an electric field around the emitter. This high voltage field interacts with the electrons in the nearby gas molecules, resulting in positive or negative ions, depending on the type of high voltage that is applied.

AC Corona Ionization

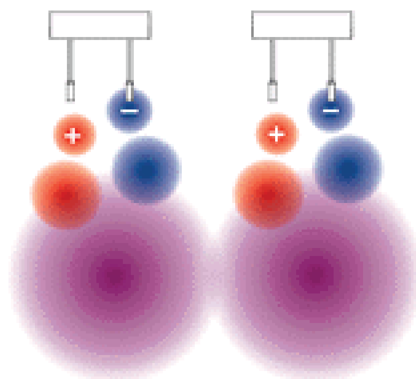
To create AC ionization, high voltage is applied to a single emitter point, which cycles between negative and positive at line frequency (50/60 Hz). Since the cycles are so fast, there is a high level of recombination of ions. As the ionization depends on the power line directly, it is difficult to generate positive and negative ions in equal numbers. The AC ionizer consists of a single point (blowoff gun or nozzle), an array of such points arranged around a fan (AC Blower), a straight line of points (AC Bar), or an area (AC grid). Ionizers that employ AC corona must be accompanied by strong airflow to push ions away from emitter points. This can be inconvenient since the ionizer must rely solely on the environment it is installed into for its airflow, or else incorporate additional fans or blower devices.

AC corona ionization is most appropriately used in industrial applications where the ionizer can be placed close to the charged objects and cleanliness is not required. AC corona ionizer designs are often simple and low cost, making them an attractive choice in many manufacturing environments.

DC Corona Ionization

Unlike AC corona ionization, which emits both positive and negative ions from the same emitter point, DC corona ionizers emit ions from separate positive and negative emitter points. Since the ions are emitted from separate points, there is much less recombination of ions. Since ions are emitted independently for each polarity, it is possible to monitor and control the amount and the equality of ions emitting from the positive and negative emitter points. Various types of monitoring and control systems are available for DC corona ionizers. As a result, ionizers using DC corona offer great degrees of control and fine-tuning. The high level of system sophistication along with the low ion recombination rate also means that DC corona ionizers are appropriate for ESD-sensitive and contamination-critical technology applications.

Two types of DC corona ionization are employed: pulsed DC and steady-state DC.



Pulsed DC corona

Steady-state DC continuously applies positive high voltage to half of the emitter points and negative high voltage to the other half. The ionizer may contain a single pair of emitters (blowoff guns or nozzles, and in ceiling emitters), an array of pairs of emitters (DC Blowers), or a straight line of emitter pairs (DC Bars). Steady-state DC ionization may be employed with low or high airflow, depending on how far apart the emitter points are spaced. Steady-state DC ionization is commonly used in room systems, laminar flow hoods, blowers, and blow-off guns.

Pulsed DC ionizers allow positive and negative emitter points to be turned on and off alternatingly, creating clouds of positive and negative ions. Ionizers using pulsed DC may be finely tuned to allow timing cycles and polarities to operate as exactly needed for a specific application. Positive and negative emitters may be set to turn on alternately, usually in a time period of seconds. In certain areas, a greater proportion of one polarity may be needed over the other, or the time that the voltages are on may be stretched to prevent any recombination.

Ionizers using pulsed DC can be appropriately used both in and out of the cleanroom, most commonly in ceiling emitters or bar-type ionizers. It is not efficient for use in ionizing blowers or blow-off guns.

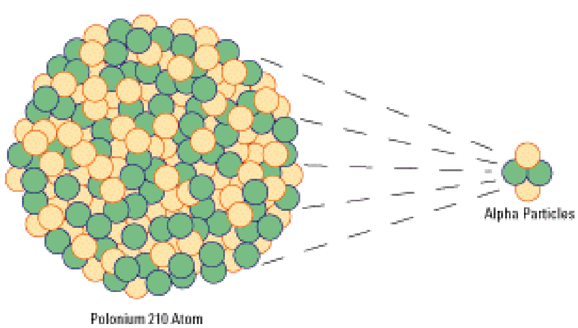
In the past, pulsed DC and steady-state DC corona ionizers were fine-tuned manually according to readings taken with environment instrumentation, such as a charge plate monitor (CPM), with a manual adjustment on the ionizer itself. Modern systems used in high tech semiconductor and flat panel display (FPD) environments today employ digital systems that allow a high degree of exact tuning, usually remotely with digital interfaces.

