

DRYING OF LODGEPOLE PINE 2x6-INCH LUMBER TO SPECIFICATIONS OF THE NEW DRY STANDARDS

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Lodgepole pine lumber production is steadily increasing in Canada. According to the Canada Year Book, about 60 Mfbm of the lumber was manufactured in 1953, while the last available statistics show 253 Mfbm of the lumber was produced in 1966. This represents an increase of about 320% over 13 years, so that lodgepole pine has become the seventh species in importance among Canadian woods. It is the second most plentiful species in the interior of British Columbia.

Owing to the increased production and market requirements for this species, more kiln capacity is needed. One of the methods for increasing kiln throughput is the reduction of kiln residence time by using improved schedules.

A survey of B. C. kiln practices carried out prior to this study showed that mills were drying in times ranging from 40 to 84 hours, resulting in some charges having more than 15% of the pieces more than 19% moisture content (M. C.).

The objective of this early 1971 study was to develop as short a schedule as practical for drying fresh-cut 2x6-inch lodgepole pine to conform to the new dry standards without causing undue degrade.

Methods

The work reported here in detail was preceded by several trials using the laboratory's 3-foot deep experimental kiln. Eleven charges of 2x6-inch lodgepole pine were dried in times varying from 80 to 100 hours, with only slight degrade and a few pieces more than 19% M. C. The most promising schedule developed was subsequently tested in a semi-commercial pilot kiln at the laboratory.

The pilot kiln operated with an air-circulation rate of 500 fpm to simulate air flows used in present kiln designs. Steam consumption was measured in the main steamline in the first experimental charge and in the spray line only during the equalization of the second. The power consumption of the fans was measured by a watt-hour meter.

Two charges, each consisting of 400 pieces of 2x6-inch mill-run lodgepole pine lumber in random length from 12 to 20 ft., were dried using the schedule shown in Table 1.

Table 1. Drying Schedule Used for 2x6-Inch Lodgepole Pine Dimension Lumber in a Steam-Heated Pilot Kiln.

Hrs.	DB°F.	WB°F.	Depr. °F.
24	160	145	15
23	180	160	20
28 1/2	190	165	25
1/2	100 (163)*	100 (130)*	cooling
4	100 (165)*	150 (150)*	conditioning
80			

* Actual conditions achieved by the settings quoted are in parentheses.

The following procedures were carried out for each kiln charge: Half of the pieces were sampled near one end for initial M. C. distribution. For segregation of sapwood from heartwood, chemical indicators on both ends of freshly cut boards were used (1). Twenty-two percent of the first charge and 10% of the second were sapwood, defined as those pieces containing at least a third sapwood on their cross-sectional area.

A power-loss meter (Moisture Register Model L) reading two feet from the grade-stamped end was obtained on each piece of S4S lumber according to the standard procedure (2). Each reading was corrected for temperature and species and expressed in M. C. Average M. C. s and their ranges were determined separately for the sapwood and heartwood pieces.

After completion of the drying cycle, a half-hour cooling period was allowed with fans operating. The observation door was open during cooling. This step was followed by a 4-hour equalization period at a moderate initial setting of 100° F. dry bulb (DB) to prevent admission of external heat and the wet bulb (WB) was set at 150° F.

