MACLAC

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Lacquers for Wood - Then and Now

Environmental regulations have been the driving force for extraordinary changes to paint and lacquer formulations. Compliance is often achieved at the expense of more difficult application and different performance properties. The regulatory field is a spider's web of federal, state and local regulations. Regulations within a state do not necessarily agree. For example, California has 35 different air quality districts and each one can write their own regulations. What is legal to use in one county may be illegal in the next county. Manufacturers of paints and coating have had to make profound changes to their products in order to achieve compliance in an increasingly complex regulatory arena.

This discussion will focus on lacquers and related products used for wood finishing.

A (true) lacquer is defined as a coating that dries solely by the evaporation of solvents. As the solvents evaporate and leave the wet coat, the resins quickly form a dry "film" of lacquer.
Therefore, since a lacquer dries by solvents leaving the coating, and no resin reaction takes place, the lacquer can be re-dissolved at any time in its own solvent (lacquer thinner).
This is one of the reasons lacquers are so easy to work with. Application is easily adjusted with solvents, and the lacquer can be re-coated at any time with virtually no inter-coat adhesion problems. The new coat of lacquer will slightly re-dissolve or re-melt the previous coat and the two coats will bond strongly with each other.

Note: both "precatalyzed" and "post catalyzed" lacquers do not exactly fit this definition. These reacting lacquers will develop limited resistance to lacquer thinner solvents. Generally, post-catalyzed lacquers will have a higher degree of reactivity than the precatalyzed lacquers.
It is important for the applicator to understand these differences between "true" lacquers and "reactive" lacquers when choosing a coating system.

True lacquers dry solely by evaporation of the solvents. When the solvents have evaporated the lacquer will achieve most of its performance properties. Both precatalyzed and post catalyzed lacquers will continue to cure after the initial air dry. The amount of additional cure is dependent upon the manufacturer's formulation.

The performance of any good lacquer coating is directly dependent on good application.
If the lacquer has been properly applied it will achieve expected performance and durability.

The surface of wood is very porous. If you magnify the surface of wood you will see that it is full of "valleys and crevices". The insides of these pores and crevices contain pieces of wood fiber, particles of sanded wood, and dust or other debris.
In order for a lacquer to adhere to the wood, it must by applied in such a way that the liquid coating will penetrate into (or flow into) all the pores of the wood. It must also displace all the air from those areas, and it must stay wet enough to allow the air bubbles to come to the surface and leave the coating.

In order for the lacquer to develop optimum adhesion it must "wet onto" the entire surface area - including any stain materials and fibers or dust. Proper wetting will ensure maximum bonding or adhesion of the lacquer to the wood.
Additionally, the lacquer must be correctly applied so as to achieve correct dry film thickness. Optimum dry film thickness for good performance for most lacquers is in the range of 2 to 4 mils. We recommend a maximum dry film thickness of 5 mils. Sanding sealers and primers should be applied to no more than a maximum dry film thickness of 1.0 mil. Note: since the sanding sealer or primers are typically less tough than topcoats, the thickness of the sealer or primer coats needs to be limited. The topcoats will give more durability to the overall coating system when they are used to build coating thickness.
If the lacquer is applied too thin, moisture will have an easy path to get to the wood, and a thin coat will not afford protection from other chemical and physical exposures.
Conversely, if the lacquer is applied too thick, the coating may not be able to "stretch & shrink" along with the wood - causing cracking or "checking".
We recommend you apply the lacquer so the dry film is 2.0 mils or greater but less than 5.0 mils. The minimum thickness will provide adequate protection, while the thicker coat will provide heavy-duty protection. The maximum film thickness includes all coats of lacquer (including the sanding sealers). Note: 1 mil is one-one/thousandth of an inch. Additionally, we recommend that all coatings in the system be applied from the same lacquer "family". It is not recommended to mix different technology coatings. For example, we never recommend the mixing of a catalyzed curing system with a true lacquer drying system. Consult data sheets and technical representatives for more information.

If a lacquer is applied properly with good flow it will wet the entire porous surface of the wood. If the lacquer is not applied with good flow and wetting - it will "bridge" across some of the pores. "Bridging" means that the lacquer has not flowed into the pore. Therefore, parts of the wood are not coated with lacquer. Areas where the lacquer has "bridged" will not be protected. Moisture will penetrate under those "bridged" areas, and it will swell the wood (much like a sponge) and the swelling will break the coating loose. When the coating breaks loose from the wood it takes on a "white" or "milky" look. Particular care must be given to sharp corners, joints, and the porous "end grain" sections. Additionally, make sure the doors and any sections that are easily exposed to water are properly coated. The entire piece must receive sufficient coating to seal and protect.

