A NOTE ON EFFECTS OF KILN STICK THICKNESS AND AIR VELOCITY ON DRYING TIME OF SOUTHERN PINE 2 BY 4 AND 2 BY 6 LUMBER[1]

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ABSTRACT

To dry to 10% moisture content, 4- and 6-inch-wide lumber 1.75 inch thick required about 13.7 h (including 4¾-h kiln warmup time) in 5-ft-wide loads at 260 F (wet-bulb temperature was 180 F) on 1.0-inch-thick sticks with air cross-circulated at 1,000 fpm. If air velocity is increased to 1,400 fpm or stick thickness increased to 1.5 inches, kiln time required to reach 10% moisture content should be about 12.5 h (including 4¾-h kiln warmup time).

Keywords: High temperature drying, moisture content, drying rate, kiln drying, air circulation, flexural properties.

During the last 15 years, procedures have been developed that drastically shorten time required to kiln-dry southern pine dimension lumber (Koch 1969, 1973). A 24-h schedule is now common in the industry. Thus, a mill's daily output can be charged at the end of each day and removed at the same hour the next day, making room for another day's production of green lumber.

If a batch kiln could be operated on a 12-h schedule, such a kiln could be charged twice daily, thereby halving kiln size and significantly reducing kiln cost. Or, a 12-h schedule might make practical a tunnel kiln through which lumber is conveyed continuously—in the manner of railroad cars moving through a tunnel (Koch et al. 1978).

We surmised that we could reduce kiln time from 24 to 12 h (for 1.75-inch-thick southern pine) if we could increase dry-bulb temperature from about 240 F to 260 F or slightly higher, increase speed of air cross-circulation from 1,000 fpm to 1,400 fpm, and increase kiln-stick thickness from ¾ inch to 1 inch or 1.5 inches. Also, 12-h drying would require minimal kiln warmup time and kiln load 5-feet wide or less.

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Table 1. *Moisture content, modulus of rupture, and modulus of elasticity of southern pine lumber dried for 8, 14, and 20 h at 260 F (wet-bulb temperature was 180 F) at two air cross-circulation velocities and two stick thicknesses.*

			Moisture content				Properties of small specimens		
Time in kiln	Air velocity	Stick thickness	Green	Average	Minimum	At time of strength test	Density	Modulus of rupture	Modulus of elasticity
			116.2	33.5	17.1	7.3			
			90.1	21.1	11.2	9.4			
			101.1	21.9	9.7	9.2			
		1½	109.7	24.0	12.9	7.2			
14			115.1	8.6	3.4	8.7			
		1½	108.1	5.7	1.6	8.3			
		1	105.8	7.3	3.0	8.1			
		1½	103.3	5.7	3.3	7.8			
20		1	112.8	2.4	1.7	8.6			
		1½	99.6	2.8	1.3	6.1			
		1	97.6	2.4	1.4	7.7			
		1½	116.8	3.0	1.2	7.5			

