Improving Liquid Spray Transfer Efficiency

Increasing transfer efficiency reduces waste and yields lower costs and a cleaner environment . . .

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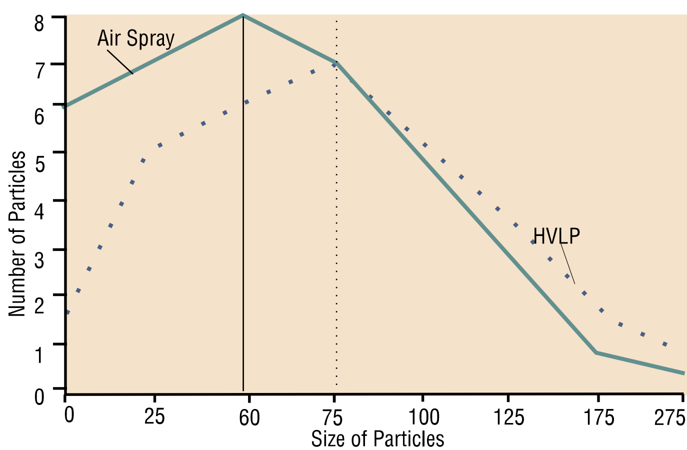
Transfer efficiency is defined as the weight of coating gained on a sprayed part compared to the weight of coating not sprayed on the part. This is usually expressed as a percentage relating to weight gained over weight sprayed. As an example, if an operation is 30 pct transfer efficient, then 30 pct of the total material ended up on the part and 70 pct was lost to the booth, overspray and other factors.

Why is transfer efficiency so important? Cost and waste. Any material that does not coat the part is waste. Overspray could end up in the filters, on the floor, booth walls, hangers, or anywhere, but it is not on the part. Clean-up represents additional cost that is added onto the cost of coating materials. The secondary cost of this clean-up typically exceeds the initial cost of the material. If the waste is hazardous, clean-up costs may be outrageous.



1. ATOMIZATION PROCESS for HVLP

The more material you use, the greater the output of VOCs to the atmosphere. Increasing transfer efficiency can decrease the overall quantity of material used and thus decrease the total VOCs emitted.

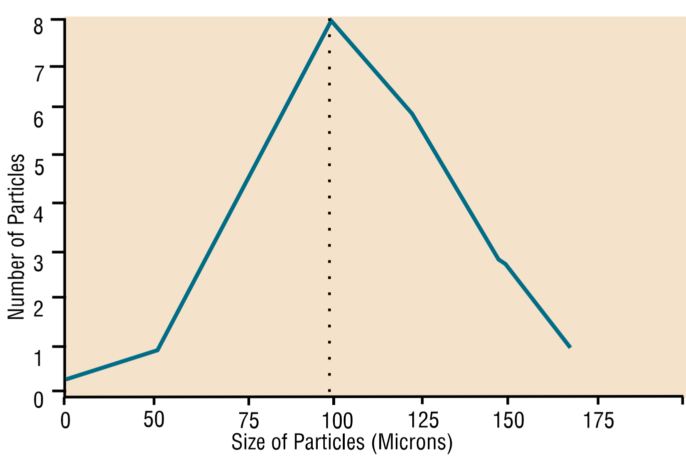
Atomization. In liquid spray coating, there are some atomization basics relating to transfer efficiency. Atomization is a factor of energy transfer. It takes energy to break up the coating into small droplets. There are three basic atomization methods: 1) Air spray; 2) Airless spray; and 3) Rotary atomization.

Air Spray. Air atomization occurs when air energy, in the form of pressure and volume, are directed against a fluid. The physical factors of fluid volume and fluid viscosity (thickness) determine the amount of energy needed to obtain a desired atomization level. Additional fluid volume and/or a heavier material will require more energy to atomize. As a rule, the more energy applied in an atomizer, the lower the transfer efficiency.

A typical picture of an air spray gun features clouds of overspray around the part. Generally, the amount of overspray is related to the air pressure used at the gun. It is typical to see spray guns operating at pressures of 70-90 psi and corresponding volumes of overspray generated.

The air atomization process, because of its mechanism of air/fluid interface, atomizes coatings with a wide diversity of particle sizes. As the air energy increases, the atomized particles become smaller. Particles 20 microns and smaller tend to become airborne and create overspray.

Air spray tends to over atomize the majority of the coating when the applicator is not set up properly. Controlling air energy allows for control of air atomizer efficiency. As an example, an air spray gun running at 70 psi air pressure can yield approximately a 10 pct increase in the transfer efficiency by reducing the air pres-



2. ATOMIZATION PROCESS for Airless/Air-Assisted Airless

sure from 15-20 psi (20-25 pct) to 50-55 psi (Fig. 1).

HVLP. High-volume, low-pressure is a form of air atomization that controls the air energy to a limited level. Typically, HVLP is defined as atomization at a maximum of 10 psi at the air cap. In air spray, a reduction in air pressure (energy) will yield an increase in transfer efficiency. HVLP limits the pressure allowed for atomization, and, while specific guns handle the low-pressure air better than a standard air spray gun, it achieves better efficiency. HVLP can typically yield a doubling of the transfer efficiency achieved with any air spray product.

