34th International
PARTICLEBOARD
COMPOSITE MATERIALS
SYMPOSIUM
&
PRE-SYMPOSIUM TECHNICAL WORKSHOP

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Abstracts of the Technical Forum Presentations

The Technical Forum will be presented Tuesday afternoon, April 4, from 3:00 - 6:00 pm in the Compton Union Building 2nd Floor, Junior Ballroom.

The Technical Forum is a cooperative effort between the WSU Wood Materials & Engineering Laboratory, the WSU Conferences & Institutes, and the Forest Products Society.

BOOTH 1

Tafisa-Lac Megantic Expansion Through Technology Innovation = Largest Particleboard Plant in the World

Frederick T. Kurpiel, Ph.D., President, IMEAS, Inc., Peachtree City, GA, USA; *Riccardo Ferrari*, Sales Director, IMEAS, SpA, Villa Cortese, Italy

The production worldwide of particleboard, MDF, OSB, and other composite panels has increased dramatically over the past several years. Tafisa Canada, part of the global group Sonae Industria, will enter the new millennia raising its capacity of particleboard from 300,000 m^3/yr. to 750,000 m^3 plus, to become the largest such mill in the world. The most significant trends responsible for this change are: change in raw material, cycle speed increases, continuous process, and finishing 'extra wide' master panels. Tafisa-Lac Megantic has brought this European technology to the largest building materials furniture market in the world – North America. This expansion incorporated a 38-meter continuous press and IMEAS Super Performance© 8 head 'extra wide' 3.2 meter sanding line to produce master panel width 10-foot panels. Since 1995, to meet the increasing demands for added capacity and surface quality, a new concept for wide-belt sanding came on stream. The new extra-wide sawing machine (Super Performance© model) is an evolution from the grinding machines used for decades in the metal industry (up to 12 ft. wider) and for precision calibrating-finishing the endless stainless steel belts for all continuous presses in the world (more than 400). The key point is "power is nothing without control." We must be in a position to know and control, exactly what happens during the continuous process and sanding operation – to control precisely the speed of the board with speed of the abrasive belt to produce a superior finished product.

BOOTH 2

Fiber Screening with DiamondRoll Technology

Desmond E. Smith, Technical Director/Sales Manager, and *Kendall R. Kreft*, Chief Applications Engineer, Acrowood Corp., Everett, WA, USA

Cleaning contaminants from a high volume flow of refined fiber in a MDF plant has proven to be very difficult. Air systems rely on a density difference, or an air-resistance difference, to drop contaminants like resin balls and solid resin chunks out of the fiber before it gets into the forming process and into the press. High fiber flow rates, uncertain airflow, daily differences in operation and upstream upset conditions can all affect air-system performance. Still, platen-damaging resin deposits and steel belt-damaging metallic pieces can wreak havoc on continuous and multiopening presses. Even one contaminant sneaking through will leave its mark. Physical exclusion of these contaminants is now possible using the patented DiamondRoll screen. This technology uses chromed steel rolls cut with a textured patterned surface. This highly specific texture catches and passes acceptable fiber, yet the rolls are set with tight spaces between them that prevent larger particles from passing through. The contaminants are tumbled down the length of the screen and discharged by the smooth action of the turning rolls, while a vacuum system below the screen catches and suspends the fiber in air for conveying to the next stage. This high capacity, highly-efficient system is adjustable both for throughput and for contaminant size by roll spacing control and roll speed. The best location for the screen is after resin addition, drying, and metering, just ahead of the forming area. At this point all possible contaminating particles are removed before they can cause damage. The screen is matched for width to an existing surge and feed bin, with a short pneumatic transport system used to move the fiber from below the screen to the top of the forming bin. Roll-screening technology has been used successfully for particle-size segregation in green and dry end particleboard furnish screening, OSB flake recovery screening, pins recovery and fine screening in sawmilling and chip production, and in many other industries. This latest development successfully extends roll screening into the realm of pure fiber screening and MDF process improvement, and promises to save literally millions of dollars annually in press repairs alone.

BOOTH 3

Response Surface Methodology (RSM) Study of VOC Plywood Press Emissions

Alpha Barry, Research Scientist, *Richard Lépine*, Industry Advisor, and *Rawell Lovel* and *Diane Corneau*, Technologists, Forintek Canada Corp., Ste-Foy, QC, Canada

Press emissions as a function of plywood panel processing parameters were evaluated by means of a laboratory caul-plate-press, stack-collection system. The panel-pressing conditions were set at 140°, 150°, and 160°C for the pressing temperature, the pressing time was set at 7, 9, and 11 minutes and the mat resin solids content at 15, 18, and 21 g/pi² (161.46, 193.75, 226.04 g/m², respectively). The RSM with the Box and Behnken design was used to define the minimum number of experimental points needed to fully represent a quadratic regression model. A total of 15 experimental points and 3 extra center points were determined leading to an incomplete 3^3 factorial design. Results indicated that plywood press emissions are affected by processing parameters in different ways depending on the type of the VOC of interest. The quadratic RSM models in terms of the coded factors showed that press formaldehyde emissions were more sensitive to pressing time, while methanol and total VOC emissions were more sensitive to mat resin content. However, an increase in processing conditions resulted in an overall increase of press emissions. On the other hand, formaldehyde and total VOC emitted from the resulting plywood panels were more sensitive to mat resin solids content than to pressing temperature and time, showing a decrease with increasing of the resin content. The use of an optimization procedure based on the geometric mean of each response desirability function allowed multiple solutions with minimum press-emission levels with a desirability value of up to 0.97 when the imposed limits during the optimization procedure were less stringent, the ideal situation being 1.0.

