Flexibility, Productivity And Quality Improvements In Electrostatic Powder Enameling

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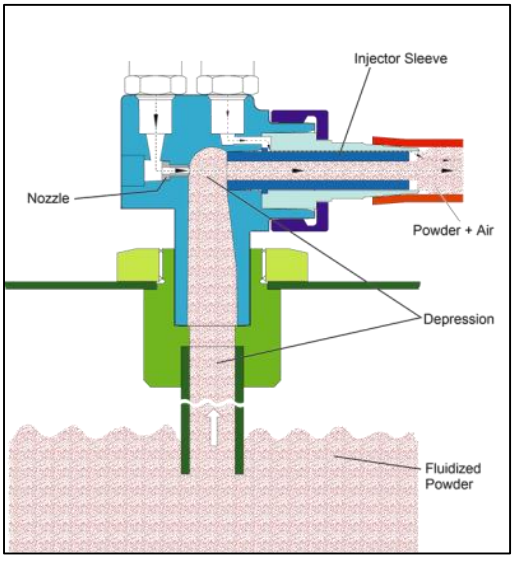
Introduction

Electrostatic Powder Enameling is nowadays a well-known technology that is widely used in many industrial applications serving different end-markets. Since its early appearance its key success factors in comparison to alternative enameling technologies have been the ease of use, the cost effectiveness and the environmental friendliness. On the other side an even wider diffusion of this technology has been slowed down by some limitations in the finishing quality that could be achieved and by the relative rigidity of the most common application systems, that made it difficult to successfully compete in Just-In-Time manufacturing environments where higher levels of flexibility were required.
In this paper we will present a few examples of technology improvements that can overcome some of the above mentioned limitations and open new application opportunities for the Electrostatic Powder Enameling technology. The examples are focusing on the key elements of the Electrostatic Powder Enameling process, in particular on powder feed technology, powder charging technology and powder recovery systems technology.

Discussion

Improvements in powder conveying technology

The most common technology that has been used for decades to feed porcelain enamel powder to the electrostatic guns and within the recovery systems has been the Venturi injector, whose well known operating principle is illustrated below:

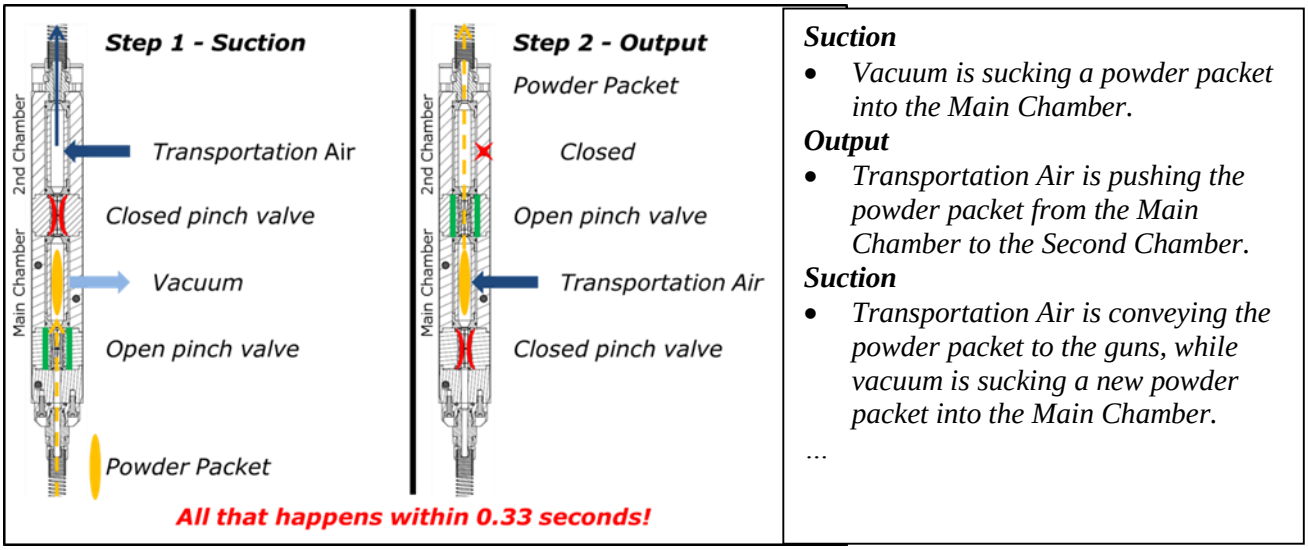


- *Nozzle blows compressed air into the Venturi chamber.*
- *This creates a depression in the Venturi chamber*
- *Depression sucks powder from the fluidized hopper*
- *The powder and air mixture is conveyed to the gun*

