

EFFECT OF PROCESSING PARAMETERS, RESIN, AND WAX LOADING ON WATER VAPOR SORPTION OF WOOD STRANDS

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Abstract. The outdoor use of oriented strandboard (OSB) is undesirable if exposed to atmospheric vapor or rain; however, increasing resin and wax content can mitigate adverse sorption behavior of panels under such negative conditions. The objective of this study was to investigate the effect of resin loading, emulsion wax loading, and pressing parameters on the water vapor sorption behavior of loblolly pine strands. Pure earlywood of loblolly pine (*Pinus taeda*) strands were cut and oven-dried at 50°C. The phenol-formaldehyde resin or wax was sprayed on the wood strands, which were oven-dried at 50°C for 900 s. All specimens were equilibrated at 11% relative humidity (RH) over a saturated salt solution. After equilibration, specimens were placed in a conditioning chamber with the RH increasing from 11–80%. The mass change was continuously recorded by a dynamic contact angle analyzer. The results show that platen temperature, wax loading, compression ratio, and resin loading were influential, in decreasing order, on sorption behavior.

Keywords: Resin loading, wax loading, compression ratio, sorption, wood, OSB.

INTRODUCTION

The volume of oriented strandboard (OSB) produced, particularly for the residential market, has increased significantly over the last few decades. As a wood-based composite material, OSB is hygroscopic, in that the material adsorbs or desorbs moisture from the changes in the environment, ie temperature and/or relative humidity (RH). OSB is dimensionally unstable when exposed to a humid environment. The thermal softening of wood leading to the breakage and

rearrangement of inter- and intramolecular bonds is dependent on moisture content (MC) of wood and the environment during hot-pressing. The high MC in wood can weaken the hydrogen bonds in the amorphous parts of the cellulose chains, and this leads to a weakening of wood strength (Van Der Put 1989). Moisture content changes may lead to loss of mechanical properties and aesthetic quality (Kamke and Miller 2006).

The moisture-related properties of OSB have been investigated as water vapor permeability/resistance (Vinha et al 2002), equilibrium moisture content (EMC), and sorption isotherms (Hartley et al 2007; Richards et al 1992; Sekino

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et al 1999). The moisture sorption response of commercial OSB panels at room temperature was examined as a function of RH (Hartley et al 2007). The results showed that the sorption behavior of three species (pine, aspen, and poplar) and two resin-type (phenol-formaldehyde (PF) and methyl di-isocyanate (MDI)) commercial OSB panels was not different at 25°C. Modeling of the data with the Guggenheim-Anderson-deBoer (GAB) sorption model showed a 6–8 times increase in the heats of sorption in OSB compared with solid wood. Ye et al (2006) investigated water mobility and mold susceptibility of OSB. The results showed that neither MC nor water activity (a_w) is a reliable indicator of mold susceptibility of OSB. NMR relaxometry together with distributed exponential analysis detected that the state of water with the longest spin-spin relaxation time is responsible for the mold susceptibility of OSB. OSB made from southern pine had greater mold susceptibility than that made from aspen because the pine OSB had a third water component with very long spin-spin relaxation time (6035–7346 μ s).

The diffusion of water into panels is an important parameter for sorption behavior. Diffusion is highly dependent on panel density, particle geometry, surface area, temperature, and flake orientation. Diffusion coefficients slightly increase when vapor movement occurs parallel to the machine or surface flake direction. Past research has shown flake orientation to exhibit little influence on diffusion rates, particularly in low-density panels (Lehmann 1972). Therefore, factors controlling diffusion rates may come from solid wood characteristics, ie lumens, cell walls, and pit openings.

Wood is a porous, hygroscopic material, and its anatomy and properties vary with position in the tree. A recent study by Neimsuwan et al (2008a) indicated that earlywood had greater sorption rates and diffusion coefficients than latewood, while outer tree rings had greater sorption rates and diffusion coefficients than inner rings. The sorption isotherms of earlywood, latewood, and different tree ring locations within the stem

cross-section fit very well with a Hailwood-Horrobin model.

