FLATTENING WAVY EUCALYPTUS VENEER DURING FINISH-DRYING

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ABSTRACT

Sliced *Eucalyptusglobulus* veneer 0.5 mm (1/50 in.) thick, which had been pre-dried in a conventional non-pressure dryer, was finish-dried in an inexpensive, continuous press dryer for thin veneer, resulting in reduced waviness and improved grade. When finish-drying was started at about 30 percent moisture content (MC), using 240°F and 2.4 psi for 2 minutes, the result was flat, A-grade veneer (instead of C-grade as in conventional drying), at a final MC below 10 percent. Data variability, however, was a problem, and further trials are warranted.

Recently, Steinhagen et al. (9) addressed the opportunity of flattening wavy eucalyptus veneer 0.5 mm (1/50 in.) thick through pressure and heat during finish-drying, starting at about 20- to 30-percent dry-basis moisture content (MC). The authors concluded that important variables for reducing veneer waviness in their laboratory experiments were drying temperature (given fixed pressure), as well as MC and veneer waviness at the start of the test.

The objective of this paper is to discuss the results of a follow-up industrial trial. After predrying green eucalyptus veneer in a conventional non-pressure dryer (causing the veneer to buckle), we used, for finish-drying at various initial MCs, a continuous press dryer for thin veneer and tested its effectiveness to reduce waviness and to improve grade. An add-on press dryer for pre-dried veneer can be relatively inexpensive and economically attractive to mills that do not want to replace their presently available, conventional dryer with a new, one- or two-stage press drying system for green veneer (1,2,4-7). For completeness, we also tested the press dryer on green eucalyptus veneer that had not been pre-dried.

PROCEDURE

As in the previous laboratory study (9), we used in the industrial trial, sliced *Eucalyptus globulus* veneer 0.5 mm thick from Chile. Specimens were cut to 14 inches in the fiber direction and 8 inches across. Three drying test levels were conductd each in temperature (T = 150°, 200°, and 240°F), pressure (P = 0.6, 1.2, and 2.4 psi), exposure time (t = 2,4, and 6 min.), and initial MC at the start of the test (MC_i = 10%, 30%, and 100%, approximately), and we used three replications at each level. In total there were 243 specimens. Veneer to be used at MC_i = 10 and 30 percent respectively, had been pre-dried in a conventional non-pressure veneer dryer to about 10 percent MC and was, on average, wavy C-grade veneer. Half of this veneer was rewetted to the test level of 30 percent MC. Veneer at MC_i = 100 percent had not been pre-dried.

MC_i was determined for each specimen using the ovendrying method (initial weight was determined before the trial and ovendry weight after the trial). Associated with MC_i was W_i, the initial veneer waviness defined as the ratio of wave thickness to veneer thickness and dimensionless as such. W_i was determined as shown in **Figure 1** and described in the previous study (9). Also associated with MC_i and W_i was $Grade_i$, the initial grade. A-grade veneer may have a waviness ratio up to 3, B-grade up to 7, and C-grade up to 10 (9).

The trial was conducted at Pacific Burl & Hardwood Co., Grants Pass, Oregon, using the plant's continuous press dryer for thin veneer **(Fig. 2).** The design of this dryer was based on the modular veneer press (MVP) continuous dryer by

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Loehnertz (4,5,7). It had been construtted in-house from used parts for less than $10,000. The dryer had a rotary cylinder that measured 80 inches in width and 36 inches in diameter and could be heated up to 240°F. A belt held the veneer tightly (up to 2.4 psi) against the cylinder. As the hot cylinder rotated, the belt moved along with it, and the veneer's trajectory during a pass described the letter "C." The 1-minute pass was repeated with the veneer being turned around so as to heat it from the other side as well, using multiples of the 2-minute double pass. All veneer was fed with its grain parallel to the feed direction (longitudinal feed).

