

How Spray Operators Impact Application Efficiency

When well-trained technicians operate the spray guns, finishers see improvement in application efficiency.

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The efficiency of a coating operation is the function of a number of variables. One process variable often neglected, overlooked and/or undervalued is operator training. Spray operators are typically responsible for the setup, operation and maintenance of application equipment. Consequently, operator education and performance play a significant role in application efficiency. Unfortunately, many businesses are reluctant to invest in spray technician training even though it can have a significant and direct impact on production costs and environmental regulatory burden.

Conducting a study

The effect of technician training on application efficiency was the focus of a recent Iowa Waste Reduction Center study. During the course of the project, painters were invited to the IWRC Applied Research Facility and received approximately 4 hours of informal training on spray equipment and technique. To assess the program's impact, painters were instructed to finish a set of six test panels before and after training using industrial coating-application equipment and materials provided by the IWRC.

Spray-application equipment used for the study included a Graco Delta Spray HVLP gun fed by a pail-mount diaphragm pump. Because of the viscosity of material to be sprayed and the desired fluid-delivery rate, the spray gun was fitted with a 0.110 fluid nozzle/needle/air cap combination. For consistency, IWRC personnel set up the spray gun for each technician participating in the training. Fluid pressure was set at 10 to 12 psi at the pump. This produced a fluid-delivery rate of approximately 5 to 6 ounces per minute from the gun when fully triggered. Atomizing air pressure was set at 45 to 50 psi at the pump regulator. This produced 8 to 10 psi of atomizing air pressure at the gun's air cap and atomized the coating sufficiently to produce an acceptable finish.

Unreduced Sherwin-Williams Kem 400 white alkyd enamel was sprayed during the study. This product was selected because of its fast-drying characteristics and suitability for a large number of industrial applications. After thoroughly mixing the product for spraying, IWRC personnel measured and recorded paint viscosity. A 2- to 3-milliliter sample was also collected before and after the training sessions to obtain a percent solids determination on the product sprayed. Throughout the study, the viscosity and percent solids of the coating remained relatively constant. The viscosity measured approximately 18 to 20 seconds on a #3 Zahn cup while the percent solids of the material was determined to be approximately 49% by mass.

Flat test panels measuring 16.5 by 12.5 inches and constructed of 1/16-inch aluminum were used as targets. Prior to painting, each panel had been etched, cleaned and labeled with a unique identification number. The set of six panels was then presented to the spray technician, providing a total surface area of approximately 8.6 square feet. The precoating mass of each panel was also measured and recorded to the nearest tenth of a gram for subsequent transfer efficiency (TE) calculations.

During the first session, designated as the pre-training session, panels were sprayed prior to receiving any significant training on spray technique or use of the equipment. However, before beginning the pre-training panels, technicians were allowed to finish practice panels until they became comfortable with the equipment and coating. Technicians then finished the pre-training panels to their satisfaction.

At the conclusion of each participant's pre-training session, IWRC staff reviewed the basics of good spray technique and equipment operation. This included a review of training videos, hands-on instruction and the opportunity to practice training concepts on a number of practice panels. After becoming comfortable with the training concepts, each technician was instructed to finish a set of post-training panels.

For each spraying session, a Micro Motion Elite flow-metering system was used to monitor and record the amount of material sprayed by the technician. The Micro Motion metering system provides highly accurate flow-measurement data on a mass and volume basis, making it an ideal tool for TE studies. Additionally, the Micro Motion metering equipment provides information on the density, temperature and fluid-delivery rate (on a mass or volume basis) of the material sprayed. Information recorded by the meter also allowed IWRC staff to provide each technician with immediate feedback on the amount of material used to finish the panels.

After curing, pre- and post-training panels were again weighed to the nearest tenth of a gram to determine the mass of coating deposited on each part. Finish quality was also evaluated through visual inspection. In an effort to quantify appearance defects, flaws (classified as either major or minor) were counted and recorded.

To assess film-build efficiency (FBE), 10 dry-film thickness measurements were collected at two-inch intervals diagonally across each panel. The average mil build for the entire set of panels was then determined and compared to a target film build of 1.75 mils. By dividing the average film build by the target film build, a percentage FBE was obtained (i.e., a 100% FBE represents a film build of 1.75). Based on observations and dry-film thickness measurements, a film build of 1.75w0.25 mils (or an FBE range of 86 to 114%) produced good hiding of the unprimed substrate while providing an achievable film-build range.

