



Unmatched Powder Coating Performance

Dense-Phase (HDLV) powder delivery

Performance by design

Nordson

Many powder coating innovations are directed at optimizing charging efficiency of the application system. Historically, the main focus has been on electrostatics and charging system controls. Yet experienced powder coaters know that control of the charging system is not the only important factor in optimizing powder application efficiency and coverage of recessed areas. Aerodynamics is no less important and, oftentimes, can play a major role.

Aerodynamics is Key

To optimize the aerodynamics of a powder application process, several issues must be addressed:

- spray pattern dynamics of an applicator;
- working characteristics of a powder pump; powder-to-air ratio;
- aerodynamic turbulence in the powder deposition area.

Ejector-pumps traditionally are used to transfer powder coatings from the feed hopper to the spray system. However, ejector-pump technology has hindered further improvements in efficiency of powder coating systems, since it requires an excessive volume of air to deliver powder. In recent years some improvements have been made in the design of conventional venturi pumps. Yet, they've produced only marginal gains in spray application efficiency. Fortunately, another technology is available that significantly improves:

- overall powder application efficiency;
- coverage of difficult geometries and recessed areas;
- applied coating cost control;
- speed and quality of changing color in a powder coating system;
- powder recovery efficiency.

High Density Low Velocity Technology

The efficient powder application technology from Nordson. At its core, is a remarkable method of delivering powder coating from the feed hopper to the spray nozzle of an applicator. HDLV® (High Density Low Velocity) powder pumps of the Encore® HD spray system break through the limitations imposed by traditional ejector-pumps. To better understand the advantages of this revolutionary technology it is important to review, and fully understand, the shortcomings of traditional methods. Consider the different powder coating application environments illustrated in **Figure 1**.

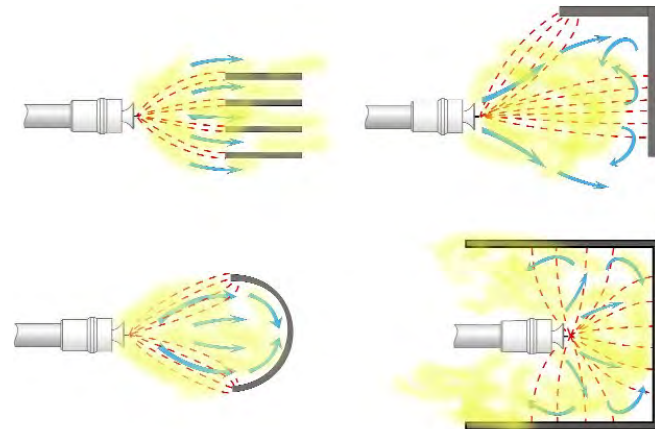


Figure 1

Each product shape shown represents a powder coating challenge. The picture of the electric field and airflow dynamics are very different in each illustration. Electrostatics can be successfully managed through the use of variable load lines of the charging system (Select Charge® technology) and current limiting. However, optimization of coating efficiency in all four cases is more heavily dependent on the ability to manage aerodynamic forces in the

coating deposition area than on the electrostatic system operation (assuming the powder is adequately charged).

Let's look at a typical powder coating application system using an ejector-pump (**Figure 2**).

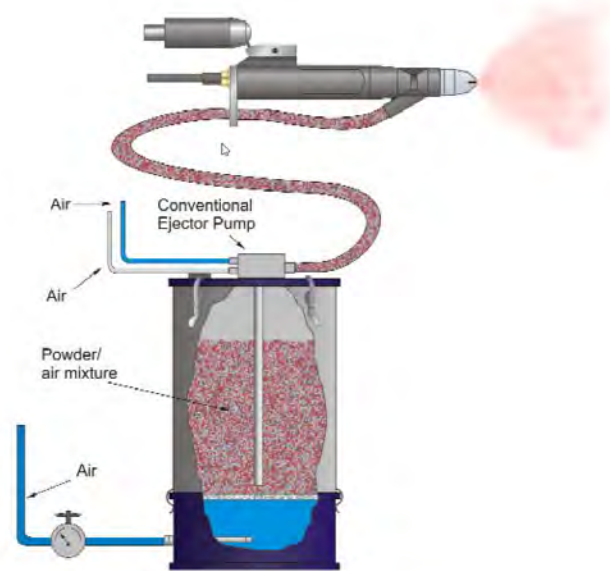


Figure 2

Compressed air is used to:

