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WOODWORKING AND HARDWARE
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Treating Green Wood with PEG

Introduction

PEG 1000 is purchased as a room temperature solid. It melts at 104°F (40°C). It stabilizes the green or partially green wood, entering the fine cellular structure by diffusion. Its large molecules displace the natural moisture in the microscopic, lattice-like structure of the fiber walls. For maximum dimensional stability, PEG must be diffused into the wood in amounts of 25 to 30 percent of the dry weight of the wood. Lighted treatments are satisfactory if you are using PEG as a drying or seasoning agent to prevent or minimize such defects as checking, cracking, and bark separation. In cases like this, your objective is to place only enough PEG into the outer shell of the pre-shaped object to adequately prevent drying defects that occur during humidity changes.

The density, structure, moisture content, thickness, and other qualities of each kind of wood have a bearing upon the treatment period. Woods that are low in moisture content are less effectively treated than green woods that are at or above the fiber saturation point. Consequently, partially dried wood should be soaked in water for two to three weeks before treating in the PEG solution.

You need very little equipment to get started with PEG, and you can re-use the PEG solution indefinitely by replenishing the small amounts of PEG the wood takes up in each treatment.

Green and partially dry wood is relatively easy to obtain. Since PEG treated wood is highly stabilized, it is extremely predictable; you don't have to make allowances for expansion and shrinkage, and the bark of PEG-treated wood will remain attached permanently.

PEG-treated wood cuts easier and faster, does not dull tools as quickly, and is much cleaner to use than other woods. You can cut, turn, and sand green wood without stirring up a great deal of dust.

The PEG treatment is fast. It's obviously not as fast as going to the lumberyard and buying a chunk of wood, but PEG provides the quickest way to season your own green wood for predictable indoor use. You can heat the PEG solution (up to 140°F, 60°C for most species). In fact, some low-density woods, 1½" thick, can be treated in 24 hours or less this way. Last but not least, PEG treatment is permanent.

PEG does have some disadvantages, but they are minimal and easy to overcome.

Surfaces that have been heavily treated with PEG can be somewhat difficult to sand by conventional techniques. In atmospheres above 90 percent relative humidity, unfinished PEG-treated surface become waxy and moist to the touch. Many of the conventional finishes do not work with PEG-treated wood, although there are a number of special and effective finishes available.

PEG treatment does not work on all species of wood. You cannot, for instance, effectively treat heavy and more dense woods such as the heartwoods of maple and white oak.

Mixing PEG Solutions

Woodworkers commonly use solutions that are 30 and 50 percent PEG by weight to make various quantities of mixed solution. To estimate the amount of PEG you will need for a one-shot job, place the object to be treated in the smallest possible container and pour in a pre-measured volume of water to cover it. Check the table to see how much PEG you need. Remember, you can fill in voids or empty spaces, such as the insides of bowls, with nonporous rocks or stones. This will raise the level of the solution, but reduce the amount of PEG you need. It may take several days to dissolve the PEG into the required amount of cold tap water. You can speed the process by breaking the solid PEG into smaller pieces. Use warm (or hot) water and stir until the PEG is thoroughly dissolved. You can also melt the PEG in a separate, non-metallic container, then pour it into the water. Remember, PEG melts at 104°F (40°C).

A 30 percent solution of PEG has a specific gravity of 1.05 at 60°F (16°C). A 50 percent solution has a specific gravity of 1.093 at 60°F. To test a new or used solution of PEG for the proper concentration, cool a small sample to 60°F in the refrigerator, pour it into a suitable container, and check it with the hydrometer. Be sure the hydrometer floats freely. Read the scale at the liquid level. It is not necessary to maintain a high degree of accuracy with the optimum specific gravity. However, it is best to try to stay within a range of plus or minus 10 percent.

Water will evaporate during the long treatments, even when you are using covered, but not air-tight, vats. You can adjust for this, of course, by adding more water to the solution. Even better, you can drastically reduce evaporation by using expanded polyethylene covers.

