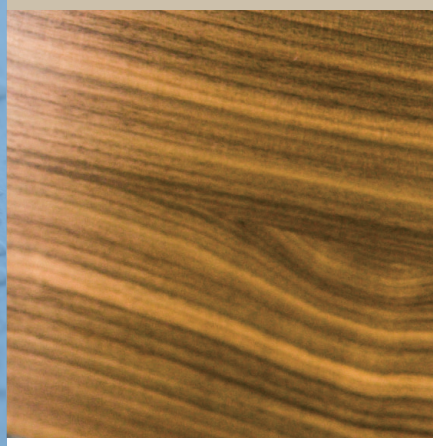
ACROMAPRO™

Facts on Finishing



Foreword

AcromaPro is committed to improving its customers' competitiveness by developing products and techniques geared to their needs and those of the environment.

As new finishing techniques become available, it becomes increasingly important to understand the complex relationship between products, application methods and curing techniques, and how these form an integral part of the finished wood product.

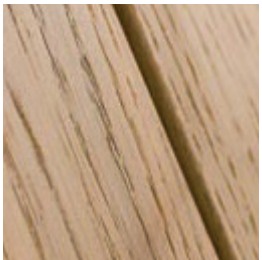
This version of "Facts on Finishing" describes the most common surface finishing materials, the various substrates, and the different application and curing methods. It also addresses topics such as environmental considerations, cost efficiency and the durability of finishes.

We trust that "Facts on Finishing" will prove useful, wherever a basic knowledge of finishing techniques is required.

If you would like more detailed information about finishing techniques or our products and services please contact us. We have a dedicated team of distributors across North America to help serve as your experienced finishing experts.

You'll find a list of our distributor locations on page 6.

You can also send an email to info@acromapro.com for more information.



Contents

Brilliant, cost-effective solutions that help your business grow

YOUR NEED

Planning & Development

New product, new finishing line. Re-design of existing line. Optimized lacquer, paint and stain solutions.

OUR SOLUTION

Our Offer

Advice and assistance with planning, development, training, pre-installation, installation and service. Consultancy for new investments and installations. Testing and development of new, cost-effective lacquer, paint and stain solutions.

Solutions – everywhere

We can help you with the entire process, from evaluating and selecting the proper product to finishing the final product. We develop the customized lacquer, paint and stain products you want and offer a package of services to help you with the application and finishing solutions you need.

Across North America our distributors can help you with any and every aspect of the application and finishing process. In real terms we can help you boost your profits, cut your costs and make your operation more efficient and environmentally compliant. To learn more about how AcromaPro can help you reach your finishing goals, visit www.acromapro.com/distributor-locator and locate a distributor near you.

Where do you see AcromaPro fitting in to your processes?

- Planning and Development
- Quality & Environment
- Implementation
- Maintenance, Follow Up and Optimization

Application areas

- Home furniture
- Office furniture
- Kitchen and bath
- Flooring
- Exterior
- Joinery
- Board

Quality Assurance & Environment

Quality, cost-effective, efficient production, environmentally compliant production process and solutions.

Our Offer

Environmental compliance onsite production-parallel testing and development. Offsite testing and development.

Implementation

Installation and start-up of new production line at your plant.

Our Offer

Integration and running of equipment. Testing/ development and calibration. Cost-effective production and process solutions.

Maintenance, Follow Up & Optimization

Maintaining continuous, efficient production process and results.

Our Offer

We continuously maintain, follow-up and optmize your AcromaPro solutions. We're helping.

We've got it covered

As a leading producer of solutions for the North American wood finishing industry, AcromaPro's products, skills and knowledge extend across the spectrum of wood finishing industries: home furniture, office furniture, kitchen and bath, flooring, exterior, joinery and board.

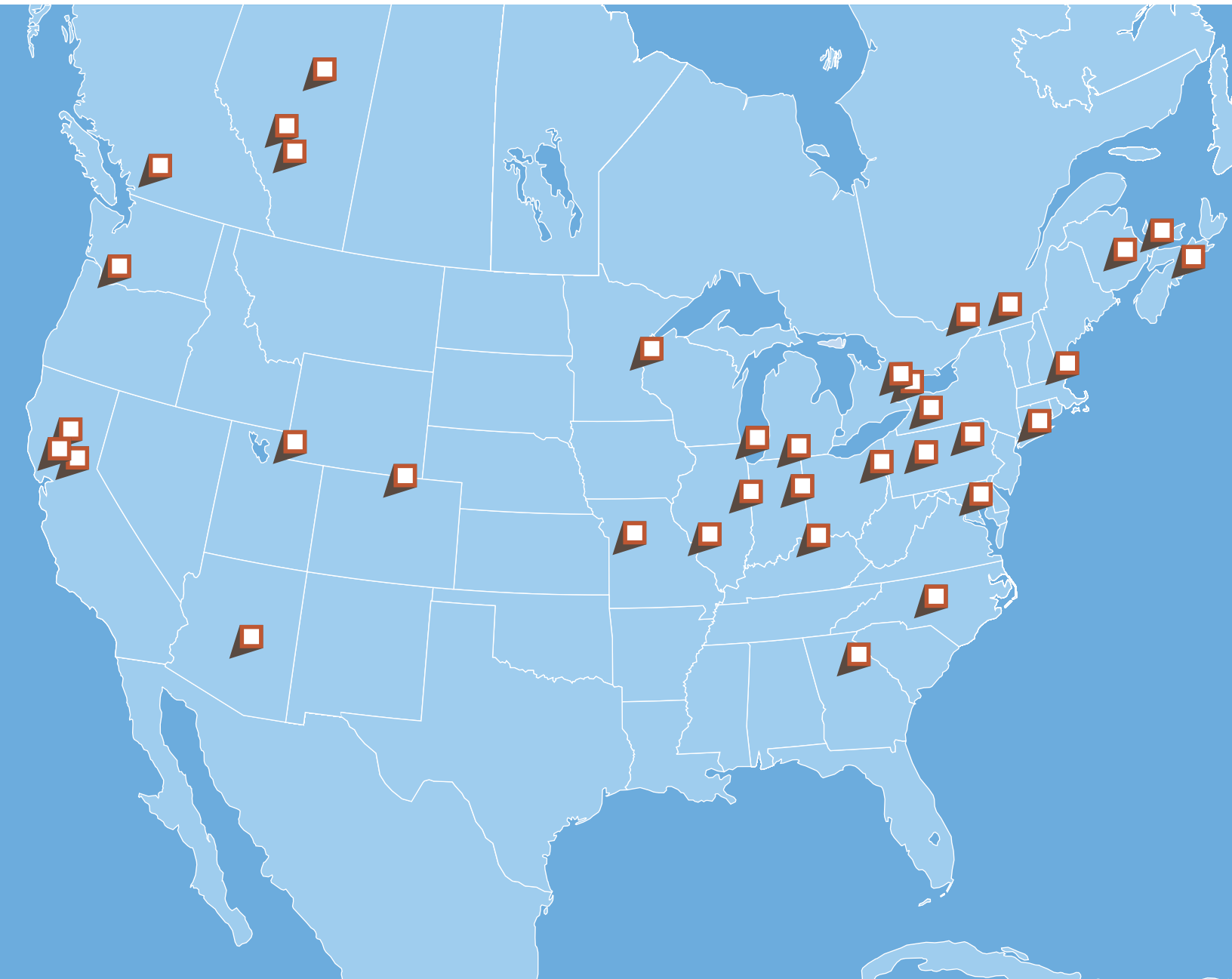
We help our customers gain a competitive edge with our cost-effective, environmentally compliant products that save our customers money and time and reduce environmental impact.Water-based lacquers, paints, and UV-curing products can dramatically reduce the amount of solvent released into the environment compared to traditional solvent-based coatings, while delivering comparable beauty and durability. Contact your local AcromaPro distributor to find out more about our water-based products or visit www.acromapro.com for more information.

Benefit from solutions delivered with the confidence of local support.

Leading solutions delivered locally

Whether or not your business is small, mid-sized or spans across North America, you'll benefit from our innovative technology, product availability, inventory management, color and product consistency and expertise across your value chain. When you rely on us for your finishing needs, you'll experience the personalized support of a local partner backed by the powerful resources of a coatings leader. Our local team of distributors are dedicated to serving your business to align our products and solutions with your needs, no matter where you're located.

If you would like more information about AcromaPro please visit www.acromapro.com.



1. Advice and instructions

This section provides guidance on how to achieve the optimum finish while optimizing capacity and cutting production costs.

1.1 The substrate

The evenness and density of the substrate is critical to a satisfactory finish and low surface treatment costs. It is therefore essential that sanding of the wooden substrate and finished surface is done correctly.

Repairing defects and damage to the substrate during the finishing process is time-consuming and expensive. If defects re-occur you should investigate the source of these and resolve the problem. Avoid using inferior veneers and be precise when trimming and joining them. Sanding through primers and sealers leads to absorption in the substrate causing fiber raising and "matte patches."

To minimize dust in the finishing department make sure that components are dust-free prior to surface treatment. To avoid impurities such as grease, oils, waxes and silicones getting on to the substrate, make sure that your hands are clean when handling the substrate. This will reduce creepage, glossy patches and craters to a minimum.

You can read more about substrates in section two of this guide.

1.2 The container

Water-based products should be kept in plastic or stainless containers. Containers with UV curing products should be stored with lid on, to prevent unnecessary exposure to light.

Acid-curing coatings should be kept in plastic (polyethylene) containers or acid resistant steel, to prevent discoloration of the contents caused by acid acting on the metal of the container. When this happens, the coating acquires a reddish-brown or dark gray hue that discolors light-toned wood. Aluminium should never be used.

Note that the original container is not suitable for mixing. To avoid mistakes, keep unmixed finishing materials in their original containers and use other containers for ready-mixed materials.

1.3 The finishing material

- Ensure that the correct material, color and gloss are used.
- Ensure that the material and substrate are at room temperature.
- Stir carefully. Pigment and flatting agents stratify during storage, so insufficient stirring can cause differences in color and gloss.
- Storage times for paints and lacquers can vary greatly. Conventional solvent-based products normally have a storage time of one year. The storage times for water-based, PE-based or UV curing products can be considerably shorter. It is important to check storage times. These are stated on the product data sheets. The date the product was manufactured and batch number is stated on the container label.

Follow this simple rule – when it comes to stocks of finishing material – first in, first out.

1.4 The hardener

- Check that the correct hardener is added.
- Make sure that the correct quantity is used. Use proper graduated cup for measuring polyethylene or stainless steel. If too much acid hardener is used, for example, the coating may become brittle and cracked (an effect called "crazing"), the hardener may be "sweated out" and the veneer become discolored. Too much or too little PU hardener will result in a coating that is too hard or too soft. An incorrect quantity or incorrectly mixed batch of PE hardener can actually be dangerous and destroy the coating.
- Never add amounts of hardener measured with a "dip stick" or by eye. When mixing PE, never mix the hardener with the catalyst.

1.5 The thinner

In most cases, a certain amount of thinner must be added to the finishing material. Thinners are mixtures of solvents adapted to suit various types of materials and application methods. Ensure that the correct thinner is used and that the mixture is stirred thoroughly.

1.6 Viscosity check

Guide values indicating the appropriate viscosity for different application methods are stated in AcromaPro's technical data sheets. Always check that the mixture has the correct viscosity. Viscosity is normally measured using a cup (DIN cup) featuring a 4 mm drain hole. Some products have higher viscosity or are very thixothropic and must be measured in a DIN cup with a 6 mm drain hole. The cup is filled with the mixture, and the time it takes for the cup to empty is then measured. The time taken, in seconds, is used as a measure of viscosity. Note that the paint/lacquer must be 73°F (23°C), to conform to the DIN criteria. If it has been stored cold, it thickens and more thinner is needed to dilute it. Cold lacquer can result in thin coatings, blistering and other surface defects. When curtain coating or roller coating, check viscosity when starting, prior to and after breaks. Also check viscosity when refilling with a new lacquer and regularly while coating is in progress.

Use an automatic viscosimeter to ensure consistent viscosity. Let the mixed lacquer "stand" prior to use as this releases any air worked in during the agitation process. This is critical when curtain coating, because trapped air bubbles can lead to curtain break, blistering, or foam in the lacquer film.

1.7 Pot life

The curing process (polymerization) starts when hardener is added to a two-pack finish. The time it takes for the mixture to gel (set) after adding hardener is called the pot life. Depending on the type of lacquer, the pot life can vary from a few minutes to several weeks. If all of the ready-mixed, acid-curing lacquer cannot be used on the same working day, the surplus can usually be mixed into the next day's batch. If this is the case, observe these ratios: one part of the original mixture to two parts of the new. This eliminates differences in gloss, and the lacquer retains its original properties. Always consult your supplier about the best way to store and use your lacquer. All polymerization will cease when kept in sub zero storage.

1.8 Quantity applied

AcromaPro has prepared a list of recommended application quantities for different types of lacquer. These are guidelines only, and you can add to or reduce the quantities to achieve the desired result. Maximum values are indicated for some lacquers. These apply mainly to light-colored sealers and very fast drying two-pack finishes. If these lacquers are applied too heavily, problems such as cracking may arise during the subsequent finishing process. When spraying, it can be difficult to determine the amount of lacquer to be applied to a given substrate. One way of measuring the approximate amount to be applied is to test spray a surface, and then lacquer a piece of paper as described below. Careful checking of viscosity and the quantity of lacquer applied ensures a uniform result and minimum consumption. When curtain coating, check the amount to be applied by coating a piece of paper and weighing it on a scale. Do this at the start of operation, prior to and after breaks, each time the coater is filled with new lacquer, and at least every hour while coating is in progress. The amount applied can be checked using a 10 in. x 15 in. (150 sq. in.) (250 mm x 400 mm (0.1 m^2) sheet of paper. Weigh the sheet, attach it to a board before coating, and weigh it after coating. Calculate the difference and multiply by 10. An even easier way of doing this is to calibrate the scale to zero to calculate net tare (i.e. the scale is adjusted to zero with an uncoated sheet on top).

1.9 Drying – curing

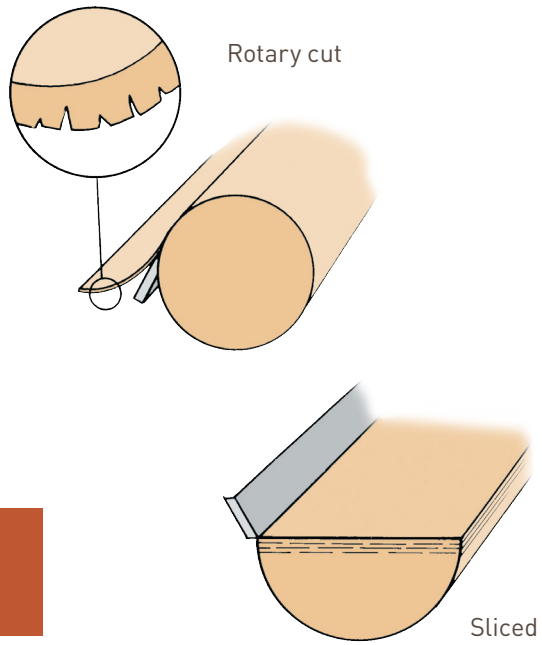
The drying time for different coatings can vary considerably, depending on fluctuations in temperature, air supply, humidity and the amount applied. When a coating is dried and cured at room temperature, with no heat or air supply other than that designed for heating and ventilating the premises, drying times for the same coating will always vary. Low nighttime temperatures and/or excessive humidity can severely inhibit the curing process, reducing abrasion resistance and resulting in sticking when stacking newly coated products. These problems will increase with water-based products. At low temperatures the film forming process in water-based products will stop and cannot be restarted by increasing the temperature later. Drying and curing at a higher temperature, in combination with effective ventilation, will always reduce the curing time and ensure an optimal finish. Refer to the "Drying and curing" section for more information.

1.10 Sanding finishes

Curing times for coatings have been reduced in recent years, at the same time that the finishes themselves have acquired increased resistance to chemicals and solvents. Consequently, the finish must normally be sanded on the same day/shift, before adding a new coating, to avoid problems with poor adhesion. This is especially important if the coating has been cured at a higher temperature (curing oven) or if the period between coatings is prolonged (such as a weekend). Read more about this in the "Sanding" section.

2. The Substrate

The correct choice of substrate and correct treatment is crucial to the final result in all types of surface treatment. In this section, we highlight some of the fundamental factors to achieving a successful result. If you are uncertain about the suitability of your wood substrate for surface treatment, or have other questions about the finishing process, please contact us for help.



