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Poster Presentation Abstracts

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Mimosa Tannin and Cornstarch-Sugar Based-Wood Adhesive

At present, formaldehyde-based adhesives such as urea-formaldehyde (UF), melamine-formaldehyde (MF), melamine-urea formaldehyde (MUF), etc. are mostly used in the wood-based panel industry because of their high reactivity, chemical versatility, and economic competitiveness. However, formaldehyde-based wood adhesives are produced from non-renewable resources, and also formaldehyde emission limits are more restricted day by day. Therefore, there has been a growing interest in the development of environment-friendly, economically competitive, bio-based wood adhesives to meet wood-based panel industry requirements.
In this study, as a formaldehyde-free adhesive, Mimosa tannin and corn starch-sugar-based wood adhesives were synthesized. Hexamethylenetetramine was used as a hardener for the Mimosa tannin-based resin system.
Solid content, viscosity, and gel time analyzes of the prepared hybrid adhesive systems were performed to evaluate the adhesive processability. FTIR characterization technique was used to elucidate the chemical structures of the cured adhesive samples.
To evaluate the performance of the prepared bio-based resin formulation, particleboards were produced on a laboratory scale, and mechanical, physical properties of the boards were investigated. Besides, the formaldehyde contents of the boards were determined by using the perforator method.
The obtained results revealed that the developed bio-based wood adhesive formulation can be a good potential candidate to use the wood-based panel industry with some developments.

Keywords: Bio-based wood adhesives, Cornstarch, Mimosa Tannin, Sugar.

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Investigation of the influence of increased temperatures on tensile strength of glued wood with various adhesives

Glulam is one of the most important solid wood-based materials and is constantly gaining in importance. Condensation resins (PRF, MUF, MF) and elastomeric adhesives (EPI and 1C-PUR) are used for the production of glulam.
The temperature resistance of glulam used in glued wood construction is a very important assessment criterion and is largely dependent on the used adhesive system.
In case of fire, but even with intense solar radiation (e.g. area of skylight windows, winter gardens) the outer area is exposed to high or elevated temperatures. In North America, wooden beams are tested at 220° C or 230°C as a requirement in the building industry.
The shear strength of native and glued wood and the wood failure percentage (WFP) depend on the level of thermal

stress in all the adhesive systems investigated (PRF, MF, 1C-PUR, EPI and also PVAc. The reduction in tensile shear strength in the temperature range (20°C to 200°C) for the tested adhesives is 33% for PRF, 34% for MF, 53% for both tested 1C-PUR, 96% for PVAc, 50% for EPI and 34% for solid wood.
The highest strengths and WFP of glued wood in the temperature range of 200°C are achieved using thermoset condensation resins. Only the tested thermosetting adhesive systems (MF, PRF) meet the fire resistance requirements according to ASTM D7247.
TG values from the thermoset systems (PRF and MF) are clearly the highest. It is known that PF resins post-cure when exposed to temperature.
This determined tendency largely correlates with the highest strengths and WFP achieved in the shear strength test at 200°C.
TG for elastomeric products (1C-PUR and EPI) and thermoplastic PVAc are much smaller. These correlate with lower shear strength values and the proportion of wood breakage at 200°C.

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Physio-Mechanical properties of Composite boards made from Eucalyptus camuldulensis with Gum arabic as a Bio adhesive.

Gum Arabic (Acacia senegal gum) was used as a binder for the production of Eucalyptus camaldulensis particleboards. The physical and mechanical properties of the binder bonded particleboards, including moisture content, internal bond (IB) strength, thickness swelling (TS), water absorption (WA) and field-emission scanning electron microscopy was used to characterize the particleboards. Two different particle sizes of the Eucalyptus camaldulensis with three adhesive levels and two levels of additives were utilized. Results showed that the inclusion of Gum Arabic into the particleboards improved the overall properties.
The Gum Arabic (GA) bonded particleboards resulted in smoother surfaces, rigid texture and better internal bonding strength compared to binded particleboards made without using any additive. All specimens had internal bond strength of more than the minimum requirement of the American Society for Testing and Materials Standard and were noticed to improve by increasing the adhesive level. However the GA bonded particleboards had lower percentage of WA and the TS compared with the binded boards without additives. Microscopic study also revealed that particleboards bonded with the gum had better contact compared to the binded boards without additives. Based on these results, it could be concluded that gum Arabic is an effective natural, nontoxic substance and environmentally friendly that could be added to manufacture particleboards to improve its physical and mechanical properties.

