COMPARISON OF TRIBO AND CORONA CHARGING METHODS: HOW THEY WORK AND THE ADVANTAGES OF EACH

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Comparison of Tribo and Corona Charging Methods: How They Work and the Advantages of Each

Abstract: This paper compares the fundamental design and functional differences between Corona and Triboelectric charging methods. An evaluation of the applicators and tools developed to enhance the capabilities and performance characteristics will be made, together with suggestions for the appropriate use of both technologies.

Introduction

The powder coating industry has grown tremendously in recent years. With this growth have come challenges to develop better powder coating equipment and processes. The powder applicator most often used is typically the corona charging gun. However, the tribo charging gun has gained popularity in recent years due to developments in the powder coating materials and gun technology. To better understand each technology, we will compare both corona and tribo charging methods.

Corona Charging Method

In corona charging, a high voltage potential is developed at an electrode located in or near the powder stream. With most corona guns this occurs as the powder exits the gun. (See diagram #1.) An ion field is generated between the electrode and the grounded product. Powder particles passing through this field are bombarded with ions, become charged, and are attracted to the grounded product. The charged powder particles accumulate on the grounded product and are electrostatically retained long enough for the product to pass through a cure oven where it flows into a continuous coating. Most corona guns charge the powder to a negative potential, however, guns are available to positively charge the powder.

Different types of power supplies, electrode placement, and nozzle configurations have been used for corona charging methods over time. The power supply generates the high voltage supplied

to the electrode. In some equipment the power supply is located away from the gun and is connected to it by a high voltage cable. In other equipment the power supply is actually built into the gun or the mounting bracket for the gun. The placement of the charging electrode in relationship to the powder stream is critical in achieving effective powder charging. Some guns have the electrode directly in the powder stream while others are adjacent to it. The electrode placement is often dictated by the nozzle configuration used. All different types of nozzles have been used to effectively coat products that have intricate corners, flat surfaces or unusual shapes. Two of the more typical nozzles are deflectors which create a round spray cloud and fan spray which create a flat spray cloud. Nozzles have been developed that have swirl or forward air to affect the powder cloud shape. Others nozzles have two or more heads on them to apply powder in specific areas. Many of these possibilities have been mixed and matched to create effective powder coating guns.

Tribo Charging Method

The charging of the powder particles in a tribo gun is achieved by the friction of two dissimilar materials coming in contact with one another. (See diagram #2.) In the case of most tribo guns, electrons are stripped from the powder particles as they make contact with the gun wall or tube which is typically made of teflon. This results in the particle giving up electrons which leaves it with a net positive charge. The positively charged powder particle is transported to the grounded product by the air stream leaving the gun. The powder particles accumulate on the grounded product and are attached long enough for the product to pass through a cure oven where it flows

into a continuous coating. The electrons that were removed from the powder particles are discharged to ground through the teflon material. This discharge of electrons to ground must happen quickly and continuously for tribo guns to operate effectively.

Tribo charging has typically been limited by the types of powder it can apply. This is due to the fact that dissimilar materials must be used to create an electron swapping situation. (See diagram #3.) Teflon is typically the material used in the gun because of its ability to accept and discharge electrons and its wear characteristics. Because telfon is on the negative end of the table, materials at the positive end are the most successfully used as tribo powders. The best example of this is epoxy which has for years been one of the few powders that is consistently used for tribo. However, in recent years powder manufacturers have been able to develop tribo formulations of many other powders including polyesters, urethanes, and hybrids that can successfully be used with tribo.

The tribo gun is designed to maximize the amount of interior surface area the powder is capable of coming in contact with in order to achieve optimum charging. This is the reason tribo guns are often longer than corona guns. There are tribo guns with one inner tube that has air ports positioned so as to create a spiral effect of the powder as it passes through the tube. There are also guns that have multiple tubes that split the powder into smaller, more concentrated areas as it passes through the gun. Another type gun has a wavy surface down the length of the inner tube of the gun that creates contact as the powder passes through the gun. While these guns are capable of charging the powder, concern must be taken in cleaning and wear of the gun. Some

guns are time consuming to clean because of the multiporting or uneven surfaces inside the gun.