For example, Ion's digital AeroBars and digital ceiling emitter allow users to choose between either pulsed or steady-state DC ionization as the application demands, immediately and without removal of any system components. Adjustments are made using digital remote controls or a software interface that installs directly into equipment or environment computers, allowing remote and immediate management of all parameters. Such parameters include periodic and automatic synchronization of the ion on times, and adjustment of positive and negative high voltage output levels, which affect the distance and velocity of ions. Another feature is the ability to set the exact point at which an alarm will trigger. Some systems also allow a balance setting, which corrects the balance of time that one polarity of high voltage is on versus the other.

Alpha Ionization

Some ionizers use a low level alpha particle radiation source to create ions. Alpha sources of radiation have a short range in air (less than 3 cm) with minimal penetration ability (less than 40 microns in human tissue), making them safe to use and handle while providing high ion output. Polonium 210 (Po210) is used as the alpha source. Polonium 210 is a naturally occurring radioisotope that emits alpha particles that collide with air molecules and dislodge electrons. The electrons are subsequently captured by neutral gas molecules. Pairs of positive and negative ions are the result of this collision process.

Polonium 210 has a half-life of 138.4 days, during which the activity of the source reduces by 50 percent. Eventually, the source decays into a naturally occurring and stable isotope, lead 206 (Pb^{206}), and in five years all but 0.01 percent of the source decays completely into lead. Alpha particles cannot penetrate to the live layers of human skin and are completely encapsulated, allowing them to be safely handled and used.



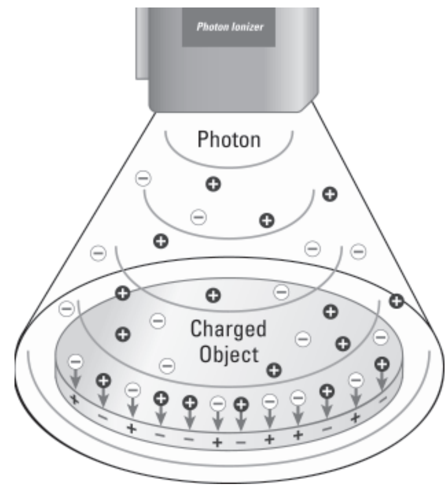
Alpha particles

Since alpha sources do not use high voltage to ionize, electric fields are not created. Since the ionization process always creates ion pairs and the ionizer can maintain a zero balance, with no additional control systems. This makes alpha ionizers extremely efficient for small and sensitive device manufacturing such as disk drives.

A disadvantage of alpha ionizers is that they require tracking (regulations of the Nuclear Regulatory Commission [NRC]) and most are only available for use on a lease basis with annual replacement required.

Photoelectric Ionization

Ionizers that are photoelectric, called photon ionizers, use deep UV or soft x-ray photons to create ions using the photoelectric effect. When the photon passes near the gas molecules in the air it gives up some of its energy to dislodge electrons, which are subsequently captured by neutral gas molecules. Pairs of positive and negative ions result. The soft x-rays used in photon ionizers have drastically lower energy than those used in the medical profession.



Photon ionization

Advantages of photon ionizers include excellent discharge times with little or no airflow, and little or no chance for recombination. Like alpha ionizers, electric fields are absent since no high voltage is used, and the ion generation occurs in pairs, allowing photon ionizers to have a zero balance without additional control systems. These very desirable factors make photon ionizers appropriate for extremely sensitive applications and tight spaces, especially those with little or no airflow.

Photon ionizers are required by the FDA to be used in a shielded and electrically interlocked environment and come with some additional registration regulations.

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