Venturi injectors offer undoubted advantages in terms of simplicity, low investment and ease of maintenance. However in particular applications Venturi injectors can show performance limitations, directly deriving from their technology:

- The amount of powder that can be conveyed by the injector is related to the amount of compressed air that is blown by the injector nozzle. The high air volume that is necessary to convey large powder quantities can represent a disadvantage in the application process as it can decrease the powder charging efficiency and the uniformity of the applied powder film. The problem is particularly evident for application into cavities like baking ovens, boilers, etc.
- The high amount of air that is required to convey high powder volumes determines high powder velocity in the hoses and inside the guns. This high velocity of the abrasive enamel powder can determine quicker wear of the systems components, and consequently a decrease in the process performance and higher maintenance and operating costs.

In the last decade new technologies have been developed that overcome some limitations of the Venturi injectors.
We will illustrate the **Smart Inline Technology,** used in the last generation of "OptiSpray" powder pumps by Gema.



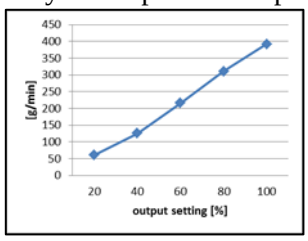
Smart Inline Technology offers significant advantages for the conveying process of enamel powder:

- The powder is transported with a lower amount of air, using smaller transport hoses. The lower powder velocity determines a reduction of wear.

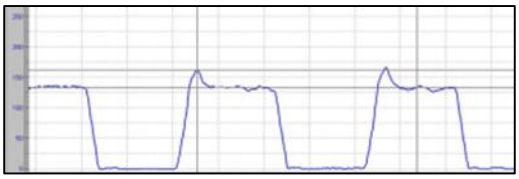
- The powder output is regulated by the duration of the Suction / Output cycles and NOT by the amount of compressed air. The independent regulation of the powder quantity and of the air quantity can facilitate the achievement of better coating results, improved surface quality, higher transfer efficiency.

- The reduction of wearing allows the system to maintain powder output and application performance for long time without human intervention.

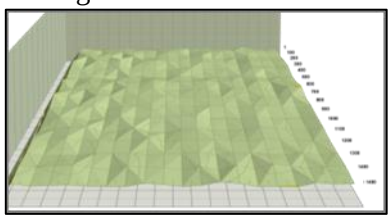
- Easy linear powder output regulations.



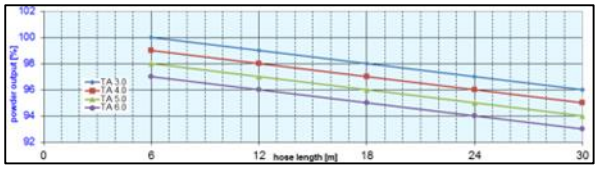
Rapid start / stop reaction time



- Homogeneous film thickness distribution



Flexibility to use different hoses length

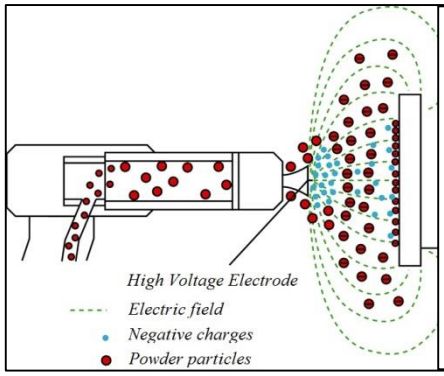


- Very compact design

Easy to integrate into new or existing lines.

Improvements in powder charging technology

In a typical Electrostatic Powder Enameling system the powder application guns use the well-known and proven “Corona” technology.



- A High Voltage Electrode (normally up to 100 kV) emits negative charges and ionizes the surrounding air.
- The free electrons and the air ions transmit the charge to the powder particles.
- The powder particles are attracted by the object to coat (that needs to be properly grounded).

In the practical applications only a relatively small portion of the charges emitted by the High Voltage Electrode really charge the powder thus contributing to the electrostatic application process. The majority of the free electrons and of the air ions do not charge the powder but simply get attracted by the object to coat, preventing further powder from being deposited on the substrate and generating surface appearance damages commonly known as “back-ionization”, “orange peel effect, “starring”, etc.

