

Wood Finishing and VOC Emissions

Pennsylvania searches for a way to reduce emissions without disturbing coating appearance and durability

Robert M. Cox Jr.
Oreland, PA

The Pennsylvania Dept. of Environmental Resources is studying ways to reduce VOC emissions in the finishing of wood kitchen cabinets, office furniture and household furniture. A new regulation may soon be adopted, which could set a precedent for other states in the eastern United States, where wood finishing is an important industry.

The state hopes to be able to require wood finishers to use coatings containing no more than 7.36 lb/gal VOC. This goal could be difficult to achieve because of the peculiar requirements of wood finishing.

Finishing on wood has a dual purpose: 1) appearance and 2) protection. The appearance must appeal to the customer's vision and sense of touch. The durability must withstand various physical and chemical tests. Durability requirements are normally more stringent with kitchen cabinets and office furniture than with household furniture.

Achieving appearance

The appearance portion of a finish can range from a very simple wiping or spray stain to a complex layered system with four to five applications.

Clear finishes can be as simple as a one-step final clearcoat, as in an "oiled finish" look. Or it can include a five- to six-step clear application. The multiple steps enhance the appearance. Some multiclear and color finishes are rubbed either by hand or machine or both. A fine furniture finish is usually a multistep process. Custom kitchen cabinet finishes are generally less complex due to the reduced demands by the customer. Kitchen cabinet finishes for appearance demands can in some cases be achieved through a wiping filler stain, a spray and wipe stain or an accent spray stain.

Most other wood quality-appearance finishes involve the following steps:

- sap uniforming stain
- body stain
- accent stain
- wiping/filler stain
- speck and distress
- glaze highlight, gun pad

Kitchen cabinet finishes in the clear applications do not carry a washcoat for the most part unless tinted. This is similar to an accent stain. The clear steps generally are achieved through one or

two sealer coats and a single topcoat.

Furniture finishes are mostly derived from nitrocellulose resins. Most washcoats, sealers and topcoats are nitrocellulose-based. Nitrocellulose adds sheen and brightness to the system and is very easy to repair during manufacture. It has been used for over 100 years.

Nitrocellulose is very forgiving and can be washed readily. The clear portions of nitrocellulose-based coatings are the washcoats, sealers, buildcoats and topcoats. They are all used for appearance and durability. They make a deep, attractive "fashion-layered" look.

The nitrocellulose family of resins has two basic drawbacks to the formulator: 1) They tend to have poor durability. 2) They are extremely difficult to formulate into high-solids coatings because of film integrity.

Kitchen cabinet finishing

Kitchen cabinet finishing, however, is a different situation. Appearance finishes can be obtained in a two- or three-step fashion application with conversion sealers and a conversion topcoat.

The topcoats and sealers for most kitchen cabinets are alkyd/urea-based systems using an acid catalyst. These have high durability, excellent toughness and excellent water resistance. They are generally resistant to weak household solutions, such as ammonia and vinegar.

Alkyd/urea-based systems can be formulated upwards of 38% to 55% solids by weight. Viscosity spray considerations currently limit going higher in solids.

