DROPLET DYNAMICS APPLIED TO THE ASSESSMENT OF WATER PENETRATION RESISTANCE OF COATINGS ON WOOD

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ABSTRACT

Surface free energy is usually determined by measuring the contact angle of a probe liquid deposited on a surface, at a moment in time. When dynamic image analysis (DIA) is used, it becomes possible to track the behavior of an evaporating droplet. The geometry of a spherical sessile droplet on a surface can be characterized by a number of parameters, including volume, contact angle, height, cap radius, base radius, cap and base areas. The conducted study shown that at any moment in time, if only two droplet parameters out of these listed above are known, all other parameters were able to be determined, using simple geometrical formulas. In a general case, the two parameters given were the droplet volume and the contact angle. A simple model was then developed to predict the dynamic behavior of spherical sessile droplets on impermeable surfaces. With a known evaporation rate, it became possible to characterize and predict the droplet shape dynamics. With further knowledge on the receding contact angle, a more complex droplet behavior can be simulated. The model was then used to simulate experiments reported by other researchers, showing that simple geometrical relations account for many features of the dynamic sessile droplet behavior reported in the literature. It is also demonstrated that the often reported bulk evaporation rate, without being adjusted to the droplet cap area, should not be used as a meaningful indicator of droplet dynamics. In addition, other studies have shown that the intensity of the evaporation over the cap area is not uniform. The present work also studied the effect of droplet geometry on the average intensity of evaporation in non-saturated environments. The evaporation flux is shown to be related to the contact angle and to the droplet shape factor. An experiment was conducted by polymerizing glass slides with octadecyltricholorosilane (OTS) in order to obtain different hydrophobicity surfaces, thus resulting in different contact angles and droplet cap and base areas. The results show a linear correlation between the evaporation flux and a range of the droplet shape factor, defined as the cap area over the base area. By correlating the droplet geometry with the average evaporation flux, it is possible to determine the volume of liquid that diffuses into a permeable surface. This is accomplished by developing a model that subtracts evaporated volume from total droplet volume. The difference will then correspond to the amount of water that diffused into the permeable surface. The fact that one can quantify this diffused water allows a further application of the concept to the field of wood surface science. Particularly, it becomes possible to apply the DIA, as a low cost and reliable method, to assess the resistance of water penetration of coatings on wood, by quantifying and comparing the diffused water among different samples.

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Faculty advisors: Lech Muszyński & Douglas Gardner

THE ABILITY OF NEAR INFRARED SPECTROSCOPY TO MONITOR WOOD DENSITY

Brian K. Via, Chi-Leung So, Todd F. Shupe, Michael Stine, and Leslie Groom

ABSTRACT

Wood density was a function of the area under the spectra curve. The root mean square error of calibration (RMSEC) was approximately 0.045 with an R2 ≈ 0.70. Depending on the modeling technique, 15 to 30% of the overall density variation was due to wood chemistry associated wavelengths, independent of latewood fraction. However, such a distinction is difficult to discern given the covariance between latewood/earlywood density, and chemical morphology. When estimating the standard deviation of density, an RMSEC of 0.03 was achieved when a replicate of only 3 was used. Much tighter RMSEC's are possible with increased samples size per data point. Such data acquisition would be feasible on a manufacturing line where data acquisition can occur continuously.

Bending Strength Properties of Hot-Melt Adhesives Used in Kitchen Cabinet Construction

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Hot-melt adhesives were first introduced to the furniture industry in the 1950's commonly for edge banding operations. More recently however, they have found applications in the assembly process, particularly in attaching the back panel to the top, bottom, and side panels of kitchen cabinets. This study deals with primarily the bending strength properties of three hot-melt adhesives on four common back panel joint constructions. It describes contribution of staples when used together with the adhesive in joint construction and also assesses the effects of changes of temperature and humidity based on the condition experienced in service and during transportation. The general results showed that there was no significant difference between the three hot-melt adhesives used. The results also showed that butt joint had the best performance when using all the three hot-melt adhesives as compared to the rabbet 1, rabbet 2 and butt joints. Staples use in adhesive joint construction did not have any strength contribution, but the changes of temperature and humidity greatly influenced the strength with ethyl vinyl acetate performing best at low temperatures and polyamide performing best at high temperature. From the study it can be concluded that under bending loading conditions it is sufficient to use hot-melt adhesive without the additional use of staples in joint construction. It can also be noted that for better performance choice of a hot-melt should be based on the service condition.

