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Processing Trees To Lumber For The Hobbyist And Small Business

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The hobbyist or small business owner can save a great deal of money and realize a greater sense of achievement if projects are made from lumber sawn and dried "in house" rather than from purchased lumber. This publication presents the designs for a simple solar kiln; explains the process of obtaining logs and sawing them into lumber, explains the necessary steps in preparing lumber for drying; and offers advice on maintaining optimum lumber drying rates.

BUILDING A SOLAR KILN

Constructing a solar kiln is relatively straightforward and inexpensive. The plans given here have been used to construct over 300 kilns nationwide. The success of this design is in its simplicity and adaptability to any size. The dimensions given are only a suggestion: build a kiln to suit your drying needs.

A kiln constructed to these specifications (Figure 1) will dry 450 board feet of one-inch-thick hardwood lumber in 6 weeks or less of good weather, or 600 board feet of two-inch hardwood lumber in 15 weeks. Softwoods will typically take half the time of hardwoods. Drying times vary with sun intensity, moisture content of lumber and relative humidity,

When deciding on kiln size, consider the maximum capacity of the kiln in board feet to be 10 times the roof area in square feet. For maximum year-round performance, the roof angle of the kiln should be equal to its latitude in degrees north of the equator. Wisconsin's latitude ranges from 42.5° to 47°, so a roof angle of 45° is ideal. Increasing the roof angle to 55° would improve the kiln's winter performance.

Frame the kiln floor with 2 x 6-inch joists; cover with 5/8-inch plywood top and bottom. For durability, use pressure treated lumber and exterior plywood. Space floor joists 16 or 24 inches apart and mount with joist hangers. Insulate the floor with blanket-type or solid foam insulation. Avoid insulations with a foil vapor barrier, as they may trap moisture inside the floor. Do not use poured-in or blown-in insulation. Apply two coats of aluminum- or oil-based.

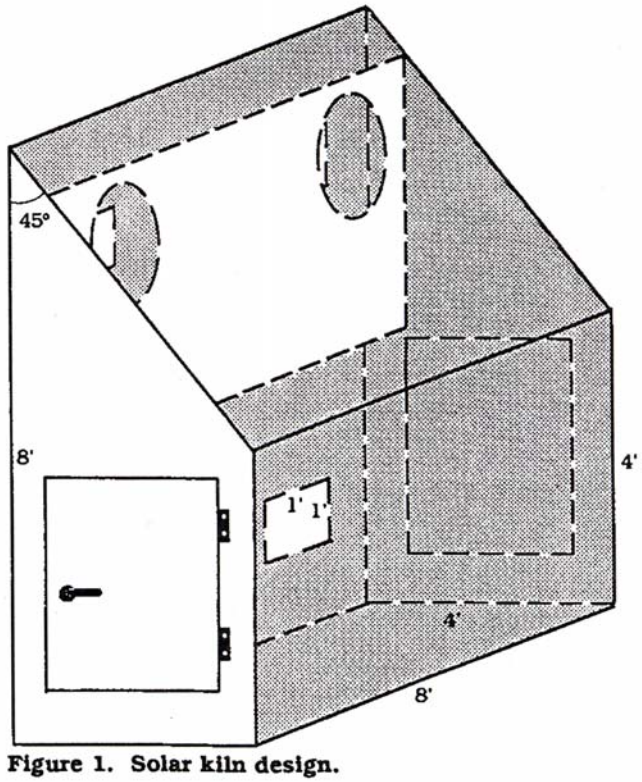

Figure 1. Solar kiln design.

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paint to the top sheet of plywood (the kiln floor) to prevent moisture from seeping into the floor. Cover with flat black paint for maximum solar absorption.

Construct the walls of 2 x 4-inch studs and 3/4-inch plywood. Be sure, the studs on the side walls frame openings for doors at least as large as the end dimensions of the wood pile. The back wall studs should frame four 1-foot square vent openings, two on top and two on the bottom. Paint the interior walls in the same manner as the floor. Cover vents with screen, to keep birds and rodents out, and simple doors.

