CATALYZED FINISHES

From *The College of Wood Finishing Knowledge* by Ron Bryze

There are many different types of catalyzed finishes; lacquers, conversion varnish, polyurethanes, polyesters and even some vinyl sealers. Each of these finishes has their own particular set of characteristics with different strengths and weaknesses.

A catalyst is a chemical that increases the rate of a chemical reaction. The particular chemical reaction that takes place in wood finishes is called cross linking. Think of the molecular structure of a finish as strands of spaghetti. The catalyst caused the ends to join together to form long chains of molecules. The long molecular strands make the finishes harder and more resistant to water and chemicals.

Catalyzed finishes are broken into two types; PreCatalyzed and Post Catalyzed. As the name implies, the PreCat already has a catalyst mixed into it and since the catalyst is rather weak, it has a pot life in the range of months. The most common PreCatalyzed finishes are PreCat lacquer, vinyl and occasionally a conversion varnish. Post Cat products require that you add the catalyst to the finish right before you spray. The catalysts used in these products are much stronger (hotter) that that used in PreCats and once added they have a pot life ranging in hours to minutes. All of the above mentioned finishes are available in a post catalyzed version.

When discussing these products we will be talking more in generalities than specifics because an individual manufacturer's formulations can have an influence on several critical factors.

- Pot life. The time in which you have to use the finish after the catalyst is added. After this time the finish will either no longer crosslink or it will harden in your equipment. Generally the hotter the catalyst the shorter the pot life and the harder the finish. Every manufacturer states the pot life for their particular products. The pot life generally decreases with an increase in temperature.
- Applied wet mil thickness. How much of a wet film can you lay down at one time. Can vary from 3 mils for some vinyl's to 8-15 mils for polyesters. Follow your manufactures recommendations to achieve the proper dry film thickness and reduce runs.
- Total system maximum dry mil thickness. Some manufacturers recommend a maximum limit to the amount of dry film accumulated on a piece of wood. Exceeding this amount can lead to finish failure such as cracking.
- Induction time. Also known as the sweat in time. Some products require that after mixing the components, you let them sit for a time period before spraying. This lets the chemical chain reaction get fully underway before atomizing. Not all finishes require an induction time and for those that do, it is usually temperature dependant.
- Recoat windows. As the catalyst gets hotter, the importance of applying the next coat of finish within a defined time period increases. This window of time that the finish won't wrinkle the previous coat or adversely affect adhesion. The time window is often affected by temperature. It can even create a window where one may not have normally occurred. For instance, some conversion varnishes don't have a stated recoat window; however in low temperatures the curing process slows down. Because of the evaporative effect of the solvent the surface skins while the underside is still fairly soft, kind of like a bowl of pudding. If you sand thru the cured surface of the finish and expose the uncured layer below, the solvent from the next coat will re-melt the burn thru and get under the cured surface. It will attack it from the underside causing it to wrinkle as it dries.

As opposed to shellac or nitrocellulose lacquer, once dry catalyzed finishes do not melt into the previous coat; so to get an acceptable intercoat adhesion it is vital that you sand between coats.

The exception is if you are applying a wet on wet coat, in which the first coat has not totally dried so the solvent in the following coat will burn into the first coat causing it to chemically bond. Your timing when applying wet on wet coats is critical. If the first coat is too wet it will run, too dry and the second coat will not burn in. Wet on wet coats are frequently used when spraying polyester so that there is no halo if you burn thru a layer when polishing.

PreCatalyzed Lacquers
PreCatalyzed lacquers come in both a water white or amber version. Since the clear lacquers contain an amount of nitrocellulose, they can yellow over time; some more than others. There are pigmented versions of the precats that are non-yellowing. The pot life of these products can range from a few months to over a year. As these products age past their pot life, they generally lose their ability to crosslink rather than gel up or harden in the can. There are versions of PreCat lacquers that are thermosetting, that is they do not soften when exposed to heat. Once cured, the thermosetting versions of these products will even resist being re-dissolved by their own lacquer thinner. While they have improved performance characteristics and a higher percentage of solids by volume than nitrocellulose, they spray and have similar dry times. PreCat lacquers work well over most stains, except those that contain a lot of oil. They may also have difficulty adhering to oily woods like rosewood or teak. Vinyl or non-stearated sanding sealers are usually recommended as a first coat. Some PreCat lacquers are able to be used as a self sealing product. A vinyl sealer will help some to meet KMBA kitchen and bath moisture resistance standards. Many of this product group will meet HAP's and VOC standards.

PreCat lacquers are a good choice for fast drying, medium performance applications, where yellowing is not an issue.

Post Catalyzed Lacquers
As the name implies, you add the catalyst just prior to spraying. Most of these products have a higher percentage of solids by volume and better water, chemical and scratch resistance than the PreCat lacquers. Most will also yellow over time because of their nitrocellulose content. Generally these products have an 8 to 12 hour pot life and will gel and harden in the can once the pot life is exceeded. The pot life is accelerated by an increase in temperature.