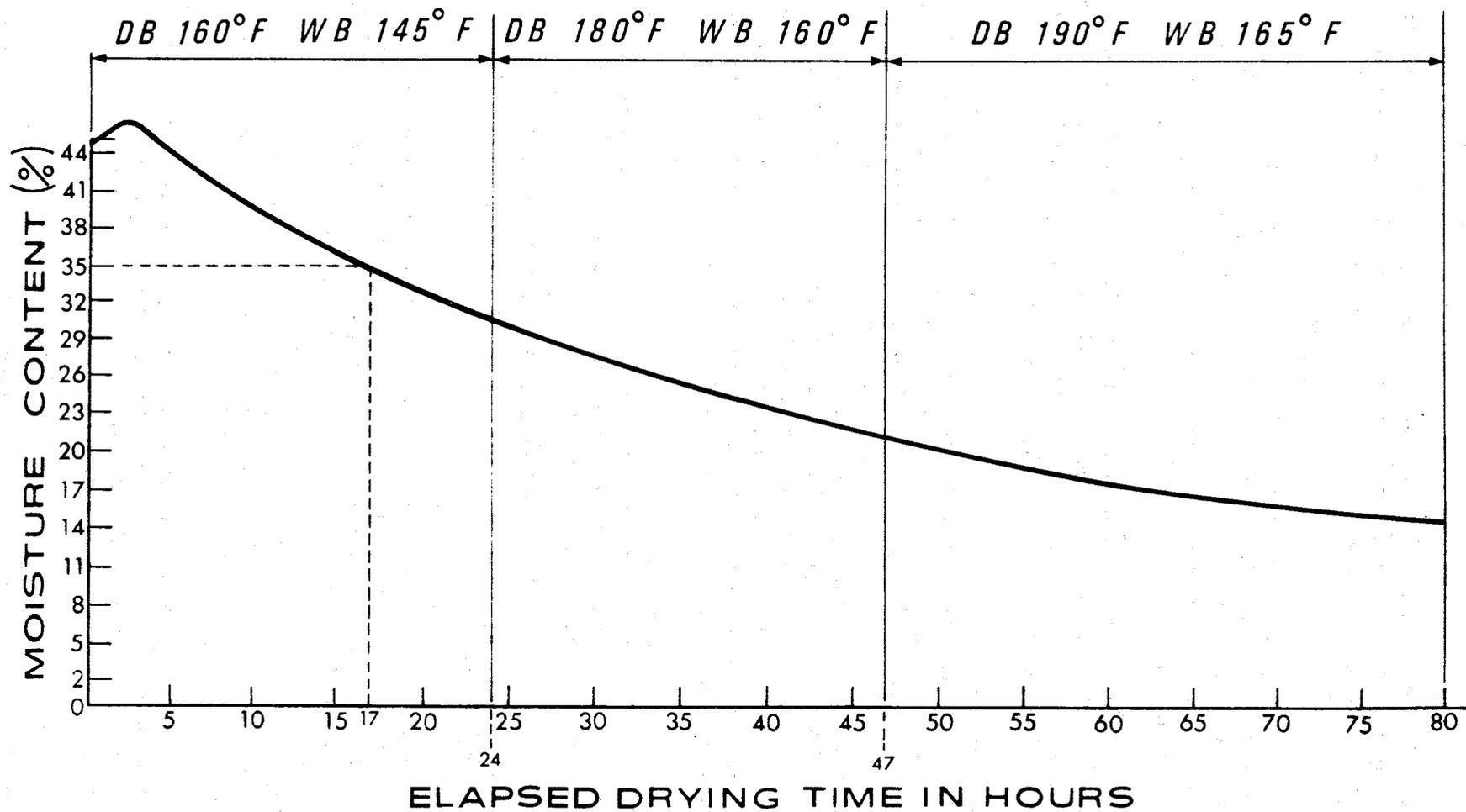


Figure 1. Drying rate curve for green 2x6-inch lodgepole pine.

A certified Pacific Lumber Inspection Bureau grader graded the lumber using WWPA-1970 Standard Grading Rules for Western Lumber, and the grade losses due to seasoning were determined. Grade falldown was expressed as the difference between potential dry value and the actual dry value of April, 1971, prices F.O.B. mill.

Results

The initial and final M.C.s and other data for lodgepole pine lumber are shown in Table 2. While the average drying rate was 0.59%/hr. in the first charge and 0.48%/hr. in the second, the sapwood rate of the first charge was 0.96%/hr. and that of the second 0.86%/hr. The M.C. ranges and distribution for each of the charges are also shown along with steam and power consumption data. The first charge had more pieces less than 12% and more than 19% M.C. than the second charge.

Industrial drying studies by Kimball and Lowery (3) showed that about 94 hours were necessary to dry 2x4-inch lodgepole pine studs. The M.C. that they determined on shell and core sections indicated that the studs met the present requirements of the revised softwood standard. However, the drying time indicated for the studs was 14 hours longer than that used in our pilot kiln studies on random length 2x6s.

The lumber used in the laboratory study was rough sawn to 1 7/8 inches, since in the interior of British Columbia the change to new thickness standards is just now taking place. Assuming that a rough thickness of 1 3/4 inches would be adequate to meet the new surfaced lumber thickness of 1 1/2 inches, the overall drying time for this dimension could be reduced by about 7 hours, according to calculations made from a standard equation (4).