BOOTH 4

Forintek MDF Pilot Plant

André Moffet, Industry Advisor, Forintek Canada Corp., Ste-Foy, QC, Canada

The MDF Pilot Plant is located at the Forintek's Quebec laboratory. This facility has all the necessary equipment to: produce MDF fibers from sawdust, planer shavings and chips obtained from wood or agricultural-based raw material; dry fiber at any required humidity level; add glue to fibers using a blowline blending system, an air spray atomizer or a rotary blender; and press fiber-based panels. The MDF Pilot Plant is based on the following state-of-the-art system: 1) Refining system – The Andritz pressurized refiner is equipped with a large 56cm. (22in.) disc, a 160kW (215hp) motor with a variable speed drive that can go from 0 to 3600rpm. This equipment is designed to operate close to industrial conditions and can produce very high-quality fiber. Throughput can vary between 50 and 250kg (110 and 550lb.) of dried material per hour. The digestor and the refiner can operate up to 18 bar (266 psi). 2) Resin-injection system – The blowline injection system includes a pressurized pump that can inject up to 65kg (140lb.) of resin per hour. A massflowmeter measures the exact quantity of resin being injected. The blowline is made of sections so resin can be injected at different points throughout. A stand-alone system can spray resin on fiber already dried when the use of a refiner is not needed. A conventional rotary blender is also available. 3) Flash tube dryer – This dryer is an industrial type flash tube dryer 90m. (300ft.) long. Heating is done with a 4 million BTU/hr. natural-gas burner, which has a variable control that permits it to operate at a different temperature. Sensors in the dryer continuously monitor the temperature throughout the length of the dryer. 4) Mat forming and bagging station – At the outlet of the dryer, a fiber mat can either be formed or the fiber can be put in industrial type 50kg. (110lb.) bags for further use. 5) Presses – A state-of-the-art Dieffenbacher press with an 86cm. by 86 cm. (34in. x 34in.) platen with steam injection capacity is available. This press has a completely automated pressing cycle. Platen position, gas pressure, and temperature are monitored continuously. Available pressure from the press is 750 ton and temperature can go up to 230ºC (446ºF). 6) Complete monitoring system – The monitoring system installed on the MDF Pilot Plant produces reports for all the main operating variables. 7) Testing services – Forintek has the necessary equipment to perform all major tests related to MDF manufacturing (MOR, MOE, IB, Linear

Expansion, Baur MacNett, Freeness Tester, VOC emissions, etc.). 8) A team of experts at your service – Forintek has a team of over 100 technicians and scientists that can help you analyze your problems and propose solutions that can be tested in our Pilot Plant. We have specialists in composite products and processes, resin development, raw material analysis and environmental issues. 9) Answer to your questions – This facility will help you answer questions related to MDF manufacturing without the need to perform a costly full-scale trial in a large industrial plant. For example: What is the impact of using a new type of raw material such as recycled wood, agricultural residues, or annual plants on the panel properties? What operating parameters will permit the ability to produce the required physical properties for a new type of MDF panel? What will be the impact of using a new resin? How can we diminish electrical consumption? How can we diminish VOC emissions from the press? What is the best pressing cycle for recycled wood?

BOOTH 5

Flake-Alignment Effects on Temperature and Gas Pressure Development During OSB Hot-Pressing

Pablo J. Garcia, Graduate Student, *Stavros Avramidis*, Professor, and *Frank Lam*, Associate Professor, Dept. of Wood Science, Univ. of British Columbia, Vancouver, BC, Canada

Internal temperature and gas pressure development during hot-pressing was monitored in strandboard mats of different densities and varying degrees of flake alignment. Fine-gauge thermocouple wires and steel capillary tubes connected to pressure sensors were built into single-layer mats, which were then hot-pressed at 180ºC to a 10-mm thickness. A robot mat-forming system was used to ensure repeatable and nonbiased random forming with specified flake-alignment distributions. A set of 660- by 660-mm mats had temperature and pressure sensors placed at several positions along the core's mid-plane to monitor lateral heat and temperature gradients. Another set of 240- by 240-mm mats had sensors at various thickness positions to examine the transverse gradients. The experiments showed anisotropic trends in gas pressure and temperature gradients across the board-plane for the more highly aligned mats, with greater heat and gas flow occurring in the flake-alignment direction. Flake-alignment positively affected the lateral permeability while negatively affecting transverse thermal convection. Increasing density reduced the mat permeability, and thus lessened the influence of flake-alignment. Therefore, it seems that less aligned mats will initially heat faster but have higher internal gas pressures. There is also a possibility of board property and quality variations across the board-plane of highly aligned mats. The data collected will allow detailed quantitative modeling of mass and energy transfer as affected by mat structure.