PEG does not volatilize or evaporate from the solution even at high temperatures. However, water will evaporate from your heated solution, and you will have to add more from time to time.

Treating and Drying Green Wood

You can treat sections that are 2" to 4" thick and sections in which the end-grain faces are exposed. However, since a heated PEG solution will effectively penetrate only 2" of an end-grain section of walnut or other medium-density wood, you couldn't treat a bolt any thicker than 4" (PEG will penetrate 2" on each side).

You'll have the most luck treating wood that is already in the shape and size of your project. Work of this type generally requires lighter treatments, depending, of course, on the total bulk size (thickness and grain length). Even a relatively light PEG treatment will protect the work against splitting and checking during drying and penetrate the wood enough to give you an adequate skin or shell.

Work your project to within 1/4" to 1/2" of its final size or shape. This allowance will enable you to clean up your project and work it to its final form after you treat and dry it. A 1/2" to 1" PEG penetration is considered about average for side grains of wood having lower densities. Plan on less penetration with denser hardwoods. The type of grain exposed on the larger surfaces also influences PEG penetration; PEG will penetrate deeper and faster into end grains.

Treating Schedules
(See chart on back)

The soaking time you need to treat a project is contingent on a number of factors. The major considerations are the kind of wood (its density) and type of graining, the concentration of the solution, and the temperature of the solution. You can speed the diffusion of the PEG into the wood and decrease the soaking time by using the more concentrated (50 percent) PEG solution or by increasing the temperature.

Researchers at Forest Products Laboratory did most of their PEG test with walnut, a medium density wood. You can use these figures to estimate the treatment times for woods that are lower and higher in density than walnut.

Soak across sections of woods with lower densities such as white pine, spruce, redwood, soft maple, cottonwood, willow, and butternut for one-half to two-thirds as long as you would walnut. For yellow birch, beech, red oak, apple, and other high density woods, double or triple the treating times.

You can elevate the temperatures to treat very dense woods and the burls of most species. Experiment with the woods from your own locality to determine the best treatment schedule. Growth conditions and wood densities vary. It will take you longer to treat southern hardwood grown in Michigan.

For some projects you will have to treat the wood to eliminate drying effects and to stabilize it (to ensure that it will not swell or shrink in humid or dry environments). To obtain a high degree of dimensional stability, elevate the temperature of the solution and diffuse PEG into the wood until you get a minimum retention of 25 to 30 percent of the dry weight, with most wood you can obtain this level of penetration by using a solution no warmer than 140°F (60°C); never raise the temperature higher than that.

You will have to over-treat the outer surfaces in order to attain the desired PEG level in the center of the wood. For example, by the time the center of 1¼" thick slab has taken up the desired amount (25 to 30 percent) of PEG, the outer surfaces will have taken up about 40 percent. Getting the PEG deeper and deeper into thick pieces of wood drastically increases the required treatment times. In general, it is very impractical to treat woods that are over 1¼" thick for a high degree of dimensional stability.

You may find some woods that will present special problems that you cannot resolve with a heavier concentration (50 percent) and elevated temperatures. Honeycombing is a condition marked by thin, diamond-shaped cracks or openings that develop below the surfaces. In cherry, you can reduce, and often eliminate, the honeycombing condition by lowering the temperature to 110°F (43°C) and lengthening the treatment times by approximately one-third. As a general guideline, you can treat a 1" thick piece of cherry with a 50 percent solution at 110°F for 45 days. However, before treatment, a 1¾" diameter hole was bored completely through the vertical center and many additional holes were drilled (upwards) from the bottom to allow greater PEG penetration into the project.

Fine checks or cracks may occasionally appear, despite your careful treatment, sometimes these defects are in the green log or tree even before you put a hand on it, the results of wind damage and other stresses. Often they develop when you fell the tree.

In partially dry slabs or chunks of wood where the outer surfaces are below the fiber saturation point, internal stresses may already have been set up. In the early stages of treatment, these tensions are released in the form of checks and cracks. Partially dried woods treated with PEG may also be susceptible to warping.