Lacquer performance and durability are affected by a variety of factors:

The lacquer coating system itself:
Has the correct lacquer system been chosen for the job? Will the performance specifications meet requirements and expectations? Has the applicator considered component interactions? All components: stains, colorants, solvents, glazes and any intermixing must be well thought out.
EPA regulations have impacted coatings formulations so much that many "old time" practices may no longer work with today's compliance systems.

Spray equipment and atomization:
The spray guns must be adjusted so as to atomize the paint into droplets small enough to penetrate into the pores of the wood. Smaller droplets are able to penetrate into smaller pores easier.

Solvents for flow and wetting:
The lacquer solvents must be adjusted so that once proper atomization is achieved; the applicator is able to hold a good "wet edge" during application. The proper amount (and type) of solvent will eliminate "orange peal" and result in a smooth "wet" film without runs. After the atomized lacquer has reached

the wood surface, it must still be wet enough to be able to flow into all the tiny pores. The lacquer must have some slow or "tail" solvents to promote good flow and reduce blushing.

The skill of the applicator:

This is crucial to a good job. If the applicator fully understands the forces at work, he can make on the job adjustments to compensate for differing conditions. A knowledgeable applicator knows his equipment and coating material. He will be able to recognize common application problems (bubbling, orange peel, blushing, etc.) and make adjustments.

Assuming that the applicator has selected a coating system that will meet the job requirements, then proper application will result in the expected performance.

Note: A coating system consists of all the elements required for the desired look (includes stains, sealers and topcoats). The applicator must also consider the inter-compatibility of the components. In the past, especially before air quality regulations, inter-compatibility of various wood coating components was not as critical. The high lacquer thinner content helped to make slightly incompatible components more compatible.

Proper Maintenance:

Assuming a cabinet has been well constructed with quality materials and properly coated with the correct coating system, then it must be maintained properly for long life.

The owner must understand and follow recommended cleaning and maintenance of the finish in order to prevent damage to the wood. In addition to regular cleaning, any food spills must be cleaned up quickly. The most common problem associated with improper maintenance is water damage. This is due to excessive water exposure. Food build up can also hold moisture and food chemicals on the surface – thus contributing to problems. Usually accidental spills or too much water will run down the cabinet door and collect on the underside out of sight. Water will sit on the surface and with enough soaking time it can migrate under the finish where it soaks into the wood. Note that standing water – with enough time- can get through the finish through micro-pores, butt joints, sharp edges or other surface irregularity. Wood is a natural product that has an affinity for water. We are not aware of any commercially viable finishing system for wood that will allow it to achieve unlimited standing water resistance. A customized application of some coating systems that are applied with a complete understanding of all the mechanisms at work can achieve improved water resistance. However, once the water soaks into the wood (it won't matter how tough the coating system is) the wood will swell up and break the coating loose. Those areas where the coating has broken loose will look white or milky. The lacquer or coating itself has not been directly damaged by water, but rather the coating has been broken loose due to the swelling action of the wood. It is the wood that has been damaged under the lacquer. Any foods or juice that get to the wood may accelerate the damage.

When Maclac lacquers have been properly applied to wood, the wood surface becomes water resistant but *NOT WATERPROOF* – which means the surface will withstand temporary water exposures, but not long term water soaking. Any drops, puddles or standing water must be removed immediately. All parts of the cabinet must be dried with a soft cloth after cleaning. Maclac lacquers are best cleaned with mild household cleaning agents. The waterborne cleaning solutions are the least aggressive. We have not found any adverse effects as long as the recommended cleaning directions are followed. After light application of cleaning agent it is essential to dry the area with a soft cloth. Use a "dabbing" motion rather than aggressive scrubbing. Excessive scrubbing can remove lacquer protection.

For best results apply a wood treatment to the clean surface in order to improve water resistance. We recommend you use a waterborne oil soap designed for wood surfaces. Another choice that works well is a lemon oil polish in a mineral spirits base. Both types will penetrate well and give the surface water resistance. Always test a small area first to note any adverse reactions. Many wood cleaner products will both clean and polish.

