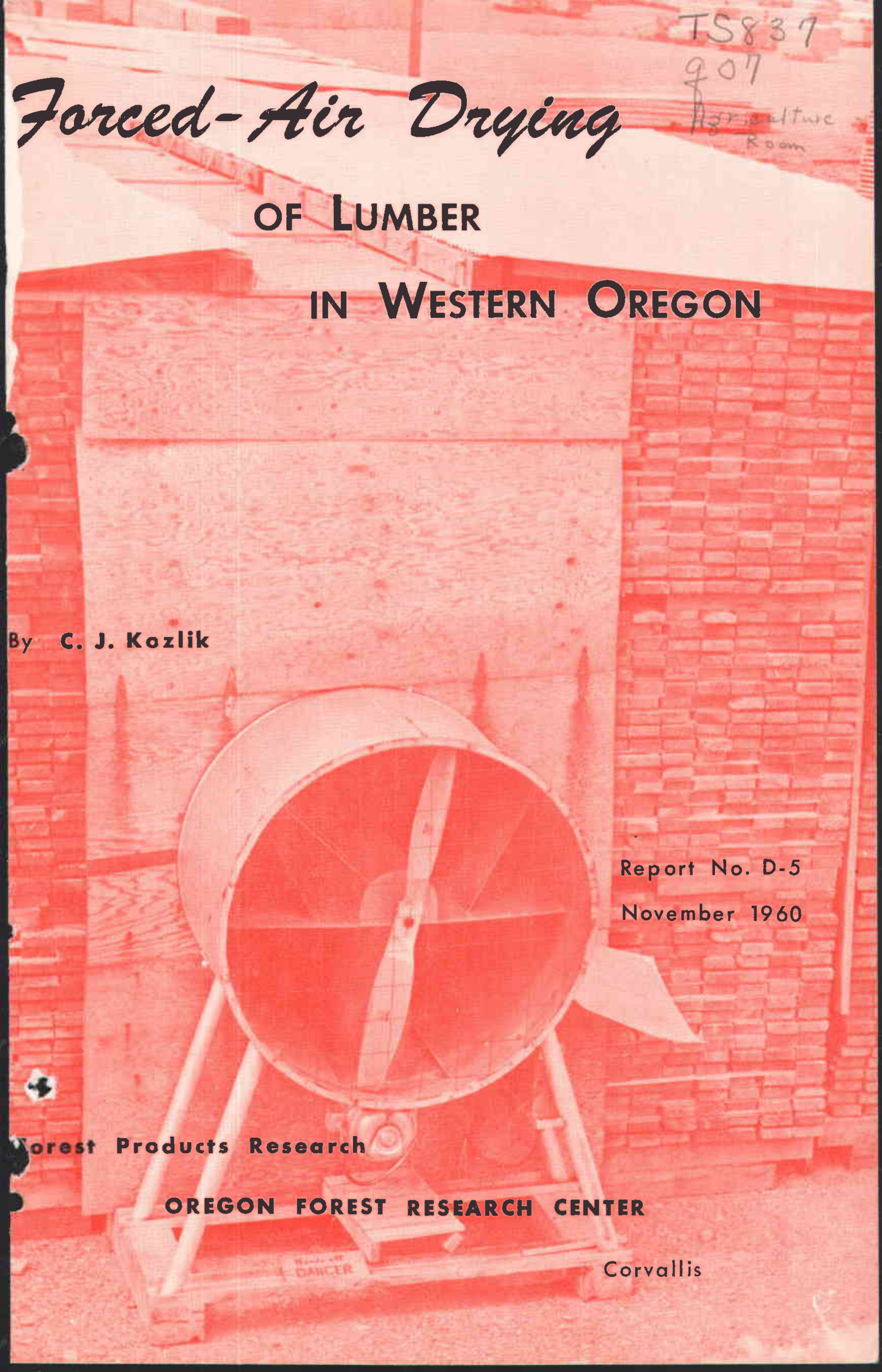

Forced-Air Drying of Lumber in Western Oregon

By C. J. Kozlik

Report No. D-5

November 1960

Forest Products Research

OREGON FOREST RESEARCH CENTER

Corvallis

OREGON FOREST RESEARCH CENTER

Two State programs of research are combined in the Oregon Forest Research Center to improve and expand values from timberlands of the State.

A team of forest scientists is investigating problems in forestry research of growing and protecting the crop, while wood scientists engaged in forest products research endeavor to make the most of the timber produced.

The current report stems from studies of forest products.

Purpose . . .

