The Oklahoma Cooperative Extension Service
Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; home economics; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of Cooperative Extension are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and based on factual information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

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Robert M. Kerr Food & Agricultural Products Center

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Basics of Solar Lumber Drying

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Solar drying of lumber is one of the more efficient and the least expensive methods to reduce moisture content of wood. The objective of this fact sheet is to give a basic understanding of solar drying of lumber and its elements from the point of practical applications.

Solar Drying

Principle aspects of kiln and air-drying of lumber were presented in two previous fact sheets – FAPC-146 Fundamental Aspects of Kiln Drying Lumber and F-5042 Practicalities of Air Drying of Lumber.

Because of its low cost and simple operation, solar drying lumber is considered an attractive method to dry small quantities of lumber. There are many small, homemade solar kilns that can be built for approximately $600-$700. The main operating expense of such a kiln is electricity, which is used to run fans for air circulation. Additionally, these solar kilns do not require a large space. For example, a kiln with a capacity of 150-250 board feet can be built on approximately 90-100 ft^2. A board foot, or bdft, is the amount of wood contained in an unfinished board with a thickness of 1 inch, length of 12 inches, and width of 12 inches.

The operating temperature of a solar kiln is approximately 120-130 degrees Fahrenheit, unless high-cost solar collectors are used as a heating source. Rough-sawn green lumber with a high moisture content easily can be dried in a solar kiln to reduce moisture content to 6 to 10 percent.

When the price of kiln-dried lumber is compared to that of solar kiln-dried lumber, the profit margin is noticeably higher.

Aspects of Solar Kilns

Solar kilns can be classified into two general groups: greenhouse kilns and external collector kilns.

Greenhouse Kilns

A solar collector is a device that extracts energy from the sun, not indirectly, and converts it into a usable form. A common type of greenhouse kiln is a simple construction with a lumber frame made of plywood or oriented strand board (OSB) sheeting.

A well-insulated floor and walls are important for an efficient drying process in a solar kiln. Typical solar collectors in such kilns utilize glazed glass, fiberglass or plastic sheets, facing to the south. The face also may be angled toward the south as illustrated in Figure 1.

Various factors influence the amount of heat that can be obtained from sunlight; however, the slope of the roof is the most important. The ideal roof angle depends on geographic location, but is generally sloped at a 40-45 degrees angle to the south. There is always some variation depending on wood species. Figure 1 illustrates a typical greenhouse solar kiln.

Proper air circulation also is one of the more important parameters to control the quality of dried lumber. One or two fans located on the top of the kiln remove moist air from the surface of the lumber. The air circulation rate through the lumber should be approximately 150 feet per minute. When this volume is multiplied by total sticker space openings, the average required cubic volume of air in the kiln can be calculated. For example, if a 12-foot-long lumber is

stacked in the form of 10 layers using 0.5 inch thick stickers, the ideal average air volume in the kiln will be: *12 ft. × 10 layers × 0.5 /12 ft. ×150 ft./min. = 750 ft³/min.*

External Collector Solar Kilns

The overall process of the external-type collector solar kiln is more complicated than that of the greenhouse kiln process.

The surface area of the external collector is approximately 1 ft² for each 8-10 bdft of lumber with a thickness of 1 inch. Figures 2, 3 and 4 show an external solar kiln and its collector.

A thermostat controls the temperature within the kiln, allowing a duct to be closed or opened to move hot, moist air in and out of the kiln.

The drying rate can be controlled by changing the relative humidity, resulting in adjusting equilibrium moisture content of wood in the kiln. As humidity in the kiln is reduced, the lumber will dry faster.

Ventilation also is an important element influencing the quality of drying of the lumber. Hot, moist air should be continuously exhausted while cooler air from the outside is introduced into the kiln. During ventilation of hot air from the kiln, it is important to make sure that excessive hot air is not vented in order to conserve energy.

During the drying process, relative humidity can be monitored using a simple sling psychrometer that has wet and dry bulb thermometers. Also, depending on the size of the kiln, one or two sample boards should be removed to calculate moisture content of the load. One-inch-wide samples are sawn from the board 12 inches from each end for moisture content measurement. These samples are weighed at an accuracy of 1 gram before they are put in an oven at 214-218 degrees Fahrenheit (103 ± 2 degrees Celsius), until they reach a constant weight. This process usually takes approximately 15-35 hours depending on the species of the wood. Samples are then re-weighed to find oven dry-weight and their moisture content is calculated based on the following equation:

Moisture content (%) = [[Original weight (g) - Oven dry weight (g)] / Oven dry weight (g)] x 100.

As a rule-of-thumb, lumber should not be dried at faster than moisture content loss per day as displayed in Table 1. Otherwise, drying defects such as surface checks, warping and splitting may occur, reducing the final quality of the lumber.

Species	Moisture Content Loss per Day	
	1 in. thick	2 in. thick
Red Oak	3.0	1.5
Walnut	8.2	5.5
Yellow Poplar	13.8	5.5
Cherry	5.8	2.3
White Ash	10.4	4.1

Table 1. From Bond, Virginia Cooperative Extension Publication, 420-430.

