Abstract

The purpose of this research was to determine the feasibility of continuous press drying of veneer. An experimental dryer developed at the USDA Forest Service, Forest Products Laboratory (patent applied for) shows promising results. Compared to a laboratory roller dryer with longitudinal air flow, the experimental dryer dried 1/32-inch aspen veneer in 25 percent less time, with 67 percent less transverse shrinkage and volume loss, and the veneer was much flatter and smoother. Compared to a laboratory platen press, the experimental dryer dried veneer with 75 percent less thickness loss and 60 percent less volume loss.

Conventional veneer dryers

The most common kinds of veneer dryers use hot air to dry veneer in a continuous process. However, hot-air dryers cause several problems. Veneer transverse shrinkage can be as high as 10 percent (1); thin veneer (1/32-in.) may dry with wavy ends, which interfere with glue application (5); the veneer may break or jam up in roller transports (6); the dry veneer may have a widely varying moisture content (MC), which results in poor gluebonds and exhaust air that is tainted with hydrocarbons in particulate form (“blue haze”) (1,2).

Platen press drying is faster than hot-air drying because the veneer is dried by direct contact, and the intermediate step of heating air is eliminated. Compared to hot-air dryers, the veneer dries flatter and shrinks less because it is restrained by the press platens. Because heat is transferred by conduction, and the thermal conductivity of wood increases with increased MC (3), heat is transferred more rapidly into the wetter areas. Therefore, dry veneer has a more uniform MC.

In spite of the advantages over hot-air drying, platen press drying poses several problems. For example, the platen pressure causes an unavoidable thickness loss, and surface checking can occur due to restraint after drying (6). In addition, the process may not be efficient for drying veneer thinner than 1/16 inch because the time required to load and unload the press becomes significant compared to drying time.

Modular veneer press dryer

The purpose of this research was to determine the technical feasibility of continuous press drying of veneer. The economic feasibility was not explored. Heebink (4) previously studied this concept in 1962. The work reported here incorporates what he learned and develops the concept into a practical process.

A modular veneer press (MVP) dryer combines the continuous operation of a hot-air dryer with the restraint of a platen press dryer. The MVP dries veneer by direct contact with rotating heated drums arranged in series (Fig. 1). Each drum has an endless flexible belt that travels on three rollers arranged so that the belt wraps halfway around the drum. The belt is tensioned by moving one of the three rollers with hydraulic cylinders. The belt holds the veneer against the drum with sufficient pressure to reduce shrinkage and waviness. The pressure exerted on the veneer is directly proportional to the ratio of belt tension to drum radius:

\[ P = \frac{T}{R} \quad [1] \]

where:
- \( P \) = pressure, pounds per square inch (psi)
- \( T \) = belt tension, pounds per inch of width (piw)
- \( R \) = drum radius, inches

For example, a belt tension of 120 piw and a drum radius of 12 inches would provide 10 psi on the veneer.

The drums are heated internally by hot oil supplied by a separate system. The oil flows into the drums through fluid unions connected to the hollow drum
The drums are driven by a 1-horsepower direct current motor through a speed reducer, and the direction of rotation is reversible. Rotation speed can be adjusted to suit the particular veneer being dried. As the drum rotates, the belt moves along with it and does not slip because of the pressure between the belt and drum. Belt tension around the drum changes only slightly during rotation. If the belt creeps sideways, a tracking adjustment can be made by slightly offsetting one end or the other of the movable roller.

With a two-drum unit, the veneer follows a serpentine path (Fig. 2). The veneer is heated on one side by the bottom drum and on the other side by the top drum. If needed, the cycle can be repeated. The MVP was designed with the capability to dry veneer with the grain direction either parallel or perpendicular to the feed direction. In the latter case, however, some slack must be kept in the veneer sheet between the drums to prevent splitting due to transverse shrinkage. The slack can be created either by turning the drums at slightly different speeds, or by using two drums of slightly different diameters.

Materials and methods
Comparison tests were made with both a laboratory platen press and a roller dryer with longitudinal air flow. The test material was rotary-peeled 1/32-inch aspen veneer (*Populus tremuloides*). Samples measured 14 by 14 inches, and the drying temperature was 280°F for all machines.

Only one drum of the MVP dryer was operational at the time of testing, but two-drum operation was simulated by passing a piece of veneer around the single drum twice, turning it over between passes. A typical drying cycle was two passes at 60 seconds per pass, a total drying time of 2 minutes. The grain direction of the veneer was parallel to the feed direction (longitudinal feed).

Two types of belts were used in the MVP dryer. One was a woven fiberglass belt, made endless with an overlapped and glued splice. This belt, chosen for its high strength, was tensioned to produce 8 psi on the veneer. However, the glue splice came apart as the glue softened at temperatures well below the stated limit. The other belt was a woven stainless steel wire belt. Although not as strong, its welded seam was insensitive to operating temperatures. This belt was tensioned to produce 4 psi on the veneer.

