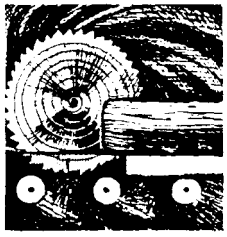
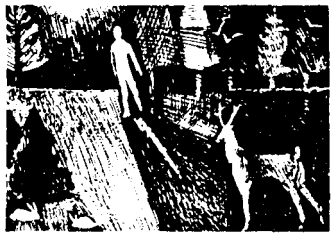
West Virginia University
Extension Service

Wood Industry Fact Sheet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Solar Drying Basics

Characteristics of Solar Drying

Solar lumber drying offers several advantages to those desiring an inexpensive means of drying small quantities of lumber. A solar kiln may be easily constructed with readily available building materials. When compared to the cost of custom kiln drying, the investment and operating costs of a solar kiln are minimal.

When compared to air drying, drying lumber in a solar kiln offers several advantages. A well-designed solar kiln will be 20 to 30° F hotter than the outside temperature on sunny days. Thus, solar drying is a much faster process and is capable of drying lumber to moisture contents of 6 to 10%, particularly in the summer months. It is unusual for air dried lumber to ever reach moisture contents much below 20% unless it is dried in a heated building. Since solar drying offers protection of the lumber from the elements, the quality of the dry lumber is usually much better than air dried material in terms of seasoning checks and other defects.

Solar drying is not without disadvantages. Topmost among these is the method's dependence upon the weather. Drying rates vary greatly depending upon the outside temperatures and the number of hours of sunshine per day. Lumber dried in 30 days or less during the summer may require an entire winter to dry in a solar kiln. Likewise, it is not possible to reach the low moisture content (6-8%) desired for furniture making or other quality indoor products by solar drying during inclement seasons of the year. It is also difficult to maintain uniform moisture contents within a charge of solar drying lumber. Thus, it may be advantageous to allow lumber to condition for several weeks in a heated building in order to achieve a desired equilibrium moisture content.

There is a greater chance of checking and other seasoning defects with solar drying than with conventional kiln drying. However, defects may be kept to a minimum by following a few simple recommendations. End checking can be significantly reduced by painting the ends of freshly sawed lumber with a commercial end coating or an aluminum based paint. Proper stacking and stickering procedures will reduce warp and some end checking. Top weighting the charge with bricks or concrete blocks will greatly reduce warp. Staining may be reduced by stacking and stickering lumber immediately after sawing. (Refer to Wood Industry Fact Sheet DR-2 for details.)

Checks and other seasoning defects are typically caused by too rapid drying. Wengert (1980) recommends that the following species not be dried any faster than the maximum moisture content loss per day until the moisture content of the lumber is below 22%. Thus, it is necessary to closely monitor the moisture content of the lumber according to accepted procedures (see Rasmussen 1961, or Wengert 1980). It is also good practice to observe the temperature and moisture content in the solar kiln. If the lumber is drying too rapidly, Wengert (1980) recommends that the drying rate be slowed by shutting off the fans, and on very hot, sunny days partially covering the collectors,

External Collector Kilns

Solar kilns may be equipped with an external solar collector connected to the kiln chamber by insulated ducts. An external collector kiln can be very sophisticated with thermostats controlling dampers that can shut off the ducts to avoid too high temperatures inside the kiln during the day and heat losses at night. Forest Service scientists in Carbondale, Illinois, have added a dehumidifier to an external collector solar kiln with very promising results (Chen and Rosen 1981, Chen *et al.* 1982). Two external collector designs are illustrated.

External collector kilns offer greater control of the drying process and better efficiency than greenhouse kilns but they are more expensive to build and require some engineering knowledge to design.