Title: Effect of Juvenile Wood on Strength Properties, Dimensional Stability, and Durability of Black Spruce Medium Density Fiberboard Panels

Author: Jun Li Shi [1&2], S.Y. Zhang [1&2], and Bernard Riedl [1]

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Abstract

Black spruce (*Picea mariana* (Mill.) BSP.) is one of the most important commercial species in Eastern Canada. This study was conducted to examine strength properties, dimensional stability, and durability of medium density fiberboard (MDF) panels made from black spruce 0-20, 21-40, and over 40 year old wood. The information derived from this study is essential for forest management to determine black spruce tree rotation period so that economical and effective utilization of forest resources can be achieved.

MDF panels were manufactured under the same pressing program. After 4 weeks of conditioning at 22 ^{o}C and 65 % relative humidity (RH), the panels were evaluated for modulus of rupture (MOR), modulus of elasticity (MOE), internal bonding (IB), linear expansion (LE), thickness swell (TS), and water absorption in accordance to ASTM D 1037-99, while durability was evaluated by inspecting the scale of mold growth on the panels after 4 weeks of incubation at favorite condition. An analysis of covariance (ANCOVA) was performed in this study to examine the differences in panel MOR, MOE, and TS using panel density as a covariate to adjust the mean values that were partly attributed to panel density. Results indicate that MOR, IB, and water absorption of MDF panels made from 0-20 year-old fiber, which contained 100 % juvenile wood, were significantly superior to those of panels made from the other two age classes; whereas, LE of MDF panels made from 0-20 year-old fiber was significantly higher than that of panels from the other two age classes. The differences in MOR, IB, LE, and water absorption between MDF panels made from 21-40 and over 40 year-old fiber were not significant. The comparisons of panel MOE and TS were relatively dependant on panel density due to existence of interactions among the 3 age groups. There was no significant difference in MOE between the age groups of 0-20 and 21-40 while panel density was in the region of 716-743 kg/m^3 at 0.05 of probability, however, if panel density was lower than 716 kg/m^3 or higher than 743 kg/m^3, difference in MOE between the two groups became significant. Difference in MOE between the groups of 0-20 and over 40 was not significant while panel density ranged from 642 to 748 kg/m^3. If panel density was lower than 642 kg/m^3 or higher than 748 kg/m^3, the difference in MOE between these two groups was significant. Durability against mold infection of MDF panels made from 0-20 year-old fiber was the best and significantly different from that of panels made from the other two age classes. Additionally, panel density had a considerably influence on panel MOR, MOE, and TS.

This study was sponsored by NSERC (Natural Sciences and Engineering Research Council of Canada), Forintek Canada Corp. and Université Laval.

Dielectric Characterization of Phenol-Formaldehyde Cure

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Abstract

The wood composites industry is constantly looking to optimize its production processes. Beyond the installation of larger pressing equipment, it has been difficult to increase processing capacity beyond current levels. Because the cure time is often the bottleneck of composite manufacturing processes, it is important to understand cure rates of today's thermosetting adhesives.

This research attempts to create a detailed and accurate model of phenol formaldehyde cure behavior using viscosity data from a parallel plate rheometer. This data can then be used to optimize press conditions and reduce production times and costs.

