

KILN DRYING HARD-TEXTURED DOUGLAS FIR

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In learning to dry hard-textured Douglas fir the first thing I asked myself was "why is there a hard-textured Douglas fir?" The Douglas fir that I have been used to drying has been what the natives or the old lumberjacks used to call "yellow fir", and it was of a very definite soft nature. The texture reminded me considerably of the large white pine which grows in northeastern Washington.

On examination of this yellow fir I found a considerable difference in the number of annual rings compared to the hard-textured Douglas fir. In the old-growth yellow fir the annual rings ran from twenty or more per inch. On examination of the annual growth ring of this wood I found that the layer of large, thin-walled spring wood cells exceeded in thickness several times the layer of the summer wood cells, the hard portion of the ring. In the hard-textured Douglas fir the very opposite was true. Upon looking at a good many samples, I found sixteen rings to the inch and less, usually only six to twelve. Examination of these rings often showed the summer wood to be two to three times as thick as the spring wood. Upon looking at this summer wood through a high-powered glass it had the appearance of resin, such as used on belt dressing or violin bows. It was of a clear, hard crystalline nature. The wood has a very definite trend to split or peel down the grain next to one of these heavy layers of summer wood. For drying this stock I set up several high humidity schedules.

The idea of having the high humidity was to prevent any possible checking that might develop during the first three days of drying.

In the flat grain of this same species I used a high humidity and a lower temperature schedule to minimize drying stresses set up across the width of the board (which I think causes quick and severe checking). To my way of thinking, the low temperature and high humidity would move the water more slowly and more evenly through the boards, especially in the first three days of drying when most of the free water is leaving the lumber.

Following are three of my schedules for kiln drying Douglas fir:

For 1-5/8" and 6/4 shop, both 5 to 10 inches in width.

<u>Time</u> <u>Hours</u>	<u>D.B.</u> <u>°F.</u>	<u>W.B.</u> <u>°F.</u>	<u>EMC</u> <u>%</u>	<u>R.H.</u> <u>%</u>
0-12	150	146	16.5	90
12-24	155	149	14.0	85
24-36	160	152	12.7	81
36-48	165	155	11.2	76
48-60	170	155	9.2	69
60-72	175	155	8.0	62
72-84	180	155	6.5	54
84-96	185	155	5.6	48
96-108	190	150	4.4	40
108-120	190	150	4.4	40
120-132	190	150	4.4	40
132-138	190	150	4.4	40
Conditioning				
138-144	190	175	8.9	71

In this schedule which is set up on a six day basis plus six hours final steaming, I have found by samples that the charge generally becomes dry enough during the 120 and 130 hour period. If so, you can start your steaming process then. In the schedule I have shown what I consider the maximum hours.

Having made considerable success with this schedule, I then set up one for 2-inch V.G. all 5 to 10 inches wide. Naturally, this V.G. I am speaking of is not Common but Shop lumber. Instead of experimenting with this 2-inch run by guess and taking kiln samples, I was guided by two things

in developing a schedule for the 8/4. First, that with greater thickness of the board I would not be able to start with the initial temperature with which I started the 1-5/8 or 6/4 runs. Second, the thicker stock would require longer to dry, as the drying time is roughly proportional to the square of the drying thickness. To determine the drying time more accurately, I referred to the Forest Products Laboratory report R1642. In this report there is a formula by which you can calculate the drying times required to kiln dry different thicknesses of the same species, provided you know the drying time for one thickness. The drying time is proportional to the square of the thickness of the equivalent drying square, which can be computed by the following formula:

$$C^2 = \frac{2 (a \times b)^2}{a^2 + b^2}$$

in which C is the thickness of the equivalent drying square and a and b are the thickness and width, respectively, of the piece of wood in question.

The 6/4 by 5" hard-textured Douglas fir could be dried by the above schedule in 5 days; how long will be required to dry 8/4 by the same schedule?

$$\text{For } 1.625 \times 5", C^2 = \frac{2 (1.625 \times 5)^2}{(1.625)^2 + 5^2} = \frac{2 (66.016)}{2.641 + 25} = \frac{132.032}{27.641} = 4.78$$

$$\text{For } 2" \times 5", C^2 = \frac{2 (2 \times 5)^2}{2^2 + 5^2} = \frac{200}{29} = 6.90$$

$$\frac{6.9}{4.8} \times 5 = 7.2 \quad \text{A little over 7 days.}$$

The following is a record of a run of 2 x 5, 6, 8 and 10", which was dried in somewhat less time than calculated:

Drying Time/Hours	D.B. °F.	W.B. °F.	EMC %	R.H. %
0-12	130	126	17.2	90
12-24	135	129	14.8	85
24-36	140	132	13.2	80
36-48	145	135	11.8	76
48-60	150	138	10.8	72
60-72	155	140	9.5	68
72-84	160	143	8.8	64
84-96	165	145	8.0	60
96-108	165	145	8.0	60
108-120	175	150	6.6	51
120-132	180	150	5.7	47
132-144	185	150	5.3	43
144-156	190	150	5.0	40
156-168	190	150	5.0	40
Conditioning 168-180	190	175	9.2	73

In the drying of the flat grain of this same species a suitable drying schedule calls for a high humidity and low temperature so there would be no undue checking or shrinkage across the width of the boards. Following is a schedule for 2" flat grain clear to be dried to industrial specifications:

Drying Time/Hours	D.B. °F.	W.B. °F.	EMC %	R.H. %
0-24	120	116	17.4	88
24-48	125	119	15.0	83
48-72	130	122	13.4	78
72-96	135	125	12.0	74
96-120	140	128	10.9	70
120-144	150	135	9.5	66
144-168	150	130	8.0	57
Conditioning 168-174	150	140	11.8	76

You will note that I have one definite change only once every 24 hours. This is because in flat grain any change in temperature produces a definite shock to the width of the boards. Thus, changing the run once every 24 hours I was able to minimize the amount of checking due to these temperature changes.

On every one of the schedules the fans shall be reversed once every 12 hours. This is to equalize the drying on both sides of the loads, as across the loads there is a definite temperature drop of 2 to 4 degrees, with the corresponding increase in humidity.