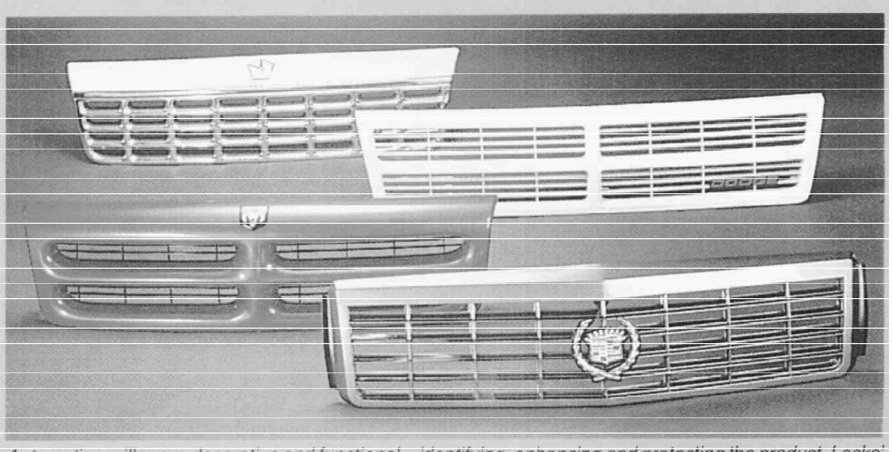
Pollution Prevention Steps for Plastic Coaters—A Simplified Approach, Part II

By James P. Lamancusa, CEF

This article features pollution prevention practices and facility planning successfully undertaken by tacks Enterprises, Inc., an automotive supplier in Grand Rapids, MI. Primary emphasis is placed on the painting of plastic exterior trim components. Part I (published in the January 1994 issue) provided background information concerning regulations arid how to prepare a pollution prevention plan. Part II focuses on transfer efficiency (T. E.) and selection of application equipment to increase T. E., alternate coating technologies, solvent- and water-based coatings. Source reduction process changes, including methods to reduce paint and solvent usage and wastes, are highlighted.



Automotive grilles are decorative and functional—identifying, enhancing and protecting the product. Lacks' finishing capabilities produce high-quality, visually appealing grilles that satisfy a variety of styling objectives.

Increasing Transfer Efficiencies

Regarding the very extensive subject of reducing scrap paint, the amount of paint used is influenced by many factors. Probably the biggest factor of all is material transfer efficiency (T.E.).

According to the U.S. Environmental Protection Agency (EPA), transfer efficiency means the percentage of coating solids material that leaves the coating applicator and remains on the surface of the product. It's calculated by dividing the weight of coating solids that remain on the surface of the part by the total weight of coating solids leaving the coating applicator.

So,

$$T.E. = \frac{100 \times \text{wt of coating solids remaining on part}}{\text{wt of coating solids leaving applicator}}$$

T.E. is a function of many different variables. It's influenced by the paint formulation, part configuration, coating application equipment, part racking, and the skill and efficiency of painters and technicians.

Selecting Application Equipment

In general, automatic application equipment is capable of achieving higher T.E. than a comparable manual system. The phrase often heard in the industry regarding automation is "Improve your efficiency with more consistency." This is certainly appropriate when you're talking about coating technology.

Converting to a robotic spray applicator may cause your T.E. to rise five to ten percentage points, which can do wonders in reducing paint usage. For example, a manual application system with a 25-percent T.E. would have to use 40 percent more paint to coat the same number of parts produced by an automatic system having a T.E. of 35 percent. Another way of putting it is this: If it took 100 gallons of paint to cover 1,000 parts on an automatic system, it would take 140 gallons to achieve the same results using a manual system.

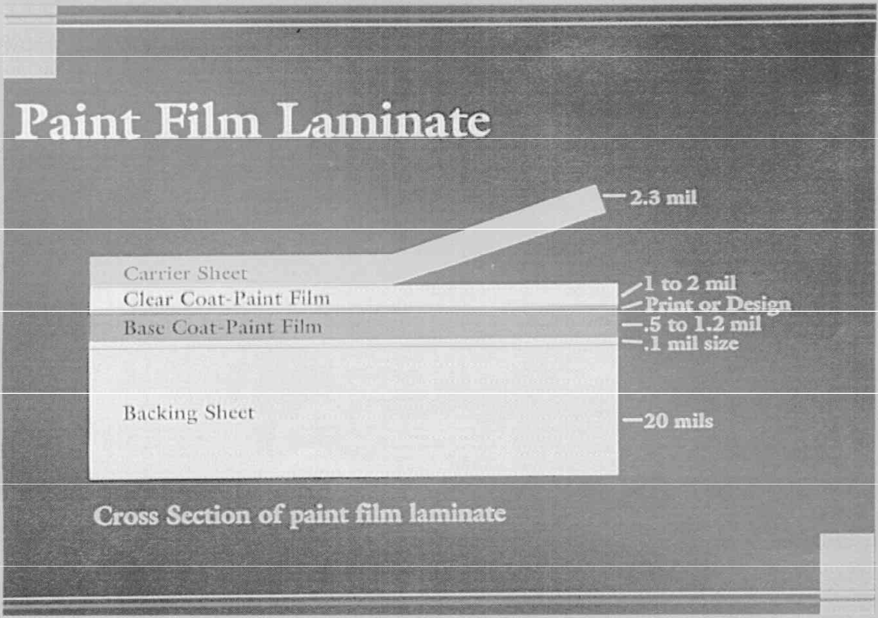
Existing Application Equipment

Plastic coatings at Lacks Enterprises are applied using an assortment of spraying techniques. Spray methods include robotic air-assisted airless, manual and robotic HVLP (high volume/low pressure), and robotic and manual electrostatic, The spray application methods used at all five Lacks facilities meet EPA's requirements for either Best Available Control Technology (BACT) or Lowest Achievable Emission Rate (LAER). In some cases, hot spray variations to these different techniques are also used. Heating of paint lowers the coating viscosity, thereby allowing the use of paint formulations with higher solids content and a lower volatile organic compound (VOC) content.