Obviously, if the air energy is reduced, then either the quantity of fluid output or the fluid viscosity must be lowered to achieve the same level of finish quality. The lowering of these performance criteria is the key to increasing transfer efficiency for HVLP spray.

With air spray the operator controls the energy, which is essentially unlimited. Therefore, it can be over atomized easily in the name of increased production requirements. HVLP puts limits on this atomization energy, reducing the high level of small particles generated and obtaining high transfer efficiency while maintaining all the operator flexibility and control.

Unfortunately, reducing atomization energy is contrary to the trend of materials today. Solvents are being limited, and the viscosity of many materials is increasing. The result is a somewhat slowed production capability. This reduced capacity is somewhat offset by the increase in efficiency, but the HVLP process is somewhat lower in production capability than normal air spray.

Airless. Another method of liquid atomization is airless or hydraulic atomization. This differs primarily from air atomization in that the energy is put into the coating via pressure, and the atomization occurs when the fast-moving coating reacts with the atmosphere. High fluid pressure (2,000-3,000 psi) is generated and forced through a small orifice that forms the coating into a sheet. This sheet of liquid reacts with the atmosphere to cause a folding/oscillation of the sheet and eventually the break-off of liquid droplets. High fluid pressures are required to obtain a full, complete pattern.

The resulting atomization is somewhat coarser than air spray or HVLP, but the droplets or particles move at a high velocity and the fluid delivery rate is high. Because of this, the airless atomization method is typically used on large surfaces that require high-speed coating and where finish quality is not important. Transfer efficiency is high in this application, since particles have a high directional velocity and the targets are large. If used on smaller objects, the higher fluid delivery rates cause operator handling difficulties and efficiency suffers. Airless also produces a small number of small particles, thus overspray is low. Airless efficiency is similar to that of HVLP because of the reduction in the fog due to over atomization.

Air-Assisted Airless. Atomization does not get appreciably better after about 1,000 psi, but the pattern is not completely formed. An air cap is used to provide an additional energy source to cause pattern completion. The result is an airless spray at a reduced pressure. This gives a reduced particle velocity and lower fluid delivery rate. Gun operation is easier, and efficiency is better than pure airless. Efficiency is usually equal to HVLP with better production capabilities. Finish quality is better than airless, but not quite as flexible as air spray. This tool fills the gap for products that are large enough to require a large amount of material and high production rates, yet need a high-quality finish.

Rotary. This is a special atomization method typically used in automated finishing. The basic form is a rotating disk or plate on which material is placed. Due to centrifugal force, the coating is forced to the edge where it atomizes as it leaves the disk. Because the energy formed is relative to the rotational speed of the disk, atomization is consistent. Due to the radial/spiral path of particle flight, particle velocity is quickly reduced. The low velocity and controllable particle size optimize the capability and efficiency of this method. Efficiencies in excess of 90 pct are achievable.

Electrostatics. Electrostatics can be applied to any form of atomization. It is simply charging coating droplets with an electrical charge. Typically, this is done by emitting electrons while the coating is atomized. The electrons attach themselves to coating droplets, giving them a potential charge. When a part is sufficiently grounded, the particles act as magnets and are attracted to the part. The result is that much of what was lost to overspray in non-electrostatic applications lands on the part. Capturing the potential overspray results in greater transfer efficiency. Air spray, because of its over abundance of overspray, benefits the most from electrostatics. Air spray can go from 30 pct to 65 pct transfer efficiency with the use of electrostatics.

The key to using electrostatics is particle size and velocity. The smaller the particle and the slower it moves, the more the electrostatics affect particle direction. In all cases, efficiencies of greater than 60 pct are possible with any form of atomization.

Energy Control. Transfer efficiency is increased by controlling small particles or over atomization. Maximizing the quantity of energy required improves overall efficiency.

One way to control the operation is to reduce fluid viscosity without adding any solvent. Controlling (reducing) the fluid viscosity (thickness) can yield a reduction in energy required to cause atomization. Heat is commonly used to reduce the viscosity of solvent-borne materials. All material viscosities are somewhat reactive to heat. A material should be tested to establish its “thermal reactivity” and the results used to effectively apply a fluid heating system. It is not out of the question to have a material outside normal sprayable ranges at ambient temperatures be easily sprayable at 120-140F. Any method that lowers the energy required for atomization will result in better transfer efficiency.

Increased transfer efficiency in a spray environment is critical to waste reduction. Transfer efficiency will reduce the quantity of material used. This reduction can mean less waste generated, lower overall VOC generation and a healthier environment.

Transfer efficiency is controlled by controlling the energy used for atomization and overspray, if it is generated. The proper atomization tools, setup, and use of application tools are critical to maximizing transfer efficiency.

Users of atomization equipment must know and understand the tools they have to use and the materials they are working with. Increasing transfer efficiency equals waste reduction and yields lower cost and a cleaner environment. **PF**

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