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Effect of Refining Pressure and Resin Viscosity on Resin Flow, Distribution, and Penetration of MDF Fibers

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SUMMARY

The growth of medium density fiberboard (MDF) in North America has experienced robust growth over the past 20 years and is projected to increase by another 60 percent in the next 8 years. Compounding this increase in demand for MDF is a raw material that is ever-increasingly lower in density and higher in juvenility. The dichotomous concept of increased demand with a poorer raw material requires a more fundamental understanding of the mechanisms involved in fiber-to-fiber stress transfer to better engineer a structural wood fiber-based composite. Our laboratory has been investigating several of the most important factors in the mechanics of MDF structural formation. This paper will present some background information on the effect of raw material juvenility on individual fiber and MDF panel stiffness and strength. Additional information will also be presented regarding the effect of refining pressures on fiber and panel properties. Qualitative fiber surface morphology as ascertained by scanning electron microscopy and atomic force microscopy will also be presented. This information will be vital to discuss resin behavior on individual fibers during application and pressing. The main focus of this paper is the resin-fiber interaction. Specifically, a low, medium, and high viscosity UF resin was applied to various fiber types to investigate fiber penetration and distribution on the fiber surfaces. MDF panels were constructed to determine the difference in resin distribution for blowline-blended and laboratory drum-blended fibers. Panels were also dissected to study the effect of pressing variables on resin flow. A qualitative analysis of resin flow on the fiber surfaces as well as penetration into the cell wall and lumen will be discussed. There will also be a discussion of future work that will quantify the effect of viscosity on resin distribution and flow for various viscosity resins related to fiber juvenility and refiner pressures.

Keywords: Loblolly pine, juvenility, confocal, SEM, AFM, urea-formaldehyde

INTRODUCTION

The manufacture of MDF relies on an efficient utilization principle of breaking down solid wood into wood fibers via refining and then reassembling the fibers into a structural composite. The primary factors that govern the physical and mechanical properties of MDF

are the fiber properties, fiber orientation, panel density, density profile, and fiber-to-fiber adhesion. This paper will focus on the results of an on-going study that investigates the relationship between fiber juvenility, fiber generation variables, and fiber-to-fiber adhesion.

In traditional wood-based composites such as plywood and laminated veneer lumber, the structural performance of the composite is directly dependent on the mechanical properties of the wood components. This axiom does not apply to wood fiber-based composites. The mechanisms for transferring stresses amongst composite components are different. Clear wood and veneer composites have a finite number of transfer points with adequate adhesion. Wood strand composites have many more stress transfer locations with a lesser amount of adhesive coating the surfaces. As a result, wood strand components have diminished structural properties as compared to their clear wood and veneer-based counterparts. However, the strand components are still planar and generally oriented, resulting in a modulus of elasticity (MOE) that is less than half of the equivalent clear wood MOE.

The development of the mechanical properties of wood fiber-based composites differs from the previously discussed composites, relying on a near infinite number of 'spot welds'. These spot welds are dictated by the resin type, content, flow, and distribution on the fiber surfaces. These variables are selected both by the composite and resin manufacturer and are based on empirical observations. However, the choice of resin and its relationship with the fiber surface has remained largely unstudied because of the inability to adequately determine resin location on the fiber surface. Recent advancements in microscopy and fluorescent staining techniques have allowed definition of resin distribution on the fiber surface (Kamke and Scott 2000, Scott 2001, Xing et al. 2004).

The mechanical properties of individual wood fibers are equally important in the development of MDF structural properties. However, the relationship differs from clear wood, veneer, or strand composites: structural performance of MDF increases as the proportion of compliant fibers increases. This is supported by previous studies that show that the stiffness and strength of MDF panels increase with increasing proportions of compliant juvenile wood fibers (Groom et al. 1999; Groom et al. 2000).

The long-term goal of this on-going study is to ascertain the mechanisms that govern the physical and mechanical properties of structural fiberboards. These goals are achieved by studying the primary factors governing MDF: fiber properties, fiber-to-fiber stress transfer, density, density profile, and fiber orientation. Data presented in this paper are the compilation of several studies that address these factors. Specifically, the objective of this paper is to ascertain the resin distribution on and penetration of individual wood fibers during blending and pressing.

MATERIALS AND METHODS

The raw material for the MDF panel manufacture was mature loblolly pine (*Pinus taeda* L.) harvested from a conventional plantation in southern Arkansas (USA). The felled loblolly pine logs were divided into 4 juvenility zones: juvenile (pith to growth ring 8), juvenile-transition (growth rings 9 to 16), mature-transition (growth rings 17 to 24), and mature (growth rings 25+). The loblolly pine logs were segregated into these 4 zones using a portable sawmill as well as a series of ripsaws at the Southern Research Station (SRS),

Pineville, LA, USA. The wood generated from the saws was chipped, dried, and sent to the BioComposites Centre (Bangor, Gwynedd, UK) for refining.