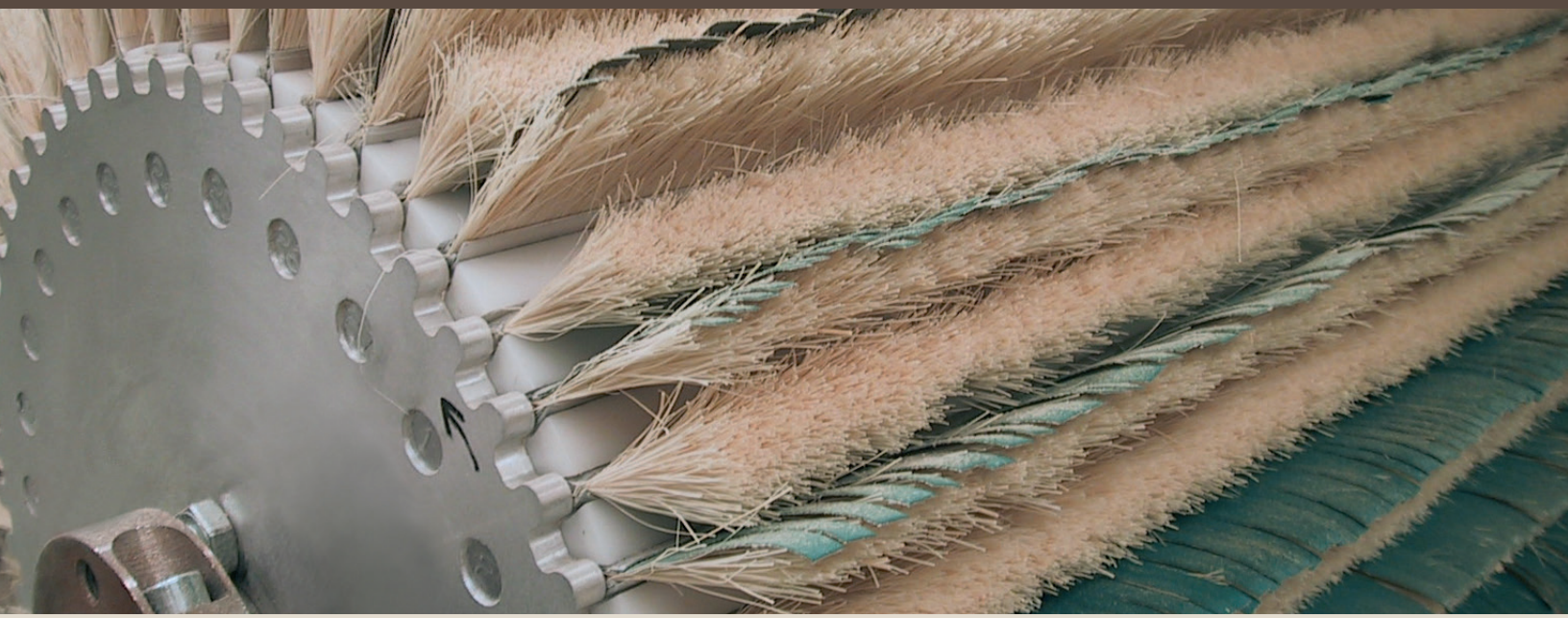
2.1 Solid wood and veneers

The wood substrate, whether solid wood or veneer, is a natural product of indigenous or non-indigenous trees. Regardless of origin, the structure of these trees has a number of common features. An annual ring is formed for every year of the tree's growth. This annual ring consists of a light-colored band of spring growth (early wood), followed by a darker band of autumn growth (late wood). Taking a closer look at the wood cells, which are the tree's building blocks, the cells of early wood feature thin walls and large cavities, while those of late wood have thick walls and smaller, flattened cavities. Consequently, late wood is a harder and denser material than early wood. This is worth remembering, since it has a significant impact on the end result. When working the wood, blunt cutting tools can cause "depressions" in the soft early wood and these become visible when the surface is stained or lacquered. This problem is further accentuated if water-based materials are used. Certain conifer species, known as "pitchy" woods, have a high resin content, while the cellular structure of deciduous species often have large cavities or "pores." These radically differing properties demand quite different approaches and present various problems when sanding and surface treating the wood. Coarse-pored species of wood such as ash, mahogany and koto form a beautiful substrate for a range of surface treatments, such as rustic staining. However, they can also cause a number of problems: blistering, a common problem that can arise after surface treatment; problems with good wetting properties when using water-based finishes; problems associated with removing sanding residues from the pores etc. Veneers demand certain special qualities of the surface treatment material. Veneer is manufactured by slicing or rotary cutting in thicknesses that normally range between 1/64 in. and 1/32 in. (0.5 and 0.8 mm). Consequently, breaks can easily occur during the manufacturing process and then appear as cracks in the veneer and coating.

2.2 Board materials

Chipboard (particle board), MDF board (Medium Density Fiberboard), HDF board (High Density Fiberboard) and hardboard are the dominant materials in the production of furniture and fittings. Chipboard is available in a number of different types and qualities, geared to a range of different applications. It is manufactured with a number of different finishes: with a veneer; coated in paper, foil or melamine; or primed and sealed and featuring a surface smoothed with filler. Each type of board requires its own special treatment. Melamine-coated board requires special treatment to ensure good adhesion. Choosing the appropriate finishing technique is therefore crucial to cost efficiency and the end result. MDF board has, in principle, replaced solid wood as the material of choice for machined and profiled wood products, it requires special pre-treatment and finishing. It is important to select the right type of steel and cutting angle when machining, and to fine-sand the wood with sandpaper of the correct grain size. MDF board always requires a finer grade of sandpaper than solid wood. For more details, please refer to the "Fine-sanding wood" section. The AcromaPro range of solvent-based and water-based products and UV curing systems meets every requirement, across all MDF board types and all production process. To avoid cracking and delamination, MDF board must have the right moisture content. This should be monitored before and during the application process. In general, a moisture content of 6-8% is recommended.

3. Sanding



Number of Sanders	1	2	3
Calibrating sanding, with substantial wood loss	40.50	40+60	36+50+80
Calibrating sanding, with less stock removal	80	50+80	40+60+100
Sanding of solid wood		80+120	60+100+150
Sanding of solid wood with high quality finish		100+150	80+120+150 (alt. 180)
Sanding of veneer		120+180	120+150+180
Sanding of MDF*	220.240	180+220 (alt. 240)	180+220+280
Sanding the finish	320.400	400+500	400+500+600 (alt. 800)

* The final sanding belt should feature a silicon carbide coating.

3.1 Wood sanding

Correct sanding techniques, combined with the right finishing material and technology, all make for a quality finish. A quality finishing material can never compensate for poor pretreatment or a poor quality substrate. The surface treatment process is more likely to exaggerate any defects in the substrate, rather than masking them.

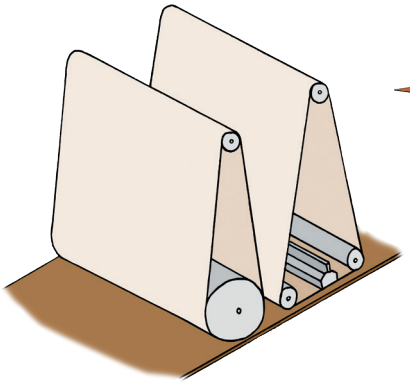
3.1.1 Points to keep in mind

- All surface treatment should be performed as soon as possible after pretreatment and preferably on the same day. Wait too long and problems will arise. The wood will swell more, the resins in the wood will rise to the surface and there will be an increase in fiber release. Ideally, finishing should be done "online" and just after pre-treatment.
- Pre-treatment smoothes away differences in the substrate. The more uniform the properties of the material passed from one unit to the next, the more consistent the result. Ensure that film-thickness tolerances are rigorously observed, especially when roller coating. They should be kept to an absolute minimum of no more than +/- 1/64 in. (0.2 mm).
- Fine-sanding will eliminate any traces of "cutter marks."
- The air in a wood finishing plant, especially during winter, can be very dry. Consequently, the wood raw material can dry out rapidly, leading to warping. Warped material poses severe handling problems in a well-controlled process and can often cause through sanding, uneven coating etc. Avoid this by checking and regulating the humidity in the finishing department.
- Correct pretreatment eliminates all mechanical defects in the substrate – soiling, depressions etc.
- Correct fine-sanding ensures uniform and attractive staining. Sanding that is too coarse causes excess stain penetration, producing a dark finish. Sanding that is too fine inhibits stain penetration, producing a light finish. It also causes the stain to puddle over the surface, creating a blotchy, uneven effect.

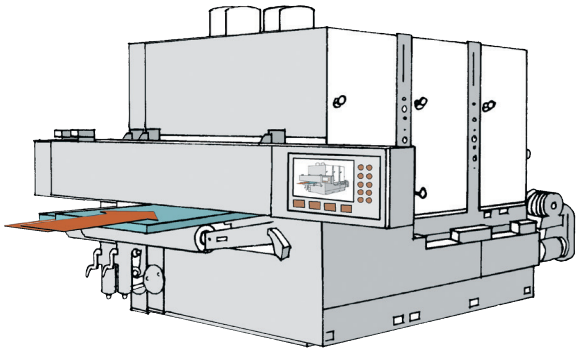
3.1.2 Grain size

There are many grain sizes to choose from when sanding. The normal range for widebelt sanders is 24 to 800. The lower the number, the coarser the grain, and vice versa. Coarse grains remove more than fine grains and have a longer service life. The coarser the grain selected, the cheaper the sanding process per component. Conversely, coarsely sanded substrates require more lacquer and more sanding of the sealer. The finish will be much better on a finely sanded component if 180 grain sandpaper is used instead of 120 grain. This produces significant fiber release, binding the primer above the true surface. Sanding with 180 grain paper reduces fiber release, improving primer penetration of the wood substrate and avoiding the need to

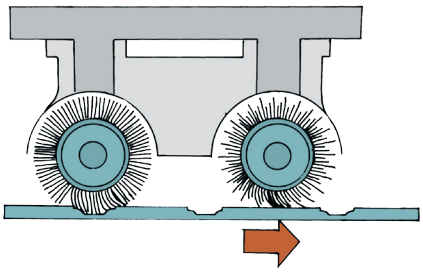
Grain	Stock removed
24-50	Coarse sanding 5/64 in. - 1/64 in. (2.0-0.5 mm)
60-100	Intermediate sanding 3/64 in. - 1/64 in. (1.0-0.3 mm)
120-180	Fine sanding
280-800	Superfine sanding (lacquers)



Working sketch of a widebelt sanding unit, featuring a roller and pad.



Widebelt sander with crossbelt.



Profile sander; traditional and with supporting brushes.

sand away surplus primer. It therefore pays to select a fine-grain sandpaper for the final fine-sanding process. If this sanding is done immediately prior to applying the primer, good adhesion is assured. A sanding belt featuring a one grade finer grain can reduce paint consumption by as much as 20%. A two-grade increase in grain size is a reasonable step between each sander or sanding process. This usually ensures good load distribution between sanding belts and contributes to a satisfactory service life. Practical tests, including a follow up of the sanding result, must be conducted to determine the optimum combination. The examples above of commonly used grain series can provide a useful guide when selecting the most appropriate grain sizes.

3.1.3 Type of sanding unit

Several methods can be used for fine-sanding wood: a cross belt and sanding pad, a widebelt sander and sanding pad, a roller sander or various combinations of all three. Determining the best method for each occasion depends on a number of variables, such as the material/substrate, the required result, the choice of surface treatment material etc. When using water-based finishing systems for example, pre-sanding treatment most often differs from that required when applying UV curing systems or solvent-based finishing systems. Another method that can be used in combination with widebelt sanding, or on its own, is brush sanding (denibbing). This is a very common method for lacquer-sanding sprayed articles such as mouldings and kitchen cabinet doors. In some cases it can even replace a widebelt lacquer sanding machine. Different combinations of brushes, strips and grain sizes are used for sanding different articles.

3.2 Lacquer sanding

There are two primary reasons for sanding: to create the best possible surface, by removing raised fibers, burls, excess lacquer and any surface defects; and to ensure good adhesion between different coats of lacquer. Generally speaking, sanding includes the sanding of filler, primer or sealer. Finishing (application of lacquer and numerous sanding stages) should be conducted on the same day as fine sanding of the wood substrate, or at least as soon as possible, to protect workpieces from dirt and to inhibit raised fibers caused by humidity. Ideally, the finishing line should be directly adjacent to the wood fine-sanding unit. When using two-pack, acid-curing lacquers, sanding of the lacquer must be conducted on the same day/same shift as the next stage in the finishing process to avoid adhesion problems. Well sanded wood, meticulously cleaned workpieces and uniform application of primer reduces the need for subsequent sanding of the lacquer to remove surface defects. An additional benefit is reduced cost, thanks to reduced lacquer consumption and fewer rejects. Completely clean workpieces are essential to ensure correct lacquering, and anti static sanders form the basis of a thoroughly dust-free process.

Care in fine sanding the wood substrate and thorough inspection prior to finishing always pay dividends. There is a general misconception that defects and damage incurred during the finishing process can be repaired. This is not the case. No matter how excellent the finishing material, it can never compensate for poor fine sanding of the wood or for a sub-standard substrate. If the sanding is not fine enough, the lacquer cannot fill the sanding scratches. This will result in a "thin" surface. The most common defects on newly finished furniture are sanding scratches, "thin" surfaces and sections where the lacquer has sagged.

Brush sanding head

Remember: A well-sanded surface is halfway to the perfect finish!

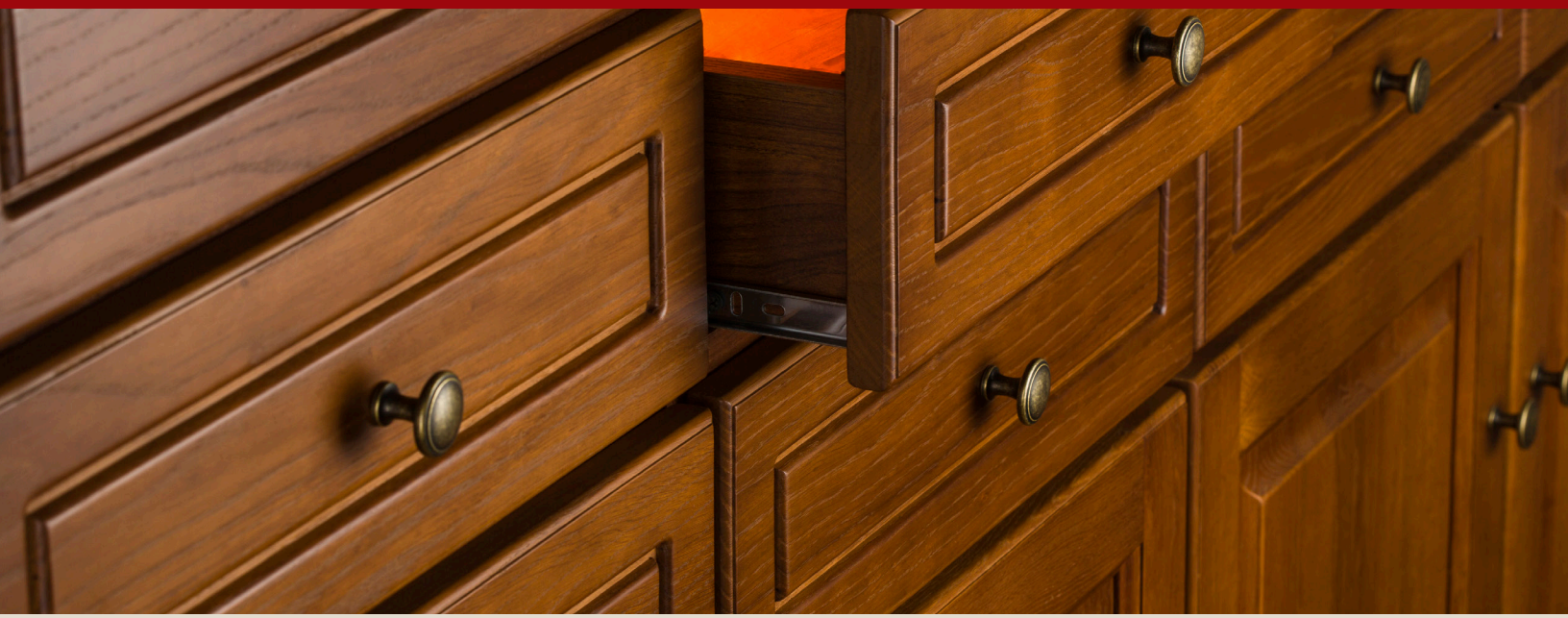
Sanding the wood is designed to ensure that the lacquer adheres well to the substrate. The entire surface must therefore be sanded clean. Most modern lacquers are not especially sensitive to solvents, making sanding between coats essential to achieving satisfactory adhesion. The way lacquers are applied, dried and cured is what determines the actual service life of sanding tools. Sanding poorly dried workpieces, or workpieces with excess lacquer, can clog the sanding medium and thereby reduce the service life of the sanding belt. The way the lacquer is sanded has a decisive effect on the quality of the final finish. It is important to ensure that no scratches or sanding patterns arise in connection with sanding. A clogged sanding medium can destroy an otherwise good finish.

When staining, uniform sanding of the wood is important to ensure that the stained color appears consistent and uniform. Cutter marks in the surface can, for example, result in light colored lateral streaks on the "peaks" of the workpiece where sanding has removed the stain. These cutter marks absorb varying amounts of stain and thereby enhance the uneven impression given by the workpiece's surface. This type of surface defect remains visible even after clear lacquering and top coating. In some cases it is actually better to use a coarser grit to obtain a homogenous stain picture. Sanding lacquer with a widebelt sander demands a special technique. This requires a correctly adjusted sander with variable belt speed, low belt tension and a pliable sanding pad.

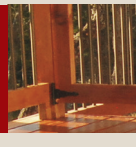
As in wood sanding, using a cross-sanding unit on the primer improves the final finish. The belt speed should be low when sanding any type of lacquer (less than 39 ft/min (12 m/sec) and adjustable down to3 ft/min (1 m/sec) according to type of lacquer and curing stage. Fully cured and hard polyester coating can quite safely be sanded at39 ft/min (12 m/sec). Lower belt speed should be used for less cured coatings. Sanding two-pack and UV lacquers is a relatively simple process. Thermoplastic and water-based coatings, however, are often more difficult to sand. One possible approach that can prevent problems is to keep the sanding belt at a very low speed, adapting it to the predetermined feed speed of the production line. Where possible, the sanding belt should run counter to the direction of the feed conveyor, to ensure a finish that is fully satisfactory. This is as important when sanding lacquer as when sanding wood. Grain size is determined by several factors. Silicon carbide is still the most popular choice for intermediate sanding of coatings. It produces the finest finish thanks to the shape of the silicon carbide grain. A surface finish of this quality is sometimes necessary prior to applying a topcoat, such as in the case of high-gloss paints, especially in darker colors, or in cases where the topcoat is to be polished to a high gloss.

A good alternative for intermediate sanding is the corundum grain. Its pointed, sharp-edged form ensures less glazing, less friction and reduced temperature fluctuation because lower sanding pressure and belt speed is common when using corundum, versus silicon carbide sanding belts. This often increases the service life of the sanding belt. Corundum produces slightly deeper surface scoring than silicon carbide. Corundum is often the best solution, for water-based lacquers in particular and for thermoplastic lacquers in general. When water-based lacquers are used, a well-sanded wood surface is even more crucial to the quality of the final finish than when using conventional lacquering systems.