Fully utilize the resource by:

- developing more by-products from mill and logging residues to use the material burned or left in the woods.
- expanding markets for forest products through advanced treatments, improved drying, and new designs.
- directing the prospective user's attention to available wood and bark supplies, and to species as yet not fully utilized.
- creating new jobs and additional dollar returns by suggesting an increased variety of salable products. New products and growing values can offset rising costs.

Further the interests of forestry and forest products industries within the State.

Current Program . . .

Identify and develop uses for chemicals in wood and bark to provide markets for residues.

Improve pulping of residue materials.

Develop manufacturing techniques to improve products of wood industries.

Extend service life of wood products by improved preserving methods.

Develop and improve methods of seasoning wood to raise quality of wood products.

Create new uses and products for wood.

Evaluate mechanical properties of wood and wood-based materials and structures to increase and improve use of wood.

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ACKNOWLEDGMENTS

Facilities for testing drying equipment were furnished by three Oregon firms; Santiam Lumber Company, Lebanon, Hult Lumber Company, Junction City, and Eugene F. Burrill Lumber Company, Medford.

SUMMARY

Forced-air drying of lumber is economically feasible as an aid to sawmills without dry kilns. Reduced cost of shipping more than offsets cost of drying with forced circulation of air. Investment in equipment is small.

In the Willamette Valley, forced-air drying probably can be accomplished successfully throughout the year. High relative humidities and low temperatures apparently make drying by this method impractical at Medford during winter months.

Forced circulation of air provides faster drying than does conventional air-drying. Kiln schedules may be shortened by previous forced-air drying.

FORCED-AIR DRYING IN THE WILLAMETTE VALLEY AND AT MEDFORD, OREGON*

by

C. J. Kozlik

INTRODUCTION

In recent years, increased freight rates, increased volume of lumber with high moisture content, improved design of fans, and improved methods of handling lumber have made forced-air drying of lumber appear feasible. This has been particularly true for owners of sawmills without dry kilns and with limited capital to invest.

Forced-air drying offers several potential advantages. Economical reduction of weight of lumber could lower shipping costs, or reduction of moisture content to 19 per cent could increase selling price. Removal of some moisture through forced-air drying could shorten kiln schedules.

In 1956, the Oregon Forest Research Center began to test for feasibility of drying western softwood lumber with forced circulation of air. This study did not determine the best method of forced-air drying, nor did it determine drying schedules by species or volume of lumber. This study did determine approximate cost of forced-air drying 4 charges of unseasoned Douglas-fir lumber at Lebanon, Oregon. Savings in reduced shipping costs were computed. Additional charges of lumber were dried in the mid-Willamette Valley and at Medford, Oregon, to determine climatic and seasonal limitations on forced-air drying.

*Introductory and cost-analysis information for this report is taken from the article "Forced-Air Drying Pays Dividends", by J. R. Pfeiffer, which appeared in the Forest Products Journal, November 1958, before completion of the study.

EXPERIMENTAL PROCEDURE

Lumber for study was stacked in an arbitrary manner that gave satisfactory results. Portable aluminum roofs protected the lumber. With one exception, unit packages were stacked two rows wide and three tiers high along both sides of an 8-foot alley. Planks and plywood covered the alley (Figure 1).

A preliminary charge of West Coast hemlock was stacked three tiers high, five rows wide and 18 feet deep on each side of the central alley. This arrangement was unsatisfactory.

Fans faced each other from ends of a central alleyway, and openings around fans were closed by 8- by 14-foot baffles (Figure 2). In most instances, fans drew air from the alleys rather than blew into them

Lumber in the Willamette Valley was dried by a set of two 60-inch propeller fans driven by 7 1/2-horsepower electric motors. At Medford, two 72-inch disc fans were turned by similar motors. Fans were designed to deliver about 50,000 cubic feet of air a minute at a static pressure of about one-half inch. Both sets of fans were controlled with a humidistat so operation ceased when relative humidity exceeded 90 per cent.

Data on temperature and relative humidity were provided by recording hygrothermographs at each location of drying. A watt-hour meter attached to the set of fans operating in the Willamette Valley provided records on power requirements.