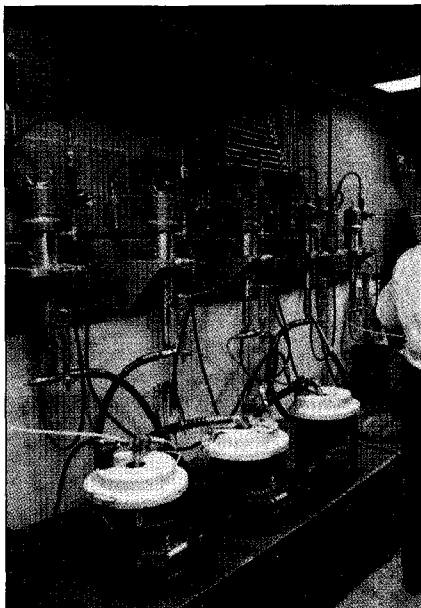
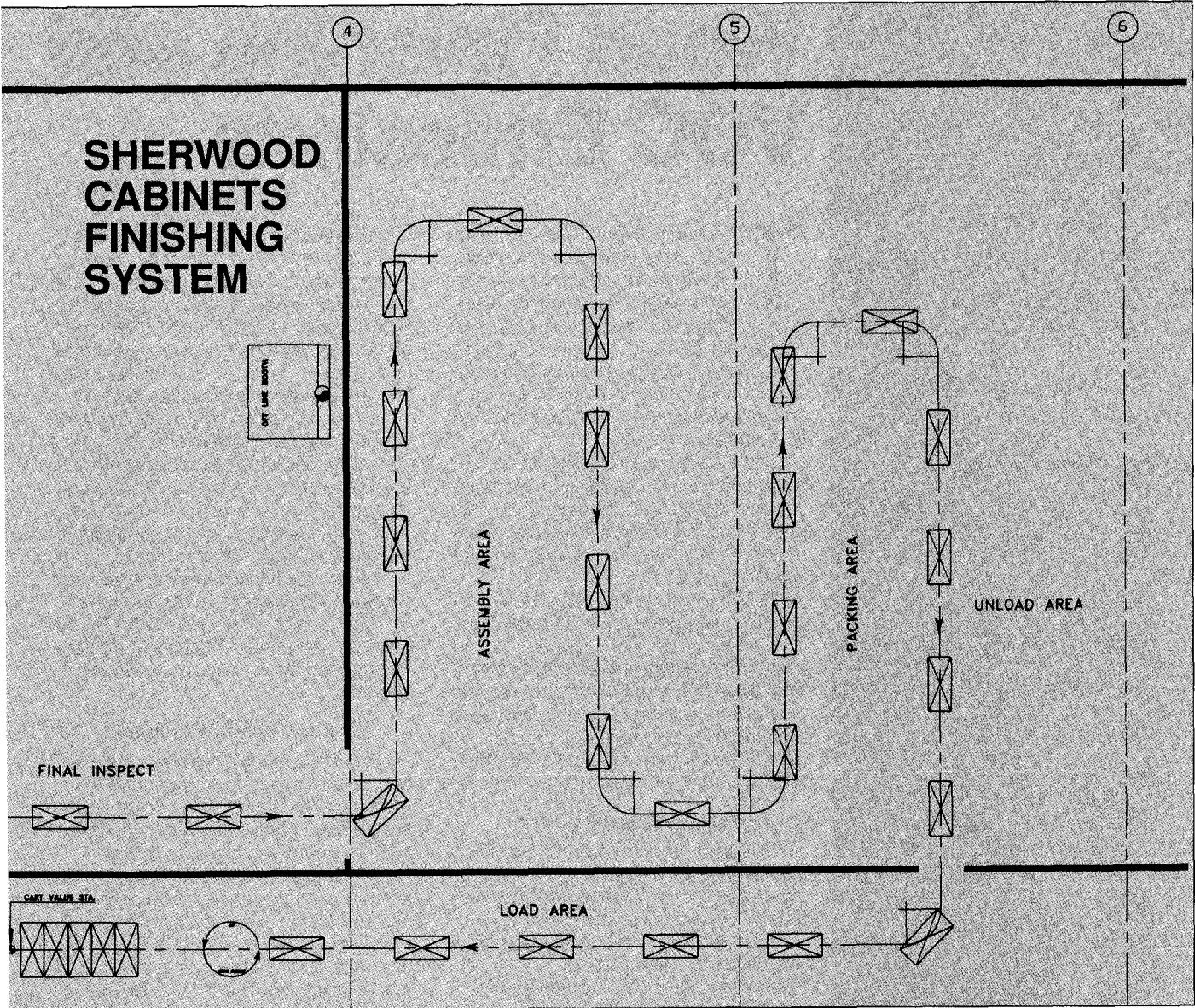
A 40% solids-by-weight conversion topcoat has a VOC of 4.51 lb/gal compared to a 25% by weight lacquer topcoat at 5.8 lb/gal VOC. Thus, the reduction in VOC in the two topcoats is 22%.

