

## SOME CONSIDERATIONS IN DRYING OAK

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### Introduction

To a western dry kiln operator accustomed to drying only soft-wood species, the drying of hardwoods--particularly a refractory wood such as oak--poses a difficult problem. The entire philosophy of drying must be reexamined. Whereas the structural softwoods of the West are dried predominantly with time schedules, oak should be dried by a moisture content schedule if costly degrade is to be avoided. The dry kiln operator must concern himself with the moisture content of the oak as it dries, making his schedule changes only as indicated by the changes in moisture content of the load.

Preliminary to the drying itself, careful sampling of the material going into the kiln is necessary. Samples of wet, dry, wide, narrow, thick, thin, sap, and heart material must be selected which will be used to monitor the drying conditions in the kiln. The successful drying of the charge will be largely influenced by the type of kiln samples chosen. This system is called the sample-board method and moisture contents are calculated periodically by weighing the sample boards during the kiln drying--the calculated oven-dry weight of each sample board being previously determined by cutting small moisture sections from each board. The moisture content of the wettest half of the kiln samples will determine the step in the kiln schedule. More detailed information on the sample-board method of drying is found in Agriculture Handbook No. 188 entitled "The Dry Kiln Operator's Manual."

### Requirements for Successful Air Drying

Air drying of oak is probably more difficult than air drying most other species of wood because of oak's tendency to split, check, and perhaps even honeycomb and collapse during the air-drying process. Good stickering, pile covers, proper placement on the air-drying yard, end coating for thick stock, and good foundation systems will minimize problems during air drying. Close stickering will minimize the development of warp during drying. As a board is bent during drying, so will it remain--much as steam bending of wood. This applies to all species of wood. Good roof covers will prevent the direct rays of the sun and the wetting action of the rain from opening and closing surface checks, warping the top layers, and excessive end splitting. Proper placement in the yard will keep hot, dry wind away. A few hours of brisk wind and low relative humidity are enough to begin the surface checking on such woods as oak and beech, with their wide rays. In hot areas of the West, air drying should perhaps be done undershed or be limited to periods of the year when temperatures are low and relative humidities higher than summertime. In some areas of California, this may mean that air drying be limited to the winter months if adequate shed drying is not available.

## Kiln Drying

Normal material of California black oak may be dried with the T4-E2 schedule from the Dry Kiln Operator's Manual. If dried from the green condition, the schedule may be entered as discussed and shown in the FPRS News-Digest of October 1974 entitled "A Suggested Kiln Schedule Acceleration for 4/4 and 5/4 Upland Oaks." Before drying oak in a western softwood kiln, the kiln should be checked to make certain that wet and dry bulbs are operating correctly, air velocities are uniform, and baffling is being properly used. Vents and steam traps should also be in good operating condition. Small wet-bulb depressions are called for during the initial stage of drying green material. This is the period in the kiln schedule when the likelihood of checking and end splitting is most likely to occur. The wood, being wet and warm, is also weaker and the danger of collapse is most likely to occur at this stage of drying. Heavy surface checking or damage to cell walls due to stress development during this stage may also lead to honeycomb during later stages of the drying schedule.

With well-air-dried material which has not been surface checked and which has been dried to a uniform moisture content on the yard or undershed, kiln drying can be approached with less fear. Early work by Leif Espenas in 1951 discusses many aspects of drying California oak and other Oregon hardwoods. In a publication dated 1961 by the Pacific Southwest Forest & Range Experiment Station, Harvey Smith made recommendations for drying California black oak and found that two schedules were suitable for air-dried material from a low-temperature dryer where initial moisture contents were 25 percent or lower, starting with dry-bulb temperatures of 130° in one case and 135° in the other and depressions of 20°. The dry bulb was gradually raised to a final temperature of 180°F. and a 50° depression to complete the drying. Smith also found, however, that low-temperature drying was best if initial temperatures were not over 100°F. with a 5° depression on the wet bulb. He also discovered that with higher air speeds (800 ft. per min. or more), closer control of the wet bulb was important and that lower air velocities were probably safer for this check-prone species. The Forest Products Laboratory also recommends 130°F. as a safe starting point for well-air-dried material which has reached 25 percent moisture content. If material has been dried to as low as 20 percent moisture content, it may be possible to start at 180° in the dry kiln. However, if surface moisture has been added as a result of exposure to high humidity or rain, we recommend a small depression of about 10° during the first 12 to 24 hours before moving to the full depression called for in the schedule. This is to make certain that any surface moisture is evaporated. The recommended kiln schedule is T4-E2, shown below and in table 2 of the previously mentioned News-Digest. However, if objectionable checking does occur, it may be necessary to back off and use a more conservative T4-D2 schedule, shown below and in table 1 of the Digest. Four-quarter or 5/4 material should dry from the green condition in no more than 28 days. Well-air-dried stock may be finished off in the dry kiln to a 6 to 8 percent moisture content final in 5 to 7 days. Longer drying times are possibly indicative of kiln problems or problems with the wood itself.