The research will further examine resin cure through dielectric analysis; such a technique could monitor resin cure directly and in real-time press situations. Hot-pressing processes could conceivably no longer require a set press schedule; instead they would be individually set based on dielectric data for every press batch. Such a system may lead to a more efficient and uniform product because press times could be based on individual press cycles instead of entire product lines. A more likely scenario, however, is the use of *in situ* adhesive cure monitoring for troubleshooting or press schedule development.

Cure Modeling: This is a continuation of a previous project. Consistent experimental methods will be used to ensure any data produced is comparable to data found in the previous study. Five temperature ramps of 1, 5, 7.5, and 10ºC from 25 to 150ºC will be used to approximate the cure in press situations and to compensate for the

slow heating of the rheometer chamber. Oscillation of the rheometer will be controlled by % strain.

Dielectric Analysis: Oriented strand board composed of commercial yellow-poplar (*Liriodendron tulipifera*) will be used for any panels formed in the study. Flakes will be prepared by the student. Results from such a board should be able to be applied to subsequent, different wood composites.

Mats of differing water contents and different press schedules will be required to test the accuracy of the dielectric measurements performed by the press equipment. Board thickness will also be varied to ensure accurate results can be obtained throughout a range of useful board thicknesses. Because the system has the capability to vary signal strength and frequency, this should allow for enough control to isolate a signal that corresponds to resin cure.

Mechanical and physical properties evaluation will be performed as described in ASTM D1037. Static bending, internal bond, thickness swell, and water absorption will be tested.

Due to equipment problems data collection has not yet begun, therefore no results are yet available.

Sawing and Drying of Hardwood Lumber from Small Diameter Logs for Optimum Utilization

Matthew S. Scholl, Paul R. Blankenhorn, Jan Wiedenbeck, Lee R. Stover

Each year sawmills are processing more and more smaller diameter hardwood logs. Most of the mills do not know the lumber yield, lumber grade, or cost of processing these logs. For this project small diameter (10" and lower) black cherry, red oak, and sugar maple logs are sawn on a portable bandmill. The location of each board is mapped in relation to the logs profile. After being sawn every board is examined for end checks, surface checks, shake, twist, bow, cup, crook and pre-drying grade. Drying is conducted through the use of conventional kiln drying schedules and two modified kiln schedules. The first modified kiln schedule lowers the initial dry bulb setting, while the second decreases the final dry bulb setting. After drying each board is examined for end checks, surface checks, shake, twist, bow, cup, crook, and post-drying grade. Other characteristics that are being noted include slope of grain, degree of slope of grain, and the presence or absence of pith. By mapping the boards as they are sawn and testing the modified kiln schedules an optimum sawing pattern and kiln drying schedule will be determined. Lastly, the strength and dimensional stability of the lumber will be investigated. The goal is not only to saw and dry clear-faced lumber but to also ensure the woods performance in service. This study will provide the wood products industry with a better understanding of processing small diameter hardwood logs.

Improving the Performance of Thermosetting Wood Adhesives Using Multiphase Emulsions

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Abstract: Despite intense competition and possible improved utilization efficiency, North American wood composite manufacturers are limited with only two commercially viable exterior grade thermosetting adhesives: alkaline phenol formaldehyde (PF) and polymeric methylenebis(phenylisocyanate) (pMDI). Recent studies have shown that a simple physical blend of the aqueous PF and the organic pMDI may offer several synergistic improvements over the two existing technologies. While this blend of "old" technologies may hardly seem novel, the dual-phase nature of this immiscible blend actually provides new areas for adhesive development through manipulation of the "oil-water" interface. However, many properties of this system remain poorly understood.