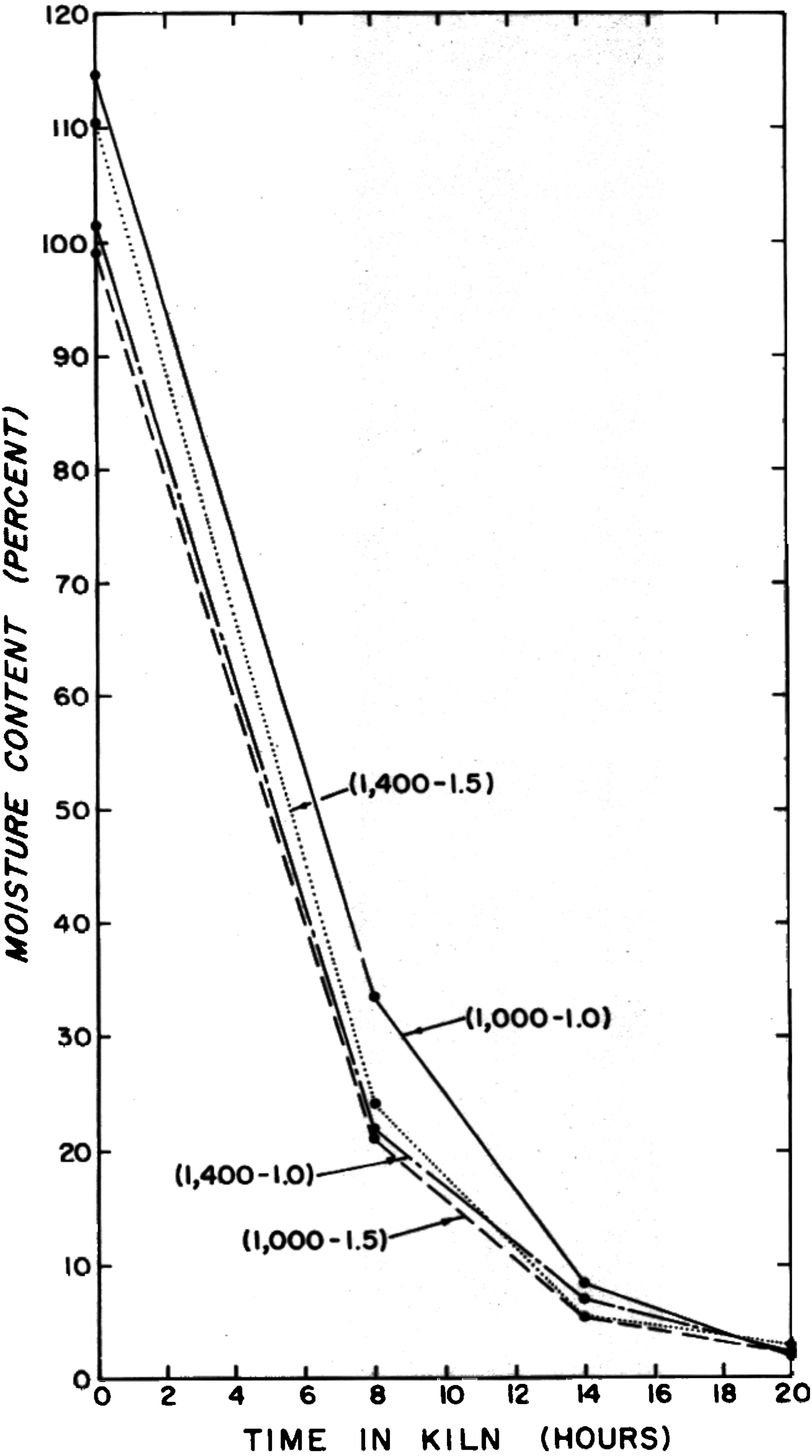

FIG. 1. Changes in moisture content in 4- and 6-inch wide, 1.75-inch-thick southern pine lumber dried in 5-ft-wide loads at 260 F (wet-bulb temperature was 180 F) after 8, 14, and 20 h of kiln time (including 4¾ h of kiln warmup time), with air cross-circulation velocities of 1,000 and 1,400 fpm and stick thicknesses of 1.0 and 1.5 inches.

PROCEDURE

To obtain data needed for design of a 12-h kiln, we conducted an unreplicated experiment during which twelve loads of 1.75-inch-thick lumber were dried, as follows (2 stick thicknesses × 2 air velocities × 3 drying times):

Stick thickness: 1.0 and 1.5 inches (all sticks were 1.5 inches wide).

Air velocity: 1,000 and 1,400 fpm.

Drying time: 8, 14, and 20 h (including 4¾ h to warm the preheated kiln from an initial temperature of 170 F to 260 F dry-bulb temperature).

Freshly sawn, 8-ft-long, mill-run 2- by 4-inch and 2- by 6-inch southern pine lumber was surfaced S1S to 1.75-inch thickness and temporarily stored under water. The lumber (447 2 × 4s and 294 2 × 6s) was randomly assigned to the twelve kiln loads. Each load contained four courses, each 5 feet wide. Since moisture content was the major property of concern and the majority of boards in a large kiln package are between courses of lumber, data were taken only on the central two courses. Both courses were comprised of 2 × 4s alternated with 2 × 6s.

Before boards were dried, the weight of each board for initial moisture content determination was obtained. After warmup, the kiln was controlled so that the dry-bulb temperatures on inlet and outlet sides of the load averaged 260 F; wet-bulb temperature was held at 180 F.

After the lumber was removed from the kiln, three slices each measuring 1 inch along the grain were removed from each board at quarter points, and their moisture contents determined and averaged. Also, two knot-free specimens measuring 23 inches long, 1.5 inches wide, and the thickness of the board were removed from an edge of each board. These bending specimens were equilibrated to about 8% moisture content and then tested to destruction with center-point loading over a 21-inch span. Moisture content and specific gravity of each specimen were measured immediately after test. Because kiln loads were not replicated, statistical analysis of the data was not performed.

RESULTS

Wood dried 20 h was not weaker or less stiff in bending than wood dried 8 h. No substantial differences occurred in density, modulus of rupture, or modulus of elasticity (Table 1).

If we assume a straight line relationship connecting data points, the time required to dry lumber to a specified moisture content can be estimated (Fig. 1). Wood dried on 1-inch-thick sticks with air cross-circulated at 1,000 fpm would require about 13.7 h to reach 10% moisture content; that dried on thicker sticks or with higher air velocity should take about 12.5 h (including 4¾ h warmup time) to reach 10% moisture content.

A kiln with 1-h warmup time or a continuous tunnel kiln with essentially no warmup time could probably dry lumber to about 9% moisture content in 12 h if kiln sticks were 1.5 inches thick, air-cross-circulation velocity 1,400 fpm, kiln temperatures 260/180 F, and loads not over 5 feet wide. Within kiln loads, individual boards might vary in moisture content from about 3 to 13% moisture content.

An experiment with replicated kiln loads is scheduled and should determine the effect of kiln-stick thickness and air cross-circulation velocity on time required at 260 F to dry 1.75-inch-thick southern pine to 9% moisture content, and to determine within-load variation in moisture content for 5-ft-wide loads.

REFERENCES

KOCH, P. 1969. At 240°F southern pine studs can be dried and steam-straightened in 24 hours. South. Lumberman 219(2723):26, 28–29.

———. 1973. High temperature kilning of southern pine poles, timbers, lumber, and thick veneer. Proc., Am. Wood Pres. Assoc. 69:123–149.

———, W. WELLFORD, JR., AND E. W. PRICE. 1978. Continuous kiln dries southern pine studs nearly warp-free in about 12 hours. Pages 386–388 *in* C. W. McMillin, ed. Complete-tree utilization of southern pine: Symp. Proc., New Orleans, LA, April 17–19. For. Prod. Res. Soc., Madison, WI.