

Waterborne Finishes Come of Age

The best are now as good as or better than solvent finishes;
the worst should still be avoided

BY CHRIS A. MINICK

When Congress enacted the Clean Air Act of 1990, doom-sayers predicted that oils and waxes would be the only options for wood finishing. Optimists said waterborne finishes would come to the rescue. But at the time, waterborne finishes were little more than latex paint without pigment; they were hard to apply, offered almost no protection, and looked bad.

Five years later I tested 15 waterborne finishes (*FWW* #115, pp. 48-53) and found that while they had improved, they were still far from equal to their solvent-based counterparts. Even so, waterborne finishes offer a package of benefits that no solvent-based finish can match. They have far less odor than lacquers; they dry quicker than oils and oil-based varnishes; they offer more protection than shellac; and they can be sprayed safely without an explosion-proof booth.

So fast-forward another 11 years and it's time to look at waterborne wood finishes again. I purchased 13 readily available, clear waterborne finishes, from the hardware-store variety to those aimed at professionals, and subjected each finish to a battery of tests. What I found surprised me. In the three critical areas of

application, protection, and appearance, many of these waterborne finishes are every bit as good (or better, in some situations) as the solvent-based finishes I normally use in my shop. That's a bold statement, but here's how I came to that conclusion.

Whether sprayed or brushed, the finish must be easy to apply

The clarity of a particular waterborne finish or the protection it imparts to the wood matters little if you can't apply it without drips, runs, sags, or brush marks. I used a number of tests to evaluate the application characteristics of each finish. Some tests—viscosity and vertical sag—are industry standards; others—brushability, sandability, sprayability, and grain-raising—are of my own design.

Viscosity: Don't rush to thin a waterborne finish—With solvent finishes, viscosity usually has a direct effect on flow-out and leveling. Waterborne finishes are different. Most are thixotropic; that is, they have a high viscosity in the can but “thin out” when brushed or sprayed. While low-viscosity waterborne finishes will run off a vertical surface, that doesn't mean that ones with high viscosities and great resistance to sag are impossible to apply. Try



GENERAL FINISHES HIGH PERFORMANCE

Minick's best-overall choice was a pleasure to work with. It brushed and sprayed easily, dried flat, and offered great protection, except from heat.



HYDROCOTE RESISTHANE PLUS

This was Minick's choice as the best value. It brushed and sprayed well, and left a durable, truly clear finish. It's also only \$9 a quart.

Testing for ease of application

Testing brushability. To get an initial feel for how each finish brushed, Minick applied a coat to a plywood panel using a synthetic-bristle brush.



See how they run. A notched drawdown bar applied strips of finish ranging from 3 mils to 12 mils in thickness. The test card was then hung up to dry and the thickest line that didn't sag or run was recorded. This gives an indication of how forgiving a finish will be if too thick a coat is applied to a vertical surface.

to brush or spray your waterborne finish straight from the can before you thin it—you may be surprised.

Vertical sag measures runs and drips—In this test, a notched drawdown bar applied 10 strips of finish that graduated in wet-finish thickness from 3 mils to 12 mils. The card was then hung in a vertical position and allowed to dry. The sag reading is simply the thickest strip that did not run or drip. Except for one, all the waterborne finishes had vertical sag values of 4 mils or greater. A typical brush coat is 3 to 4 mils thick, so runs and drips should not be a problem with most of these finishes.

Brushing and spraying properties varied widely—I brushed a coat of each finish onto a brush-out card, an industry-standard uniform surface used for testing finishes, and inspected it for brush marks and bubbles. A finish was rated excellent if it dried flat with no bubbles; good meant slight brush marks or a few bubbles; fair indicated a noticeable number of bubbles; and poor was an unacceptable amount of bubbles.

For the spraying test, I used a pressure-feed HVLP conversion gun to spray a 2-ft. by 3-ft. test board hung vertically on the back of my spray booth. Finishes were rated excellent if they sprayed like solvent lacquer; good if the dry finish had a few bubbles; fair if trapped micro-bubbles caused a slightly hazy finish; and poor if the dried finish looked like orange peel.