To improve water repellency of wood composites, several techniques have been used. Increasing resin and wax content can improve sorption behavior of panels. PF thermosetting resins are commonly used in the production of molded plastics, wood products, and aerospace components because of their highly hydrophobic properties. Zhang et al (2007) investigated the effect of PF resin and emulsion wax on the water uptake behavior of commercial southern pine strands using a wicking test. The results indicated that resin level, wax content, grain direction, and strand density had highly significant effects on water uptake behavior of strands. Lower resin level and wax content led to a more rapid water uptake rate during the early stage of the wicking test and a greater total amount of water adsorbed at the end of test. Not only PF resin, but isocyanate adhesives such as MDI can react with water and form cross-linkages with the wood constituents, which reduces the adsorptive nature of wood (Alexander et al 2000; Harper et al 2001). An addition of 2% wax can improve water repellency by reducing surface energy, which makes it hydrophobic. Wax properties such as chemical composition, melting point, viscosity, and oil content closely relate to liquid and vapor repellency of OSB. Other processes also influence wood strands as well, such as the drying method on surface wettability (Wang et al 2007) and hot-pressing on EMC (Wang and Winistorfer 2001).

The three major raw materials, wood, resin, and wax, play key roles in determining properties of the product. How resin and wax affect the water vapor sorption behavior of resinated and waxed strands remains unclear. Although OSB fabrication is a complex process where several parameters interact simultaneously, this work will study each one of the parameters individually to avoid complex interactions. The objective of this study was to investigate the effect of resin and emulsion wax loading on the water vapor sorption behavior of loblolly pine strands using microscale measurements. This study also investi-

gated the influence of pressing parameters, ie platen temperature and compression ratio, on sorption properties of loblolly pine strands.

MATERIALS AND METHODS

Experimental Design

Four levels of PF resin loading (0, 2, 4, and 6% based on oven-dry mass) were applied to wood strands for the resin study. Four levels of wax loading (0, 0.5, 1.0, and 1.5% based on oven-dry mass) were applied for the wax study. Two compression ratios (1.05 and 1.65) and three pressing temperatures (120, 160, and 200°C) were used. Each parameter was independently designed; the experiment design is shown in Table 1.

Materials

Loblolly pine (*Pinus taeda*) strands were flaked from stems obtained from a traditional plantation located in Crossett, Arkansas. Commercial liquid PF resin (solid content of 50.5%) from Dynea USA Inc and commercial wax emulsion (solid content of 57.04%) from Hexion Specialty Chemicals were used in this study.

Specimen Preparation

Pure earlywood stands were cut to 5-mm width × 15-mm length × 0.5-mm thickness. Earlywood was used due to its greater domination in the wood strand. Additionally, it was difficult to

consistently prepare latewood specimens at 0.5-mm thickness due to the narrow size of some latewood rings in the juvenile wood zone. Although these wood strips were shorter than the tracheid length, the sizes were necessary since a shorter time of sorption was desired. The grain direction was parallel to the long length (15 mm) of the earlywood strips. These strips were cut from the same area within the wood strand to reduce variability in sorption. The cutting diagram is shown in Fig 1. The specimens were oven-dried at 50°C to avoid wax evaporation until the mass was constant and the value recorded. After spraying resin or wax on one side of the specimen, it was oven-dried at 50°C for 900 s. Resin or wax was then sprayed on the other side, which was oven-dried at 50°C for 900 s. The resin or wax loading was calculated based on oven-dry mass. For pressing studies, pairs of specimens were pressed together with a hot-press system (Carver Inc). Six replicates were used. The pressing parameters are shown in Table 1.

Sorption Kinetics

All specimens were equilibrated at 11% RH at 25°C over a saturated salt solution (LiCl). After equilibration, specimens were placed in a conditioning chamber at 25°C with RH changing from 11 to 80% by adding water vapor. The mass change was continuously recorded by Dynamic Contact Angle Analyzer DCA 332 with 0.01-mg precision. The experimental setup of

Table 1. *Experimental design for resin, wax, and pressing parameter study.*

Studies	Level (%)	Description	Matrix dependent variable
Resin	0.0, 2.0, 4.0, 6.0	No wax	Diffusion, Sorption rate, EMC
Wax	0.0, 0.5, 1.0, 1.5	No resin	Diffusion, Sorption rate, EMC
Pressing parameter			
Compression ratio	1.05, 1.65	4% resin content No wax 160°C of press temperature 180 s of press time	Diffusion, Sorption rate, EMC
Temperature (°C)	120, 160, 200	4% resin content No wax 1.05 of compression ratio 180 s of press time	Diffusion, Sorption rate, EMC

