Stabilizing and Bending of WOOD

for the Hobbyist

LSU AgCenter
Research & Extension

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Introduction

Lumber scraps and cross-sections of angle cuts sawed from small logs or large limbs can be made into attractive items, but only if the wood is first treated with polymers and then properly seasoned, or if the wood is initially seasoned following special techniques. These treatments and techniques can result in profitable uses of "low grade" logs and oddly shaped scraps that might otherwise be discarded. This publication describes some techniques of stabilizing and bending wood for hobbyists.

Freshly cut cross-sections normally check badly and develop typical pie-shaped or v-shaped cracks during the drying process. This is because wood shrinks twice as much in the tangential direction (parallel to the annual rings) as in the radial direction perpendicular to the annual rings). The internal stresses that result from such differential shrinkage invariably cause serious checks and splits as the wood loses moisture and comes to moisture content (MC) in a heated or air-conditioned wood shop. These are some of the techniques for drying wood cross-sections. These techniques can also be used for lumber scraps.

PEG-1000 Chemical Treatment

One method recommended often in recent years is stabilization of wood with a bulking agent such as polyethylene glycol (PEG). PEG treatment requires soaking the wood for a long time. This tends to darken the sapwood. Also, PEG is hygroscopic and raises the MC of the wood; under humid conditions, the chemical may cause the finished board surface to develop discolored streaks. To avoid these problems, you must dry the disks without chemicals.

Many hobbyists use PEG as a bulking agent that greatly reduces the dimensional changes of green wood. PEG is a white, wax-like chemical that resembles paraffin, is solid at room temperature, has an average molecular weight of 1000 and dissolves readily in warm water. PEG melts at 104 degrees Fahrenheit, is nontoxic, noncorrosive, odorless, colorless and has a very high firing point (580 degrees Fahrenheit). It is chemically related to antifreeze.

The PEG treatment, which physically bulks the wood cell walls (fibers), prevents shrinkage and thus prevents the development of destructive stresses (figure 1.). Green wood heavily treated with PEG retains its "green dimensions" indefinitely, and thus is permanently restrained from shrinking, swelling or warping, regardless of humidity changes.

Figure 1. (Above) Unusual pieces should not automatically be discarded. (Below) This clock is an example of value-added production of waste wood. The wood was treated with PEG and coated with polyurethane.

The detailed treatment procedures are as follows:

1. Choose a treating tank: This is used for soaking the wood disks or slabs. It can be made of glass or any nonmetallic substance. A large plastic garbage can that has been lined with a thick plastic bag can also be used for the soaking tank. The treating tank needs a cover to help conserve heat and water. Some water will evaporate and change the concentration of the PEG solution, but this will be balanced as the PEG is absorbed by the wood. It is also desirable to cover the sides, bottom, and especially the top, with fiberglass insulation to conserve heat.

2. Preparing PEG solutions: Wood may be soaked in either a 30% or a 50% PEG solution. Soaking times are longer in the 30% solution. To prepare seven quarts of 30% solution, dissolve 4.46 pounds of PEG-1000 in five quarts of water. The specific gravity of the solution (at 60 degrees Fahrenheit) will be 1.05. Check the specific gravity of the solution, using a hydrometer that is similar to the one used to check the concentration of antifreeze in the radiator of a car. These solutions can be reused. Between uses, store them in glass containers. One to 2% borax added to the solution will prevent the growth of some bacteria and fungi, but not mildew and mold.

3. Put fresh wood disks in solution: Stack wood with thin slats separating the pieces, so that circulation of the solution is complete. Weight down the wood with a rock to assure complete immersion. Only green wood (with MC above the FSP or approximately 30% MC) can be treated effectively by the PEG method.

4. Heating: For faster results, equip treating tanks with electric heating elements (with a built-in thermostat) of the type used in a water heater. A small pump may be used periodically to circulate the PEG solution. Hand-stirring will do the job of the pump, but regularity is important.

5. Soaking time: This depends on solution strength and temperature, wood species and wood thickness. Table 1 shows the treating time necessary for walnut disks to obtain the desired 25% to 30% concentration of PEG in the finished product.

Woods of lower density, such as soft maple, cottonwood, willow and pine, require only one-half to two-thirds the time suggested for walnut. Heavy woods, such as hard maple, oak, apple, beech and birch, require a soaking time two or three times longer than does walnut. Very hard woods, such as mesquite and the burls of all species, must be treated at high temperatures for longer periods.

