SIMCO ION™
An ITW Company

TECHNOLOGY SOLUTIONS

Realizing Ionizer Balance and Maintenance

The Need for Maintenance

The subject of maintenance for air ionization systems is often misunderstood. The requirement for occasional balance is related to how the environment affects ion delivery and ion balance. Environment changes can cause an ionizer with perfect balance to deliver unbalanced ionization, resulting in the need for ionizer readjustment. Such environmental changes are typical as a production line evolves in the course of its normal factory life.

Eliminating surface charge is critical in high technology manufacturing processes where static charge creates a contamination problem. An air ionizer must provide a balanced delivery of negative and positive ions to eliminate surface charge successfully. If balanced delivery does not occur, the ionizer discharges objects in the environment to non-zero voltages. Virtually no ionizer achieves perfect balance, but an ionizer that discharges objects from potentials of tens of thousands of volts to levels of a few tens of volts is considered adequately balanced.

The reason that stable ionizers move out of balance is rooted in chemistry and physics.

Ion Mobility and the Effect on Balance

The physics of air ions is a complex one. The air is made up of a mixture of gasses. The most common constituents are nitrogen (N2), oxygen (O2), and water (H2O). An ionizer primarily produces O- (oxygen ion) and N+ (nitrogen ion) ions. Electric fields from the ions rapidly attract water vapor molecules which are highly polarized (Figure 1).

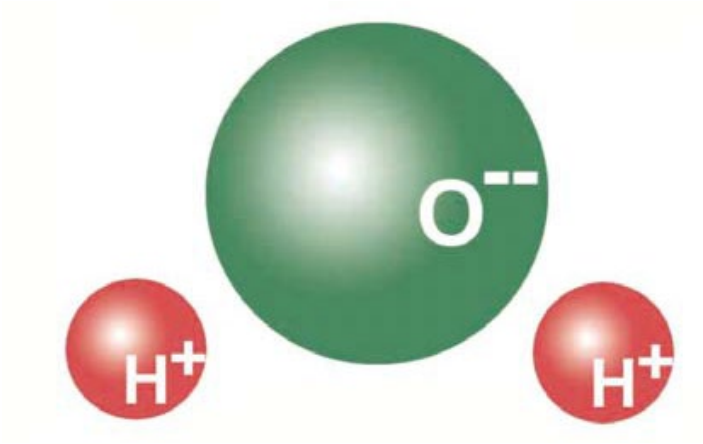
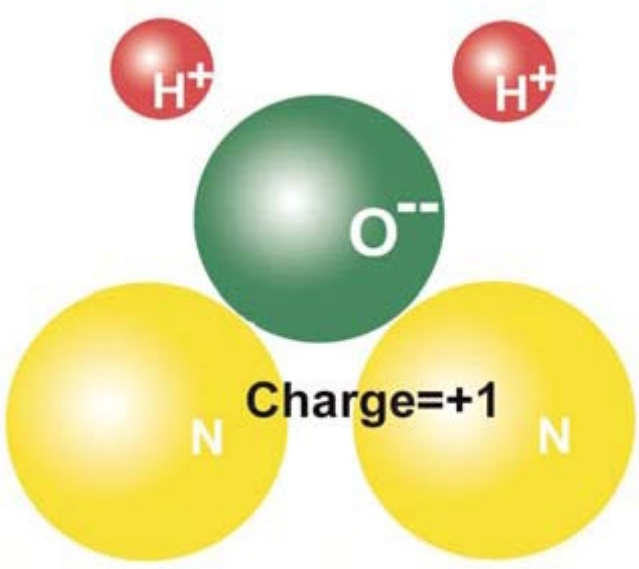
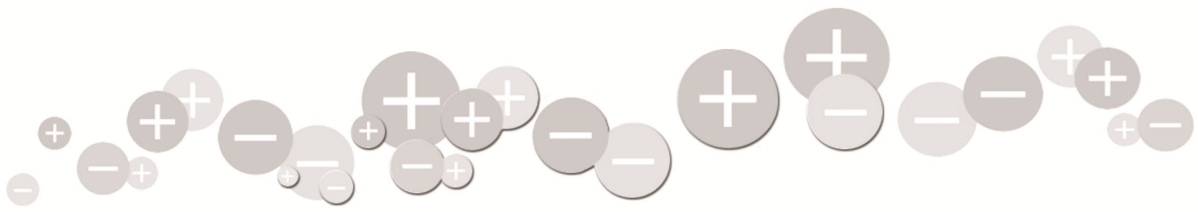
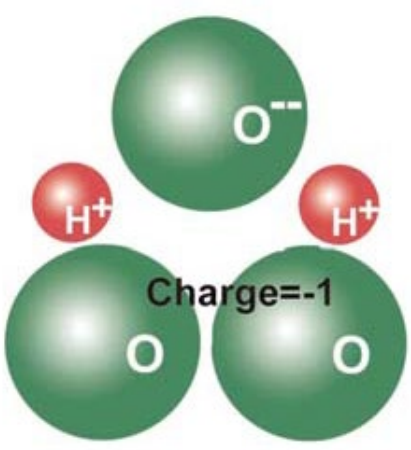