Most wood finishers applying the high-solids conversion topcoat use one coat and do not apply multiple topcoats as is prevalent in lacquer applications. Alkyd/urea conversion topcoats, however, do not have the sheen of nitrocellulose and are not as easily rubbed or repaired. This keeps the furniture industry reluctant to change.

Other resins

Other resins used in low-solids wood coatings are butyrates and acrylics, primarily for pure white finishes. The acrylic

SHERWOOD CABINETS FINISHING SYSTEM



Part of the pump room.

the prep booth.

The washcoat is a CAB/vinyl sealer reduced 4:1. It is applied with an air-assisted airless gun.

The stain is either a vinyl-modified pigmented-wiping stain or a spray no-wipe material. It is also applied with an air-assisted airless gun.

The sealer is a high-solids water-white catalyzed material at 45% solids by weight. It is applied to 4.5 to 5 mils wet with an air-assisted airless gun.

After a 24-min flash/drying, the sealer is mechanically sanded in the downdraft-controlled sanding room using a 320-A Tri-Mite paper.

The medium-satin topcoat is a water-white catalyzed varnish applied at 48% solids by weight to a dry-film thickness of 3.2 to 4 mils. It is also applied with an air-assisted-airless gun. Only one of the topcoat booths is currently used.

The sealer and topcoat is an acid-

ure European conversion varnish supplied by Campbell Coatings (North Kansas City, MO). All coatings are applied with Graco (Minneapolis) air-assisted-airless guns using Graco pumps.

Work enters the drying oven after three finishing tasks: stain, sealer and second topcoat. The gas-fired convection oven is designed for low- to medium-temperature operation.

All finished surfaces are inspected closely for quality. Work that needs repair is moved to the off-line booth. ■

Need More Details?

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butyrate family is close to nitrocellulose products in solids but do not apply, repair or rub as readily as do nitrocellulose lacquers.

Urethane coatings are known for a high luster and exceptional appearance. They can be repaired readily and "rub

out" to a durable, hard finish. Urethanes, however, are limited in solids content in formulation for wood coatings. They need to carry their own urethane solvents and are easily contaminated. Their isocyanate content makes them a potential health hazard.

Polyester resins can be formulated into coatings up to 98 to 99% weight and volume solids. They can be made to cure through convection or infrared heat or UV or electron-beam radiation.

Polyester is excellent for filling properties in medium-density fiberboard and

Glossary of Wood Finishing Steps 'From Start to Finish'

Sap/uniforming stain: Methanol (alcohol-derivative solvent) with bright dyes added to give uniformity to the wood. It uniformly discolors the wood and ties in substrate variances. It is a very weak colorcoat.

Body stain: Also an alcohol-derivative solvent with bright dyes added in increased concentrations to give a basic color tone to the substrate.

Accent stain: Generally formulated from earthtone pigments with solvent and a small amount of resin. This stain begins the process of accenting the pore and grain character of the wood.

Washcoat: A low-solids (8 to 14%) clearcoat. The solids choice depends on the wood. A porous wood, such as pine, would take increased solids. The washcoat is a combination of nitrocellulose or vinyl in conjunction with oils, plasticizers and solvents applied over a stain to enrich it and raise or stiffen the fibers of the wood. This improves sandability.

Sand washcoat: Prepares wood for additional color steps and further applications to add build to the final finish.

Wiping/filler stain: A fairly heavy-bodied pigmented

colorcoat. It defines the wood pore through filling and accenting, softening appearance.

Speck and distress: Antiques the wood, giving it a "lived-in" characteristic through opaque or transparent specking stains.

