Controlled Spraying and Laser Touch in the Fiber Reinforced Plastics Industry

Controlled spraying significantly reduces styrene emissions from open mold fiber reinforced plastic application processes. This pollution prevention technique benefits employee health, the manufacturing operation and the natural environment, by increasing material transfer efficiency, which reduces styrene emissions.

Transfer efficiency is the amount of material adhering to the mold compared to the amount of material sprayed. Increase transfer efficiency in your FRP shop by minimizing resin atomization and reducing overspray loss—material that misses the mold during spray application. Both atomization and overspray expose the surface area of resin and gelcoat particles to air, increasing styrene emissions.

A study by the Indiana Clean Manufacturing Technology and Safe Materials Institute, Purdue University, showed that styrene emissions from gelcoat and resin application could be reduced by 20 percent or more through controlled spraying. American Composites Manufactures Association (ACMA) tests show that styrene emissions are directly related to the exposed surface area and are independent of the film/layer's thickness. According to ACMA's *Controlled Spraying Handbook*, three major elements work together to reduce emissions:

- Capturing overspray at the mold perimeter
- Spray gun settings
- Training operators

Spray Gun Settings

Spray guns transfer resin or gelcoat from bulk containers to the mold. Sprayed in a fan shaped pattern material efficiently covers the mold. In the case of externally mixed spray equipment—mixing catalyst and resin after they exit the spray gun—the finely divided liquid droplets of the fan pattern aid in mixing the catalyst with the resin or gelcoat. Proper mixing is required to adequately cure the laminate.

Calibrate Pressure

The amount of atomization depends on a variety of characteristics, including resin temperature and properties, type of spray gun, gun-to-mold spray distance and mold shape. Each set of characteristics has an acceptable amount of atomization. To minimize atomization use the lowest gun fluid tip-pressure that gives an effective fan pattern and insures adequate mixing of the catalyst and resin or gelcoat. Maintain a pressure calibration log so you can track if operators are monitoring atomization. More details are available in chapter 4 of ACMA's *Controlled Spraying Handbook* <acmanet.org/ga/Controlled_Spray_Handbook.pdf>.

Control the Fan Pattern

Select a fan pattern that allows operators to work efficiently while maintaining control over the resin or gelcoat's placement and thickness. Match orifice size and tip angle to the resin's characteristics and to the size and shape of the mold. Use wide spray patterns for wide parts and narrow spray patterns for narrow parts. Because spray equipment varies, consult the manufacturer to determine the best operating pressure for a given set of conditions. In general, as tip pressure increases the fan pattern moves from a circular pattern to an erratically elongated pattern to a “clean” elliptical pattern. At higher pressures, an undesirable larger elliptical pattern forms. Ideal conditions are usually at the lowest pressure that yields an elliptical pattern. This distributes material evenly across the fan, providing uniform coverage.

Capturing Overspray

To minimize the amount of material that hits the floor, capture overspray as close to the mold's edge as possible. This will reduce styrene emissions. Capture overspray by:

- Incorporating a removable flange extension
- Using wide disposable masking
- Widening the mold's flange

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Operator Spray Technique

Spray technique has a significant impact on the amount of waste generated in open mold processes. Inefficient technique results in excess material use, reduced transfer efficiency and increased amounts of overspray. Train operators to maximize your operation's efficiency.

Thoroughly train operators on proper spray techniques. Explain the need for controlled spraying, including how overspray impacts material use and styrene emissions. Also, explain the importance of proper spray equipment setup and spray technique.

Proper Spray Techniques

1. Spray gun orientation. Hold the gun perpendicular to the mold surface as material is applied. A more even mil thickness and the least overspray is produced the closer the gun's angle is to 90 degrees.
2. Spray pattern. Establish a pattern that gives the proper coverage. Use smooth, long parallel strokes. Start at the area of the mold closest to the operator and follow the mold's contour as closely as possible. Keep the stroke rate, gun-to-part distance and gun angle constant.
3. Mold perimeter. Spray the mold's perimeter first, keeping overspray within the containment flange. Next, work from the mold's interior out to the perimeter, stopping short of the mold's edge.
4. Corners. Spray inside and outside corners at a 45 degree angle.
5. Large molds. A large mold may make it difficult for an operator to keep the gun angle at 90 degrees near the mold's center. In this case, add material starting from the outer edge working to the interior. At the center of the mold deviating the angle from perpendicular is less of a problem because material is likely to fall on the mold's surface and not become overspray.
6. Gun operation. Do not trigger the spray gun on and off. This could make the catalyst and resin ratio inconsistent.
7. Mil thickness monitoring. Operators should use a mil thickness gauge to monitor laminate buildup. This check helps ensure that they hit the target weight for parts and keep overall emissions minimal. Or, use equipment that monitors the amount of material dispensed to achieve tighter control over part weights.