Depending on the parts being sprayed, the T.E. for the above automatic methods ranges from 30 to 60 percent. If the coating is manually applied, the T.E. is approximately 5 to 10 percent lower. Some of the Lacks facilities do open spraying on a conveyorized coating line. In this operation, the parts are placed on racks or a carrier device and are then painted as the parts travel through the booth. In other Lacks plants, mask spraying is done in either manual or robotic HVLP booths. Similar in concept to a stencil, metallic masking devices are used to selectively block out areas on the part that are not to be coated. The robotic HVLP booths consist of a turntable/turret device that rotates a fixture containing the part and the mask 180 degrees from the "part loading position" to the "coating application position."

Substrates coated at Lacks include urethane and thermoplastic resins. The urethane parts are produced using a reaction injection molding (RIM) process. Thermoplastic parts are manufactured using an injection molding process. The thermoplastic resins used at Lacks consist mostly of ABS, polycarbonate, mineral-reinforced nylon (MRN),themoplastic olefin (TO) and various ABS alloys.

The Lacks Saranac Plant molds and prime-coats automotive RIM plastic parts, including facias (bumpers) and body moldings. Air-assisted airless spray guns



An alternate spray application process is called paint film laminate. With an overall thickness of 21 to 26 mils, the laminate consists of a composite of a 20-mil-thick extruded thermoplastic backing sheet pre-coated in the factory with a base coat and a clear coat, or a base coat only. The paint laminate composite also has a removable 2.3-mil protective carrier sheet placed over the actual paint film. This process involves inserting the paint film laminate into the cavity of the mold. As the part is molded, the backing sheet of the laminate thermally bonds to the molten resin being injected into the mold, producing a painted surface on the part. (Art by Jeanette Wallin.)

are suitable for this operation because the parts being coated are relatively large and the coating delivery rate is relatively fast. Electrostatic application, on the other hand, was not considered suitable for prime coating RIM parts because the substrate being coated is not conductive. If a conductive prime coat is applied, the succeeding base coat and clear coat may be applied using electrostatics. This is precisely what is done at the Lacks 52nd Street Plant, where electrostatic applicators are used to apply base coat and clear coats to thermoplastic parts, such as automotive wheel covers and grilles. Air-assisted airless was not considered suitable for coating smaller, more intricate parts (such as automotive grilles), because the paint goes on so fast it floods the part, causing the paint to run. For the smaller parts that have to be sprayed using a metallic masking device, electrostatic applicators are not feasible because the paint would preferentially coat the metal mask.

In order to obtain maximum T.E. using electrostatics, it is essential to operate the system at the correct voltage for the established conditions. Each of the electrostatic booths at the Lacks 52nd Street Plant is equipped with independent control units mounted locally at each booth so the operator can continuously monitor the voltage and current and make any necessary adjustments. The controllers are adjusted as needed to maximize transfer efficiencies. The controllers also provide the operator with an immediate indication if a resistor is losing efficiency or has failed. If this occurs, the change-out time is just a matter of a few minutes.

Alternate Spray Application Techniques

Powder coating techniques, which reportedly can achieve transfer efficiencies near 100 percent, with no VOC emissions, currently cannot be used in the Lacks Enterprises operations because the required curing temperature is too high. Powder coats must be cured at temperatures between 350 and 450 °F, which exceeds the maximum allowable temperatures of all the resins used at Lacks. Part distortion occurs in RIM plastic at temperatures greater than 280 °F, and many of the thermoplastic resins mentioned previously begin to distort at temperatures as low as 160 °F. There is currently ongoing R&D being done in an effort to develop powder coatings that have lower curing temperatures and/or plastic resins that have higher distortion temperatures.

In-Mold Painting is a relatively new process that is already starting to be used to coat plastic automotive parts on a limited basis. Some in-mold coating application methods offer a production-ready method for painting thermoplastic parts without spray painting. One process involves applying a coating (either liquid or granular) to the inside of the mold during or prior to injecting the molten plastic.

Another process, which may be more applicable to the Lacks' operation, is called *paint film laminate*. With an overall thickness of 21 to 26 mils, the laminate consists of a composite of a 20-mil-thick extruded thermoplastic backing sheet precoated in the factory with a base coat and a clear coat, or a base coat only. The paint laminate composite also has a removable 2.3-mil protective carrier sheet placed over the actual paint film. This process involves inserting the paint film laminate into the cavity of the mold. As the part is molded, the backing sheet of the laminate thermally bonds to the molten resin being injected into the mold, producing a painted surface on the part.

If and when this process is approved for production, more than likely it will be used for non-plated, mono-colored parts having very simple configurations. Likely candidates for this type of operation would be relatively smooth or flat wheel covers, wheel hubs or body side moldings. The environmental advantage of this coating process is that it does not emit any VOCs at the parts manufacturing facility. It emits minimal VOCs at the paint laminate manufacturing facility because the paint film is applied over wide, flat laminate strips, using a rolling method.

