International Wood Composites Symposium

Technical Forum Poster Session

5:00 – 7:00 pm

Wednesday, April 30, 2014

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1.

Gate-to-gate life-cycle inventory of hardboard production in the United States and Canada

Richard Bergman, Research Forest Product Technologist, USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin

Adam Taylor, Associate Professor, University of Tennessee, Knoxville, Tennessee

Whole building life-cycle assessments (LCAs) populated by life-cycle inventory (LCI) data are incorporated into environmental footprint software tools for establishing green building certification by building professionals and code. However, LCI data on wood building products are needed to help fill in the data gaps and thus provide a more complete picture for whole buildings LCAs. Specifically, no LCI data are available in the United States and Canada on producing hardboard. This paper presents materials and energy data collected from the hardboard industry through an intensive survey exercise using Consortium for Research on Renewable Industrial Materials Research Guidelines and internationally recognized standards. An LCI approach will be applied for tracking the gate-to-gate production of hardboard. This paper will describe how wood flows through the different unit processes beginning with logs at the forest road and ending with the final product at the output of mill gate. Modeling the weight-averaged material and energy data per functional unit will provide the LCI flows of hardboard production in the United States and Canada. The LCI will show the raw materials consumed and the emission profile of producing one cubic meter of hardboard. Once formatted, these LCI data will be uploaded into the US LCI Database for other LCA practitioners and environmental footprint software providers to use.

Key words: life-cycle analysis, hardboard, LCA, life-cycle inventory, green building

2.
Surface quality control inspection of raw panels

Stephan Zimmermann, President and CEO, GreCon, Inc., Tigard, Oregon

In the production line, the raw panel surface inspection system SUPERSCAN SPR 5000 inspects the surface of each panel to ensure consistent sorting. The automatic image processing system guarantees 100% inspection of each panel and allows for continuous and consistent sorting. Detailed conclusions of upstream production process adjustments are possible through the fault and statistics reports. The SUPERSCAN not only provides sorting information, it can also be used to optimize the entire production process. Besides easy system operation, new defect types can be learned independently and individual sorting criteria created. Inspection process: Each panel is inspected by a camera system on the top and bottom surfaces. Defective areas are detected where the surface differs from the normal (faultless) surface. Any detected area is classified as types as to the faults and defect. The parameterization of quality allocation and sorting rules is adjustable. The data of the surface faults or defects of each panel are shown on the monitor. The inspection results are transferred to the PLC of the production system and it will conduct the sorting of the panels.

The Benefits:

- Reliable, objective, complete inspection of sanded panels
- Evaluation of sanding results (optically and topologically)
- Detection, classification and distinction of defect types
- Early detection of defects prior to downstream coating processes
- Detailed reports on defect location on the panel
- Independent learning of new defect types
- Creation of individual sorting criteria

3.

The U.S. Lacey Act: Impacts on the Asian furniture and flooring market

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Ivan Eastin, Professor/Director CINTRAFOR**,** School of Environmental and Forest Sciences, University of Washington, Seattle, Washington

Indroneil Ganguly, Assistant Professor Research**,** School of Environmental and Forest Sciences, University of Washington, Seattle, Washington

Until recently, little regulatory action was taken in developed countries to address the problem of illegal logging or to stem the trade in wood products manufactured from illegally sourced wood products. In 2003, the American Forest and Paper Association commissioned a report which indicated that "illegal material depresses world prices by 7% - 16% on average, and U.S. prices by 2% - 4%, depending on the product." In 2008, the US Congress passed a landmark legislation expanding the scope of the Lacey Act to include wood and non-wood materials. Since that time, both the EU and Australia have adopted legislation of their own designed to make it a crime to import illegally harvested wood into their region/country. This study will look at the effects of timber legality policies on timber export markets with a focus on the attitudes and perceptions of timber exporters in Vietnam, Thailand and China. The impact of legality legislation on business practices, material sourcing decisions, and the use of Chain of Custody certified products will be addressed. This study uses surveys and interviews of tropical hardwood exporters in China, Vietnam and Thailand and results will be analyzed to identify market trends, segmented by company demographics and compared across industry sectors. The survey includes categorical questions, yes/no questions, and Likert scales and will be analyzed using univariate and multivariate statistical techniques. These findings of this study will be assessed to identify global trends and market opportunities.