All 4 juvenility chip types were refined at the following pressures: 2, 4, 5, 6, 7, 8, 10, 12, 14, and 18 bars. Fibers were dried, bagged, and sent back to the SRS for analysis and MDF panel manufacture. Additionally, several MDF panels were from fibers refined at 5.5, 7, 8.5, and 10 bar in which full-sized panels were produced directly from the blowline using one of three different molecular weight resins. Panels were sanded and sent back to the SRS for property determination.

Refining

Refining was conducted at the BioComposites Centre pilot plant with an Andritz Sprout-Bauer 12-inch pressurized refiner. The refiner consisted of an in-feed hopper leading to a modular screw device (i.e. plug feeder), which conveys the material from atmospheric pressure into the desired pressurized environment. Wood chips were fed through the modular screw device via a 2.6-meter long cooker to a 60-liter digester.

The material from the digester was fed by screw conveyor to the center of the stationary refiner disc, and hence into the refining zone. In order to maintain a level of comparability, refiner feed screw settings and energy consumption were maintained for all fiber production using nominal refiner plate gaps that maintained the level of energy consumption.

Drum-Blended MDF Panels

One set of panels was constructed to determine resin penetration and distribution onf the fiber surfaces and then flow patterns during the pressing process. The first set of MDF panels were constructed at the Dynea research facility located in Winnfield, LA, USA and measured 300- by 300- by 15-mm. Before blending, the moisture content was determined for each of the loblolly pine fiber types and refiner pressures. The appropriate quantity of water was then added with the resin to yield a target unblended fiber moisture content of 10%. The water was added to the resin prior to blending to ensure uniform distribution of moisture. The appropriate amount of 65% non-volatile solids urea-formaldehyde resin (8% resin solids based on oven dry fiber) and the additional water was applied via spray atomization in a rotary drum blender. MDF mattresses were then formed using a cyclone attached to a laboratory scale hammer mill with the screen removed. The mattresses were hot-pressed to thickness at 160°C for 270 seconds. The hot-press cycle does not reflect the 30 second close time and a 10 second decompress time. A target density of 780 kg/m^3 was used for this study. A total of 220 test panels were manufactured.

Blowline-Blended MDF Panels

MDF panels were produced on-line at the BioComposites Centre with 600- by 600- by 13.5-mm dimensions. These were produced using the fibers obtained from the 4 loblolly pine zones refined at 4 different pressures (5.5, 7, 8.5, and 10 bar) resulting in 16 different zone/pressure fiber combinations. Each fiber combination was blended with each of 3 different UF resins varying in molecular weight (all with a solids content of 50%). The resins varied in molecular weight (high, low, and medium) and had viscosities of 233, 325, and 589 centipoises. Three panels were produced for each fiber/resin combination. The resin was injected into the blowline at a point 1 meter from the blow valve. The target resin addition level was 10% resin solids based on the oven-dry weight of the fibers. A wax emulsion was also injected into the refiner at an addition level of 0.5%. Formed mattresses were cold pre-

pressed and then transferred to the hot press. Panels were pressed at 160°C with a press cycle time of 250 seconds. The target density was 780 kg/m^3.

Determination of Resin Distribution

Selected panels from Phase I (vertical drum blended) and Phase II (blowline blended) were constructed with a fluorescent dye to investigate resin distribution and cell wall penetration. For selected panels, a 1% by weight based on resin solids of Rhodamine B was added to the resin immediately prior to blending. The Rhodamine B resinated fibers were formed and pressed in accordance with standard techniques and settings. These samples were then observed with a BioRad 1024 confocal scanning laser microscope (CSLM).

RESULTS AND DISCUSSION

It is generally difficult at best to determine the effect of refining pressure on the properties of wood fibers and the corresponding MDF panels because of the vast number of invariate parameters inextricably linked to the refining process. The goal during the refining of the chips into fibers was to maintain a relatively constant throughput of fibers amongst the various pressure regimes. This was done primarily by adjusting plate gap and retention time.

Effect of Refining on Fiber Quality

Understanding of resin distribution on the fiber surfaces and penetration into the cell wall begin with the physical properties of the refined fibers. The effect of refiner pressure on fiber furnishes is apparent by the color change seen in Figure 1. The fibers refined at 2- and 4-bar pressure were light in color and comprised primarily of fines and shives. The shives of the low-pressure refined fibers were large in number and size. Fibers refined at 12-bar pressure and greater showed an increased darkening of color with increasing pressures. In conjunction with the color change, an increase in refining pressure also increased the number of fines. Fibers generated at 18 bars of pressure were powder-like in consistency and deep brown in color. These trends were present for all four levels of juvenility.

Scanning electron micrographs show that fibers refined at lower pressures contained numerous intrawall tears (Fig. 2). Fibers refined at intermediate pressures had rather smooth surfaces with a lightly granulated surface, the probable result of redeposition of constituents during the refining process. Fibers refined at high pressures were highly fragmented and predominantly fine fractions. Subsequently, an attempt was made to quantify surface characteristics of all juvenilities and refiner pressures with an atomic force microscope (AFM). Chemically-macerated and refined fiber images on the AFM are shown in Figure 3. Several algorithms were employed with the AFM images but were unsuccessful in distinguishing various fiber types. Although it was hoped that fiber surface roughness or total fiber surface area as determined with the AFM might prove useful in determining subsequent panel properties, the inability to distinguish even the most rudimentary fiber properties questions the usefulness of the AFM as it pertains to MDF research.