Post catalyzed lacquers, like the PreCats work well over most stains, except those that contain a lot of oil. They too may also have difficulty adhering to oily woods like rosewood or teak. Vinyl, catalyzed vinyl or catalyzed non-stearated sanding sealers are usually recommended as a first coat. Some PostCat lacquers are able to be used as a self sealing product. A vinyl sealer is usually not necessary to meet KMBA kitchen and bath moisture resistance standards, however to meet the AWI quality standards a vinyl sealer is required. There may or may not be recoat windows when using this type of product. Many of this product group will meet HAP's and VOC standards.

Post Catalyzed Lacquers are a good choice for fast drying, medium to high performance applications, where yellowing is not an issue.

Conversion Varnish
Conversion Varnishes are a post catalyzed alkyd resin based finish and have most of the same specifications as Post Catalyzed Lacquer with only a few exceptions.

CV will often have a slightly higher percentage of solids by volume than the lacquers and may take a little longer to dry. It also provides some additional wear and chemical resistance over the lacquer products. Usually these products have an 8 to 12 hour pot life and will gel and harden in the can once the pot life is exceeded. The pot life is accelerated by an increase in temperature.
There are versions of CV that have non-yellowing formulations and still others that will yellow even in the absence of sunlight. Some pigmented versions are actually more prone to yellowing than pigmented PreCat lacquers.

Conversion Varnish works well over most stains, except those that contain a lot of oil. They too may also have difficulty adhering to oily woods like rosewood or teak. Vinyl, catalyzed vinyl or catalyzed non-stearated sanding sealers are usually recommended as a first coat. Some PostCat lacquers are able to be used as a self sealing product. A vinyl sealer is usually not necessary to meet KMBA kitchen and bath moisture resistance standards, however to meet the AWI quality standards a vinyl sealer is required. There may or may not be recoat windows when using this type of product. Many of this product group will meet HAP's and VOC standards, however some use xylene as a reducer which is on the HAP's list.

Conversion Varnish is a good choice for moderately fast drying, high performance non-yellowing applications.

A note about Stearated sealers:
To achieve improved sanding some sealers add Zinc Stearate to their formulation. Zinc Stearate is a soap like material that acts like a lubricant during the sanding process. Most Post Catalyzed Lacquers and Conversion Varnishes use an acid based catalyst. If an acid cure top coat is put on top of this type of sealer, a chemical reaction takes place between the zinc and acid causing "blooming", and a haze forms in the coating after the finish is fully cured. This haze may not appear for weeks or even months.

Catalyzed Polyurethane
Two-component polyurethanes consist of a polyisocyanate hardener and a resin, either an acrylic or polyester. Once combined, they result in a highly cross-linked finish. The isocyanate hardener can be either aromatic or aliphatic. Aromatic polyurethanes are prone to darkening and yellowing on exposure to sunlight but are faster drying. Aliphatic polyurethanes do not yellow and retain their gloss better than aromatics. Polyurethane can be either clear or pigmented and is offered in a wide range of colors and gloss levels.

2K Poly have a higher percentage of solids by volume than Conversion Varnishes and are a little slower to dry. They provide excellent wear, water and chemical resistance properties. Usually these products have a 4 to 6 hour pot life and will gel and harden in the can once the pot life is exceeded. The pot life is accelerated by an increase in temperature. When mixing, the resin should be stirred as the catalyst is added to avoid shocking the mixture and forming a gel where the two components meet. Some of these products have an induction or sweat in time.
2K Poly usually works well over most stains, including those that contain oils, however check the manufacturer's recommendations. Some require a barrier coat over solvent based stains. Most 2K products have their own sealers, some of which may contain Zinc Stearate to improve sanding. Since there is no acid catalyst there is no reaction with the zinc. There often is a recoat window with these products, and sometimes a "no sooner than" and a "no later than" window. Recommended wet film and maximum dry film thickness often exceeds that of Conversion Varnish. Some catalysts are moisture sensitive. Some have a very limited shelf life once opened.
Two-component polyurethanes are a good choice for applications where a very hard, durable, chemical resistant finish is needed. 2K Polys are also very flexible finishes. See the warning about isocyanates after the section on Polyester.

Polyester
Polyester is a three component finish: the resin, the promoter (cobalt) and the catalyst (methyl ethyl ketone peroxide, or MEKP). When mixing these three items together extreme caution should be used because if the promoter comes in contact with the catalyst, the reaction can be quite violent. Polyester has a higher percentage of solids by volume than Conversion Varnishes and is slow to dry. It provides excellent wear, water and chemical resistance properties; however the finish can be brittle, especially in the cold and is subject to impact damage. Polyester has a pot life rated in minutes and will harden in the can once the pot life is exceeded. If this stuff hardens in your gun you will have to buy a new gun. The pot life is also greatly accelerated by an increase in temperature. I have heard some people actually recommend refrigerating the resin on hot days. If you are going to shoot this product with any regularity it would be wise to invest in a plural component gun that mixes the components together in the air stream as they are sprayed.
Polyester is very selective about sticking to stained surfaces. For stained or oily woods it is recommended that a barrier coat is applied before sealing. Some manufacturers sell a barrier coat product, others recommend using a 2K Poly.

