A Guide to the Spray Application of Waterborne Finishes

By
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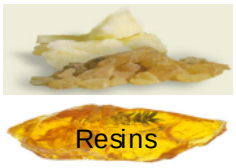
Many people have difficulty when switching to a waterborne finishing system. I think this is because they approach it like they would a solvent based system, which will give mixed results at best. The first rule to remember when making the switch is that you are dealing with a water emulsion rather than a solvent solution so the entire chemistry dictates a different set of rules that you have to follow. I believe that with a better understanding of the fundamentals and how they relate to application techniques will help make the transition easier and less frustrating.

WATERBORNE FINISHES

Our discussion will center on waterborne finishes, and not water based finishes. Water based finishes are essentially latex paint without the pigment. While there are certain applications for water based finishes, most furniture and cabinetry products are better suited for waterborne finishes.

To understand waterborne finishes a little bit better let's look at solvent based finishes first.

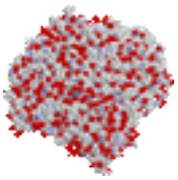
Basic Solvent based Finish Components:
- Resins
- True or Active Solvents
- Diluent Solvents
- Latent Solvents



Various resins, both man made and natural, are selected for their particular performance characteristics; hardness, flexibility, scratch resistance, water resistance, cost, etc. They are mixed together in a ratio that will give the desired properties for the finish that is being formulated. There are three classes of solvents in a finish and each class can contain several different solvents. True solvents are solvents that will melt the resins into a liquid at room temperature. When added to the resins they melt into a thick syrupy liquid that is too thick for spray application. Diluent solvents do not melt resins at room temperature, however ever they do mix with the True solvents and reduce the viscosity of the resin / solvent mixture to a level that gives it the ability to be sprayed. The Latent solvents are solvents that on their own will not melt resins at room temperature, but are "activated" by the True solvents so that in combination they increase their potency. They are usually less expensive than the True solvents and thus help reduce the overall cost of the finish.

Once mixed the resins and solvents for a solution. This means that the resin is totally dissolved in the solvent, just like salt dissolves in water. When the finish is sprayed on to the wood the solvents start to evaporate. Every one of the individual solvents in the finish evaporates at a different rate. The faster evaporating solvents, generally the diluent and some latent solvents are the ones that "thin out" the finish so it can flow out on to the wood. As these evaporate out the slower solvents, usually the True solvents are left to melt the resins together into a smooth thin film. Although temperature and humidity effects how fast this all happens the whole scenario takes place in relatively short period of time.

Basic Waterborne Components:
- Polymer Emulsion - Acrylic or Polyurethane
- Coalescent Solvent – usually a Glycol Ether
- Water

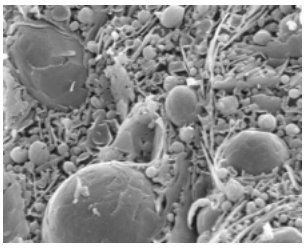


Polymer Emulsion

Water

There are several polymer formulations including acrylic, acrylic and polyurethane, polyurethane and acrylic, and finally straight polyurethane. The polymers are combined to take advantage of the non-yellowing characteristics of the acrylic and the increased wear characteristics of the poly. Obviously, the greater the amounts of polyurethane present the harder the finish, but then the greater the chance of yellowing.

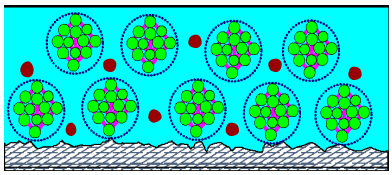
This sounds a little odd, but waterbased finishes are actually formulated on a solvent based platform. A glycol ether solvent is used because it is compatible with water and it will melt most acrylic and polyurethane resins. Another factor is that it evaporates more slowly than water. It importance of this will be shown later.



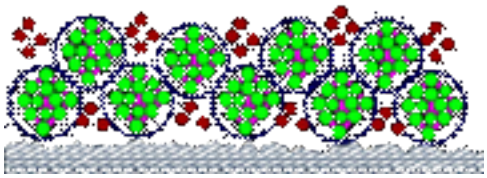
Water Emulsion

The basic waterborne finish can be defined fairly simply; the polymer resins are manipulated to form tiny droplets called latexes. They are dispersed in the water to create an emulsion. An emulsion is a liquid made up of unblendable substances. A good example of an emulsion is oil and vinegar. Then the coalescent solvent is added. Even though the process is relatively simple to explain, the chemistry involved is another matter. The polymers and water are not chemically compatible, so getting them to work together is quite complicated. Overcoming the issues of surface tension, ph, grain raise, and foaming are much more difficult than in their solvent-based cousins.

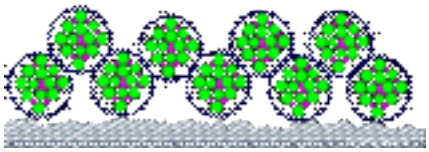
A simple explanation for the drying process is that the water evaporates and the polymers form a layer on the surface of the wood. At this point, the coalescent solvent is at a high enough concentration to dissolve or soften the polymers so that they melt together forming a thin smooth film on the wood.



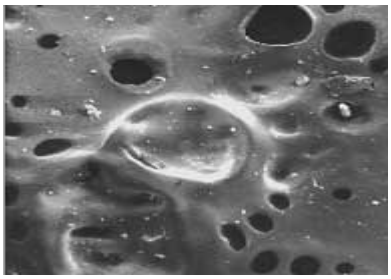
Polymers and coalescing solvent in water emulsion



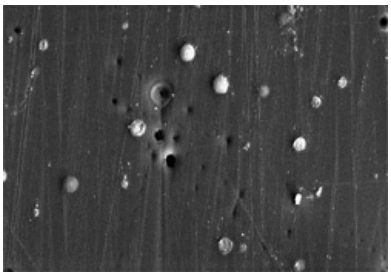
As water evaporates the concentration of coalescing solvent increases



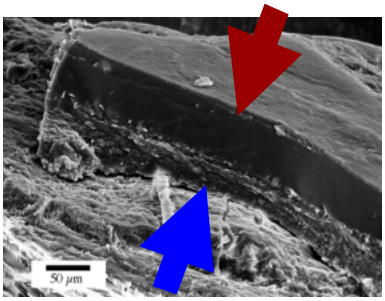
As the coalescing solvent evaporates it melts the polymers together to form a flat film



Finish right after spraying. Holes are atomizing air and solvents evaporating



Dried finish. Notice pin holes and sanding scratches. White dots are entrapped air bubbles



Cross section of dry finish. The blue arrow shows the sealer coat; the red arrow the top coat.

Waterborne finishes produce a coating that has excellent water and abrasion resistance, however their Achilles heel is solvent resistance – remember that a coalescing solvent is used to melt the resins together when they dry. Although they are not yet up to the caliber of the best catalyzed solvent based finishes the difference is becoming smaller with the introduction of Pre and Post catalyzed waterborne products.

Manufacturers are still working on a couple of issues that are keeping waterborne from becoming the standard in the industry. Clear waterborne finishes are almost perfectly clear. They also lay on the surface a little more than solvent-based finishes, so they tend to brighten the natural variations in the wood. This sometimes results in a slightly more harsh or plastic look, although they are getting much better. Solvent-based finishes tend to soften these variations resulting in a warmer look. Waterborne finishes are also are more weather sensitive, but this can be overcome with application technique. The sophisticated chemistry can add to waterborne finishes cost, but never use the dollar per gallon cost to be your main criteria for judging the acceptability of a finish. Increases in health, environmental, and safety regulations are fostering an increase in waterborne research and use.