Coating Selection

Solvent-Based Coatings

The coatings currently used at Lacks include waterborne business machine coatings and solvent-based automotive coatings. Coatings were selected to comply with BACT/LAER requirements. The flexible conductive prime coat applied to the RIM plastic is a one-component, high-bake urethane enamel. The coating cures at a temperature of 250 °F. Most solvent-based coatings used at the other facilities are air-dried coatings, dried at room temperature or in a dry-off oven at 150 to 160 °F. The air-dried coatings consist of mostly synthetic/modified lacquers, including vinyl acrylics, resist coatings and two-component urethane coatings that are mostly base coat/clear coat body finishes.

The two-component urethane coatings cure at room temperatures because of the chemical reaction that occurs between the coating resins and the catalyst, an isocyanate compound referred to as HDI (1,6-hexamethylene diisocyanate). To speed up the drying process, these coatings are force-dried in an oven at 150 to 160 °F. The resist coatings are applied prior to electroplating for the purpose of making selective areas on the part resistant to plating. One-component urethanes, similar to the coating used in RIM, cannot be used for the coating of thermoplastic resins because the required curing temperature of 250 °F is too high.

The lacquers used at Lacks are applied as either mono-coats or as accent colors on exterior trim parts that have double- or triple-finish combinations. There may be a chromium-plated grille coated with a black accent color, for example, or a chromium-plated wheel cover accented with both silver and black.

Waterborne Coatings

Plastic coating manufacturers, and automotive OEMs and their suppliers, are currently involved in a collaborative effort, investigating the application of waterborne coatings.The incentive for doing this is that the VOC content of waterborne coatings is generally less than half of what is typically found in solvent-based coatings. The VOC content in the solvent-based coatings used at Lacks, for example (except for prime, resist and other functional coatings) is in a range of 3.5 to 5.7 lb of VOC per applied gallon, less water. Coatings at the lower end of this range are considered high solids coatings (40–50 percent volume solids). By comparison, waterborne coatings typically have a VOC content between 2.0 and 3.0 lb of VOC per applied gallon, less water.

Waterborne coatings are already used extensively in the automotive and business machine industries for the coating of plastic components used in interior applications. One of the biggest challenges facing the automotive industry today is the development of water-borne coatings that are suitable for exterior exposure. Some waterborne base coats with solvent-based clear coats are already being used successfully on exterior automotive surfaces. The difficulty lies in the development of water-based mono-coats that will hold up to exterior exposure.

There are many challenges facing plastic coaters, OEMs, and the coating manufacturers in converting to waterborne coatings:

- Stainless processing equipment is required, including stainless steel plumbing and mixing vessels.
- Because the water content must be driven off for proper drying and film formation, humidity control is very critical and heat is required for consistent films.
- Elevated temperatures of the process air or coating fluid will cause the coating to congeal or dry out at the tip of the spray gun.
- Compared to solvent-based coatings, plastic coaters have much fewer process control options available to them for making necessary adjustments. When applying a solvent-based metallic coating, for example, the process technician can achieve brighter colors by using quick-drying solvents, or darker colors, using slow-drying solvents.
- For all of the above reasons, waterborne coatings are much more difficult to apply, and, consequently, a higher level of skill is required by painters and process technicians.

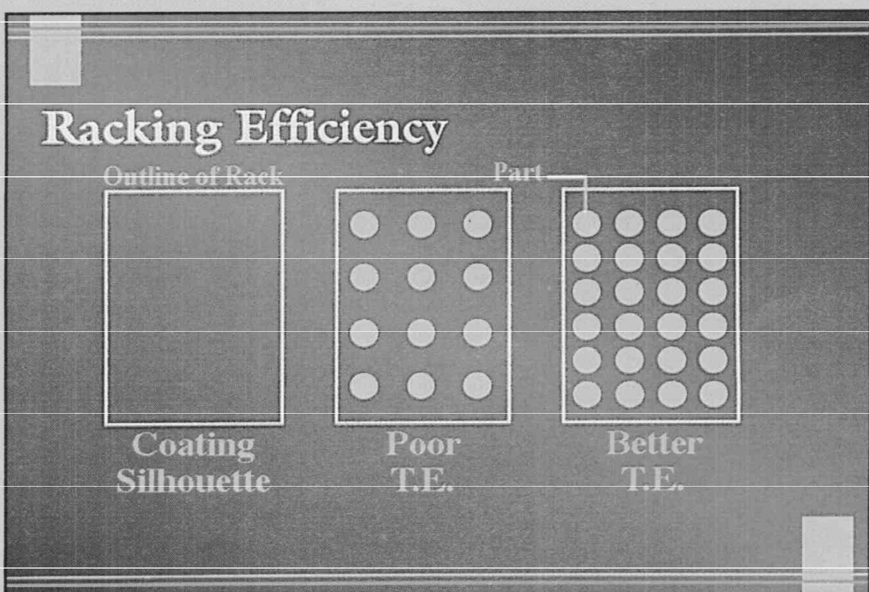
Coating Techniques Using Carbon Dioxide

A patented process* is available that blends liquid carbon dioxide into the coating prior to application. Operating at pressures of 1200 to 2200 psig, this system may result in the replacement of up to 80 percent of the organic solvents in coating formulations. Using supercritical carbon dioxide as a diluent reduces the viscosity just prior to application to a level that facilitates atomization through a spray gun.

This system allows the use of coating formulations that are much higher in viscosity and lower in organic solvent concentration than conventional solvent-based coating operations. This relatively new process may have limited applicability in the coating of plastics, however. Because the process is essentially an airless system, it appears to be more suitable to larger, less complicated parts. As a high pressure system, it doesn't lend itself to frequent color changes. At Lacks Enterprises, this system is being considered for possible future use in the coating of large RIM plastic parts, such as automobile facias and body-side moldings.