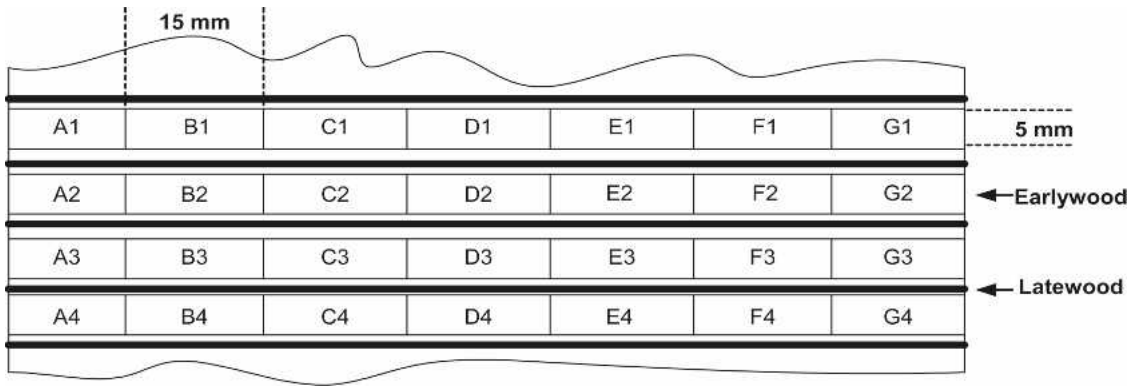


Figure 1. The cutting diagram (4 loading levels and 4 replications for each study).

the climate control instrument is shown in Fig 2. Six replications for each loading level and pressing parameter were used.

Evaluation of Sorption Kinetics

The sorption rate was determined from the slope of the plot of MC against time. The initial sorption rate (K_1) was calculated from the slope to 300 s, whereas the second slope (K_2) was calculated from the second linear slope over another 300 s. The measurement of EMC was also

investigated by equilibrating the specimen with water at 25°C. The calculation of diffusion coefficients (D), surface emission (σ), and surface resistance (S) was described in previous study (Neimsuwan et al 2008a and 2008b).

RESULTS AND DISCUSSION

Resin Loading Results

The moisture sorption of resinated strands loaded at different resin levels is shown in Table 2 and Fig 3. The calculation of diffusion coefficients was based on the solution of a practical problem such as the “non-perfect RH-step” as described by Wadso (1994). Therefore, the final part of the sorption curve was used because of the nonperfect RH-step. The accuracy of this calculation is usually best in the range of 60–80% of total sorption (Wadso 1994). The MC change can be designated as moisture sorption. The initial sorption rate and second slope were 0.0022 and 0.0021%/s^{0.5} for resinless strands, whereas it was 0.0021 and 0.0017%/s^{0.5} for 6% resin loading. The square root of time was used due to the linear relation of the plot of sorption. These results showed the resin loading affected the moisture sorption rate of resinated strands at the second step. The moisture sorption rate of resinated strands decreases with an increase in the resin loading. It was obvious that resin loading had a more pronounced effect on the second slope of water vapor sorption than initial sorp-

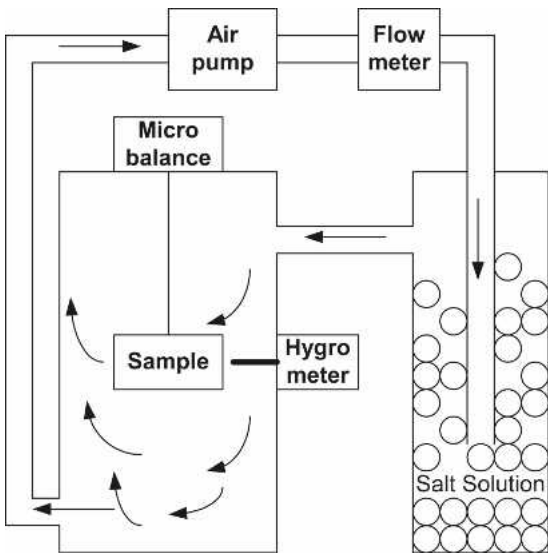


Figure 2. Climate control instrument used during the measurements.