4. Paints, lacquers and stains



Wood finishing materials consist primarily of a binder, a solvent and a range of additives. Colored paints additionally contain pigment and filler.



4.1 Binders

Binders may be "dissolved" or dispersed and feature a range of properties – such as wetting, film formation and penetration – that can be altered and controlled. Binders provide the coating with properties such as good adhesion, flexibility, durability, body and numerous other beneficial characteristics. Typical binders include nitrocellulose, alkyd resins, amino resins, acrylates and polyester resins.

4.2 Solvents

The type and quantity of solvent used in the binder determines the consistency, ease of application and wetting properties of the selected coating and, to some extent, film drying time. In this respect, water-based coatings function and react quite differently from solvent-based systems. Wetting properties, surface tension characteristics, film formation etc., are controlled in different ways and react quite differently to various surfactants. What is "correct" when using solvent-based systems may be "incorrect" when using a water-based system. When delivered, the coating will contain a specific mixture of solvents, formulated to optimize its properties. When applying the coating, more solvent, normally in the form of a thinner, is added. The amount added can be adjusted to enhance the end result (i.e. improved flow, better adhesion and rate of evaporation, elimination of blistering, etc.).

4.3 Additives

These are used for controlling certain finish properties, such as gloss, consistency, wetting, flow, blister prevention and sandability.

4.4 Pigments

Pigments are used to give finishes hiding power and a specific color. The AcromaPro range of paints uses non-toxic pigments only. Pigment is also used in glazes to obtain the right color. Both dye-stuff and dispersed pigments are used for stains.

4.5 Different types of finishing materials

Depending on what binders they contain, lacquers, paints and fillers pass through different phases during the curing and drying process, and may therefore be classified as follows:

4.5.1 Water-based products

These mainly comprise thermoplastic systems, mostly acrylate dispersions. These can be one-pack, two-pack or UV curing systems. There has been a dramatic increase in demand for water-based systems, both clear lacquers and pigmented products, over the past few years. In terms of quality they have improved significantly and are AcromaPro's fastest growing product segment. There is now a water-based alternative for every application area and these products cure faster than conventional systems. It is worth noting that moving from solvent-based to water-based systems requires a complete change in technology. Making the change demands a thorough review of the customer's existing production technology and then this must be modified for water-based products. Environmental legislation concerning reduced solvent emissions are forcing increasing numbers to use water-based systems or invest in various forms of emission control and cleaning systems. AcromaPro is a leader in developing a complete range of water-based solutions for the wood finishing industry.

4.5.2 Air-drying products

This refers to coatings that dry through solvent evaporating. These include cellulose-based lacquers where drying time can be sharply reduced by heating and good ventilation.

4.5.3 Reaction-curing products

With this group of products, the curing process is triggered by a chemical reaction. In many cases reaction-curing coatings are two or multi-pack products.

Acid-curing systems

These products are based mainly on alkyd and amino (urea or melamine) resins, often combined with nitrocellulose. The hardener (acid component) is a catalyst that starts and maintains the binder's curing process until the chemical reaction is complete. The solvent evaporates prior to and during the chemical reaction, and forms no part of the final film of lacquer, paint or filler. Curing of acid-curing products can be dramatically accelerated by applying heat. In most respects, acid-curing products offer the optimal combination of required properties; they combine a competitive price per square foot (metre) with high durability, rapid throughput and uncomplicated production processes; they can be combined with "mild" solvents and have a relatively high dry-solids content. A disadvantage is a limited release of formaldehyde in connection with the curing process. AcromaPro offers a range of AC-products that emit less formaldehyde than the natural background emission.

Unsaturated polyester systems

A cobalt catalyst and peroxide hardener are added to these products to initiate and maintain the curing reaction. In this case, solvent must also be added. This may be styrene – that also functions as a reactive element of the paint system and is included in the final coating – or conventional solvent that must evaporate first. Polyester resins offer several benefits, including more body (high dry-solids content) combined with high reactivity. The disadvantages are limited pot life and the fact that both hardener and catalyst require careful storage and handling. Pot life can be extended considerably by using mixing pumps that feature multi-component dosing, or curtain coaters with two wet-on-wet heads. In this case, the catalyst is mixed into the lacquer from the first head, while the hardener is mixed from the second.

Polyurethane systems

Polyurethane products are two-pack systems in which hydroxyl groups (the binder) react with isocyanate resin (the hardener). With pure polyurethane products, applying heat does not appreciably accelerate the curing process. With blocked polyurethane products, however, heat does accelerate the curing process. These types of products have been attracting interest because of new pending regulations covering formaldehyde-free processes. They offer a promising alternative to acid-curing lacquers, thanks to their rapid development in recent years and the sharp reduction in the previously high level of free isocyanate. AcromaPro has developed a process that ensures extremely low levels of free isocyanates.

UV curing systems

UV lacquers refer to products that are cured by exposure to UV radiation. They may be based on unsaturated polyesters, although acrylate-modified polyesters, polyurethanes or epoxy binders are more common. These are also called pre-polymers. Polyester is often diluted with styrene, vinyl ethers or an organic solvent. Acrylate pre-polymer is often diluted with a low viscosity binder. These are not volatile like an organic solvent, but form a film with the pre-polymer by cross-linking. A photo-initiator must be present to catalyze the crosslinking process. Its purpose is to transform UV radiation and initiate the curing process by means of a chain reaction. This curing process is very rapid. UV curing products with a dry-solids content of 100% are best suited to roller coating. One-pack pigmented UV curing lacquers require UV lamps, known as "Ga-lamps," featuring a staggered wavelength area (400-420 nm).

Otherwise, normal UV lamps (200-400 nm), known as "Hg-lamps," may be used. Designing a pigmented UV system for roller coating demands a thorough knowledge of roller coater techniques to achieve a superior finish. Combined systems with water-based primers and UV curing products may be a more economically viable solution for some surface qualities. Water-based UV curing systems can be one or two-pack systems, for clear or pigmented coatings. One-pack systems are the most common and are suitable in most situations and can replace most solvent-based systems (i.e. AC, PU). To ensure proper curing of the edges when using one-pack systems, UV ovens with inclined lamps must be used. The advantage of such systems, apart from the fact that they can be curtain- coated or sprayed, is that once all the moisture has been removed and the UV curing has been completed, they produce a non-thermoplastic finish that is fully comparable with the high durability commonly associated with conventional UV curing systems. Two-pack systems are used when extra high demands are required of the finish or when inclined lamps are not available.

4.6 Stains

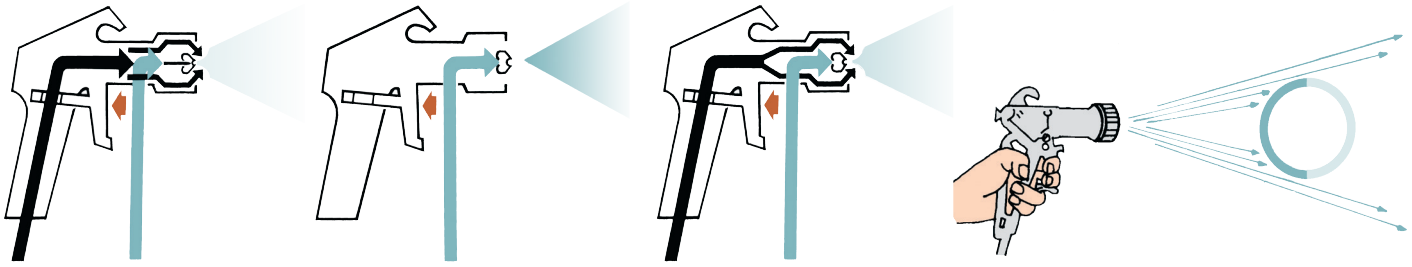
Stains are used to add color to wood without hiding the structure of the substrate. They consist of dyes and very finely dispersed transparent pigments, water, solvent and binder. Earlier, staining mainly involved solvent-based stains. In recent years, however, water-based stains have been developed and now dominate the market. Two factors in particular have contributed to this. Water-based stains make the structure of the substrate appear more consistent and there are obvious environmental gains. During the staining process the more porous portions of the wood absorb more stain, creating a reversed stain image. Stain can be applied using highly effective finishing line techniques such as spraying, roller staining or flowcoating. Stains can also be applied manually by dipping, by brushing or by sponging. Depending on quality, however, these can differ greatly. For example, a roller stain is much more concentrated than a spray stain. Also keep in mind when staining that fine sanding of the substrate is crucial to the end result. The color can vary considerably depending on the size of grain and type of sandpaper.

For this reason, always conduct a stain test before starting production to check and determine the color and appearance of the stained product. When using UV curing systems, be very careful when selecting the stain quality as there is a risk of bleeding or color changes in the stain.

4.7 Surface treatment with oils

Oil has a strong, penetrating effect on wood and varies according to the structure of the substrate. How the wood has been prepared has a dramatic effect on the amount of oil the wood absorbs. A solid but unevenly grown piece of wood will demonstrate very different absorption characteristics and may give the oiled surface a blotchy appearance. Normally, the surface must be dried and perhaps sanded again before the next layer of oil can be applied. Oil can be lightly tinted to function both as a stain and surface protection. Here, a smoothly sanded surface with consistent absorption characteristics is critical. All oiled surfaces require periodic after-treatment to retain their protective properties.

5. Application methods



Spray gun for conventional spraying.

Spray gun for airless spraying.

Spray gun for airmix spraying.

Conventional spraying.

5.1 Conventional (low pressure) spraying

This is the most flexible and adaptable application method in which the finishing material is transported and dispersed with compressed air. The finishing material is fed forward to the paint nozzle. The flow is controlled by a needle valve, operated via the spray gun trigger. When the trigger is depressed, the compressed air valve is opened first. The needle is then drawn back, and the finishing material can pass through the paint nozzle. The paint meets the jets of air beyond the nozzle and is atomized in the form of tiny droplets. Spray width and spray pattern (spray fan) are regulated by the amount of air supplied to the air nozzle. The finishing material is fed to the nozzle by suction or pressure generated by a pump or pressure vessel. The correct spray nozzle must be selected, according to the method used. The amount of finishing material can be roughly regulated by adjusting the pressure in the lacquer container and the size of the hole in the spray nozzle. Fine adjustment is achieved by changing the length of stroke of the needle. The disadvantages of conventional spraying are the relatively slow production rate, fairly high paint consumption and high environmental load.

5.2 HVLP

Conventional spraying has been modified to reduce overspray. The spray gun and nozzle have been modified to atomize the paint using a large volume of air at low pressure; the High Volume, Low Pressure (HVLP) method. This method has shown to be suitable for application of 100% solid UV products at very low application amounts less than 1 mil (1 1/1000 of an inch) (30 g/m). In some places around the world HVLP-like systems are mandatory to reduce emissions.

5.3 Airless spraying

This method offers certain advantages compared with conventional spraying, but is not as flexible when regulating spray-fan width. Atomization of the coating is less satisfactory and in some cases inadequate. It is a rapid method with a minimum of overspray. With airless spraying, the finishing material is fed forward to the spray gun nozzle under high pressure (as much as 200 bar). It is atomized as it passes through the spray gun nozzle. Pressure is generated by a piston pump. Spray width and paint/lacquer quantity are adjusted by replacing the spray gun nozzle. Better atomization can be obtained by using a "pre-nozzle" (a.k.a. fine finish nozzles), which makes the spray fan less elliptical (to achieve a less diffuse spray pattern). Airless spraying is now widely used when applying water-based finishes with automated spray coating systems.

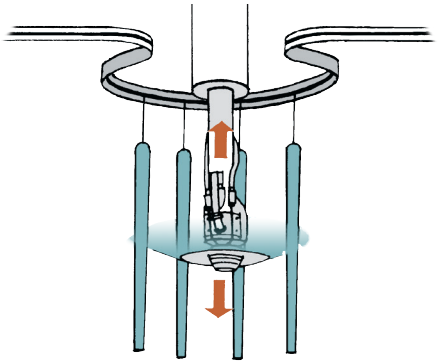
5.4 Airmix spraying

Airmix spraying is one of the most commonly used spraying methods in the wood finishing industry because of its fine atomization and minimum overspray attributes. Some spray gun producers offer nozzles specially designed for either solvent-based or water-based systems. The combination comprises:

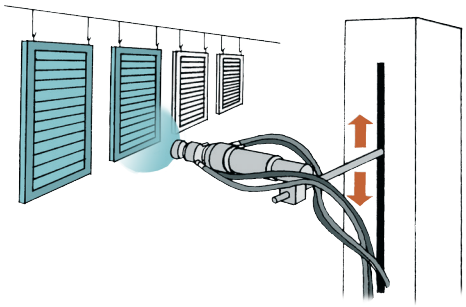
- A high-pressure pump featuring an adjustable pressure of 15-45 bar (far less than for airless spraying). The pump sucks the finishing material from an open container.
- A spray gun with a high-pressure nozzle and an air nozzle for atomization and spray-width adjustment, that can shape the mist of coating to a spray fan. The air pressure used to atomize the coating is usually very low – no more than 0.5-2 bar – with air consumption of approximately 1.4 cubic feet (40 litres) a minute. The finishing material is fed from pump to spray gun via a thin hose. The pump has a pressure relief valve to adjust the amount of compressed air fed to the spray gun nozzle.

5.5 Hot spraying

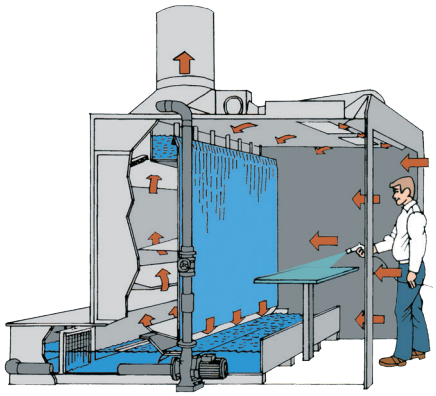
When spraying 100% solid UV materials, the viscosity can be controlled by using hot spraying to achieve good leveling. When using this type of system the material must be constantly circulated to avoid polymerization. The technology can, in some cases, be used to reduce the use of thinners in solvent-based systems, and enable their compliance with local emission regulations



High-speed rotary disc



High-speed rotary bell



Spray booth with water curtain

5.6 Spray booths

When spray painting, premises must be effectively ventilated to remove solvent emissions and other chemical substances associated with the finishing material. Spray rooms or spray booths are used for manual spray painting. Although such facilities are equipped with some form of separation system for solid particles, solvent emissions have until now generally been released direct to the open air. However, efficient techniques now exist for cleaning this type of emission. Spray booths are designed according to the dry or wet separation principle. The latter is most efficient and should be used for continuous spray painting, but demands higher maintenance than the dry method. However, the risk with the dry separation method is that the overspray can in some cases self ignite when using products containing oils or alkyds (such as NC and AC products). This problem can be avoided by cleaning the spray booth daily and soaking the used filters and overspray in water outside the building.

5.6.1 Choice of spray booth

It is important to select the correct size and type. Air consumption is considerable, and the energy expended on heating the air to room temperature incurs substantial costs. Energy recovery from exhaust air from spray booths is difficult and costly for a variety of reasons. The best way to reduce energy consumption is to install a spray booth dimensioned for current needs, and to turn off the fan when painting is not in progress.

5.6.2 Suction hood – evaporation zone

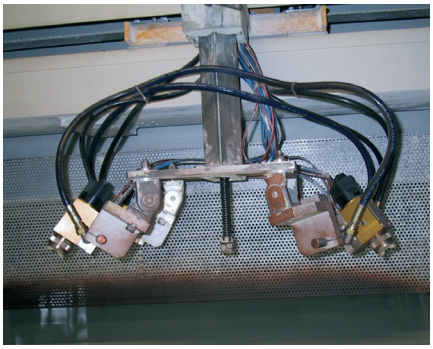
Newly painted products release a range of solvent and chemical emissions that can pollute the air breathed by workers in the paint unit. Such newly painted products are normally placed in drying trolleys. Before they are placed in the drying room or curing oven, the paint film is highly sensitive to dust and draughts. A suction hood prevents emissions from newly painted products escaping into the ambient air. The ventilation air in the hood also helps accelerate solvent evaporation.

5.7 Air extraction for application equipment

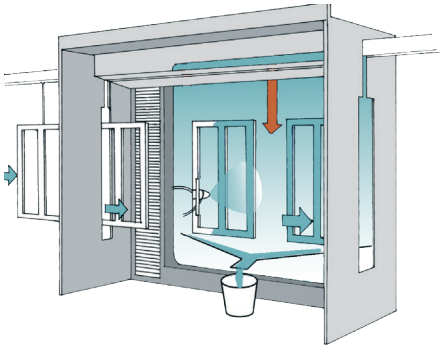
All solvent emissions are heavier than air. The air extraction system should therefore be located near the base of application equipment where air flows are not normally directed.

5.8 Cleaning of/heat recovery from exhaust air

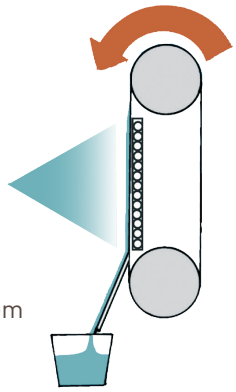
Demands from authorities for the reduction or elimination of solvent emissions, combined with increasing energy costs, have resulted in the development of a range of new cleaning and heat recovery solutions for solvent-saturated exhaust air. These are fully viable solutions, even if the initial investment cost may be high, and offer the only acceptable approach where UV curing or water-based paint systems cannot be used. There are a number of different "catalytic" incinerator systems on the market, with a normal working temperature of approx. 662°F - 840°F (350°C- 450°C), or ceramic incinerators with working temperatures of 1292°F (700°C) or higher. Both types must be fed with a fairly consistent stream of solvent-saturated air to sustain the combustion process. During production stops, the incinerators must be kept up to temperature from an external power source, adding to operating costs. Such incinerators are therefore best suited to large-scale industrial production, with several shifts. AcromaPro, offers products suitable for biological cleaning and has long been a pioneer in introducing the most environment-compatible, solvent-based products on the market. The majority of these products are based on ethanol and esters. Biological cleaning of solvents can produce extremely good results, and the method is less dependent on a continuous production process. In a biological cleaning process, the solvents should be free of aromatic and aliphatic hydrocarbons to achieve optimum results. AcromaPro's specialists can contribute advice when biological cleaning is to be installed, and assist in selecting the best products for the best performance. Selecting the wrong product can have a severe impact on the micro environment and cause major disruptions in production. Many companies choose to continue to use solvent- based coatings, and can now satisfy the related environmental requirements. AcromaPro cooperates with leading companies that build these facilities.