This is due to the differences in the way green and partially dry woods absorb PEG as well as to internal tensions. If you think your piece of wood might be below the fiber saturation point, work it in water for two weeks or longer so the dry areas take on moisture.

Sometimes wood in a firewood pile will still be green and treatable. However, the ends will tend to check and crack. So simply cut the ends off to expose the treatable green wood. If you think the wood might still be too dry for treatment, soak it in water for two to three weeks.

Dry Treated Wood
After you remove the treated wood from the vat, take a water moistened sponge and lightly wipe the surfaces to remove sediment or any scum. Do not wash the treated wood under a stream of tap water, this will cause the PEG, which is water soluble, to leak out.

The thickness of the wood, the temperature, and the relative humidity affect the amount of time it takes to dry PEG treated projects.

You can air dry the projects in a heated room, or in many cases, even dry them in a kitchen oven. Don't air dry treated wood out of doors; it will take considerably longer than it will indoors. Pile disks, slabs, and other flat, parallel pieces with stickers between each layer. Evan large treated disks, 4" thick by 40" in diameter, will dry in six to eight weeks in a heated room. You can hang bowls, lamps, and carvings with string from beams and rafters. The air is warmer near the ceiling, and you get free air movement all around the objects.

You can efficiently force-dry small, PEG treated objects in a kitchen oven. Low density woods, such as cottonwood, willow, and butternut will dry sufficiently in six to eight hours at 180°F (82°C). Heavily treated walnut of about 1 inch thickness has been successfully dried in eight hours in a 220°F (104°C) kitchen oven. With properly treated wood, there will be no surface checking, end splitting, or warping, regardless of how fast the moisture is removed.

The objective of the drying process is to dry only the outer surface shell to a depth of 1/4" to 1/2". It is not essential that the wood be completely or uniformly dry throughout its total thickness before you start the final finish cutting and sanding.

Finishing
You will quickly discover that PEG treated wood reacts to smoothing and sanding differently than untreated wood. First knife-cut the surfaces as closely as possible using the jointer, turning chisel, hand plane, carving knife, or whatever tool is most appropriate. As you already know, PEG treated wood cuts cleaner and easier with edge tools than untreated wood. Stanley "Surform" tools work very well on three dimensional or irregularly curved surfaces.

Regular (garnet) abrasives will quickly load up with PEG; medium and fine grits will load up especially fast. For best results, use coarse grits. These won't leave deep, hard-to-remove scratches.

"Wet or dry" sandpapers are especially effective on PEG treated wood. Water, which is a solvent for PEG, will dissolve away sawdust from these papers. In fact, you can even use water as

a lubricant for the sanding operation. It is a good idea to use two pieces of paper for each step. Soak one piece in warm water (dissolving the waxy sawdust) while you use the other piece.

Bleaching

Sometimes the outer 1/16" of your wood will darken during treatment. This condition is caused by the concentrated pigments, minerals and extractives that develop during long and high temperature treatments. You can remove these darkened surfaces by bleaching with oxalic acid. Dissolve 4 heaping tablespoons of oxalic acid crystals in 1 cup of hot water. Apply the solution with a rag or brush. Oxalic acid is a poison, so handle it carefully. Wear rubber gloves and be careful to keep the solution out of your eyes.

After you have let your bleaching solution soak in for an hour or so, remove the excess acid by sponging the surface with a rag dampened in a dilute solution of household ammonia. Allow the wood to dry for a day, then sand it with fine grit wet or dry paper to remove any raised grain or scratches. Again, allow the wood to dry thoroughly, then apply one of these finishes: special moisture cure and regular Polyethylene vanish, penetrating natural Danish oil or epoxy. Most conventional wood finishes, such as lacquers, do not work well on PEG treated wood.