Fasten a 3/4-inch plywood fan baffle to the side walls. The fan baffle ensures that air flows through the wood pile rather than over the top of it (Figure 2). Cut holes for mounting two electric fans as close to the roof as possible to eliminate dead hot air pockets in the upper corner. The baffle should extend from the roof to within 6 inches of the lumber pile. A sheet of plastic or canvas can be used to close the gap between the baffle and the lumber pile.

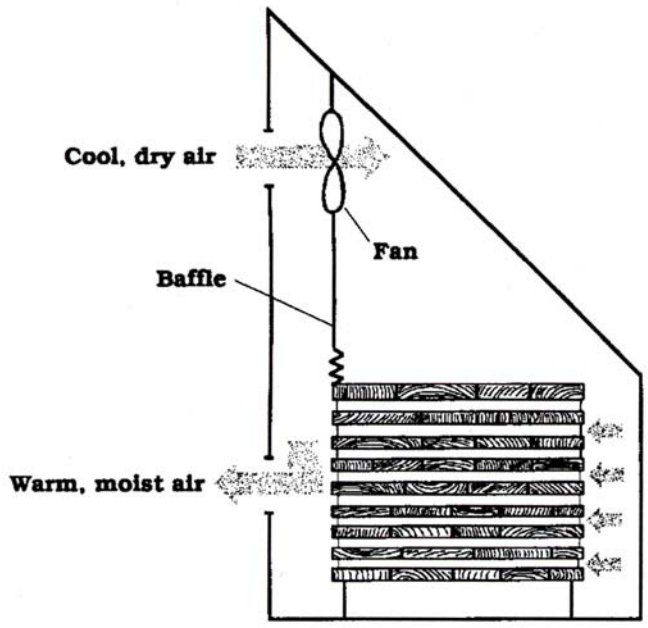

Figure 2. The baffle forces air drawn in by the fans to flow through the lumber pile before exiting the kiln.

Mount electric fans to the baffle. Temperature can exceed 150°F inside the kiln, so avoid fans with plastic parts that could melt; typically, multispeed, metal window fans are used. Fans should blow towards the front of the kiln (away from top vents).

Raise the kiln off the ground with cinder blocks or railroad ties, or construct a cement foundation. The kiln floor structure will deteriorate rapidly if resting directly on the ground. Align the kiln so the angled roof faces south. Stain the exterior of the kiln with a dark-colored stain. Do not use any covering that is impervious to water and may trap moisture in the insulation, such as oil-based paints.

Cover the kiln roof with one or two layers of translucent fiberglass, plastic film or glass. Two layers will decrease drying times. Fiberglass is inexpensive, resistant to breaking and the easiest to work with. Apply a non-hardening, silicone caulk to the outer surface of the frame to provide a seal between the plastic and the wood. Secure the fiberglass to the frame with 1 x 4-inch treated wood strips.

OBTAINING LOGS AND SAWING LUMBER

Following simple guidelines for obtaining logs and sawing them into boards will help to ensure the highest possible lumber quality. These guidelines can eliminate needless quality losses later in drying.

Obtain logs from live trees. Avoid logs with large wounds or dead branches. Standing dead trees frequently are heavily stained and may not produce premium-quality lumber.

End-coat all logs as soon as possible after the tree is felled to prevent rapid drying of log ends. Rapid drying can cause end checks and cracks. Satisfactory end coatings include water-based wax, asphalt-based roofing cement, aluminum paint in a spar-varnish base, and paraffin.

Saw logs into lumber as soon as possible. In the summer, quality loss in logs can begin within one week; in winter, losses won't be detectable for several months. If sawing must be delayed, retard quality loss by submerging logs in water or continuously sprinkling them with water.

Before sawing logs, carefully determine the lumber thicknesses needed. As a general rule, it is very difficult to manufacture and dry lumber thicker than two inches or thinner than 3/4 of an inch. If projects require thicker lumber, it is better to saw 1-inch boards, dry them, and glue them back together in the same order as they were sawn. Do not plan to resaw thick dried lumber - saw it to the desired size before drying. Lumber thinner than 3/4 of an inch is prone to warping.