Do not use any abrasive-cleaning agents on these lacquer surfaces.

Following is an overview of the *primary* components of a standard wood coating system.

Stains

Stains are used to bring color into the wood. They are generally applied (by spray, rag or brush) to properly prepared bare wood, and then wiped to a uniform appearance. The material that is left in the wood is the part that gives it the desired color. The amount of stain left in the wood affects both:
1) the color (tone or cast) and
2) the depth of color (its relative intensity).
In the past we were able to use a lot of solvents in the stains, which helped them penetrate deep into the wood. The deep penetration gives the stain strong color. And then since most of the stain was solvent, once the solvent evaporated, not much stain material remained. The *small amount* of stain solids left in the wood minimized any compatibility differences between the stain and the lacquer.
Stains should not be applied to sealed wood, nor should they be used as a toner coat between coats of lacquer. When stains are used in such a manner they will interfere with adhesion of the next coat.
Note on pre-sanding wood prior to staining:
Coarser grades of sandpaper will result in a darker color. The rougher or more open surface will absorb more stain.
Finer grades of sandpaper will "close" the surface and not allow deeper stain penetration – therefore the color will be lighter.
Also note that a coarser or rougher surface will generally result in better adhesion of the lacquer. This is true if the coating is properly applied for best penetration through the stain into the wood.

Today stains have to be lower in VOC (lower in solvent content). That means that these higher solids stains will leave more stain material in the wood. This higher level of stain materials in the wood has to be accounted for when applying the first coat of lacquer material. Therefore, all the stain materials (colorants, resins, oils, solvents) have to be much more compatible with the lacquer in order for the lacquer to develop good wetting and adhesion.

In the past, "oil" stains were typically made with some type of drying oils or oil resins. The colors were usually oil base (solvent borne) colorants, and the solvent was usually paint thinner (mineral spirits). The paint thinner gave the stain good working and wiping properties. Most of these stain components are incompatible with lacquers. If you applied a lacquer right on top of a freshly applied oil stain, it was possible for the lacquer to develop a "milky/gray" look. Also, the lacquer would most likely have poor adhesion over the stain. This is because of the interaction and incompatibility between the lacquer and the stain materials. As a rule, you had to let the oil stain dry for about 24 to 48 hours. This allowed the paint thinner to leave, and the oils would begin to dry. High levels of lacquer thinner in the first coat of lacquer would then minimize any residual compatibility problems. This is why it is a big problem today to try to use a low VOC lacquer with a traditional or high solids oil stain. The lacquer is still incompatible with most "traditional" oil stain materials, and the lower VOC lacquers do not contain enough lacquer thinner to counteract compatibility problems. The lacquer will tend to either "float" on top of the oil, or it may "kick out" at the interface. Either way the result is poor adhesion and appearance. You have to choose the coating components much more carefully.

Clear Lacquers - First Coat (Sanding Sealers)

The first coat of lacquer material (whether it is a sanding sealer, or any lacquer finish coat) has to wet into or through the stain material in order for a good bond to develop between the coatings and the wood. Again, in the past, lacquers were typically sprayed at around 85% - 90% lacquer thinner content, and this high level of solvent flowed into and wet through the stains. The high content of lacquer thinner - which also means low solids - made the lacquer easier to atomize. An easy to atomize coating means that it is easy to break it up into tiny droplets. Smaller droplets make it easier to penetrate the tiny pores of the wood. When the (wet) lacquer droplets can penetrate the tiny pores of the wood there will be very little bridging. Additionally, the high lacquer thinner content also minimized any compatibility differences between the stain material and the lacquer material. Furthermore, even if no stains are used, the lacquer still must wet into any residual sanding dust or loose fibers left in the wood. The lacquer has to "bond" all these "loose" components into the coating and to the wood surface. Keep in mind that it is job of the *lacquer thinner* to flow into and wet the wood. The *lacquer thinner* will carry the lacquer (solids) with it into the wood.
However, today we are limited by air quality regulations as to how much lacquer thinner can be used - and a significant part of the lacquer thinner is now acetone - which evaporates so fast that it does not help much in the flow and wetting process.