Table 2. Initial sorption rate (K_1), second slope (K_2), diffusion coefficient (D), surface emission coefficient (σ), and surface resistance coefficient (S) of resinated wood. The superscript capital letters in the EMC column represent significant differences computed through the Tukey statistical method.

Resin loading	K_1 (%/s)	K_2 (%/s)	$D_{0.5}$ (10^{-10} m ² /s)	$D_{0.6}$ (10^{-10} m ² /s)	σ (10^{-7} m/s)	S (10^6 s/m)	EMC (%)
0%	0.0022 (0.0002)	0.0021 (0.0003)	1.73 (0.06)	1.97 (0.11)	4.85 (0.21)	2.07 (0.09)	22.7 (0.40) ^A
2%	0.0022 (0.0003)	0.0021 (0.0002)	1.71 (0.09)	1.95 (0.11)	4.87 (0.28)	2.06 (0.12)	20.4 (4.29) ^{AB}
4%	0.0021 (0.0002)	0.0019 (0.0002)	1.65 (0.16)	1.82 (0.11)	4.72 (0.49)	2.14 (0.23)	17.0 (1.23) ^{BC}
6%	0.0021 (0.0002)	0.0017 (0.0001)	1.64 (0.11)	1.81 (0.10)	4.78 (0.24)	2.10 (0.11)	15.1 (2.02) ^C

Values given are means (STD)

The same letters or no letters are not significantly different at $\alpha = 5\%$

Remark: $D_{0.5}$ = diffusion at 50% of total sorption, $D_{0.6}$ = diffusion at 60% of total sorption, and EMC = equilibrium moisture content

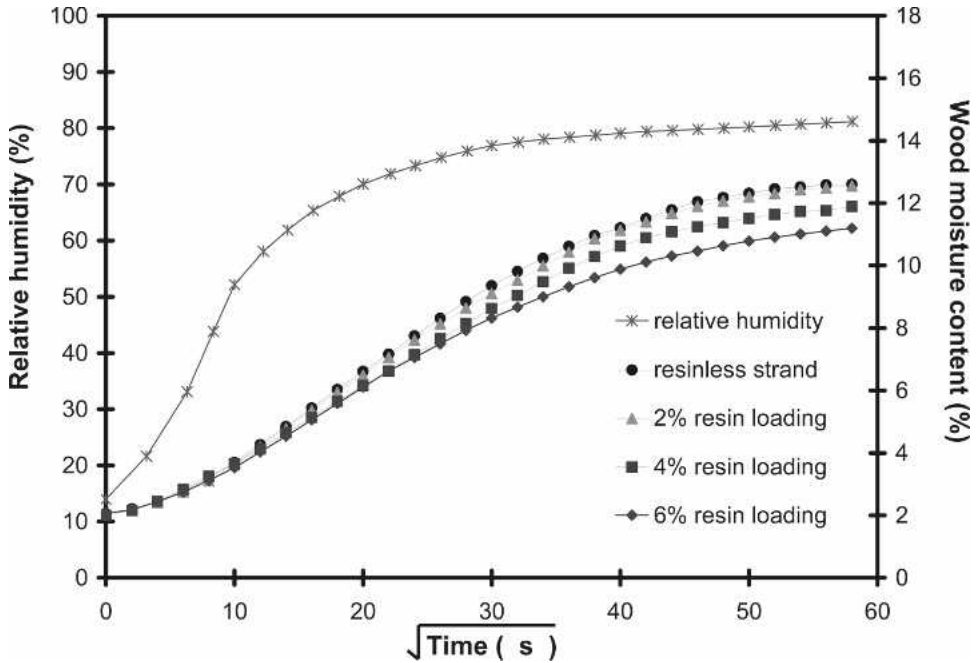


Figure 3. The moisture sorption of resinated strand loaded with different resin levels.

tion rate. This is possibly due to the effect of the transition period of RH change at the early stage. The moisture sorption rate of resinated strands decreased with an increase in resin loading. It is possibly due to the greater resin coverage causing a reduction of available surface area for water vapor sorption. At 2% intervals of resin loading, it may not be possible to detect differences in sorption rate. This could be attributed to the difficulty of uniformly applying a constant resin distribution at the microscale.