In this study the hybrid's liquid morphology is examined along with its impact on the solid-state adhesive properties following cure. A polymeric membrane is found to rapidly encase the dispersed pMDI phase upon resin blending. This rationalizes several unusual thermal transitions reported in literature, but challenges their methods used in determining the hybrid's residual isocyanate content. PF adhesives of varying alkali and methylol contents are synthesized to further probe this interface. Their effect on the hybrid morphology is studied using optical microscopy, flow rheology and oscillation cure rheology. The literature reported residual isocyanate contents are also reexamined using alternative methods. Dynamic mechanical analysis is then used to examine the thermal transitions and degree of PF-pMDI molecular interaction occuring in cured test specimen prepared from the liquid hybrids. A low temperature glass transition is identified near that of neat pMDI, suggesting that the polymeric membrane may be inhibiting cure. Solid-state ^{13}C nuclear magnetic resonance and Fourier transform infrared spectroscopy are then used in conjunction with the sample dynamic mechanical analysis to better explore this low temperature transition as well as several other observed thermal transitions. Finally, imaging of the solid state morphology is performed using transmission electron microscopy.

TITLE:

Best Manufacturing Practices and their Linkage to Top-Performing Companies in the US Furniture Industry

AUTHOR:

Henry Quesada

AFFILIATION:

Ph.D Candidate. Department of Forestry and Natural Resources, Purdue University.

ABSTRACT:

This study has three objectives - to determine and rank manufacturing practices, to statistically test if best manufacturing practices are related to higher performance in the furniture industry, and to develop a database of best manufacturing practices for use by industry.

Four average and two world-class manufacturers were involved. Two plants produce kitchen cabinets, two office furniture, one office furniture and household furniture and one institutional furniture.

In order to determine the initial set of manufacturing practices, a gap analysis was performed in all plants. The resulting initial set of 122 identified manufacturing practices was then scored using a criteria matrix for identification and evaluation of best practices. By using logistic regression, the use of best manufacturing practices was positively linked to higher company performance.

Finally, a database of best manufacturing practices was developed. Results of this study show that the best manufacturing practices classification matrix can be easily adopted by any plant or company in the manufacturing sector..

FACULTY SPONSOR:

Dr. Rado Gazo.

Associate Professor. Department of Forestry and Natural Resources. Purdue University

A VECTORIZATION OF THE RASTER IMAGE OF THE TRANSVERSE PLANE OF SOFTWOOD: DIFFERENTIATION OF THE REGIONS OF THE SECONDARY WALL AND THE COMPOUND MIDDLE LAMELLA (CML)

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Wood is a hierarchical material but often treated as a material without the hierarchical structure. The negligence of the hierarchical characteristics of the wood may produce too simplified a result to describe the complicated internal physical and mechanical processes inside the wood. The simplication based on several assumptions has been conducted by many researchers partly due to the lack of methods to connect the anatomical characteristics of the wood to the material properties of the cell wall.

Integration of a numerical method and the hierarchical structure is the crucial step to evaluate the effect of the anatomical characteristics, such as the shape and the distribution of the cells, and the material properties of the cell wall. There have been many studies to calculate the material properties of the cell wall using the material properties of the chemical constituents of the cell wall. However, the studies could not provide the link between the effect of the anatomical characteristics of the wood and the material properties of the cell wall.

Numerical methods, such as the Finite Element Method (FEM), the Finite Difference Method (FDM), and the Finite Volume Method (FVM), have been adopted to simulate the physical and mechanical behavior of the wood. Unfortunately, the elements of the numerical methods often did not properly describe the anatomical characteristics of the representative volume, which includes a number of cells in the region.

A mesh generation technique is very important step for any numerical process. With the same constitutive equations, balance equations, and discretization method for a numerical model, the geometric configuration of the numerical model is the remained factor to affect the numerical result by the numerical model. Thus, it is required to develop a new meshing technique to describe the anatomical characteristics of the wood for the numerical methods.

The vectorization of raster image of the transverse plane of the wood is the technique to produce the anatomical mesh for the numerical method. The development and result of the vectorization procedure as well as the brief application of the technique will be shown in this presentation.