Spray booth with water curtain



Spray booth with recovery system



Recovery system concept for spray booth

5.9 Automatic spraying

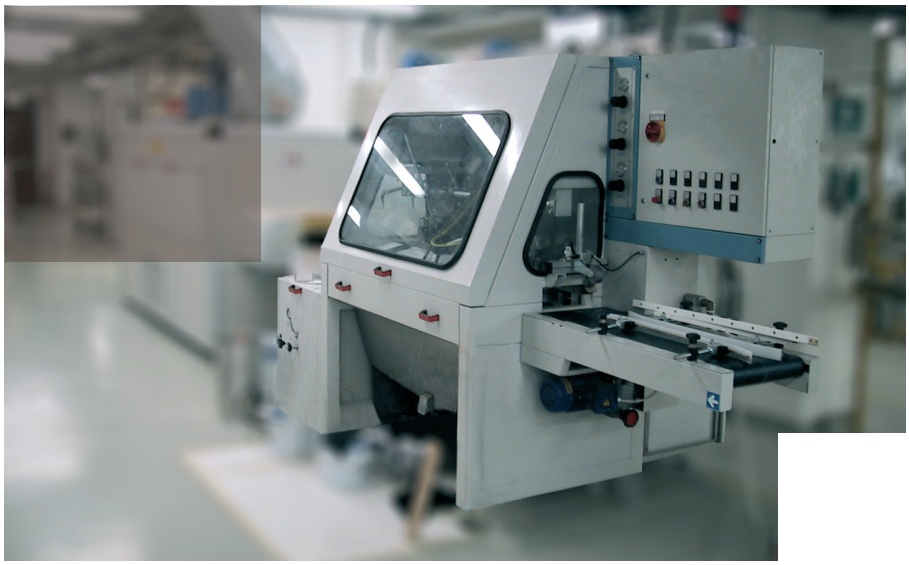
There are numerous types of equipment for automatic spray painting. The choice of automatic spraying unit is determined mainly by the shape and size of the items to be sprayed and, in some cases, by the type of finish selected.

5.9.1 Automatic moulding sprayer

Used for high-capacity spray coating of mouldings, fillets, wood edgings, etc., the goods are transported at relatively high speed under fixed spray guns. These days, modern automatic moulding sprayers can be connected to high-efficiency UV curing ovens, enabling the use of UV technology. These automatic sprayers are sealed units, so no spray mist can escape. It is extremely important that these units are connected to high-efficiency cleaning filters, since UV lacquer spray mist must not be released into the open air. Both clear lacquer and pigmented coating systems are available for this application technology, producing a full-bodied coating with the fastest and best curing.

5.9.2 Automatic reciprocating spray machines

In these units, the automatic spray guns pass over a horizontal conveyor. In some cases, the automatic spray guns are installed on an oval spray gun carrier, a large wheel, a cross or a suspension device. An automatic reciprocating spray machine may include two or more spray guns. The number of spray guns depends on the width of the unit, the speed of the conveyor and on whether the unit needs to apply different coatings. Considerable care must be taken when selecting spray equipment. Most automatic spray units are now equipped with airmix spray guns and depending on the type of finish selected and nature of the product to be coated, airless and conventional spray guns may also be used. To ensure optimal paint economy, the automatic spray unit should be equipped with sensors that detect the location of the goods to be coated. The spray pattern of the guns is determined as they are switched on/switched off as the front, rear and sides of each object on the conveyor passes the sensors. Modern automatic spray units can operate at fairly high conveyor speeds, and speeds of between 49 ft. - 66 ft (15 and 20 metres) per minute are not unusual. Consequently, these machines have a very high throughput.
To meet these needs AcromaPro has developed special solvents and cleaning systems to optimize the cost efficiency of both its water-based and solvent-based finishing systems.



Automatic moulding sprayer

Automatic reciprocator

5.9.3 Automatic reciprocators (vertical spray units)

These are used for painting goods transported by a suspension conveyor. The unit features a vertical reciprocating movement. The spray unit control system is similar to that used by automatic reciprocator machines. The technique involves spraying objects transported by a conveyor belt (that can be chilled for higher transfer efficiency) from which overspray can be recovered and reused. This method is most suitable for water-based products. This can sharply reduce spray loss when coating small components. If the vertical reciprocator unit also comprises electrostatic spraying, spray loss will be reduced to an absolute minimum.

5.9.4 Rotary spindle machines

Mass-produced, small, circular items such as knobs and handles can be painted in an automatic rotary spindle machine. This unit consists of a large disc on which a number of rotating spindles are mounted. The objects to be painted are attached to the spindles and the disc (table) rotates, step by step, past the automatic spray guns. The spray guns are mounted in the center of the table and face outward. The spray mist is captured by an evacuator equipped with paint traps. The paint is applied to the side opposite to where products are either mounted, or removed from the spindles. This type of machine also functions well with electrostatic equipment.

5.9.5 Chain-on-edge machines

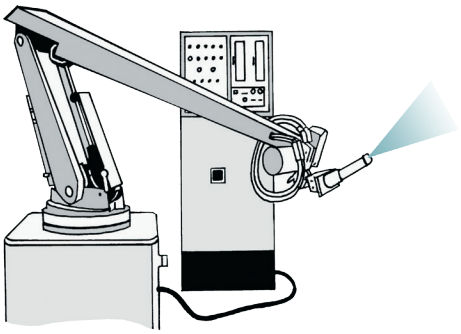
These units also have rotating spindles and the paint is usually applied by fixed automatic spray guns. The spindles are mounted in the holes for the bolts in a long "swivel joint" chain, placed on edge. The space between the spindles is determined by the pitch of the chain (i.e. the spacing between the bolts), and can be as small as approx. 4 in. (100 mm). This unit can also be used to paint large circular products, if they are placed intermittently on every third or fourth spindle.

5.9.6 Painting robots

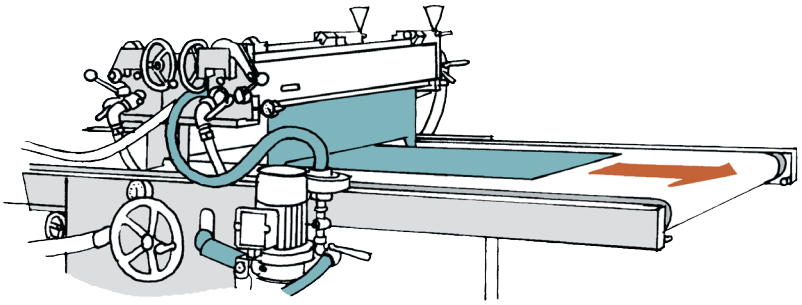
Automated painting sometimes requires that spray guns perform more complex movements than are feasible in an automatic painting unit. To replace a human worker effectively, the movements and "learning capacity" of a machine must correspond as closely as possible to those of a human operator. Industrial robots are an attractive option for heavy or monotonous jobs. However, they have certain limitations where the job involves painting large numbers of items of varying shapes and sizes. The pace of development in industrial robotics is advancing rapidly and simple robots with smart functions will become increasingly common. We can assume that this type of robot will be used for finishing edges, milled grooves etc. etc., and they will become commonplace. They are ideally suited for use in environments where human operators are at risk because of spray mist or strong UV radiation. A robot need not be static. It can be mounted on a trolley and follow a process as it moves along an assembly line.

5.10 Curtain coating

Curtain coating used to be the most commonly used application technique in the wood finishing industry and is a very fast method of application. Normal conveyor speed is between 150 to 230 ft/min (45 and 70 metres a minute), although speeds in excess of 330 ft/min (100 metres) a minute are feasible. The method is suitable for sheets and strips (fillets, mouldings) that are flat or slightly contoured in one direction. Today, roller coater applications have replaced curtain coater technologies in most flatlines due to the switch over from traditional systems to 100% solid UV curing systems.
If the products are placed at an angle on the conveyor belt (passing through the curtain like a plough), two straight edges can be coated simultaneously. In addition to its considerable coating capacity, a curtain coater functions just as well when coating relatively small numbers of products. The high production capacity of a well maintained machine more than compensates for the time spent on start-up and cleaning. The amount of coating applied, which can vary from 3 to 12 wet mils (70 to 300 g/m$^{2)}$, can be regulated by a combination of the following factors:



Robotic spray unit



Curtain coating machine

- The viscosity of the coating. Thin coating runs through the jaws faster than a viscous coating (normally 20-50 seconds, DIN 4)
- The setting of the slot opening in the curtain head
- The speed of the conveyor belt 66-500 feet per minute (20-150 metres per minute)
- The amount of coating pumped to the curtain head (determined by the pressure in the curtain head that is controlled by adjusting pump speed or by throttling the flow from the pump)

In a flat-line finishing process, it is essential to be able to swap curtain units rapidly to avoid production downtime when changing coatings, or in the event of a breakdown. There should be two or more curtain units for these machines. There are a number of new variants of curtain coating machines. One is a curtain coater with a completely open head, in which the finish runs over an edge and then onto the products to be coated. This machine is recommended when applying a coating that is sensitive to blistering. Another way to avoid blistering is to use a special cogwheel pump that ensures a more uniform flow and avoids the risk of air being "whipped in" during pumping. To further improve the result, use a cartridge filter instead of a plane filter. The coating will be more efficiently de-aerated as it is forced through the cartridge filter's considerably larger filter area.

5.11 Roller staining

A roller staining machine can stain large quantities of flat wood products rapidly and efficiently. This application technique offers several advantages – uniform staining, ease of integration into a finishing line, limited stain consumption and extremely high capacity. The products are transported on rollers or a conveyor belt and are pressed against the application roller that is clad in a layer of porous rubber ("moose" rubber). The circulation pumping system feeds stain to the roller. The amount is regulated partly by means of a doctor roller, which presses against the rubber roller, and partly by contact pressure between the application roller and the wood product. The porosity of the rubber plays a decisive role and is graded accordingly: BY-1, BY-2 and BY-3. BY-3 are the most porous and therefore deliver the most stain. BY-2 is the most commonly used roller rubber. The hardness of stain rollers is indicated by a Shore number (based on the Shore hardness test). The normal rating is approximately 20 Shore. Roller stains must be matched to the type of application roller, required stain effect and color intensity. Since rubber can be sensitive to certain solvents, especially aromatic hydrocarbons, it is important that stain solutions, thinner and cleaning liquids are approved for use with the specific rubber roller. AcromaPro's roller stains and thinners have been specially formulated to avoid damaging the rubber roller. The solvents contained in roller stains are volatile. Consequently, the colors darken unless new solvent is added during the process.

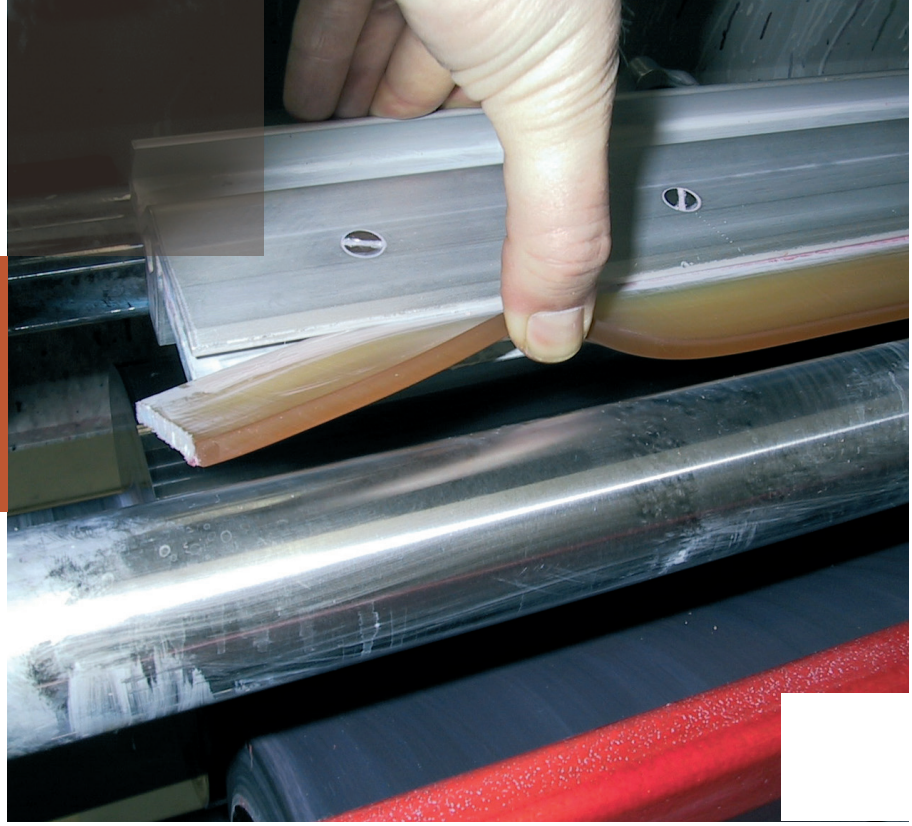
This color change often goes unnoticed so it is advisable to check the color following breaks and downtime and dilute the stain if required.

5.12 Roller coating

Roller coating technology is one of the fastest growing application techniques because it is a rapid, simple and cost efficient way of coating flat products. New systems for transferring coating from the rollers to the object to be coated have yielded excellent results. It is possible to increase the amount of coating applied and the method can now be used to achieve a premium quality topcoat. New rubber grades ensure that the rollers can withstand powerful solvents and can also be manufactured with resilience sufficient to tolerate limited irregularities in the items to be coated (for example, board on frame constructions) without sacrificing the smoothness of the finish.

5.12.1 Single-roller machine with synchronized application roller

The illustration shows a single-roller coating machine, equipped with a synchronized application roller. The finishing material is pumped out between the doctor and application rollers. The amount of coating applied varies from 0.2 to 1.5 mils (10 to 40 g/m$^{2)}$. Single roller coating always results in corrugated trace patterns (ropiness). The hardness of the roller rubber is indicated by a Shore number.



Doctor blade – plastic material

This type of roller is normally covered in rubber rated at 25-50 Shore. A soft roller (25-30 Shore) is preferable when the substrate is fully equalized (fx board on frame constructions).

5.12.2 "Relative process" roller application

In this case the doctor roller (steel roller) is a counter-rotating roller. When applying coating by "relative process" the amount applied can be increased and you can considerably reduce the risk of corrugated trace patterns. With the "relative process" the amount of lacquer applied can be very precisely regulated by adjusting the speed of the doctor roller. High speed means low lacquer consumption. The applied amount can vary from 0.1 to 1 mil (2 to 30 g/m^2). When producing pigmented surfaces with UV coatings, the application of basecoat is vital and for the best results apply at least three thin layers. The speeds of the conveyor belt, the doctor roller and the application roller must be individually adjustable. In the "relative process," the doctor blade must be pressed against the doctor roller (steel roller). Because most doctor blades are now made of plastic, there are fewer problems with them when used over long periods. Steel doctor blades eventually become razor sharp and sections of the edges can break away, causing visible lines in the lacquered finish.

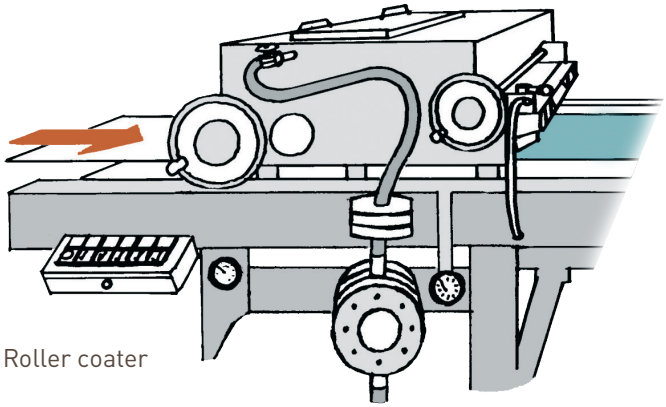
5.12.3 Roller coating by applying filler with a glazing roller

This roller coating machine is built along the same lines as the single-roller machine with synchronized application roller as described above. It is also equipped with an adjacent steel glazing roller. The filling process involves applying filler generously with the synchronized rubber-clad roller. The workpiece is then processed by the counter-rotating, steel glazing roller, that removes any surplus and presses the filler into every joint and surface defect. Thanks to the way modern UV fillers are formulated, they seldom present a problem when drilling holes or dressing edges. This coating technique ensures very thoroughly filled and very smooth surfaces. This reduces raw material loss from excess sanding, that would otherwise be required to achieve a satisfactory substrate for a primer and sealer. Filling has also proved economical because it provides a smooth and low cost, defect-free primer base. Heavy filler coating machines are best suited for processing chipboard and similar materials, while light filler coating machines are recommended for MDF board and veneers. Fillers that can be pumped with a diaphragm pump and adapted for the application of primer and filler are also available. The technique offers significant benefits in the production of veneers, ensuring efficient filling of joints between veneer panels. UV fillers have made great advances in the panel furniture industry, with respect both to clear lacquer and pigmented production. Filling now offers a competitive alternative to paper-coated and melamine-coated panels. To optimize the performance of the UV filler machine the glazing roller may be heated to smooth out the UV filler better. Cooling down the doctor roller also ensures that the filling properties are maintained. Water-based fillers require a cooled system for both the doctor roller and glazing roller.