Greenhouse Kilns

Greenhouse kilns incorporate the solar collector into the structure of the kiln chamber. The kiln itself may be constructed of framing lumber with plywood sheating or may be block or other similar

SPECIES	MAXIMUM RATE OF MC LOSS PER DAY FOR 1" LUMBER	MAXIMUM RATE OF MC LOSS PER DAY FOR 2" LUMBER
Beech	4.5	1.8
Birch, Yellow	6.1	2.4
Cherry	5.8	2.3
Elm, American	10.4	4.1
Maple, Soft (Sap)	13.8	5.5
Maple, Hard	6.5	2.6
Oak, Red Upland	3.8	1.5
Oak, White Upland	2.5	1.0
Oak, Southern	Variable 1.0 to 3.0	0.4-1.2
Sweet Gum (Red Gum)	5.3	2.1
Tupelo (Black Gum)	10.9	4.3
Walnut	8.2	3.2
Yellow-Poplar	10.0	4.0

construction. The kiln must have a well insulated floor, preferably with a drain of some sort to remove condensation from inside the kiln. The inside walls and floor of the kiln should be painted black to better absorb and store heat. Concrete block holds an advantage over wood framing in this regard but is not as efficient as an insulating material. Walls and floor should have a vapor barrier on the interior side such as polyethylene, foil, or aluminum based paint. All non-collector surfaces (walls, floor, roof, doors, etc.) must be well insulated.

The collector consists of some transparent glazing material, typically plastic or fiberglass. The collector should face directly south at an angle to the horizon equivalent to the north latitude (38° to 40° in West Virginia) or 45°. The collector should consist of one square foot of glazing material for every 10 board feet of lumber contained in the kiln. The collector is possibly the most critical surface for heat loss from the kiln during cool, cloudy days or at night. Therefore, double or triple layers of glazing maybe advisable.

Three greenhouse solar kiln designs are illustrated. The kilns may be constructed from materials available at any building supply center. There is a trade off between the builder's desire for durability and cost. It is strongly recommended that if the builder desires to cut cost that the collector and insulation be the *last* items to sacrifice quality in return for reduced expense.

Air Circulation

It is very important to maintain air flow through the lumber piles during drying. The designs illustrated in this Fact Sheet all call for fans and baffle systems. Typically, fans in small solar kilns are inexpensive window fans available at most home centers and department stores. in order to save electricity, fans should not be run when temperatures inside the kiln are lower than 65° F in winter or 75° F in summer (Wengert 1980).

The baffles deflect airflow through the lumber piles. They may be constructed of black painted plywood or particle board.

Most solar kiln designs include ventilators for exhausting excess heat and humidity from the kiln. However, some scientists question the need for vents since condensed moisture may be removed from the kiln through floor drains and the need to vent excess heat is rare. In any case, vents should be closed for the first third of the drying process when high humidities are desired.

References

Bois, P. J. 1977. Constructing and operating a small solar heated lumber dryer. U.S. Dept. of Agr.; Forest Service; Forest Products Util. Tech. Rep. No. 7; Madison, WI.

Chen, P. Y. S. 1981. Design and tests of a 500BF solar kiln. Forest Products J. 31(3): 33-38.

Chen, P. Y. S. and H. N. Rosen. 1981. Drying lumber In a solar-dehumidifier kiln. So. Lumberman: December 15, 1981.

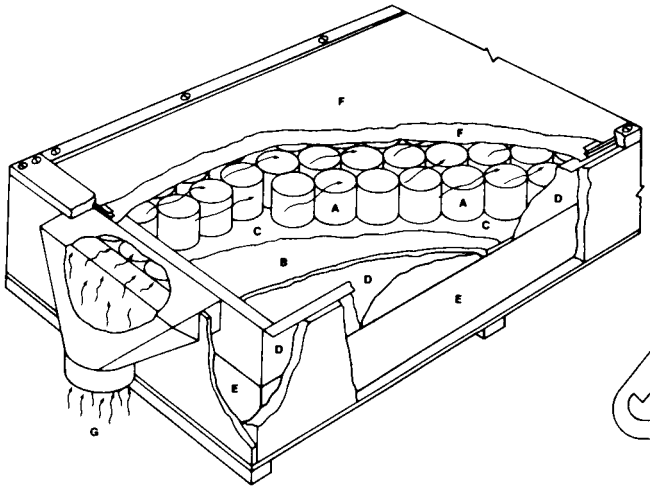
Chen, P. Y. S. and Helmer, W. A., Rosen, H. N. and D. J. Barton. 1982. Experimental solar-dehumidification kiln for drying lumber. Forest Products J. 32(9): 35-41.