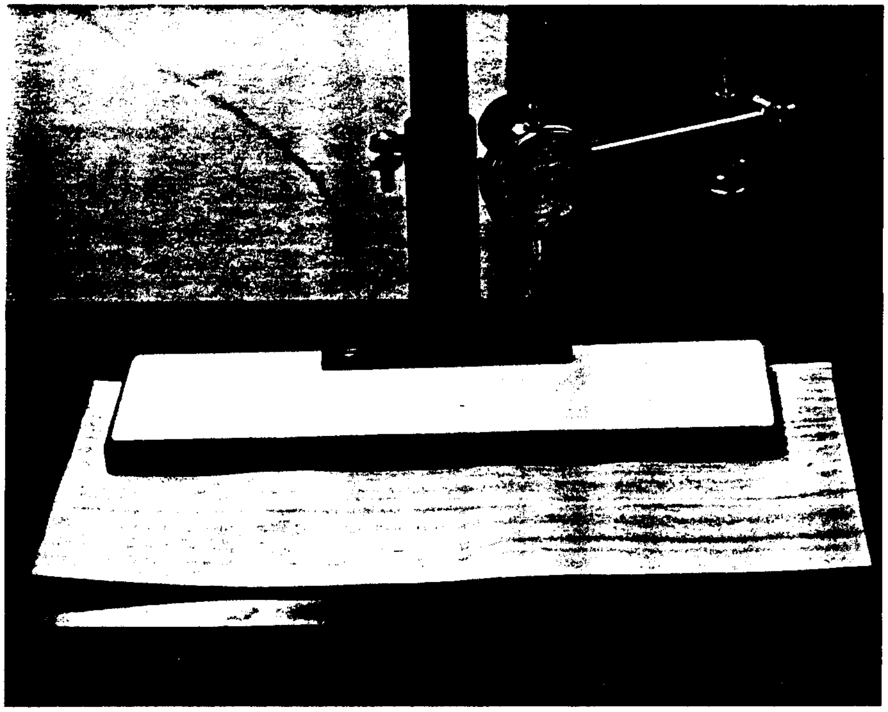

Figure 1. — Apparatus for determining veneer waviness.

After the trial, final MC (MC_f) and final waviness (W_f) were determined using the methods just mentioned.

Percent waviness reduction was determined for each specimen according to the following formula:

$$[(W_i - W_f)/W_i] \times 100\%$$

This data was statistically processed to determine if waviness reduction was significantly affected by T, P, t, or MC_i. The statistical methods used were exploratory factor analysis, analysis of variance, and multiple comparison procedures for group means of waviness reduction using the Tukey honest significant difference (HSD) and Fisher least significant difference (LSD) procedures (3,8).

TABLE 1. — Preferred test combinations and results.[a]

Test[b]	T	P	t[c]	MC_i	MCf	W_i	W_f	$[(W_i - W_f)/W_i] \times 100$	$Grade_i$	$Grade_f$
	(°F)	(psi)	(min.)	------- (%) -------		----- (mm/mm) -----		(%)		
1a	200	1.2	2	28	12	9.2	4.6	50	C	B
b				31	12	7.1	3.4	52	C	B
c				27	12	10.0	4.6	55	C	B
2a	200	1.2	4	29	7	3.8	3.7	3	B	B
b				33	7	7.4	2.1	72	C	A
c				37	7	7.1	2.8	60	C	A
3a	200	2.4	2	24	7	9.7	3.3	66	C	B
b				25	7	6.3	2.1	67	B	A
c				20	7	9.4	2.8	71	C	A
4a	200	2.4	4	21	4	7.7	3.6	53	C	B
b				20	4	7.9	1.6	79	C	A
c				23	4	8.3	1.6	81	C	A
5a	240	1.2	2	24	3	6.8	3.9	43	B	B
b				28	1	6.4	2.1	67	B	A
c				26	3	9.2	1.4	85	C	A
6a	240	1.2	4	29	4	5.5	2.3	58	B	A
b				28	3	10.2	2.4	77	Reject	A
c				28	3	6.3	0.2	97	B	A
7a	240	2.4	2	41	5	7.5	1.7	77	C	A
b				36	4	9.5	2.9	70	C	A
c				33	3	7.6	1.9	75	C	A
8a	240	2.4	4	44	9	11.6	0.7	94	Reject	A
b				37	4	5.1	1.3	74	B	A
c				34	3	7.3	0.1	99	C	A

[a] T = temperature; P = pressure; t = time; MC = moisture content; W = waviness ratio; subscripts: i = initial; f = final.
[b] Three replications (a, b, c) at each test level.
[c] The 6-minute test data are omitted because benefits were insignificant.

RESULTS AND DISCUSSION

Statistical analysis of data suggested somewhat hazy results. Exploratory factor analysis indicated a significant effect" of T and MC_i on waviness reduction, but no significant effect of P and t. Analysis of variance suggested a highly significant group effect of T and MC_i (significance level: 0.0000), and a marginal effect of P and t.

Trends in group means "X" of waviness reduction as a function of T and MC_i appeared obvious to the eye (Fig. 3). However, the HSD procedure yielded no significant difference between these contrasting means due to the large data variability. In the **Figure 3** data ranges, the rectangle includes 50 percent of the data and each of the outer lines 25 percent; it should also be noted that the arithmetic mean value "X" usually differs from the median value "-·-", indicating an asymetric distribution of data. Follow-up LSD procedure, contrary to the more rigorous HSD procedure, suggested that all these differences are significant.

It appears that the effect of T on waviness reduction can be increased by applying more than 240°F **(Fig. 3);** the previous study (9) had identified an optimum at around 280°F.

Maximum effect of MC_i on waviness redution occurred at 30 percent MC_i **(Fig. 3b).** Using 10 percent MC_i yielded significantly less waviness reduction **(Fig. 3a).** In contrast, when MC_i was 100 percent, little waviness and waviness reduction was observed but the dry veneer had checks throughout, and was therefore, unacceptable in grade.

In addition to these comprehensive results, **Table 1** gives more specific results from eight test combinations that were relatively effective in reducing waviness and uplifling grade. These tests were conducted with T= 200 and 240°F, P = 1.2 and 2.4 psi, t = 2 and 4 minutes, and MC_i = 30 percent, approximately. Resulting MC_f was at target (less than 10% MC), with the exception of Test 1. W_f was usually much below W_i, so that percent waviness reduction was considerable (although quite variable). $Grade_f$ was either A or B; particularly when 240°F was used $Grade_f$ was A (one exception out of 12), regardless of $Grade_i$.