4.
Calculating profit loss on over-densifying particleboard

Benjamin Gardner, Flakeboard Quality Control Intern**,** Oregon State University, Corvallis, Oregon

Scott Leavengood, Professor, Oregon State University, Corvallis, Oregon

Particleboard mills produce high volumes of differing panel grades. Slight inefficiencies over the course of a year can mean a significant loss in profit. Flakeboard Company has previously conducted tests to estimate the loss of money for certain increments of density excess. This information has simply told them that small overages on density targets can lead to large profit losses over the course of a year. This concept is difficult to prioritize for a line operator, who is frequently adjusting settings on the press in order for the board to pass standards. The profit loss calculator consolidates the ingredients, weight and pricing information into a simple pop-up box for the line operator to understand the implications of each density variation. Also, prices and recipes for the panels change often. This program will function straight from the recipe list, so any changes in pricing or material ratios will be appropriately reflected.

5.

Woody biomass feedstock logistics: LCA scenarios for forest harvest residuals in the Mid-Cascade to Pacific Region

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Cindy Chen, School of Environmental and Forest Sciences, and
Cody Sifford, School of Environmental and Forest Sciences, University of Washington, Seattle, Washington

Typical forest harvest operations in the Pacific Northwest (PNW) leave a considerable volume of unused woody biomass in the forest in the form of tree tops and branches. Despite the environmental benefits, the economic feasibility of extracting these residuals from the forest is limited due to low market demand and high collection and transportation costs. Most of the unused woody biomass is piled and burned to reduce the fire risk or it is left on the forest floor to decompose. New technologies in forest logistic operations make it more feasible to efficiently extract and transport low value forest residuals into a higher valued bio-fuel feedstock.

The Northwest Advanced Renewables Alliance (NARA) research project is exploring the potential of converting woody biomass into bio-jet fuel within the PNW region. This poster assesses the environmental implications of producing woody biomass based bio-fuel within the Western Washington/Oregon region. In order to document the environmental benefits of substituting biofuel for fossil fuel, a detailed Life Cycle Assessment (LCA) is being conducted to evaluate the environmental impacts of using woody biomass as a feedstock for conversion into bio-jet fuel.

This poster presents the results of the feedstock logistics portion of an LCA of woody biomass feedstock to be used for bio-jet fuel production. The life-cycle represented will be focused on the processes from greenhouse seedlings until the unloading of the ground residuals to the pre-treatment processing facility. This poster explores multiple biomass transportation scenarios with various logistical pathways to find an optimal system that minimizes environmental impacts. The study incorporates the avoided environmental costs associated with piling and burning the woody biomass on the forest floor into the LCA calculations. Environmental burdens for each of these scenarios are assessed in terms of global warming, acidification, smog, and ozone depleting potentials.

6.

Incorporation of the carbon sequestration into the life cycle assessment of woody biomass based bioenergy

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The renewability of woody biomass plays an important role in evaluating the overall carbon footprint of renewable energy. However, there is no general consensus on a methodology for incorporating carbon sequestration within the Life Cycle Assessment (LCA) framework. The objective of this study is to propose a methodology for incorporating carbon sequestration within the bio-energy LCA framework. Forest types, species mix, and silvicultural techniques play an important role in evaluation of the proposed carbon sequestration methodology. This study proposes a global warming impact assessment methodology for incorporating carbon sequestration in Life Cycle Assessment of wood based bio-energy.

The proposed methodology considers the effect of the dynamic carbon sequestration and of the residuals decomposition on the global warming impact through the radiative forcing. Greenhouse gas decay functions in the atmosphere have been utilized to evaluate the temporal impacts and benefits associated with the emission and sequestration of carbon during the forest life cycle. The results suggest that forest type, species mix and silvicultural treatments influence the level of environmental benefits derived from woody biomass based bio-energy.

Key words: Carbon sequestration, Life Cycle Assessment

7.
Wood-generated formaldehyde

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Formaldehyde regulations have evolved to the point where all emission sources must be accounted, both synthetic and natural, biogenic sources. Lignin is believed to be the principal source of native-wood formaldehyde, and this work is testing a specific lignin reaction mechanism in that role. *Pinus virginiana* specimens are subjected to elevated temperatures in closed-capture reactors that allow quantitation of heat-induced formaldehyde formation. Cellulose and hemicellulose undergo minor changes during heating, while lignin undergoes a major structural change that correlates with formaldehyde generation. The poster will discuss efforts to define the precise chemical mechanism of biogenic formaldehyde generation in an effort to manipulate that process.

8.