Reducing Paint Waste

The question to ask at this point in the pollution prevention evaluation is: Has your operation done everything that is economically and technically feasible to maximize transfer efficiencies? That is, are you using the most efficient application equipment for the type of parts being coated? Have you selected coatings with the highest possible solids content and lowest possible VOC content? Have your painters and technicians been trained and your robots programmed to spray each different job at the highest possible T.E.? If you can answer "yes" to all of these questions, you are ready to move on to the next step in the process.



Strategic racking of parts increases transfer efficiency (T.E.). (Art by Jeanette Wallin.)

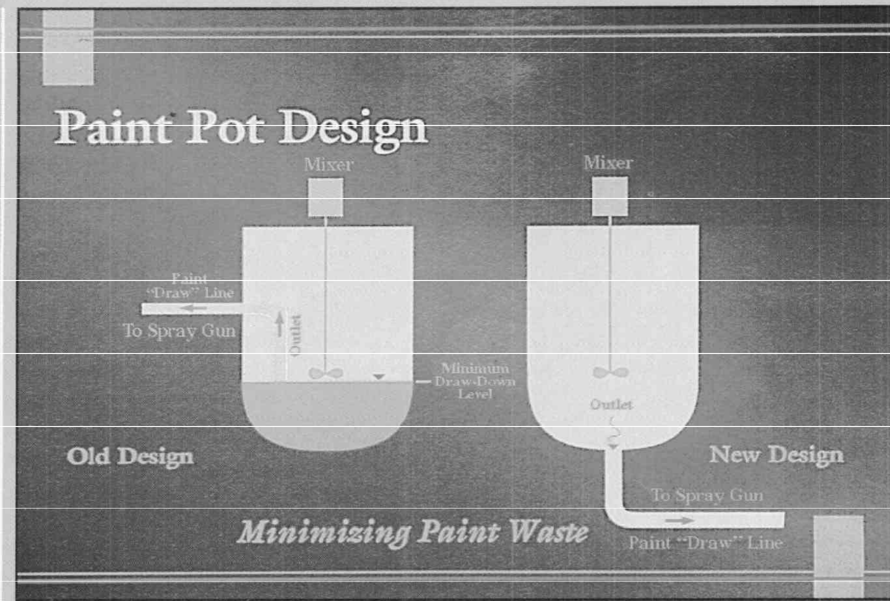
Before going on to a discussion of the other solid wastes generated in plastic coating, there are still a few additional items which should be covered regarding minimizing paint wastes.

Improving Racking Efficiency

One method of reducing paint waste is through racking efficiency. This is applicable to coating lines that consist of a continuous conveyorized process. As a rack travels by a spray booth loaded with perhaps 24 small ornamental parts, the

*UNICARB, Union Carbide, Union, NJ

robot applies the coating across the entire face of the rack. If you draw a two-dimensional rectangle around the perimeter of the rack so it encompasses all the parts, you have defined the painting "silhouette" that the robot has been programmed to paint. In essence, although 24 parts are painted, the robot is actually programmed to paint what appears to be a flat rectangular panel. What creates paint losses, or a reduction in the T.E., is all the overspray that passes through the void space located between all the parts. If it is possible to reduce the void space by rearranging or re-designing the rack so it would hold more parts spaced closer together, a higher percentage of the paint would get on the parts, and there would be less overspray, resulting in a higher T.E. All this equates to less paint usage and less pollution. A change in the rack design as described was actually made at the Lacks 52nd Street facility for a small automotive ornamental part, allowing the number of parts racked to increase from 24 to 40—a 67 percent increase.



A method of reducing paint wastes, especially 2-K material, is to modify the "draw" line so it is located at the very bottom of the tank. By having an outlet located at the bottom of the concave section, all the 2-K paint may be utilized before a new batch is made up, thereby eliminating the need to throw out the small volume of material in the concave section because of pot life considerations. (Art by Jeanette Wallin.)

Minimize Color Changes

Another way to save on paint usage is to minimize color change-overs. This may not always be so easy to do, especially with "just-in-time" deliveries, but if it is possible, production should be scheduled so all parts having the same coating are racked in a sequence for a single "color run." This is important, because every time there's a color change, paint is lost through purging and flushing operations.

Paint Recovery at Change-Overs: Evacuate System & Save Paint

If you've done everything possible to minimize color changes, the next step is to examine the purge-and-flush system. Unless a coating has a limited pot life, such as a two-component urethane (2-K), there usually is no good reason for not containerizing and saving the reduced paint remaining in the lines and the mixing vessel at the end of a color run—no matter how small the quantity. Prior to flushing the paint lines with cleaning solvents, there should be a system that allows all the paint remaining in the lines to be blown back to the paint vessel, using compressed air and/or a purged solvent. The purged solvent has a dual function: It is first used to "push" the paint out of the lines; then it is used to flush the paint line. If the paint feed system is designed properly, it should be possible to capture all the paint remaining in the lines, with the exception of a small amount between the blow-back connection and the tip of the spray gun. As mentioned earlier, it's not possible to save leftover two-component coatings if the catalyst has already been added. Unless you have a dual system that has a separate line with a proportioner for the catalyst, the only thing that can be done to minimize your 2-K paint wastes is to carefully compute the amount of paint you need for the job, and then make-up the batch of paint so it's no more than what's needed.

The most efficient method for minimizing your 2-K paint losses is to install a separate catalyst line with a proportioner. This type of system, which can be installed on automatic spray booths, injects the catalyst at a point just prior to the spray gun. The controller for this system is usually tied into the robotic computer controls, which in turn proportions the catalyst at a rate entered by the technician. Even with this proportioner, however, there is still a small amount of catalyzed paint and purged and flushed solvents between the catalyst injection point and tip of the gun that must be discharged as waste.

