# ELECTROSTATICS – APPLICATION PROCESSES

## Basic Principles behind Corona Discharge Coating Technology

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The basic principle of electrostatic application processes is the transfer of electrons from one object to another. The object which loses electrons becomes positive, and that which gains electrons becomes negative. Charged objects will either attract or repel one another. They will also set up an electric field in the space surrounding them with lines of force operating in a specific pattern.

The air around us consists mainly of neutral gas molecules with no charge. However, there are always some molecules losing electrons giving rise to positive ions and free electrons. These are in equilibrium.

When an electrical field is brought into being, the free electrons will be attracted towards the positive pole. On their way, they will collide with neutral molecules, and create additional free electrons and positive ions, or they might simply "stick" to the neutral gas molecule, creating a negative gas ion. The positive ions will travel towards the negative pole, and the negative gas ions will join the electrons travelling towards the positive pole.

In the spraying of powder, we need to produce a suitable electrostatic charge on the surface of each powder particle and a suitable electrostatic field to transport the charged particles. Finally, we need an earthed workpiece so the charged particles will be attracted to it.

The most common way of charging the powder particles is to pass them through a region of intense ionization. We create this by raising the voltage of a pointed conductor (the electrode of the gun) to a very high level. This creates an intense electrostatic field which causes the surrounding air molecules to become high ionized. We call this a corona discharge.

The powder particles pass through this zone and by interacting with the various charged particles, become charged themselves. Due to the high potential difference between gun and workpiece a strong field will be set up with the lines of force from gun to workpiece.

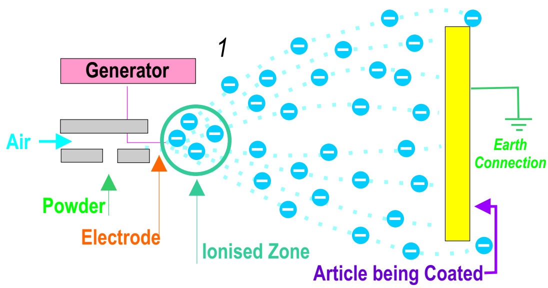


*Diagram 1*

The diagram on page 1 shows the negatively charged powder particles. Note that uncharged powder particles and negative and positive ions and free electrons would also be present.

## CORONA CHARGING

The level of charge depends on:

- Nature of the powder
- Particle size and shape (surface area)
- Strength of the electrostatic field
- Time spent by the particle in the field

The transport of the particles to the workpiece would be affected by:

- The charge on the particle
- The field intensity
- The velocity of the air stream
- The particle size (small particles – higher velocity)

As the particle leaves the gun, the predominant force would be aerodynamic, and as the particle approaches the workpiece, the electrostatic force would take over.

The electrostatic field develops as soon as the gun is triggered. The field intensity depends on the voltage and on the distance between gun and workpiece. The shape of the field is governed by the shape of the workpiece, as the field lines end at right angles to the surface. Field lines concentrate at sharp points such as edges.

On arrival at the surface, the charged particles will be held by electrostatic attraction. New arrivals will be attracted to uncovered areas, but repelled by particles already in place. This balance of forces will tend to limit the thickness of the deposited layer. *See diagram 2 below.*

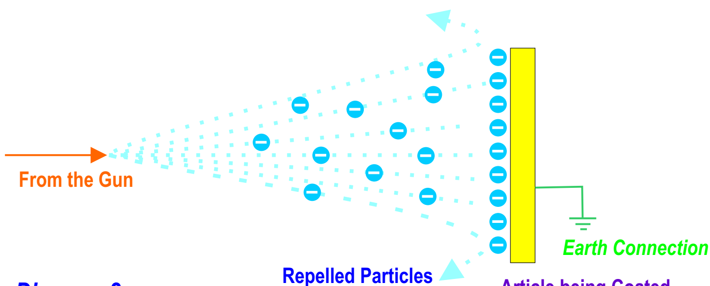


***Diagram 2***

## DEPOSITION OF CHARGED POWDER

However, as the layer grows, so does the level of charge held in the layer. If this voltage exceeds the dielectric strength of the air, back ionization will occur in a similar way to the corona discharge, but opposite in polarity; this causes ions to be pulled away from the surface, through the deposited layer, causing disruptions which can lead to film defects.

## FARADAY EFFECT

The lines of force tend to terminate at high points or edges and do not penetrate cavities. This effect is known as the Faraday effect, and leads to little or no powder in recesses. *See Diagram 3 below.*

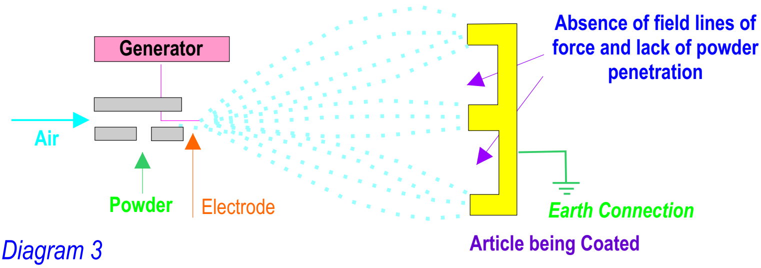


*Diagram 3*

The Faraday effect presents the coating service provider with some difficulties and special attention is required to overcome the constraints created by this phenomenon. To an extent modern technology offers some solutions and corona guns can be adjusted to help overcome this effect, but many problems can be minimised if the manufacturer of the product takes the Faraday effect into consideration during the design stage of the product.

The author of this article, Cornel Botha, has been involved in all facets of the powder coating business since he was still at school and seriously pursued it since 1992. Starting as a sprayer he worked his way up to Factory Manager in a few of the well-known large powder coating companies in South Africa. Moving forward he later became a Sales Representative for Wagner equipment. Today he is the sole importer of Wagner powder coating equipment in South Africa. He believes in having all-round experience to do a perfect job.