Grain-raising was not a problem—Waterborne finishes have a reputation for raising wood grain, so I took this opportunity to



Did the finish raise the grain? Each panel was tested with a surface profilometer to measure its smoothness before and after the first coat of finish was applied. With most finishes, the grain-raising was insignificant.



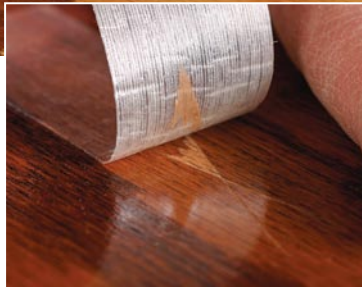
The finish should sand easily. Minick sanded the first coat of each finish with P180-grit no-load sandpaper. Good finishes powder with little effort.

Testing for durability

ADHESION QUALITY



Peel-away finish. To test how well each finish adhered to the stained section of the panel, Minick cut an X in the finish, applied packing tape, and then ripped it off. Most finishes stuck well; this one didn't.



SURFACE HARDNESS



Scratching the surface. A set of pencils graduated from soft to hard were sanded to a flat tip and then pushed across each test panel at a 45° angle. The softest pencil to scratch the finish was recorded.



find out. I borrowed a surface profilometer and used it to compare the roughness of oak plywood before and after one coat of finish had been applied. Even the worst result was fairly minimal, so it seems that waterborne finishes either have been unfairly stigmatized or have come a long way.

Some finishes sand easily, others clog the paper—No one likes to sand, but if a finish sands easily it makes the job less painful. Sanding the first coat with P180-grit, no-load paper, I rated a finish excellent if the finish powdered easily and the sandpaper didn't drag or clog; a good rating meant the finish still powdered up but sanding took a little more effort; fair finishes required a lot of muscle to sand and quickly caused clogging.

Each finish was cut, scratched, heated, and stained with food to test durability

To ensure an even playing field when testing the durability of each finish, I applied a uniform thickness to a homogeneous surface. I used 10-in. by 16-in. panels from a single sheet of 1/2-in.-thick oak plywood whose face was made from a single flitch of veneer. I stained half of each panel with a dark walnut, oil-based stain and allowed it to dry for two days before applying any finish.

I used an industry-standard Mayer rod to apply each coat of finish. This is a round stainless-steel bar wound tightly with stainless-steel wire. The diameter of the wire regulates the thickness of the coating; for this test I chose a wet-coating thickness of 3 mils. I applied three coats of finish to each panel and let it cure for three weeks. In addition to the waterborne panels, I prepared two control panels with solvent-based finishes: a profes-

sional self-catalyzed lacquer and a conventional brushing varnish. Note that all these tests were done with fresh cans of finish. Many woodworkers don't realize that a waterborne finish has a shelf life of about four years. The chemical additives slowly deactivate over time; warm storage conditions will hasten this deterioration. A sign that a waterborne finish is beyond its useful life is the formation of gelatinous stalactites on the underside of the lid or the rim.

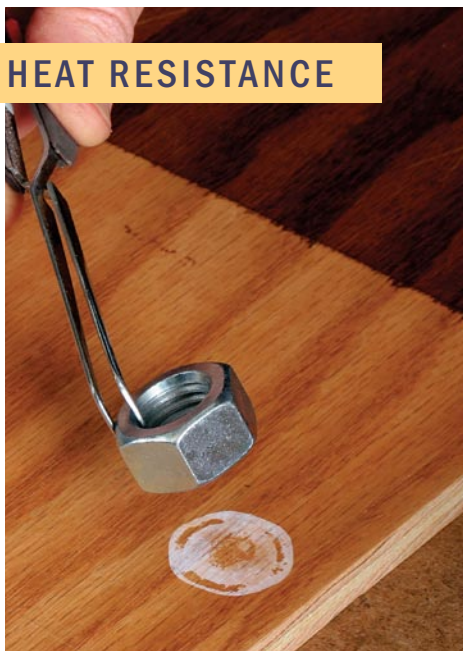
A good finish must stick to the surface—To test each finish's ability to adhere to a surface, I made an X with a razor knife through the coating over the stained section of the panel, burnished a piece of high-tack packaging tape over the X, and then ripped off the tape. An excellent score meant no finish came off; fair meant finish loss of less than 1/16 in. wide at the intersection of the cut, while a loss of more than 1/16 in. rated poor. All the finishes except two had excellent adhesion.