Comparing Abrasive Resistance of Different Woodfiber-Plastic Decking Materials to Solid Wood and Plastic Decking Material

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The US market for decking material is a large user of new woodfiber-plastic composite materials. One of the most important quality factors for any decking material is its resistance against surface wear, such as for example from human traffic. This study was performed to evaluate the abrasive resistance of commercially available woodfiber-plastic decking materials and to compare the performance of these materials to solid wood decking and pure plastic decking. In addition to the abrasive resistance, the surface roughness of all materials was monitored during the study.

Nine different decking materials where chosen for testing: five woodfiber-plastic composites (Choicedek®, Smartdeck®, Trex®, Fiberon®, Excel®), three solid wood products, namely Maple (*Acer spp.*), White pine (*Pinus strobus*), and Southern yellow pine (*Pinus spp.*), and one pure plastic decking material (CareFree®). The abrasive wear was tested with a Tinius-Olsen navy-type wear machine. The surface roughness of the samples was monitored with a laser optical profilometer during the whole test series. Test procedures followed ASTM standard 2394-83 and ASTM standard 1242-95a.

All materials except CareFree® showed a significant change in thickness at least once, over all cycles from 0 to 500. Similarly all materials except CareFree® showed a significant change in weight at least once, over all cycles from 0 to 500. The reason for the CareFree® material's apparently better performance could be that this material showed in particular signs of inclusion of abrasive grit into its surface. This abrasive grit could have concealed losses in weight and thickness during abrasion. The multi-comparison analysis of variance showed that among the 45 possible material combinations for thickness loss 15 pairs showed similar behavior over time. In the case of weight loss only one combination (Choicedek® and Fiberon®) showed a similar behavior.

In conclusion there was no evidence that one or more of the tested materials performed better or worse than the others with regard to abrasive wear. Future studies should be performed with exposure of the same materials to a different abrasive wear test procedure.

Acknowledgements: The author thanks Melanie Kail, Graduate Student, Department of Statistics, North Carolina State University, for statistical consulting. This study was supported by the Department of Wood and Paper Science, North Carolina State University, and by the Wood Machining and Tooling Research Program, North Carolina State University. It was performed under the supervision of Dr. Urs Buehlmann, Assistant Professor, Department of Wood and Paper Science, North Carolina State University.

Quantitative Analysis of Glue distribution in Wooden Dowel Joints Using Radio Frequency Capacitance

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Strength and stiffness performance of wooden dowel joints in furniture construction depends on dowel gluing quality in terms of glue distribution pattern and quantity applied. Lack of adhesive is one of the key causes producing weak joints. There is no existing device available to assist furniture manufacturers to monitor gluing quality and inspect gluing defects of wooden dowel type joints.

The radio frequency capacitance method is proposed and explored for determining gluing quality. The effects of the glue distribution pattern and glue quantity on the dielectric properties of wood composites were investigated. Two electrode arrangements, opposed and adjacent sensor positioning are proposed to measure the dielectric responses.

Preliminary experimental and simulation work indicated that the dielectric responses are sensitive to the polyvinyl acetate polymer emulsion (PVA) adhesive distribution pattern and the amount applied around the dowel fastener of a dowel joint. The adhesive distribution pattern influenced the dielectric properties of glued dowels in wood composites. These observations indicate that the radio frequency capacitance method can applied to measure gluing quality in terms of the glue distribution pattern and amount applied.