- fluidize powder in the feed hopper and make it suitable for pumping;
- create negative pressure inside the ejector-pump, draw powder/air mixture into it, and propel the powder/air mixture into the hose;
- keep powder fully atomized while traveling through the hose and gun, to prevent an unstable supply.

The downside is that all the air added into the system to ensure consistent powder delivery, must exit through the spray nozzle of an applicator. Provided that most conventional spray nozzles have a fixed-size opening, air used to deliver powder to the nozzle also shapes the spray pattern and defines the aerodynamics of the spray application process.

With conventional ejector-pump technology, the task of delivering powder from the feed hopper to the spray nozzle cannot be separated from the task of shaping the spray pattern and optimizing the aerodynamics in the powder application zone. Thus, we are limited in our ability to independently optimize powder output and the aerodynamics of the spray pattern.

And the matter gets progressively worse as one tries to increase powder output. **Figure 3** illustrates the typical working characteristic of an ejector-pump – the so-called “pump curve”.

It's easy to see that at low powder flow rates, the slope of the curve is rather steep and more or less linear. When operating at point A of the curve, an increase in powder output of ΔQ would require an increase ΔV_1 in the volume of dozing air.

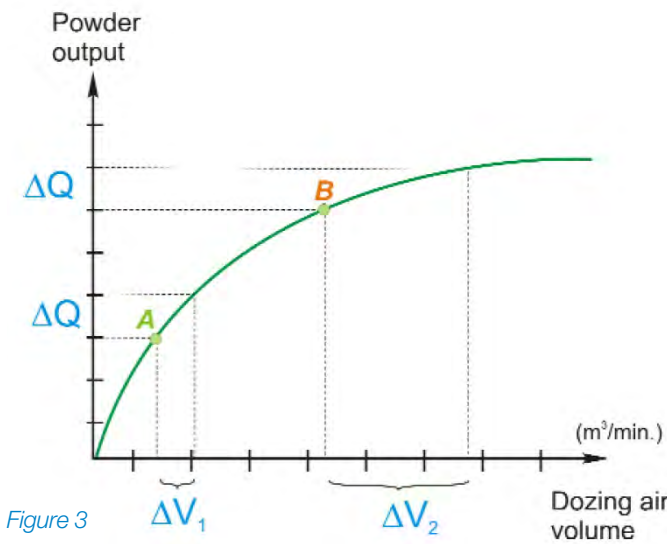


Figure 3

As powder output increases, the pump curve flattens and each consecutive increase in output requires a progressively greater increase in air volume. At point B of the curve, the same ΔQ powder volume increase demands an air volume increase of $\Delta V_2 > \Delta V_1$. This dramatic increase in air volume can have a significant negative impact on application efficiency of a spray system due to increased spray pattern velocity.

To gain full control over spray pattern velocity, we must first find a way to break through our dependence on air and find a way to deliver powder to the spray applicator's nozzle with minimum air volume. This is accomplished with HDLV pump technology (**Figure 4**).



Figure 4

A detailed explanation of how this HDLV pump works would take too much space in this article. The easiest way to understand its principle of operation is to imagine a two-cycle engine – two cylinders working counter-phase of each other. Only instead of pushing the engine pistons, the cylinders expel powder with a very small volume of air – just enough to empty the cylinder. And most importantly, no moving parts that can get clogged with powder. The powder requires only slight fluidization, is drawn into the cylinders by vacuum, and expelled from them into the delivery hose with only the slightest positive pressure. Powder travels through the hose to the spray gun in virtually a solid stream with absolutely minimum air.