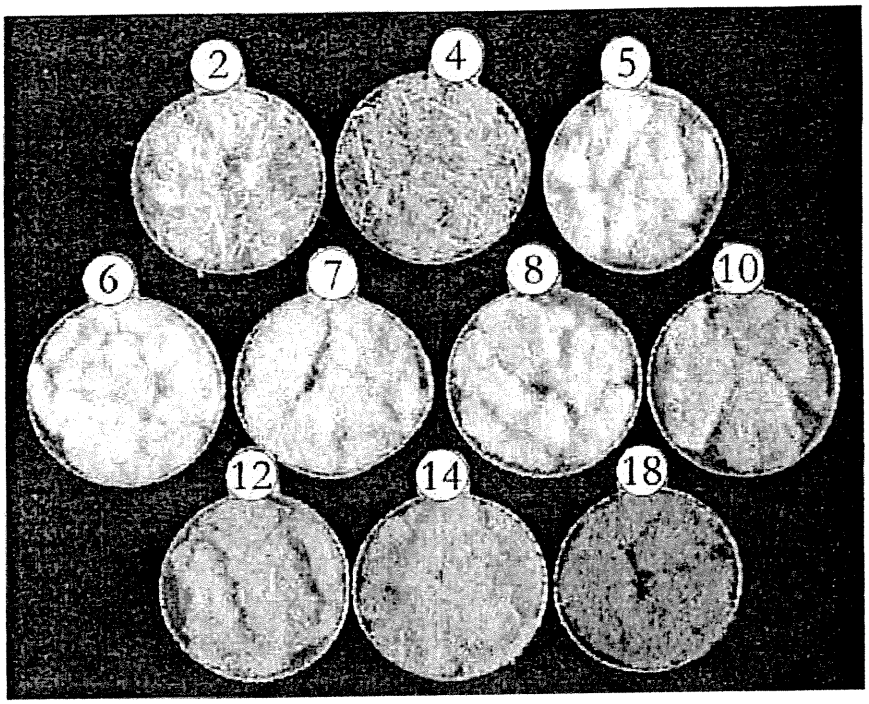

Figure 1. Fiber furnishes refined at pressures ranging from 2 to 18 bar. The chip source for these fibers was juvenile loblolly pine.

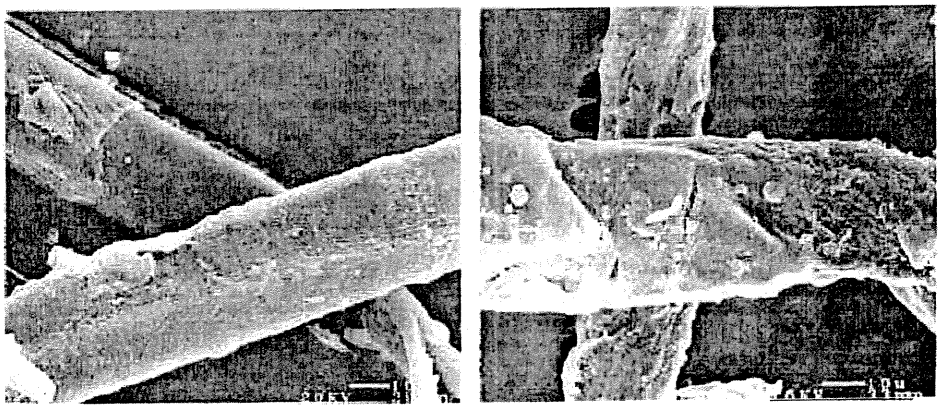

Figure 2. Scanning electron micrographs of refined juvenile loblolly pine fibers. The image at left was refined at 8 bars pressure; the right image was refined 18 bars pressure.

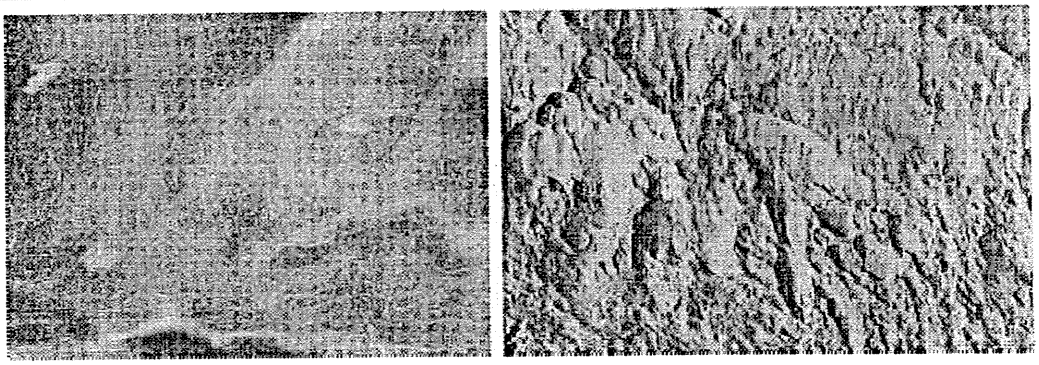

Figure 3. Atomic force micrographs of loblolly pine fibers. The left image is of a loblolly pine fiber that was chemically macerated (5 micron scan). The image at right is also of a loblolly pine fiber but one that was refined at 8 bars pressure (25 micron scan).