Polyester sealers have very good grain filling characteristics and can be applied a very high wet mil thickness. These products are best applied wet on wet so there is no haloing if during sanding you burn thru a coat. The dry film thickness of polyester can be several times that of a conversion varnish.

There are two different types of polyester; direct gloss and paraffinated. Direct gloss usually uses a separate sealer, where as the paraffinated is a self sealing product. The paraffinated product has the shortest pot life of the two and requires the largest diameter fluid tip. Both of these products are designed to be shot wet on wet with very critical time windows. Once applied, the direct gloss may require a little polishing to remove minor surface contaminants and achieve the perfect gloss. The paraffinated product requires the surface to be "ground down" with a fairly course (280) sandpaper and then up thru the grits before polishing and buffing. Always wait the specified time before starting the grinding or polishing process to allow the materials to harden appropriately. This will allow you to obtain a higher gloss with less shrink back.

Both of these products can be used to simply fill the grain and then be top coated with a 2K Poly in various sheens. In any case follow the manufacturer's instructions implicitly and mix materials exactly as instructed. Do not deviate and once again remember that warm temperatures greatly accelerate drying.

Use polyesters to obtain that deep wet look. This finish is not very flexible and can be easily damaged by impact.

Isocyanates
There are two different schools of thought on isocyanates. Most European countries do not consider them a problem; they consider formaldehyde emissions to be the greatest risk. In the USA it is just the opposite. This is where the problem comes in; depending on the country of origin of the finish manufacture you will get different health warnings.

Some people can become sensitized to isocyanates. Exposure to them can bring on upper and lower respiratory reactions that are similar to asthma. Skin reactions such as rashes are also possible. Once you become sensitized, you will always have a reaction. Isocyanates are present in the finish up until the time that a full cure is achieved. This means that you can be exposed when the finish is in liquid or vapor form, as well as by coming in contact with the sanding dust and overspray. Once the finish is cured, the risk is gone.

The first line of defense is to limit physical exposure. An enclosed spray room with a booth that has sufficient air flow to remove the vapors and overspray is the best place to start. By enclosing the spray operation you limit outside exposure to vapor, as well as the dust and overspray. Protective clothing and rubber gloves are the second line of defense. You skin is your bodies largest organ, protect it. Goggles, or even better, a full face respirator prevents the vapors from getting in thru the eyes. Finally we come to the respirator. While there are cartridge type respirators that will filter out isocyanates, the danger lies in the fact that isocyanates are odorless so you can't tell by smell when the cartridges are spent.

In the big picture of things, neither formaldehyde nor isocyanides are good for you and you should take precautions to minimize your exposure to either of them.

UV Curable Coatings

UV curable coatings have been around for over 40 years. Simplistically, they are coatings that use ultraviolet light to cure. Sometimes a simple mercury vapor lamp is used as the light source. Most of the UV wood finishes are based on acrylated epoxies, polyesters, and urethane monomer resins. Photo initiators are added to the formulas. They start a chain reaction when exposed to UV light which results in the polymerization of the resins.

Initially UV curable coatings were 100% solids, however today waterborne and even solvent based UV curable coatings are available. These lower solids formulas are used to achieve thinner surface films, reduce toxic monomer content, provide a mechanism to formulate different sheen levels, and to speed up the cure rates. UV coatings can be formulated as stains, clears and pigmented coatings, in all of the various glosses.

With UV the cure rate is almost instantaneous. This means that very high production rates can be achieved. The product exits the light zone cured and ready to pack and stack. As a result UV applications are typically conducted on automated lines. This also helps reduce worker exposure to the skin irritating resins and powerful light sources. Once applied, the limited open time of the chemicals before cure helps reduce flammability concerns. The normally high solids contents will reduce the VOC's to practically zero. UV coatings remain a liquid until exposure to UV light. This means that the coatings can sit in reservoirs for several days and still be ready for use. The need for frequent equipment cleaning is eliminated. Unreacted material can be cleaned from equipment without the use of solvents. Not only does this significantly reduce labor, but hazardous waste disposal costs as well.

UV coatings are usually applied by spray, flow coating or roller coating. Their application is predominantly on two dimensional objects, such as items like flooring and panels. UV curing equipment can be configured for use on mouldings and even three dimensional objects like pieces of furniture, but changing configurations and adding light sources can be expensive and time consuming. UV curing equipment typically has a lower energy cost and a smaller equipment footprint than conventional ovens.

UV coatings offer higher chemical, impact and abrasion resistance than most of the typical catalyzed coatings.