Mechanochemical modification and applications of organosolv and kraft lignin

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Junna Xin, Post-doctoral Research Associate, Composite Materials and Engineering Center, Washington State University, Pullman, Washington

Michael P. Wolcott, Regents Professor, Composite Materials and Engineering Center, Washington State University, Pullman, Washington

Jinwen Zhang, Associate Professor, Composite Materials and Engineering Center, Washington State University, Pullman, Washington

Organosolv and Kraft lignin were mechanochemically treated with vegetable oil to develop modified lignin. This treatment greatly reduced the hydroxyl value of the lignin, and ^{1}H NMR analysis also verified the occurrence of chemical reactions between lignin and vegetable oil. The modified lignin exhibited improved plasticity as it could be turned into films by hot pressing, while the untreated lignin was not able to form integral films. The solubility of the modified lignin in organic solvents also greatly increased. The modified lignin was further blended with poly(lactic acid), poly(butylene adipate-co-terephthalate) and polycaprolactone through solution casting.

9.
Partially depolymerized enzymolysis lignin: Preparation, characterization and application

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Biorefinery of the second-generation bioethanol utilizes the easily convertible carbohydrate portions of the lignocellulosics and leaves lignin (referred as "enzymolysis lignin") as a main byproduct. In this work, partial depolymerization of enzymolysis lignin was studied via two methods: mild hydrogenolysis under Raney Ni and base-catalyzed depolymerization (BCD). The depolymerized lignin products were low molecular weight oligomers with increased hydroxyl values. The solvent selected, use of base and various reaction parameters were all found to influence yield of depolymerization, the molecular weight and hydroxyl value of partial depolymerized lignin (PDL). The structure of PDL was characterized by GPC, 31P NMR and FTIR. Applications of PDL for adhesives and PDL-based epoxy asphalt were developed. The modified asphalt exhibited enhanced glass transition temperature and thermal stability. Green adhesives based on PDL in combination with PEI and soy protein demonstrated high dry shear strength and water-resistance. The results suggest that the depolymerized lignins have great potential to be used as feedstock in many valuable applications.

10.

Preparation and properties of glassy liquid crystals derived from rosin

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Novel glassy liquid crystals with tricyclohydrophenanthrene dehydroabietyl core were prepared from pine wood rosin feedstock. The phase transition behaviors of the obtained liquid crystals were investigated. The mesophase of the liquid crystals could be frozen to glassy state when the cooling rate was 20 ºC min^{-1}. These glassy state liquid crystals exhibited superior chemical purity and favorable rheological properties over the polymeric counterparts. These liquid crystals may find potential application in information storage, nonlinear optics (NLO) and second harmonic generation (SHG).

11.

Preparation of a new liquid thermal stabilizer from rosin and fatty acid and study of the properties of the stabilized PVC

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In this work, a dimer acid was prepared by addition reaction of rosin and industrial fatty acid (RODA) and then neutralized to receive zinc (RODA-Zn) and calcium (RODA-Ca) salts. The solid Ca and Zn salts were formulated with various auxiliary agents to obtain liquid form thermal stabilizers (RODA-LTS). The thermal stability, tensile and dynamic mechanical properties of PVC compounds stabilized by RODA-LTS and commercial liquid stabilizers were compared. The PVC compounds stabilized by RODA-LTS exhibited superior thermal stability and comparable strength, modulus and glass transition temperature than those PVC compounds stabilized by the commercial counterparts.

12.

Technical efficiency, technical progress and total factor productivity of China's paper industry

Shuai Tang, Ph.D. Student, Center for International Trade in Forest Products (CINTRAFOR), University of Washington, Seattle, Washington

Since the reform and opening up in 1978, China's paper industry has been developing very quickly. However, the growth of the industry is primarily dependent on abundant availability of wood, pulp and cheap labor and the existing technology falls far behind the developed countries. This study calculates the total factor productivity (TFP) of China's paper industry and tries to find out the influencing factors of TFP by data envelope analysis and Malmquist index from 2000 to 2011. It also compares the TFP of paper industry in different provinces in China, including Shandong, Jiangsu, Guangdong, Zhejiang and Henan, to study the regional differences of China's paper industry. The results show that the TFP of China's paper industry shows an upward trend over this period and the mean of Malmquist index reached 1.150 in 2011. The TFP experienced significant fluctuation since 2000, with two peak points in 2004 and 2007 and two valley points in 2005 and 2009. Whereas, technical progress in the sector is the primary reason for the increase of TFP, technical efficiency contributes marginally to the whole country and each single province indices. The study also reveals that the TFP of paper industry differs greatly among provinces.

13.