Minjeong Kim
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Demethylated Kraft Lignin Modified Phenol-Formaldehyde Resins for Plywood

As an interest in bio-based materials increases due to environmental and sustainable issues, research and development on lignin, the abundant aromatic natural polymer, is growing. However, there is a limited research on the replacement of phenol with Kraft lignin in phenol-formaldehyde (PF) resins because of a por reactivity of Kraft lignin (KL). This work presents the effect of KL demethylation of converting methoxyl group to hydroxyl group on the modification of PF resins to improve the reactivity of KL. Technical KL is fractionated with acetone to have acetone soluble KL (ASKL) and acetone insoluble KL (AIKL), which are subsequently demethylated for the synthesis of PF resins. Different levels of the demethylated KL are used for the synthesis of PF resins. Characterization of the modified PF resins and their adhesion measurement are underway to understand chemical reactions between the demethylated KL and PF species, thermal curing behavior, and adhesion performance.

Min Lee
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Characteristics of light colored-particleboard made by modified phenol-formaldehyde resin adhesive

Phenolic resin adhesive has been used for wood composites industry in Korea for a long times because of its excellent adhesion performance, water resistance, and low formaldehyde emission. However, its color shows dark brown after curing of resin, and it needs longer curing time than other adhesives. Therefore, phenolic resin adhesive was used mostly in plywood industry and rarely used in particleboard. The purpose of this study was to synthesize a light colored phenolic resin adhesive with fast curing time. In the synthesis of the resin, the molar ratio of phenol to formaldehyde was 1:2. After the phenol and formaldehyde were mixed, additional reaction and condensation reaction were carried out at 85°C with adding the (36-38 %) ammonium hydroxide and the alkaline catalyst (50% Sodium hydroxide). After the end point, the resin was cooled and the Urea was added and dissolved. thus, a resol-type light colored phenolic resin was synthesized. The gelation time of the light colored phenolic resin adhesive synthesized by this method was about 14 % shorter than that of commercial phenolic resin adhesive. The particleboard was prepared with 13% resin content. The physical properties of the particleboard were investigated according to KS F 3104. As a result, the bonding strength was 1.0 N/mm2, and the thickness swelling was 11.7%. Formaldehyde emission was 0.37 mg/L, so it satisfied super E0 grade. The particleboard made with light colored phenolic resin adhesive showed lighter color than the particleboard made with commercial phenolic resin adhesive.

Min Lee
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Improvement of Storage life of Natural Adhesive for Wood Based Panels

The natural adhesives derived from the bio-materials such as proteins and carbohydrates are getting public interest and many scientists were conducted to develop these adhesives for wood-based panels. A practical preparation method for formaldehyde-free wood adhesive based on rice powder and polymeric methylene diphenyl diisocyanate (pMDI) as a crosslinker was developed. Rice powder has been chosen as a carbohydrate source because it has hydroxyl functional groups that can easily react with -NCO group of pMDI. Natural adhesives have the longest history of adhesives, and starches and proteins such as corn and soybeans are generally used as adhesive. Natural products can be used an adhesive throughout the absorption process of amylose and amylopectin, that is, the glue process. However, the nature adhesive has limitation for using as adhesive due to short storage. The storage of nature adhesive is influenced by temperature and pH. In this study, preservatives A and B were used to improve the storage of rice powder based adhesive (RPA). Developed adhesive was used to make plywood and particleboard. Then, we evaluated their performances such as bonding strength and dimensional stability. A 24h-cyclic boiled tensile strength of plywood manufactured with rice powder adhesive satisfied Korean Standard (KS F 3101, ordinary plywood) which was above 0.7 N/mm2. Internal bond strength of particleboard manufactured with rice powder adhesive also satisfied Korean Standard (KS F 3104, particleboard) which was above 0.3 N/mm2. As a result, the storage stability of the RPA was improved to 30 days which was about 6 times longer. The plywood was prepared with each RPA, the cold press was good, and no deformation of the plywood was observed after the heat pressure. Moreover, the tensile shear bond strength of plywood prepared were 0.8 ~ 0.9 MPa, which satisfied the standard (0.7 MPa) of KS F 3101.

