Paint application using airless equipment is, and has been for many years, the method of choice for large industrial painting projects. Although the industry is aware of the differences in the equipment from various suppliers, some of the basics of airless application common to all equipment manufacturers are not being effectively communicated to applicators. It is important to the quality and economics of the project that everyone understands and pays attention to these basics.

There are four areas that demand better attention by applicators and paint manufacturers. These are:
1) Worn spray tips,
2) Excessive application pressure,
3) Proper tip selection, and
4) Variability in applied film thicknesses.

A number of factors, including tip selection, application pressure and applied thickness variability can affect the quality of an airless spray application job. Courtesy of Graco Inc.

Editor’s Note: This Applicator Training Bulletin is an update of an article written by Gary Tinklenberg of Corrosion Control Consultants & Labs, Inc. (CCC&L) that originally appeared in the June 2001 JPCL. It was updated for this issue by Graco Inc.
Worn Spray Tips

Nothing will waste more paint in less time than a worn spray tip. Most specifications require the painter to apply the coating to a minimum dry film thickness (DFT). Worn tips increase the average DFT by affecting the uniformity of the applied paint film. Worn tips also affect quality.

A tip is completely worn out if the spray pattern is round. The easiest way to understand the dynamics of a tip is to think of the round pattern being the result of spraying the paint through a circular hole. A proper spray pattern is elongated. This is achieved by squeezing the metal on two opposing sides of the circular opening. The more it is squeezed, the flatter the fan, hence the wider the spray pattern.

In actuality, there are two little “wings” of metal that are used to “squeeze” the fan. The spray pattern becomes rounder and rounder as these pieces of metal are worn away by the abrasive action of the pigments in the paint. As the opening becomes rounder, the paint is deposited on the surface too quickly to control, and the resultant application is usually unacceptable.

However, long before the “wings” are completely worn away, the tip or nozzle will stop depositing a uniform amount of paint across the entire fan width. The amount of paint in the center of the fan increases. If the fan is not uniform, applied DFT variability increases and more paint is needed to achieve the minimum DFT.

There is a very simple test to determine if a spray tip is worn. Take a piece of cardboard (or any smooth surface) and mount it in a vertical position. Holding the spray gun as steady as possible and in a position to create a horizontal pattern on the surface, apply a short burst of paint. Obviously this will result in an excessive amount of paint being applied, and the paint will drip or run down the surface. Examine the drip pattern. If the drips are all uniform, evenly spaced and of equal length, the tip is satisfactory. If the drips are longer in the center of the pattern, the tip is worn and should be replaced. This very simple test should be performed at least daily.

Why is it that something so easy and cost-effective is not part of many professional painters’ routines? The answer is simple. Sometimes the true cost of a job is forgotten. Too much importance is placed on the cost of equipment rather than on the cost of paint and labor to apply it.

First let’s consider the cost of paint. Once the surface is blasted, it generally needs to be painted as quickly as possible. However, worn spray tips can easily result in an average applied DFT of 25 microns (1 mil) greater than a coating film applied with new tips.

This problem can result in the application of as much as an extra gallon (3.8 liters) of paint to every 500–800 square feet (46–74 square meters) of surface area, depending on the volume solids of the paint and the configuration of the surface. The cost of wasting this much paint could certainly pay for a new tip.

Excessive Application Pressure

Most applicators are aware that low pressure in spray equipment can cause problems, but they are not aware or do not believe that high pressures can also cause problems. It is rare to see applicators adjusting spray pressures as a matter of routine, even when starting a new project with a new paint. But too much pressure can be costly and can affect quality.

The proper pressure is affected by several variables, including temperature, paint viscosity, batch-to-batch variability, hose length, and resistance to flow. Since it is impossible to know the consequences of all these variables each time paint is applied, a simple field method is needed to arrive at the proper pressure. If there is insufficient pressure, the spray pattern will result in “tails” (Fig. 3). A “tail” pattern is evidence of an incomplete fan. In other words, as the spray gun is moved through a normal stroke, there is a line of paint at the top and bottom of the spray pattern that is separated from the rest of the pattern. If tails are present, the pressure must be increased to the point where the tails disappear.

Again the question must be asked: why is something so simple not a part of a typical painter’s daily routine? There are several reasons, but the most important is that the consequences of higher than necessary pressures are not completely understood.

One of the important characteristics touted by the manufacturers of airless spray
equipment is its improved transfer efficiency compared to conventional spray, as noted in “On the Differences Among Spray Systems,” JPCL, July, 1999. Transfer efficiency refers to the percentage of sprayed paint that actually sticks to the surface. However, transfer efficiency is reduced by excessive pressure. The paint has excess energy when it reaches the surface, causing it to bounce off rather than stick to the surface.

Excessive pressure wastes paint and increases tip wear, the problems of which have already been discussed.

High spray pressure also increases the prevalence of dry spray by partially drying the paint droplets before they reach the surface. Dry spray, in turn, can result in poor film formation because the coating will not be smooth and continuous. When this happens, the dry spray needs to be sanded out, and a new layer of coating applied. The cost can be very high.