Results from controlled tests

Results for shrinkage are summarized in Table 1. The MVP was able to dry veneer with less thickness and volume loss than veneer dried in either of the other two dryers. Also, it caused much less transverse shrinkage than the roller dryer. The veneer dried in the roller dryer

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**TABLE 1.** — Veneer drying results for 1/32-mch aspen veneer, dried at 280°F.

<table>
<thead>
<tr>
<th>Dryer</th>
<th>Pressure on veneer (psi)</th>
<th>Drying time (min.)</th>
<th>Green MC</th>
<th>Final MC</th>
<th>Transverse Shrinkage (%)</th>
<th>Thickness</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platen press</td>
<td>22</td>
<td>1</td>
<td>79.8</td>
<td>4.2</td>
<td>1.3</td>
<td>9.9</td>
<td>11.3</td>
</tr>
<tr>
<td>Roller dryer</td>
<td>--</td>
<td>2</td>
<td>76.8</td>
<td>3.5</td>
<td>6.1</td>
<td>6.7</td>
<td>12.7</td>
</tr>
<tr>
<td>MVP trial 1</td>
<td>8</td>
<td>2</td>
<td>78.7</td>
<td>4.4</td>
<td>3.4</td>
<td>4.9</td>
<td>8.5</td>
</tr>
<tr>
<td>MVP trial 2</td>
<td>4</td>
<td>2</td>
<td>82.0</td>
<td>4.0</td>
<td>2.0</td>
<td>4.9</td>
<td>4.4</td>
</tr>
</tbody>
</table>

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*a* All data are averaged over a minimum of 24 samples.

* Calculated from actual change in dimensions of sample.

* Dryer was only 15 percent full across the width, thus increased nip pressure may have contributed to thickness loss.

* Stretching and subsequent narrowing of belt may have contributed to transverse shrinkage.

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1 Maximum veneer thickness is about 1/12 inch when feeding in parallel direction, based on fiber stress at proportional limit for several species.
was wavy and bumpy, whereas the MVP-dried veneer and the platen-dried veneer were flat, smooth, and flexible, even when oven-dry (Fig. 3). The wire belt (trial 2) apparently provided more restraint than the fiberglass belt (trial 1), even at lower pressure. Using the MVP with the wire belt resulted in veneer shrinkage that was about 33 percent of the shrinkage in the roller dryer. Veneer thickness and volume loss were about 25 percent and 40 percent, respectively, of that occurring in the platen press, while transverse shrinkage was 50 percent greater, although still small. The wire belt left no markings on the veneer.

The thickness loss observed for the wire belt (trial 2) is unusually low, but the results indicate that thickness loss is proportional to the pressure used in drying. In the platen press, 22 psi appeared to be the minimum pressure that would adequately restrain the veneer. For a platen press, the pressure must be high enough to overcome variations in veneer thickness and in the flatness and alignment of the platens. In contrast, the flexible belt used in the MVP appears insensitive to slight dimensional irregularities of the veneer or drum.

**Other tests**

Many additional samples were used to establish drying rates for the three dryers. In general, the MVP was only about half as fast as the laboratory platen press, but was 25 to 33 percent faster than the roller dryer. Transverse shrinkage was measured for many of these samples, with typical values of 1 percent for the platen press, 2 percent for the MVP, and from 6 to 7.5 percent for the roller dryer. Other samples were dried with grain direction perpendicular to feed direction (transverse feed). Results were not significantly different compared to longitudinal feed. Further, it did not seem to matter whether the loose or tight side of the veneer was against the drum on the first pass.

When the final MC was greater than 4 percent, the dry veneer tended to have wavy ends, regardless of the dryer used. (The roller dryer was the worst in this regard.) This indicates that the veneer continues to dry and shrink slightly after it is removed from the dryer, thus some of the advantages of press drying are lost. Therefore, press-dried veneer may need to be cooled to ambient temperature while still restrained in the dryer. The last drum in a multi-drum system patterned after the MVP could do this.

Initially, there was concern that veneer dried with longitudinal feed would become curved from the drum. Longer samples that measured 14 inches by 48 inches were used to study this potential problem. When this veneer was dried in three or more passes, it did not have any residual curvature from being wrapped around the drum. When dried in only one or two passes, it was slightly curved from the last pass. This phenomenon may be related to species and to final MC of the veneer. It is not known what effect cooling the veneer while still in the dryer would have on curvature.

**Summary**

The MVP dryer combines the continuous operation of a hot-air dryer with the restraint of a platen press dryer. The MVP dries veneer by direct contact with rotating heated drums arranged in series. A flexible belt holds the veneer against each drum with sufficient pressure to reduce shrinkage and waviness.

Compared to a laboratory roller dryer with longitudinal air flow, MVP dried 1/32-inch aspen veneer in 25 percent less time, with 67 percent less transverse shrinkage and volume loss, and the veneer was much flatter and smoother. Compared to a laboratory platen press, MVP dried veneer with 75 percent less thickness loss and 60 percent less volume loss, although drying time was twice as long.

When long pieces of veneer were dried in three or more drum passes, the veneer did not have any residual curvature from the drum. When dried in only one or two passes, it was slightly curved from the last pass.

Full-scale tests using both drums on veneer of different thicknesses and species are planned for the future.

**Literature cited**