The EMC of resinless strands was 22.7%, whereas resinated strands were between 15.1

and 20.4% (Table 2). The EMC from Figs 3 and 4 are at pseudo-equilibrium, which is different than the corresponding EMCs presented in Tables 2 and 3 due to the shorter time period and limitation of experimental set up. The EMC of resinless strands was significantly greater than EMC of resinated strands with 6% of resin loading (p -value = 0.0004). The MC of OSB equilibrated at approximately 100% RH after 30 h was reported by Ye et al (2006) as only between 12.3% and 16.9%. The voids were possibly covered by resin, which blocked moisture sorption at high humidities. For PF resin, the sorption

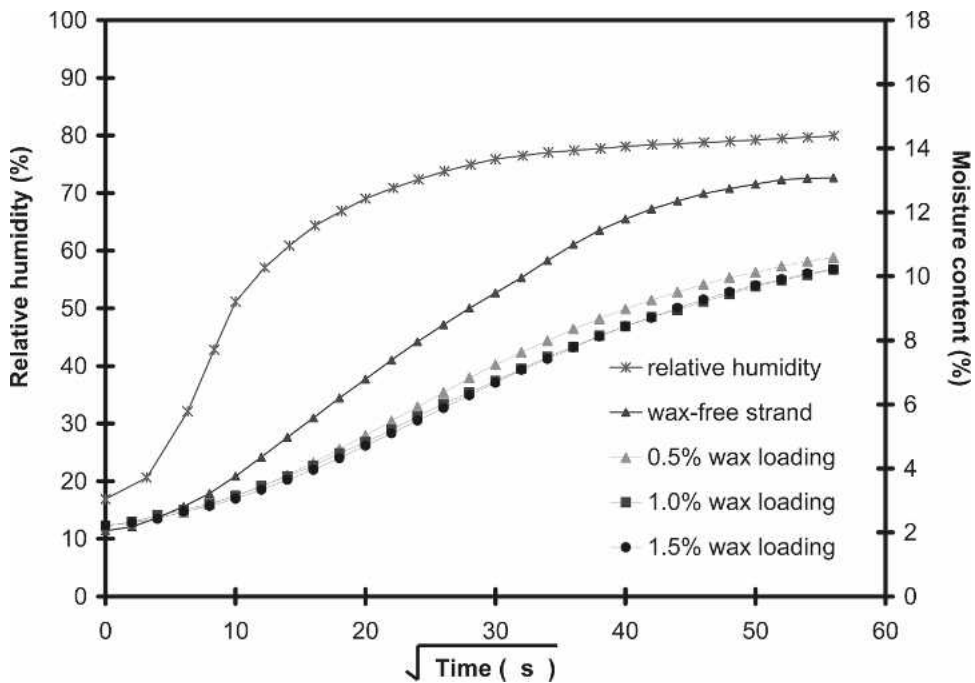


Figure 4. Moisture sorption of wood strands loaded with different wax levels.

Table 3. Initial sorption rate (K_1), second slope (K_2), diffusion coefficient (D), surface emission coefficient (σ), and surface resistance coefficient (S) of waxed strand. The superscript capital letters in the column represent significant differences computed through the Tukey statistical method.

Wax loading	K_1 (%/s)	K_2 (%/s)	$D_{0.5}$ (10^{-10} m ² /s)	$D_{0.6}$ (10^{-10} m ² /s)	σ (10^{-7} m/s)	S (10^6 s/m)	EMC (%)
0%	0.0023 (0.0005) ^A	0.0022 (0.0003) ^A	1.70 (0.07) ^A	1.91 (0.07) ^A	4.77 (0.25) ^A	2.10 (0.11) ^A	22.5 (0.35) ^A
0.5%	0.0010 (0.0001) ^B	0.0013 (0.0003) ^B	1.13 (0.10) ^B	1.26 (0.11) ^B	3.19 (0.263) ^B	3.15 (0.24) ^B	17.4 (1.65) ^B
1.0%	0.0010 (0.0001) ^B	0.0012 (0.0003) ^B	1.12 (0.08) ^B	1.23 (0.18) ^B	3.18 (0.27) ^B	3.16 (0.26) ^B	16.5 (0.73) ^B
1.5%	0.0009 (0.0001) ^B	0.0012 (0.0001) ^B	1.03 (0.10) ^B	1.20 (0.14) ^B	2.97 (0.20) ^B	3.38 (0.24) ^B	16.8 (0.97) ^B