Abstract
For
SWAT Student Poster Competition
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Utilization of Chinese Tallow Tree and Bagasse for Medium Density Fiberboard (MDF)

The objectives of this research were to (1) identify the best adhesive system and (2) determine the optimum composite formulation for selected mechanical and physical properties of medium density fiberboard (MDF) made from Chinese tallow tree (*Sapium sebiferum*) and bagasse fibers. The mixing ratios of bagasse and tallow tree wood fiber were 100/0, 75/25, 50/50, 25/75, and 0/100 respectively, and the furnish moisture content (MC) was 4%. The resin systems used were 8% urea formaldehyde (UF), 2.5% MDI (4,4'-diphenylmethane diisocyanate), and a mixed resin system of 1% MDI and 4% UF. Panels containing 100 % bagasse furnish were also prepared with either 3.5% or 4.5% MDI at a furnish MC of 0, 4, and 8%. Two mixing combinations (50/50, and 25/75) of bagasse/tallow tree fiber yielded mechanical and physical properties which were not statistically different from higher proportions of *Sapium* fibers and provide the maximum utilization of bagasse fibers into the panels. The MC of the furnish and additional moisture from the resin applications were significant factors influencing the mechanical properties of the composites. MDF made from eight percent MC bagasse fibers obtained a 63 percent increase in modulus of rupture (MOR) and a 30 percent in modulus of elasticity (MOE) compared to composites manufactured with 0% MC furnish. Panels at all fiber combination ratios with the mixed resin system performed superior to all furnish mixes with 4.5% MDI for MOR and MOE. Internal bond (IB) test results showed that the mixed resin system yielded slightly lower IB mean values than panels produced with 4.5% MDI.

Utilization of Chinese Tallow Tree and Bagasse for Medium Density Fiberboard (MDF)

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Title: Understanding Seismic Behavior of Wood Shear Walls under Environment Effects from the Material Level by Testing and Modeling

By *Jian Li* PhD Candidate

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Abstract:

Wood shear walls are designed to resist lateral loads due to earthquake and winds, but the long term environment effect cause loss to performance of wood shear walls. It is important to know if wood shear walls can resist both disaster load and environment aging effect. Researchers have to separate the broad study into small parts and use different simple approaches because of technique difficulties and the lack of knowledge. It obstructs the further understanding of the seismic performance of wood shear walls.

The poster shows the current holistic research on seismic behavior of environmentally-exposed wood shear walls at UC, Berkeley. The research is conducted from material to substructure level by integrating modern NDE techniques, seismic testing methods, computer modeling and simulation underlying the state-of-the-art.

The research includes three related parts: sheathing and framing material, single sheathing-to-framing connection, and wood shear wall substructure.

At the material level, the local physical and mechanical properties of wood sheathing panels will be studied by using traditional test methods and X-ray attenuation or other NDE methods (Acousto-Ultrasonic).

The behavior of single sheathing-to-framing connection is assumed to be predictable from measurements of material. Single sheathing-to-framing connection will be characterized by a modified BWBN model and it can be used as a nonlinear finite element for different scale wood shear walls model.

The seismic performance of small scale wood shear walls substructure under moisture treatment will be studied by pseudodynamics test method with the new-developing hybrid control algorithm. Seismic behavior of full scale wood shear walls can be simulated and evaluated for different seismic signatures.

This research will help to improve the current design and construction method of wood shear walls and enhance the serviceability of wood shear walls.

** As the last PhD candidate, this research is for the memorial of Forest Products Laboratory at UC, Berkeley (1943~2003)"*

Changes in OSB Mat Permeability During Hot-Pressing

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Frederick A. Kamke, Professor, Sustainable Engineered Materials Institute, Virginia Tech, Blacksburg, VA. (Faculty Sponsor)

Abstract

Convective heat transfer during hot pressing in wood-based composite panel manufacturing is widely accepted as the most important means of heat transport for resin curing. The rate of convective heat transfer to the panel core is controlled by its permeability. Permeability in the plane of the panel also controls the flow of vapor to the panel edges, thereby influencing the potential for panel "blowing".

This research considers how flake thickness, flake alignment and changing mat density during hot pressing influences OSB mat permeability, through its thickness and in the plane of the panel. Some previous research exists but it fails to address the affects of horizontal and vertical density gradients as well as flake alignment.