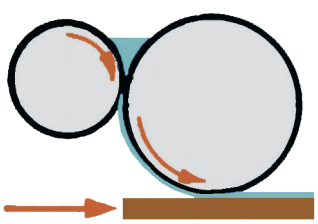
Blades for roller coater

5.12.4 Opti-roller coating

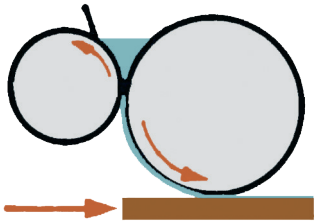
Opti-roller coating (as named by Bürkle) is a technique used in particular for applying UV curing coating lacquers. The surface of the application roller is threaded with small grooves that rupture surface tension in the coating to produce a completely smooth film. The Opti-roller technique for applying clear lacquers and pigmented systems on a UV curing base produces results that are as good as curtain-coated and spray-coated finishes. The Opti-roller method is an excellent way of applying large quantities of lacquer and achieving a smooth finish. With smooth rollers, it is difficult to apply more than 0.3-0.5 mils (8-10 g/m^2) if a smooth finish is required. With larger quantities, the surface becomes "ropy" or stippled, due to surface tension. The Opti-roller has a very fine thread cut in the surface. It is the crown of this thread that ruptures the surface tension, ensuring that the coating lies flatter against the substrate. Today there are rollers that combine high resilience and high durability and can be pressed hard against the substrate to create a vacuum that presses out the coating into a smooth film.



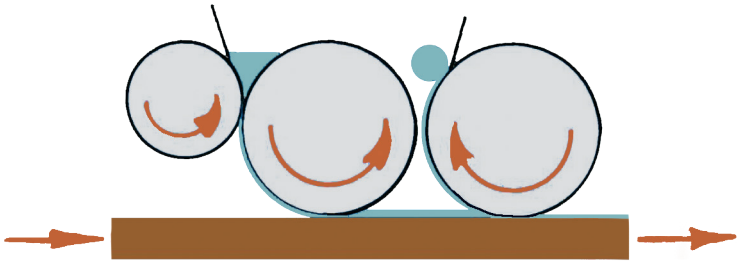
Roller coater



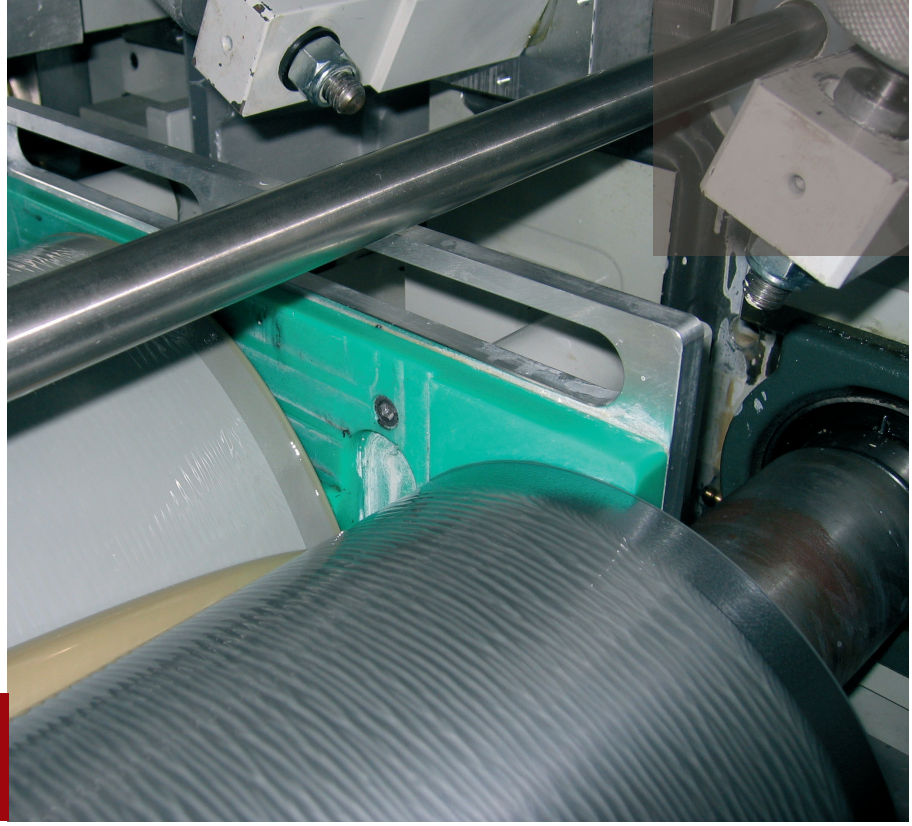
Normal process



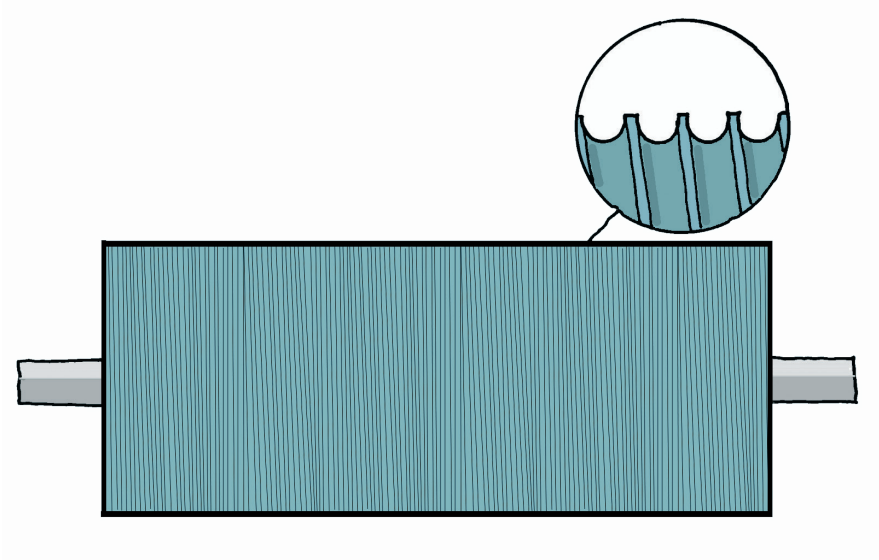
Relative process



Filler machine concept



Opti-roller

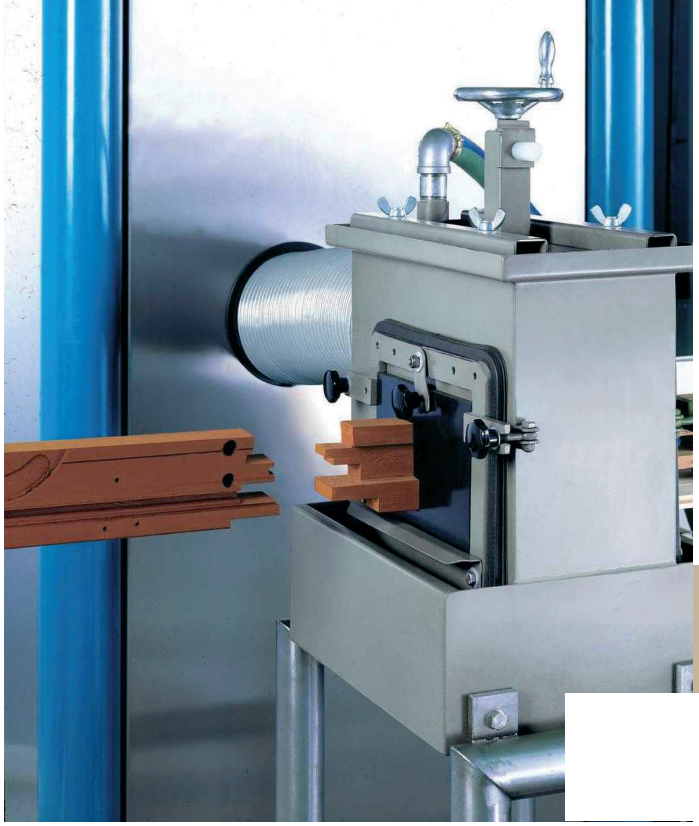


This technique also reduces the number of machines required in a coating line and it can be built shorter. The technique has been developed for pigmented UV products, and produces finishes that offer the same high resistance and with properties that compare favorably with spray-coated or curtain-coated finishes. It can be used equally successfully with clear lacquers, primers and sealers. Development engineers have also come up with Opti-rollers clad in very resilient rubber and rated at 20-25 Shore. These are highly tolerant of uneven board products, and are also more durable.

5.13 Printing

This old technology, also called indirect deep print ("flexo"), has become very popular and competitive. It is similar to normal roller coating, but the steel roller has the desired pattern engraved into it and transfers the pattern to the application roller and then to the substrate. A printing machine normally has three printing heads (applications). New synchronization control systems have made this technology viable for modern production lines. Many of the larger and well known

furniture producers use this technology. Exclusive veneers can be duplicated on top of cheaper veneers in a way that even experts would find hard to spot. Printing on chipboard or MDF is a way to replace foils, often with a more realistic look than the old foil systems could offer. To make the print even more realistic it is also possible to add physical or chemical embossing to simulate the wood structure. Water-based and UV inks are both popular systems. Water-based inks dry physically and UV inks cure with UV radiation. Basecoats and topcoats generally derive from UV curing products. The UV inks form an integrated part of the UV system. A full UV system minimizes the risk of problems with intercoat adhesion and scratch resistance. By combining different technologies, printing systems can be used on everything from very cheap board systems to exclusive tabletop across a wide price range. Today, printing, combined with UV coatings is among the fastest line concepts available for industrial coatings. A pigmented UV line can easily be converted to run print systems.



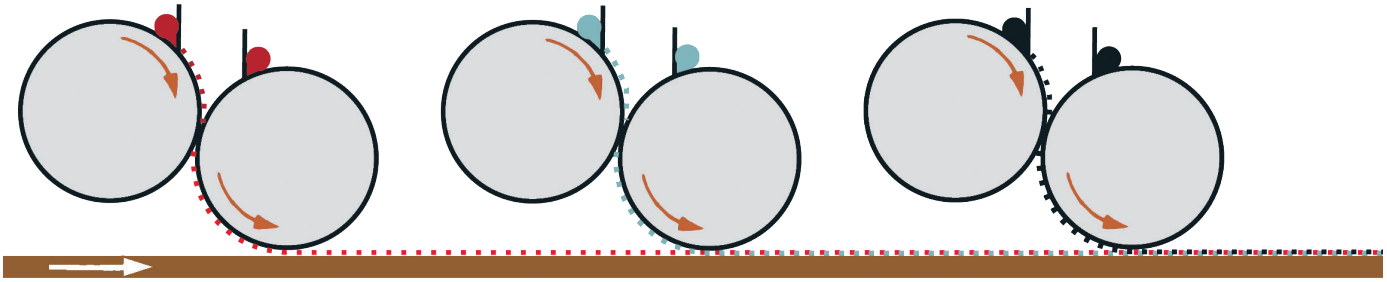
Vacuum coater

5.14 Vacuum coating

Vacuum coating is an extremely rapid technique for applying paint and lacquer. The entire workpiece is drenched in paint or lacquer and then subjected to a partial vacuum until enough paint/lacquer has been sucked from the substrate to leave the desired film thickness. One disadvantage is the difference in the amount of finish applied to the front and rear of the individual workpiece. However, the method is well suited to tasks such as coating strip, fillets or mouldings by the foot (metre). Specially developed water-based products are available for vacuum coating. Oil-based and UV curing products are also suitable for vacuum application.

5.15 Dip coating

Dip coating is an effective technique that is suitable for many different products. There are two basic approaches. The first is geared to achieving as thick a film as possible. The products are dipped very slowly in a dipping bath containing high-viscosity lacquer. The method is common in the general implements industry (spade handles, baseball bats, etc.). The second approach involves dipping in thin solutions. This is suitable for staining, priming and even for applying sealer/topcoat to, for example, machined components. Because of the considerable risks associated with exposure to solvent emissions, water-based products should be used for manual dipping. The dipping vessel should always be of plastic or stainless steel. Contact AcromaPro for advice on choosing the most appropriate coating for dipping.

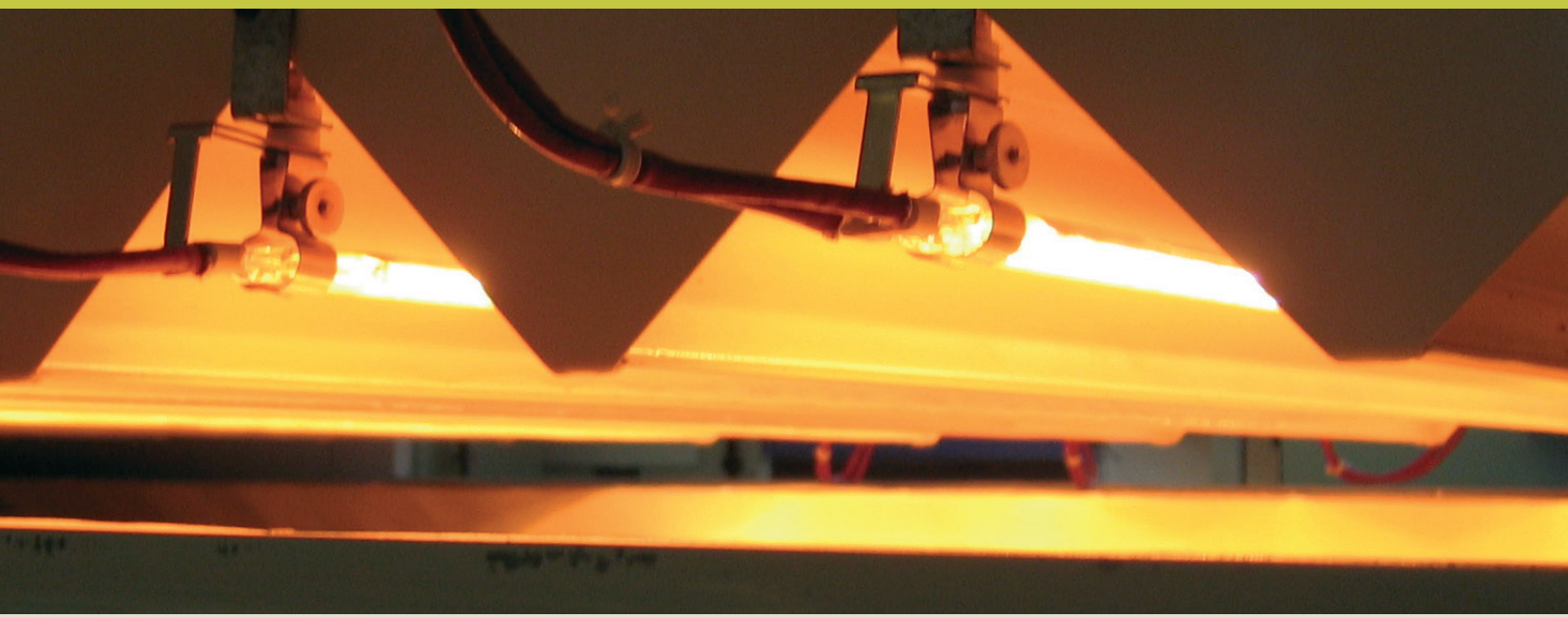


Concept of printing machine

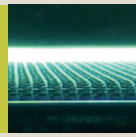
5.16 Flow coating

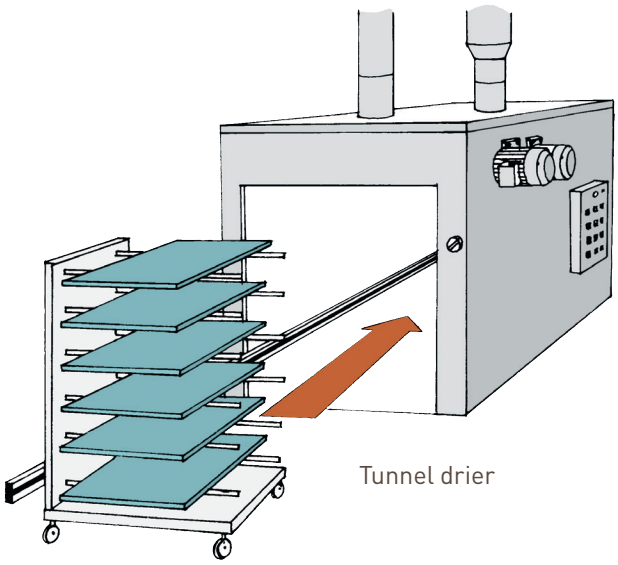
Flow coating is gaining increasing acceptance. This is partly due to an increase in the popularity of stained wood products, especially pine and partly to the development of environmentally safe water-based stains. All sides of the workpieces are stained in a single pass through the machine. The workpieces are transported by a conveyor or hanging conveyor, that passes through a spray zone where stain is applied via a diaphragm pump from nozzles located above and below the conveyor. Surplus stain on the surface, in cavities and accumulated in the milled contours of products is removed by an air jet emerging from the tunnel. This process, which may involve one or more stages, is activated from above and below. Surplus stain from the spray zone and air jet zone is led back to the stain vat for recovery and filtering, and will be pumped back later and reused. The method is not recommended for use with solvent-based stains because of solvent evaporation during atomization and circulation pumping.

6. Drying and curing



Drying lacquers at room temperature not only takes a long time, but also allows solvent emissions to spread, resulting in high environmental impact. This method also demands more storage space. So the best way to accelerate drying and reduce the occupational hazards posed by solvent emissions is to ensure that the process is "sealed" as far as possible. Curing at increased temperatures also enhances the properties of the finish.





Tunnel drier

6.1 Thermally accelerated drying and curing

The application of heat can sharply reduce curing times for several types of coatings. Curing time for an acid-curing coating, for example, is halved in proportion to every ten-degree increase in temperature. Really fast curing times are attainable at surface temperatures in excess of 122°F (50°C). Accelerated drying can cut curing times for a whole range of different coatings, from water-based systems to polyester systems and NC modified PU systems.