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Structural performance improvement of particle board according to melamine content of MUF resin

Structural particle board (S-PB) was manufactured to replace the imported structural OSB, and it was attempted to establish manufacturing conditions suitable for domestic industry conditions. A melamine-urea-formaldehyde resin adhesive (MFU resin) was used to provide water resistance, and mechanical performance was evaluated by varying the resin content ratio to optimize the amount of resin used. The synthesized MFU resin was F/MU=1.00, melamine content 27%, solid content 62%, and by applying different middle layer content for each condition, 20% ammonium chloride aqueous solution and wax emulsion together. The resin content of surface layer particle was fixed at 15%, and the resin content of middle layer particle has differently applied as 12%, 14%, and 16%. After application, the moisture content of the middle layer was 12.83%, 14.15%, and 14.77%, respectively, and the surface layer was the same as 11.54%. The ratio of the surface layer to the middle layer of the board was 40:60 selected in the previous study, and the target density was set at 750 kg/m3. The hot press conditions were a temperature of 180°C. and a time of 15 s/mm, and the pressure was divided into four steps. The basic physical properties of the board manufactured according to ISO 16893 were comparatively analyzed. S-PB was prepared close to the target density under all conditions, and the moisture content was found to be 5 to 6%. As the content ratio increased, MOR and MOE tended to increase to 18.4 to 21.5 MPa and 3846 to 4003 MPa, respectively. In addition, bonding strength and absorption thickness expansion coefficient were improved. All specimens satisfies the structural grade specified in ISO as a whole, and it was analyzed that the increase in resin content in the middle layer had a positive effect on strength improvement.

Mariusz Maminski
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Powder Aminoresins With Dispersed Fiber Reinforcement - Adhesive Performance and Properties

Powder aminoresins are still underestimated in most temperate zone countries, though they exhibit some important advantages over the liquid resins. These are: no water content which is important for the efficiency and cost of transportation or longer shelf-life up to 9 months.
A new line of powder modified aminoresins has been developed and is under investigation in our company. Powder resins were blended with additives like modified starch, formaldehyde scavengers and dispersed fiber reinforcement. The effect of the additives on the mechanical properties, formaldehyde emission and morphology of composites were examined. Tensile tests of bondlines in solid wood exhibited high rate of cohesive failure in wood. Pull-off tests revealed strengths higher to those of the unreinforced resins. Formaldehyde emissions from wood-based composites determined according to EN 717-2 revealed variations between 0.6 mg/m2h and 9.0 mg/m2h, however, at the current stage, the best-performing formulations allowed achieving emissions comparable to those common in industry - i.e. plywood <0.7 mg/m2h. Fracture morphology of fiber-reinforced polymers was imaged by SEM.

Jorge Martins
Universidade de Porto

The effect of fiber bleaching treatment on the curing properties of the melamine-urea-formaldehyde resin assessed by ABES