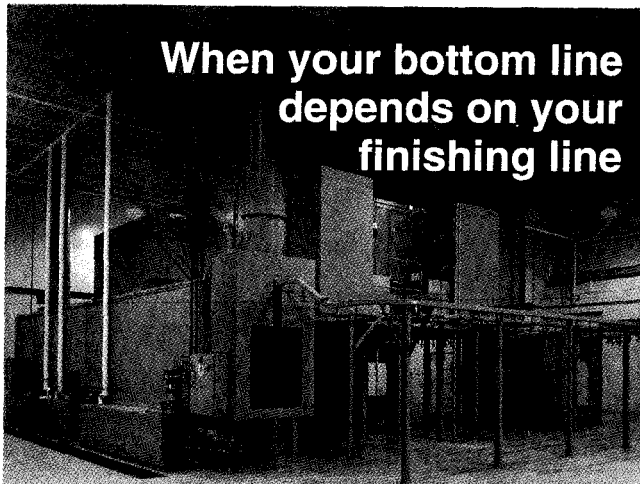
Sealer: A nitrocellulose, oil resin combination that seals in the color coat, raises the grain somewhat and prepares for final topcoat application.

Sealer sand: Smooths the overall system and removes any wood fiber roughness.

Glaze, highlight gun pad: Applied to add character to the finish. It is either an alcohol-based stain or heavy-bodied glaze to accentuate light and dark areas.

Buildcoat: A medium- to high-solids nitrocellulose coating to help increase the build of the finish.

1st and 2nd lacquer: Lacquers are butyrate- or acrylic-modified nitrocellulose topcoats ranging in solids from 20 to 30%. They are designed to protect the finish. The two final lacquer coats give the piece its luster, whether it be flat, satin, semigloss or full gloss. They are very clear and give a bright, deep look to the final appearance. They control some of the build and all of the luster of the finish.



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particleboard. It forms a very tough finish but has its tradeoffs.

As a topcoat polyesters are difficult to repair. They have a limited "look," appealing to high-build/high-gloss "looks" on contemporary offerings. Polyesters do not allow the "close-to-the-wood" look needed in most country, traditional and transitional offerings in wood furniture and kitchens.

Polyesters with MEK peroxide as a catalyst are considered to be a health hazard. The catalyst is used to "kick over" the film-formers.

Waterborne coatings

Waterborne coatings in the appearance-formation steps will raise the grain of wood and cause blotchiness. Water introduced into some wood-finishing formulas can be tolerated in limited amounts. Water can be used in proportions in some wiping stains and in the washcoat, sealer and buildcoat, which are preparatory for the final topcoat.

Because of problems, waterborne topcoats "have not arrived as yet." The main problem is the potential contamination of the waterborne coatings with oil-based coatings. Such contamination can cause havoc in a repair situation and bring equipment problems. The window of forgiveness with waterborne coat-

ings is 25 to 40% less than with conventional coatings.

Waterborne systems are difficult to repair after they are cured. They are tough to "wash off" and require their own dedicated finishing lines and stainless steel hardware.

Waterborne coatings are generally thought of as having a voc content of up to 2.75 lb/gal voc, counting water as part of the voc.

A compliance strategy

A compliance strategy for the wood-finishing industry could revolve around the following scenario:

- Sap-uniforming, body and accent stains should remain solventborne. They are difficult to reformulate in water. They are close to the wood and give a basic color tone for beginning the finishing process.
- Some of the higher-hiding wiping stains may be reformulated to meet the proposed 7.36 lb/gal voc rule. Clean, clear stains will be difficult to reformulate in waterborne.
- Improved transfer efficiency should be an important step toward compliance. HVLP spray guns can improve transfer efficiency by 10 to 20% in some cases. Some equivalency credit should be given for switching to HVLP.

- R&D should be intensified to improve waterborne formulations in washcoats, sealers, buildcoats and topcoats.

