Water-Borne Finishes

The "Green" Alternative?

We begin our examination of water-borne finishes by explaining why we refer to them as *water-borne* and not the more commonly encountered term, "water-based." Water-borne acrylic finishes are not based on water in the sense that an oil-based varnish is based on oil. In the manufacturer of an oil-based varnish (Click link to article on *Oil Based Varnish*), oil is one of two primary ingredients, the other being resin, which are blended and "cooked" to produce varnish. Oil, therefore, is the *base* on which varnish is manufactured. Varnish is also identified by the resin used. For example, Pratt & Lambert #38 varnish is a soya (soybean) oil-based alkyd resin varnish, Waterlox Original is a tung oil-based phenolic resin varnish, and General Finish Arm-R-Seal is a linseed oil-based urethane resin varnish. The common thread is that all are *oil-based*. Water, by comparison, plays absolutely no role in the finish film produced by a water-borne acrylic finish. Water is just the carrier in which the acrylic finish is borne.

A water-borne acrylic finish consists of minute droplets of pre-cured acrylic resin, the outer shell of which have been softened by the addition of glycol ether, the actual solvent in a water-borne finish. In this form the finish would be an unusable, sticky mess. However, by taking advantage of the fact that glycol ether, which is chemically similar to anti-freeze, is also compatible with water, the acrylic finish is *dispersed* in water—the acrylic finish, therefore, is borne in water. Water is not the solvent as many believe. Water, which typically comprises over 50% of the volume of these finishes, is simply the medium in which the finish is *borne*. By comparison, glycol ether, the actual solvent, accounts for less than 10% of the volume of these finishes.

The role of water is similar to the role of mineral spirits in an oil-based varnish—it thins the actual finish making it easier to spread. Thus, to be consistent in our terminology; if we are going to call these finishes "water-based", we should refer to oil-based varnish as "mineral spirits-based." Mineral spirits contribute nothing to a varnish finish film—water contributes nothing to a water-borne acrylic finish film. The role of both is simply thin the actual finish making them easy to apply.

Water-Borne Finishes Are *Coalescing Finishes*

As the water evaporates (water evaporates faster than glycol ether) the softened, pre-cured droplets of acrylic resin come together—they coalesce. As more of the water evaporates the droplets of acrylic touch and stick to one another. After the water has evaporated the glycol ether evaporates and the pre-cured acrylic droplets again harden to complete the process of forming the finish film.

By understanding this process, we can see why water-borne finishes are referred to as "coalescing finishes". It is also apparent that they are chemically and functionally much different than "reactive finishes" (varnish) which cure in the presence of oxygen. We can also see why the manufacturers warn us not to thin their water-borne acrylic finish with water. Adding water will disperse the glycol ether softened acrylic droplets too much and they will not properly coalesce as the water evaporates thus forming a spotty, weak finish film.

Some water-borne acrylic finishes have a small amount of urethane resin added thereby improving the abrasion resistance of the finish. The urethane resin usually comprises less than 10% of the finish, by volume. Water-borne acrylics with urethane resin added are usually marketed under a name that includes the word "poly". For example, General Finish PolyAcrylic®. Regrettably, some manufacturers marketed these finishes as "water-based polyurethane", a term that is both inaccurate and misleading.

Water-Borne Finishes Are Neither "Varnish" Nor "Lacquer"

Can labels and marketing aside, it is not appropriate to refer to water-borne acrylic finishes as either "varnish", "polyurethane", or "lacquer". These terms totally misrepresent the nature of water-borne finishes. Varnish (polyurethane is varnish made with urethane resin) is a *reactive finish.* It cures by chemical reaction when the varnish is exposed to oxygen. Once cured, varnish can no longer be softened by mineral spirits. By comparison, water-borne finishes are easily softened by their solvent, glycol ether. When one applies a new coat of water-borne finish to a previously dried (coalesced) coat, the glycol ether solvent in the new coat will soften the previous coat and the two will "burn-in" or melt together at the point of contact. Given this characteristic, some manufacturers market their water-borne acrylic finish as "lacquer", making the rather tenuous leap in logic that if a finish exhibits "burn-in", it must be lacquer. Never mind that lacquer is an *evaporative finish* and that its

chemistry is vastly different than that of a water-borne acrylic. Never mind also that since "burn-in" is a universal property of all water-borne finishes, including those sold as "water-based poly", in order to be consistent this also means that all water-borne finishes must be lacquer, including those sold as "varnish" or "poly".

The problem is that "burn-in" in a coalescing finish is not exactly the same as "burn-in" in an evaporative finish (lacquer and shellac). This logic is somewhat analogous with saying that since both pork and beef are meat, then a slab of bacon is the same as top sirloin.

Finish Film "Durability"

Water-borne finishes are quite hard due to the properties of acrylic resin. This makes them excellent for cabinet interiors, drawer boxes, children's furniture, work surfaces, and other applications where a hard, clear finish is indicated. However, water-borne acrylics are subject to damage from a wide range of common household chemicals, particularly those containing alkalis. A number of food acids can also damage the finish film over time. In addition, water-borne finishes are much less resistant to moisture, both water-vapor and liquid water, than varnish. They should not be used in environments where humidity and moisture are a problem, or where household cleanser containing ammonia are frequently used.

Finish Clarity

Water-borne finishes are frequently advertised as being "water-clear", which means that they do not impart an amber color to the wood as does an oil-based varnish. This property can be used to your advantage when you want to apply a finish that will impart as little color as possible. However, "water-clear" is not the same thing as saying that these finishes impart no color at all. On dark color woods such as cherry and walnut and on dark stained wood, water-borne finishes tend to give the wood a dull, blue-gray, washed-out look. This effect can be mitigated somewhat by first applying a coat of boiled linseed oil or shellac (or both), or by tinting the finish with a small amount of amber colored water-soluble dye to mimic the color of an oil-based finish.

Read Everything. But Be Careful What You Believe.

Water-borne finishes have improved tremendously since their introduction in the 50's. However, the misleading advertising surrounding these products, particularly on-line, is on a par with that associated with "Tung Oil Finishes" (See *What is a Woodworker to Do*, Winter 2005 Newsletter). All water-borne finishes, whatever the manufacturer may call them, are simply water-borne acrylics; some with a small amount of urethane resin added. In recent years we have begun to see the proliferation of the term "water-based lacquer" and "water-based polyurethane" in advertising. These finishes are neither lacquer nor varnish—they are water-borne acrylics.

The latest marketing gimmick is the use of the term "pre-catalyzed water-based lacquer". There are catalyzed water-borne finishes. But, without exception, are all two-part products and the catalyst is usually a cross-linker called aziridine—a very hazardous chemical subject to MSDS disclosure. These are professionally applied finishes primarily used in factory settings.

One-part water-borne finishes advertised as "catalyzed" almost certainly are not, at least not in the proper sense of the word. In fact, an examination of the MSDS for most of them reveals absolutely no significant difference between the so-called "catalyzed" finish and a common water-borne acrylic. The only hazardous chemical listed on the MSDS is the glycol ether solvent. Presumably, the term "pre-catalyzed" is simply drawn from the fact that the acrylic resin is "pre-cured". They are still coalescing finishes—they do not cure through a chemical reaction as would a true catalyzed finish.