Resin distribution on the wood fiber surface: The distribution of UF resin on the surface of drum-blended and blowline-blended fibers is currently being studied. Figures 4, 5, and 6, respectively, show the distribution of low, medium, and high MW UF resins on drum-blended fibers. Confocal microscope observations of fiber furnish coated with low MW UF resin show that the resin distributed on the fiber surfaces were comprised of very small to very large droplets that readily wet with a small contact angle (Fig. 4). Observations of the high MW resin show there were a greater number of large droplets with much larger contact angles (Fig. 6). Medium MW resin falls somewhere in between (Fig. 5). An attempt is currently underway to quantify the 3-dimensional size and distribution of these resin droplets.

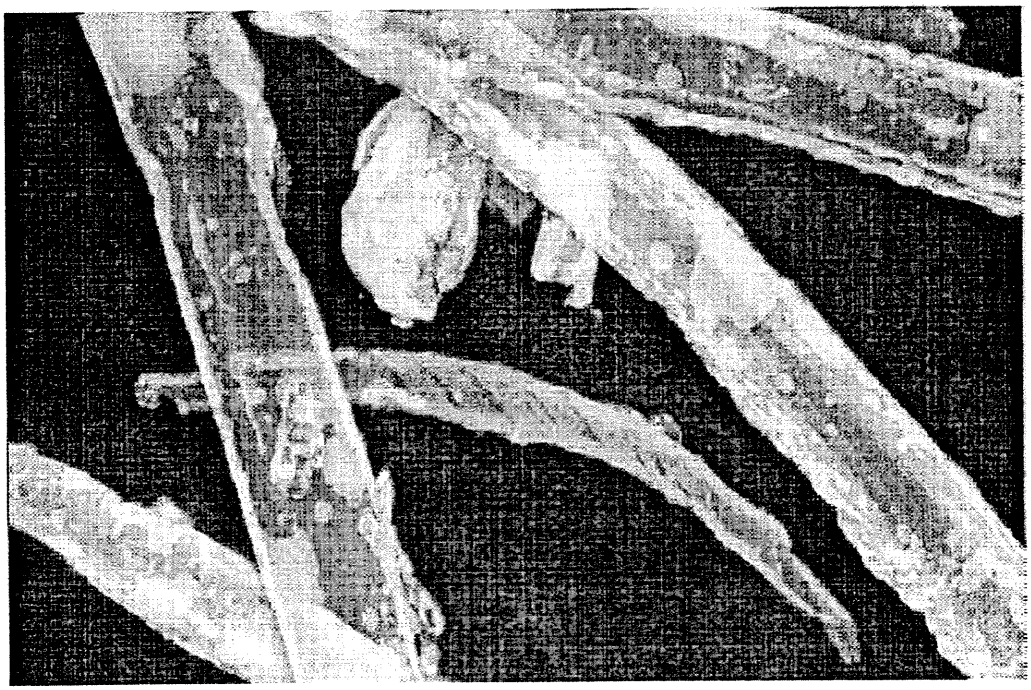

Figure 4. Distribution of a low molecular-weight UF resin on the surface of a drum-blended fiber extracted from MDF furnish