Moisture-Cure and Regular Polyethylene Varnishes

You should use moisture-cure varnish as a base coat over heavily PEG treated wood as well as on those projects with a high degree of exposed end grain surfaces. This type of finish will set up rapidly on a wet surface or when it is exposed to atmospheric moisture, is extremely hard and durable, and most importantly, is quite effective in sealing PEG in the wood during prolonged periods of high humidity. It is thick and sticky and tends to leave brush marks. Work it quickly. Sand the surface thoroughly between coats using 220 grit or finer paper. Apply up to four or five coats of the moisture cure varnish at full strength (without thinning) at one-day intervals. For best results, follow this treatment up with one, two, or more coats of any good grade of conventional (chemically hardened) Polyethylene varnish - the type commonly available at paint stores. It may take as long as two days for the first coat of regular polyethylene to set up.

Using Regular Polyethylene Varnishes

You wont need to apply a base coat of moisture-cure polyethylene to projects that are relatively easy to finish. Examples are lightly treated carvings, bowls, and other projects that have a minimum of end grain surfaces, are not made from oblique-cut slabs, and are not likely to be exposed to extremely high humidity for prolonged periods of time. For these projects, use conventional polyethylene varnishes.

Danish Oil Finish

Of the many oil-type “natural” finishes, the Danish oil penetrating finish performs most satisfactorily on PEG treated wood, especially on indoor projects having a lot of exposed end grain. Danish oil is good for almost all projects, including those that are likely to be exposed to periods of high humidity. However, when you apply Danish oil to heavily treated PEG surfaces they may become tacky, especially during humid periods.

Epoxies are the most serviceable film forming finishes for PEG treated wood. Their major advantage is their percentage of solids, which are excellent moisture barriers. Other finishes, such as lacquers, urethanes, and polyesters, hold water out (or in) but they contain solvents and other flowing agents that evaporate during drying. As they evaporate, they leave small microscopic openings in the finish allowing water vapor to pass through and settle on the wood.

There are hundreds of different epoxy formulations. To finish PEG treated wood, use the heavy-bodied, single-application, flow-on polymer epoxy finishes or those with a thin consistency, good penetrating character and adherence quality. You will get deeper penetration and better adherence with epoxies of thinner viscosities, but you will have to apply several coats to get a suitable film depth. On the other hand, flow-on polymer epoxies are easy to apply. Particularly on flat level surfaces, you’ll only need one coat.

The flow-on epoxies have exceptional self-leveling qualities so you should keep troweling and brushing to a minimum. If air bubbles get trapped under the coating of varnish, blow lightly on the surface or pass a propane torch over it from a distance of 6 to 10 inches. If the bubbles still don’t pop, puncture them with a pin. Always cover freshly epoxied surfaces with a dust cover.

Here is an effective finishing system for PEG treated projects (this technique does not apply to bowls you will be eating from):

1. Finish with penetrating Danish oil; allow to cure for three days to one week.

2. Apply epoxy over the oil finish. Use flow-on epoxy for flat, horizontal surfaces. Use thinner consistency epoxies with brush-on application for turnings. Sometimes you will need as many as five coats to get a suitable film depth.

3. Spray on lacquers or brush on Deft or a similar material as the final finish (this step is optional).

Temporary or Improved Vats

You can devise vats cheaply and easily. Plastic garbage containers and plastic pails make ideal cold treatment vats and are very inexpensive. They are especially good for small slabs, large bowls, and lamp bases. You will need less chemical if you use a round container, since there will be no unused corners in which solution goes to waste.

You can make one-shot vats to treat larger slabs, which you’ll be using to make tabletops and large slab clocks. A simple wood frame supports heavy sheet plastic. Fill in the corners as well as irregularities under the plastic with sand, sawdust, or rocks. This way you’ll need only a minimal amount of PEG to submerge the work.

Raise the slabs off the bottom with a couple of narrow sticks. This allows the PEG to flow under the work, insuring uniform penetration. Use a weight – preferably a heavy, nonporous stone, to keep the wood submerged; this will counteract its buoyancy. Cross-section slabs, even as large as 5 feet in diameter, have been successfully treated in this type of one-shot vat. You can also use a child’s plastic swimming pool, plastic tubs, and similar items; just be sure they don’t leak. Loss of the chemical through a leak is not only messy, but expensive, too.

