Reducing Volatile Emissions in the Fiber Reinforced Plastics (FRP) Industry

Being an FRP processor may mean being a major source of volatile emissions released to the environment. Acetone (a solvent used to clean tools and other surfaces contaminated with resin) and styrene (the volatile component of polyester resin and gelcoat) are the largest contributors to volatile emissions from a FRP processing facility.

Reducing volatile emissions is smart business if you're an FRP processor. Just look at the benefits:

- Reduced disposal cost of spent solvents as hazardous waste.
- Less concern about tough OSHA regulations related to worker exposure to chemicals, especially styrene.
- Less concern about tough regulation of air pollutants as a result of the 1990 Clean Air Act Amendments (CAAA).
- Reduced fire hazards associated with a high concentration of these chemicals in the workplace.

This fact sheet describes some of the options available to reduce acetone and styrene emissions from FRP operations, and also includes a list of suppliers with additional information.

Some common FRP products are:
Boats; Modular tub and shower units; Sinks and vanities, Ladders; Portable toilets; Architectural facades, Window lineals; Components for RVs, trucks, campers; Automotive body panels, Playground equipment; Underground gasoline storage tanks; Pollution control equipment; Waste water treatment equipment; Food and pharmaceutical processing equipment; Components for appliances, business equipment, electrical equipment

Material Substitution or Process Change Considerations

No single option is likely to replace the plant-wide use for a solvent or completely eliminate the source of volatile emissions. Alternatives that combine several options should be carefully examined. When a substitute is being considered, keep in mind the following:

- Will a new waste stream be created and how will it be handled?
- Do the new materials pose a worker health or safety risk?
- What will be the effect on product quality and production levels?
- What experience have others in the industry had with the alternative you are considering?
- How much employee training will be required for successfully implementing a substitute?
- Are there regulations that need to be considered for the alternative?

Reducing Styrene Emissions

Styrene is a significant source of volatile emissions from most FRP processes. Emissions from open-mold processes tend to be high because:

1) The spray-up technique used to apply the resin or gelcoat
2) The large surface areas of the parts exposed during curing.

During the manufacturing process, styrene emissions result during two phases: liquid application (evaporation from liquid droplets) and laminate cure (heat from reaction drives off volatiles). Opportunities for reducing styrene emissions include:

- Substitute low-styrene emission resins
- Implement more efficient resin or gelcoat application process/equipment
- Convert open-mold process to closed-mold
- Train employees on equipment set-up and application technique

Low-Styrene Emission Resins

Low-styrene emission resins are grouped into two general categories: reduced styrene resins and vapor-suppressed resins.

❖ **Reduced styrene resins** contain less styrene than conventional resins. For example, conventional resins can contain more than 42 percent styrene on a weight basis; whereas, reduced styrene resins contain from 35 percent, (the "Rule 1162 Resin"), to around 38 percent styrene. The costs of reduced styrene resins are comparable to the conventional general-purpose resins and using these resins will reduce volatile emissions.
  - **38 percent resin.** 38 percent resin is easily incorporated into existing processes with minimal changes to the application equipment and has shown no negative impact on part quality. One barrier to using this resin is that its higher viscosity makes roll out of the liquid over the reinforcing material tougher.
  - **"Rule 1162 Resin."** The resin's higher viscosity causes roll out difficulties that add to the incidence of voids in the laminate. It also tends to produce laminates with lower glass to resin ratios.

❖ **Vapor-suppressed resins** contain a wax-like additive that migrates to the surface of the laminate during the cure step, forming a barrier that inhibits the release of styrene. These resins continue to have limited acceptance by FRP processors because the waxy barrier has the potential to hinder the bonding of subsequent layers. However, the bond strength is improved by lightly sanding the surface of cured parts prior to applying the next layer.

Application Equipment

Many FRP processors use conventional spray equipment to apply resin and gelcoat. This technology relies on high fluid pressure or compressed air to create a spray of the resin or gelcoat. A negative side effect of any spray technology is misting which usually results in decreased transfer efficiency and higher emissions.

The solution is to switch to:

1) One of several non-spray application technologies that eliminates misting
2) Spray equipment with higher transfer efficiency guns.

Either alternative will lower emissions.

1) **Non-spray resin applicators** include flow coaters and pressure fed rollers.
   a) Flow coaters are internal mix guns that produce low-pressure streams of resin. These guns can be equipped with a glass chopper to simultaneously apply catalyzed resin and reinforcing media.
   b) Pressure fed rollers also use an internal mix chamber, but the mixture is fed by low pressure to a roller mechanism that directly applies it over the reinforcement.

   In both cases, the application surface area of the resin is greatly reduced, thus minimizing the emissions from the application step.