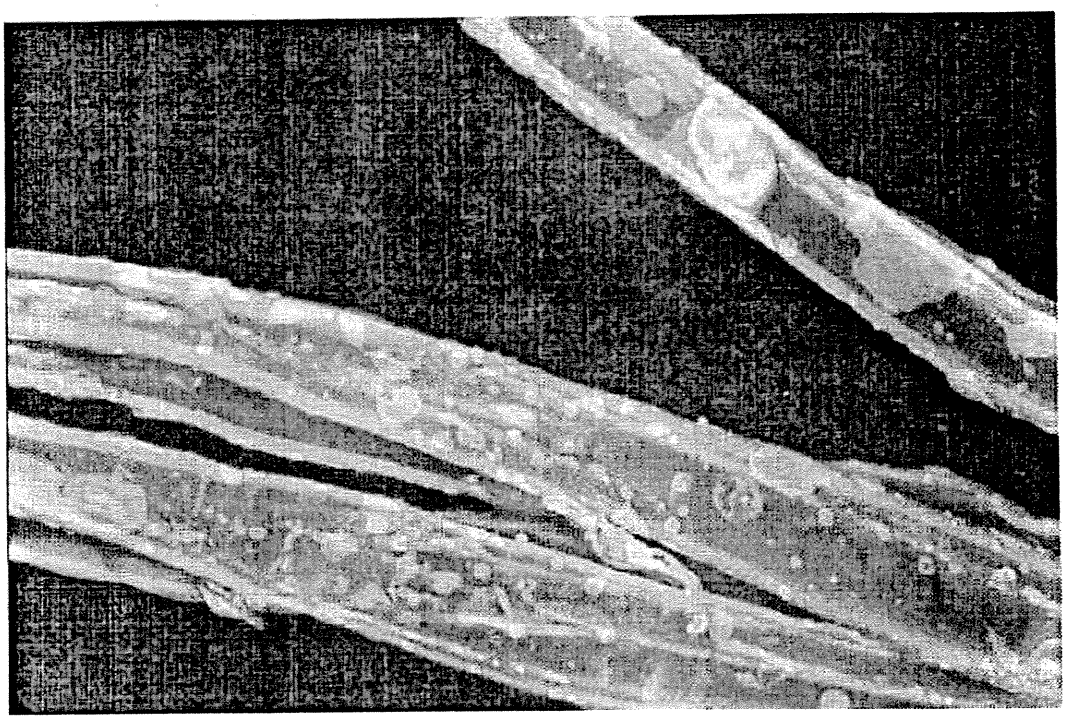

Figure 5. Distribution of a standard MW UF resin on the surface of drum-blended fibers from a MDF furnish

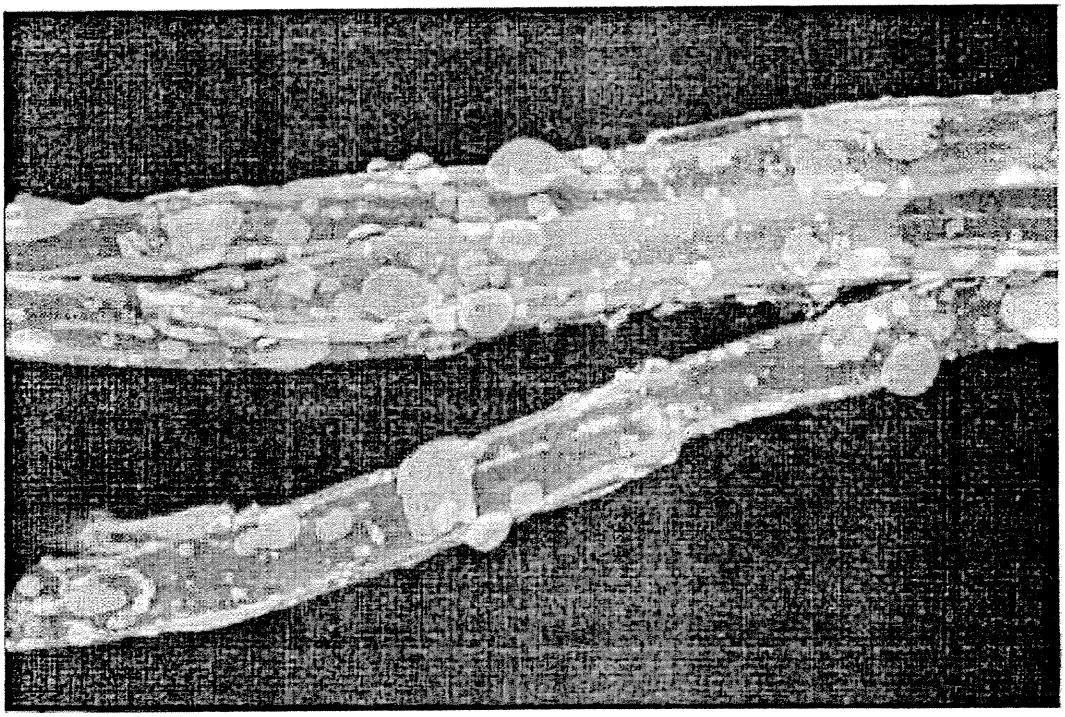

Figure 6. Distribution of a high MW UF resin on the surface of drum-blended fibers from a MDF furnish

Resin Penetration

The also appears to be a distinct propensity of the UF resin of all molecular weights to migrate through the cell wall and coat the fiber lumen surface by capillary action. This is especially evident in fiber removed from pressed panels. Figure 7 shows a fiber removed from the core of a MDF panel with resin migration into the cell wall lumen. In this case, resin migration occurred through a pair of pits. But typically, resin migration into the cell wall and lumen occurred through cell wall intra- and interwall cracks resulting from the refining process. An example of this lumen migration is shown in Figure 8. The cracks generally followed the microfibril angle of the S2 layer. Juvenile fibers appeared to have a greater propensity for cracking and thus providing additional paths for resin migration. The number and severity of cracks are being quantified for statistical analyses and will also include resin migration as well.

Figure 7. Confocal micrograph showing the UF resin penetrating through two pits in the wood fiber. This fiber was removed from the core of a MDF panel.

