Oil / Varnish Finishes

Experiment to find the right proportions

by Don Newell

Most finishers have probably experimented with mixtures of boiled linseed oil and varnish in an attempt to produce a better finishing material than either oil or varnish alone. Whether the resulting finish is really better depends on what is needed in terms of drying time, hardness, luster and film build. Because no information exists on the properties of specific mixtures of varnish and drying oils, the finisher must continue to experiment. To give the would-be experimenter some data on which to base the experiments, I ran a series of tests under controlled conditions, eliminating as many variables as possible.

The oil / varnish homebrew mix — I chose a typical soya alkyd varnish (because most varnishes on the market are of this type) and a commercial boiled linseed oil as the base ingredients. I blended the varnish and oil samples into mixtures of the following proportions: 100% varnish, 90% varnish/10% oil, 80%/20%, 60%/40%, 40%/60%, 20%/80%, 10%/90% and 100% boiled linseed oil. The 100% varnish and 100% oil samples were the standards against which I compared the various mixtures. The 90%/10% varnish-to-oil and oil-to-varnish mixtures were used to determine how a mere trace of oil changed the properties of pure varnish, and vice versa. The other formulations were varied by 20% steps to keep the total number of test mixtures manageable.

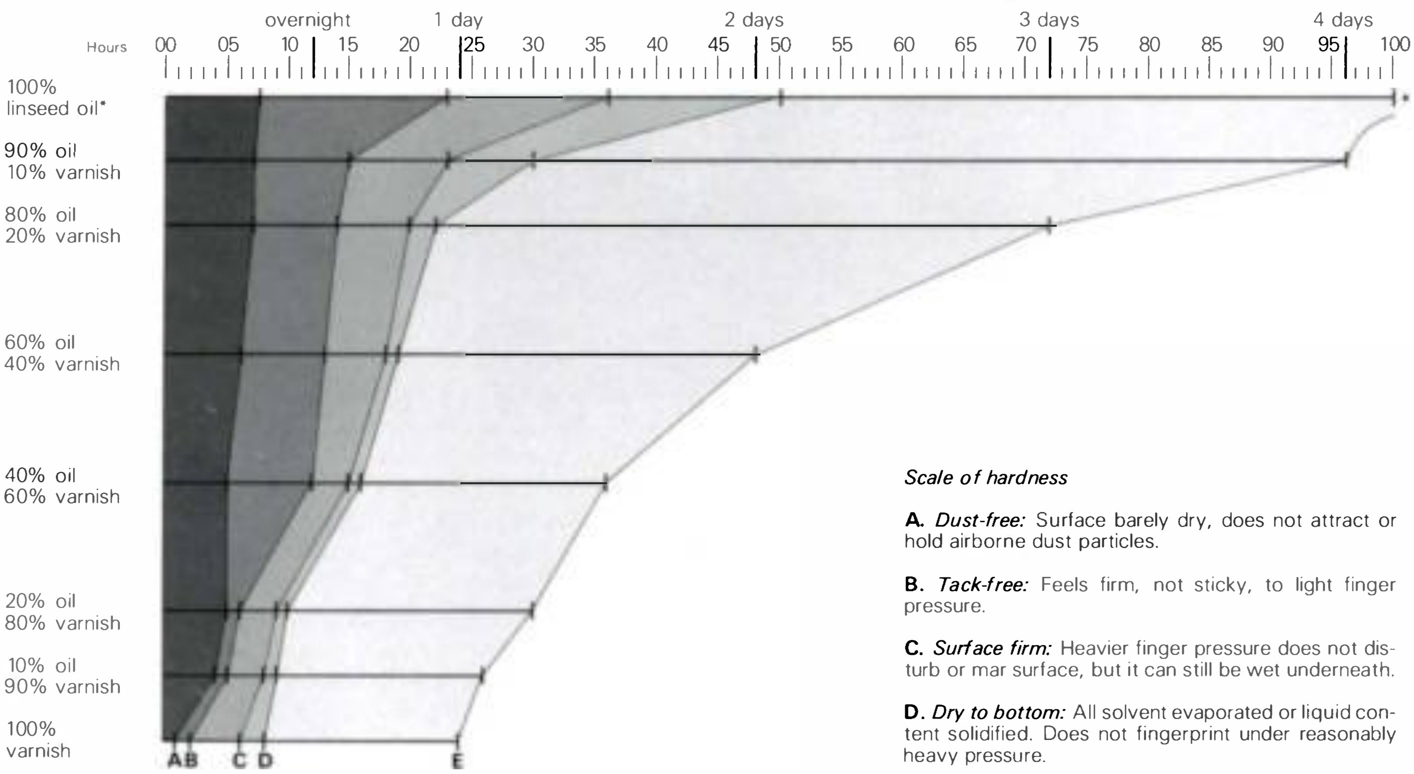
I drew out each of the mixtures on a piece of chemically clean glass to a uniform wet film .009 in. thick. The drying times are shown in the table. The only real surprise was that the addition of 10% boiled linseed oil to varnish produced a substantially softer film than one might expect, and that a 10% addition of varnish to oil produced a harder film. In the other mixtures, each material's properties were modified by the other's properties to about the same degree as the amount of each component present. In practice, this means the more oil you add to the varnish, the slower the film will dry and the softer it will remain.