Setting the proper pressure seems so easy, but it is so often ignored. An applicator can simply turn the pump to the maximum pressure and spray. It will work — not ideally — but it will work. Dry spray is one of the most common coating defects encountered with spray application, and it is one of the simplest things to correct.

Proper Tip Selection

The proper tip is determined by the viscosity of the material, the size of the object to be painted and sometimes the particle size of the raw materials used to produce the paint.

However, before proper tip selection can be discussed, it is necessary to discuss how tip sizes are designated. There are two important characteristics to airless tips. The first is the orifice size of the tip. This represents the diameter of the hole if it were a perfect circle; thus, the larger the orifice, the larger the hole in the tip. The second is fan width. Different manufacturers use different methods of denoting fan width. In some cases the fan width is designated by the angle of the material as it exits the tip. A 20-degree fan is quite narrow, while an 80-degree fan results in a wide pattern. A tip designated as 4-19 would be one with a 40-degree fan and a 0.019 thousands of an inch orifice.

One of the first rules in tip selection is that the thinner (lower viscosity) the material that is to be applied, the smaller the orifice size needed. According to equipment manufacturers, the best rule is to use the widest fan and the smallest orifice size that is practical.
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The size of the object being painted must also be considered when selecting a tip. On a project in a fabrication shop, for instance, a crew was painting steel components fabricated from 3-inch by 3-inch (7.5-cm by 7.5-cm) angle iron. They were using a 50-degree fan. When asked why, their response was very simple: “It’s what we always use, and besides it’s all we got.” This tip resulted in the use of about two gallons (7.5 litres) of paint and about 10 minutes of labor per component. But most of the paint was being sprayed into the air due to the length of the spray pattern. Obviously, reducing the fan width to a 10- or 20-degree fan could have reduced paint waste and consumption by at least half. (It is interesting to note that, in this case, the fabrication shop could have further reduced its waste and saved money by using conventional application methods. The cost of the paint wasted by using airless spray was more than the cost of the additional labor required by the use of conventional equipment.)

Finally, sometimes the paint itself has particles of sufficient size that require spray tips with a minimum opening size. Opening size is different from orifice size. The actual opening of an airless tip is in the shape of an eye. The orifice size is the width of the eye (the x direction). The height of the eye determines the fan width. The smaller the height of the eye, the longer the fan pattern will be. Think of it as simply squeezing the same size round pattern as previously described. Sometimes, it is possible to solve plugging problems due to particles in the paint simply by reducing the fan width, since the opening did not have to be “squeezed” as tight. Given the same size orifice, the narrower the fan is, the larger the actual opening.

Variability in Applied Film Thicknesses

Airless spray frequently results in coatings applied with more variation in thickness than allowed in product data sheets. This problem can be addressed in two ways. First, users must become aware of normal film thickness variation; second, the product data sheets must list achievable limits.

Today’s coatings are being formulated to lower volatile organic compound (VOC) content. This often results in higher volume solids. At the same time, information on film-thickness tolerance on product data sheets has not necessarily changed.

This example provides a good explanation. A project stipulated that the material be applied in accordance with the manufacturer’s product data sheet, requiring the 65% volume solids coating to be applied at 40–65 microns (1.5–2.5 mils) DFT. The
owner assumed these were a minimum and maximum and insisted that the applicator meet this “requirement.” This was a very large project and the only practical way to apply the coating was with airless equipment. With the airless equipment used, the minimum applied DFT to achieve hiding of the surface was actually 50 microns (2 mils). Therefore, 50 microns became the minimum, not 40 microns (1.5 mils). At 65% volume solids, the minimum applied WFT would be 75 microns (3 mils). Using 75 microns as minimal WFT and a variation of 50 microns WFT, the overall range is computed as 75 to 175 microns (3 to 7 mils), or 125 ±50 microns (5 ±2 mils).

Thus, the expected applied variation in DFT based on 65% volume solids is 50 to 115 microns (2 to 4.5 mils), where DFT= % volume solids x WFT.

A reading of 125 microns (5 mils) would be common given complicated shapes. This is the best that can be expected! Even under the best of conditions, an applicator cannot apply coatings to a maximum variability of only 10 microns (0.5 mils) DFT from the average, as was required by this example. This conclusion is based on a review of lab data both from paint companies and from independent labs.

Coatings manufacturers and owners must realize that while the percent solids by volume of paints has been increasing, the ability of applicators to maintain ±50 microns WFT — at best — has not changed. Manufacturers must provide realistic thickness ranges on product data sheets and owners must have realistic expectations for the ranges in the field. Increased volume solids also means that coating application by airless spray has become more exacting and applicators must be aware.

Conclusion
The quality and economy of airless spray application can be improved by attention to the equipment and properly setting the spray pressures. Proper tip selection, pressure setting and early replacement of worn tips will reduce paint waste and spray gun clogs, and result in a more uniform application. More realistic ranges for coating thickness must be established with the newer, high-solids coatings.
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