As in corona guns, tribo has a wide variety of nozzles. Many of the same style nozzles are used for both corona and tribo. One style nozzle used with tribo guns is the multi-head nozzle. This nozzle allows a great deal of flexibility in directing powder into corners and difficult areas. Also, tribo guns do not have electrodes in the powder stream as corona guns do. This provides an advantage in gun cleaning and wear.

Differences Between Tribo and Corona

When evaluating the two type guns for a specific application, there are some fundamental items to take into consideration. The differences between tribo and corona guns are outlined in this manner.

Faraday Cage Effect: Probably the most common reason to consider tribo guns for an application is the ability of the tribo gun to coat products with a high degree of Faraday cage effect areas. (See diagram #4.) Examples of these areas are corners of boxes, fins of radiators, and support seams on shelving. In these cases, powder is attracted to the flat areas of the product and forced out of the corners and seams due to electrostatic repulsion of similarly charged particles in the area or intense air flows. Tribo guns are well suited for this application because an ion field is not generated between the gun and the product. It is the ion field which increases the electrostatic repulsion. This effect can be reduced in corona guns by operating the gun at a lower voltage

output. This removes one variable from the application and becomes an issue of air flow dynamics.

Powder Output: The powder output of a gun determines the amount of powder that can potentially be applied to an product. Corona guns can operate at low and high powder outputs due to the consistent charging capability. Tribo guns typically must operate at lower powder outputs due to flow restrictions. The flow restriction is a result of forcing the powder through multiple tubes, using air to rotate the powder around the inner tube, or having dimples to disrupt the powder flow through the tube. When the tribo gun is operating at a low powder output, the powder particles have more opportunities to impact the walls of the gun and become charged. At high powder output, the powder particles are moving at a higher velocity through the gun but the flow restriction limits the powder output.

Conveyor Speed: Conveyor speed also plays a differentiating role between the two gun types. Tribo guns often need more guns to apply the same amount of coating as corona guns, especially at high line speeds. Corona guns have the ability to coat products at low and high conveyor speeds. Because tribo guns operate at lower powder outputs, more guns are required to apply the same coating thickness.

Powder Types: The type of powder required for an application is important to the type of gun used. Most powders have been developed to function with corona guns. This is especially important to operations that require frequent color change to many different type powders. Tribo

guns, however, are very dependent upon the type of powder used because it must be capable of transferring electrons between dissimilar materials in order to charge effectively. This has limited the usage of tribo to specific applications that only use powders formulated for tribo charging.

Powder Finish Quality: The powder finish quality each type gun can apply to an product is also different. Corona guns are very successful in achieving a consistent film build especially with thin film thicknesses. While other parameters such as room environmental conditions, conveyor speeds and powder outputs change, corona guns are capable of making adjustments to meet coating needs very consistently. However, corona guns can develop a very high charging field which actually limits the amount of powder that can be applied and maintain a smooth finish. A phenomena called back ionization occurs when the powder accumulating on the product dissipates its charge through the accumulated powder. The result is what looks like a small crater on the cured finish. Also, with heavy powder thickness, a wavy look considered "orangepeel" occurs. These conditions usually only occur with finishes of 3 mils or more. Tribo guns are not as susceptible to back ionization and orangepeel because the powder particles are charged and no electrostatic field is developed. As a result, tribo guns can develop heavier powder thicknesses with a very smooth finish.

Environmental Conditions: Corona guns tend to be more forgiving than tribo guns in harsh environments. Even though a controlled environment is recommended for all coating operations, occasionally this is not the case. Variances in room temperature and humidity effect the coating performance of both types of guns. Tribo guns are especially effected because as these conditions

change so does the charging effectiveness of the gun. The ability of electrons to transfer from the powder particles to the teflon material varies with changing conditions. This can result in inconsistent coating of the product over time. Because corona charging does not rely on the properties of the materials as much, they are not as effected by variances in environmental conditions.

Uses of Each Technology

Understanding the differences between corona and tribo charging, assists in deciding which technology is best for an application. Each type of charging has typically been used for specific industries.