Valbopan is the only Portuguese producer of colored dry process fiberboards (MDF) as structural component for indoor use in humid conditions. Melamine-urea-formaldehyde resin is the most used adhesive to produce this type of MDF given that it confers a high resistance, a lower thickness swelling and a high durability to the boards.
Getting light colors, such as white and pastel for MDF is an enormous challenge due to the natural color variation of the fiber itself. In order to avoid the use of high amounts of pigments/dyes, it is common to use optical brighteners such as TiO2. However, the TiO2 high cost and the price fluctuation in the market have motivated the industry to find alternatives.
In this work, oxidative bleaching agent (hydrogen peroxide), reducing agents (sodium sulfite and sodium dithionite) and a commercial bleaching agent were tested to treat wood the fibers. Different amount (5, 10 and 15%) of bleaching agents were tested. The effect of fiber bleaching treatment of fibers and different dyes on the curing of melamine-urea-

formaldehyde resin was evaluated by ABES (Automated Bonding Evaluation System). A new methodology was developed in order to assess the cure of the melamine-urea-formaldehyde (MUF) resin inside a fiber mattress. The effect of dyes and bleaching agents on physico-mechanical properties (internal bond, thickness swelling, bending strength) of the MDF boards produced with the treated fibers were also evaluated.

Mario Núñez-Decap
Universidad del Bío-Bío

Development of bio-based adhesives in proteins and modified lignin for the manufacture of radiata pine plywood for construction

The aim of this research was to develop adhesives with low formaldehyde emissions, from yeast proteins and lignin, for laboratory-scale plywood. Proteins from the yeast industry and modified lignin were used as reinforcement. A phenol formaldehyde (FF) adhesive was used as a reference. The yeast was prepared by homogenization, ultrasound, centrifugation and spray drying processes. FF adhesive blends were also prepared. The physical-chemical and thermal properties of the adhesives were studied. Plywood boards were manufactured from 5 sheets of 2.7 mm thick radiata pine wood, and 400*400 mm2. A grammage of 200 g/m2, a pressure of 15 kg/cm2, a temperature of 150°C and a pressing time of 350 seconds were used. The solids content of the adhesive mixtures varied between 40 and 45%, while the viscosity varied between 1240 and 6840 cP, with a pH between 5.59 and 11.18. The results of the thermal analysis by means of DMA showed an increase in the reactivity of the adhesive mixtures with respect to the FF. The stiffness and resistance of the plywood boards manufactured with the adhesive mixtures varied between 5944 and 6748 MPa for the MOE, and between 36.05 and 84.23 MPa for the MOR. The results of the mechanical properties of the boards showed that it was possible to replace up to 75% of the FF resin without affecting its physical and mechanical properties. The adhesive bond strength varied between 1.07 and 2.60 MPa. Regarding formaldehyde emission, emission levels decreased from 0.276 to 0.052 mg/L. Finally, it was validated on a laboratory scale that it is feasible to develop and use bio-based adhesives in the manufacture of plywood boards, totally or partially replacing the FF resin.

Simon Pardo Holtheuer
Bioforest S.A.

Use of nanofibrillated cellulose modified with carboxymethyl cellulose (CMC) as a binder for medium density fiberboard (MDF)

In this work, nanofibrillated cellulose (NFC) was investigated as a binder in the formulation of medium density fiberboards (MDF), focusing on obtaining a formaldehyde-free, highly reactive adhesive that could be used in short pressing times. For this purpose, carboxymethyl cellulose (CMC) was attached to bleached softwood kraft pulp through a treatment with HCl and NaHCO3, and the resulting pulp was subsequently refined through a friction grinder.
The CMC-modified NFC (CMC-NFC) was then mixed with polyamide-amine epichlorohydrin (PAE) as the crosslinking agent, thus obtaining an adhesive with a 11.6% solids content. The adhesive strength was then tested using the ABES system and by measuring the internal bond (IB) of manufactured MDF, whose values obtained were compared to standard urea-formaldehyde (UF) resin for MDF.
Under this comparative analysis, it was observed that there is a direct relationship between the solids content of CMC-NFC and the IB of the boards. Because of this, an increase of the CMC-NFC solids content was evaluated, reaching a maximum of 5,5% due to operational limitations during the refining process.
The CMC-NFC adhesive formulation showed its best performance at pH 10 where the highest strength values using the ABES system were obtained. However, when applied in the manufacture of MDF its efficiency is reduced due to its low solids content which leads to an intense subsequent drying process that could promote pre-curing of the adhesive. Under these conditions, IB values were higher than those of UF-MDF at a 2,6 times lower resin content (8% vs 20,8%) and same pressing times.