If the lumber is variable in thickness, uniform thickness should be obtained by planing one or both board faces. Planing reduces face or surface checking and cracking, and uniform thickness helps to prevent warping during drying.

If you are unable to saw your own lumber, find a commercial sawmill to process your logs into lumber. You can still save money over retail lumber prices by drying the lumber yourself.

PREPARING LUMBER FOR DRYING

It is important to prepare lumber and begin drying it soon after the lumber is sawn. Green lumber will begin staining immediately if not stacked and dried - especially in warm weather. If polyethylene glycol (PEG) is used, to prevent green wood from swelling or shrinking during or after drying, the lumber should be put into the solution immediately after cutting.

For optimum lumber quality, load the dry kiln according to the following suggestions. Place "stickers" on the kiln floor, perpendicular to the lengthwise direction of the lumber pile. Stickers are dry pieces of wood 3/4- to 1-inch thick, 1 and 1/2-inches wide and as long as the wood pile is deep. Never place lumber directly on the floor.

Stack lumber in single layers of uniform thickness, with the thinnest material on the bottom and the longest boards on the outside edges. Separate each layer with stickers of uniform thickness. Place the stickers every 12 to 18 inches along the length of the pile, directly above the stickers in the layer below. Stickers allow air movement through the pile and prevent warping. Make sure there are stickers above and below every board end - whether at the pile's end or somewhere in the middle. A board with a loose end will warp.

Fill the kiln to its designed capacity, to within 6 inches of the bottom edge of the baffle, and to a width that leaves one foot of air space on the sides (Figure 2). A smaller load will dry more rapidly than is desired.

Cut several 30-inch-long sample boards from the lumber (Figure 3). Because the wettest lumber generally has the highest risk of degrade development, the sample boards should represent the wettest lumber in the dryer: that is, the most recently cut boards, the widest and thickest boards, and quartersawn boards (Quartersawn =  ; Face- or flatsawn = ). Avoid cutting sample boards from areas near knots and areas closer than 12 inches to the ends of the lumber. Cut a 1-inch section from each end of the sample boards. Weigh the sections and the sample boards to the nearest gram (1/25 ounce); record weights directly on the wood pieces. End coat both ends of the sample boards and return them to the wood pile in a spot where they will receive the same air velocity as the rest of the lumber. Number and save the 1-inch sections.

After stacking, end coat any uncoated, exposed ends of the lumber. Cover the stack with a black-painted sheet of plywood or scrap lumber (separated by stickers from the top layer of lumber) to protect the upper layer from repeated exposure to direct sunlight. Place rocks, scrap iron or other heavy weights on top of the cover to keep the top layers of lumber from warping.

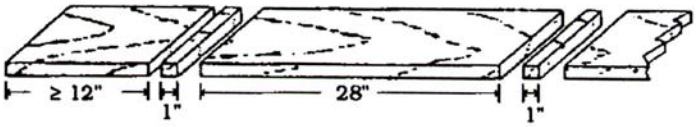

Figure 3. 28-inch sample boards and 1-inch sections are used to monitor the drying rate of the lumber in the kiln.

DRYING LUMBER

Lumber can be air-dried or kiln-dried, or both. Air drying will bring the moisture content of the lumber down to around 20% - low enough for exterior use. Air dry 1-inch lumber 45 to 60 days, 2 inch lumber 60 to 90 days, in a breezy, warm, not too humid place to reach 20% moisture. For interior use, however, lumber must be kiln dried to a moisture content of 7% to avoid splitting or warping in use. The following procedures apply to drying in a solar kiln. Kiln drying of lumber requires some attention. Because wood dried too quickly will develop degrade, the fundamental rule of drying lumber is that the quality of drying is controlled by the rate of drying. Air drying rates are difficult to control, and thus, solar kiln drying is recommended - especially during the critical initial drying of "green-from-the-saw" lumber.