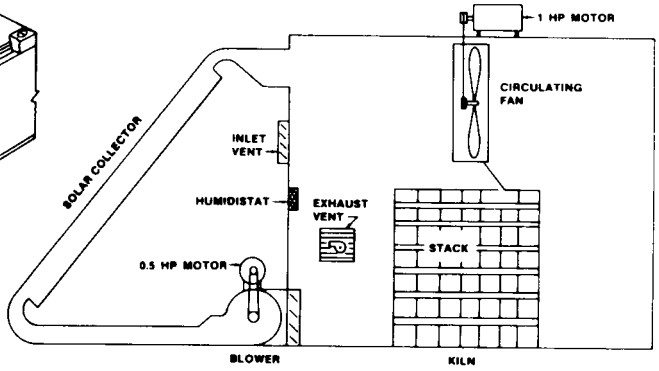
Lumley, T. G. and E. T. Choong. 1979. Technical and economic characteristics of two solar kiln designs. Forest Products J. 29(7): 49-56.

Rasmussen, E. F. 1961. Dry Kiln Operator's Manual, U.S. Dept. Agr. Handbook No. 188. U.S. Forest Service: Forest Products Laboratory, Madison, WI.

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

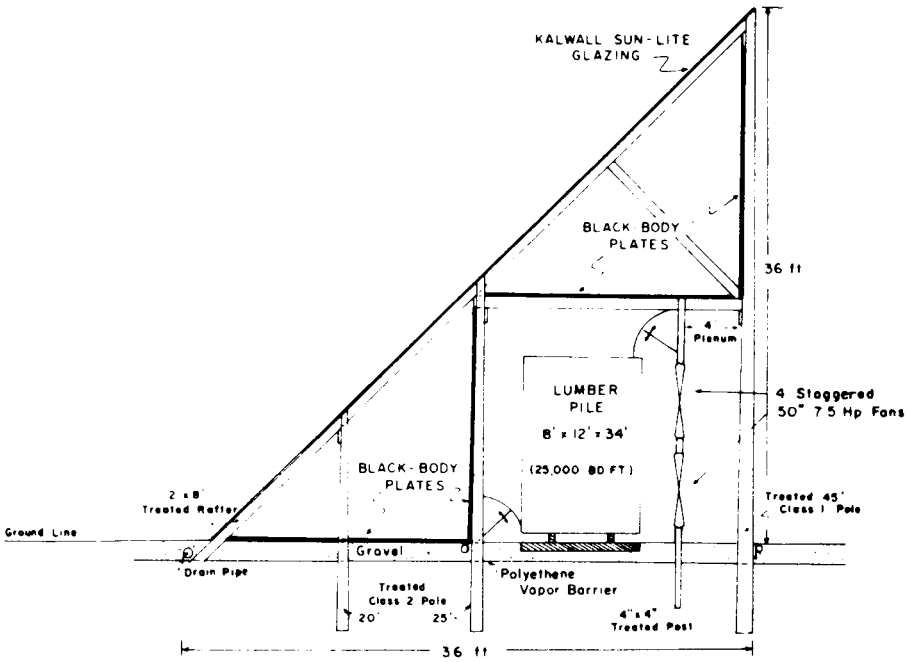
Yang, K, C. 1980. Solar kiln performance at a high latitude, 48° N. Forest Products J. 30 (3): 37-40.