Seongsu Park
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Effects of Oxidation Level of Dialdehyde Cellulose on Performance of Low-Molar-Ratio Urea-Formaldehyde Resins

This experiment employed bio-based dialdehyde cellulose (DAC) with different oxidation levels to convert crystalline structure of urea-formaldehyde (UF) resins to improve their performance. Different oxidation levels of DAC were obtained by controlling the oxidation times such as 12, 24, and 48 hours. Two DAC levels (10% and 15%) were used to modify UF resins, which were characterized with gel permease chromatography (GPC), Fourier transform infrared (FTIR), X-ray diffraction (XRD) to observe molecular weight, functional groups, and crystallinity, respectively. Tensile shear strength (TSS) and formaldehyde emission (FE) were also carried out to observe the performance of modified UF resins from plywood.

Karol Peredo
Bioforest – Arauco

Reactivity of Urea Formaldehyde Resins Reinforced with Cellulose Nanofibers

This work discusses some technical advantages and challenges, about the application of nanofibrillated cellulose (CNF) in resins for particleboard (PB) and medium density fiberboard (MDF) industry.
CNF (0.5-3.0 wt%) was applied to UF resins as a reinforcement agent. The fibrillation degree had a strong influence on the resin properties. Under selected process conditions, it was found that the strength at the bond line, measured using ABES System, increased by more than 30%, enhancing the mechanical properties of the boards (Internal Bond). According with those results, it was possible to reduce the amount of adhesive by up to 15% while maintaining the quality of the boards.
The availability of hydroxyl groups in cellulose makes the surface of the nanofibers likely to be modified, thus improving their interaction with the resin. Therefore, oxidation of cellulose pulp with sodium periodate prior to mechanical defibration was studied. As a result, a reduction in the number of passes required to achieve the required fibrillation level and a marked reduction in the cure time of the adhesive mixture was observed. A kinetic study showed that the addition of this CNFs increased the reactivity, which could be utilized for the development of lower molar ratio resins, obtaining boards with lower formaldehyde emissions.
In conclusion, the incorporation of CNF allowed the reinforcement of adhesive mixtures. Additionally, chemical modifications on the surface of the CNF may add interesting properties in its application, such as a higher reactivity towards resins.

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Using different crosslinkers for networking of cellulose nanofibrils as a matrix in production of biodegradable, low-cost composite hydrogels for detection VOC from meat

VOCs such as volatile amines, hydrogen sulfide, ethanol, and carbon dioxide are formed during food spoilage, and are commonly used as indicators for detecting food freshness. Networking of carboxylated cellulose nanofibrils as a matrix in production of biodegradable, low-cost composite hydrogels for detection volatile organic compounds (VOC) from meat using different cross linkers and the formation of interconnected porous 3D networks was investigated. Dynamic viscoelastic, internal morphology, chemical structure, thermal behavior, compression strength and UV-vis properties of the resulting hydrogels was studied. Different anthocyanins as indicator dyes were successfully extracted from plants and conjugated onto the nanocellulose in hydrogels. The colorimetric hydrogels presented visible color changes over time due to a variety VOCs and CIELab results confirmed that the resulting composite hydrogels could be used to monitor the real-time and visual detecting meat freshness. Based on the results, depending on crosslinkers type

stemmed from their various binding energy, pH etc. different hydrogels with different moduli could be produced and the optimum concentration of nanocellulose, crosslinker and anthocyanin type and concentration for VOC detection was determined. The resulting interpenetrated polymer network hydrogel taking advantage of their low cost, biocompatibility, distinctive color change, containing free water to interact with gases, fraud free, no leaching problems etc. could be promising candidate to guarantee food freshness and preventing food spoilage and decreasing greenhouse gases.
Keywords: Crosslinker, Nanocellulose, Composite hydrogels, VOC, Biodegradable

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Development of an in-situ approach towards sustainable, carbohydrate-based adhesives