When first learning to dry lumber, or when drying lumber thicker than one inch, monitor moisture content daily to avoid drying too rapidly. Drying speed is monitored by measuring the moisture content of the sample boards and comparing the daily rate of moisture loss with the "safe rate" for that species (Table 1). Exceeding the safe rate drying speed for a given species can cause defects in the lumber. If drying is found to be too fast, it may be necessary to cover part of the roof, or turn off the fans and close the vents during the hottest part of the day. While this may increase the temperature inside the kiln the trapped air will quickly reach 100% of its capacity to hold water and the lumber will not dry any further.

Table 1. "Safe rates" for drying 1-inch thick Wisconsin Lumber.[1]

Species	Maximum Rate of MC loss Per day
Beech	4.5%
Birch	6.1%
Hard Maple	6.5%
Soft Maple	13.8%
Red Oak	3.8%
White Oak	2.5%
Walnut	8.2%

[1]The maximum "safe rate" for 2-inch hardwood lumber can be obtained by dividing the 1-inch safe rate by 2.5. Thus, the 2-inch safe rate for beech is 1.8% MC loss per day (4.5 ÷ 2.5= 1.8).

At night, as the dryer cools down and the humidity builds up, water may condense on the walls. This is an essential part of the drying process as it relieves stresses in the wood that develop during the day as the wood dried. For this reason, do not run the fans at night.

In a solar dryer like the one presented here, the roof area and capacity are designed so that even on hot, sunny days, the dryer cannot dry 1-inch oak lumber too rapidly. That is, the maximum drying rate will not exceed 2.5% moisture content (MC) loss per day for white oak, 3.8% MC loss per day for red oak (Table 1). For thicker lumber, however, with slower maximum drying rates, samples must be used to carefully monitor the drying rate. For 2-inch, heavy, green hardwoods, covering half of the roof area to reduce the amount of solar radiation will slow the drying process.

It is important to note that safe rate refers to the loss in one day, not the average loss over several days. An 8% loss one day and 2% loss the next is not equivalent to a 5% per day MC loss rate. Safe rates must be adhered to until lumber moisture content drops to 20%.

Sample boards provide the means for determining moisture content loss rates. Use the following procedure to measure daily moisture content:

1. Place the 1-inch sections (sawn earlier from the sample boards) in an oven at 215^{O}F (102^{O}C). After the pieces are dry (usually 18 to 24 hours depending on the oven), reweigh them and obtain the oven-dry (O.D.) weight.

2. Calculate the moisture content (MC) of the sections with the formula below. Average the MCs of both sections taken from each board to obtain the MC of the sample boards. The wet weights are recorded on the sections from the earlier weighing.

$$\%MC = \frac{\text{wet welght of 1-inch sample}}{\text{O.D. weight of 1-inch sample}} - 1 \times 100$$

3. Estimate the oven-dry weight of each sample board using the formula below, the average MC from step 2, and the wet weight recorded on the sample board.

$$\text{Estimated O.D. weight} = \frac{\text{wet weight}}{(100 + \%MC)} \times 100$$

4. Record the estimated oven-dry weight of the sample boards and return them to the kiln.

5. Reweigh the sample boards daily and calculate the current moisture content.

$$\text{Current } \%MC = \frac{\text{current weight}}{\text{estimated O.D. weight}} - 1 \times 100$$

6. When moisture content reaches 20%, a more accurate estimate of moisture content can be obtained by cutting a new 1-inch section six inches from the end of one of the sample boards. Weigh the shortened sample board and the new 1-inch section. Follow steps 1 through 5. Be sure to use the new wet weights and the new oven-dry weight of the section in finding the current MC of the sample board (step 5).

If you do not have access to precise scales or temperature-controlled oven, there are other methods to determine and monitor moisture content loss. Write the authors for that information.

Good Luck! Enjoy the satisfaction of collecting, sawing and drying your own lumber.

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Write for plans for a larger, 1500 bd. ft. solar kiln.