AIR DRYING LUMBER WITH FORCED AIR CIRCULATION

by

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INTRODUCTION

Over a year ago the Oregon Forest Products Laboratory became interested in accelerating air drying of lumber by forced circulation to aid sawmills without dry kilns reduce shipping weights with minimum capital investment. A study is underway, and progress will be reported.

Objective

The study was aimed at finding means of reducing moisture content in lumber before shipping. Rising freight rates and increased volumes of high-moisture-content lumber from West Coast hemlock and young-growth Douglas fir threaten mill operators with mounting costs.

Economical reduction of weight could lower costs. Reduction of moisture content to or below 19 per cent could mean increased selling price, also.

Work of Other Investigators

As early as 1929 and possibly before, there is literature available concerning companies and individuals who have investigated drying by means of forced air circulation. Firms such as Weyerhaeuser Timber Company or The McCloud River Lumber Company, and individuals such as Herbert Fryer actually had constructed installations for forced air drying. Early conclusions, as stated in one letter, were that this method of drying was economically unsound.

More recently, firms such as Simpson Logging Company and Hammond Lumber Company have made studies to dry redwood in this manner. In discussing with them some problems they encountered, they indicated that, while forced air drying did not have much promise for coastal mills, it shows promise for mills east of the Coast range.

Results of early studies were discouraging, but changing conditions encouraged initiation of the present work. Improvements have been made in fan design and lumber handling, freight rates have increased, and much lumber sawed now has high moisture content.

PROCEDURE

In November 1956, after preliminary design work was completed, equipment was fabricated by the Laboratory and installed at the Santiam Lumber Company mill in Lebanon, Oregon. This firm had dried lumber similarly on a commercial scale.
Charge One

About 75,000 board feet of 2-inch West Coast hemlock dimension lumber in 6-, 8-, and 10-inch widths, were stacked in two piles as shown in Figure 1. A framework of planks and plywood covered the central alleyway between fans, and polyethylene sheeting was placed over all to shed rain. Wind damaged the plastic sheeting after three weeks, and it was replaced by portable wooden frames covered with aluminum roofing.

Two 5-foot, 2-blade, propellor fans with 7 1/2-horsepower motors were placed on skids between the piles to draw air through about 25 feet of lumber on each side. The fans were rated at 40,000 cubic feet of air per minute at half-inch pressure, and 53,000 with free air flow.

One hygro-thermograph recorded relative humidity in the central alleyway between fans; another recorded outside conditions.

Air velocity was measured outside and inside the piles.

Charge Two

Piling method was changed for charge two in attempt to:

- Increase volume of lumber dried
- Improve uniformity of air velocity
- Increase ease in lumber handling

About 105,000 board feet of 2-inch Douglas fir dimension lumber in 6- and 8-inch widths were stacked as shown in Figure 2.

Fans were spaced about 65 feet apart, and lumber was piled two tiers wide along an alleyway between the fans. The central alleyway was covered with planks and plywood, and the lumber tiers were roofed with aluminum-covered frames and plastic sheeting to divert rain.

Air velocities were measured along inside and outside of piles when fans were blowing into the central alleyway, and again when fans were blowing out. Drying was done with fans blowing out.

A humidity control was installed to turn off fan motors at relative humidities above 90 per cent, and turn on fan motors at humidities below 90 per cent.

Economic Aspects

A procedure to determine economic feasibility of this method of forced air drying is as follows:

1. Cost of installation (including roof) $2,300

2. Operating costs per day
   A. Variable (considering length of drying only)
      1. Power (assume $0.01 per kwh)
2. Interest at 6% on inventory of 105 M fbm
   (assuming $50/M for cost of logs and sawing)
   $5,250 at 6% = $0.86/day

3. Amortization of equipment over 5 years
   (assuming 300 days per year) $ 1.53/day

B. Fixed costs
   1. Cost of stickering;
      Two men for 3 days at $20/day each $ 120.00
   2. Lift truck, operator, 1 day @ $4.50/hour 36.00
   3. Roof moving, 12 man-hours @ $2 24.00
      Total fixed costs per charge $ 180.00

3. Illustration, assuming 21 days' drying time and
   105,000 fbm Douglas fir
A. Variable costs
   1. Power, 2,040 kwh $ 20.40
   2. Interest 18.06
   3. Amortization 32.13
      Total variable costs $ 70.59
B. Fixed costs $ 180.00
      All costs of drying $ 250.59
      Costs per M fbm 2.39

Some indication of returns from forced air drying are given in Table 1.

