DRYING VENEER
TO A CONTROLLED
FINAL MOISTURE CONTENT
BY HOT PRESSING
AND STEAMING

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ABSTRACT

A problem with currently used continuous mechanical veneer dryers is the inability to control the final moisture content of the veneer within the limits desirable for further processing such as gluing. This report describes successful control of the final moisture content of veneer by steaming during press drying. Final moisture contents of 4, 5½, 7, and 11 percent, ±1 percent, were obtained by control of the steaming temperature. The ability to control the moisture content of veneer out of a dryer can result in less degrade, less loss by shrinkage, and provide veneer more suitable for gluing.
The main objectives of drying veneer are to dry it: (1) fast at minimum cost, (2) flat, and (3) to a uniform moisture content suitable for gluing.

In order to dry fast, the temperature of commercial veneer dryers has been gradually raised so temperatures of 250° to 400° F are common. This results in an atmosphere within the dryer that can produce an equilibrium moisture content (EMC) condition for wood of 2 percent or less. The green moisture content of veneer entering the dryer varies and the drying rate within a sheet of veneer generally varies. As a result, veneer dried to an average moisture content of 8 percent often varies from 4 to 15 percent as it comes from the dryer. Nonuniform moisture content in the dried veneer is one of the major problems with conventional veneer drying systems.

In a recent report (3) Dokken and Lefebvre state that some 1110-inch balsam fir veneer had an extreme moisture content of 43 percent after it was dried at 450° F in a gas-fired, cross-circulation dryer to an average moisture content of 10 percent.

Further processing effects are produced by nonuniform moisture content in veneer. For example, Chen and Rice (2) studied the relationship of variable moisture content in veneer to glue bonds. They state, “This dilemma reemphasizes the urgent need for improved veneer dryer control and performance in order to achieve a uniform and moderate average moisture content level.”

Press drying has been shown to be a fast means of drying veneer and has the second advantage of producing veneer that has less buckle than other means of drying (1,5). However, press drying may also result in nonuniform moisture content in the veneer as it comes from the press.

Steam at atmospheric pressure but temperatures higher than 212° F can be used to control the moisture content in wood. As shown in figure 1, steam at 220° F results in an equilibrium moisture condition of about 11 percent and steam at 240° F results in an equilibrium moisture condition of about 5 percent. This phenomenon has been known for many years and is described in some detail by Grumach (4). Recently Villière (6) described experiments at Centre Technique du Bois to control the final moisture content of veneer by steaming it at various temperatures in a kiln.

The main objective of this report is to show the results of laboratory experiments aimed at controlling the final moisture content of the veneer by steaming it during the course of press drying.

EXPERIMENTAL EQUIPMENT AND PROCEDURE

One red oak bolt 4 feet long was rotary cut into veneer 0.042 inch thick. Clear heartwood veneer was clipped into 12- by 12-inch specimens for drying. These specimens

\[\text{Maintained at Madison, Wis in cooperation with the University of Wisconsin.}\]

\[\text{Bold numbers in parentheses refer to Literature Cited at the end of this report.}\]
were numbered consecutively as cut and randomly selected for different drying conditions. Special aluminum platens were made to fit inside a 14- by 14-inch hot press. The aluminum platens are channeled and have 1/16-inch-diameter holes ¾ inch on center over the central 10- by 10-inches of the platen. Fourdrinier wire, 75 mesh and 0.015 inch thick, was placed next to the aluminum platens. Steam from a 15-pound line was reduced to a pressure of 1 pound or less, trapped to remove condensate, and introduced into the channels in the aluminum platens. The steam passed through the 1/16-inch holes in the platens, was distributed across both faces of the veneer by the Fourdrinier wire, and finally escaped from the four edges of the press. The special aluminum platens were heated to the drying temperature by contact with the regular steam-heated platens of the press.

A second drying device was a conventional steam-heated roller conveyor veneer dryer having longitudinal air circulation.

Three basic drying conditions were used—press drying, press drying with steaming, and drying in a conventional steam-heated roller conveyor veneer dryer. A pressure of 50 pounds per square inch on the veneer was used for press drying and for press drying with steaming.