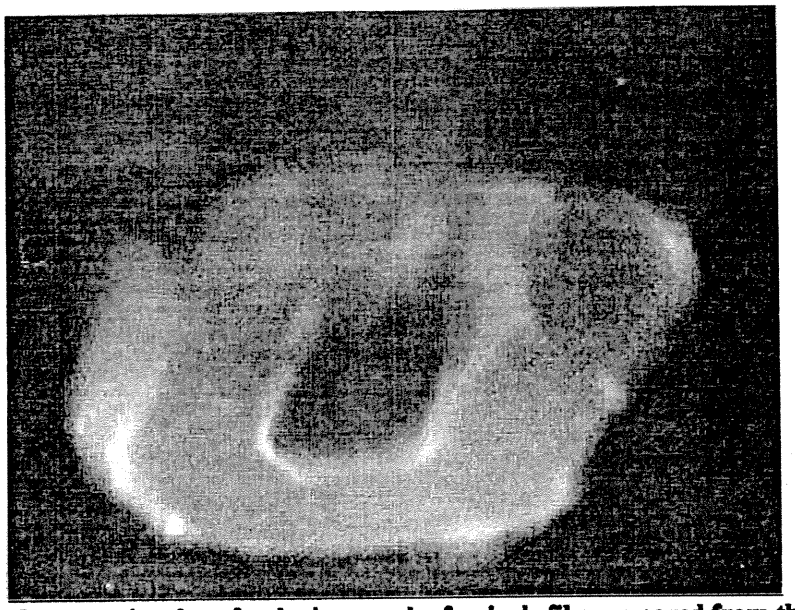

Figure 8. Cross-sectional confocal micrograph of a single fiber removed from the core of a MDF panel. Note the resin coating the lumen surface via a crack (top).

Comparison between drum-blended and blowline-blended fibers

The ability to determine resin distribution and penetration of UF resins on individual fibers vary with the resin application technique. Figures 9 and 10 show the difference in resin distribution on individual wood fibers and in the MDF panel, respectively. There are several factors that control this change in resin distribution. Drum-blending is done at relatively dry fiber moisture contents and the fiber move slow enough such that fiber-fiber interactions are at a minimum. The application of resin in a blowline occurs with fibers at a high moisture content and thus the contact angle of the resin at initial contact is greatly minimized (Bucking 1982). This increased resin spreading as well as fiber velocity in the blowline upwards of 100m/second result in a very thin distribution of resin on the fiber surface (Gran 1982). The thin, homogenous nature of the resin on blowline-blended fibers makes analysis difficult because of the fluorescent interactions with the residual lignin in the wood fibers.

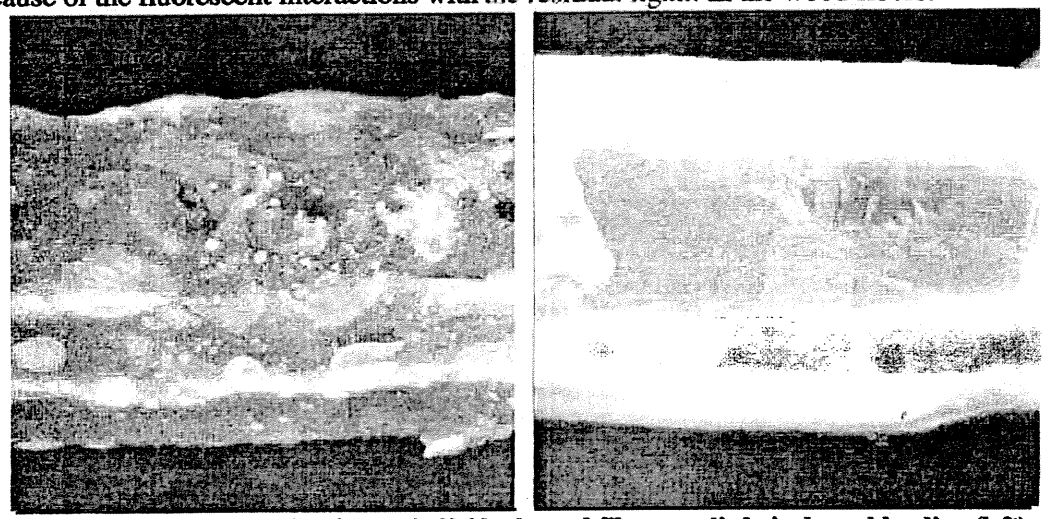

Figure 9. UF resin distribution on individual wood fibers applied via drum blending (left) and blowline blending