Schedule T4-E2 for Red Oak--4/4, 5/4

Moisture Content (Pct.)	Dry Bulb (°F.)	Wet Bulb (°F.)	Depression (°F.)
Above 60	110	106	4
60 to 50	110	105	5
50 to 40	110	102	8
40 to 35	110	96	14
35 to 30	110	80	30
30 to 25	120	80	40
25 to 20	130	80	50
20 to 15	140	90	50
15 to 0	180	130	50

Equalize & condition  
as necessary.

Schedule T4-D2 for Red Oak--4/4, 5/4

Above 50	110	106	4
50 to 40	110	105	5
40 to 35	110	102	8
35 to 30	110	96	14
30 to 25	120	90	30
25 to 20	130	80	50
20 to 15	140	90	50
15 to 0	180	130	50

Equalize & condition  
as necessary.

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Bacterially infected material has been found in oaks almost everywhere in the country. Research by Jim Ward at the Forest Products Laboratory has discovered the relationship between bacterially infected red oak and the honeycomb and ring failure which develop during kiln drying. Research Paper FPL 165, published in 1972, describes the situation. More recent information on working with bacterially infected oak lumber was reported by Ward at the 28th Annual Meeting of the Forest Products Research Society in June 1974 and should be in print shortly. Bacterially infected material is found in red oak heartwood and is characterized by a sour or rancid odor from a mixture of volatile fatty acids. This rancid heartwood is weaker than sound red oak heartwood with normal odors and is very susceptible to honeycomb formation under normal kiln-drying conditions. Severity of honeycomb increases when the drying rate of the rancid heartwood is accelerated. Ring failure also occurs in this material, but it appears to be an incipient form of ring shake that was initiated in the tree and then ruptured from kiln-drying stresses. Under kiln-drying conditions, honeycomb and ring failure can occur in all grades of green red oak lumber with rancid heartwood. However, because of associated shake and bacterial infection patterns in the tree, rancid heartwood tends to be more prevalent in the lower stem section of red oaks and the lumber from the butt log contains more rancid heartwood than the upper logs. A very mild kiln condition is called for. If dried green from the saw, a 4° to 5° depression with as low as 105° F. on the dry bulb is recommended. Recognizing that these

low dry-bulb temperatures may be impossible to achieve at certain times of the year or possibly in batteries of kilns where adjacent kilns are operating at higher temperatures, it may be necessary or advisable to carefully air dry the material first using the precautions stated earlier. The following schedule is recommended by Jim Ward and John McMillen and may be used in an effort to control degrade developing from this bacterially infected material.

Suggested Kiln Drying Schedule  
for Infected 4/4 Red Oak

Moisture Content Wettest Half of Kiln Samples (Pct.)	Dry-Bulb Temperature (°F.)	Wet-Bulb Depression (°F.)	Wet-Bulb Temperature (°F.)
Above 45	105	4	101
45	105	6	99
35	105	12	93
33	110	15	95
30	115	15	100
27	120	20	100
24	130	30	100
18	150	40	110
14	160	50	110
Equalizing	180	35	145
Conditioning	180	10	170

Accelerated Drying Techniques

Presurfacing is one method of accelerating the drying of oak. It has been reasoned that presurfacing before drying removes the tiny surface fractures induced during headsawing of lumber. With the tiny fracture areas removed, the likelihood of surface checking is reduced and therefore an acceleration of the kiln schedule is possible. Presurfaced 1-inch northern red oak was kiln dried experimentally to 5 percent moisture content in 14-1/4 days using an advanced kiln schedule. Air velocity was higher than conventional and estimated savings in time were 29 percent over the use of conventional temperature, relative humidity, and air velocity on rough 4/4 oak. Indications were also obtained that presurfaced oak can be dried by a combination of 2 weeks of forced air drying and 5 to 7 days of kiln drying. These experimental techniques and schedules used are described in USDA Forest Service Research Paper FPL 122 entitled "Accelerated Kiln Drying of Presurfaced One-Inch Northern Red Oak," published in December 1969. Again, referring to the News-Digest, a systematic method of accelerating kiln schedules is described.

Summary

Successful air drying of California black oak will depend on careful yard handling in hot, dry areas. Consider air or low-temperature drying only during cooler, wintertime conditions where higher relative humidities and lower temperatures prevail. Kiln drying normal

material green from the air-dried condition should not be a problem if the sample-board method and the proper kiln schedule are carefully followed.

Avoid bacterially infected material; and if utilization is unavoidable, use greater care and more conservative schedules. Perhaps detection techniques will be found to separate bacterially infected oak from normal wood. This appears to be the most promising method of dealing with this difficult-to-dry material.