BOOTH 6

Panel Sizing: Increased Panel Mill Capacities and Continuous Growth of Value-Added Markets

Giordano Checchi, President, Giben America, Norcross, GA, USA; *Bob Schimetat*, Product Manager, Giben Impianti, Pianoro, Italy; *Ricki Kielesinski*, Engineering Development Manager, Giben America, Norcross, GA, USA

Utilization of book-saw system solutions in the primary board mill allows the producer significant capacity increases over conventional two-pass saw lines with added benefits that include: 1) 100 percent versatility in panel sizing options; 2) Dimensional accuracy; 3) High-capacity thin-panel processing; and 4) Increased cut-edge quality, which allows for reduction in required edge sealant and increased visual acceptability. This poster presentation will reveal stages of book-saw processing from saw infeed to material storage through a series of three-dimensional images, photographs, and drawings. Analysis will be presented of maximum throughput based on panel thickness and panel sizing requirements.

BOOTH 7

Update . . . Low Temperature, Conveyorized Strand Drying Technology

Jeffrey L. Dexter, Sales Manager, Drying Technologies, George Koch Sons, LLC, Evansville, IN, USA; *Bill Nowack*, President, Industrial Technology Midwest, Wilmot, WI, USA; *Daniel Wolff*, President, CoProTech Inc., Norcross, GA, USA; *Wade Ficklin*, General Sales Manager, George Koch Sons, LLC, Evansville, IN, USA

With the emergence of low temperature, conveyorized strand dryers over the past few years, this poster presentation provides an in-depth look at the most recent developments regarding Koch's patented "drying and exhaust abatement" technology, along with its added benefits of low VOCs and particulate emissions. It will also illustrate the specific details for both our "exhaust abatement patent," which was granted in May 1998, and our "drying methods patent," which was granted earlier. The exhaust abatement process, which is an environmental enhancement, eliminates the need for expensive regenerative thermal oxidizers (RTOs) on the exhaust streams, thereby playing an important role in reducing both capital equipment investment and associated operating costs. With the commissioning of five systems in 1995, one in April of 1996, and now with seven more soon to follow, this drying technology continues to become the preferred choice for select OSB manufactures. This presentation highlights the assessment and acknowledgement by the Minnesota Pollution Control Agency of Koch's drying process as being Best Available Control Technology (BACT) along with the compliance test data. Finally, with increased demand throughout the industry for both higher production and increased yields, this presentation features the most recent performance data from our Generation II systems, which have been specifically designed to evaporate 40,000 pounds of water per hour, per system. This drying technology, along with discussions concerning lower plant emissions, reduction in fire hazards, improved energy balance, increased wood utilization, and the ability to dry longer strands without curling will be of particular interest to OSB mill managers, environmental engineers, product engineers, process engineers, production managers, and maintenance supervisors.

BOOTH 8

Novel 'Fast-Cure' Technology for the Production of OSB with MDI-Based Binders

Chris Skinner, Team Leader, Huntsman Polyurethanes, Everberg, Belgium; *Rodolfo Kaufman* and *Chris Watt*, Business Support, Huntsman Polyurethanes, West Deptford, NJ, USA

The maximization of the production rates in OSB manufacturing facilities, ensuring the best use of the fixed assets, is a continual challenge. The use of pMDI binders, such as Rubinate 1840, within the core of an OSB composite has enabled many facilities to lower their overall press cycle time relative to traditional phenol-formaldehyde resins, thus reducing their production costs. However, many facilities currently operate at the maximum cure speed of standard pMDI binders and further speed increases could be advantageous. This poster presentation introduces a novel 'fast-curing' resin technology that provides significant enhancement in production rates for OSB manufacturing. The technology allows the ultimate cure speed of the isocyanate to be tailored to suit both the production and economic requirements of the target production facility. Experimental work in Europe and the United States has demonstrated that the technology maintains panel properties while allowing production of panels at rates of up to 20 percent faster than standard conditions. An economic evaluation of the use of this 'fast-cure' technology will also be presented.

BOOTH 9

Nondestructive, Inline, Real-time Determination of Density Profiles in a Continuous Panelboard Process

Stephan Zimmermann, Sales Director, and *Barry Alley*, National Sales Manager, Measuring, GreCon, Inc., Tigard, OR, USA; *Ralf Schäckel*, Director, R&D, Fagus-GreCon, Alfeld-Hannover, Germany

The StenOgraph density profile analyzer is designed to determine the density profile of the moving, endless panel directly at the outlet of a continuous panel press. The evaluation of the density at any position through the thickness of the panel is based on imaging using a combination of x-ray penetration and forward scatter. A cross section of the moving panel, preferably oriented at an angle of 45 degrees to the plane of the panel, is irradiated by a tightly collimated x-ray. A stationary detector records the penetrating radiation and, from the x-ray attenuation, the total density of the cross section can be calculated. A scanning detector system receives the density-dependent scattered radiation (Compton-scatter) from any specific point in the irradiated cross section. After correcting the scatter signal by the attenuation known from the penetration detector system, the density of any point along the irradiated cross section can be calculated and density against position can be continuously recorded. While the panel is measured there has to be as little vibration as possible in the motion of the panel. Consequently, the analyzer is best suited for in-line measurement of the density profile of wood-based panels directly on the outlet of continuous presses. The analyzer provides the following information on the panel's cross section: total density of the panel's cross-section; raw density profile through the panel's cross-section; and information on the location of blisters in the panel's cross section (provided the blister passes through the measuring ray).