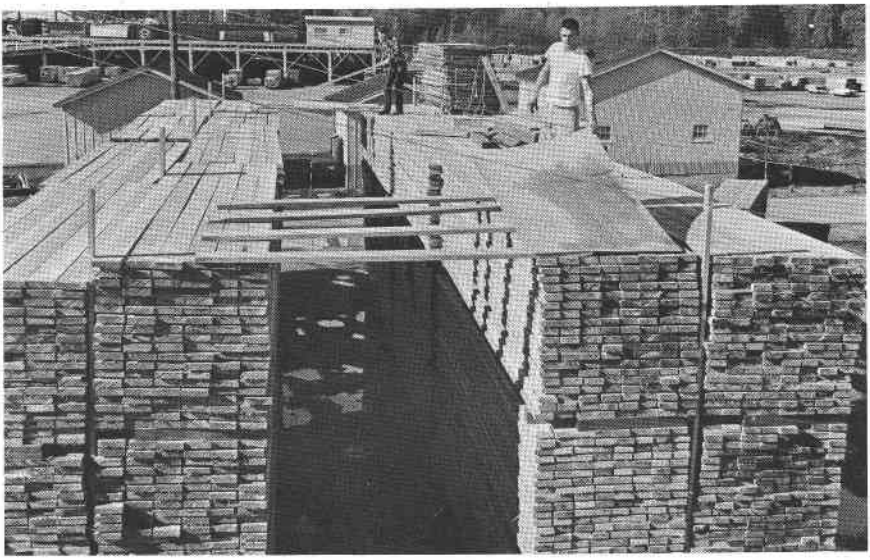

Figure 1. Alleyways between stacks of Douglas-fir dimension lumber were covered preparatory to drying lumber with forced circulation of air.

Figure 2. Dimension lumber of Douglas fir ready to be dried with forced circulation of air.

RESULTS

In addition to four charges of Douglas-fir lumber dried at Lebanon with forced circulation of air for analysis of cost, eight charges of West Coast hemlock, two charges of western red cedar, and nine charges of white fir were dried by this method. Hemlock and cedar were dried in the mid-Willamette Valley; white fir was dried at Medford.

Analysis of Cost

Cost of fans, motors, mounts, humidistat, and portable roofs for propeller fans was about $2,300, including cost of fabrication. The similar unit with disc fans cost about $1,700. Amortization of the greater cost, computed on a basis of five 300-day years, was $1.53 a day.

Other operating costs, variable with drying time and size of charge, were interest and electricity. Interest was estimated at 6 per cent on lumber at $50 a thousand board feet. Cost of electricity was estimated at one cent a kilowatt-hour consumed.

Costs of labor for each charge were for stickering, operating lift trucks, and moving roofs. Cost of stickering was estimated at $120 a charge (6 man-days at $20 a day) for volumes up to 150,000 board feet. For volumes from 150,000 to 200,000 board feet, cost of stickering was $160 a charge (8 man-days at $20 a day). Cost of operating lift trucks was estimated at $36 a charge (8 hours at $4.50 an hour). Cost of moving roofs was estimated at $24 a charge (12 man-hours at $2.00 an hour).

Cost of shipping lumber dried with forced air was compared with cost of shipping unseasoned lumber. Shipping weights for unseasoned lumber were obtained from West Coast Lumbermen's Association. Freight rate was assumed to be $1.41 a hundredweight.

In the summer, Douglas-fir dimension lumber was dried to final moisture content of 18 per cent in about 15 days. Moisture content of 22 per cent could be reached during winter months in about 21 days. Cost of drying ranged from $247 to $285 a charge (Table 1) and from $1.55 to $2.41 a thousand board feet of lumber.

Table 1. Estimated Cost of Drying Four Charges of 2-Inch Douglas-Fir Lumber With Forced Circulation of Air.[1]

Volume	Drying time	Cost				
		Labor	Electricity	Interest	Equipment	Total
M/fbm	Days					
105	21	$180.00	$16.92	$18.12	$32.13	$247.17
105	21	180.00	22.72	18.12	32.13	252.97
125	21	180.00	25.96	21.57	32.13	259.66
184	14	220.00	22.08	21.17	21.42	284.67
519	77	$760.00	$83.68	$78.32	$117.81	$1,043.81

[1] Costs assumed: general labor, $2.00 an hour; lift truck, $4.50 an hour; stickering, $20.00 a day; electricity, $0.01 a kilowatt hour; interest, 6 per cent on lumber at $50 a thousand board feet; equipment, $2,300 amortized over five 300-day years.

For each thousand board feet of lumber, forced-air drying reduced weight of unseasoned lumber by as much as 490 pounds. Shipping costs, influenced by this reduction in weight, were reduced by as much as $6.91 a thousand board feet. After deduction of cost of drying, net savings ranged from $1.88 to $5.36 a thousand board feet (Table 2).

Testing in Willamette Valley

Data from drying the first nine charges in the Willamette Valley are listed in Table 3.

Table 4. Data Obtained From Forced-Air Drying Dimension Lumber of West Coast Hemlock and Boards of Western Red Cedar in the Willamette Valley.