Analyzing the data

Using the data collected, TE and FBE numbers were calculated for each operator's pre- and post-training session. Tables 1 through 3 summarize the findings of the study. Pre-

training and post-training results are presented in Tables 1 and 2, respectively, while a "before and after" comparison summary is provided in Table 3. Information presented in Tables 1 and 2 includes the amount of paint used to finish the set of panels (by mass), the operator's TE and the overall FBE achieved by the operator (relative to the target mil thickness of 1.75 mils). Subjective data recorded for finish quality is also provided.

Table 1-Pre-Training Results				
Operator	Material Consumption(lbs)	TE	FBE	Finish Quality #Visible Defects (Major/Minor)
#1	0.913	41.5%	138%	6 major-excessive dry spray on all panels
#2	0.749	44.4%	119%	3 major (dry spray), 7 minor
#3	0.633	49.5%	116%	0 major, 9 minor
#4	0.719	51.7%	136%	3 major, 3 minor

Table 2-Post-Training Results				
Operator	Material Consumption(lbs)	TE	FBE	Finish Quality #Visible Defects (Major/Minor)
#1	0.404	60.7%	74%	6 minor
#2	0.454	62.4%	82%	6 minor
#3	0.433	61.6%	86%	4 minor
#4	0.446	77.5%	98%	5 minor

Table 3-Comparison Summary				
Operator	Reduction in Material Consumption	Increase in TE points	Percentage Increase in TE	Percentage Points from 100% FBE Pre-training/Post-training
#1	56%	19.2	32%	38 / 26
#2	39%	18.0	29%	19 / 18
#3	32%	12.1	20%	16 / 14
#4	38%	25.8	33%	36 / 2

As indicated in Table 3, each participant realized a significant reduction in product consumption after receiving training. Material consumption decreased by approximately 32 to 56% among the four operators who participated in the program. This is attributable to improved TEs and FBEs. As shown, participants improved their TEs by approximately 12 to 26%, meaning that a higher percentage of paint sprayed was actually deposited on the part.

FBE results indicate all four operators applied too much coating on their pre-training panels (this is based on a desirable film-build range of 1.5 to 2.0 mils, which corresponds to an FBE range of 86 to 114%). Post-training FBEs, however, reflect lower film builds that more closely approached the target film build of 1.75 mils. As shown in Table 2, two of the four operators applied the coating at the desirable film-build range, while the other two fell short of the FBE range. This data also identifies a potential pitfall to avoid - insufficient film builds. Coating performance problems associated with insufficient film builds (i.e., poor adhesion, corrosion resistance and gloss retention) are often more serious than those caused by applying too much coating. Consequently, as part of the training, the operator must be made aware of the importance of correct film-build.

Probably the most beneficial aspect of training revealed by the study is its effect on finish quality. As shown, the number and severity of appearance defects noted for the panels decreased markedly after training, a favorable indicator of reduced rework.

Table 4-IWRC Staff Results				
Trial #	Material Consumption(lbs)	TE	FBE	Finish Quality #Visible Defects (Major/Minor)
#1a	0.356	88.9%	113%	6 minor, 2 major
#2a	0.462	78.4%	111%	1 minor
#3b	0.424	82.4%	102%	0 defects
<p>a-Results achieved using Graco Delta HVLP gun equipped with a 0.110-inch fluid nozzle/needle/air cap combination</p> <p>b-Results achieved using Kremlin M21 VLP gun equipped with a 0.087-inch fluid nozzle/needle/air cap combination</p>				

What is achievable?

Study results such as these often lead to questions of what is achievable and how these findings carry over to the work environment. In an attempt to provide some insight, three

sets of test panels were finished by an IWRC trainer under the same or similar study conditions. Results of this effort are summarized in Table 4. As shown, TEs approaching or even exceeding 80% and FBEs well within the desirable range are achievable under test conditions.

Achieving these same efficiencies in the workplace, however, is an entirely different matter. Conditions of the study eliminated a great number of variables that affect application efficiency in the workplace. For example, most businesses in the coating industry don't have the luxury of finishing stationary, flat panels. Instead, workpieces tend to vary in size and geometric complexity. They may also be presented to the operator on a conveyor line.

Other common obstacles to an efficient finish with manual spray- application equipment include:

- poorly maintained or inoperable equipment
- improper setup and operation of spray-application equipment
- minimal understanding of the variables that affect the efficient and effective use of equipment and materials
- years of poor spray habits.

Focusing on and investing in the operator remains one of the best and most readily available means of improving application efficiency. Although TEs over 80% aren't very realistic, the real goal is continuous and relative improvement in application efficiency. Through operator training and education, percent improvements approaching those presented in this study are not beyond the realm of possibility.