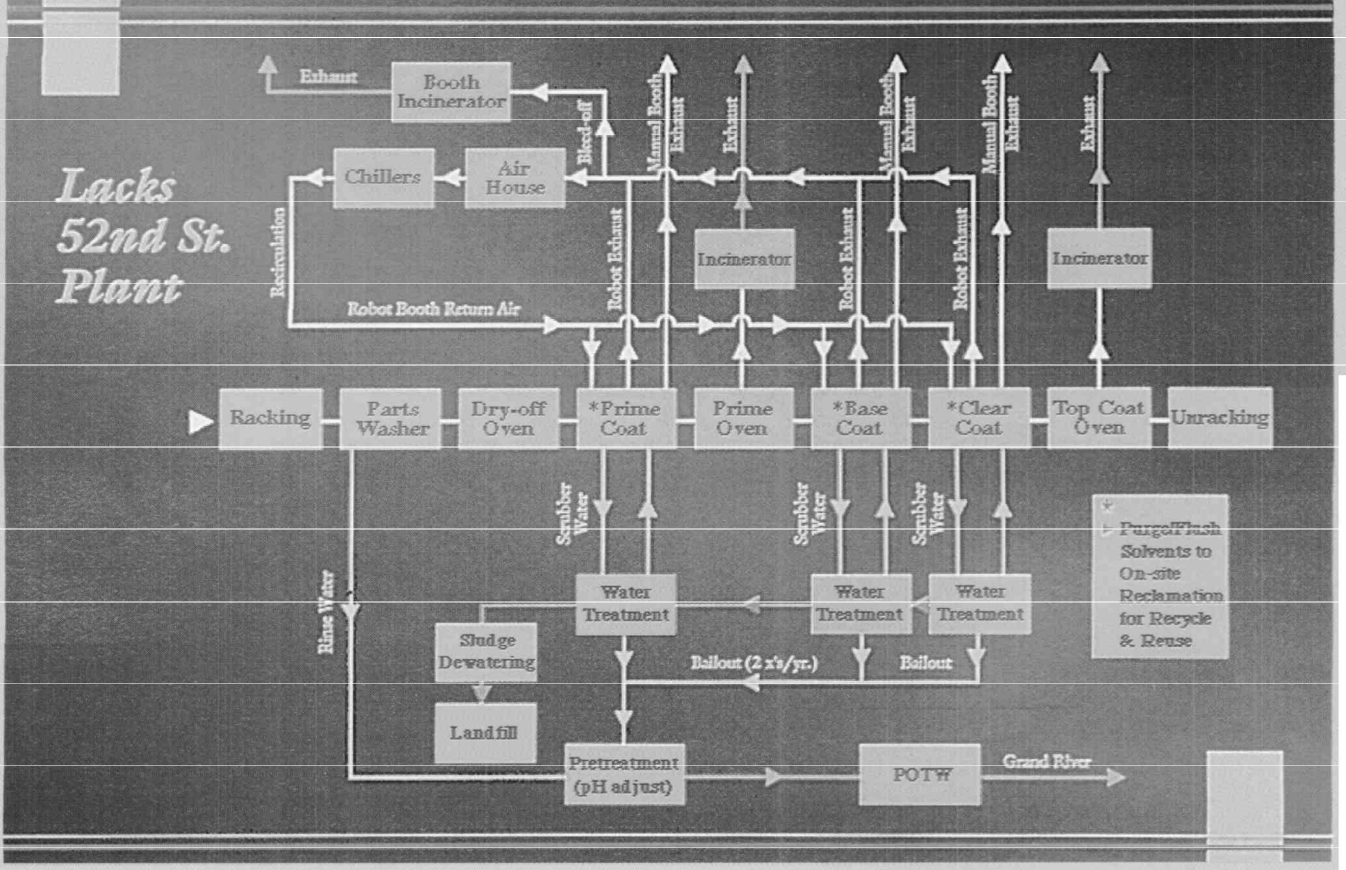
It is usually not advisable to attempt to reclaim 2-K paint and solvents contaminated with catalyst through distillation/evaporation techniques, because, in all likelihood, it will clog up your equipment. Lacks Enterprises ships out 2-K paint wastes to licensed hazardous waste fuel blenders, who, in turn, distribute this material to cement kilns as a supplemental fuel source. R&D work is ongoing to reduce or eliminate this waste source.

Bottom Outlet for Feed Tanks

Another method of reducing paint wastes, especially the 2-K material, is purchasing or modifying paint pots and other paint mixing vessels so the outlet, or "draw" line, is located at the very bottom of the tank. Most paint pots have concave bottoms with the mixer located in the center and the draw line extended down into the tank to the point where the concave section starts. By having an outlet located at the bottom of the concave section, all the 2-K paint may be utilized before a new batch is made up, thereby eliminating the need to throw out the small volume of material in the concave section as a result of pot life considerations.

Monitoring Paint Usage

Another measure that can be taken to help reduce paint usage and associated paint wastes is by closely monitoring usage through physical inventories and closely monitoring paint usage for each job on a piece/gallon basis. Some of the Lacks facilities have gone a step further by adding flow totalizers at each of the spray booths. These totalizers are frequently calibrated and comparisons are made between the readings and the physical inventory measurements. Once perfected, the totalizers will be used to give daily and hourly readings for paint usage and VOC emissions at the plant's centralized computer control room.



When preparing a pollution prevention plan, simplify a schematic of operations to show only the essentials of the process. This is a schematic of the Lacks Enterprises 52nd Street painting facility. (Art by Jeanette Wallin.)