Kitchen cabinet compliance

The following is an example of possible compliance strategy for a hypothetical manufacturer of semicustom kitchen cabinets using 100,000 gal/year of conventional finishing materials:

- Appearance stains, 30% by volume, average voc of 6.50 lb/gal, 30,000 gal. Total voc = 195,000 lb.
- Conversion sealer, 40% by volume, 24% weight solids, voc of 5.60 lb/gal, 40,000 gal. Total voc = 224,000 lb.
- Catalyzed topcoat, 30% by volume, 33% weight solids, voc of 5.1 lb/gal, 30,000 gal. Total voc = 153,000 lb.
- Total voc = 195,000 + 224,000 + 153,000 = 572,000 lb.

Some of the stains could be switched to a hybrid coating containing some water. This could reduce the voc of these stains from 6.50 to 5.50 lb/gal, bringing a voc reduction of 30,000 lb.

A waterborne sealer with a voc of 1.63 lb/gal and a weight solids of 35% could be used. The voc savings would be 5.60 - 1.63 lb/gal = 3.97 lb/gal voc. This would reduce voc emissions by 166,624 lb.

The solids of the topcoat could be

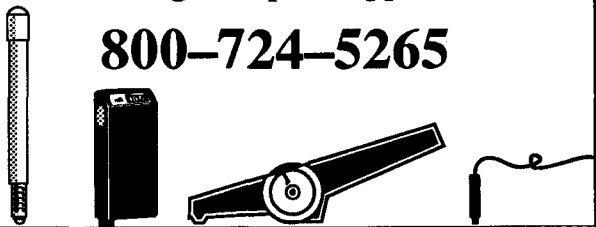
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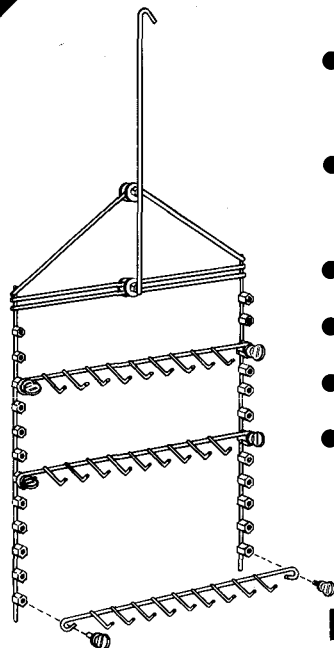


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increased 2% by weight. This would reduce the voc from 5.13 to 4.84 lb/gal, saving 8700 lb voc.

The comparison is:

	Conventional Coatings voc (lb)	Compliance Program voc (lb)
Stains	195,000	165,000
Sealer	224,000	84,256
Topcoat	153,000	144,300
Total	572,000	393,556

Furniture compliance

The following is an example of a possible compliance strategy for a hypothetical furniture manufacturer using 125,000 gal of mid- to high-cost paint a year. Clears, washcoats, sealers and topcoats (all nitrocellulose-based) amount to 60% of coatings use. The breakdown is:

Coating	Use (gal)
Sap stain	7,500
Body stain	8,800
Accent stain	10,000
Wiping filler stain	18,500
Glazes, gun pad	5,200
Clear washcoats	10,000
Clear sealers	20,000
Clear topcoats	45,000

Two stains (sap and body) could be combined, eliminating a stain at 6.8 lb/gal voc.

The 5.5 lb/gal voc wiping filler stain could be replaced by a hybrid at 4.5 lb/gal voc.

A waterborne washcoat could be used at 3.5 lb/gal voc, replacing the 6.5 lb/gal voc coating.

The 6.2 lb/gal voc waterborne sealer could be used at 3.2 lb/gal voc.

One of the 5.9 lb/gal voc lacquers could be replaced with a waterborne buildcoat of 2.9 lb/gal voc.

The comparison is:

	Conventional Coating voc (lb)	Compliance Coating voc (lb)	
Sap stains	51,000	Body & accent stains	102,000
Body stains	59,840	Waterborne washcoat	35,000
Accent stains	68,000	Hybrid water-wipe	
Washcoat	65,000	fill stains	83,250
Wiping/filler		Waterborne sealer	56,320
stains	118,400	Gun/pad/glaze	35,360
Sealer	124,000	First lacquer	
Pad/glaze	35,360	waterborne	55,463
First lacquer	132,750	Second lacquer	
Second lacquer	132,750	conventional	132,750
Total	707,100	Total	500,143

The compliance target date could be 1995. Spraying equipment and holding tanks could keep the material from freezing in the cold weather by adding heat.