Figure 1. A Water Molecule Is Highly Polarized

Many water molecules are attracted to each air ion, creating a cluster. Depending upon whether the ions are positive or negative, water molecules are attracted with the hydrogen side in or the oxygen side in, meaning that the waters can pack together is different depending upon the polarity of the ion in the center.







Figures 2a and 2b. Water Molecules Are Attracted to Air Ions

The two types of forces drive air ions made into clusters. Aerodynamic forces drive the clusters by the air flow from HEPA fan-filter units. The other force that is electrostatic, caused by fields in the environment. These forces are greater than aerodynamic forces, resulting in the displacement of ions from the path they would normally follow if they moved strictly on the airflow. A large part of the electrostatic force is caused by an effect referred to as "mirror charge" in conductors. The electrons in a conductor rearrange to cancel electric fields within the conductor but in the process cause conductors to attract external charges. See Figure 3.

While both polarities of ions are attracted to conductors near the path of their movement, positive ions are more rapidly attracted due to their lower mass.

For that reason, when a balanced population of ions is directed toward a product, the positive ions are more strongly diverted toward a conductor, causing the net ion delivery to become unbalanced. The degree of unbalance depends upon the size and location of the conductors, but it could result in a 2-volt effect or it could be a 200-volt effect.

The Effect on Balance

What is important to learn from this differential ion leak is that the balance of an ionizer could be perfect when it is shipped from the factory and the ionizer could be set to deliver a perfect balance of positive and negative ions but the presence of conductors in the airflow will cause the ionizer to deliver a significantly unbalanced ion population to the target. This would result in an ionization system which dis- charges the product to some non-zero value which may be unacceptably high.

In such cases, it becomes important to set the balance of the ionizer such that the ion delivery to the target is balanced, requiring that the ion delivery from that ionizer be unbalanced to compensate for differential ion absorption described above.

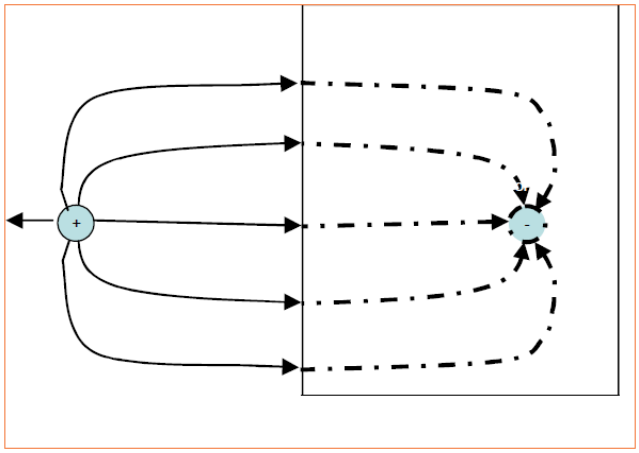


Figure 3. Charged Particles Are Attracted to Their Mirror Charge Nearby Conductors

It is important to remember that a production environment is not static; it evolves as the product matures. New tools may be introduced into the area, inspection ports may be installed in mini-environments, or extra support structures installed in the process tool. These types of changes perturb the environment and affect the balance of an ionizer.

A poorly balanced ionizer results in increased contamination levels and ESD damage. A balanced ionizer is fundamental to maintaining high-yield production. The importance of a properly balanced ionizer in high technology manufacturing processes where changes in the environment degrade ionizer balance means it is critical to developing an ionizer maintenance program that measures and adjusts the balance of the ionizer at the target. This will ensure proper balance no matter how accurately the ionizer controls its internal balance.

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