Clear Lacquers - Finish Coats

After the sanding sealer (or first coat) has been applied, some sanding is usually necessary. The sanding operation will take care of any surface roughness or grain raising that has taken place. This will leave a smoother surface for the next coat.
At this point the user will usually blow off the remaining sanding dust before applying the next coat. We recommend that applicators always remove sanding dust. If the sanding dust is not removed, then the next coat of lacquer will have to redissolve the dust. (Since most of the dust is lacquer material, it can be re-dissolved in lacquer thinner.) If the next coat of lacquer does not contain enough solvent to completely re-dissolve the dust, then the dust will remain in the film as small particles. These small particles will detract from the performance and the appearance of the finish. Additionally, some of the lacquer thinner in the new coat will begin to re-dissolve some lacquer from the previous coat. Therefore all the lacquer thinner consumed by dissolving the dust and by dissolving some of the previous coat is no longer available to help the new coat flow smooth.
Accordingly, if you were able to use unlimited amounts of lacquer thinner (as was true in the past), this would not present any problem. You would simply add lacquer thinner in quantities sufficient to re-dissolve the sanding dust. High levels of lacquer thinner also allowed the lacquer to wet into the previous coat and flow out smooth.

Keep in mind that in the case of "precatalyzed" and "post catalyzed" lacquers, the sanding dust may not re-dissolve anyway, so it should always be removed.

Application of multiple thin coats is much better that applying one thick coat. The thin layers will dissipate stresses better, and the multiple thin layers form a superior barrier to moisture.

Building the total film thickness should be done with topcoats. Sealers and undercoaters have historically been “weaker” finishes than topcoats. Do not apply sealers or undercoaters to more than 1 mil DFT. Higher build with sanding sealers or undercoaters will weaken the finish system.

Glazes

A glaze is typically an accent color that is applied to a sealed or already coated surface. Glazes are

usually applied by spray, brush or rag, and then they are wiped into the areas where color is desired. The glaze should not have any affect on the coating that it is applied onto. It should also stay wet long enough to move it to where it is desired, and to remove it from the areas where it is not desired. Some glazes may dry and form a paint-like finish. However most glazes do not dry to a strong finish, and they require a clear coat to seal and bond them to the previous coat. It is therefore crucial that the final lacquer coat be thinned enough so that the lacquer will penetrate the glaze and bond through the glaze the lacquer underneath. If sufficient lacquer thinner is used to wet through the glaze, then a good bond will develop, and adhesion and durability will be acceptable. Never "dry spray" a finish lacquer coat over a glaze.

There will always be a better bond of glaze with a solvent lacquer system. This is because if enough solvent is used to wet through the glaze it will partially re-dissolve the base lacquer and encapsulate the glaze in the lacquers. This is not true of a converting or catalyzed system. Such systems (like conversion varnish) will not re-dissolve and therefore the only bond is a physical one.

Always test a glaze (specially in a converting or catalyzed system) for suitability. A converting or catalyzed system is very likely to have poor adhesion over the glaze.

Most glazed systems are weakest at the glaze level, and if there is any film failure you can usually see it right at the glaze. The glaze will always decrease the inter-coat adhesion of the coating system. The thicker the glaze has been applied then the more it will compromise the system.

Pigmented White and Color Lacquers

Pigmented lacquers apply and behave much like their clear counterparts. Thinning lacquers with lacquer thinner helps them wet the surface better and also helps the flow-out. In addition, the lacquer thinner in subsequent coats will partially "re-melt" the previous coat, which will give lacquers excellent inter-coat adhesion. Most of the products in this class are whites and off whites. However, sometimes a darker color is needed. Usually, (depending on manufacturing equipment and raw material availability) a different formula is used for the darker colors, and these may take longer to dry and may not develop as much hardness and toughness as the whites. Again, the applicator should pre-test the material to determine suitability for the project. Generally the new (conventional dry) compliance lacquers have different properties than the older lacquers.

Applying Clear Lacquers over Color Lacquers

Sometimes the applicator may want to apply a clear lacquer over a color lacquer. This should be done with caution. First, keep in mind that the lacquer thinner in the new coat will partially re-dissolve the lacquer color coat. Some organic pigments will actually partially dissolve and "bleed" into the lacquer thinner. These pigments are described as having poor "fastness" or high tendency to "bleed". Many organic yellows and reds have a tendency to bleed. As the new lacquer thinner moves into the color coat it will partially dissolve a "bleeding" pigment.

This dissolved pigment will then easily move into the clear coat and change the color.

The applicator should check on the bleed or fastness properties of the colorants in the coatings.