Values given are means (STD)

The same letters are not significantly different at $\alpha = 5\%$

Remark: $D_{0.5}$ = diffusion at 50% of total sorption, $D_{0.6}$ = diffusion at 60% of total sorption, and EMC = equilibrium moisture content

properties of bonded strands decrease with decreasing caustic content (Wittmann 1973). It can be said that in liquid phase, the sorption process involves both physio- and chemi-sorption, whereas in vapor phase the sorption process involves a primary surface or chemi-sorption, which is dependent on the free hydroxyls. These OH-groups will interact with themselves instead of with water molecules and, due to the coverage of nonpolar moieties, it reduces the availability of OH-groups to form H-bonds with water molecules (Rennekar et al 2006). Water molecules interact with strong forces in OH-groups, which

is greater than the capillary condensation of water vapor (Sheppard and Newsome 1934).

The diffusion coefficient of resinless strand at 60% of total sorption was 1.97×10^{-10} m²/s, whereas it was between 1.95×10^{-10} and 1.81×10^{-10} m²/s for resinated strands (Table 2). Although the diffusion coefficient of resinless strands was not significantly different from resinated strands with 2% resin loading, it was approximately 10% greater than resinated strands with 6% resin loading. These data show that moisture can diffuse slightly more in resin-

less strands. The surface resistance coefficient and surface emission coefficient of resinless strands were 2.07×10^6 s/m and 4.85×10^6 m/s, respectively. There was no significant difference of surface coefficients of strands treated with different resin loadings. However, surface resistance coefficients were slightly lower than that of unresinated strands. The greater surface resistance in resinated strands causes slower sorption processes. Zhang et al (2007) found that resin levels influence the water uptake of strands. A lower resin loading strand had a greater water uptake, although the resin loading only slightly affected moisture sorption. This is possibly due to the slower sorption of water vapor than liquid water. Water uptake was dependent on the penetration of resin into wood cell walls and lumens to block capillary action. In contrast, moisture sorption is more dependent on surface properties (Ye et al 2006). Under hot-pressing in composite manufacture, resinated strands experience only a few minutes of environmental change during pressing. Resin loading may not significantly influence sorption properties of resinated strands for such a short time period.

Wax Loading Results

The moisture sorption of waxed strands loaded with different wax levels is shown in Table 3 and Fig 4. The initial sorption rate and second slope of wax-free strands was 0.0023 and $0.0022\%/s^{0.5}$, respectively. It was 2.5 and 1.5 times greater than waxed strands for initial sorption rate and second slopes, respectively. These results showed the same trend of resin loading. However, the influence of wax loading on water vapor sorption rate and EMC is more obvious than for resin loading. Wax application is used commercially to improve water-resistant properties of composites. This application also reduces mechanical properties by decreasing bond quality. In this experiment with individual wood strands, it was clear that wax application may reduce the bond quality of interstrand attachment. The moisture sorption rate of waxed strands was lower than that of wax-free strands. Garcia et al (2006) stated that the sorption be-

havior of wax use is independent of the resin used. Sernek et al (2004) stated that wax and heat treatment impedes vapor sorption.