CONCLUSIONS

The inexpensive, continuous press dryer for thin veneer, used in the mill trial, performed well in a number of tests

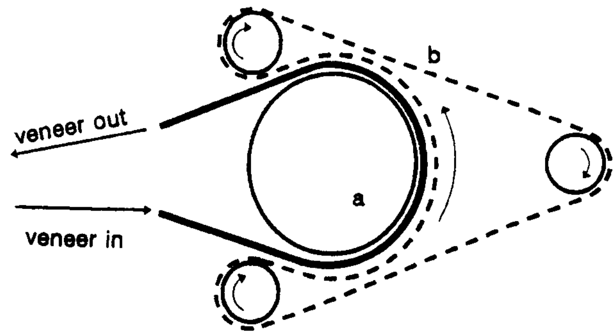

Figure 2. — Schematics of the Pacific Burl & Hardwood Co. continuous press dryer for thin veneer after Loehnertz (4,5,7), "a" being the heated, rotating cylinder, and "b" the moving belt.

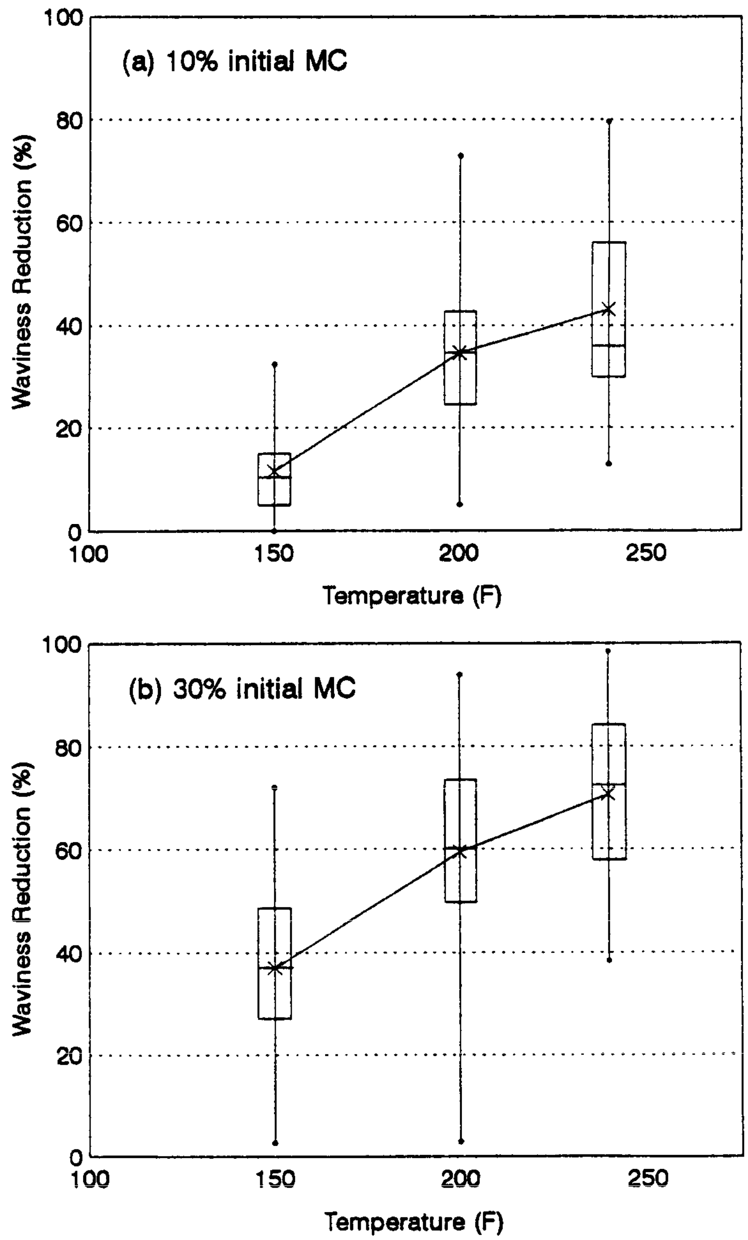

Figure 3. — Effect of temperature on waviness reduction, at 10 percent initial MC (a) and 30 percent initial MC (b).

to flatten wavy eucalyptus veneer 0.5 mm thick during finish-drying. Over the test range, temperature and MC at test start were important for waviness reduction, but pressure and exposure time had a marginal effect at best. Based on this study, it is recommended that finish-drying of thin eucalyptus veneer in the press dryer be started at about 30 percent MC, and that 240°F (or perhaps more) and 2.4 psi be applied for 2 minutes. This procedure should considerably reduce waviness and likely result in A-grade veneer (instead of C-grade as in conventional drying), at a final MC below 10 percent. Exceptions to the rule are to be expected however, due to data variability. Further trials are warranted.

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