Even the powder delivery hose is different. The absence of air eliminated the need for large-diameter hoses. Even high volumes of powder (in excess of 400 g/min) can be delivered as a high-density stream through a tube with the internal diameter of 6 mm.

With HDLV technology, the powder-to-air ratio inside the delivery hose is several times higher than with conventional ejector-pumps. If powder output needs to be increased, it's achieved not by adding more air, but rather by increasing frequency of the pump cycles. Thus, the pump curve of an HDLV pump is linear, and the powder-to-air ratio does not change with the output.

What about the spray pattern? We've managed to deliver powder to the spray applicator virtually without air, but can we achieve a spray pattern of the desired size while keeping total air volume to a minimum?

To take fullest advantage of this powder pumping technology, Nordson developed the Encore HD powder spray systems. In addition to the HDLV pumps, the Encore HD systems feature:

- Innovative spray nozzle designs that allow for effective shaping of the spray pattern with minimum air volume
- Spray applicator design in which a controlled volume of spray-pattern shaping air can be added directly to the spray nozzle.

Figure 5 shows the components of a Encore HD spray system. To enable effective control of the spray pattern size, velocity and uniformity, pattern air is added (routed through the spray gun) to the very tip of the spray nozzles.

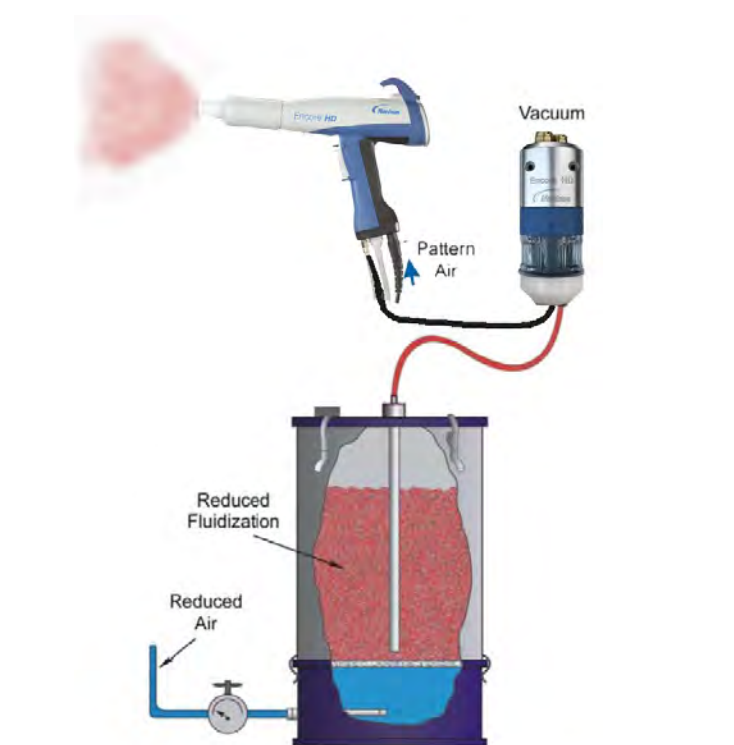


Figure 5

As already mentioned, the HDLV technology allows us to control spray-pattern parameters totally independent of the powder delivery system. Unique, soft-spray patterns are achieved this way with the total air volume in the spray nozzle significantly lower than what is observed with conventional spray systems.

The soft, flexibly controlled spray patterns combine with Nordson Select Charge technology and advanced powder charging controls, to deliver the powder deposition efficiency and recess coverage unattainable with earlier-generation spray systems (**Figure 6**).



Figure 6

Another major benefit of the Nordson HDLV dense phase technology is greatly enhanced control of applied coating thickness. In most powder coating operations, the cost of applied coating is the major overall operating cost component. With conventional ejector-pump technology, wear of the pump's internal components strongly affects powder output rate. It's ironic that results of engineering efforts invested to develop advanced digital spray system controls (intended to minimize variances in applied coating thickness) can be significantly hindered by wear of one of the smallest and rather primitive spray system components – the ejector-pump insert.