BOOTH 10

Effect of Spatial Density Distribution on the Layer Thickness Swell of MDF

Siqun Wang, Post-Doctoral Research Associate, and *Paul M. Winistorfer*, Professor/Director, Tennessee Forest Products Center, Univ. of Tennessee, Knoxville, TN, USA

The vertical density distribution describes the change in density through the panel thickness. The horizontal density distribution represents the change in density throughout the horizontal plane. Many researchers indicate that both the vertical and horizontal density distributions are correlated to many panel performance characteristics. However, both the vertical and horizontal density distributions individually only focus on one spatial direction in the panel and do not account for variation in the other spatial plane. The purpose of this study was to develop an analysis technique of qualify spatial density that considers both the vertical and horizontal density distributions and then investigates the association of spatial density distribution with the layer thickness swell (TS) of MDF. A commercial x-ray densitometer (QMS Density Profile System) and high resolution x-ray computed tomography (MicroCat) system were used to generate spatial density information. A nondestructive optical technique was used to determine layer TS within intact MDF samples. Preliminary results employing these three analysis techniques are presented for MDF. Results show that there was a strong relationship between spatial density distribution and layer TS of MDF. We suggest that this analysis approach has potential application for other panel products, including OSB and particleboard.

BOOTH 11

Variation of Tensile Strength Through the Thickness of Oriented Strandboard

Richard M. Bennett, Professor, Dept. of Civil & Environmental Engineering, *Paul M. Winistorfer*, Professor/Director, Tennessee Forest Products Center, and *Caryn M. Steidl*, Graduate Student, Dept. of Civil & Environmental Engineering, Univ. of Tennessee, Knoxville, TN, USA

It is well known that the density varies through the thickness of oriented strandboard (OSB), with the face being much denser than the core. Hence, the strength should vary through the thickness. To determine the variation in strength through the thickness of the panel, a piece of commercial OSB was sliced into 15 layers to obtain specimens for tension testing. The specimens were obtained using multiple sawblades on an arbor in milling machines. By offsetting each sample, the width of the saw kerf specimens were obtained for each layer through the thickness of the panel, with a total of 14 specimens being obtained for each layer. Specimens were obtained both parallel and perpendicular to the length of the panel. The specimens were tested in tension using straight-side specimens and unbonded tabs. For specimens parallel to the length of the panel, the face layers had a tensile strength approximately an order of magnitude greater than the core. For perpendicular samples, the tensile strength was relatively uniform through the thickness. This was due to a combination of density changes and flake orientation. The denser faces, with the strands orientated perpendicular to the applied tension in testing, had approximately the same strength as the less dense core, where the flakes were aligned with the applied tension.

BOOTH 12

Process Modeling of Internal Bond in MDF Manufacture

Timothy M. Young, Assistant Professor, *Paul M. Winistorfer*, Professor/Director, Tennessee Forest Products Center, Univ. of Tennessee, Knoxville, TN, USA; *Chris Huber*, Technical Director, Georgia-Pacific Resins, Inc., Orangeburg, SC, USA

A process simulation model for internal bond (IB) for medium-density fiberboard (MDF) was developed for a southeastern U.S. manufacturer. The MDF furnish was a mixture of southern pines (*Pinus taeda*, *Pinus elliottii*, and *Pinus palustris*). A regression model was developed from historical process and product attribute data. One hundred and nine potential independent variables were examined for 2,638 observations, which spanned 12 months in 1999. The model was developed in the spirit of using the least number of independent variables and a reasonable number of observations. The best solution for a process simulation model was developed for a short time period, which spanned 2 weeks (n=61). The process model had four independent variables: resin addition (%); core density (pcf); press closing time (sec.); and scan difference (g). Scan difference is a key process variable for the MDF manufacturer and is the difference in grams between actual fiber weight and electronically measured weight. The regression model did not include an independent variable for time. A detailed statistical summary of the regression model is presented, which includes an assessment of the predictability of the model for future values. The model is intended for use by the manufacturer as a short-term predictor of IB. New coefficients for the model should be developed when new process and product attribute data are available.