6.2 Heat transfer

The heat applied to the wet film to accelerate curing may be transferred in several ways:

Convection

The surface-treated goods are heated by circulating hot air through a room or by transporting them through a tunnel equipped with circulating hot air. The heat generated by domestic radiators is mainly in the form of "free" convection, when air circulates in the room. Go one step further and add a fan to force air past a radiator (as in an Aerotemper), and the result is forced convection. This accelerates the heating process, with maximum heat transfer achieved at air velocities of 50 ft/min (15 m/sec).

Radiation

Energy is generated electromagnetically. When the radiation hits a surface it is absorbed and converted into heat. Infrared (IR) radiation is a typical example. The distance between the radiation source and the object to be heated is crucially important. Only those sides which face the radiation source become heated. Compare with solar radiation or thermal radiation from an open fire. IR-radiation is subdivided into short-wave, medium-wave and long-wave radiation.

Conduction

In the furniture industry, conduction heat is used to preheat the products in convection or radiation ovens. The film of lacquer is then heated by the substrate, causing rapid evaporation of the solvents, and the curing process starts.

6.3 Chamber driers and drying rooms

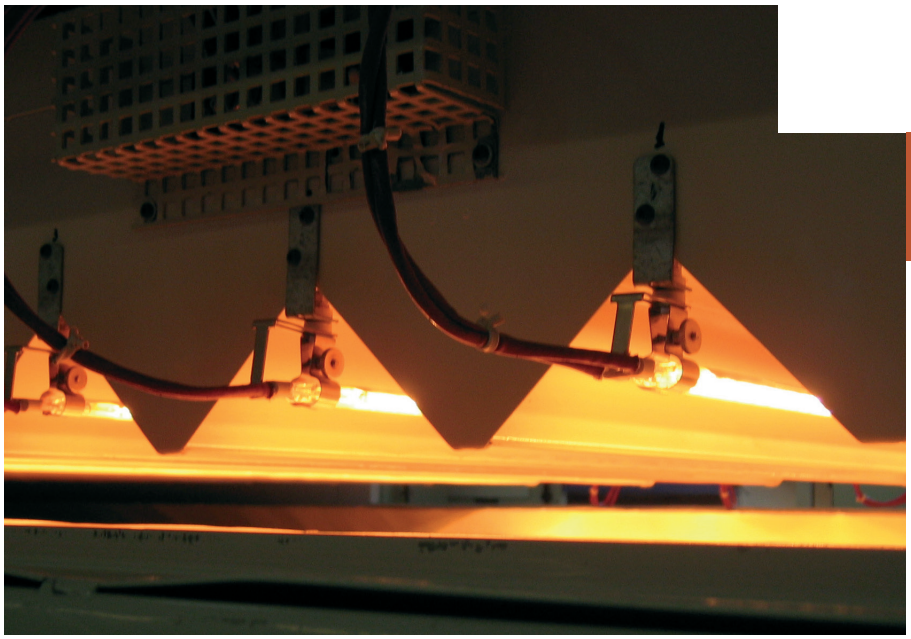
In chamber driers and drying rooms, the lacquered goods are wheeled in on trolleys, placed on trestles or on the floor. This type of drying unit is most appropriate for small industrial operations with very mixed production.

6.4 Tunnel driers

Tunnel driers, which may be described as a further development of a drying room, consist of a tunnel. The lacquered goods are transported through this tunnel on trolleys, stands or suspended from an overhead conveyor. Tunnel driers are normally organized into different temperature zones. Starting at 68°F (20°C), the temperature increases from zone to zone, rising to a maximum of 158-176°F (70-80°C). A cooling zone, which uses air at the prevailing outdoor temperature to cool the goods, is normally placed at the end of the tunnel. Most tunnel driers are equipped with some form of drive chain, to move the drier trolleys through the tunnel.

6.5 Vertical driers

The vertical drier can easily be combined with other driers and with automated spray units. It offers low energy consumption and can also easily be combined with various forms of combustion or catalytic cleaning systems. The lacquered goods are fed into the drier on transporters, and then moved vertically, on pallets, through the drier. The drier can simply be divided into different temperature zones. The speed at which the air circulates is also simple to adjust. Maximum temperature can be varied, although 122-158°F (50-70°C) is most common. The use of vertical ovens is mostly used for medium and slow curing systems since the system offers fairly long drying times in a small space.



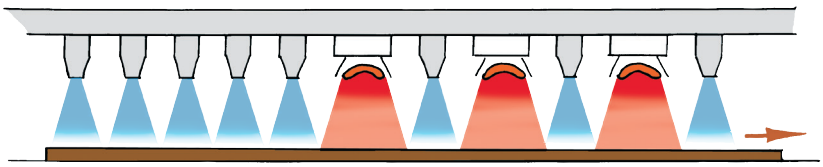
Speed oven

6.6 Flatline ovens

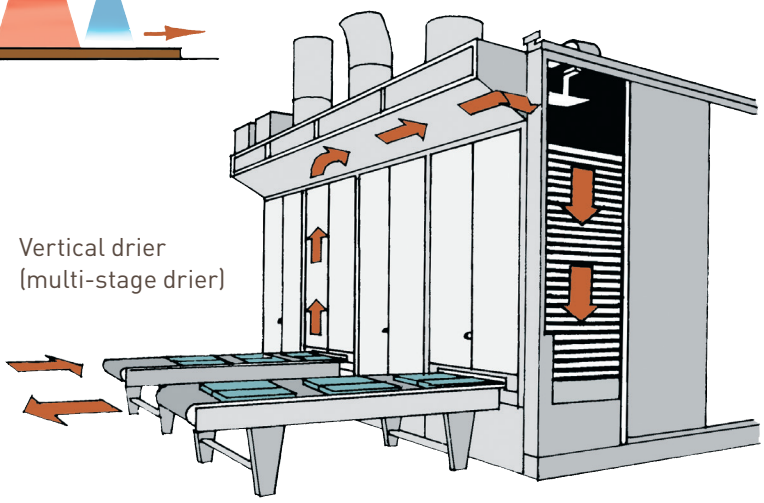
These types of ovens have been used with NC, AC and water-based systems for over 40 years. And the layout has changed much in recent years. An older oven set-up would include: Laminar air at low velocity and temperature + Laminar or Jet air at high velocity and temperature + Pure IRM section + Jet air cooling. The newer set-ups are more geared to fit water-based and water-based UV products. The most efficient way to dry water-based products is to maintain an open film while evaporating the water as fast as possible. To achieve this there are a few different methods – microwave, IR shortwave (NIR) and controlled humidity. A modern oven system can consist of any of these methods in combination with a following Jet air + IR oven (speed oven). New developments in the drying process minimize fiber raising and wood swelling and shorten the drying process. Even if the process is geared toward water-based products, with some modifications, it works very well with solvent-based systems.

6.7 UV ovens

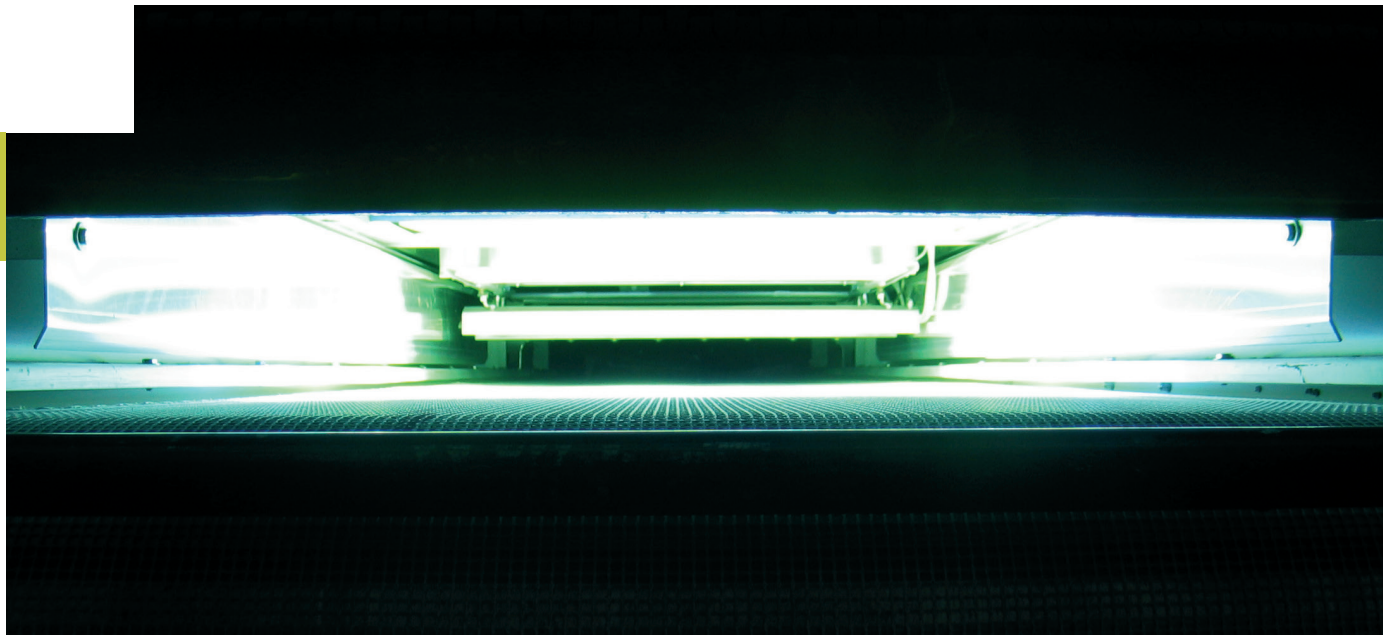
The term "UV ovens" refers to curing ovens in which UV reactive materials are cured by radiating them with ultraviolet light. This produces very fast curing times. UV lamps may be mercury-vapor lamps, which are most appropriate for clear lacquers, or gallium doped, which are necessary for curing pigmented coatings. The power and wavelengths of lamps may vary.



Concept of speed oven

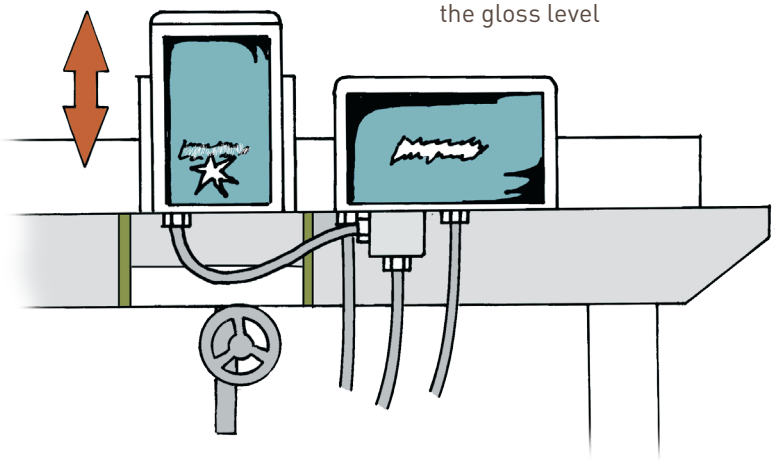


Vertical drier
(multi-stage drier)



UV oven

The quality and light intensity of the lamps must be checked regularly to ensure that production equipment that operates on a daily basis can maintain consistent and good curing results. The lamps and reflectors must be cleaned regularly, at least once a week. With UV curing, there is normally no need to preheat the substrate or build evaporation or cooling zones. Consequently, finishing lines that include a UV curing unit can be made much shorter and much more energy-efficient than lines of corresponding capacity that feature conventional ovens. When running at either extremely high or low conveyor speeds, or when coating resinous woods (pine, spruce, etc.), jet air cooling between the UV lamps is required. Every industrial operation that uses UV radiation equipment should have access to metering equipment to control its process function, ensuring that complete curing is always achieved.

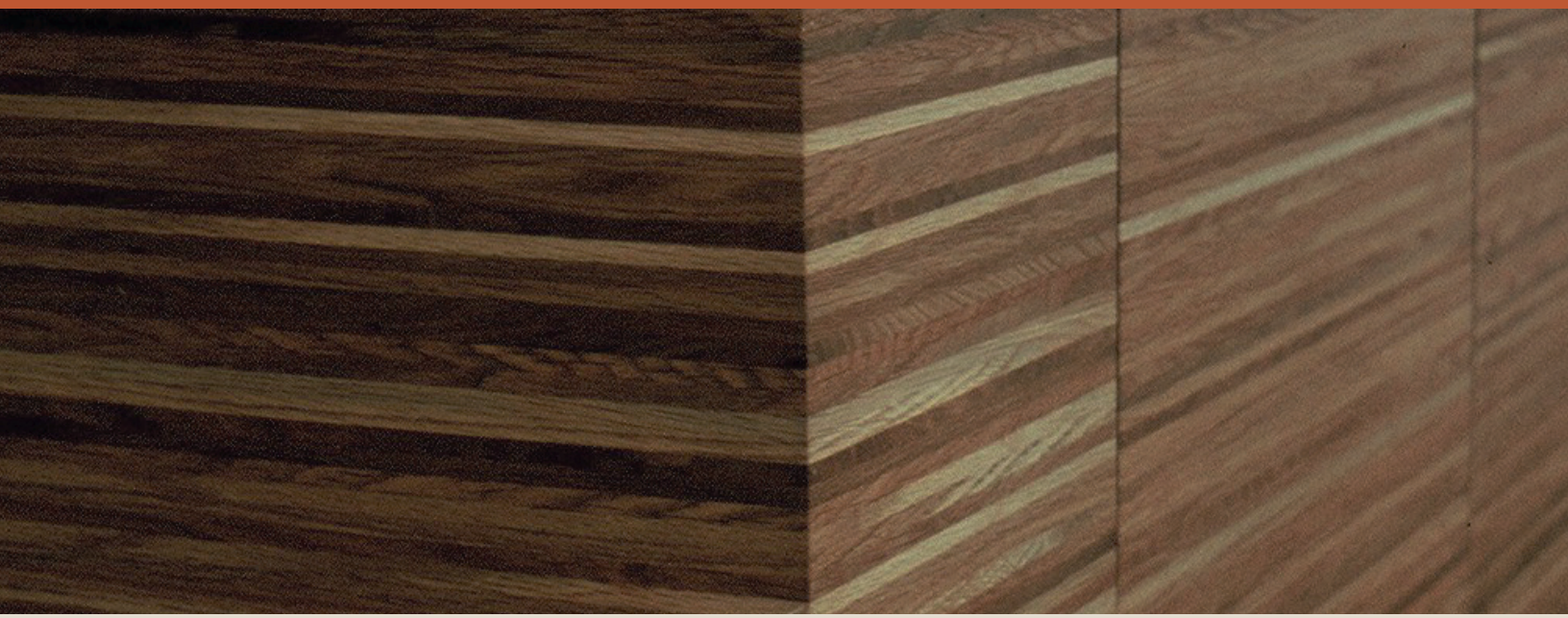


UV oven featuring in the first unit reflectors that can be raised or lowered in order to adjust the gloss level

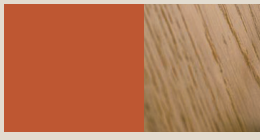
6.8 UV curing with LED (Light Emitting Diode) units

The UV light from a diode is almost monochrome. It emits UV-energy in a very narrow spectrum, but with a very high intensity, apart from the regular UV discharge lamps which emit energy in the whole light spectrum 200-1000nm (where 700-1000nm is the IR-range and generates heat radiation). The most common is diodes doped to 395nm, but are also available in other wavelengths (365, 385 & 405nm). Since the diodes have such a narrow spectrum they do not emit any heat, a common problem with standard UV discharge lamps. Curing with UV LED does not increase the surface temperature of the substrate so they are very suitable to use when working with heat sensitive substrates, such as pine. The diodes are not damaged by being turned on and off frequently (as discharge lamps are) and ramp up to full power in fractions of a second. This can be utilized so the LED unit is only on when parts are passing through the oven. The LED units have an accumulated on-time of more than 10,000 hours and maintain almost full power throughout its lifetime. You can combine LED with standard UV discharge lamps to reach specific properties.

7. Surface finishing and economy



When comparing the cost of different finishing systems, you must take several factors into account: type of product, the product's dry content, density, dilution curve, etc. We would like to highlight a few factors to keep in mind when analyzing your surface finishing requirement.



7.1 Production time

How can you achieve the desired result in the minimum of time with different coatings? This may mean faster drying times, fewer coats, faster paint changes, etc

7.2 Substrate

Choosing the correct substrate and the most appropriate pretreatment will save primer. This will improve total economy.

7.3 Coating equipment

The efficiency of different types of coating equipment can vary considerably. Avoid conventional spray coating if airmix spraying is available, and, when coating components, use a curtain coater or roller coater over an automatic spray booth.

7.4 Sandability

Good sandability extends the useful life of sandpaper. This can have a major impact on total economy. A finishing system which makes sanding unnecessary means greater savings.

7.5 Pot life

A coating with a short pot life can often lead to substantial lacquer loss. Always mix the appropriate quantity for the job required as there's money to be saved. Finishing equipment that includes a recycling system is usually a good investment.

7.6 Energy costs

Investment in systems that feature low energy consumption can generate major savings. This may involve the energy requirement for the curing process alone, or the ventilation requirement associated with different types of coatings. Radiation-curing products, such as UV products, normally require less energy than other types of reaction curing products. Low solvent content products demand less energy in the form of ventilation systems, etc.

7.7 Cleaning

Paint changes that involve a long and comprehensive cleaning process take time, and often require expensive cleaning fluids.

7.8 Emissions regulations

Ever tougher emissions regulations require users adopt a clearer policy on the types of coatings they mean to use. In the future, it will be impossible to use solvent-based systems without some form of cleaning system. Solutions based on low solvent or solvent-free systems will become highly competitive.

7.9 Insurance costs

Savings can be made here, both with respect to production and storage, if a solvent-free, non-flammable system is used.