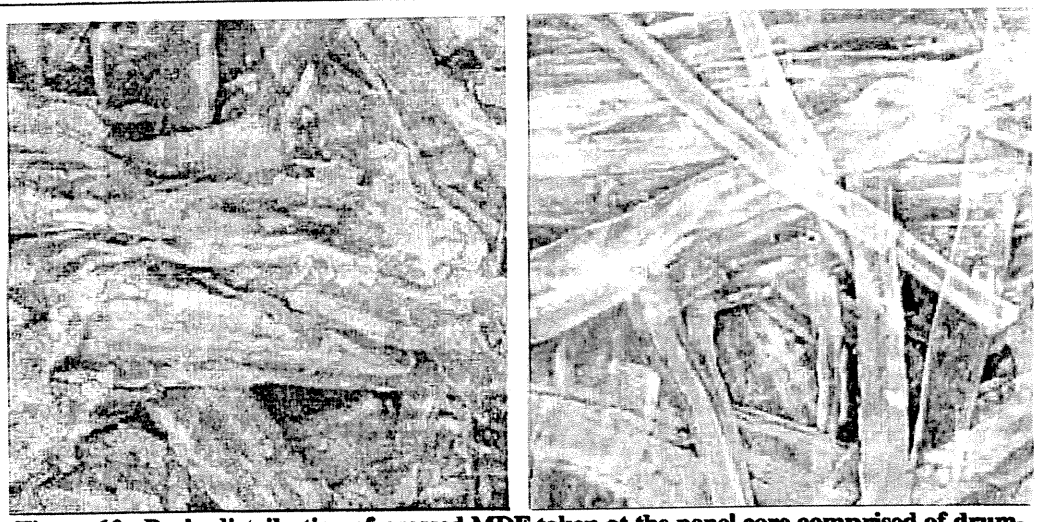

Figure 10. Resin distribution of pressed MDF taken at the panel core comprised of drum-blended fibers (left) and blowline-blended fibers (right)

Applicability of AFM to Evaluate Resin Distribution

An attempt was made to evaluate the distribution of resin on fiber surfaces in this study. The digital nature of the AFM allows for numerous algorithms to quantify surface features and it was thought that it may prove applicable on these fibers. It was found in this study that although the AFM was capable of producing high resolution images, its usefulness in these types of studies are questionable. The AFM is useful in differentiating resin and wood fiber surfaces (Fig. 11). However, the slow acquisition rate of the AFM limits its practical use on studies of this magnitude. Another disadvantage of the AFM is that it can only evaluate surface distribution and provides no data on penetration.

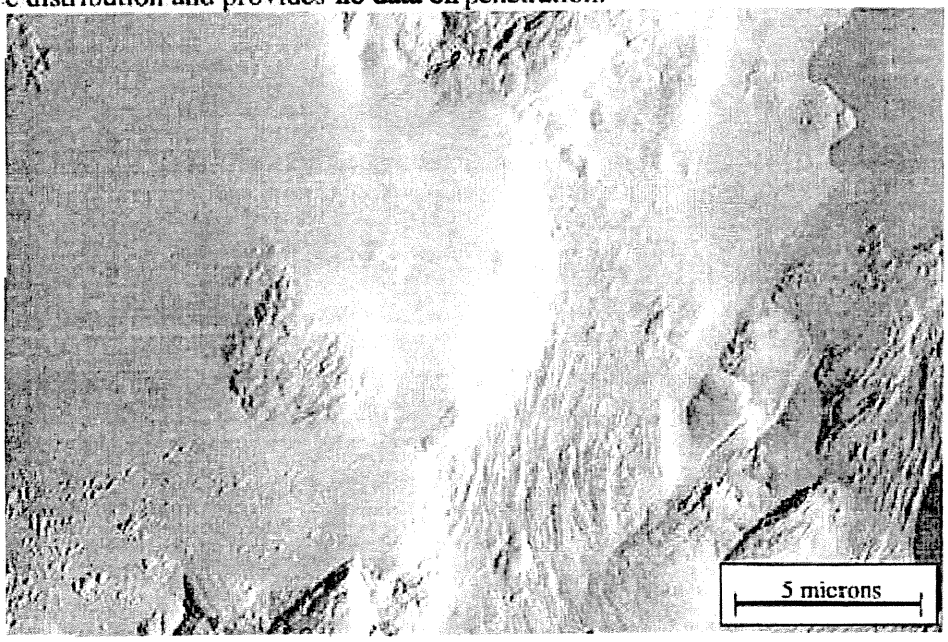

Figure 11. Atomic force micrograph of a refined loblolly pine fiber with a standard MW UF resin. The left half of the images is coated with resin. The right half of the image show the remnants of a pit border.

Effect of pressing on resin flow

Although the analysis is currently underway to correlate resin distribution on the fiber furnish with actual MDF resin distribution, some observations have already been noted. The most noteworthy being that the differences in resin distribution in a MDF panel after pressing with low, medium, and high MW resins is not as easily distinguishable as with the corresponding furnish. Figure 12 is an image of a MDF panel core sample with low MW resin. Figure 13 is a similar image of a MDF panel core sample except with a high MW resin. It is difficult to distinguish the figure by physical observation alone. It may be that no correlation exists between resin MW and resin distribution inside a MDF panel. A full quantifiable analysis is to be conducted for a statistical assessment.

