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SIMPLE TREATMENT PREVENTS SHRINKAGE PROBLEMS IN WOOD

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Wood has always been a valued and popular art material. Artisans and craftsmen have transformed it into works of art that have enriched the lives of men throughout all ages. Its natural beauty--its figure and grain, coupled with its availability, easy workability with simple hand tools, and ability to take a wide range of rich deep finishes, have all contributed to its popularity and value.

But unfortunately, the usefulness of wood as art and hobbyist material is frequently limited by the largest piece that can be found and kept free of defects. In many instances it is almost impossible to obtain material of the size desired that does not contain serious splits and checks. Conversely, wood that was originally defect free, often splits and checks after it has been worked into its desired form.

These defects are called seasoning defects. They occur because of internal stresses set up in the wood when it dries. When wood loses moisture it shrinks. If shrinkage progressed uniformly throughout the wood, most seasoning defects would not occur. But it does not, and stresses arise during drying which tend to pull certain sections of the wood apart while compressing other sections. If these stresses become greater than the inherent strength of the wood, it "fails" and defects such as checking and splitting occur.

Even after wood has been thoroughly dried, checking and splitting may still occur. Wood is hygroscopic; that is, it attracts moisture. When exposed to high relative humidity, wood adsorbs moisture from the air; when exposed to low relative humidity, it loses moisture. Some people have described this phenomenon by saying that wood breathes. Thus, in the winter when the relative humidity is low, wood loses moisture and shrinks. Likewise, in the summer when the humidity is high, wood adsorbs moisture and swells. As a result of these seasonal variations in moisture and consequent shrinking and swelling, wood articles, defect-free in summer, might develop defects in winter and vice versa.

Attempts have been made for many years to develop methods of preventing wood from shrinking and swelling to eliminate seasoning defects. Most of these treatments, however, either impart undesirable properties to the wood or are too expensive and require too much specialized equipment for general hobbyist and home use. One of the most successful methods available today, both because of its simplicity and effectiveness, is treatment of the wood with polyethylene-glycol 1000. Polyethylene-glycol 1000, often designated p.e.g., is a white wax-like substance that looks and feels like ordinary paraffin. Chemically, it is closely related to permanent-type antifreeze. P.e.g. is known as a bulking agent. That is, it enters into the wood substance--the cell walls--and keeps it in a permanently swollen condition even after the wood dries. It does this by pushing out and replacing the water molecules in the cell walls. The excess moisture evaporates from the cell cavities, but the polyethylene glycol remains in the wood.

Treatment of wood with polyethylene-glycol is relatively simple. The first step is to obtain a container for soaking the wood. It should be large enough to cover all the material completely with solution. Non-metallic containers should be used since some woods contain chemicals that attack metals. A plastic wastebasket, stone crock, or porcelanized canner kettle (if it is not

chipped) make good containers. The canner kettle has an added advantage in that it may be heated, and it also comes equipped with a lid, which is needed to prevent evaporation of the water from the solution. If needed, larger containers may be fabricated from wooden boxes lined with plastic sheets or bags.

The second step is to mix the p.e.g. - water solution in the container. A 50 per cent p.e.g. - 50 per cent water solution works very well in these treatments, but other concentrations such as 30 per cent p.e.g. - 70 per cent water may also be used. Mixing the solutions is relatively simple. Since water weighs about 8.3 pounds a gallon, a little more than 8 pounds of p.e.g. added to a gallon of water makes a 50 per cent solution. Or in smaller quantities this reduces to a little over a pound of p.e.g. to a pint of water. To make a 30 per cent solution, add 8 pounds of p.e.g. to 2 gallons of water, or in smaller quantities, 1 pound of p.e.g. to 2 pints of water. If accurate scales are available, solutions of any desired concentration may be mixed, but either of the two concentrations described above will be suitable for most applications. At room temperatures, p.e.g. 1000 is a solid and should be broken into small pieces to help dissolve it in water. Since p.e.g. is non-toxic, no special handling precautions are needed. Heating the solution helps to dissolve the p.e.g.

If the solution is used several times or if large quantities of material are treated relative to the volume of the container, it will be necessary to add p.e.g. to the solution to make up for that taken out by the treated material. It may also be necessary to add water to the solution to make up for that lost because of evaporation. Determining how much to add can be simplified by using a hydrometer. A hydrometer is an apparatus for measuring specific gravity and consists of a closed graduated cylinder, loaded so that it floats upright in a liquid. A service station attendant uses one form of a hydrometer when he measures the concentration of anti-freeze in the radiator of a car. A hydrometer need not be complicated or expensive and is easy to make. Obtain an inexpensive, long thin-stemmed, floating aquarium thermometer. Place it in a freshly prepared solution of the desired concentration. Note and mark how far the thermometer sinks into the solution. As p.e.g. is removed from the solution during treatment, the thermometer will sink deeper into the solution. To bring the solution back to its original concentration, add enough p.e.g. so that the thermometer floats at its original level. If water is lost during treatment because of evaporation, the thermometer will float higher in the solution. Add water to bring the solution to its original concentration.