The EMC of wax-free strands was 22.5%, whereas waxed strands were between 16.5 and 17.4%. The waxed strands had a lower sorption amount and moisture uptake rate than wax-free strands. This study agrees with the finding that high wax content reduces the total water uptake amount and decreases the water uptake rate, in which liquid water is used for testing (Zhang et al 2007). The diffusion coefficient, surface emission, and surface resistance of waxed strands are shown in Table 3. The diffusion coefficient of wax-free strands at 60% of total sorption was 1.91×10^{-10} m²/s, whereas it was between 1.26×10^{-10} and 1.21×10^{-10} m²/s for waxed strands. The diffusion coefficient of wax-free strands was significantly greater than for waxed strands (p -value = 0.0001). It was approximately 1.5 times greater than waxed strands with 1.5% wax loading. Analysis of the data supported the idea that moisture can diffuse more in a wax-free strand. The surface resistance coefficient of wax-free strands was 2.10×10^6 s/m. It was lower for wax-free strands than for waxed strands. The diffusion coefficient is characterized as the internal moisture transfer rate in the strand, whereas the surface emission coefficient is characterized as the resistance when the water moves through the strand surface. The greater surface resistance in wax-free strands results in a slower sorption process. In most wood composites, resin application provides bonding of wood elements, while wax resists water absorption (Maloney 1993). Strands loaded with lower resin and wax level exhibit a greater rate of water uptake during the early stage of sorption (Zhang et al 2007). Results from this study supported the idea that greater resin and wax loading can resist water vapor sorption, but it may have a small effect in relation to overall board sorption. Wax loading has more influence on water vapor sorption rate and EMC than resin loading, although the wax penetration into wood was not investigated. Under hot-pressing, the influence of wax on water vapor properties in the

short time period was more pronounced than the influence of PF resin. However, it is important to mention that due to the complexity of the pressing phenomena and limitation of the experimental design, further studies should be pursued to better understand the complex interactions.

Pressing Parameters

Hot-pressing parameters that may affect sorption properties were investigated. The initial sorption rate and second slope of strands pressed with 1.05 compression ratio were 0.0013 and 0.0015%/s^{0.5}, respectively (Table 4). The initial sorption rate and second slope of strands pressed with 1.65 compression ratio were 0.0012 and 0.0014%/s^{0.5}, respectively (Table 4). The influence of strand density on liquid water penetration was reported by Zhang et al (2007). The water penetration was low for high density strands. However, there were no differences in sorption rates between strands pressed with 1.05 and 1.65 of compression ratios (*p*-value > 0.05).

The initial sorption rate and second slope of strands pressed at 120°C platen temperature were 0.0017 and 0.0021%/s^{0.5}, respectively (Table 4). It was approximately 1.5 times greater than for strands pressed at 200°C platen temperature for both initial sorption rate and second slope. Results demonstrated that platen temperature exhibited a strong influence on the moisture uptake rate of a resinated strand. An increase in platen temperature resulted in a decrease in moisture uptake rate. Resinated strands pressed at 120°C exhibited a moisture uptake 1.5 times greater than a resinated strands pressed at 200°C. This phenomenon was possibly due to the heat treatment leading to a decrease in hydrophilic properties. The OH-groups of wood strands may be replaced with *O*-acetyl groups during heat treatment (Hinterstoisser et al 2003). Additionally, hemicellulose degradation occurs with increased temperature and results in a reduction of hydroxyl sites; changes in lignin structure also cause a decrease in moisture sorption (Repellin and Guyonnet 2005). However, Sernek et al (2004) stated that VOCs are emitted

Table 4. Initial sorption rate (K_1), second slope (K_2), diffusion coefficient (D), surface emission coefficient (σ), and surface resistance coefficient (S) of resinated strand pressed with different compression ratios and temperature. The superscript capital letters in the column represent significant differences computed through the Tukey statistical method.

Pressing parameter	K_1 (%/s)	K_2 (%/s)	$D_{0.5}$ (10^{-10} m ² /s)	$D_{0.6}$ (10^{-10} m ² /s)	σ (10^{-7} m/s)	S (10^6 s/m)	EMC (%)
Compression ratio							
1.05	0.0013 (0.0003)	0.0015 (0.0002)	2.99 (0.16) ^A	3.38 (0.28) ^A	4.72 (0.27) ^A	2.13 (0.12) ^A	18.4 (1.24)
1.65	0.0012 (0.0002)	0.0014 (0.0003)	2.29 (0.11) ^B	2.73 (0.15) ^B	3.96 (0.22) ^B	2.53 (0.14) ^B	18.1 (0.67)
Platen temperature							
120°C	0.0017 (0.0002)	0.0021 (0.0003)	3.73 (0.22) ^A	4.36 (0.30) ^A	5.61 (0.21) ^A	1.79 (0.06) ^A	18.5 (0.58)
160°C	0.0013 (0.0003)	0.0015 (0.0002)	2.99 (0.16) ^B	3.38 (0.28) ^B	4.72 (0.27) ^B	2.13 (0.12) ^B	18.4 (1.24)
200°C	0.0012 (0.0003)	0.0014 (0.0003)	2.95 (0.11) ^B	3.17 (0.18) ^B	4.64 (0.09) ^B	2.16 (0.04) ^B	16.9 (0.56)