Commercially produced vats are available in 30 gallon and 50 gallon sizes. They are made of industrial quality plastic, are of durable-wall construction, and come with or without a heating element. When you order a unit with a heating element, you also get a lid and a perforated fiberglass element protector. Insulating floats are also available. The 50 gallon size is about half full when 100 pounds of PEG are mixed at a 50 percent solution; the 30 gallon size is about half full when 50 pounds of PEG are mixed in a 30 percent solution.

Treatment schedules for walnut

Solution	Temperature	Pieces up to 9" dia. and 1" to 1½" thick	Pieces up to 9"dia. and 2" to 3" thick
30 percent	70°F (22°C)	20 days	60 days
50 percent	70°F (22°C)	15 days	45 days
30 percent	140°F (60°C)	7 days	30 days
50 percent	140°F (60°C)	3 days	14 days

30 percent PEG solution

Weight of Solid PEG	Dissolved in following amounts of tap water[1]	Will make following amounts of 30 percent solution[2]
4.46 lbs (2.0 kg)	10.43 lbs (4.7 kg) in 5.0 qts (4.7 l)	7.0 qts (6.6 l)
10.00 lbs (4.5 kg)	23.33 lbs (10.5 kg) in 11.2 qts (10.5 l)	15.4 qts (14.6 l)
20.00 lbs (9.0 kg)	46.66 lbs (21.0 kg) in 22.4 qts (21.0 l)	30.8 qts (29.2 l)
30.00 lbs (13.5 kg)	69.99 lbs (31.5 kg) in 33.6 qts (31.5 l)	46.2 qts (43.9 l)
40.00 lbs (18.0 kg)	93.32 lbs (42.0 kg) in 44.8 qts (42.0 l)	61.6 qts (58.5 l)
50.00 lbs (22.5 kg)	116.65 lbs (53.0 kg) in 56.0 qts (53.0 l)	77.0 qts (73.1 l)

[1] At 60°F

[2] A 30 percent (by weight) PEG solution, at 60°F, has a specific gravity of 1.05, contains 2.6 pounds of PEG per gallon, and weighs 8.65 pounds per gallon.

50 percent PEG solution

Weight of Solid PEG	Dissolved in following amounts of tap water[1]	Will make following amounts of 30 percent solution[2]
10.00 lbs (4.5 kg)	10.00 lbs (4.5 kg) in 4.8 qts (4.5 l)	8.48 qts (8.0 l)
20.00 lbs (9.0 kg)	20.00 lbs (9.0 kg) in 9.6 qts (9.0 l)	16.96 qts (16.1 l)
30.00 lbs (13.5 kg)	30.00 lbs (13.5 kg) in 14.4 qts (13.5 l)	25.44 qts (24.2 l)
40.00 lbs (18.0 kg)	40.00 lbs (18.0 kg) in 19.2 qts (18.0 l)	33.92 qts (32.2 l)
50.00 lbs (22.5 kg)	50.00 lbs (22.5 kg) in 24.0 qts (22.5 l)	42.40 qts (40.3 l)

[1] At 60°F

[2] A 50 percent (by weight) PEG solution, at 60°F, has a specific gravity of 1.093, contains 4.717 pounds of PEG per gallon, and weighs 9.434 pounds per gallon.

Mold, bacteria, or fungi will eventually develop on the surface of uncirculated solutions. Don't be alarmed. This is common, and you can skim off the growth periodically. Some woodworkers say they can eliminate this problem by adding a 1 to 2 percent concentration of borax (cleaner) or sodium pentachlorophenolate to the PEG solution. However, only moderate success with these activities can be expected.

The treatment for these instructions have been taken from Patrick Spielman's book "Working Green Wood with PEG." If you desire to go into this type of work in greater depth, we suggest you obtain this book from us.

You can obtain commercial type vats, portable heating elements, hydrometers, etc. by writing directly to Spielman's Wood Works. 188 Gibraltar Road, Fish Creek, Wisconsin, 54212.

Attention Rockler Plan User

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