Because these technologies use internal mix chambers, the operator will have to routinely flush the chamber to minimize contamination build-up. This may affect hazardous waste generation, depending on the solvent used
.

2) **For the conventional spray equipment**, those that operate as airless and low pressure will produce the fewest emissions.
   a) High volume, low pressure (HVLP) units tend to produce the least overspray and fewest emissions.
   b) Electrostatic gelcoat application is gaining consideration with a number of FRP operations. This technology uses an electric charge to attract the gelcoat to the mold, reducing overspray. If gelcoat use is high at a facility, reducing overspray can make the investment very appealing. A major consideration for this technology is safety because of the high voltage necessary to charge the system. A significant amount of employee training will be necessary.

Closed-Mold Process Change

Many current open-mold processes could be modified to a closed-mold process that would not only reduce emissions, but by optimizing the ratio of glass to resin would produce a higher quality laminate. The two techniques presented here are vacuum bagging and resin infusion.

Vacuum Bagging Technique

How it Works

- The resin and reinforcement are applied in the traditional manner, by hand or spray. Before the laminate starts to cure, a thin plastic film is placed over the uncured laminate in such a way that a vacuum can be drawn on the system. This supplies one atmosphere of pressure over the laminate surface forcing excess resin from the system.

Benefits

- Eliminates emissions during the cure.
- Increases the glass to resin ratio, which enhances physical properties of the laminate, and reduces the amount of resin used to produce part.

Barriers

- If the bag is not reusable, solid waste from applying this technique will increase.

Where Has It Been Used?

- Has been used often by the high performance canoe manufacturing industry.

Resin Infusion Technique

How it Works

- In general, existing open-molds are fitted with a flexible membrane around the mold perimeter. Once the reinforcements have been tacked into place, the membrane is sealed around the mold edge and a vacuum is drawn on the system. The membrane stretches to make contact with the reinforcing media. At some point, a valve is opened and resin is sucked or infused into and through the reinforcing media.

Benefits

- Reduces styrene emissions even more than vacuum bagging by eliminating the exposure of liquid resin to the plant environment during the entire manufacturing process.
- A minimum quantity of resin is used.
- Reduced labor from using technique helps to justify cost.

Barriers

- Some solid waste increase, but the membrane can be used multiple times so increase is less than vacuum bagging.

Where Has It Been Used?

- Resin infusion has been successfully applied in situations where multiple reinforcing layers are built up to produce a part.

Training operators on application technique and equipment set up can have a very significant impact on styrene emissions. To **properly set up the spray equipment,** the operator needs to match the spray tip size to the part being produced and set the system pressure to create a proper fan of spray. In general, a spray tip should be selected that will allow the gun tip to be within 12-18 inches of the surface being sprayed. This will reduce losses due to overspray. Once the spray tip is selected, the system pressure needs to be adjusted to the lowest pressure capable of producing an acceptable spray pattern. The higher the system pressure, the smaller the droplets. Smaller droplets lead to more emissions and the tendency towards higher overspray.

The operator's **application technique** also plays a significant role in emissions. The spray gun should be held as close to the mold as feasible, once the gun has been properly set up. The angle that the fan pattern intersects the mold should be held as close to perpendicular as possible to ensure that spray particles impact the mold surface. The perimeter of the mold should be sprayed in a careful manner to avoid spraying over the edge.

Reducing Acetone Emissions

Acetone continues to be a commonly used solvent for cleaning uncured polyester resin and gelcoat from tools and other contaminated surfaces. Regulatory pressure to stop using acetone has been lessened as a result of its reclassification as a non-VOC. However, the fire hazard associated with elevated concentrations of the vapors in the workplace and the need to manage the spent solvent as hazardous waste, maintain strong incentives for a shop to find viable alternatives.

In a typical FRP operation, more than 50 percent of the purchased solvent used can be lost to the air through evaporation. The remaining spent solvent portion can be processed on-site to reclaim the acetone or disposed of off-site as hazardous waste. Still-bottoms remaining from the reclamation step must also be disposed of as hazardous waste.

Acetone substitutes can be used to reduce volatile emissions. These substitutes are grouped into two general categories: 1) higher-boiling solvents, and 2) aqueous cleaners.

1) **Higher-boiling Solvents**
   These solvents work the same way that acetone does by dissolving the resin, except that they do not evaporate as readily. Parts or tools cleaned with acetone are typically air dried after they have been cleaned. With higher-boiling substitutes, that evaporate less readily, the liquid film remaining on the part may have to be removed with a towel or by some other means.

   Higher-boiling solvents can be directly substituted for acetone in many applications, but their effectiveness needs to be verified for each different cleaning situation. Also, carefully review the material safety data sheet (MSDS) to note any potential safety or worker exposure hazards. Protective equipment such as splash goggles and gloves may be necessary.