Although I evaluated alkyd varnish and boiled linseed oil, any drying oil can be mixed successfully with varnish. Polyurethane and phenolic varnishes will work well in place of alkyd types, as will tung oil in place of linseed. But whatever the makeup of a given mixture, its overall properties will probably vary as the proportions of its components vary.

Only experimentation will provide answers. However, a 50%/50% mix of whatever components the finisher chooses is an excellent starting point. Chances are the finisher will never need to experiment with other proportions.

I didn't use thinner in testing because it would have introduced a variable without changing the ultimate results. In

Drying times of mixtures of soya alkyd varnish and boiled linseed oil. All samples drawn out on glass to a film thickness of .009 in.



Scale of hardness

A. *Dust-free:* Surface barely dry, does not attract or hold airborne dust particles.

B. *Tack-free:* Feels firm, not sticky, to light finger pressure.

C. *Surface firm:* Heavier finger pressure does not disturb or mar surface, but it can still be wet underneath.

D. *Dry to bottom:* All solvent evaporated or liquid content solidified. Does not fingerprint under reasonably heavy pressure.

E. *Maximum hardness:* Hardening reaction completed.

* *Still soft after a week, never really gets hard.*

actual finishing, however, such mixes are often thinned with either mineral spirits or turpentine.

Thinning helps the first coat penetrate the raw wood and seal its pores, but probably has no effect on subsequent coats. In most cases, the thinner present in the varnish as it comes from the can provides adequate penetration. But if you want to thin the first coat, mix equal parts of thinner and oil/varnish mix. Keep in mind that the more a mixture is thinned, the lower the solids (film-building) content. Consequently, you'll need more coats of a thinned mixture to produce the same film thickness as an unthinned mixture.

As mentioned, tung oil may be used to replace boiled linseed oil in the oil/varnish homebrew mix, and in fact it will produce results superior to linseed. To this end, I ran another test comparing a 50%/50% mix of polymerized tung oil and the same alkyd varnish. Chart 2, right, shows the results. Though the tung/varnish mix remained fluid long enough to rub out well under hand pressure, the film dried hard all the way through in the same period of time it took the linseed/varnish mix to become only tacky.

The three faces of tung — Tung, or China wood oil, has been used as a binding agent and finishing material for centuries, and many finishers consider it the ultimate material for the classic hand-rubbed oil finish. Tung is available in three forms: plain (so-called pure) tung oil, tungseed oil and polymerized tung oil. Plain tung is oil pressed from the nuts of the tung tree and filtered to remove impurities. Tungseed is basically the same as plain tung, but it is dissolved in thinner to provide maximum penetration of the wood. It contains about 21% oil solids. Polymerized tung is the most useful form. This is tung that has been heat-treated to initiate the polymerizing process (molecular cross-linking by which the oil dries to a solid film) but remains in a sort of holding pattern. Such oil need only absorb oxygen to complete the hardening process. Polymerized tung usually comes thinned to about 49% solids to make the oil fluid enough to penetrate the wood surface.

Any of the tung oils is suitable as an in-surface finish. Generally, two or three coats are applied by hand, rubbed in well and allowed to dry. This leaves the pores and grain structure of the wood open, yet protected by the oil film.

Tung oil films are about twice as resistant to moisture passage as are linseed oil films. In fact, they can stand up to a dilute solution of household lye that will completely strip away an equivalent film of aged boiled linseed oil.