Additionally, even if the pigment does not bleed it is possible that some pigment color will "flood" or "float" up into the clear lacquer – thereby changing the color. Heavier coats of lacquer or high levels of lacquer thinner will increase the tendency of pigment to flood or float.

You should check a small spot first before continuing.

Additionally, a clear nitrocellulose lacquer on the top of a color may have a tendency to turn yellow faster than the color lacquer (depending on the environment and exposure).

A Quick Note On Spray Guns

Air quality regulations have also mandated changes in application equipment. New restrictions on spray equipment have changed their atomization properties.
Today's regulations regarding spray application equipment are geared towards achieving a minimum of 65% transfer efficiency. Transfer efficiency means the amount of paint that actually coats the part as compared to the total amount sprayed.
It was found that the older conventional spray guns gave about 25 - 50% transfer efficiency.
In other words, only about 25 - 50% of the atomized spray paint actually got onto the piece being coated. The excess paint waste resulted in more emissions to the atmosphere. Higher transfer efficiency means less waste and fewer emissions.

Conventional guns are quite easy to adjust and favorable results are easy to achieve.
However, spray guns with higher transfer efficiency (airless, air-assist airless, HVLP, etc.) are not as easy to use. They generally require more understanding and tighter controls to achieve similar results.
Equipment manufacturers are the best source of information.

Summary & Lacquer Systems Overview

This is intended as an overview of some of the compliance issues facing lacquer applicators today.
Environmental regulations continue to drive changes in lacquers for wood.
In order to achieve premium performance and appearance, it is essential for the applicator to understand all the elements of the job.
The coating system and all its components must be chosen for suitability and compatibility. Many of the properties of the old lacquers cannot be taken for granted anymore, and the applicator needs to test for suitability.
Many of the practices from the "old days" are no longer applicable to achieving both good results and regulatory compliance.
Potential unfavorable interactions between coating system components should be eliminated or minimized.
More knowledge and training with added skills are necessary in the workplace. The new systems offer equal or better performance, but only if they are correctly chosen and properly applied.

We offer the following general statements to help the user decide which coating system is best for them. Please note that these statements refer to R.J. McGlennon systems only. Other manufacturers may have different performance associated with their system.

Generally the lowest cost lacquer is the standard amber lacquer. We also sometimes call these our “contractor lacquers” They are very easy to apply, and relatively low in cost. They offer limited resistance to moisture and have limited durability. They also tend to be amber in color when applied, and they will get more amber in time.

Next up is our mar resisting systems. These offer a little better performance over the standard lacquers, and they contain additives and resins that help them resist marring. Some lacquers in the mar resistant type will be slightly amber, while other mar resisting lacquers are made as “water-white” lacquers. Check with the manufacturer.

Next is the “water-white” lacquer system. The term water-white refers only to the fact that the lacquer color is closer to that of water (no color) rather than amber. These lacquers usually have a very slight color to them, but much less than the conventional amber lacquers - and there will be some batch to batch

variations due to raw materials. These lacquers have better resins in them, and offer less color as well as better durability.

The next level of performance is achieved with our precatalyzed lacquer systems. These are also in the water white category. Since precatalyzed lacquers dry by both solvent evaporation and a reaction between the resins, they offer higher durability and performance. Note that because these lacquers usually develop some resistance to lacquer thinners, they sometimes have optimum recoat windows. Properly applied, these lacquers are suitable for the kitchen and bathroom environments.

For greater performance, the catalyzed lacquer is hard to beat. The catalyzed lacquer will outperform the precatalyzed lacquers. Since you add the catalyst at the time of application, a stronger and faster catalyst is used. This will result in a stronger and more durable finish that is much more resistant to household chemicals However, since this finish develops such good resistance, the applicator will have to pay attention to recommended re-coat times.

For superb performance we suggest our conversion varnish. This system does not fit the definition of a lacquer even though it is often applied as a lacquer. All the resins in the coating will react with each other as it cures. There is no air dry or lacquer type resins in the coating. Therefore the coating takes longer to dry and cure than a regular lacquer. After cure, conversion varnishes become resistant to most common chemicals. The conversion varnishes may have a slight amber color in the can – due to the nature of the resins but once applied they have very little tendency to yellow. Additionally they do not become so brittle as they age (when compared to nitrocellulose lacquer). These finishes are very water resistant, but they do not make wood waterproof.

Note: we also offer a very high performance two-component acrylic urethane system. This is best for very harsh environments or exposures.

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