Tribo charging has typically been used in industries which require epoxy powder or products that have intricate shapes. Insulating products such as electrical equipment that only require a protective coating are prime users of tribo charging guns. This protective coating is generally epoxy due to its tough finish. Also, industries such as wire mesh products, airfoil grills, and radiators are often users of tribo because of the difficult shapes to coat. Tribo charging is capable of coating the intricate corners of many of these parts because an ion field is not present to cause the faraday cage effect or back ionization issues seen with heavy film thickness.

Corona charging has been used in industries where many types of powder are used, where quicker conveyor speeds are required, and where specific film thickness control is required. Custom

coaters use corona guns because of the need for flexibility with different types of powders and the quick color change time. Many industries such as outdoor products and decorative products use corona not only because of the type of powder required but also because of conveyor speed. Conveyors running product at speeds greater than twelve to fifteen feet per minute generally require corona guns in order to coat the product at a reasonable capital investment expense. More tribo guns are required to coat products on conveyors operating at higher speeds. Corona guns can apply powder at high line speeds due to the higher powder output capability, the ion field charging, and wrap capability of the powder particles. Other industries such as appliance and automotive products require very specific film control requirements. Corona charging is capable of doing this at low and high powder output levels and over extended periods of time.

Different types of powder are used with the two technologies. Table 1.0 shows list of different powder types and the type of applicator that can apply it.

Powder Type	**Tribo Gun Applications**	**Corona Gun Applications**
Epoxy	most	All
Hybrid	some	All
Urethane	some	All
Polyester	some	All
TGIC	few	All
Acrylic	few	All
Wrinkle	few	All
Metalic	few	All
Enamel Powders	none	All

Table 1.0

Powder manufacturers are capable of developing powder formulations for many different coating requirements. If there is an application that could be used with either tribo or corona guns, discuss the coating requirements with the powder manufacturer and the equipment supplier to achieve the best results.

New Technologies

Equipment manufacturers have tried many different guns and nozzles to optimize the coating process over the years. However, most new technologies are developed to meet the needs of specific market requirements.

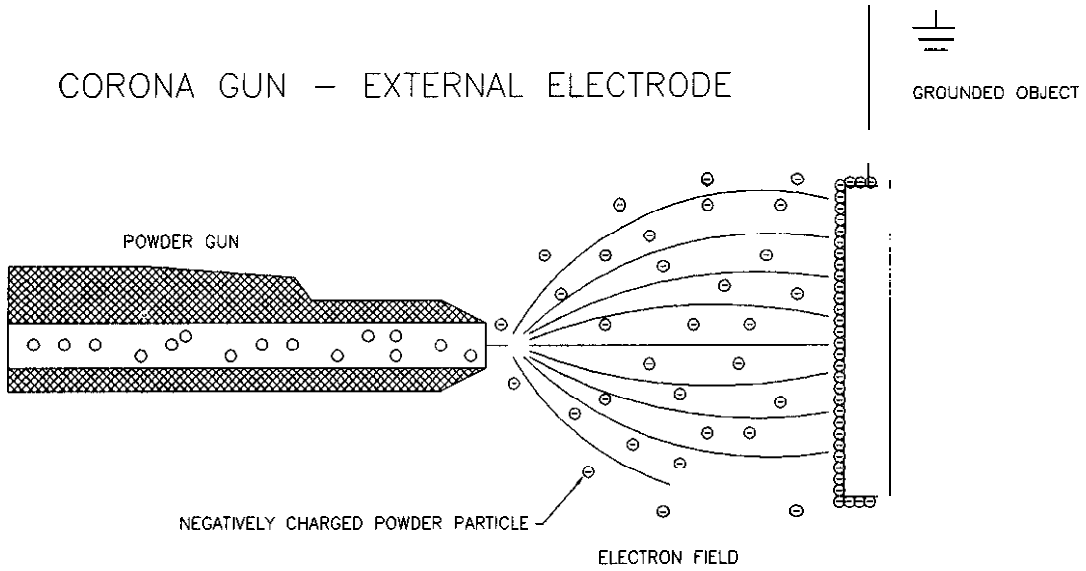
A corona gun technology that has been used in different forms is the grounding ring or sleeve. This grounding ring is usually located either inside or outside the gun at some distance from the electrode and opposite the product being coated. It can be located on the gun itself or an attachment that surrounds the gun. The effect of using the grounding ring with the corona gun is to develop a higher, more consistent current draw from the electrode. This results in two beneficial advantages. The powder can be applied at heavier film thicknesses and without the orangepeel appearance typically associated with corona guns that apply thick coatings.