While tung in any form dries faster and harder than linseed, the speed of drying varies among the three different forms. One indication of the differences in reaction speed can be seen on the shelf, assuming half-empty cans of each type. Tungseed oil is the most stable because 79% of the contents are thinners, which do not react with air. Yet tungseed oil will gel solid within 60 days when stored in a half-empty can. Plain tung oil absorbs oxygen from the air in the can more quickly, creating a gelled layer on the surface of the oil within a few days. Polymerized tung oil, however, is much more reactive. It is so hungry for oxygen that a solid layer can form overnight on the surface of the oil in the can.

Drying speed — In tests on wood and on clean glass, tungseed appears to dry a little faster than polymerized tung and much faster than plain tung (chart 3, top right). This is

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Comparative drying time for 50%/50% polymerized tung/varnish and 50%/50% boiled linseed/varnish

	Dust free	*Tack free*	*Surface firm*	*Dry through*
Tung/varnish	55 min.	1½ hrs.	2 hrs.	6 hrs.
Linseed/varnish	6 hrs.	13 hrs.	16 hrs.	18 hrs.

Comment: The tung/varnish film was much harder at through-dry time than was the linseed/varnish film. Even after a week of drying time, the linseed/varnish film remained much softer than the tung/varnish film.

Comparative drying times of tung oil types

Type of oil	*Dust free*	*Tack free*	*Maximum hardness*
Plain tung	12 hrs.	20 hrs.	30 hrs.
Tungseed oil (20% solids, 80% thinner)	2 hrs.	4 hrs.	15 hrs.
Polymerized tung (50% solids, 50% thinner)	3 hrs.	6 hrs.	20 hrs.

Safe Finishes for Toys and Food Utensils

Finishing toys and utensils used for food service poses special problems for woodworkers. Many conventional clear finishing materials normally used for furniture and other interior wood surfaces contain compounds which, if ingested, are dangerous.

Driers pose the greatest threat. Ordinarily they are composed of metals or metal compounds; driers containing lead are the most dangerous, but no amount of any metal can be considered absolutely safe. Drying oils such as linseed and tung and most varnishes contain metallic drier compounds. Even though the actual quantity of metal in a given amount of finishing material is small, little by little it can accumulate to dangerous levels in humans.

In the case of wooden toys, a child can quickly strip and ingest the finish by chewing or sucking. Wooden dishes and utensils in food service are not so likely to be chewed, but with continuous exposure to foods and liquids the compounds can be leached out of the finish and carried into the human system together with the food.

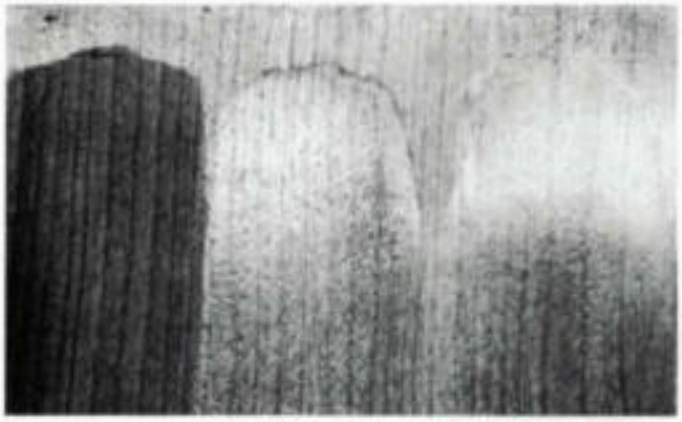
Countertops and food-preparation surfaces can safely be finished with most varnishes, because food is less likely to remain in contact with the finish for long periods of time, and the potential for drier compounds leaching out is reduced. Nevertheless, because the possibility of a hazard exists, the woodworker has a responsibility to select the safest possible finishing materials.

A report by the Safety Products Division of the U.S. Food and Drug Administration indicates that their major concern is with the presence of lead and mercury in a finishing material. The report concludes that as long as lead or other metals are not present, a finish can be considered nontoxic and acceptable for food service and toys.

Consequently, finishing materials that fall into this nontoxic classification are clear woodfinishing lacquers, both spraying and brushing types, and water-based or "latex" varnishes. Among the finishes approved by the FDA are Behlen Salad Bowl Finish (Woodcraft Supply Corp., 313 Montvale Ave., Woburn, Mass. 01801); Wood Bowl Finish (Craftsman Wood Service Co., 2727 South Mary St., Chicago, Ill. 60608); and Wood Bowl Seal (Constantine's, 2050 Eastchester Rd., Bronx, N.Y. 10460). The Watco-Dennis Corp. maintains that Watco oil leaves a solid, nontoxic finish, but stresses that at least 30 days should elapse between finishing and use of food utensils and children's toys to ensure complete polymerization. This is not the finish to use on Christmas eve for next-morning toys.