Overspray Capture System

Cross-draft Dry Filter Booth

Before discussing any of the other miscellaneous wastes generated in plastic painting, there should first be a general discussion of the two different methods used at Lacks for capturing and controlling the particulate material that is emitted from the various paint booths. Four paint facilities out of five at Lacks Enterprises use a cross-draft, dry filtration system. As the name implies, there is a horizontal movement of air across the paint application zone and into a bank of dry filters located on the inside wall of the booth. The movement of air is achieved by the mechanical action of an induced fan that draws the air from inside the building through the filters and up the stack. The filters, which rapidly fill up with paint solids (over-spray), must be replaced routinely, and in most cases, at least once per shift. The buildup on the filters can be easily monitored by the use of manometers.

Down-draft Waterfall Booth

The other type of particulate control system used at the Lacks 52nd Street facility is a down-draft waterfall booth. For this system, the air flows downward from the painting zone and through a "waterfall," which is sometimes called a "water curtain." In the air pollution control field, this type of control system is commonly called a "wet air scrubber." The overspray becomes entrained in the water as it passes through the water curtain. Compared to the cross-draft dry filter system, the waterfall booth design provides a much cleaner working environment in the paint room, which is commonly referred to as the "paint proper." It does, however, create wastewater and a very humid environment. Because the coating process cannot tolerate high humidity, chillers are typically needed for humidity control. The Lacks 52nd Street plant uses chillers because the booth exhaust air from 10 robotic spray booths is recirculated to the booths as supply air for the purpose of concentrating the air stream prior to VOC incineration.

Disposable Fabric Filters

Both these methods of controlling particulates create solid waste. For the dry system, spent dry fabric filters are created. The disposable filters usually consist of a multi-layer cellulose paper. The spent filters must be tested so proper disposal methods may be determined. Depending on the type of coating being applied and the test results, disposal options include incineration or landfilling. There are a couple of things that can be done to minimize the amount of fabric filters requiring disposal. One way is rotating and reusing individual filter panels. It may be possible at each filter change to reuse the corner panels by shifting them inward. This is only possible, however, if the corner panels load up on paint solids at a much lower rate than the interior panels. It may be possible to reduce booth filter waste by adding a roughing filter in front of the current filtering system. This may not help much, though, because the roughing filters require disposal also.

Reusable Dry Filter System

Another method currently available is a reusable dry filter system. This is achieved by using a metal baffle arrangement, a metal fabric filter, or a combination of the two. The overspray strikes and adheres to the baffle surface as it passes by. Eventually the coating gets so heavy it begins to run down the baffle and into a drip pan. The drip pan is periodically dumped into a container for eventual disposal or for some applications, it may be reused. Periodically, the baffles have to be removed and thermally cleaned by placing them in a bake-off/burn-off oven.

These bake-off ovens are equipped with after-burners that will destroy 95 percent or more of the VOC emissions. The baked-off solids fall into a pan at the bottom of the bake-off oven. The solids emptied periodically from the pan are then tested and landfilled or otherwise sent to a recycler if there's a market for the dried solids. The metal fabric filters located behind the baffles are similar in principle to the disposable filters, except they can be reused. They are cleaned in the bake-off oven in the same manner as the metal baffles. Although not as environmentally friendly as reusable metal baffles, there are also cardboard baffles available on the market. Claims have been made that cardboard baffles will significantly reduce booth filter usage if properly used, and thereby, reduce your overall waste. The drawback of the cardboard baffles is that they require disposal by landfilling or incineration. Metal baffles have been tried at Lacks without any success, mainly because air-dried coatings dry so fast that they don't adhere to the baffles. The above-described systems are better-suited for paint systems using high solids, high-bake paints. Because 90 percent or more of the coatings applied at Lacks are air-dried, the above systems are not economically or technically feasible at this time.

Solid Wastes:

From Waterfall Booths

The scrubber water generated from the water curtain system is treated and recirculated to the booths. Treatment consists of chemical detackification and flotation, followed by skimming and dewatering. After the material is tested, it is further treated, if required, and then disposed of, either in a hazardous or non-hazardous landfill, depending on the test results. As an alternative to landfilling, there are off-site facilities available now that will process this material into a marketable powder material. The cost of doing this, unfortunately, is still extremely high. Compared to landfilling, this process is several times more expensive to the waste generator.

One method of minimizing the waste generated from this process is evaluating all the different chemical treatment systems currently available. A recent change was made in the type of detackification and flotation chemicals used at the Lacks Enterprises facility, resulting in a 40-percent reduction in chemical costs and a 10-percent reduction in waste volume.

As an alternative to the chemical treatment of the "curtain water," a non-VOC solvent emulsion system can be used. Once the solvent emulsion system is saturated with paint overspray, the solution is pumped out and hauled to an off-site facility, where separation of the water, solvent and paint solids takes place. The paint solids are then refined so they may be marketed as a usable product. This process is currently under investigation at the Lacks 52nd Street Plant.

Miscellaneous Solid Wastes

Miscellaneous solid wastes generated in plastic coating operations include booth-coat and floor-coat materials, and nonreturnable containers. The use of floor runners, which is a good housekeeping measure to minimize the tracking of paint throughout the plant, is another common waste material generated in paint facilities. To minimize the generation of this waste, the Lacks 52nd Street now uses rubber floor runners that are periodically cleaned and reused.

Booth-coats/floor-coats applied to the floor and walls of the booth make housekeeping easier because the excess paint build-up can be easily peeled off. Because a clean, dust-free environment is so critical in most coating operations, booth- and floor-coats are often a necessity. If you have a good T.E. and the air flow adequately carries the overspray to the filters or water curtain, there may only be minimal build-up of paint solids inside the booth. Consequently, booth- and floor-coat materials may only have to be used sparingly. These measures are generally not required for "waterfall" booths.