2) **Aqueous Cleaners**
   Aqueous cleaners rely on mechanical action (such as brushing) to clean resin from contaminated surfaces, while acetone and the higher-boiling alternatives clean by dissolving the resin. The mechanical action used with aqueous cleaners separates resin from the part surface so that the resin droplets can be wetted by the aqueous cleaner. This allows the coated resin to settle to the bottom of the cleaning tank. A towel or a stream of air can then be used to dry the tool prior to reuse.

   Although aqueous cleaners have been demonstrated to be effective substitutes, special attention needs to be given to training employees in using the new cleaning procedures. Lack of training usually results in a lack of acceptance of the new procedures by employees, which can cause implementation to fail. Some examples of aqueous cleaners are Thermaclean and

Replacetone. These cleaners are typically supplied as concentrates and diluted on-site to a concentration suitable for a particular situation (dilution factor 5:1 to 10:1).

a) **Disposal Considerations.** Although aqueous cleaners eliminate volatile emissions, they create two other waste streams. These are the spent aqueous solution and the under-cured resin material that collects at the bottom of the cleaning tank.

i) Information from MSDS for some aqueous cleaners suggests that the spent liquid solution can be disposed of by discharge to the sewer. However, prior to disposal, be sure to obtain approval from the local sewage treatment facility and comply with all local, state and federal regulations.

ii) Small batches of the under-cured resin can be hardened by adding an appropriate amount of catalyst and disposed of as nonhazardous solid waste.

RESOURCES & INFORMATION

Composites Fabricators Association
1655 N. Fort Myer Dr., Suite 510
Arlington, VA 22209
Phone: (703) 525-0511 Fax: (703) 525-0743 Email: **cfa-info@cfa-hq.org**

Fiberglass Fabrication Industry Resources, Pacific Northwest Pollution Prevention Resource Center (http://www.pprc.org)

The following publications provide further information on waste reduction in the fiberglass fabrication industry:

1. *Composites Fabricators Association Open-Mold Styrene Emissions Test Project: Phase I - Baseline Study for Hand Lay-up, Gel Coating, Spray-up, including Optimization Study*, Composites Fabricators Association, 1996.
2. *EPA Guide To Pollution Prevention: The Marine Maintenance and Repair Industry*, EPA/625/7-91/015, October 1991.
3. *EPA Guide To Pollution Prevention: The Fiberglass-Reinforced and Composites Plastics Industry*, EPA/625/7-91/014, October 1991.
4. *Establishing Waste Reduction Benchmarks and Good Manufacturing Practice for Open -Mold Laminating*, David Hillis, North Carolina Division of Pollution Prevention and Environmental Assistance, 1997.
5. *Waste Reduction Strategies for Fiberglass Fabricators*, David Hillis and Darryl Davis, East Carolina University, 1995.

The following companies supply the FRP industry with materials and application equipment and can provide more information on the options available to reduce volatile emissions from your FRP operation:

Midway Industrial Supply Co., Inc.
4759 Old Highway 8
St. Paul, MN 55112
(612) 780-3000

Worum Fiberglass Supply Co.
2130 Energy Park Drive
St. Paul, MN 55108
(612) 645-9224

GLS Corporation
833 Ridgeview Dr.
McHenry, IL 60050
Tel: 888-667-3240
Fax: 815-385-8533

Composite Materials, Inc.
11917 Altamar Pl.
Santa Fe Springs, CA 90670
Tel: 888-821-2661
Fax: 562-906-8473

Fibre Glast Developments Corp.
95 Mosier Pkwy.
Brookville, OH 45309
Tel: 800-838-8919
Fax: 937-833-6555
Technical Support & Training Available

Tool Chemical Co., Inc.
31200 Stephenson Hwy.,
P.O. Box 71970
Madison Heights, MI 48071
Tel: 800-344-7776
Fax: 248-588-5909

Rostone, Div. Of Oneida Rostone Corp.
2450 Sagamore Pky., S.,
P.O. Box 7497
Lafayette, IN 47903 7497
Tel: 800-637-4851
Fax: 765-474-8785

For additional information contact:
Customer Services Division
Pollution Prevention Program
(405) 702-1000 or (800) 869-1400

This document was prepared by the Oklahoma Department of Environmental Quality Pollution Prevention Program with assistance from the MN Technical Assistance Program (MnTAP).

This publication is issued by the Oklahoma Department of Environmental Quality as authorized by Steven A. Thompson, Executive Director. 200 copies have been printed at a cost of $0.0105 each. Copies have been deposited with the Publications Clearinghouse of the Oklahoma Department of Libraries.