The steam consumption indicated in Table 2 for charge 1 is slightly more than a previously reported value of 4.60 million BTU/Mfbm for spruce (5). Cooler ambient conditions and higher initial M.C. in lodgepole pine contributed to this increased consumption. In view of the many gas-fired kilns used in the interior of B.C., the steam consumption for conditioning charge 2 is also presented as a guide to the accessory steam that might be required for conditioning lumber dried in such kilns. However, the actual steam requirement for drying in gas-fired kilns may be greater due to demands for humidification during drying.

Drying losses from charges 1 and 2 were calculated together (Table 3). No volume loss was experienced, since seasoning defects requiring trimming were not encountered. Grade falldown was primarily due to warp and end splits, and amounted to \$1.71 per M fbm. This figure is moderate by Williston's (6) standard that a loss of \$3.00 per M fbm for seasoning and trimming is reasonable for West Coast dimension lumber.

Application of Schedule to Partly Air-Dried Lumber

Stickered unit packages air dry to varying degrees before they are placed in kilns. As a consequence, such lumber requires less time in a kiln than fresh-cut lumber.

Recommended schedules for kiln drying partly air-dried softwoods have not been worked out, either at our laboratory or at the U.S. Forest Products Laboratory. However, the following steps, based on the drying rate curve for lodgepole pine 2x6 determined from an experimental kiln run, are suggested as guides to schedule modification:

- (1) Estimate the ingoing M.C. of a kiln charge by weighing unit packages and following the procedure outlined in a previous report (7);
- (2) If the M.C. is greater than 40%, dry the lumber as green material without altering the schedule;
- (3) If the initial M.C. is less than 40%, use Figure 1 to determine the elapsed time that may be subtracted from the drying schedule.

As an example of the use of Figure 1, let us assume that the highest M.C. of a unit load is 35%. Figure 1 shows that this M.C. is not attained with green lumber until approximately 17 hours have elapsed in the kiln at conditions of DB = 160° F. and WB = 145° F. Therefore, the time that the lumber should remain at these first settings may be reduced to 24 minus 17, or 7 hours.

Conclusions

The two pilot charges of green 2x6 lodgepole pine were dried in 80 hours without undue degrade. The average M.C. of both charges was about 14%, while 2.2 to 6.4% of all boards were beyond the 19% exclusion limit.

Table 2. Drying Characteristics and Power Consumption for Two Kiln Charges.

Charge No.	Lumber volume fbm	Portion of charge	Initial MC% of rough lbr.			Final MC% of S4S lbr.			Drying rate % MC/hr.	Moisture distribution of S4S lbr. (% of total)			Consumption	
			Min.	Ave.	Max.	Min.	Ave.	Max.		Under 12%	Between 12-19%	Over 19%	MM Btu/M fbm	Kwh/M fbm
1	6271	Total (100%)	28.2	61.9	164.6	6.7	14.6	23.2	0.59	12.6	81.0	6.4	5.63	41.5
		Sapwood (22%)	37.5	91.5	164.6	10.5	14.6	23.2	0.96					
		Heartwood (78%)	28.2	53.9	140.2	6.7	14.6	23.2	0.49					
2	6574	Total (100%)	29.1	52.8	115.5	11.8	14.1	23.5	0.48	2.2	95.6	2.2	0.17 ¹	1.7 ¹
		Sapwood (10%)	50.2	82.2	115.5	11.8	13.6	15.0	0.86					
		Heartwood (90%)	29.1	49.4	100.2	11.8	14.0	23.5	0.44					

¹ Consumption for conditioning only.

Table 3. Grade Losses Due to Kiln Drying

Grade	Potential volume distribution fbm	Potential grade value ¹ \$	Actual volume distribution fbm	Actual grade value \$	Potential minus actual \$
Con.	9,819	745.06	9,186	697.03	48.03
Std.	2,018	121.08	1,808	108.48	12.60
Ut.	1,008	50.40	1,721	86.05	-35.65
Ec.	--	--	130	2.99	- 2.99
Total	12,845	916.54	12,845	894.55	21.99

¹ F.O.B. mill prices were: 15% STD. and better \$73.50/M; Std. only \$60/M; Utility \$50/M and Economy \$23/M.

If green lumber is cut to 1 3/4-inch thickness, 73 hours for drying should be sufficient. Schedule revisions and drying times of partly air-dried lumber can be estimated if initial M.C. of kiln charges is known.

Acknowledgement

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