Minimizing Empty Container Wastes

One way to reduce container wastes is to purchase chemicals in bulk. To justify this economically, the bulk price has to be low enough, and your chemical usage has to be high enough, to offset the cost of installing a bulk storage tank and a secondary containment structure. When doing this analysis, it's important to account for the cost savings to be realized by eliminating containers that require disposal. Another consideration is the savings from eliminating the one- to two-percent loss in chemical that occurs as a result of the residue remaining in containers. Chemicals stored in bulk at Lacks include purging solvents and chemicals for parts washers, wastewater treatment and floor cleaning. A large bulk storage tank has greater inherent risks, because larger volumes of chemicals are stored in a single vessel. These risks are manageable and can be minimized, however, by storing the tank in a properly designed secondary containment system.

Reducing Liquid Wastes

Interrelationship Between Multi-Media

Even though reduction of liquid wastes hasn't been specifically discussed, the fact of the matter is that source reduction between the different environmental media is often closely interrelated. When you reduce a waste in one environmental medium, you're actually reducing it in a second and third also. The prime example of this is optimizing T.E. Increasing the T.E. as previously discussed will reduce solid waste, such as disposable booth filters. Increasing the T.E. also does wonders at reducing VOC air emissions from the spray booths and ovens. Because filtering systems do a less than perfect job, increasing the T.E. also helps to reduce the amount of particulates that are emitted to the atmosphere. Minimizing color changes reduces paint usage and paint waste, but it also helps to reduce spent solvent wastes, and "still" bottom solids from solvent reclamation operations.

On-site Solvent Reclamation

The spent solvent wastes that are unavoidably generated at the Lacks paint facilities are reclaimed on-site and reused, utilizing either a stationary or a mobile distillation unit.

Conserving by Reusing Curtain Water

As mentioned earlier, the scrubber water used for the waterfall booth system is treated and recirculated. In an effort to conserve water, it is only added to compensate for evaporation and during tank clean-outs that occur no more than once every six to nine months.

Mask Washing

For mask spraying operations, it is necessary to periodically strip the accumulated paint off the mask. How frequently this is done is called "mask life." For those concerned about production efficiencies, mask life values are extremely important. Metal masks are cleaned by placing them in a washing vessel that is equipped with high pressure spray nozzles that spray the dirty masks with a cleaning solution either continuously or intermittently. The cleaning unit is called a *mask washer* and the cleaning solution is either a solvent or an aqueous alkaline material.

Solventless Mask Washers

There are very few solvent-type mask washers at the Lacks facilities. Ninety percent or more of the mask washing at

Lacks is done using "solventless mask washers." The cleating in these units is accomplished using a hot alkaline aqueous solution. These washers do an adequate job of cleaning the masks, but they don't always do a complete job of stripping all the paint build-up.

Strip Tanks

After several mask life cycles, the masks must be stripped clean using a harsher solution, which may be either a heavy duty solvent-type cold parts cleaner, or a more aggressive hot alkaline stripper. The solvent cold parts cleaners in the past have always contained chlorinated solvents. Cleaners are now available that contain non-chlorinated solvents only. For stripping operations, Lacks Enterprises uses aqueous-type stripping solutions and non-chlorinated stripping solvents.

Solvent *Mask Washers*

After the masks are stripped with the solvent cold parts cleaner, the stripping residue is washed off with a solvent mask washer that contains a milder, non-chlorinated solvent. The solvent mask washers and the hot alkaline strip tanks are quite expensive to install if plant steam isn't available. The cost of purchasing these units, even if a steam boiler is needed, generally pays for itself in a short period of time because of the savings in waste disposal and reductions in purchases of virgin solvents.

Reducing Air Contaminants

VOCs from Mask Wash& Strip Tanks

The solvent-type strippers and mask washers just mentioned are both sources of VOC emissions. To minimize the VOCs emitted from this cleaning process, the fide for the process tanks should be opened only when it is absolutely necessary. Stripping masks with the cold parts cleaner is currently a manual operation that is done under an exhaust hood.

Methods to minimize VOC emissions from the solvent mask wash tank include changing to a solvent mixture that evaporates more slowly, using a tank lid that is flat and free of any warpage, providing a rubber seal for the lid, installing a timer on the spray system so the sprayers are operating intermittently rather than continuously, and removing and containerize. ing the contents from the tank on weekends and during shutdowns.

Minimizing Fugitive Emissions

Source reduction measures to minimize miscellaneous VOC emission sources, such as just described for the solvent mask washer, are a part of a strategy called *fugitive emission control.* Fugitive emissions are often overlooked, because each fugitive source in itself is not very significant. Fugitive emissions become significant, however, when you add them all up. Some examples of fugitive emissions are open solvent containers and tanks, leakage of solvents from an enclosed, recirculated spraying system, purge evaporation losses, and solvent emissions from miscellaneous ancillary operations.

It is difficult to measure each individual fugitive emission source, but it may be possible to perform a mass balance to determine the sum total of all fugitive sources for a given system. A mass balance of the purge-and-flush capture and reclamation system at the Lacks 52nd Street Plant, for example, revealed that the fugitive emissions were less than 10 percent.

VOCs from Tanks& Containers

Except for vent holes that are needed during filling and draining, all lids, access covers, and bung caps should be securely fastened down on all tanks holding solvent-type materials. On a smaller scale, drums and pails holding solvent material should never be left uncovered. If a drum is being used for the accumulation of waste solvents and a funnel is used, the funnel should be equipped with a closing lid. This not only helps in the reduction of fugitive VOCs, it is required by the RCRA hazardous waste management regulations.