Scratch the surface with a pencil—It may seem counterintuitive, but soft (elastic) finishes are generally more scratch-resistant than hard (brittle) finishes. When an object strikes a soft finish, the finish deforms slightly, then rebounds to its original shape; a brittle finish fractures, causing a scratch. However, a hard finish is a better choice if you want to rub out your finish to a high gloss.

I used a set of pencils ranging from a soft 6B to a hard 6H. I held each pencil at a 45° angle to the surface and pushed it across. Pencils softer than the coating skated along without scratching; pencils harder than the coating dug into it.

Neither heat nor food should mar the finish—I patterned the food-stain test on the one used by the Kitchen Cabinet Manufacturers Association. I placed a dollop of 10 foods on each test

HEAT RESISTANCE



Can't stand the heat. Minick placed a steel nut, heated in boiling water, on each test panel and evaluated the results after 24 hours. Most finishes survived unscathed; Moser's Simple Success simply failed.

STAIN RESISTANCE



Spilled food, spoiled finishes. Ten different foods and drinks were applied to each panel to see if they marred the finish. Most finishes coped well, but mustard left a stain on many panels.

Assessing the appearance

CLARITY



A clear finish. Each panel was examined under a halogen light for color and clarity. Only a few finishes exhibited the bluish cast that was once the trademark of waterborne finishes.

COLOR



Waterborne finishes can add color. Some of the finishes, such as Hydrocote Resisthane Plus, dried clear. Others, such as M.L. Campbell Ultrastar, added a touch of yellow, while J.E. Moser's Marine Shield was dark yellow.



Comparing the finishes

Every finish was tested first for ease of application, by brush or spray gun. The dried finish was then evaluated for its appearance, and finally subjected to a series of assaults to test its durability.

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panel, then after 24 hours washed the panel clean, dried it, and graded it. I awarded two points if the finish was undamaged, one point if the finish needed buffing to remove the stain, and no points if I observed permanent damage.

The Fuhr 355 and M.L. Campbell's Ultra-star scored a perfect 20 points with the rest of the pack close behind. This is a pretty tough test, so any of these finishes would be fine on a well-cared-for dining table.

For the heat-resistance test I boiled a bunch of 3/4-in. galvanized steel nuts in water for five minutes and then immediately placed one on each panel. After 24 hours I inspected the panels and assigned a rating of excellent for no damage, good for slight damage that could be buffed out, and poor for permanent damage.

Clarity and color determine a finish's appearance

The application and protection properties of a finish are meaningless if it looks bad on the wood. Waterborne finishes have a reputation for having a hazy, almost bluish appearance, especially when applied over a dark stain. However, most of the finishes tested were completely transparent. A few were slightly hazy but looked fine under normal lighting conditions, but J.E. Moser's Simple Success had a distinct bluish haze that I found objectionable.

Finish Brand	Source	\$ gallon/ quart
AQUAZAR WATER-BASED POLYURETHANE	Dealer locator: www.ugl.com	53/20
BENWOOD FINISHES STAYS CLEAR	Dealer locator: www.benjaminmoore.com	45/15
CRYSTALAC PREMIUM GLOSS	McFeely's; www.mcfeelys.com	42/17
FUHR 355 ACRYLIC VARNISH	Homestead Finishing; www.homesteadfinishing.com	39/19
BEST OVERALL GENERAL FINISHES HIGH PERFORMANCE	Rockler; www.rockler.com	63/26
BEST VALUE HYDROCOTE RESISTHANE PLUS	Hood Finishing Products; www.hoodfinishing.com	20/9
J.E. MOSER'S MARINE SHIELD	Woodworker's Supply; www.woodworker.com	70/25
J.E. MOSER'S SIMPLE SUCCESS	Woodworker's Supply; www.woodworker.com	45/18
MINWAX POLYCRYLIC	Hardware store or home center	43/15
M.L. CAMPBELL ULTRASTAR	Dealer locator: www.mlcampbell.com	34/8*
OLYMPIC POLYURETHANE	Lowe's; www.lowes.com	40/16
OXFORD ULTIMA BRUSHING VARNISH	Homestead Finishing; www.homesteadfinishing.com	58/22
VARATHANE DIAMOND POLYURETHANE	Dealer locator: www.woodanswers.com	48/19
CONTROL GROUP		
MINWAX FAST-DRYING POLYURETHANE	Hardware store or home center	25/9
ML CAMPBELL MAGNAMAX	Dealer locator: www.mlcampbell.com	42/10*