BOOTH 13

Softwood Bark Vacuum Pyrolysis Oil-PF Resins for Bonding OSB

Carlos Amen-Chen, Ph.D. Student, and *Felisa Chan*, Post-Doctoral Fellow, Dept. of Chemical Engineering, *Bernard Riedl*, Professor, Dept. of Wood Science, and *Christian Roy*, Professor, Dept. of Chemical Engineering, Univ. Laval, Ste-Foy, QC, Canada

Bark produced as a by-product of forestry-based activities is currently burned for energy recovery or sent to landfills. Vacuum pyrolysis of bark produces phenolic-rich oils that can be used as a raw material for replacing phenol in the formulation of resols for bonding oriented strandboard (OSB). The objective of this work is to determine the amount of phenol that can be replaced by softwood bark vacuum pyrolysis oils in resols and to evaluate their reactivity and further use in the manufacture of OSB panels. Both 25 and 50 percent weight replacement of phenol by bark pyrolysis oils was studied. Formaldehyde and sodium hydroxide to phenol molar ratios and cooking temperature profile were also modified accordingly. The new formulated resins required similar amounts of reagents to those used in commercial resins. Viscosity development of resins containing pyrolysis oils was faster compared to a pure phenolic resin. Homogeneous 11mm- and 3-layer 16-mm-thick aspen poplar boards were manufactured in the laboratory. Bending (MOR and MOE), dry and 2-hour boil internal bond (IB) and thickness swelling (TS) properties were evaluated. Mechanical properties of 11-mm homogeneous panels bonded with resins containing 25 and 50 percent weight phenol replaced by pyrolysis oils were comparable to panels made with a commercial surface resin. Three-layer panels made with resins having 50 percent phenol replacement in the surface and 25 percent phenol replacement in the core passed the requirements specified by the Canadian Standards CSA O437.1-93 for OSB products.

BOOTH 14

The Best of Both Worlds: Improved Board Properties and Lower VOCs Using Hybrid Drying Technologies

Peter Zagorzycki, Technical Director, Wolverine Proctor & Schwartz Inc., Horsham, PA, USA

Previous dryer offerings to the industry have, for the most part, focused on either high-temperature rotary or low-temperature conveyor drying of strands. Although there is mounting evidence from the field that conveyor dryers are actually delivering on promises of better board properties with lower emissions, many companies are reluctant to seriously consider conveyor drying because of higher perceived capital costs. This is especially true for potential capacity increase or other upgrade opportunities where there is already considerable capital sunk in existing rotary dryers.

Competing technologies usually have both strengths and weaknesses and often the optimum process and economic solution, if feasible, is to combine technologies in a way that emphasizes the strengths of each. Drying OSB strands is no exception. This poster presentation explores the feasibility of combining conveyor drying with rotary or fluid bed drying in various ways that minimize both capital and operating costs and emissions while retaining the other proven advantages of conveyor drying that relate to improved board properties. Some of the contributors to good board properties that will be discussed are tight moisture control, and less breakage, curling and brittleness of the strands along with ways to reduce VOC emissions that go beyond simply reducing the drying temperature. Operating cost reductions through reduced resin consumption and innovative use of existing heat sources will also be discussed.

BOOTH 15

PanelMSR® - A New On-line Stiffness Tester for Structural Wood Panels

David Evans, Sales Manager, Composite Products Machinery, *Peter F. Lister*, P.E., Product Development Manager, and *Ritch McDonald*, P.E., Chief Engineer, CAE Machinery Ltd., Vancouver, BC, Canada

CAE Machinery Ltd., has recently developed a nondestructive online tester for measuring panel-blending properties. Trade named PanelMSR®, the tester is installed downstream from the press and measures panels after they have been cut-to-size. Bending stiffness and modulus of elasticity (MOE) is measured for every panel produced. This provides valuable data that can help mills better control the manufacturing process and reduce panel variability. As a result, average panel properties can be adjusted closer to the minimum code requirements, thus reducing fiber and resin usage and lowering panel cost. The PanelMSR® also provides a valuable quality assurance function. Manufactures can promote their products as "100 percent tested" and thereby guarantee panel-stiffness levels. This can help companies differentiate their products from commodity producers, eliminate nonperformance claims, and can provide an important benefit when introducing products into new markets. This poster presentation describes the PanelMSR® tester, explains how it works, and gives results from tests of the prototype machine. The potential use of online data for quality assurance and process control will also be discussed.

BOOTH 16

Anisotropic Plasticity and Failure Prediction Model for Strength and Behavior of Steel Dowels in Laminated Strand Lumber

David Moses, Ph.D. Candidate, and *Helmut G.L. Prion*, Assistant Professor, Dept. of Civil Engineering, Univ. of British Columbia, Vancouver, BC, Canada

Anisotropic plasticity and the Weibull weakest link failure model are used in this study to predict the behavior of single-dowel connections in wood composites using a three-dimensional finite element model. The model can accommodate changes in lay-up of laminated strand lumber (LSL) and connection geometry. Nonlinear, nonrecoverable behavior in compression in each of the orthogonal material directions is addressed with this model to account for localized crushing which governs the load-displacement behavior of connections. The analysis accounts for nonuniform displacements through the wood member thickness due to bolt yielding and wood crushing. The analysis was verified against experimental results for five Aspen LSL panel layups and a variety of connections geometries. The lay-ups were: a) fully oriented; b) randomly oriented; c) surfaces fully oriented, core randomly oriented; d) surfaces randomly oriented, core fully oriented; and e) eight fully oriented layers aligned at 0º and ± 45º. Specimens were tested in tension and monitored for load and slip until ultimate failure. Specimen geometries were chosen to force failure in tension parallel-to and perpendicular-to the direction of loading, in shear and in dowel yielding and wood crushing. Panel layup was found to affect the performance of single-dowel connections. With sufficient end and edge distances, panels with oriented layers at 0º and ± 45º were found to be strongest (10% improvement strength over panels with all strands at 0º). End distance of 4d was found to be adequate to avoid brittle failure in most cases. The finite element model was able to predict load-displacement curves, detect ultimate strength, and detect changes in failure modes with increasing end and edge distances.