Species	Volume	Drying period		Time charge stacked	Time fans on	Air velocity	Moisture content			
							Initial		Final	
		Start	End				Range	Mean	Range	Mean
	M/fbm			Hr	Hr	Ft/min	%	%	%	%
Hemlock	110	Jan 15	Mar 19	1512	663	80-300	35-178	76	21-52	28
Hemlock	100	Apr 28	May 19	528	467	-	42-156	76	22-41	27
Hemlock	100	May 27	June 19	548	548[1]	80-250	30-111	59	17-62	29
Hemlock	55	June 26	July 14	431	431	160-450	34-144	82	18-52	32
Hemlock	110	Aug 5	Aug 26	500	309	250-350	21-100	73	14-25	19
Hemlock	25	Aug 14	Aug 24	368	368[1]	350-700	35-167	92	18-61	29
Hemlock	50	Sept 9	Oct 4	383	383	130-460	16-109	56	16-49	30
Hemlock	75	Oct 2	Oct 27	598	482	70-360	21-129	66	21-59	32
Cedar	95	Mar 21	Apr 22	768	218	50-300	21-156	61	16-27	21
Cedar	92	Nov 2	Dec 6	840	261	100-200	36-123	74	24-47	28

[1] Estimated.

Three charges of West Coast hemlock dimension lumber were kiln-dried after forced-air drying. Volumes of hemlock were 110, 100, and 100 thousand board feet, and moisture contents, after drying with forced air, were 28, 27, and 29 per cent. Charges were kiln-dried for 36 hours to final moisture contents of 12, 14, and 14 per cent. For the two smaller charges, dry-bulb temperatures in the kiln were 170 F for the first 24 hours and 175 F for 12 additional hours. Equilibrium moisture content conditions were 9.5 per cent for the first 24 hours and 8 per cent for 12 more hours.

One charge of western red cedar also was kiln-dried. Volume of cedar was 92 thousand board feet, with average moisture content of 28 per cent after drying with forced air. This charge was kiln-dried to moisture content of 11 per cent in 72 hours.

To compare forced-air drying with conventional air drying, 12 samples, matched to those in a charge of West Coast hemlock, were placed in stacks for air drying. Initial moisture content ranged from 21 to 129 per cent, with mean of 66 per cent. After 25 days, from October 2 to October 27, samples dried with forced circulation of air had moisture content ranging from 21 to 59 per cent, with average of 32 per cent. Samples in the air-drying stacks had moisture content from 23 to 87 per cent, with average of 41 per cent.

In a charge of 25 thousand board feet of hemlock, wind velocities ranged from 350 to 700 feet a minute. Rate of drying for this charge was about the same as that for charges containing up to 110 thousand board feet dried with wind velocities ranging from 130 to 460 feet a minute.

Testing at Medford

Seasonal variation in effectiveness of forced-air drying seemed greater at Medford than in the Willamette Valley. During winter, about 4 months were required to reduce moisture content of 85 thousand board feet of 2- by 4-inch white fir from 175 per cent to 23 per cent. Drying conditions were poor until March 1 (Figure 3). Fans operated only about 1391 hours of 2945 hours (Table 5).

In the summer, 50 thousand board feet of white fir studs were dried to moisture content of 12 per cent in 18 days. This charge was stacked for 428 hours, and fans operated 424 hours.

To compare forced-air drying with conventional air drying, 12 matched samples were placed in air-drying stacks and in forced-air stacks. Initial moisture content ranged from 85 to 167 per cent, with mean of 138 per cent. After 32 days, from October 7 to November 8, samples dried with forced circulation of air had moisture content from 24 to 107 per cent, with average of 41 per cent. Samples in the air-drying stacks had moisture content from 26 to 123 per cent, with average of 60 per cent.