Values given are means (STD)

The same letters or no letters are not significantly different at $\alpha = 5\%$

Remark: $D_{0.5}$ = diffusion at 50% of total sorption, $D_{0.6}$ = diffusion at 60% of total sorption, and EMC = equilibrium moisture content

during hot-pressing above 170°C that contaminates the surface.

The platen temperature has more influence on sorption properties of resinated strands than compression ratio. Since these effects were investigated one factor at a time, the interaction between platen temperature and compression rate was not investigated. The interaction of compression ratio with platen temperature may surpass the effect of temperature or compression ratio alone. An increase in compression ratio resulted in a slight decrease in initial sorption rate.

The EMC of resinated strands pressed with different compression ratios and platen temperatures was slightly different. Tabarsa and Chui (1997) reported that compression ratio had a slight effect on EMC. A higher compression ratio of composites boards leads to a slight decrease in EMC. Resinated strands pressed with 200°C of platen temperature exhibited 9% lower EMC than other pressing parameters.

The diffusion coefficient, surface emission, and surface resistance of pressed strands are shown in Table 4. The calculation of the diffusion coefficient by maximum slope and 80% of total sorption is not appropriate due to the internal surface resistance during the initial sorption process, and non-Fickian effects at the end of the sorption process, respectively. Therefore, the calculation of the diffusion coefficient at 60% of total sorption can be used instead of the traditional method based on a calculation of the maximum slope. The diffusion coefficient at 60% of total sorption was 3.38×10^{-10} and 2.73×10^{-10} m²/s for resinated strands pressed with 1.05 and 1.65 compression ratios, respectively. The diffusion coefficients of resinated strands pressed with 1.05 and 1.65 compression ratios were slightly different (*p*-value = 0.0254). The surface resistance was 2.13×10^6 and 2.53×10^6 s/m for 1.05 and 1.65 compression ratios, respectively. The diffusion coefficients at 60% of total sorption was 4.36×10^{-10} , 3.78×10^{-10} , and 3.17×10^{-10} m²/s for resinated strands pressed with 120, 160, and 200°C platen temperatures, respectively. The diffusion coeffi-

cient at 120°C was 1.4 times greater than that at 200°C. The surface resistance coefficient was 1.79×10^6 , 2.13×10^6 , and 2.16×10^6 s/m for 120, 160, and 200°C platen temperatures, respectively. At 200°C, the pressed strands exhibited resistance to water sorption. Assuming no interaction, the data support the idea that moisture can diffuse more at 1.05 compression ratio with a 200°C platen temperature. These results suggest that platen temperature influences water vapor sorption rates and EMC more than compression ratio. This occurs because the compression ratio involves only the specimen thickness, whereas the platen temperature affects wood throughout the mat. Tabarsa and Chui (1997) found EMC decreased with platen temperature with a considerable reduction in EMC between 100 and 150°C. They stated that the reduction in EMC was due to hemicellulose degradation, where the number of available hydrogen bond sites was decreased. However, the influence of the interaction between compression and temperature on EMC was not discussed. Under hot-pressing, the influence of platen temperature may dominate water vapor properties.

CONCLUSIONS

This evaluation of water vapor sorption of resinated and waxed commercial strands provides fundamental knowledge to improve OSB manufacture and applications. The water vapor sorption of loblolly pine strands changed with resin/wax loading levels, pressing temperatures, and compression ratios. Higher resin/wax loading reduced water vapor sorption over short time periods. Wax loading had more influence on water vapor sorption than did resin loading. Higher platen temperatures and higher compression ratios reduced water vapor sorption, but platen temperatures had more influence on water vapor sorption. The processing factors dominating water vapor sorption over short time periods were wax loading and platen temperature. In summary, platen temperature, wax loading, compression ratio, and resin loading were influential, in decreasing order, on sorption behavior of wood.

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