Laser Touch Improves Spray Technique and Reduces Waste

Adequate training increases the efficiency of material use. Spray performance can improve further when a properly trained spray operator is assisted by Laser Touch technology. Mounted on a spray gun, the Laser Touch unit has two laser beams that converge into one when the gun is properly positioned. The visual signal of both lasers coming together on a part lets operators instantly know if they have proper aim, gun-to-part distances and gun angle. Improved accuracy and consistency ensures material placement, maximizing transfer efficiency. The increased performance is seen as less waste is produced.

Fiberglas Fabricators Tests Laser Touch

A MnTAP intern studied the effectiveness of Laser Touch at Fiberglas Fabricators, in Le Center, Minnesota. The company manufactures electric utility enclosures of varying sizes and shapes. The parts are rectangular and have a depth of one foot or more. The base of each part is cut out, creating a large source of waste. Trim and overspray are the other major waste sources.

The intern tested Laser Touch on a variety of parts in an average day’s production. An initial waste assessment was performed to set baseline waste numbers. The amount of gelcoat applied to the mold was determined by weighing the mold before and after application. Filled resin, catalyst and chopped glass inputs were monitored by Technology for Manufacturers (TFM) material monitoring device. Woven glass was weighed on a scale. Before the part was allowed to cure, the waste from the mold edge—trim waste—was removed and weighed. After the part was removed from the mold, edge finishing and cut out wastes were weighed. Overspray waste was the difference between the inputs and the cut out and trim wastes. Parts were carefully monitored throughout the process and the same spray operator performed all the tests. The application equipment used was the Magnum fluid impingement technology (FIT). Styrene emissions were not included in the analysis.

Using the ACMA’s Controlled Spray Program as the guide, the operator for this study was trained on proper spray technique. The Laser Touch was installed and set for the desired gun-to-part distance. Materials used and waste generated were determined as described above.

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Data and Results

Tables 1 and 2 represent data for a variety of different parts. Identical parts are represented in each trial, but direct comparisons cannot be made between tables. The average waste rate was 14.5 percent before using Laser Touch versus 10.6 percent after. The Laser Touch device and the controlled spray training resulted in nearly a 27 percent reduction in the solid waste generated.

Table 1. Baseline material use and waste data for a variety of parts in typical production.

Part	Materials used* (pounds)	Waste generated (pounds)	Percent waste
1	62.8	10.7	17.0
2	62.5	8.6	13.8
3	62.2	7.45	12.0
4	59.8	9.1	15.2
5	59.35	12.65	21.3
6	58.8	10.9	18.5
7	134.4	13.4	10.0
8	137.1	21.5	15.7
9	136.5	13.5	9.9
10	126.1	21.1	1.7
11	126.6	15.6	12.3
12	60.55	11.2	18.5
13	60.15	10.3	17.1
Total	1147.0 lbs.	166.0 lbs.	Average 14.5%

*Materials used is total amount of catalyzed filled resin, gelcoat, chopped and woven glass that is applied.

Table 2. Material use and waste data for a variety of parts using the Laser Touch device.

Part	Materials used* (pounds)	Waste generated (pounds)	Percent waste
1	58.85	7.0	11.9
2	62.7	6.9	11.0
3	129.4	9.9	7.7
4	129.9	10.6	8.2
5	63.9	5.6	8.8
6	66.15	5.0	7.6
7	62.7	8.5	13.6
8	63	7.1	11.3
9	68.3	9.0	13.2
10	70.2	12.2	17.4
Total	775.0 lbs.	82.0 lbs.	Average 10.6%

*Materials used is total amount of catalyzed filled resin, gelcoat, chopped and woven glass that is applied.

Table 3 represents a before and after comparison for identical parts. Large and small parts are represented in the sample. The large part averaged a 22 percent decrease in waste while smaller parts averaged a 33 percent decrease.

Table 3. Before and after Laser Touch comparisons of waste data for identical parts.

Part	Waste (pounds per 100 pounds input*)		Percent
	Before	After	decrease
A	12.9	8.8	32
B	11.9	7.9	34
C	17.8	13.9	22

*Input equals the sum of resin, glass, catalyst and gelcoat into part.

Economics

Because of the quick payback, Fiberglas Fabricators will consider purchasing Laser Touch if it does not move to robotic spray up.

Table 4. Economic justification for implementing controlled spray using the Laser Touch

Annual savings in materials if scrap rate dropped from 14.5 to 10.6 percent	$23,700
Decrease in landfill disposal costs	20 percent
Savings associated with decreased landfill costs	$2,600
Total annual economic benefit	$26,300
Cost of Laser Touch (4 units at $1,000 each, including installation)	$4,000
Payback period	< 2 months

For More Information

Other MnTAP publications for the FRP industry:

- Fiber Reinforced Plastics Shop Complies with New Air Permit Regulations [#83]
- Reducing Volatile Emissions in the Fiber Reinforced Plastics Industry [#75]

MnTAP has a variety of technical assistance services available to help Minnesota Businesses implement industry-tailored solutions that prevent pollution at the source, maximize efficient use of resources, and reduce energy use and cost. Our information resources are available online at <www.mntap.umn.edu>. Or, call MnTAP at 612/624-1300 or 800/247-0015 from greater Minnesota for personal assistance.

The Laser Touch study was conducted in 2001 by MnTAP.