5-Hydroxymethylfurfural (5-HMF) is a promising bio-based platform chemical for the development of new bio-based adhesive systems. Up to today, there is no large-scale industrial production of 5-HMF, which makes the pure compound expensive and not easily available. To tackle this issue, new in situ approaches for 5-HMF and subsequent adhesive production, are of high interest. It has been demonstrated that 5-HMF can improve properties of carbohydrate-amine adhesive systems.
This study describes the development of an in-situ process, in which a precursor comprising 5-HMF is produced from fructose syrup via acidic dehydratization. The formed intermediate reacts in the sub-sequent adhesive production with amine crosslinkers and additional fructose to the desired carbohydrate-based adhesives. Main focus is on the compatibility of 5-HMF precursor synthesis with follow-up adhesive production in terms of practical implementation, sustainability and scale-ability. The transition from a continuous reaction system to an improved batch reaction system in the upscaling process of the precursor and adhesive production as well as the influence of reaction conditions on side product formation, e.g. polymerization of 5-HMF to humins, are demonstrated.
The influence of 5-HMF rich precursors produced under different reaction conditions and with stabilizing additives like sodium dithionite (Na2S2O4) on the adhesive production and the adhesive properties as well as the effect of adhesive synthesis variables such as temperature, reaction time and reaction atmosphere on the adhesive performance, e.g. the tensile shear strength development, was studied.

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New particleboards for food-packaging produced from Poplar peeling by-products using a circular economy approach

Poplar (Populus x canadenses Moench.) veneers (PWV) are an interesting and sustainable raw material in the food-packaging industry and a good alternative to fossil-based products. However, in the production process of these products, a big amount of by-products is generated, mostly during poplar logs peeling to obtain wood veneers with a thickness of 0.8 to 2 mm. The project FWFI is focused on modifying these by-products, in order to produce a new raw material that can be reintroduce on the production chain. On FWFI plant, wood veneers are processed at high levels of moisture content and only the final packaging is dried. In order to be used as a new raw material, by-products have to be dried and milled to obtain a mix of fibres and particles that can be bonded with a bio-adhesive extracted from the poplar bark residues fraction with citric acid. The mix was sieved to obtain different fractions and the influence of the particle size on the particleboard properties was evaluated. Single layer 210 mm x 210 mm x 2 mm particleboards were produced (Press temperature=160 ÂºC, pressing time=10 min, resin load=10 wt%) and evaluated, with different mix obtained from the initial mix, and using different amounts of the sieved fractions. The morphology of particleboards produced with different particle size fractions was evaluated by scanning electron microscope (SEM), as well as the compatibility of the bio-adhesive â€“ fibre after the internal bonding test. It was demonstrated that the valorisation of by-products of poplar wood veneers was possible in the production of high-performance particleboards with

applicability in food packaging using a bioadhesive based on extracts of poplar bark and citric acid as binder. Particle size distribution had shown to have a significant influence on the particleboards properties, mainly on their resistance to water.

Mohsen Siahkamari
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Lignin-Glyoxal: A Fully Biobased Formaldehyde-Free Wood Adhesives for Interior Engineered Wood Products

A biobased phenolic adhesive was developed by entirely substituting both phenol and formaldehyde with unmodified lignin and glyoxal (a biobased dialdehyde), respectively. Lignin-glyoxal resins were synthesized using an alkaline catalyst with a molar ratio of lignin to glyoxal 1:2. The adhesion strengths of the formulated adhesives were determined using single-lap-joint veneer samples cured according to recommended press parameters for commercial adhesives. The lignin-glyoxal adhesive had a relatively high dry adhesion strength (3.9 MPa), with over 90% wood failure which makes this green adhesive a unique biobased glue for the production of interior wood products.

Kim Tutin
Captis Aire

Industrial Air Pollution Control Technology Enables Operators to Sell Turpentine, Sell Carbon Offsets, and Significantly Reduce Operating Expenses as it Cleans the Air

Did you know there is approximately one gallon of turpentine in one ton of oven dry wood product made from green pine wood? Did you know this turpentine could be captured and sold to generate revenue? Did you know that you could sell carbon offsets and generate revenue by implementing an advanced air pollution control device?