The third step is to soak the wood in the p.e.g. solution. Be sure that the wood is completely submerged. Since many species of wood float, it may be necessary to weight them down. Length of treatment depends upon the concentration and temperature of the solution as well as the size and species of the wood used. For example, a piece of green walnut, 2 1/2 x 6 x 18" long should be soaked 40 days in a 30 per cent solution at room temperature. Treatment periods may be shortened by increasing either the concentration or the temperature of the solution, or still better by increasing both. Thus the same piece of walnut may be treated in 7 to 10 days in a 50 per cent solution kept at 140°F. In general, woods such as yellow poplar, soft maple, white pine, and spruce require treatment periods about half as long as walnut, while woods such as Douglas-fir, beech, the oaks, and hard maple require about twice as long. Several additional treatment schedules for specific types and sizes of wood are given in publications listed at the end of this paper. Smaller pieces require much less time. If the wood can be worked or rough-shaped prior to treating, a saving in both

time and p.e.g. may be realized. A little experimentation will likely be needed to determine the best treating schedule for a particular size or species of wood. As an example, the authors found that a 14-day treatment in a 50 per cent solution held at room temperature was satisfactory for 1 inch thick by 4 inch wide by 4 inch long blocks of yellow poplar, sugar maple, and walnut; marginal for red oak; but not satisfactory for white oak and hickory. Because of the shorter treatment periods it might be advantageous to use heated solutions. A safe means of heating the solution should be used. Temperature controlled immersion heaters are perhaps the safest. If a canner kettle container is used, the solution may be heated with an adjustable temperature electric hotplate. Use a floating candy thermometer to indicate the temperature of the solution.

Freshly cut green wood treats best. If dry wood is used, soak it first in water until its weight increases 30 to 40 per cent. If semi-dry material is used, soak it until its weight increases a like amount or until it ceases to gain weight.

If room temperature solutions are used, molds and fungi may begin to grow during long treatment periods. Add about 1 to 2 ounces of Borax to each gallon of the solution to prevent their growth.

After the material has been soaked for the required length of time, it should be removed from the solution and set aside to dry in a warm well-ventilated place. The wood may be used when it is dry enough to work properly.

To apply a finish coating to the treated wood, first sponge it off with hot water and then sand as needed. Common wood finishes will not dry properly on wood treated with polyethylene glycol. Single component polyurethane varnishes give good results, however, and form tough, beautiful, water resistant finishes. Certain conventional finishes may be used, if the wood if thoroughly dried in an oven before the finish is applied. Use gentle drying temperatures (about 140°F) and test a piece of treated scrap material to see if the finish will dry properly.

Polyethylene glycol - 1000 may be obtained in small quantities from hobbyist supply houses such as the Crane Creek Gunstock Co. of Waseca, Minn. If larger amounts are used, contact one of the chemical companies.

Additional information about the treatment of wood with polyethylene glycol may be found in the following publications:

1. "Stabilized Wood Gunstocks in Marine Corps Marksmanship Competition," Dawson, Major R. E., Usher, Major E. G., and H. L. Mitchell. U.S. Forest Products Laboratory Report No. 2245, 1962.

2. "New Horizons in Bowl Turning," Englerth, G. H. and H. L. Mitchell. Forest Products Journal, Vol. 13, No. 2, pp. 48-49, 1963.

3. "Effect of Treating Conditions on Dimensional Behavior of Wood During Polyethylene Glycol Soak Treatment," Konaga, D. L. Forest Products Journal, Vol. 13, No. 13, pp. 345-349, 1963.

4. "New Chemical Treatment Curbs Shrink and Swell of Walnut Gunstocks," Mitchell, H. L., Forest Products Journal, Vol. 9, No. 12, pp. 437-441, 1959.

5. "Supplement - New Chemical Treatment Curbs Shrink and Swell of Walnut Gunstocks," Mitchell, H. L., IPS - 88.

6. "Protect Imported Carvings with P.E.G." Mitchell, H. L., Forest Products Journal, Vol. 12, No. 10, pp 476-477, 1962.

7. "Seasoning Green-wood Carvings with Polyethylene Glycol - 1000," Mitchell, H. L., Forest Products Journal, Vol. 11, No. 1, pp. 7-8, 1963.

8. "P.E.G. Treated Walnut Limb-wood Makes Handsome Decorator Clock," Mitchell, H. L., Forest Products Journal, Vol. 13, No. 9, p. 416, 1963.

9. "Conservation of 200-year-old Water-logged Boats with Polyethylene Glycol," Seborg, R. M., Inverarity, R. B., Studies in Conservation, Vol. 7, No. 4, pp. 111-119, November, 1962.

10. "Dimensional Stabilization of Wood with Carbo-waxes," Stamm, A. J., Forest Products Journal, Vol. 6, No. 5, pp. 201-204, 1956.

11. "Effect of Polyethylene Glycol on the Dimensional Stability of Wood," Stamm, A. J., Forest Products Journal, Vol. 9, No. 10, pp. 375-381, 1959.

12. "Factors Affecting the Bulking and Dimensional Stabilization of Wood with Polyethylene Glycol," Stamm, A. J., Forest Products Journal, Vol. 14, No. 9, pp. 403-408, 1964.

13. "Minimizing Wood Shrinkage and Swelling," Stamm, A. J., U. S. Forest Products Laboratory Report 1156, July, 1937.

14. "Stabilization of Wood," Stamm, A. J., Forest Products Journal, Vol. 12, No. 4, pp. 158-160, 1962.

15. "Notes on the Treatment of Wood with Polyethylene Glycol," FPL - 06, U. S. Forest Products Laboratory, March 1963.

16. "Directions for the Treatment of Cross Sections of Green Logs and Limbwood to Prevent Splitting and Checking," U. S. Forest Products Laboratory Report 011, 1964.

Single copies of most of the Forest Products Laboratory Reports and reprints of the Forest Products Journal articles may be obtained by writing to the U. S. Forest Products Laboratory, Madison, Wis., 53705.

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