Development of a method for the production of composite wood polypropylene plastic and pseudostem of banana

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Vanessa Uribe Parra, Mechanical Engineer, Universidad Tecnológica de Pereira, Pereira, Risaralda - Colombia

The WPC obtained in our investigation was fabricated using injection as polymer recycled polypropylene (PPR) and pseudostem of banana plant as organic residue; the binder and lubricant was from Clariant Company. To determine the properties of the mixtures we made use of two types of variables—the pseudostem and the PPR.

During the research we divided our process into two parts, one of which was very important pre-drying handling the percentage of water contained in the plant fiber to produce a homogeneous compound. The second process of the investigation was the mixing and the injection. Finally we carried out the injection molding and the effects of the changes to be highlighted in the physical (water absorption) and mechanical properties (tensile and flexural strength testing) relative to the composition of the material.

14.
2Glam: Second generation laminates

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Fernão Magalhães, LEPABE, Faculty of Engineering, University of Porto, Porto, Portugal

Luísa Carvalho, Faculty of Engineering, University of Porto, Porto, Portugal; Department of Wood Engineering, Polytechnic Institute of Viseu, Viseu, Portugal

This project aims to introduce advanced functionalities in high-pressure laminates currently nonexistent in international markets, thereby providing competitive and technological advantages for penetration in these markets. This includes the development of innovative impregnation resins with new functionalities for multi-functional laminates resulting from the combination of new and better properties as wear resistance, chemical resistance, UV resistance, dirt-repellence, anti-microbial activity, self-healing action and phosphorescence. This will permit the development of HPL for vertical and horizontal surfaces with different applications and functionalities: scholar furniture with mar-resistance, abrasion resistance and dirt-repellence; laboratory countertops with chemical resistance and dirt-repellency; exterior flooring with UV resistance, mar resistance and abrasion resistance; technical flooring with phosphorescent properties, abrasion and mar resistance for public buildings; hospital furniture with dirt-repellence and anti-microbial properties; whiteboards with mar and abrasion resistance. The results obtained so far by the team identified strategies to attain some of those functionalities, namely: combination of melamine and polyurethane resins for high chemical resistance and UV resistance, use of polyurethane dispersion (PUD) with the ability to regenerate microcracks, inclusion of phosphorescent pigments to provide glow-in-the-dark effect, incorporation of bioactive compounds in inorganic matrices for abrasion and antimicrobial resistance, and the use of additives for superhydrophobic surfaces.

15.

A new approach to evaluate the quality of wood-based panels surfaced with laminates

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In past years, new market requirements and the availability of raw materials drove improvements of wood-based panels (WBP) properties and optimization of their manufacturing process by changes in the basic raw material (different wood species and recycled wood), new adhesive systems (different resins, new catalysts), inclusion of additives (formaldehyde scavengers, fire retardants, moisture repellents, etc.) and even by modification of their basic physical and mechanical properties (density, internal bond, stiffness, etc.). WBP surface appearance has always been an important requirement and therefore WBP are usually overlaid with a decorative laminate, which can be a low-pressure laminate (a single melamine-formaldehyde impregnated sheet of paper) or a high-pressure decorative laminate (a complex build-up of different kinds of impregnated papers). WBP are largely applied in furniture, cabinet manufacture and building construction. For both furniture and cabinet manufacture, aesthetic appearance and processing cost are the most important requirements and are closely linked to machinability (sawing, routing, drilling, etc.) and processing conditions (geometry and size of cutting elements, feed speed, etc.) and they are usually assessed by surface quality, power consumption and tool wear. However, the machining operation often endangers the prestige of these products causing the crumble of the edges and therefore resulting in a poor finishing quality. A new methodology, based on the use of two different systems (artificial vision system for edge quality evaluation and a process monitoring system) is proposed and the results of a preliminary performance study (WBP overlaid with different kind of laminates) are presented.

Keywords: Wood based panels, edge quality, machineability.

16.

Light fillers: Development of low density particles for applications in automotive and furniture industries

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Sandra Monteiro, ARCP-Association Network of Competence in Polymers, Porto, Portugal

Liliana Carvalho, Euroresinas - Chemical Industries, Sines, Portugal

Jorge Martins, Professor, Department of Wood Engineering, Polytechnic Institute of Viseu, Viseu, Portugal

Fernão D. Magalhães, LEPABE, Faculty of Engineering, University of Porto, Porto, Portugal