7.10 Reduced costs of premises

Production based on solvent-free systems (i.e. water-based or 100% UV-curing systems) does not require separate production facilities for finishing and other product processes. Once again, this means savings. These are just some examples of factors affecting your total finishing cost. To accurately determine your total finishing cost, you must know how to calculate it correctly.

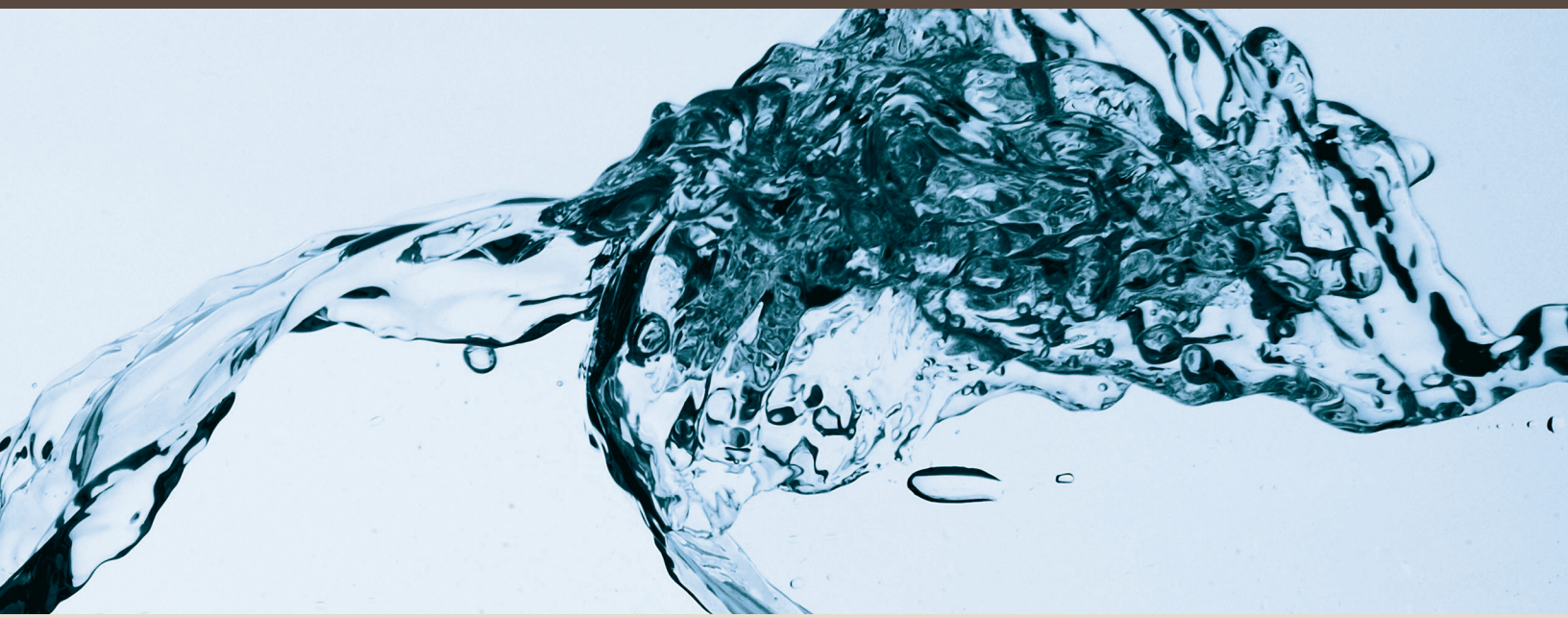
Generally speaking, you can never hope to achieve an accurate evaluation of two different types of lacquer if you merely compare them on the basis of price per gallon or pound (litre or kilo). To assess costs correctly, you must always break them down into cost per square foot (metre) of finished surface. To calculate this effectively, you must have some fundamental data:

- The lacquer or coating's mix ratio
- The price of the coating per gallon (litre)
- The density of the coating
- The solid content of the coating
- The amount of coating applied in mils (g/m^2)

The examples on page 40 illustrate how the finishing cost can vary if you base your calculation on finishing cost per square foot (metre) as opposed to price per gallon (litre). In this example, we have chosen an NC lacquer applied at 5 mils (120 g/m^2), and compared it with a water-based lacquer and a UV lacquer. All three examples have one factor in common – they contain the same dry content per square foot (metre).

These examples give the cost of lacquer per square foot (metre) in a direct comparison between three different finishing systems. For a complete cost analysis, additional costs such as cleaning thinners must be included in the above mentioned costs. Once you have completed your total cost analysis, you can determine which lacquer system or systems are the most economical. Your AcromaPro distributor can help you obtain the necessary data for a realistic cost analysis.

8. Environmental information



Paints and lacquers have many positive properties. They engage our senses, they broaden our aesthetic perceptions and they create an attractive environment. In wood finishing, their primary function is to protect the substrate, simplify cleaning and thereby extend the life of the individual product. By handling paints and lacquers in a correct and safe manner, and by employing finishing techniques that minimize environmental impact, we create a safer and cleaner work environment and ensure a better external environment.

8.1 Work environment

When working with paint and lacquers, a user can be exposed in various ways to potential health risks:

- Inhalation of fumes from evaporating solvents, spray mist or dust from sanding.
- Direct contact with the products, during handling, either via the skin or eyes. This may take the form of direct contact with liquid paints and lacquers, or with sanding dust from product that is not fully cured.

8.2 Inhalation

The most obvious and best-known risk associated with working with paint and lacquers is the threat posed to health by over exposure to solvents. For this reason, it is important to adopt protective measures in the form of sealed systems and ventilation/air-cleaning systems, and to use personal protection, such as various types of masks. Substances other than solvents can also pose a health risk upon inhalation.

You should therefore check the health risks stated on the labels when using a product (i.e. warning symbols and risk phrases). On people, the initial effect of inhaling large quantities of organic solvents is a form of inebriation that causes impaired judgement, slowed reactions, clumsiness and tiredness. Extended exposure to concentrated solvent emissions can result in chronic damage to the liver, kidneys and brain. However, not all solvents are equally dangerous. Some of the solvents that pose the greatest danger are aromatic solvents, such as toluene and xylene.

To ensure safety at work, public authorities cooperate with medical experts on a continual basis to determine standards for substances that can be dangerous if inhaled. The legal requirements vary from country to country. Most countries apply limit values (occupational exposure limits) to the substances. These limit values are often expressed as averages over specified time periods (i.e. 8 hours or 15 minutes).

Air pollutants consist of a combination of different substances. Exposure readings taken at the place of work are based on all substances present in the air, after which the additive hygienic effect can be assessed. The additive hygienic effect (HE) can be summarized in the following formula: $HE = C1/L1 + C2/L2 + C3/L3$, where C1, C2, C3 are the observed concentrations of substances 1, 2, 3 and L1, L2, L3 are the occupational exposure limit values (OEL) of these same substances (expressed in the same unit). In most countries HE must be less than 1 to be acceptable.

In recent years, the risks posed by inhalation of various types of dust have attracted increasing attention. Such risks are associated primarily with dust that is respirable, or particles that are so small that they can penetrate deep into the lungs. The afflictions that can arise, such as asthma or cancer, can be caused by a number of different factors. In some cases, the condition is the result of a toxic reaction when particles are partially or completely dissolved in the lungs. In other cases, damage to the lungs may derive from strictly physical injury (i.e. silicosis).

Never clean your skin with solvent.

Sometimes, health may be damaged when other substances attach themselves to the surface of inhaled particles, and therefore remain trapped in the lungs longer than if they had simply been inhaled in a gaseous form. It is important to protect against over-intense exposure to dust, no matter what type. The lists of occupational exposure limits state general hygienic limits for dust and define specific limits for a number of special substances.

8.3 Direct contact

Solvent dries out the skin by dissolving its natural oils. Some solvents can be absorbed directly through the skin, and thereby contribute to the total quantity of solvent to which the body is subjected. With some types of solvent, a considerable amount of the total exposure is via the skin. In most countries these solvents are flagged with a skin notation in the comments column of the list of limit values.

In general, UV products contain substances that irritate the skin ("unsaturated acrylates") and can cause allergies. Labels and safety data sheets on products and substances that pose an increased allergic risk contain the warning: "May produce an allergic reaction."

Unsaturated acrylates have the same de-fattening properties as solvents, and can therefore penetrate the skin. AcromaPro has produced special information and training materials that deal with the handling of UV curing products. If instructions on protective measures are carefully observed, risks to personnel are minimal.

The use of water-based paints and lacquers is on the increase. These products lead to a reduction in solvent emissions, with respect to both outdoor and indoor environments, and even reduce the risks that can arise from contact with the skin. However, the fact remains that these products are designed to be applied on wood, not human skin. Most water-based products contain small quantities of solvent, often the type that can be absorbed by the skin. Careless handling can mean the user is exposed to more solvent from absorption through the skin than from inhalation. Furthermore, they contain biocides that may cause allergic reactions in people who are sensitive to them. It is therefore important to prevent contact with the skin, even when working with water-based paints and lacquers.

The types of products mentioned include a number of variants with different properties, as well as hybrids that are like mixtures of the main types, such as water-based UV curing paints and lacquers. These hybrids possess the technical properties of the "parent products." In developing water-based UV products, the goal has been to retain the beneficial properties of UV curing products while combining the benefits of water-based products. However, with such crossbreeding, it is impossible to avoid inheriting some of the less attractive properties. This even applies to their environmental qualities. Compared to conventional UV lacquers, water-based UV products considerably reduce the risk of sensitization and skin complaints, but they pose a greater risk than water-based products. Damage to the skin can be avoided by using protective gloves. They should be of good quality and the material should be appropriate for the type of solvent handled. Use only CE-marked gloves, and consult the supplier about the quality and choice of material. It is normally advisable to use thin cotton gloves inside protective gloves, since certain glove materials (such as rubber) may cause an allergic reaction.

If you get paint on your skin, wash it away with soap and water, or solvent-free cleaning creams. After work, it is a good habit to use a hand cream to re-moisturize your skin. This will reduce the risk of skin complaints.

8.4 Fire risks

Incorrect handling of flammable products can result in severe injuries to people and damage to equipment. When accidents occur, they almost always arise from incorrect handling. Materials can burst into flames if a flammable mixture of air and solvent comes into contact with an igniting source. This may be a naked flame, a hot surface or a spark generated by static electricity or a tool. Flammable products should always be stored at special locations where the risk of combustion is minimal. The equipment used should be explosion-proof and the ventilation system (such as that used for spray booths) must be adjusted so that the solvent level of ventilated air is kept well below a combustible level. Obviously, smoking is prohibited when working in premises where flammable products are handled, and measures must be taken to limit risks associated with static electricity. When pouring a flammable liquid from one container to another, always ensure that the containers are linked to each other and grounded. By limiting the pouring height, you also limit the risk of sparks. Shoes and clothes should be made of anti-static material.

8.5 Risk of self-ignition

Self-ignition can take place as a consequence of improper handling of paints or lacquers containing drying oils or unsaturated alkyds. During the drying procedure, when in contact with oxygen, heat is evolved. Under normal circumstances this heat is emitted to the surroundings and is not a problem. The risk of self-ignition exists primarily in connection with cleaning of spray booths. When the spray dust is collected and put in large quantities in garbage bins, heat builds up quickly and the risk of self-ignition increases with the presence of paper, cloth etc. Similarly, there is an obvious risk if paper or cloth is contaminated with drying oils. To avoid a fire, spray dust, cloth, paper and other contaminated organic material should be wetted and placed in a sealed metal container. The waste should be sent away for destruction.

8.6 Outdoor environment

When talking about risks to the outdoor environment, we are talking about many different things. It may be a question of suspected health risks to neighboring residents because of solvent emissions, or fears that ground-level ozone (formed by the breakdown of solvents and other hydrocarbons in air) might pose a health risk or damage plant life. It may even involve the risk of disturbing the ecological balance. To evaluate the potential risks, a number of screening tests are used to determine parameters such as the toxicity, biodegradability and possible bioaccumulation levels of various substances. The results of these tests are then used when labelling the tested substances and the preparations they are included in (see below). The primary reason for reducing solvent emissions is a desire to reduce levels of ground-level ozone. Different solvents form different amounts of ozone. Choice of solvent is therefore relevant both to health and the outdoor environment. Waste from paint and lacquer products is collected and handled in accordance with local legislation. Regarding waste from dry paints and lacquers, most wood products end up being burned, which is an efficient way of breaking down the environmentally dangerous substances they may contain. Incineration, which should be carefully supervised, also permits recovery of the energy contained in waste paint.

8.7 Labelling

A brief description of the labelling system for health and environmental warnings on paints and lacquers is on the following pages. The most common warning symbols together with risk phrases (R-phrases) are described. Although there are other symbols and R-phrases, these are seldom used for wood finishing industry paint and lacquers.

8.8 Toxic/harmful properties

	Very toxic/Toxic	Carcinogenic	Mutagenic	Toxic for reproduction
	**R26** Very toxic by inhalation **R27** Very toxic in contact with skin **R28** Very toxic if swallowed **R23** Toxic by inhalation **R24** Toxic in contact with skin **R25** Toxic if swallowed **R39** Danger of very serious irreversible effects **R48** Danger of serious damage to health by prolonged exposure	**R45** May cause cancer **R49** May cause cancer by inhalation	**R46** May cause heritable genetic damage	**R60** May impair fertility **R61** May cause harm to the unborn child
	Harmful	**Carcinogenic**	**Mutagenic**	**Toxic for reproduction**
	**R20** Harmful by inhalation **R21** Harmful in contact with skin **R22** Harmful if swallowed **R42** May cause sensitization by inhalation **R48** Danger of serious damage to health through prolonged exposure **R65** Harmful: May cause lung damage if swallowed	**R40** Limited evidence of a carcinogenic effect	**R68** Possible risk of irreversible effects	**R62** Possible risk of impaired fertility **R63** Possible risk of harm to the unborn child

8.9 Corrosive and irritant properties

	Corrosive
	**R34** Causes burns **R35** Causes severe burns
	**R36** Irritating to eyes **R37** Irritating to respiratory system **R38** Irritating to skin **R41** Risk of severe damage to eyes **R43** May cause sensitization through skin contact

8.10 Flammable

	Highly flammable/flammable
	**R11** Highly flammable Note that flammable liquids with a flash-point of 70-122°F (21-55°C) are not labelled with a flame symbol but with the risk phrase: **R10** Flammable

8.11 Environmentally hazardous properties

	Dangerous for the environment
	**R50** Very toxic to aquatic organisms. **R50/R53** Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment **R51/R53** Toxic to aquatic organisms, may cause long-term effects in the aquatic environment **R52/R53** Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment (Note: this risk phrase does not give rise to the warning symbol, only the warning text is displayed)

8.12 Globally Harmonized System (GHS)

A new system for classification and labelling has been introduced in a number of countries. In time, a vast number of countries around the world will apply this system. The new system is called the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). It will replace existing systems and harmonize of the rules on a global basis. Below is a brief explanation of the GHS pictograms. These are accompanied by signal words and examples of hazard statements.

8.12 Globally Harmonized System (GHS)			
	Signal word	**Danger – Examples of hazard statements:**	**Warning – Examples of hazard statements:**
	Danger	■ Fatal in contact with skin ■ Toxic in contact with skin ■ Fatal if inhaled ■ Toxic if inhaled	
	Danger/Warning	■ May cause allergy or asthma ■ Symptoms or breathing difficulties if inhaled ■ Causes damage to organs ■ May cause genetic effects ■ May cause cancer ■ May damage fertility or the unborn child	■ May cause damage to organs ■ Suspected of causing genetic effects ■ Suspected of causing cancer ■ Suspected of damaging the fertility or the unborn child
	Warning		■ Harmful in contact with skin ■ Harmful if inhaled ■ Causes skin irritation ■ Causes serious eye irritation ■ May cause respiratory irritation ■ May cause drowsiness or dizziness ■ May cause an allergic skin reaction

8.12 Globally Harmonized System (GHS) – continued

	Signal word	Danger – Examples of hazard statements:	Warning – Examples of hazard statements:
	Danger	■ Causes severe skin burns and eye damage ■ Causes serious eye damage	
	Danger/Warning	■ Extremely flammable liquid and vapor (flashpoint < 73˚F (<23˚C) and boiling point ≤95˚F (≤35˚C) ■ Highly flammable liquid and vapor (flashpoint < 73˚F (<23˚C) and boiling point >95˚F (>35˚C)	■ Flammable liquid and steam (flashpoint ≥73˚F and ≤150˚F (≥23˚C and ≤60˚C)
	Warning		■ Very toxic to aquatic life ■ Very toxic to aquatic life with long lasting effects ■ Toxic to aquatic life with long lasting effects ■ Harmful to aquatic life (gives no symbol or signal word) ■ May cause long lasting effects to aquatic life (gives no symbol or signal word)

9. Surface resistance

When selecting the finishing material, it is critical to know the way in which the furniture will be used, its type and the environment in which it will live. This is important when selecting a finishing material that offers the appropriate wear resistance. There are many specified standards for surface resistance, including the American standard, ANSI/ KCMA A161.1, "Recommended Performance and Construction Standard for Kitchen and Vanity Cabinets."

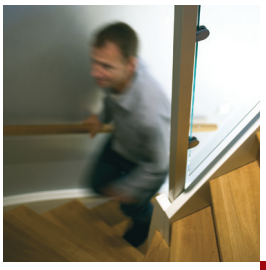
9.1 Varied results

Occasionally, furniture fails to satisfy even the lowest surface-finish requirements, which can come as an unpleasant surprise to the manufacturer, who may earlier have had his products approved to a much higher surface standard. What could cause such varied results? The nature of the substrate and its specific properties, the type of finish and the quantity applied are all highly important, as well as the care taken in conducting the entire finishing process. In the wood finishing industry, differences in local temperature, ventilation efficiency, humidity, curing oven temperature and drying times can be considerable when processing and surface treating products. All such variations affect the final result, as well as the eventual properties of a given product when tested to determine compliance with various standard specifications.