When green pine wood is dried, volatile organic compounds (VOCs), including turpentine, volatilize off the wood. These VOCs are considered air pollutants and must be abated with an air pollution control device. Traditionally, these VOCs are abated by heating the process exhaust to over 1400°F to oxidize (burn) them. Due to the low concentration of VOCs in process exhaust typical of wood drying processes, fossil fuels are the primary source of fuel (energy) used to heat the process exhaust.

The advanced air pollution control device, the Fluidized Bed Concentrator (FBC) with Bead Activated Carbon, captures >90% of the VOCs without heating the process exhaust. Thus, it enables the operator to capture the VOCs, primarily turpentine, and significantly reduce energy usage. The collected turpentine could be sold as a renewable bioproduct. Furthermore, the reduction in energy usage could be measured, registered, and verified using approved carbon accounting methodologies thus enabling the operator to sell carbon offsets.

We ran a pilot FBC system for over 1700 hours over 6 months at a commercial oriented strand board mill. The pilot demonstration showed that technology met the MACT PCWP 90% VOC reduction efficiency requirement, captured salable turpentine, reduced energy usage, and reduced greenhouse gases.

In short, the FBC technology with Bead Activated Carbon cleaned the process exhaust from the wood drying process. It enabled the operator to generate revenue, significantly reduce operating expenses, and improve the sustainability characteristics of their process, as it cleaned the air!

Almut Wiltner
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Modification strategies of different proteins and their glue performance for solid wood materials

By now, amino resins are the main resin type used in the production of wood-based materials. However, the need to reduce formaldehyde emissions during the production process as well as from the products itself forces the development of new adhesive systems. Adhesives based on native proteins are of great interest but they have large

water loads and poor adhesive potentials. In order to overcome these drawbacks, proteins are denaturized to some extent by chemicals or enzymes. Thus, the solid content of protein solutions or dispersions is increased by reducing the molecular masses of macromolecules and disturbing the intramolecular interactions within the proteins. Both interventions result in higher accessibility of free and reactive groups along the peptide chains. Using modifications of these reactive groups the adhesive potential and the formation of stable bonds can be increased. Together with the adhesive potential, the hydrolytic stability in aqueous solution is improved. In the present work, different plant proteins (e.g. pea, wheat) are used and modified chemically (e.g. NaOH, urea) as well as enzymatically. Reactive compounds (e.g. carbonic acids, epoxides) are added to these modified protein-based dispersions. The curing is observed by rheological measurements and IR spectroscopy. Finally, adhesive formulations based on modified proteins are used to bond veneer and wood slats. The adhesion potential is tested by mechanical tests.

Ewelina Winsz
Dynea AS

Optimized properties of spray-dried Powder Adhesives

Powder adhesives are used for a wide range of applications within the wood working industry, especially formaldehyde-based powder adhesives. Over the last years, new applications and emission requirements for powder adhesives are seen in the marked. This has given an opportunity to optimize the production both regarding capacity and quality.
Liquid formaldehyde-based adhesives have a limited stability due to viscosity increase, especially at higher temperatures. The main advantage with spray dried formaldehyde-based powder adhesives is the good storage stability, and the possibility for long transport distances. Traditionally powder adhesives are dissolved in water after transport, for then to be used as a liquid adhesive. New advantages with powder adhesives have been discovered in dry powder applications, where powder adhesives are used without re-dissolving. This gives advantages with less handling at the customers, and at the same time new requirements with respect to powder behaviour.
Energy consumption, production capacity and product properties will be discussed. Spray drying is a high energy consuming process. Heating of dried air and optimizing of the process streams will increase production capacity and give better energy efficiency in the drying process.
Flow properties of the powder itself is important when handling of powder adhesives in the production process and for dry powder applications. Particle size and residual moisture correlates well with how the powder flows. Introduction of particle size measurements as a process control has improved the product quality significantly.