Table 1. Treatment schedule using PEG-1000.

Solution strength and temperature (degrees Fahrenheit)	Soaking time for wood up to 9 in. in diameter and 1-1.5 in. thick (Days)	Soaking time for wood more than 9 in. in diameter and 2-3 in. thick (Days)
30%, (70)	20	60
30%, (140)	7	30
50%, (70)	15	45
50%, (140)	3	14

Wood knots, cherry wood and the heartwood of some species resist absorption of PEG and require special attention. For example, soaking cherry at a temperature above 110 degrees Fahrenheit will heart-check or honeycomb the wood. For treating 1-in. thick cherry disks, allow at least 45 days in a 50% solution at or below 110 degrees Fahrenheit.

Soaking schedules for other types of wood can be developed by experimentation. At first, soak the wood for the time recommended for walnut. Then dry the wood in an oven at a temperature of about 200 degrees Fahrenheit. If no defects develop, the soaking time is probably sufficient.

6. Drying: Pile the treated wood using dry stickers. The pile should be covered and kept in a well-ventilated room, preferably a heated area. PEG-treated wood cross-sections up to 4 inches thick and 40 inches in diameter will dry in six to eight weeks if they are kept in a heated room at low humidity. Treated wood kept outside must be completely protected from water, and the drying will take somewhat longer than indoors. Since treated wood shrinks very little during drying, it is not necessary that the wood be completely dry before you start working with it. It is only necessary that the top 1/4 inch of the surface be dry enough to sand well.

7. Gluing: White glue or polyvinyl acetate does not work very well on PEG-treated wood. Only urea resins, epoxies and resorcinols are satisfactory. For joints that require strength, a solvent should be used to cut the wax and expose the wood fibers. The wood surface should be scrubbed and washed with alcohol.

8. Finishing: PEG-treated wood may be finished after the surface of the wood has been sanded and shaped. Common single-component polyurethane varnishes give satisfactory results. Conventional wood finishes do not work well on wood treated with PEG. If high MC creates problems, use a base of four to five coats of the moisture-resistant polyurethane resin varnishes. Danish oil penetrating finish works well over PEG-treated wood, although many other oil-type clear finishes cannot be used. The Danish oil finish can be used for PEG-treated bark.

9. Treating defective pieces: Untreated wooden objects purchased in other parts of the country may check and split badly when introduced to our air-conditioned and heated environment. When such defects are noted, soak the piece in water and treat with PEG at once. If the checks close completely, they will remain closed, and no further defects will develop.

Salt Paste Method

This is a simple and inexpensive way to treat a wood cross-section. The top and bottom of the green disk are alternately brushed with a concentrated table salt paste, then the disk is dried. To mix the salt paste, add three pounds of salt to one gallon of water. Mix thoroughly. Salt crystals will be visible in the solution even after mixing. Allow the solution to stand for several hours, then mix in enough cornstarch to achieve a pastelike consistency that will build up a thick layer on the disk surfaces. Finally, mix in several egg whites (this will reduce flaking of the paste after it dries) and apply the paste to both faces of the cross-sections. The salt paste should have the consistency of oil paint or cake batter. Air dry the disks in a well-ventilated or heated room.

Drying Disks Without Chemical Treatment

No method of drying large cross-sections of wood will guarantee that cracks will not appear. The most common defect is large edge-to-center "V" cracks (figure 2). Also, disks will tend to show many short cracks on the face parallel to the wood rays. The rays in some species are visible and look like spokes in a wheel that originate in the center of the disk and extend out in a

Figure 2. This cross-section of oak wood was improperly dried and has developed "V" cracks because of the different shrinkage rates of the wood.

3. Third Stage - Slow drying at a decreased rate is accomplished by placing the disks in containers with tiny openings, such as plastic bags with small punctures. The room humidity should be adjusted to 40% RH. In the container, the evaporating moisture provides the proper atmosphere with 80% to 90% RH. Little vapor escapes, and the wood dries at a decreasing rate, reaching the MC of the room after four weeks. While heaters can be used to raise the temperature and shorten the final stage, higher temperatures make it more difficult to maintain the necessary humidity. The container should be insulated to prevent condensation at cool spots.