One other material particularly suited to finishing the end-grain wood of butcher blocks is plain paraffin wax. Melt the wax and pour it over the surface, then literally iron it down into the end grain with a hot electric iron. When cool, scrape the surface residue off, down to the wood. Such a finish remains soft, making it unsuitable for finishing any surface other than porous end grain. It can be renewed at any time simply by ironing in more wax. *D.N.*

Tests on clean glass show that plain tung oil (left) dries to a badly wrinkled, opaque film. Tungseed oil (center) dries to an opaque film with tiny wrinkles. Polymerized tung oil (right) dries to a fairly glossy, transparent film.



Plain tung (left), tungseed (center) and polymerized tung (right) films dried on cherry wood. As with the glass test, tung dries totally flat, whereas tungseed can be steel-wooled to a low gloss. Polymerized tung has a high sheen after only two coats on unsealed wood.

Walnut board sanded, whiskered and given three hand-rubbed coats of polymerized tung oil. The clear finish permits the grain to show with good contrast, and the medium luster enhances the appearance of the well-figured wood.

somewhat misleading in that upon evaporation of the thinners from tungseed, only a thin coat of the oil is left. This thin coat will harden faster than the heavier-bodied forms, but it takes many more coats of tungseed to equal the thickness of one coat of either plain or polymerized tung. Plain tung dries about four times more slowly than either tungseed or polymerized tung.

Penetration — To test the three forms of tung for depth of penetration into two different woods, one veneer and one solid, I flooded three adjacent areas of wood with the oils, allowed them to set for ten minutes and then wiped them dry. On 1/32-in. cherry veneer, plain tung oil penetrated through to the back in spots. Tungseed penetrated completely through at all points. Polymerized tung penetrated less than tungseed, but more than the plain oil.

I also tested the oil on 1/4-in. solid walnut. After wiping it dry, I sawed the wood through the center of the test areas. Plain tung oil at first showed little penetration. Tungseed showed some penetration (about 1/64 in.) and polymerized tung showed the deepest initial penetration (at least 1/32 in.).

However, several hours later I observed that plain tung continued to penetrate slowly, darkening the wood with its still-wet presence, though polymerized tung did not. Tungseed oil penetration could not be seen at all, perhaps because the high thinner content of tungseed had evaporated out of the wood, leaving a thin, virtually transparent film of oil behind. It's also possible that the polymerized oil had continued to penetrate, but because of its high reactivity had hardened to a more or less transparent state.

Surface appearance — Plain tung oil dried on the wood to an extremely dull film composed of countless microscopic wrinkles. No amount of polishing or rubbing improved the luster. Tungseed dried to a semivelvet surface that was also wrinkled, but because of the thinness of the film, the wrinkles took on the appearance of a haze. Repeated coats, with drying between, produced a satin luster which, with judicious steel-wooling, was quite attractive. Polymerized tung oil dried to a hard, transparent film with a high luster, without a matte or hazy appearance.

Film thickness — The thickness of any given finish is a function of the solids content of the material in liquid form. The three forms of tung were drawn out on clean glass to a wet film .009 in. thick. After drying for 24 hours, the plain tung oil film was .0005 in. thick, the tungseed oil film was .0001 in. thick, and the polymerized tung film was .0007 in. thick. The bigger the number, the thicker the film and the fewer coats necessary to achieve the same degree of protection. Seven coats of tungseed oil or about one-and-a-half coats of plain tung will produce a film the same thickness as one coat of polymerized tung.

Storage and handling — Tung oil in any of its forms should be treated as a highly reactive (oxidizing) material. Any papers, cloths or rags wetted with tung must be stored in covered metal containers to eliminate the possibility of spontaneous combustion.

Because in partially empty containers of tung oil there is sufficient oxygen present to react with the oil, often within just a few hours, always store it in full containers. Dropping pebbles or marbles into the storage can as the liquid is used, bringing the liquid level up to the neck each time, is one way to do this. Another is to obtain a quantity of small plastic or glass containers and transfer your stock of oil to those. Any spoilage thus will waste only small amounts of oil at a time. A third approach is to obtain squeezable or collapsible plastic containers and squeeze out the air after each use, prior to capping the container. Collapsible containers are used in photographic chemistry and sold by photo suppliers. □

Don Newell is a frequent contributor to this magazine.