Several developments in tribo gun nozzles are also available. Flat nozzles with several slots allow powder to exit the gun at lower velocities while creating additional contact points at the exit of the gun to charge the powder.

Nozzles with many flexible discharge points allow powder to be directed into specific areas of the product. Other nozzles that have been used successfully are available to meet specific needs. Tribo guns have the flexibility to adapt many different types of nozzles because no electrode is required in or near the powder stream.

CORONA CHARGING GUNS

CORONA GUN – EXTERNAL ELECTRODE



CORONA GUN – INTERNAL ELECTRODES

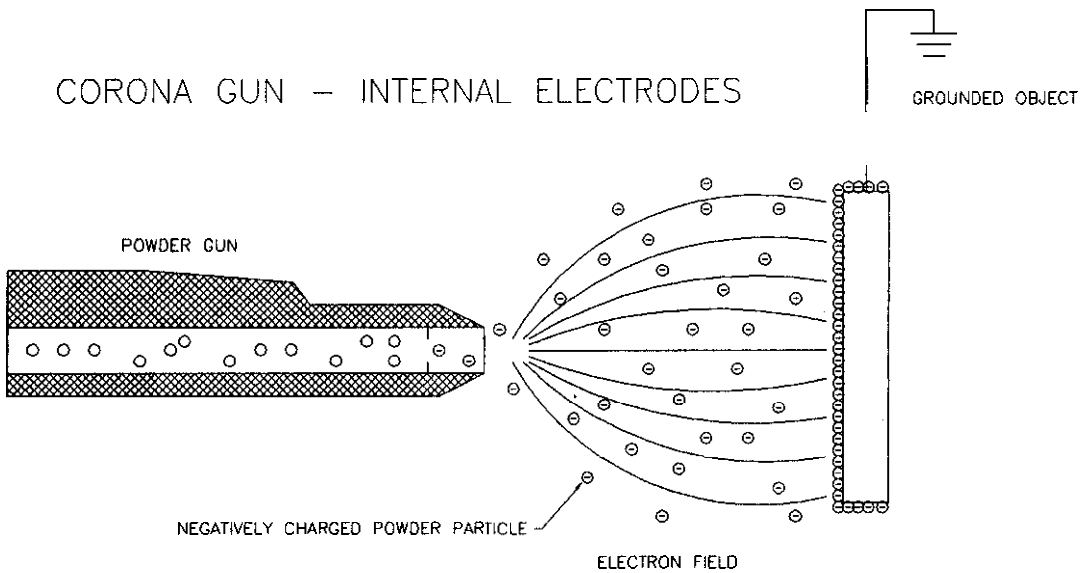


DIAGRAM #1

TRIBO CHARGING GUNS

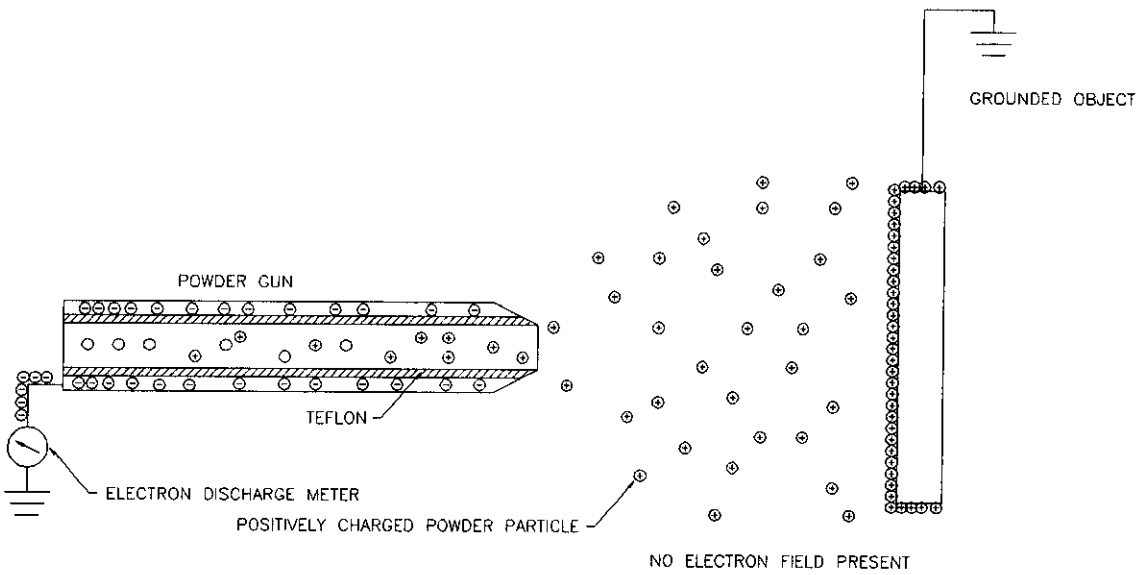


DIAGRAM #2