BOOTH 17

Improving Wood Flour Processing Efficiency

Jason Kessler, Eastern Regional Sales Manager, Bliss Industries, Inc., Fort Mill, SC, USA; *Eric Smith*, Process Consultant, ESA Process Equipment, Vancouver, WA, USA

The aggressive growth of the plastic composite industry has placed new demands on size reduction system technology. Bliss Industries has responded to the needs of the industry by reducing system power requirements and improving flour characteristics. The following will briefly describe the system designs used to produce wood flour at varying grades. Wood flour is commonly graded by mesh size. Generally speaking, the finer the flour, the higher the flour grade. Low-, medium-, and high-grade flours require different processes. A low-grade flour, 100 percent minus 20 US mesh, can be achieved in one pass through a fine grind hammermill with an incoming material of 1/2-inch minus. Production rates range from 20 to 30 pounds per horsepower per hour. A medium-grade flour, 100 percent minus 50 US mesh, requires a two-stage reduction. The primary fine grind hammermill will reduce approximately 50 percent of the 1/2-inch minus material to specification. A sifter is utilized in the system to make the separation of acceptable/unacceptable flour. The plus 50 mesh product is then processed through a secondary fine grind hammermill to be reduced to the minus 50 mesh specification. Production rates range from 20 to 30 pounds per horsepower per hour on the primary reduction and 10 to 20 pounds per horsepower per hour on the secondary reduction. A high-grade flour, 100 percent minus 80 US mesh requires a three-stage reduction. The process is identical to the medium-grade flour process; however, only 1/3 of the incoming materials is to specification after the first reduction and an additional 1/3 after the second reduction. The balance of the material flow is processed through an air swept pulverizer. This system has the capability to process fiber to extremely fine specifications. Production rates range from 5 to 10 pounds per horsepower per hour. Wood flour may be produced by a plastic composite manufacturer with the sole purpose of supplying filler to their own facility. Other times, wood flour is produced to market to a wide range of applications. In either scenario, Bliss Industries can provide the most efficient system to accomplish the specific process demands.

BOOTH 18

Spatial Variation in Wood Composites

Alejandro M. Bozo, Graduate Research Assistant (Professor of Wood Engineering, Univ. of Chile, Santiago, Chile), and *Michael P. Wolcott*, Associate Professor/Research Director, Wood Materials & Engineering Lab., Washington State Univ., Pullman, WA, USA

The objective of this research was to evaluate the spatial variation in oriented strandboard (OSB) using nontraditional statistics tools. For this project, density was chosen as a base property to characterize variability (raw data). The density was represented by Graphical analysis, with contour and three-dimensional surface plots. A Time series analysis was conducted on individual arrays (auto-correlation function and spectral density function). The auto-correlation function was plotted against the lag, k, to obtain a correlogram plot. The spectral density function was obtained by performing a fast Fourier transform (FFT) on the correlogram to change the data from a spatial domain to a frequency domain. Additionally, a relatively new technique called Geostatistics was applied (plots, spatial covariance, and variogram). The maps illustrated the continuity and sampling regularity of the spatial attributes and revealed the presence of any trends. Basic statistics were calculated including sample mean, variance, histograms, cumulative frequency plots, etc. The three-dimensional plot provided a clear picture of the level of variability that existed within a panel, but it was not possible to recognize patterns of density. When contour plots were used, patterns of density appeared. Specimen size was important; the larger specimens were sufficient to recognize patterns of density; however, smaller specimens provide a more detailed contour plot. The results obtained from the correlogram and variogram showed that there was an indication of spatial dependence of density, both along and across machine directions. A major conclusion at this point is that non-traditional statistics techniques are applicable to study spatial variation in wood composites. The recommendation is to continue this research, improving techniques and methods to detect spatial variation in order to find the best way to diminish it.