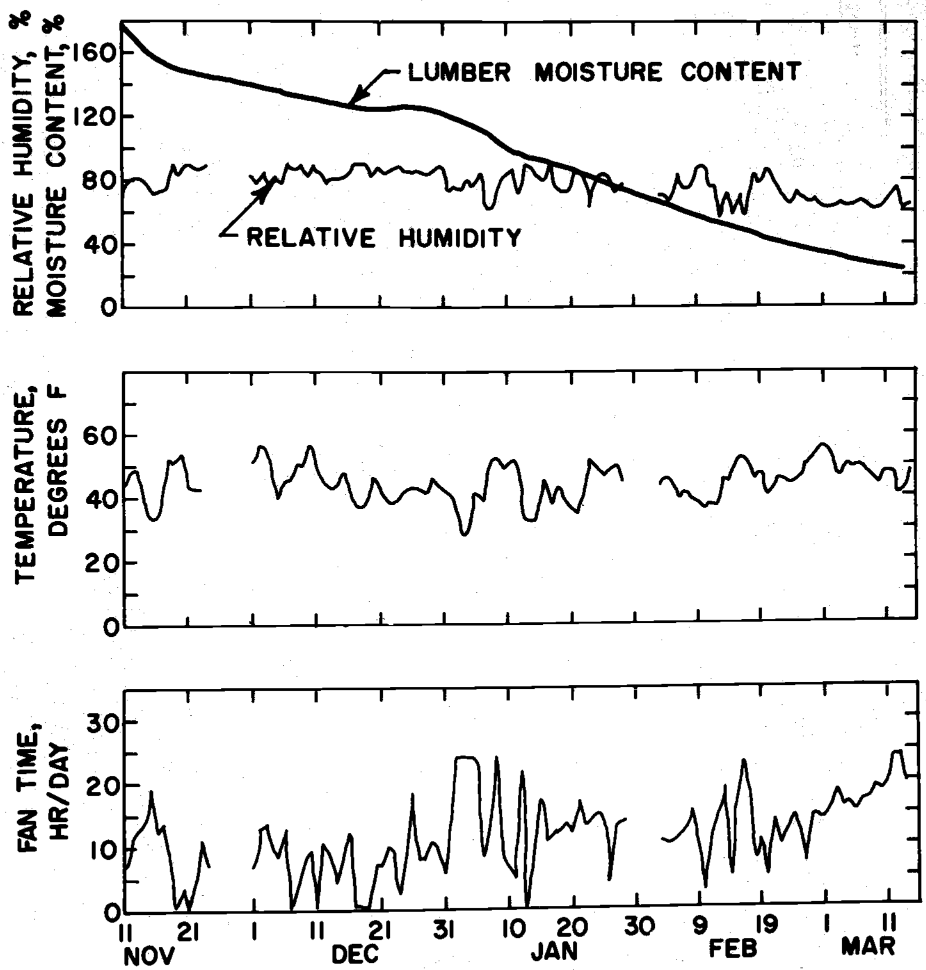

Figure 3. Relative humidity, moisture content of lumber, air temperature, and operating time of fans associated with forced-air drying 2- by 4-inch white fir during winter at Medford, Oregon.

Table 5. Data Obtained From Forced-Air Drying 2- by 4-Inch White Fir at Medford, Oregon.

	Drying period		Time	Time		Moisture content			
			charge	fans	Air	Initial		Final	
Volume	Start	End	stacked	on	velocity	Range	Mean	Range	Mean
M/fbm			Hr	Hr	Ft/min	%	%	%	%
85	Nov 11	Mar 14	2945	1391[1]	100-450	120-215	175	43-16	23
100	Mar 26	May 8	1036	901	70-250	45-146	104	11-46	23
85	May 13	May 31	426	380	-	32-128	74	12-35	18
85	June 3	June 23	477	375[1]	50-500	20-112	59	13-15	14
85	June 27	July 26	736	612	50-400	30-188	112	10-15	12
50	July 29	Aug 16	428	424	140-700	25-110	71	10-16	12
65	Aug 19	Sept 6	422	422	180-550	63-151	116	13-19	16
85	Sept 9	Oct 6	596	469	100-500	22-213	112	13-23	16
85	Oct 7	Nov 8	764	529	50-500	85-167	138	24-107	41

[1] Estimated.

CONCLUSIONS

Drying lumber with forced circulation of air was feasible. Reduced cost of shipping provided economic justification for drying lumber and more than offset cost of forced-air drying. Investment required for forced-air drying was small enough to make this process available to many sawmills without dry kilns.

In the Willamette Valley, forced-air drying probably can be accomplished throughout the year. Time required for forced-air drying increased during the winter, but drying rate apparently remained economically adequate.

At Medford, Oregon, forced-air drying was not feasible during winter months. High relative humidities and low temperatures apparently made drying impractical.

Forced circulation of air provided faster drying than did conventional air drying. The assumption could be made that difference in effectiveness of methods might decrease, economically at least, as drying conditions improved and acceptable final moisture content was raised. Similarly, difference might increase if low moisture content were desired, or if drying conditions were marginal.

Forced-air drying may serve to shorten kiln schedules. Unfortunately, no definite statement about advantages or disadvantages of forced-air drying in this application can be made. Comparison of kiln schedules for lumber with and without forced-air drying was not a part of this study.

Increase in air velocity at the expense of volume of lumber was uneconomical with volumes of hemlock up to 110 thousand board feet.

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