Further Information

Detailed information about solar drying of lumber can be found in the following literature:

Drying Wood with the Sun: How to build a solar heated firewood dryer. USDA Department of Energy. The National Center for Appropriate Technology: Butte, Montana.

Armstrong, J. P. & Hall. C. *Solar Drying Basics.* West Virginia University.

Wengert, E. M. (1980). Solar heated lumber dryer for the small business. MT #20C Utilization and Marketing, Virginia Cooperative Extension Service: Blacksburg, Virginia.

Wangert, E. M. & Meyer, D. Processing Trees to Lumber: for the Hobbyist and Small Business. Retrieved from http://owic.oregonstate.edu/solarkiln/plans.htm.

Simpson, W. T. (ed.) (1991). *Dry Kiln Operator's Manual.* Forest Products Society: Madison, Wisconsin. Retrieved from www.forestprod.org

Chen, P. Y. S. (1981). Design and test of 500 bdft solar kiln. *Forest Products Journal,* 31(3):33-38.

Yang, K. C. (1980). Solar kiln performance at a light latitude 48o N. *Forest Products Journal,* 30(3):37-40.

Solar kiln plans construction and operational information. Retrieved from www.woodscience.vt.edu/about/extension/vtsolarkiln.

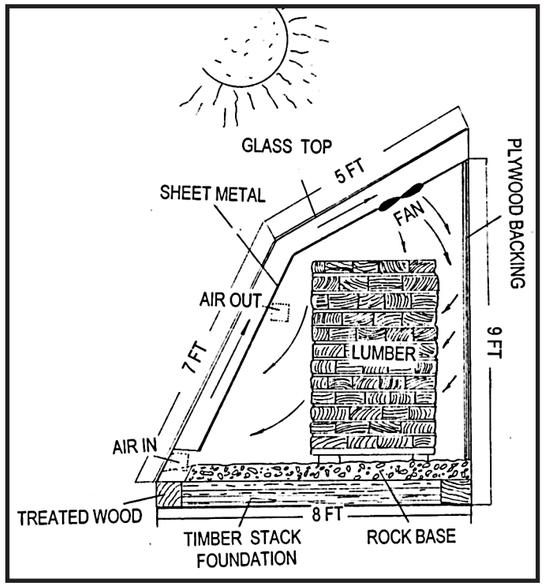

Figure 1. Greenhouse Type Solar Kiln

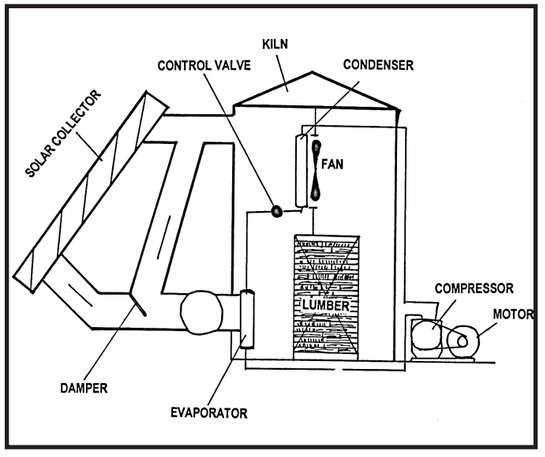

Figure 2. External Type Solar Kiln

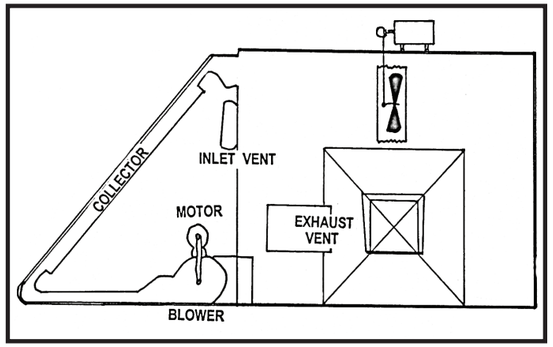

Figure 3. Solar Kiln with Built-In Collector

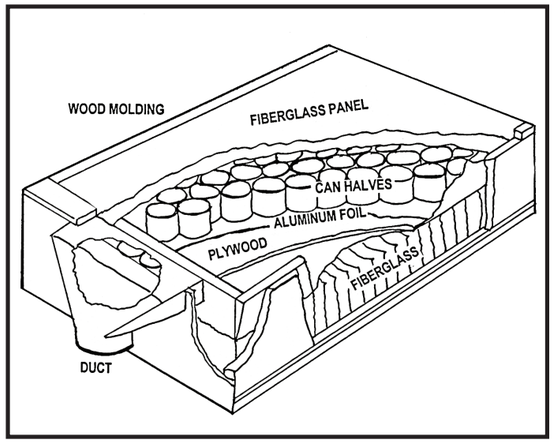

Figure 4. Solar Collector for a Kiln