"radial" manner to the bark. Sometimes cutting the slabs at an angle to the axis of the tree reduces the tendency of the disk to "V" check but will not affect the potential of radial checks to develop.

One simple way of drying untreated 1-inch disks involves three drying stages. Designed to minimize chances for the formation of checks, they are:

1. First Stage - Tape plastic film over the inner section (heartwood) of each side of the green disk. The outer portion (sapwood) of the section is allowed to dry to 30% MC at a relative humidity of 65% to 75%. This fast drying will avoid discoloration, stains and separation of the bark. About three to four days are needed. The plastic film will prevent heart checks.

2. Second Stage - The pitch area can now be exposed to an environment of 75% to 80% relative humidity (RH) and allowed to begin to dry. Let the MC of heartwood and sapwood both decrease to 25%. Maintain a moderate drying rate to avoid surface checks. At least three days are required for this stage.

Chemical-free drying can also be accomplished without plastic bags. The following guidelines can help you and will reduce the likelihood of checking.

1. Use temperature close to room temperature for the early stages of drying.
2. Use high relative humidity in the early stages of drying.
3. Thin disks (2 in. or less) are less likely to crack than thick disks, but tend to dish in drying.
4. Thick disks dry very slowly (doubling the thickness increases the drying time by 3-4 times).
5. Since the basic cause of the "V" crack is the difference in radial and tangential shrinkage of wood, choosing a species with a low ratio of tangential (perpendicular to the rays)-to-radial (parallel to the rays) shrinkage will minimize the tendency to form a "V" crack. Mesquite is a domestic wood that offers these properties. There are also some foreign woods with similar radial and tangential shrinkage properties.

Bending of Wood

Wood bending is more of an art than a science. This ancient art is still of economic importance today because it is easier, faster, more efficient and requires less expensive equipment than machining. The bending of wood is critical in the manufacture of some furniture items (figure 3), various tools and novelty items. Bent wood is usually stronger and stiffer than machined parts of equal dimension and requires less surface preparation for finishing.

The two common methods to plasticize wood before it can be bent are by using steam and with liquid ammonia. Species that often bend well using either the steam or ammonia treatment are the oaks, yellow-poplar, black cherry and sweetbay. For native Louisiana wood species, hackberry is probably one of the easier to bend by either method. Sweetgum, black gum, yellow-poplar and red maple often are difficult to bend. The bending behavior of any wood will depend on the species, treatment (steam or ammonia) and setting procedures. For any species to yield good bent wood structures, it must be knot and decay free, contain no cross or twisted grain and not be excessively low in density. Flat sawn lumber usually bends well. There is a great deal of disagreement concerning what moisture content is best for bending wood, but most moisture contents reported by researchers are less than 25%. Steam-bent wood success depends on steam time. It is somewhat weakened and may change its curvature with time, depending on exposure conditions and amount of restraint during use.

Figure 3. (Above) This is a classic chair produced with typical wood bending. All pieces except the front legs are from bent wood. (Below) A restraining strap, center, follows the convex side of this two-plane bend. An adjustable end-pressure stop is controlled by the operator's hand at lower left.

Steam bending is often done at atmospheric pressure (212 degrees Fahrenheit) or at gauge pressures below 5 psi. Most Louisiana woods need only 45 minutes to be sufficiently heated. The softening effect of ammonia is similar to that of steam, except

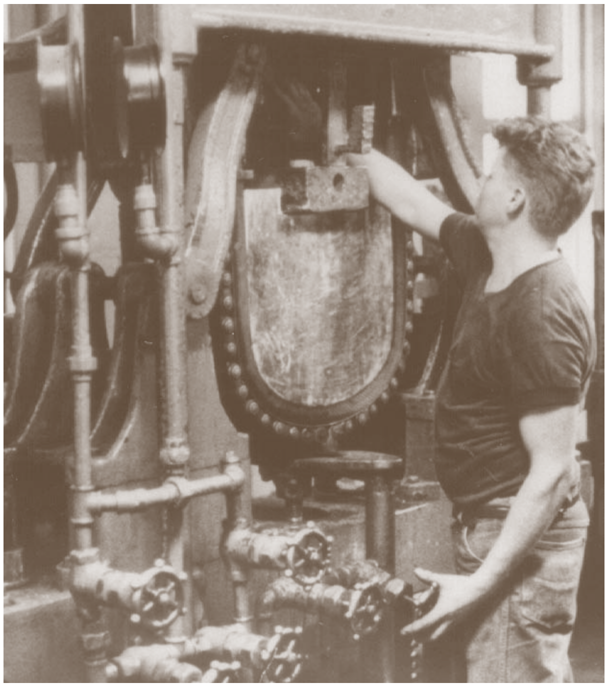


Figure 4. A hydraulic press is used to produce extreme bends in chair arms and some other furniture parts.

that ammonia has better dissolving properties. The use of ammonia allows the hobbyist to make a variety of artistic, decorative and architectural products.