Over the years different technologies have been developed to reduce the application problems deriving from excess charging. We will illustrate the **Precision Charge Control (PCC)** technology**,** used in the last generation of "OptiFlex" electrostatic equipment by Gema

- The operator sets a "current limitation", defining the maximum current that the electrode can emit.
- When the current limitation is set below 10 micro-ampere, the PCC mode automatically starts
- The electronic components integrated in the gun's control unit continuously monitor and adjust the powder charging to avoid over-charging.

Precision Charge Control technology offers significant advantages in the electrostatic powder charging process:

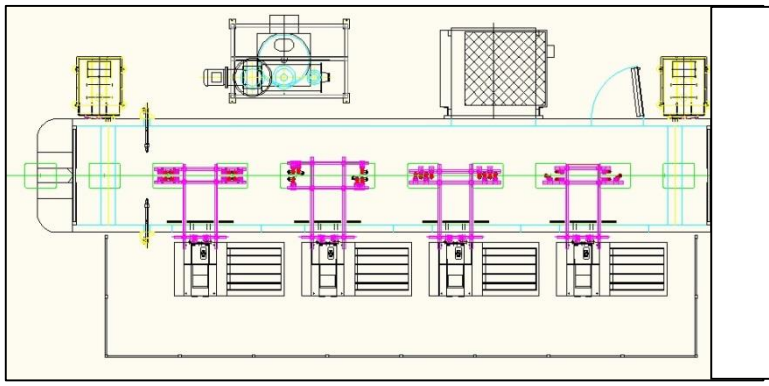
- The improved transfer efficiency and more homogeneous film thickness result in significant powder savings.

- The improved surface finishing quality thanks to the reduction of the back-ionization, orange peel and picture-frame effect reduces reject rates and makes powder enameled products appearance more appealing for many end-markets.

- The technology is very easy to use for every operator. Once identified, the ideal application parameters can be stored the application process can be automated.

Improvements in powder systems concept

For many years Electrostatic Powder Enameling booth systems have been designed primarily for mass production: their aim was to maximize the efficiency and the productivity of lines dedicated to a very uniform range of products, using one enamel powder only with as high as possible line production speed.



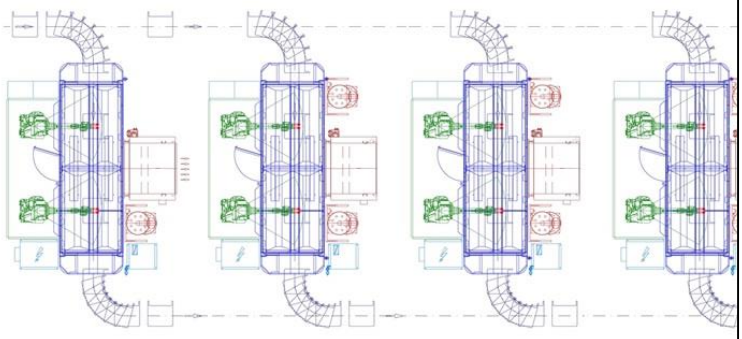
“High productivity” layout

- Single, complex booth for high line speed application, with many guns, axis and application stations.
- Ideal for single model – single powder – high volumes production

This manufacturing philosophy, very successful for many years, appeared outdated more recently as most companies started to face an increasing variety of models for their own products, and the introduction of Just-In-Time manufacturing philosophies required production systems able to produce in smaller batches with quick set-up times.

A clear trend in recent years has seen the replacement of single, high productivity large booth systems with sets of smaller booth systems, each of them equipped with more flexible application and recovery systems, often based on the use of multi-axis robots instead of reciprocators.
This new concept offers several advantages:

- easy switch from one production model to another or from one enamel powder type / color to another;
- improved application quality thanks to the use of more precise and flexible guns positioners;
- improved reliability and availability of the line.



“High flexibility” layout

- Multiple small booths systems, installed in parallel, using flexible application and recovery systems.
- Easy to produce high variety of models with different powder types.

Conclusion

Thanks to the significant innovation efforts that the manufacturers of electrostatic powder enameling equipment and systems have spent in the last years, a number of new technologies are now available that offer greater flexibility, productivity and that can grant significant application quality improvements.
The practical implementation of these new technologies will help remove older obstacles to the development of the Electrostatic Powder Enameling Technology and will facilitate the development of new market opportunities.