Even with the constant and tightly controlled air supply to an ejector pump, wear of the pump's internal component will result in a gradual but significant reduction in powder output. To compensate, a savvy powder coater periodically would have to manually adjust the control system to compensate for pump wear. Without such adjustments, a powder coater will likely operate at higher-than-needed powder output rates that will result in greater operating costs.

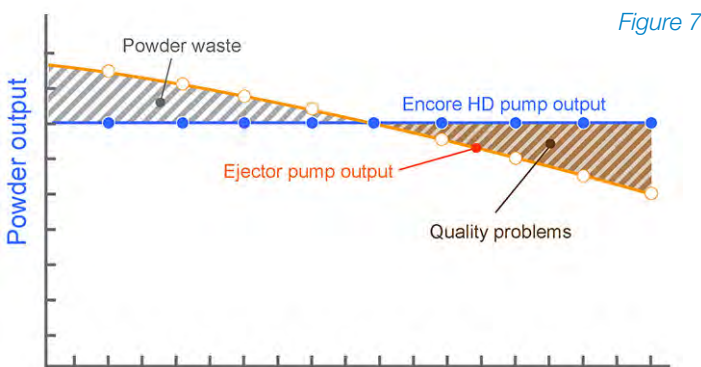


Figure 7

HDLV Technology solves the problem. HDLV pumps have no wear parts that affect powder output. Therefore, applied coating thickness can be controlled very tightly without the need for frequent manual adjustments of system parameters. **Figure 7** shows the difference in powder output of an HDLV pump compared to an ejector-pump as a function of time.

As stated earlier, powder application efficiency, excellent recess penetration, and very tight process control capabilities are not the only benefits of HDLV technology. Unmatched ease of color change is another crucial benefit.

Three factors greatly facilitate ease of color change with Encore HD:

1. Solid-phase powder pumping technology virtually eliminates impact fusion inside the powder delivery system (pump, delivery hose, internal spray applicator components), making purge-cleaning easy and reliable
2. The pump has a built-in purge function that allows powder coaters to automatically purge the pump, powder delivery hose, and powder path of the spray applicator in a matter of seconds
3. The unique powder path and spray nozzle design of Encore HD spray systems are streamlined and void of powder trapping seams.

These three factors combined produce a system that delivers exceptionally fast color change time. With Nordson Color-on-Demand automatic color change module (**Figure 8**), the whole spray system can be purged and spraying another color in as little as 18 seconds without any disassembly. With a slightly lesser degree of automation, an operator simply moves the pick-up tube



Figure 8

of a pump from one hopper to another – for a 30 second color change.

Can there be more benefits from this breakthrough technology? Yes. Nordson HDLV technology improves powder recovery efficiency of cyclone-based powder booths due to HDLV high-capacity, bulk transfer powder pumps shown in **Figure 9**.

There are two parts of a typical cyclone-based powder recovery system where powder losses can occur – the cyclone itself and a powder screener (typically vibratory) to which powder is transferred from the cyclone for sieving and reuse.

Inside a cyclone, additional powder losses can result if reclaimed powder is allowed to accumulate at the bottom of the cyclone in a 'transfer hopper'. To avoid losses, reclaimed powder must be removed promptly from the cyclone.

HDLV pumps use vacuum to actively draw powder from the bottom of the cyclone and significantly reduce the risk of powder accumulation there. Additionally, the pump creates negative pressure in the bottom of the cyclone, increasing cyclone efficiency.

Since absolute minimum air is used for powder transport, high-capacity HDLV pumps eliminate the risk of over-pressurizing the vibratory screeners to which powder is transferred from the cyclones. Over-pressurization of the screeners (common with other traditionally used powder transfer methods), reduces throughput and powder losses because of the need to vent excessive volumes of air. HDLV eliminates these problems.

Innovative Nordson Encore HD and HDLV technologies have begun a new era in the powder coating industry. Both manual and automatic spray systems featuring this technology offer powder coaters the recess coverage, coating efficiency, and color-change speed unmatched with earlier finishing solutions.



Figure 9

Nordson Industrial Coating Systems

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