BOOTH 19

Waste-to-Energy System

Eric M. Dessecker, Vice President, *Tom E. Wechsler*, Wood Division Manager, and *Peter Fuchshuber*, President, GTS Energy Inc., Marietta, GA, USA

The GTS reciprocating grate combustion system is used to take waste fuel (wood and biomass) and convert it into usable energy in a clean and efficient manner. The energy can be in the form of thermal fluid to provide necessary heat for a particleboard, OSB, or MDF press, log thawing ponds, building heat, or indirect steam generation through thermal oil. The GTS reciprocating grate combustion system can also generate direct hot gases to supply heat and drying capacity to rotary dryers for particleboard, OSB, or MDF production. The GTS combustion system is capable of producing energy in the form of high-pressure steam, which in turn can be used to produce electricity through a steam turbine. Wood waste and other biomass wastes generated in an industrial process, such as particleboard, OSB, or MDF production can be used to produce energy in an efficient and environmentally safe manner. The GTS Energy reciprocating grate combustion system utilizes waste fuels, such as bark, board trim, lumber yard waste, pallets, cardboard, and other biomass waste fuel to provide energy for process or to provide high-pressure steam for making electricity. The GTS reciprocating grate combustion system uses a ram feed system, which is more forgiving and able to take larger waste fuel sizes than other fuel feed systems. The fuel feeder is operated by a hydraulic cylinder and the waste fuel is pushed on to the moving grates via the ram feeder. GTS uses grates with a high-temperature design alloy steel (high chromium content). The GTS grates are air cooled using grate under-fire air (primary combustion air) and because of the high temperature alloy steel used, no water cooling is necessary. This eliminates problems with emergency water circulation systems, which are required for water-cooled grates. The GTS reciprocating grate also offers automatic deashing with all of the grate ash and drop off ash falling into a submerged ash conveyor and into one ash collection hopper. The grate system offered by GTS is a unique design, which is unaffected by metal or other foreign objects, which inadvertently enter the combustion chamber. Large pieces of metal, nails, conveyor flights, etc. will not jam the grate system. Each GTS grate is custom designed according to the customers' specifications for fuel and moisture content. The GTS grate can handle fuel moisture contents up to 60 percent moisture – wet basis (150% MCDB) based on grate heat release ratings and grate area. The grate can also handle dry fuels because of the conservative sizing and large volume of the furnace, which gives lower volumetric heat release in the lower furnace. GTS provides its own refractory design and engineering, which is very conservative to insure long refractory life. The GTS reciprocating grate furnace is designed to provide clean and efficient combustion with lower emissions. The combustion zone and fuel bed on the grate is very large in comparison to other types of combustion systems, which means lower amounts of fly ash in the gas stream and less particulate carryover. This is very important when considering providing direct hot gases to a rotary dryer. The grate is also known for lower CO, NOx, and VOC emissions. GTS is continually researching and fine tuning the grate system to further reduce emissions. In conclusion, the GTS reciprocating grate combustion system is a very flexible combustion system designed to provide heat energy through thermal oil heat transfer, direct hot gas transfer, and through steam heating. This system provides good reliable operation, with minimal downtime for clean out for a wide variety of waste fuels, while producing lower emissions.

BOOTH 20

Blowline Blending - A New Perspective

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A new approach to understanding the factors that influence blowline blending in MDF manufacture will be presented. The model uses a mass-energy balance over the refiner to determine the steam flow in the blowline, and the steam velocity at selected points along the line. The resin-injection system determines the resin-droplet size immediately after the nozzle, this may be further modified by the interaction of the resin jet with the blowline steam flow. The fiber density in the blowline can be calculated, resulting in volume concentrations of 2 to 4 percent at resin entry, and 0.4 to 0.8 percent at dryer entry. At this concentration the attachment of resin droplets to fibers is not instantaneous, but depends on collisions between the particles in the turbulent flow of the blowline. It is the outcome of the secondary collisions between the particles that determine the resin performance. If the resin droplets are large compared with the fibers, greater shear gradients are necessary to cause a resin bridge that has formed between two fibers to separate. If this does occur, the outcome is favorable, with the resin being distributed between the fibers. If separation does not occur, the aggregated fibers will continue to grow, eventually becoming large enough to appear in the panel as a resin spot. The model has been verified by comparison with actual plant conditions. The blowline velocities agree well with actual measurements, and resin spots have been created in a panel, and made to go away by adjusting resin-droplet size.

BOOTH 21

Emission Limits, Continuous Control, and Regulations in a European MDF Energy Plant

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In Europe, the growing ecological awareness of the public and the tendancy of the 'green' parties joining the governments in some countries, are mayor influences towards the whole environmental issues in Western-Europe. Due to this evolution, the emission regulations for woodwaste fired energy systems in Europe are becoming more and more stringent. On the other hand, energy plants have to deal with the demand for higher fuel flexibility to burn, for different mediums and capacities and last but not least a high availability of the energy system (over 8,000 hrs./yr.) with minimum intervention for maintenance (e.g. cleaning). Due to these evolutions and tendancies, woodwaste fired energy plants are becoming more and more complex. The design and construction of these energy plants has to cope with more parameters and higher exigences then in the past. As for the emission requirements, the 'usual' limits for carbon monoxide (CO), nitrogen (NOx) and dust particles are lower then before. New regulations being implemented. More and more governments are pushing energy plants towards the European regulations. In the design phase, manufacturers of energy plants have to look for solutions towards guaranteed emissions, measured continuously, limiting the CO emissions through the '2 seconds rule,' sorting out PVC or chloride-holding materials in the woodwaste preperation process, etc. The example that will be shown is an MDF-energy plant, which has recently been commissioned, explaining what emission norms and regulations have to be dealt with and what precautions have been taken to reach these norms.