The water hybrids and waterborne coatings should be kept at 40 to 45°F when stored and should be close to room temperature when applied.

Robert M. Cox Jr. is former president of the Gilbert Spruance Co. (Philadelphia).

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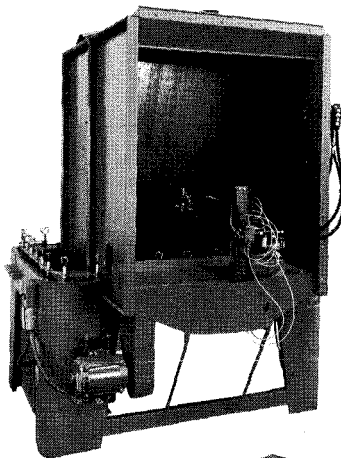
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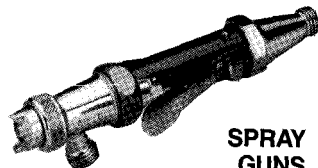
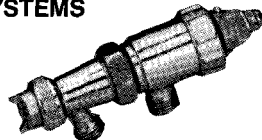
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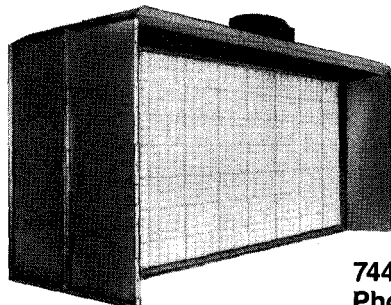


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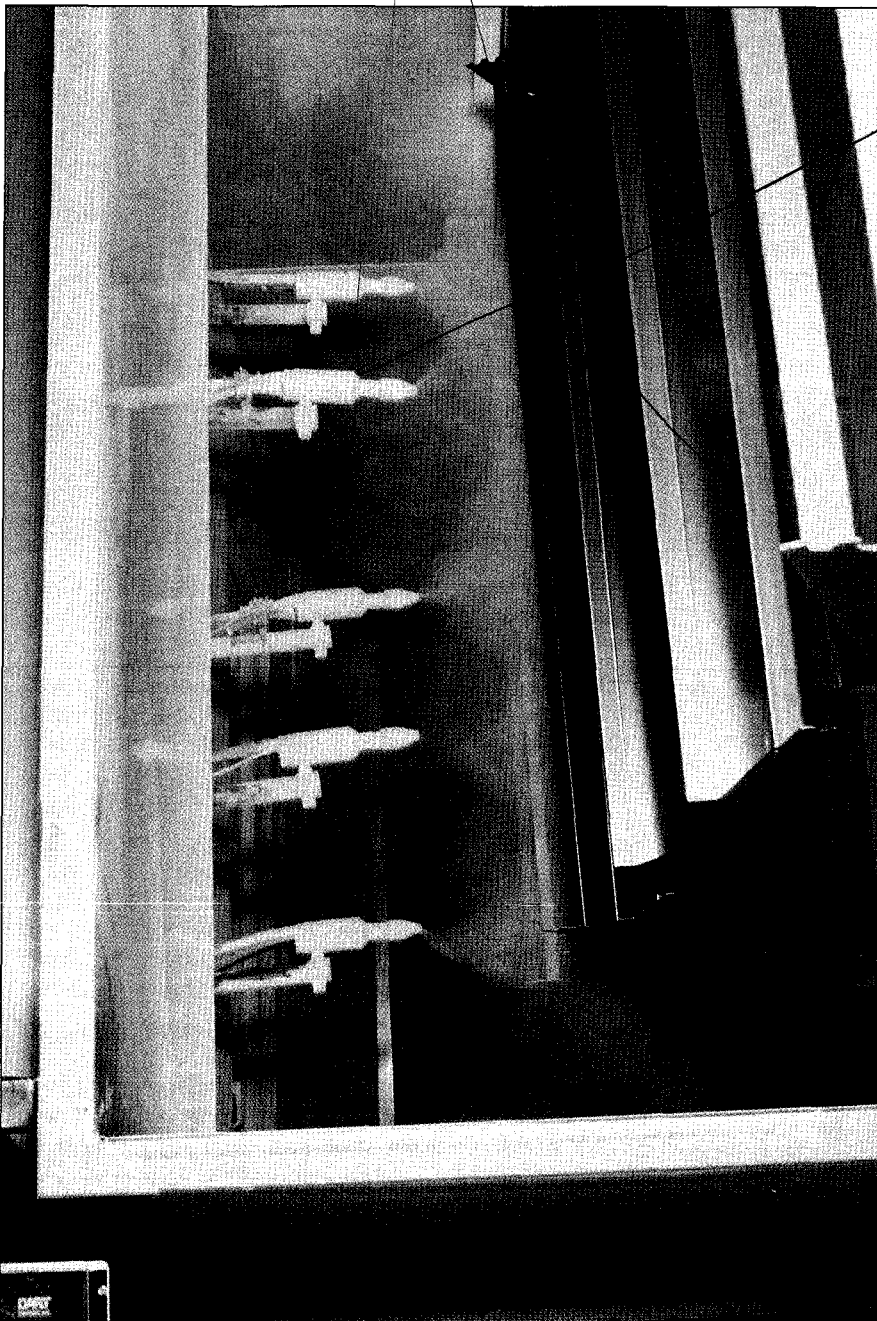
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Powder Saves \$100,000 in First Year