*Available in gallon only. Quart price equals 1/4 of gallon price.

How waterborne finishes color the wood—Conventional wisdom in woodworking circles is that waterborne finishes are completely colorless. While that is true for some brands, it is far from universal. When I measured the color of each finish with a laboratory spectrophotometer, I found that about half had an amber tint reminiscent of nitrocellulose lacquer.

The contrast between the clearest finish (Hydrocote Resistane Plus, color index 1.35) and the yellowest (J.E. Moser's Marine Shield, color index 27.34) is obvious on maple but barely detectable on dark Peruvian walnut. However, I was shocked when the same two finishes turned cherry a dark gray/green color.



APPLICATION				DURABILITY				APPEARANCE	
Vertical Sag	Brush	Spray	Sand	Adhesion	Hardness	Food Stain Resistance	Heat Resistance	Clarity	Color
Fair	Poor	Poor	Good	Excellent	Very soft	Good	Good	Slightly hazy	Clear
Excellent	Fair	Excellent **	Fair	Excellent	Soft	Good	Good	Slightly hazy	Yellow
Excellent	Good	Good **	Excellent	Excellent	Medium	Good	Good	Transparent	Clear
Excellent	Poor	Excellent	Excellent	Excellent	Medium	Excellent	Excellent	Transparent	Clear
Good	Excellent	Excellent **	Excellent	Excellent	Medium	Good	Poor	Transparent	Light yellow
Excellent	Excellent	Excellent	Good	Excellent	Medium	Good	Good	Transparent	Clear
Good	Excellent	Excellent	Good	Fair	Very soft	Good	Excellent	Transparent	Dark yellow
Poor	Excellent	Fair	Fair	Poor	Soft	Good	Poor	Very hazy	Light yellow
Fair	Fair	Good	Good	Excellent	Very soft	Good	Poor	Transparent	Clear
Fair	Poor	Excellent	Excellent	Excellent	Medium	Excellent	Excellent	Transparent	Yellow
Good	Good	Excellent **	Good	Excellent	Medium	Good	Good	Transparent	Clear
Excellent	Good	Excellent	Good	Excellent	Medium	Good	Good	Slightly hazy	Light yellow
Fair	Poor	Good	Excellent	Excellent	Soft	Good	Good	Transparent	Clear
Poor	Excellent	Excellent	Fair	Excellent	Very soft	Excellent	Excellent	Transparent	Dark yellow
Fair	Excellent	Excellent	Excellent	Excellent	Medium	Excellent	Excellent	Transparent	Yellow

**Thinning of no more than 15% needed to achieve good atomization.

This color change is caused by a waterborne finish's chemical makeup rather than the color of its resin. Waterborne finishes must be alkaline to remain stable in the can, and alkaline materials can change the color of some woods. If you don't like the appearance of a finished sample, wipe the bare wood with a sealer coat of wax-free shellac; it will act as a barrier to the waterborne finish and will prevent chemical discoloration.

Picking the winners

In a strong field, I liked the Oxford Ultima Varnish and J.E. Moser's Marine Shield because both applied clear rather than

milky white. But my choice for best-overall finish goes to the General Finishes High Performance product. This finish was a dream to work with: It brushed and sprayed easily, it dried flat, it had great protection except from heat, and it looked good. It has everything you could ask for in a finish except for price. At \$26 per quart, the General Finishes product is a bit on the expensive side, so I chose Hydrocote Resisthane Plus as the best value. Not only does Hydrocote offer a truly clear coat, but it's also a steal at \$9 a quart. □

Chris A. Minick is a consulting editor.