BOOTH 22

Reducing Moisture Swell of Densified Wood with Polycarboxylic Acid Resin

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A water-soluble polycarboxylic acid (PCA) resin was assessed for ability to limit moisture swelling of densified wood. Aspen flakes were treated in 0 (control), 1-, 5-, 10-, and 20-percent PCA resin solutions and drained for 1-, 10-, and 20-minute time periods. Following treatments, flakes were compressed to roughly 50 percent strain at 170ºC. The PCA content of flakes significantly increased with increasing concentration and drain time. Water absorption (WA) and thickness swell (TS) of flakes decreased with increasing PCA content. Both WA and TS of untreated flakes were over 100 percent, but for PCA-treated flakes, WA and TS as low as 45 and 16 percent, respectively, were achieved. Irreversible TS decreased with increasing PCA content, while reversible TS remained relatively constant. The swelling coefficient decreased with increasing PCA content, a behavior that often is associated with bulking agents for treated, uncompressed wood. However, dynamic mechanical analysis further suggested that PCA resin acts as a cross-linking agent to stabilize the position of the collapsed cell walls.

BOOTH 23

RTO/RCO Rotary Distributor Design Cuts Operating Costs in Half

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Third generation regenerative thermal/catalytic oxidizer (RTO/RCO) equipment has integrated the ceramic monolithic support into a unique rotary distribution and single can (tower) design. The benefits of these features produces a 30 to 70 percent reduction in electrical consumption and zero downtime for bake-out. In addition, the design also provides: a smaller, more compact unit at a lower capital cost; shop-assembled units with minimum field installation (less than 5 days); continuous on-line smokeless bake-out; 99 percent destruction removal efficiency as a standard design; virtually constant temperature and pressure control; no oscillating control valves; and greater reliability and improved performance. All of these features are discussed in detail relative to existing RTO/RCO equipment operating in the wood industry. The third generation RTO/RCO provides performance that will meet or exceed MACT requirements with flexibility and reliability to meet the wood industry needs for VOC/HAPs control.

BOOTH 24

Closed-Loop Fluidized Bed Energy System for Dryer Exhaust VOC Destruction

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Today's stringent environmental requirements imposed on new and existing mills mandate maximum cleanup of dryer exhaust, press room vent, and other gases laden with volatile organic compounds (VOCs) and different pollutants. Until recently, employing costly wet ESP and RTO technology was necessary to comply with the new regulations. Energy Products of Idaho (EPI) has developed a new staged combustion process using modern fluidized bed technology to recover and return all of the dryer exhaust gases back into the combustion and dryer supply systems to destroy 100 percent of the VOCs. In addition, the process reduces cost further by delivering clean hot gas to the dryers. This poster presentation explains how EPI's revolutionary new process utilizes a single fluidized bed energy system, burning bark, resinated sander dust, board trim, sawdust, and other wet or dry woodwaste to provide responsive performance and satisfy multiple loads of thermal oil and process steam, while also supplying clean, hot gas to the dryers, and meeting today's most stringent environmental regulations. Important benefits of the new process include elimination of RTOs, turndown capability of 10-to-1, fuel flexibility, and load responsiveness.

BOOTH 25

New Blending Technology for the Particleboard Industry

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Automated Process Equipment Corporation (APEC) is offering spinning disc technology for blending particleboard furnish. While new to the wood products industry, APEC has become a dominant blender supplier in the animal feed industry. Their technology is used to apply a wide range of different viscosity liquids to various types of dry particles. The success of the blender has encouraged APEC to explore new markets. APEC and Borden Chemical, Inc., investigated the efficiency of blending particleboard furnish with traditional urea-formaldehyde resin and wax emulsion. Several different resin and blender variables were studied. The APEC blender was compared to a laboratory drum blender. Past research has shown that the drum blender outperforms production blenders when considering internal bond. The superior performance is due to the relatively long retention time and small resin droplet size inherent with the drum blender. APEC's blender performed as well as the laboratory drum blender. The results of this study will provide a starting point for upcoming production trials.

BOOTH 26

Tensile Properties of Polypropylene Reinforced with Natural-Fiber Composites

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Several natural fibers, such as curaua, coir, jute, ramie, and sisal were studied in this project. Composites of polypropylene with different natural fibers were prepared. All of the composites were modified with maleic anhydride grafted polypropylene (MAPP) to improve the fiber/matrix adhesion. The effect of the combinations of fibers on the tensile properties of composites was studied. The preparation of natural-fiber polypropylene composites were using several combinations of two different natural fibers, with 49 percent of polypropylene and 1 percent MAPP by weight. These fibers along with PP and MAPP were mixed in a K-mixer at a fixed rpm (5,000), and dumped at a fixed temperature (190ºC), following single-stage procedure. The k-mix samples were pressed and granulated. Finally, ASTM test specimens were molded using a Sandretto injection molding machine. The tensile properties of the different fibers were evaluated. The natural fibers that were tested showed a great potential for applications as reinforcement in composites, based on polypropylene. Jute/coir and sisal/coir were the best combinations of fibers among those tested. The results showed that natural fibers could be used as excellent reinforcing materials for low-cost composites and are able to satisfy ecological as well as economical interests.

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