Other benefits for Self Serv Fixture Co. include improved appearance properties and elimination of VOC emissions

Joe Schrantz, Editor



Automatic guns apply powder to merchandise display panels. (Photos courtesy of Reclaim.)

Switching to powder coating saved a Dallas manufacturer \$100,000 in coating materials in the first year of operation. Self Serve Fixture Co. switched to powder in January of 1991. The company makes a line of shelving and fixtures for self-serve retail stores.

The savings come from a vast improvement in materials utilization, according to Charles R. Hickox, president. "System efficiency on our liquid paint line was probably in the vicinity of 40%. This means we were throwing away about 60% of our purchased paint. System efficiency in powder coating runs at 85% when applying production colors and recycling the powder. When applying short-run custom colors, we do not attempt to recover any powder, and system efficiency drops down to the 55 to 60% range. Increasing material utilization from the 40% level is what accounts for the \$100,000 savings."

The company's products include various shelving and fixtures for displaying merchandise, especially shoes. Other products include racks for purses, a variety of benches, folding-leg impulse tables, wire grid units, hosiery displays and general merchandise displays. The company specializes in custom fixturing developed to customer needs and specifications.

Most of the products are made of cold-rolled steel; some are wood. Metal components are fabricated from sheet metal and from square, round and rectangular tubing. From 75 to 80% of the fabricated parts are powder coated. Parts to be powder coated range in size from very small to panels up to 8 ft long. The powder-coating system can process parts up to 30 in. in width and 66 in. in height.

Other advantages

Other advantages in switching to powder, according to Hickox, include:

- Improved properties of the applied coating. "The coating is hard and gives high abrasion resistance. It has a high-quality appearance. We credit improved coating as an important contributor to our 20% increase in sales in 1992 over 1991. We look for another strong increase in sales in 1993 of at least 15%."
- Elimination of VOC emissions. "Our liquid system was giving us VOC-emission headaches. We would have had to make a considerable capital investment to bring our liquid system into full compliance."
- No liquid filter disposal. "Disposing of our spray-booth filters in our liquid booths was a major problem."
- Greatly improved reject rate. "Our powder-coating reject rate is extremely low. It was very high with the liquid system."