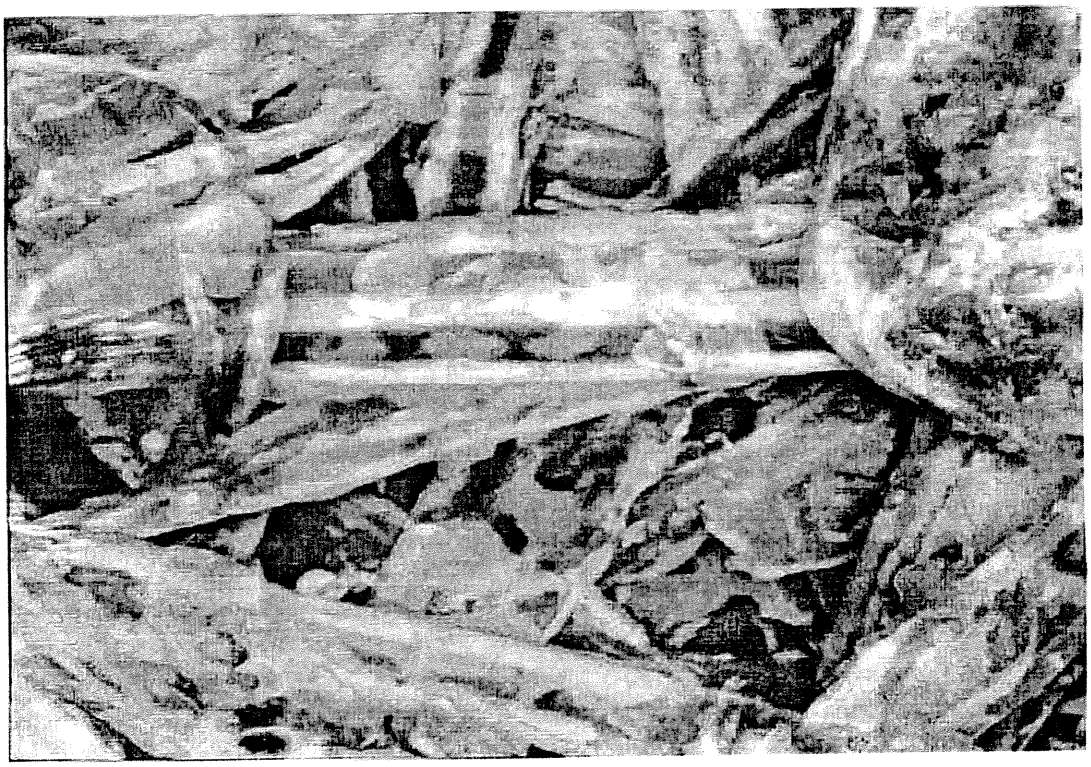

Figure 12. Confocal micrograph of MDF core. The MDF panel was constructed with low MW UF resin.

Figure 13. Comparable MDF panel core made with high MW UF resin.

CONCLUSIONS

This paper shows some of the relationships between raw materials, refining pressures, and adhesive molecular weight (MW) as they pertain to distribution on and penetration of UF resin in relation to individual wood fibers. Resin distribution was characterized by adding fluorescent stain to the resin and analyzing the fibers with a confocal microscope. Resin distribution was also studied with an atomic force microscope but the technique was too slow and limiting.

Resin distribution on the surface of drum-blended fibers is a function of resin MW. Low MW resin had a wider distribution and a lower contact angle than the corresponding high MW counterpart. These distributions did not carry into the MDF panel as both appeared to be distributed in core samples after pressing. It was also found that resin penetration into the lumen occurred through the two most common breaches of cell wall continuity: pit aperatures and fractures. Although it appears cell wall fractures are the more common location for the migration of resin in the lumen, a thorough numerical analysis is currently underway to quantify this observation.

REFERENCES

Bucking, G. 1982. Resin blending of MDF fiber. In: Proceedings of the 16th Particleboard/Composite Materials Symposium, Washington State University, Pullman, Washington, pp. 269-276.

Gran, G. 1982. Blowline blending in dry process fiberboard production. In: Proceedings of the 16th Particleboard/Composite Materials Symposium, Washington State University, Pullman, Washington, pp. 261-267.

Groom, L.H., Mott, L., and S. Shaler. 1999. Relationship between fiber furnish properties and the structural performance of MDF. In: Proceedings of the 33rd International Particleboard/Composite Materials Symposium. 13-15 April 1999, Pullman, Washington. pp. 89-102.

Groom, L.H., Rials, T., and R. Snell. 2000. Effects of varying refiner pressure on the mechanical properties of loblolly pine fibers. In: Proceedings of the Fourth European Panel Products Symposium, 11-13 October 2000, Llandudno, Wales, UK. pp. 81-94.

Kamke, F.A., and Scott, K.A. 2000. Measurement of UF resin distribution in MDF fibers. In: Proceedings of the 4th European Panel Products Symposium, Llandudno, Wales, pp. 114-124.

Scott, K.A. 2001. Economic feasibility of implementing a resin distribution measurement system for MDF fiber. M.S. thesis, Virginia Polytechnic Institute, Blacksburg, Virginia. 76p.

Xing, C., Riedl, B. and Cloutier, A. 2004. Measurement of urea-formaldehyde resin distribution as a function of MDF fiber size by laser scanning confocal microscopy. Wood Science and Technology, Vol. 37, No. 6, pp. 495-507.