EARLY RESULTS AND DISCUSSION

Charge One

Lumber in the first charge was stacked for 11 weeks, beginning in November 1956, but the fans were operated during only 8 weeks. Since the plastic sheeting was blown off at the end of 3 weeks, and not replaced for 2 weeks, the lumber piles were penetrated by rain.

At the end of drying, however, the moisture content had been reduced from 66 per cent to a final average of 29 per cent.

The method of piling charge one was unsatisfactory, as longest lumber had to be stacked adjacent to the central alleyway, and shortest lumber stacked near the outside. To remove a pile of long lumber, all short lumber had to be moved.

Air velocity in charge one ranged from 50 feet per minute at the outside center of the piles, to 2,000 feet per minute on inside edges near fans.

Charge Two

Lumber in charge two was reduced from 47 per cent moisture content to a final calculated average of 25 per cent in 14 days. Running the fans another week resulted in average reduction to 23 per cent moisture content.

Actual shipping weights were 2,200 and 2,227 pounds per M fbm for 2- by 6-inch and 2- by 8-inch lumber, respectively.
Electricity amounted to about 2,040 kwh. Assuming a cost of 1 cent per kwh, electricity cost was 19.4 cents per M fbm. The humidity control held fan operation to about 155 hours.

With fans reversed to blow into the central alleyway, air velocity out varied from 1,000 feet per minute in the outside center of the piles, to some actual movement in at ends of the piles.

With fans blowing out, air velocity ranged from 300 to 500 feet per minute along the pile. This result indicated a possibility of increasing pile width to include a lumber volume of 150 M fbm, or more.

**WORK PLANNED**

It is planned to operate the equipment for at least 12 months to determine the approximate time required to reach 19 per cent moisture content or equilibrium moisture content during the various seasons of the year, for both Douglas fir and West Coast hemlock. Based on these drying times, economic feasibility will be determined for each species for each season of the year.

**PRESENT CONCLUSIONS**

1. Stacking for charge two gave faster, more uniform drying than that from stacking for charge one. Stacking for charge one may, however, be desirable during hot, dry weather.

2. Pulling, rather than pushing, air through the piles allowed increased lumber volume per charge and increased uniformity of air flow.

3. Since the static pressure in charges one and two was considerably less than that designed for, it should be possible to reduce the initial cost of equipment by reducing the motor size or substituting a disc-type fan.

4. Based on two charges, it appears some advantage can be gained by forced air drying, since many mills report penalties for overweights up to $1 and $7 per M fbm for Douglas fir and West Coast hemlock during part of the year.

5. Based on air velocities with 105,000 fbm, it is believed the volume per charge can be increased to at least 150,000 fbm with the same equipment.

6. With a humidity control switch on the fan motors, power costs have been reduced without loss in efficiency.

### Table 1. Possible Returns from Forced Air Drying Douglas Fir Dimension Lumber to 23 Per Cent Moisture Content in 21 Days.

<table>
<thead>
<tr>
<th>Association weights</th>
<th>Actual shipping weight</th>
<th>Freight rate</th>
<th>Shipping costs</th>
<th>Net saving</th>
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<tbody>
<tr>
<td>Width</td>
<td>Green</td>
<td>Dry</td>
<td>(6 minus 7)</td>
<td></td>
</tr>
<tr>
<td>inches</td>
<td>shipping</td>
<td>freight</td>
<td>(30 M fbm)</td>
<td>Per car</td>
</tr>
<tr>
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<td>2200</td>
<td>2200</td>
<td>1.41</td>
</tr>
<tr>
<td>8</td>
<td>2550</td>
<td>2250</td>
<td>2227</td>
<td>1.41</td>
</tr>
</tbody>
</table>

Table 1-2
Figure 1. Piling method for initial charge; 75 M fbm of two-inch West Coast hemlock lumber.

Figure 2. Piling method for charge two; 105 M fbm of two-inch Douglas fir lumber.

Figure 3. Piling method for charge three; 105 M fbm of two-inch Douglas fir lumber.