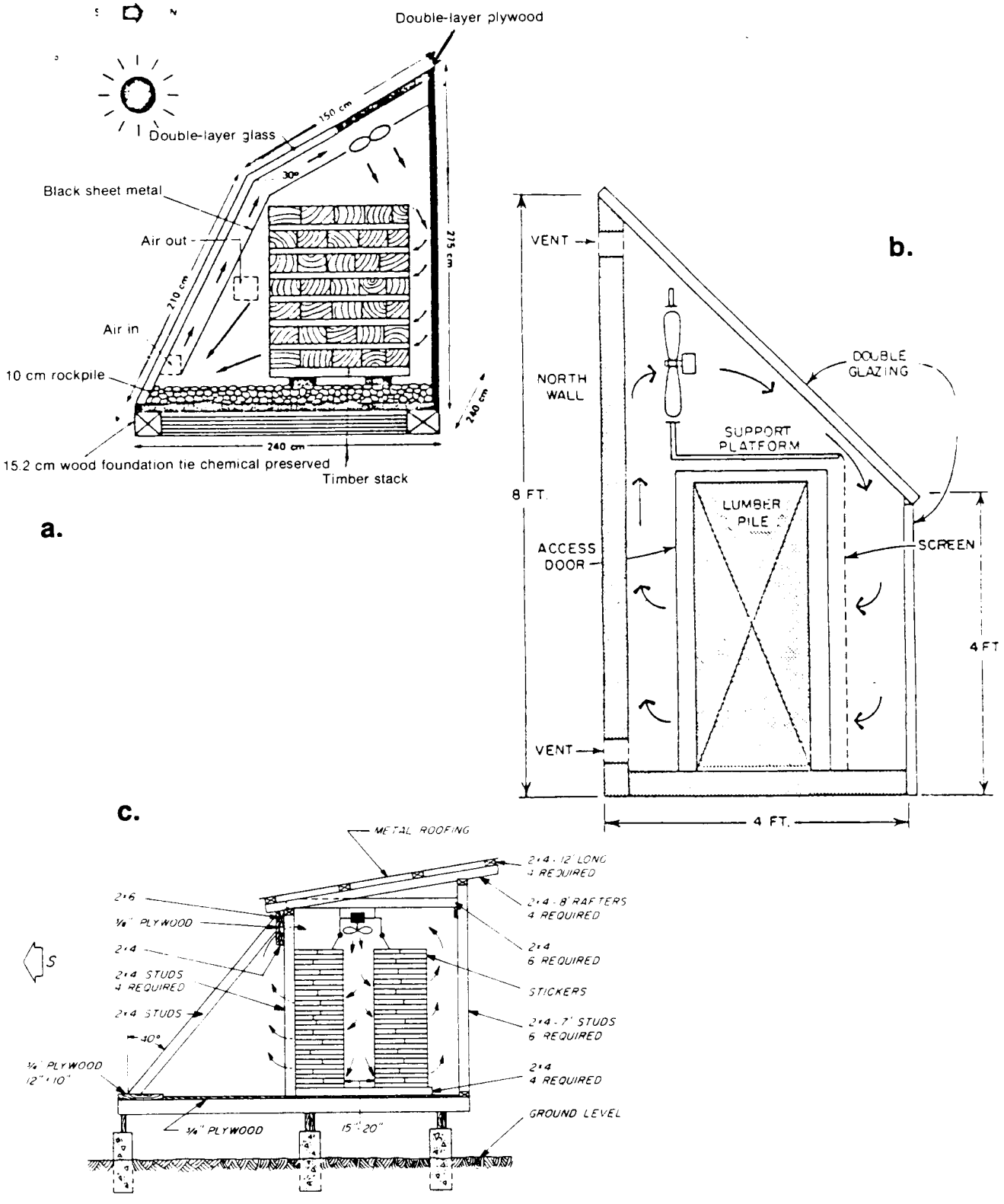


Cutaway view of solar collector. A—Aluminum cans cut in half, B—1/2-inch exterior plywood, C—heavy aluminum foil, D—wooden tray, E—polyurethane foam insulation, F—double-paned fiberglass solar collector cover, and G—air flow.

External collector kiln with flat-plate collectors (from Chen 1981).



External collector kiln with box-type collectors (from Lumley and Choong 1979).



Greenhouse kilns from (a) Yang 1980, (b) Wengert 1980, and (c) Bois 1977.

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