9.2 The importance of the substrate to the test result

Preparation of the substrate prior to finishing is extremely important in creating the conditions essential for a satisfactory final result. The wood and primer must be very carefully sanded. The nature and properties of the base are also of critical importance:

- All softwood is sensitive to scratches and impacts. Solid redwood seldom tolerates scratching. But redwood veneer on chipboard does.
- It is difficult to satisfy the requirements for the grease test on beech, since the fiber structure of beech allows grease to spread beneath the film of lacquer, something that is especially conspicuous on this wood species.
- Porous woods with deep pores must be treated with a primer that has strong wetting properties. Liquids may otherwise penetrate the substrate and spread beneath the finish.
- The red core and growth rings in redwood can be discolored when tested with alcohol. An unsatisfactory result may also be caused by solvent action on natural resin in the substrate, possibly in combination with an excessive curing temperature.
- When marks appear on dark woods or dark-stained furniture after liquid or heat tests – but not on light-colored woods that have been surface treated in the same manner – it is quite simply because dust and dirt are more conspicuous on dark, gloss surfaces. The same patches are there on light colored woods, but are less conspicuous against the light background.



9.3 Finishing materials

General properties of the most common finishes:

- Nitrocellulose-based finishes dry by solvent evaporation. They satisfy simpler standard requirements, but are not fully up to the demands made on table surfaces, etc.
- One-pack, acid-curing finishes contain a weak acid which initiates the curing process once the solvents have evaporated. Curing can be accelerated by efficient ventilation and additional heat. These products normally satisfy more stringent demands than nitrocellulose products.
- Two-pack, acid-curing finishes cure rapidly when the solvents evaporate. The hardener functions as an accelerating agent. At room temperature, most of the curing process is completed during the first 24 hours. This curing process can be sped up considerably with efficient ventilation and additional heat. The better the drying conditions (ventilation and heat), the better these finishes can meet the various demands placed upon them. This group comprises a wide range of products with different levels of surface resistance, some of which meet all combinations of standard requirements.
- Polyurethane products are cured as a result of a chemical reaction between the binders in the finish and the hardener, in relation to relative humidity. Drying and curing time can be reduced with good ventilation and additional heat. The hardener is highly sensitive to moisture. Once opened, packages must be resealed immediately once the desired dosage has been removed. In general, hardener cannot be stored for an extended period. Polyurethane products offer exceptional surface resistance.
- Water-based products may not be subjected to low temperatures when applied or dried. Drying at increased temperature and with good ventilation ensures the best film formation and surface resistance. Today's water-based products often satisfy very high resistance requirements.
- UV curing products are cured by ultraviolet radiation in special ovens. These products often have a very high dry content and produce a full-bodied film in spite of the low quantity applied. Shelf-life is more limited than for other products, about 3-4 months. They normally satisfy the most stringent requirements.

9.4 Prepare, apply, dry and cure in the correct way

Always carefully observe the treatment and mixing instructions given in AcromaPro data sheets.

9.5 Stacking and packing

Even if the finish film appears to be cured, high humidity, low oven temperatures, poor ventilation or low nighttime temperatures can halt the curing process or leave it incomplete. If stacking is done too early, it may cause defects in the form of glossy patches and stickiness. It may also cause the remaining solvent to bind with the finish film, impairing adhesion of the primer to the substrate. Similar defects can arise if furniture is packaged in corrugated cardboard before the finish film has been thoroughly cured. For these reasons, it is important to introduce production routines that ensure satisfactory curing. It is equally important to avoid "cold storage" of newly lacquered goods. For advice, contact your local AcromaPro distributor.

9.6 Summary

If instructions concerning the treatment process are rigorously observed, the result will be a highly resistant finish. If tests indicate that the finished surface fails to meet the desired standard, check the following to determine whether some important point has been overlooked:

- Poor ventilation, low temperature or high humidity during the finishing process.
- Moist substrate, water staining or unsuitable storage in high humidity.
- Excessively thin coating.
- Stacking or packaging too early.
- Inadequate agitation prior to application.
- Use of "old" mixture or old one-pack lacquer.
- Too much or too little hardener.
- Microscopic air bubbles in the finish film, due possibly to a substrate that was too cold, incorrect thinning, high viscosity on application, defective application equipment, etc.
- Unsuitable substrate.
- "Old" or unsuitably stored urethane hardener.
- Unsuitable coating or combination of products.

10. Troubleshooting

Finding a defect on a coated surface is fairly easy, but finding its cause might not be. In our experience most finishing problems originate from variations in the process, not the product. First, if you have a documented finishing system, check that you are following it and if the problem remains then check each step of the process again. There are many parameters that influence the finishing process and you need to verify each one of them, one at a time, unless the origin of the problem is obvious. This involves locating the step in the process where the problem originates. To do this, we recommend following the process backward. When you find the step in the process that is causing the problem, use Facts on Finishing to help you solve the problem or contact your AcromaPro distributor.

10.1.1 Spraying		
Problem	**Possible causes**	**Solutions**
"Blue" corners	Edges too sharp	Increase the radius of the corner either by denibber or in the woodworking process
	Viscosity too low	Increase viscosity
	Corners sanded through when sanding primer	Use a less coarse sandpaper when sanding the primer
Bubble formation	Air from the substrate	Lower viscosity
	Incorrect thinner	Slower thinner
Craters/Fish eyes	Substrate contaminated by silicone or oil	Locate the contaminating source (lubrication of woodworking equipment, compressed air system, lotions, ventilation seals)
	Compressed air contaminated by water or oil	Contact your AcromaPro distributor
Lifting/Wrinkling	Excessive layer of topcoat applied	Rub down to clean wood surface
	Topcoat applied before underlying layer is fully cured	Contact your AcromaPro distributor if unable to determine the cause of the defect
	Unsuitable combination of primer and topcoat (can also apply to pre-treated substrate)	Use correct product and application methods
	The products have been stacked too closely during drying, or the air circulation in the drying area was inadequate	Use correct product and application methods
	Incorrect amount of hardener	Use correct product and application methods
Micro bubbles	Incorrect thinner	Change thinner
	Leakage in the spray gun channels or in the suction hose of the pump	Check equipment
Orange Peel	Too high viscosity	Sand down the defective surface
	Incorrect thinner	Remedy defects as described
	Excessive temperature difference between substrate and coating	If necessary, change to slower-acting thinner
	Incorrect air/fluid pressure when spraying or incorrect distance from gun to substrate	Use correct product and application methods
	Excessive air circulation (draught) in the spray area	Reduce excess air movement in spray area
	Products too cold	Rarm product to proper temperature

10.1.1 Spraying		
Problem	**Possible causes**	**Solutions**
Pin holing	Insufficient and excessively dry spraying of the substrate	Rub down the defective surface
	Excessive application at high temperature or on heated substrate	Check viscosity of the coating
	Porous substrate (fiberboard, particleboard, etc)	If necessary, use a slower thinner
	Incorrect thinning	Introduce other changes/ measures to inhibit pin holing
Sagging on edges	Excessive amount applied	Apply lower amount
	Too slow thinner	Change to a faster thinner
	Too low viscosity	Increase viscosity
	Incorrect angle of the gun (automatic spray machine)	Change the angle of the gun
Striping	Defective or dirty air or fluid nozzle	Check and clean the nozzles
	Incorrect gun settings	Check the spray gun positions and spray fan
	Conveyor speed and the guns transversal speed not synchronized	Synchronize conveyor and transversal speed

10.1.2 Curtain coating		
Problem	**Possible causes**	**Solutions**
"Blue" corners	Edges too sharp	Increase the radius of the corner either by denibber or in the woodworking process
	Viscosity too low	Increase viscosity
	Corners sanded through when sanding primer	Use a less coarse sandpaper when sanding the primer
Gray dotted patterns	Electrostatic charged panels	Connect all machines to each other with a copper cable
		Electrically earth all machines
		Install de-ionizing equipment before the curtain coater
Gloss and tone variations	The jaws of the curtain coater are not parallel, applied amount uneven	Adjust the jaws so they are parallel
	The curtain is moving forward and backward when coating, which results in an uneven application amount	Shield the curtain from air movements
Sagging on edges	Too high conveyor speed	Decrease the conveyor speed
	Coating – thinner not optimal	Contact your AcromaPro distributor

10.1.2 Curtain coating

Problem	Possible causes	Solutions
Splitting of curtain	Air bubbles in the coating	Reduce the height of the curtain
	Coating has incorrect surface tension or rheology	Check that the paint groove is in place inside the curtain head
		Check that the splash plate is in place in the return tank
		Ensure that the head is fully filled with coating material and that you have a steady flow from the heads overflow valve
		Try to make the coating flow/pump as smooth as possible with little or no turbulence
		Make sure there is no leakage in the pump, could inject air into the coating
		Try to remove foam and bubbles, for example, a nylon stocking can act as a filter if it is placed on the return-outlet
		Contact your AcromaPro distributor

10.1.3 Roller coating

Problem	Possible causes	Solutions
Ghost image of previous panel	Application roller does not re-wet to the same level as for the previous panel	Apply scraper to the application roller
		Contact your AcromaPro distributor
Line formation, crosswise	Different speed on conveyor and application roller	Check application roller and conveyor speed (rollers must be clean)
	Damaged application roller	See if you can see any damage on the application roller
	Too high down pressure on application roller	Use less down pressure
	Pressure between doctor and application roller too high	Release pressure between rollers
	Doctor roller running reverse at too high of a speed	Slow down reversing doctor roller
	Not enough material between rollers when running doctor roller reverse	Increase the pump pressure
	The bearings in either rollers or conveyor are damaged	Change bearings
	Not enough coating to fill in on roller	Ghost image of previous panel, see above

10.1.3 Roller coating		
Problem	**Possible causes**	**Solutions**
Line formation, lengthwise	Damaged scraper on doctor roller, or in case of a light filler machine the scraper of the smoothing roller	Replace damaged equipment
	Damaged application roller	Replace damaged equipment
	The protective shutter in the UV oven is set too low (in feed)	Adjust height of shutter
	Ghost image of previous panel	Not enough coating on roller
Rough patches when using light filler machine (SAS)	Too much variation of the substrate thickness; smoothing roller can not reach low spots	Calibrate substrate
	Oversanding, if it is along the edges of the substrate; smoothing roller cannot reach rounded edges	Check the sanding process
	Application amount too low when using Opti roller	Check application amount
Scrape marks and lip formation in front or end of panel	The speed of the application roller and conveyor belt is not synchronized	Adjust the speed of the application roller
	Smoothing roller running too fast or at too high pressure	Decrease the speed of the smoothing roller and/or release pressure
	Too much material applied before smoothing when filling	Decrease application amount in light filler machine by pressing doctor and application roller together, or change speed of doctor roller
Stain color too dark or too light	Too hard (light) or soft (dark) stain roller	If possible, change stain roller
	Wood sanding too fine (light) or too coarse (dark)	Check the wood sanding process
		Contact your AcromaPro distributor
Uncoated patches	Poor calibration of substrate	Improve calibration
		Change to softer application rollers
		Check the application rollers pressure to the substrate

10.1.4 Printing		
Problem	**Possible causes**	**Solutions**
Unsharp print picture	Synchronization between print rollers off	Check synchronization
	Viscosity incorrect	Check the viscosity of the inks
	Basecoat layer not smooth enough	Ensure that correct amount of basecoat is applied
	Too high pressure of application roller to the substrate	Release the pressure of the application roller on the substrate
Weak print	Viscosity incorrect	Check the viscosity of the inks
	Incorrect substrate temperature (high or low)	Check the surface temperature of the substrate before printing
Color drifting	Incorrect viscosity	Check viscosity
	Incorrect temperature of the inks	Make sure the temperature of the inks are OK and that ink used to refill the machine is at the same temperature
	Surface temperature not correct	Check the surface temperature of the substrate before printing
	Poor UV curing of previous layer (basecoat and/or inks)	Measure the UV lamps and ensure the energy and peak values are within prescribed specifications

10.2.1 Air drying		
Problem	**Possible causes**	**Solutions**
Blushing	Humid environment in combination with fast thinners	Change to a slower thinner and, if possible, try to increase air temperature
	Water not fully evaporated in water-based UV coatings	Change drying setup; increase either time, air velocity or temperature
	Extreme amounts of micro bubbles	See chapter on "micro bubbles" in the section on Spraying
Bubble formation	Air from the substrate	Change to a slower thinner
Cracking	Too low temperature when drying water-based coatings	Sand down the surface and re-coat
	Too high amount of hardener in acid cured systems	Check mixing instructions
		Check drying conditions
Mud cracking	Too much air movement when drying (water-based coatings)	Try to minimize air movement in the drying area
	Excessive application amount (water-based coatings)	Reduce the applied amount
Poor adhesion/ Peeling	Poor or no sanding between coating layers	Check that sealer/basecoat is properly sanded before applying the next layer
	Too much time has passed between sanding and lacquering	Sand the surface lightly again
	Coating dry sprayed	Try to spray a full wet layer, change to a slower thinner
	Too much catalyst used	Ensure that the amount of catalyst is correct
	Some foils and plastics are unsuitable for coating or require sanding before application	Sand the foil thoroughly, change foil or apply special adhesion sealer
	Poor combination of coating system; some water-based coatings have poor adhesion to other types of coatings	Contact your AcromaPro distributor
Soft film/Poor drying	The coating is not fully cured because of too low temperature or too short drying cycle	Check temperature
	Temperature too low during overnight drying	Extend the drying time
	Incorrect quantity of hardener used	Check that the temperature does not drop during after work hours if drying over night
	Hardener affected by moisture (PU coatings)	Ensure that correct amount of hardener is used
		Change hardener (PU coatings), always keep hardener container closed

10.2.2 Forced drying		
Problem	**Possible causes**	**Solutions**
Blocking	Surface temperature too high when stacking	If possible, cool the surface before stacking
	Too short drying cycle	Stack lower
	Temperature in ovens too low	Increase drying cycle
	Cooling section not working	Increase the temperature in the ovens
	Too much coating applied	Check that the cooling section is working
	UV oven not working properly (water-based UV coatings)	Check the application amount
	Hardener amount too low	Check the energy and peak values of the UV oven
		Ensure that the amount of hardener is correct

10.2.2 Forced drying		
Problem	**Possible causes**	**Solutions**
Blushing	Water not fully evaporated in water-based UV coatings	Increase oven temperatures, air velocity and drying time
		Apply less coating
Bubble formation	Too much IR energy	Decrease the IR energy
	Too high temperature in ovens	Decrease the temperature in the ovens
		Increase the temperature in the flash off section
Matte patches	Bubbles that have burst too late leave matte patches (mostly common when using a curtain coater)	Try to minimize bubble formation in the curtain coater
		Change to a slower thinner
		Contact your AcromaPro distributor
Micro bubbles	See chapter about spraying	See Spraying chapter
	Too much IR energy	Decrease the IR energy
		Increase the temperature in the flash off section
Mud cracking	Coating skins over before most of the water has evaporated out from the film	Decrease air velocity in flash off section
	Too much coating applied	Apply less coating
		Contact your AcromaPro distributor
Poor adhesion/ Peeling	Poor or no sanding between coating layers	Check that sealer/basecoat is properly sanded before applying the next layer
	Too much time has passed between sanding and lacquering	Sand the surface lightly again
	Coating dry sprayed	Try to spray a full wet layer, change to a slower thinner
	Too much catalyst used	Ensure that the amount of catalyst is correct
	Some foils and plastics are unsuitable for coating or require sanding before application	Sand the foil thoroughly, change foil or apply special adhesion sealer
	Poor combination of coating system; some water-based coatings have poor adhesion to other types of coatings	Contact your AcromaPro distributor
Resin/Sap migration	Resinous wood such as pine is dried at too high temperature	Decrease oven temperature and IR energies so the surface temperature of the substrate stays below 113°F (45°C) during the drying process

10.2.3 UV curing		
Problem	**Possible causes**	**Solutions**
Odor	UV coating not fully cured	Check energy and peak values of the UV lamps
Color	Some UV lacquers might turn yellow when curing	Change to a different product
	Incorrect type of stain used underneath the UV coating	Wait, some initial yellowing vanishes after one hour
	Incorrect application amount	Check the applied amount
	Different quality or producer of the substrate compared to the time of setup	Compare original substrate with present and either change back or re-match the color
Gloss, low/high	Thin layer of topcoat gives lower gloss	Change the application amount
	Thick layer of topcoat gives higher gloss	Change the energy and/or the height of the first lamp
	If the UV energy and peak of first the UV lamp is low then the gloss will be low	Try to lower the surface temperature; turn off lamps in the previous ovens, but ensure that power is efficient
	High surface temperature of the substrate gives lower gloss	Check the energy of all UV lamps in the line
	Poor curing of the previous coat can influence the gloss (up or down)	Insure proper curing of all layers
Haze	Poor curing, might show up as a haze weeks after application	Check UV energy and peak regularly
Poor adhesion/ Peeling	Poor sanding	Improve sanding
	Poor curing	Check UV energy and peak
	Too good curing of previous layer	Check application amount
	Application amount too high	Apply as per product data sheet
Scratch sensitive surface	Poor curing	Check UV energy and peak
	Application amount too low	Check application amount
	Incorrect product for this application	Contact your AcromaPro distributor

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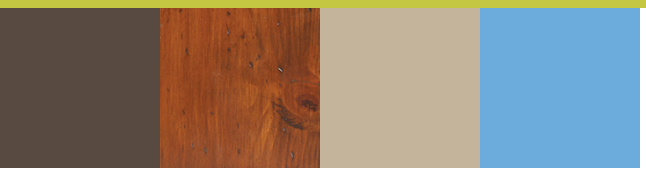

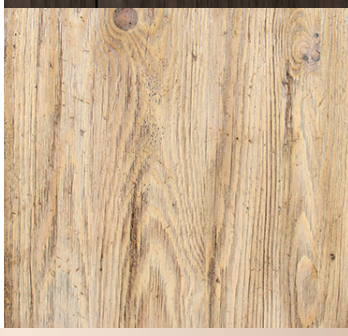

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