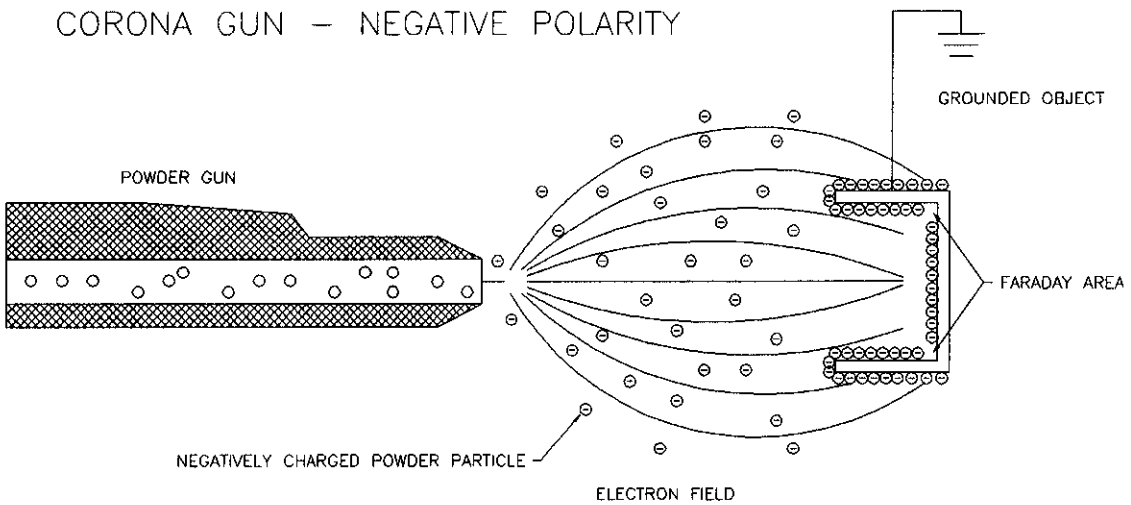
TRIBO CHARGING CAPABILITIES RELATIVE TO TEFLON

MATERIALS LISTED BASED ON THEIR ABILITY TO ACCEPT A POSITIVE TRIBO CHARGE RELATIVE TO TEFLON.

	MATERIAL
STRONG POSITIVE CHARGE	NYLON
	EPOXY
	POLYURETHANE
	EPOXY/POLYESTER HYBRID
	POLYESTER
WEAK POSITIVE CHARGE	PVC

DIAGRAM #3

FARADAY CAGE AREAS



THE LACK OF POWDER IN THE FARADAY AREAS IS CAUSED BY REPULSION OF SIMILARLY CHARGED POWDER PARTICLES AND AIR POCKETS IN CORNERS OF THE PRODUCT.

DIAGRAM #4

Biographic Information: A graduate of ITT Technical Institute, Michael Thies has nearly 7 years experience in the powder coating industry. As Product Development Supervisor for Gema, Mike is responsible for developing and testing new technologies in the powder coating industry.