The project's main goal is the development of polymeric particles with alveolar structure, with high mechanical and thermal stabilities, for use as fillers to produce lightweight wood-based panels. It is intended that the technology for production of these particles (designated as LDPs) be compatible with the technological infrastructure of the promoter. The project plan includes manufacture of a lightweight furniture prototype, which will serve as demonstrator of the potential of LDPs in this application. Another area of application that will be explored is the use of LDPs as low density fillers for thermoplastic components in the automobile industry. Again, the project goal is to produce a prototype component that will demonstrate the quality of the final product. Low density particles (LDPs) made of crosslinked polyester were produced using a water-oil-water double emulsion prepared from an unsaturated polyester/styrene solution and then cured by radical polymerization. Solid particles with multiple air-filled vesicles are obtained after drying. These particles were already tested as fillers in particleboard with interesting results. Several studies are on-going: influence of important process variables on the final particle sizes and internal vesiculation; stiffness as a function of temperature in order to obtain maximum performance when incorporated in the particleboards and submitted to hot-pressing; evaluation of the optimum particle sizes for obtaining the intended compromise between panel density and internal bond strength.

17.
Precision spray technology solutions for wax, resin, release agent and water application

Rick Grat, Spraying Systems Company, Wheaton, Illinois

New spray system technology for precision application of wax or resin to wood chips and release agents or water to mats, cauls or press belts can eliminate quality problems, reduce operating costs and boost production. These new systems automatically adjust the application rate based on operating conditions to ensure uniform and consistent coverage. The poster will cover systems for PMDI and LPF resins in the blender; slack wax, tallow wax or e-wax in the blender; surface moisture addition prior to board pressing and mixed release agent application on mats when using PMDI resins.

A technology overview will explain how these systems overcome typical problems like these using Precision Spray Control:

- Unscheduled downtime due to clogging when spraying wax or resin.
- Production disruptions caused by sticking due to poor mixing of release agents and water.
- Board quality issues resulting from uneven coverage of moisture.

An operational overview of four PanelSpray® system options will be included so Symposium attendees can understand how these systems work and the significant impact that can have increasing production time and reduce use of costly chemicals.

18.

Resin transfer molding (RTM) of wood-strand reinforced composite panels

Wenrui Yang, Graduate Research Assistant, Composite Materials and Engineering Center, Washington State University, Pullman, Washington

Vikram Yadama, Associate Professor, Extension Specialist, Composite Materials and Engineering Center, Washington State University, Pullman, Washington

Resin transfer molding (RTM) and vacuum assisted resin transfer molding (VARTM) are widely applied in manufacturing airplane and automobile interior composite products due to their cost-effectiveness. In manufacturing with this technology, resin impregnation is critical to the quality of composite products. In the development of a RTM wood strand composite, the permeability of the wood-strand preforms affects the resin impregnation, resin flow and permeability behavior needed to produce quality products with consistent performance. This study focuses on characterizing the resin flow and determining preform permeability. Meanwhile, although there have been previous experimental setups and simulations of the permeability of reinforcement presented by different researchers, few have been done with wood-strands as a reinforcement. The research also deals with determining the proper architecture of wood-strand preform for fabricating the composite panel. The significant variables in processing wood-strand preform were identified by using Design of Experiments (DOE) statistics. A linear model was then developed using response surface method (RSM) for the determination of ideal architecture for using in resin impregnation. A quadratic model was developed in RSM to study the resin impregnation. The preform permeability was calculated based on Darcy's law and Carman-Kozeny equation using four different approaches.

19.
Advanced control methodology for biomass combustion

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Small-scale biomass furnaces are considered a significant source of particulate matter (PM) emission. Well-proven and established particle emission reduction technologies are prohibitively expensive at small-scale, and are only economically viable for medium- to large-scale furnaces. The biomass combustion process depends on multiple factors such as fuel composition, format, placement in the combustion furnace and air distribution. As a result, meeting stricter emission regulations and efficiency standards is a challenge for operation on diverse fuel types. We present the first phase of a study on inexpensive combustion control system for biomass furnaces operated with a variety of fuels. The system measures major combustion species in the exhaust and utilizes a predictive chemical kinetic model to gain insight into the combustion process in real-time. The model uses a chemical reactor network (CRN) to simulate wood pyrolysis and tar formation, flame zone combustion, post-flame zone combustion and burnout in a biomass furnace. The CRN model has been shown to simulate smoldering, ignition and flaming combustion. The model agrees with experimental data obtained for a small-scale wood furnace for temperature, CO and combustion generated aerosols. Utilizing the model, the control system can potentially improve combustion efficiency and reduce emissions of particulate matter, CO, and unburned hydrocarbons that have been linked to detrimental health effects and urban and rural air pollution.