An apparatus was designed to allow cold pressing of aligned flakes to desired densities while enabling permeability measurements through the mat thickness. An additional apparatus was designed to allow the measuring of permeability in the plane of the panel. These designs permitted permeability measurements in mats that had no vertical density gradient, allowing for the direct study of permeability versus density.

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The Analysis of Tool Wear Reduction When Using Refrigerated Air for Tool Cooling

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Abstract

Using liquid coolant when machining metals is a common practice to reduce tool wear. Due to the hygroscopic nature of wood, using liquid coolant in machining wood-based materials is not practical. An alternative way to cool down tools is through the use of refrigerated air. To date, no specific study of the use of refrigerated air to reduce tool wear when machining wood has been conducted. In this study, effects of the application of refrigerated air when cutting a medium density fiberboard were analyzed. The purpose was to see if tool wear can be reduced by cooling the tool. Twenty-eight 4 X 8 sheets of ¾" thick medium density fiberboard were cut on a CNC router. Two half inch diameter tungsten carbide router bits were used. The twenty eight MDF sheets were divided into two groups of fourteen sheets each. One group was cut with and the other without refrigerated air. The refrigerated air was applied through a cold air gun using vortex tube technology. A tool RPM, feed speed, and depth of cut were set according to tool manufacturer recommendations. A current draw of the router spindle was measured with a power analysis equipment to monitor router bit performance. Tool wear was analyzed with a Nikon SMU-Z stereo microscope. Results show that there is a difference in the condition of the tool between the two cutting methods. The corrosion of carbide occurred extensively near the cutting edge of the router bit which cut without the refrigerated air. Results from this study can be used to improve the productivity of the machining of wood products and provide information to prolong tool life.

Faculty Sponsors

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Comparison Of Sample Board End Coating For Industrial Kiln Drying.

Abstract:

Moisture content is used to control the kiln schedule for drying hardwood lumber. Changes in moisture content are usually determined using sample boards. Sample boards are small clear specimens that are end coated to achieve drying rates similar to full length boards. Sample boards should be selected to contain examples of the variability represented in the load.

Sample boards are used for both manual and weight based automatic kiln control system. Since the schedule used is controlled by samples it is important that they behave in the same manner as the rest of the kiln load. It is well known that wood dries 10 to 15 times faster from the end grain, therefore, samples boards must be coated with a moisture barrier on the end grain to represent the drying rate of full size lumber.

There are several commercial end coatings available that have been shown to provide an adequate moisture barrier for kiln samples. However, a great number of commercial drying operations use tar based products and aluminum paint. Previous research has shown that the diffusion coefficient for tar based products is much higher than the commercial end coatings.

The objective of this research was to compare the effectiveness of several different end coating treatments used in commercial drying operations. The end coating treatments include: two commercial end coating products, two tar based products, aluminum paint and standard marking paint. Comparisons where made between the different sample boards and matched full length boards.

Understanding Customer Value in the Oriented Strandboard Industry

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Abstract

Today, the Oriented Strandboard industry in North America is facing concerns of increasing overcapacity and a product reaching its mature life cycle stage, especially in the structural sheathing markets. In order to create a positive shift in OSB growth phase (extend growth phase) and identify opportunities for product differentiation, managers in OSB firms need to understand the factors that create customer perceived value in the OSB industry. Creation and delivery of customer perceived value is identified as the only way to achieve competitive advantage (through product differentiation) and higher financial and social benefits in business markets in the present decade (Anderson and Narus 1999, Naumann 1995, Gale 1994).