Bending can be done with and without (free) end pressure (figure 4). Free bending is satisfactory for mild bends. Bent wood will tend to return to its original form unless restrained until set. The setting of a bend is the opposite of the plasticization of wood in that the wood is now cooled. A furniture maker will set the bend together while drying to the expected moisture content in service. The straps on the convex side and end stops should be restrained during setting. The opening or distance between the ends of a bent piece should also be controlled. A split can occur if the end pressure is too high (figure 5).

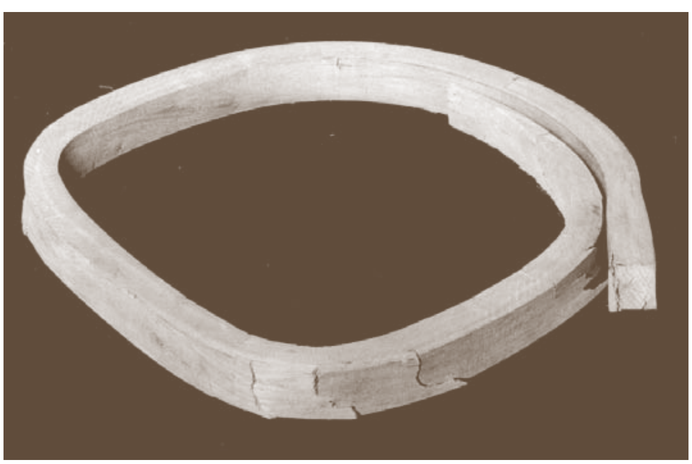
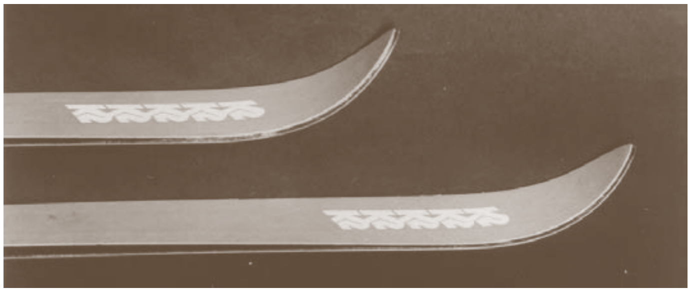


Figure 5. This bent ash wood has splits as a result of inadequate end pressure.

Figure 6. The process of bending wood is also used to produce parts of a boat. The concave strap restrained by the rods maintains end pressure and shape. The wood braces reduce twisting. (Photo originally from USDA Forest Service, Forest Products Laboratory, Madison, WI).

Wood bending is used to produce several recreational items. Among these are boat parts (figure 6) and tennis racquets and snow skies (figure 7).



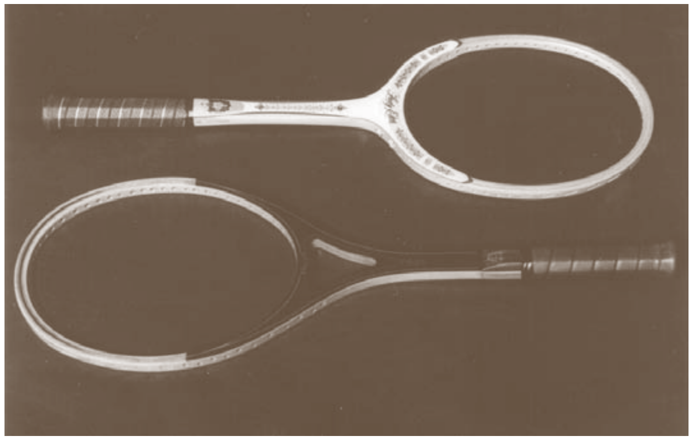


Figure 7. Wood bending is used to produce recreational items such as these tennis racquets (right) and snow skis (left).

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