Four temperatures—220°, 230°, 240°, and 250° F—were used with each of the three basic drying conditions. For each basic drying condition and drying temperature, one randomly selected 12- by 12-inch sample was dried for 2, 2½, 3, 3½, 4, 5, 10, 15, 20, or 30 minutes. At the three lower temperatures samples were also dried for 1 hour.

All veneer samples for a day’s run were soaked in cold water overnight. They were weighed just prior to drying, reweighed out of the dryer, and reweighed after oven-drying. These data were used to compute the moisture content of the individual samples after each drying condition. These data were then plotted and curves drawn to fit the data.

Figure 2 shows a sample of veneer being inserted in the press for drying and steaming.

RESULTS

Figures 3, 4, 5, and 6 give the results for the three basic drying conditions at each of the four drying temperatures—220°, 230°, 240°, and 250° F. The calculated equilibrium moisture conditions for wood in steam at atmospheric pressure and at each of these four temperatures is shown on the right-hand margin of each of the four graphs.

Veneer that was steamed during press drying came to, and remained within, 2 percent of the calculated equilibrium moisture condition for periods of drying up to 1 hour. In contrast, the veneer dried in a press without steaming or dried in a conventional roller conveyor veneer dryer continued to dry to lower moisture contents regardless of the drying temperature. All veneer samples were above 100 percent in moisture content prior to drying.

Figures 3 through 6 also show that press drying with or without steaming results in faster drying than in a conventional steam-heated roller-conveyor veneer dryer operating at the same temperature. For example, after 2 minutes of drying at 250° F (fig. 6) the press-dried veneer was below 10 percent moisture content while the veneer in the roller-conveyor dryer was above 50 percent. The differences in drying rate were slight when the temperature was 220° F, but became more pronounced as the temperature was raised to 230°, 240°, and 250° F.

COMMENTS

Pressures of 50 pounds per square inch were used on the press-dried veneer in this experiment because these had been found satisfactory when press drying black walnut veneer (5). However, the rotary-cut red oak veneer was not adequately restrained, so some of the sheets developed splits during drying. Higher pressure on the veneer should overcome this problem.

The steam to the channeled aluminum platens had to be very carefully controlled. Too much superheat in the steam resulted in lower EMC’s than those indicated by the literature. Another problem encountered was steam condensate getting into the system and rewetting the veneer. The successful system used a 15-pound steam supply, reduced to 1-pound pressure in a 6-foot-long uncovered line ahead of the press, followed by steam separators coupled as closely as possible to the heated special aluminum cauls.

A second observation during exploratory work is that the EMC in the steam atmosphere is very sensitive to temperature. In other words, the control for temperature on the regular platens of the press had to be precise or the results were erratic.
In other exploratory work, it was found that veneer that had been ovendried and was then placed in the press and steamed at a temperature of 220° to 250° F came to approximately the calculated equilibrium moisture conditions.

IN CONCLUSION

These experiments and others such as those recently conducted by Villière demonstrate that it is possible to dry veneer at temperatures above 212° F to a controlled final moisture content. The equipment to do this must precisely control the temperature, steam pressure, and superheat in the steam. Nevertheless, the technical advantage of being able to control the final moisture content of the veneer are important enough so that it is hoped equipment manufacturers will follow up this applied research.

Figure 1 - Relationship of equilibrium moisture content for a saturated steam atmosphere at atmospheric pressure to temperature (adapted from Grumach (4)).
Figure 2 - Twelve- by 12-inch veneer sample being inserted to the center of a 14- by 14-inch hot press equipped with special cauls to steam the veneer during drying.

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Figure 3 - Drying curves for 1/24-inch oak dried at 220° F.

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Figure 4 - Drying curves for 1/24-inch oak dried at 230° F.
Figure 5 - Drying curves for 1/24-inch oak dried at 240° F.
Figure 6 - Drying curves for 1/24-inch oak dried at 250°F.
LITERATURE CITED

(1) Burrell, J. F.

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(6) Villière, A.C.