A mail survey was administered to North American OSB manufacturing firms and their wholesale customers in Fall 2003/Spring 2004 in order to understand their perceptions of "value" in the residential sheathing markets and to examine the relative positioning of OSB manufacturing firms on those value attributes (using perceptual and value maps). The survey effort generated a 22 percent response rate from OSB wholesale customers (representing 45 percent of the industry value) and a 75 percent response rate from OSB manufacturing firms (representing 81 percent of the industry value). Using a logistic regression analysis, the authors show that price flexibility, branding, timely delivery of product, packaging information, and personal relationship with suppliers are the five most determinant attributes that create value for OSB wholesale customers. Value and perceptual positioning maps on the aforementioned value attributes and customer satisfaction show patterns of competition in the OSB structural sheathing market and identify critical strengths and areas of vulnerability of each OSB supplier product/brand on the OSB value attributes. Multivariate regression analysis of perceived customer value (independent variable) on its consequences (dependent variables) show that delivering higher OSB value significantly increases OSB wholesaler satisfaction and loyalty, maintains longevity of customer-supplier relationship, and finally, leads to an enhanced volume of purchase by the OSB wholesale buyers.

Results from this study provide OSB managers with valuable information on benchmarking their performance vis-à-vis that of their competitors and identifying key strategies of product improvement and differentiation for superior competitive advantage.

In addition to identifying OSB product differentiation opportunities, the results of this study allow the OSB marketing managers to benchmark their performance vis-à-vis their competitors based on value positioning maps. Moreover, a shift of emphasis from selling on price and geographical location to that of the value attributes will determine an OSB firm's competitive advantage and customer satisfaction and loyalty, in future.

Presentation title: Design Loads for Upholstered Furniture Frames

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Abstract:

Loads for strength and durability design of upholstered furniture frames have never been developed. These loads are not always predictable and frequently their determination is more difficult than the design of the furniture structure itself. Obviously, it is important that as many potential uses of the furniture as possible be anticipated. Unfortunately, a systematic scientific investigation of the loads that act on a sofa frame has never been undertaken so that relatively few service loads have been thoroughly evaluated, and there is a scarcity of pertinent quantitative data. Furniture frame performance test standards such as GSA and BIFMA are available to evaluate strength and durability performance of a furniture frame construction including components such as joints and members. Therefore, the loads of performance tests could be the best available candidates for determination of design loads for furniture frame components. As an effort in determining design loads based on available engineering design information, loads for design of a sofa frame to meet specified frame performance test requirements, for instance GSA performance test, were explored.

Environmental Burden from Kiln Drying Hardwood Lumber

Brian W. Beakler, Paul R. Blankenhorn, Jan Wiedenbeck, Lee R. Stover

Hardwood lumber drying is achieved through air-drying, pre-drying, conventional steam heated drying, vacuum drying, or dehumidification (DH) drying. The environmental burden from drying hardwood lumber is organic compounds contained in the hot, humid kiln air as VOC (volatile organic compounds). Volatile organic compounds are lower atmospheric level ozone precursors detrimental to human and environmental health. A gross estimate of the annual VOC release from kiln drying in Pennsylvania is 1,000 tons. This estimate is based on very limited and sketchy data. The environmental burden of kiln drying commercially important species of hardwood lumber needs to be quantified and environmental control measures need to be developed in order to maintain the economic vitality of the hardwood lumber industry. This research project is designed to develop an estimate of the amount of VOC emissions from conventional steam heated hardwood dry kilns, using laboratory equipment, for commercially important hardwood species. The project will also investigate any potential differences between VOC emissions from drying samples of sapwood and heartwood. Results of this study will benefit both the wood products industry and regulating agencies by providing quality emission data for determining the total VOC emissions for drying commercially important hardwoods.

TITLE:

Tracing red oak adsorption under isothermal condition below fiber saturation point

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ABSTRACT:

The amount of moisture adsorption in red oak samples subjected to isothermal condition is continuously monitored over time by electrical balance in a controlled environmental chamber. Through the data transformed from the balance, the relationship between the ambient environment and moisture transfer is analyzed in three orthogonal directions and thus calculate moisture diffusion coefficient and velocity of moisture transmission in red oak. The red oak sample was conditioned to 7% moisture content before the experiment. The environmental chamber conditions were set to EMC of 16% and moisture content changes were observed for a period time.

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