VOCs from Enclosed Spray Booths

Methods to reduce fugitive emissions from an enclosed, recirculated spraying system include caulking of all sheet metal seams in booths and in the ductwork, and only opening access doors when entering or exiting an enclosed spray booth.

VOCs from Purging& Flushing

The most significant step that can be taken to minimize evaporation losses from purge-and-flush operations is the installation of a purge-and-flush capture system.

Whether you're drawing the paint out of a simple paint pot located at each individual booth or you have a centralized paint mixing and distribution system, the solvents used to purge and flush the lines should always be captured and containerized, and should never just be sprayed into the booth. Not only would this be a waste of reclaimable solvents, it would also be a very significant source of VOC emissions.

The simple rule to follow is whenever any solvent-type materials are sprayed out of the gun for purposes other than applying coating to a part, regardless of whether it's purge, flush or paint from the previous job, it should always be sprayed into a waste container that has a lid that is taken off only when being filled. Lacks Enterprises has some robotic spray booths in which the purge is automatically directed into a funnel that has a computer-controlled retractable lid.

VOCs from Booth & Floor Coats & Floor-cleaning Operations

Although relatively minor, booth coats and floor coats are another source of VOC emissions. (At least they are if you're using a solvent-based coating.) The VOCs from this source can be reduced by half or more by using water-based booth coat/floor coat materials. Compared to solvent-based booth coats, water-based booth coats are approximately 40 to 50 percent more expensive. A common housekeeping method for cleaning in paint mix rooms (paint kitchen) involves the use of various solvent cleaners containing MEK or other active ingredients. As an alternative to this, a non-VOC cleaner can be used,such as citrus acid.

Energy Conservation

Energy-Saving HVAC Controllers

Steps taken at Lacks Enterprises to conserve energy include installing HVAC controllers (heating, ventilation and air conditioning) at all facilities to automatically turn down all heating and air conditioning equipment at pre-set time intervals, such as on weekends.

Heat Recovery from Incinerators

At the Lacks 52nd Street Plant, heat is recovered from two oven incinerators and is reused to heat the make-up air supplied to the booths.

Pollution Prevention Monitoring & Employee Training

Monitoring of Pollution Prevention Progress

Statistical Process Control (SPC) can be applied to pollution prevention by closely monitoring miscellaneous solvent usage and paint sludge generation. Miscellaneous solvent usage includes solvents used for purging and flushing of paint lines, mask cleaning and miscellaneous clean-up. A portion of this solvent is captured and recycled, some of it is shipped out for hazardous waste disposal, and some ends up as VOC emissions as a result of evaporation losses. As mentioned earlier, paint sludge is generated at the Lacks 52nd Street Plant from the treatment of the "water curtain" water. The quantity of waste generated, as well as VOC emissions, can be compared to production levels using bar graphs or other graphical representations. There are numerous software packages available for doing this. Production levels may be represented as mil/sq-ft painted. That is, equate all surfaces painted to a one-mil thickness. Example: If 100,000 square feet were coated with an average paint film thickness of 0.50 mils, the production quantity would be 50,000 mil × sq-ft. Ratios of VOC emissions and/or waste generation to mil × sq-ft painted may prove to be very useful tools when reviewing short- and long-term trends. The plotting of emissions of individual air toxic compounds *vs.* production levels may also provide good information on how well pollution prevention activities are progressing.

Employee Training & Continuous Improvement

A general employee pollution prevention awareness meeting is highly recommended to help motivate employees to pitch in at continuous improvement meetings by offering ideas and taking on assignments related to pollution prevention (empowerment). Getting your employees to "buy-into" your pollution prevention program will help tremendously during the development and implementation of such a plan.

The Next Step in the Plan

The simplified approach presented here is meant to be a guide on how to start preparing a facility pollution prevention plan. Once a simplified, multi-environmental media, pollution prevention plan is completed, the next step is to expand the plan to include a detailed evaluation of options for each hazardous or toxic chemical stored or used at your facility. If it hasn't already been done, an economic computer analysis of pollution prevention options should be performed, using available software, such as SWAMI 2.0**. A facility pollution prevention plan should contain additional information, such as detail descriptions and costs for specific source reduction improvements and an allocation of these costs, as EPA prescribes, to processes and products. That is, how much does a particular source reduction measure add to the price of a given product in cents or dollars per piece produced? Equally important, the plan should also identify costs that are being avoided as a result of various pollution prevention practices. Examples of "cost avoidance" are measures taken that result in the avoidance of waste handling, transportation or disposal costs.

What has been discussed to this point is fairly general in nature. A facility's pollution prevention plan will likely contain a considerable amount of proprietary information, such as vendor names, process descriptions, vendor product codes, vendor prices and manufacturing costs. A facility's plan will more than likely contain a "pollution prevention status report" that shows the status of various pollution prevention measures (such as: not applicable, installed and operating, equipment ordered, partially completed/ongoing, or currently being investigated). The pollution prevention plan and this status report should be updated periodically, preferably at least once a year. Because we operate in a highly competitive marketplace, it is imperative that industry as a whole take a strong stance on maintaining the confidentiality of this information. The goal of industry and government alike should be to promote and implement pollution prevention whenever it is economically and technically feasible. The challenge government has in this regard is to allow industry to proceed with pollution prevention without interfering with the forces of the free marketplace and without jeopardizing the confidentiality of proprietary information.❑

**SWAMI 2.0, U.S. EPA, Washington, DC

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