

## **Lignin Metabolic Engineering in Grass Biomass Plants for Primary Lignin Valorization**

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Trees and large-sized grasses are the major sources of lignocellulose biomass, which is indispensable for establishing sustainable societies. Large-sized grasses have much higher lignocellulose biomass yields than trees. With an overall aim to improve lignocellulose usability, it is important to improve lignin content and simplify lignin structures in biomass plants. In this context, using rice as a model for grass biomass plants, we produced transgenic lines with increased lignin content, which should be beneficial for the solid fuel use of biomass. We also generated transgenic rice lines with increased content of each of the three aromatic (i.e., *p*-hydroxyphenyl, guaiacyl, and syringyl) units of lignins. This helped to simplify the aromatic composition of lignins. These strategies are also applicable for the improvement of usability of large-sized grasses. In addition, in-depth lignin analyses of transgenic rice plants suggested the presence of a biosynthetic pathway that produces the grass-specific  $\beta$ -*p*-coumaroylated monolignols.

## **Development of “colorless wood block” and its natural hierarchical structure**

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The highly-controlled 3D structure of wood expresses the outstanding mechanical properties which allow to support the huge body and to live more than 1000 years. In order to apply this natural architecture for the novel biomaterials, we examined the removal of lignin via two-step chemical treatments with maintaining anatomical and cell structure, which is quite different from pulp and paper. The first step was alcoholysis which was conducted by ethylene glycol, and its best condition was determined by fourier transform infrared spectroscopy. The second step was bleaching wherein the delignification gradually proceeded from the surface to the core of the wood block, and finally resulted in complete decolorization. Next, multiple structural assessment from anatomical- to nano-level was carried out. X-ray CT (computed tomography) visualized ordered tracheids which mean to keep the anatomical structure. X-ray fiber diffraction diagrams obtained from “colorless wood block” showed oriented cellulose fibers, indicating microfibrils in the cell wall were unaltered. Furthermore, natural cellulose crystalline structure was kept from X-ray diffraction pattern. Lastly, transmission electron microscopic observation of microfibrils which were prepared by using TEMPO-mediated oxidation technique showed clear cellulose fibers which have long and uniform width. Given various structural analysis, we achieved in preparation of “colorless wood block” while maintaining the natural hierarchical structure.

## **Andritz Latest Screening technology for OCC Application**

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Well-known with over 5,400 pressure screens installed in numerous stock preparation lines worldwide, ANDRITZ presents the latest evolution in screening – the *PrimeScreenX*. The innovative design of the new screen builds on the successes of the widely valued *Modu Screen* family, but offers innovative key benefits. The improvements in energy efficiency, screening performance, and maintainability are significant. The *PrimeScreen X* is the natural evolution of the *Modu Screen* pressure screen family. The targets for this development were to improve both the energy and screening efficiency, while making the unit easier to maintain. The *Prime Screen X* is exceptional for all screening applications – brown and white grades, recycled or virgin, including coarse, fine, broke, thick stock, and fractionation duties.

## **Recent Trend in paper machine concept for board making**

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Defining suitable production capacity is key to ensuring the highest possible return on investment. Valmet's focus is on supplying the right papermaking lines with sustainable solutions to serve customers. OptiConceptM is a modular paper and board making concept launched in 2011 which answers these challenges. The OptiConceptM family suits both containerboard & cartonboard grade and fine paper production; Simple, well functioning solutions that meet the customer's needs. In this paper, we will introduce the OptiConceptM features as well as the recent development technologies for board making.

## **Advanced optimization method of multivariable predictive controller**

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Multivariable predictive controller (MPC) is widely applied to process industry from its real time optimization capability which makes large operation benefit from the process. MPC utilizes linear programming method (LP) to determine optimum solution under process constraints. Understanding of LP method is essential to utilize optimization function to maximize benefit from MPC. Since LP method is limited for linear algebra, optimization of highly non-linear process is difficult. Advanced optimization methods are developed for MPC to support process non-linearity. One is liner model on-line update method. Another method is hessian update. Multiple unit optimization is also available with real time optimizer. Further large scope optimization which includes production planning and blending is also available.

## **Wire Part Basic Knowledge and Latest Trend**

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The wire part is an important part that determines the paper quality, for example, the formation, the two sidedness of surface smoothness, and the MD/CD ratio of tensile strength. This paper describes the typical dewatering elements for wire parts and their dewatering mechanism, and also explains the typical types of wire parts configuration. The dewatering at wire part are hydrofoil dewatering (blade dewatering), vacuum dewatering, centrifugal dewatering, and wire tension dewatering due to the difference in dewatering mechanism. The types of wire parts are a cylinder molding former, a Fourdrinier type former, and a twin wire type former. Here, a Fourdrinier former and a twin wire type former are described. Twin wire type formers include gap formers and hybrid formers with on-top formers added to Fourdrinier formers. In addition for paperboard, there is a multi-layer former that combines multiple Fourdrinier formers.

**An Essay on Methodology for Innovating “JAPAN TAPPI JOURNAL”**  
**Part 7: “Cultural economics” Analyses on Material values and Cultural values of Paper**

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Paper products shipped from paper mills will give birth to the cultural issues and cultural values in contact with human society. Paper itself has cultural values as well as economic values. Paper industry has potentiality to produce paper products as cultural goods, therefore, often called cultural industry.

The seventh article of this series is intended to analyze the process of creating cultural values as well as material and economic values of paper using newly emerged academic area of “Cultural economics”.

The overall contents are described as below.

1. Introduction
2. Paper as goods and its process of creating values
3. The contents of cultural economics
4. Elements that create cultural values of paper media
5. The social responsibility of paper industry as cultural industry
6. “Creating shared values” for coexistence of economic values and social values
7. Epilogue

**Yield Increment of Hardwood ECF bleached Pulp by Addition of Peroxymonosulfuric Acid**

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The peroxymonosulfuric acid (MPS) was added at 0.1% dosage as  $\text{H}_2\text{SO}_5$  for the initial stage of chlorine dioxide ( $\text{D}_0$ ) treatment during elemental chlorine free (ECF) bleaching for a hardwood oxygen-bleached kraft pulp (LOKP) to improve yields of the bleached pulp. The  $\text{D}_0$  or  $\text{D}_0/\text{MPS}$  treated pulps were followed by alkaline peroxide ( $\text{E}_p$ ) stage and chlorine dioxide ( $\text{D}_1$ ) stage. The final pulp yield (93.1%) of  $\text{D}_0/\text{MPS}-\text{E}_p-\text{D}_1$  sequence was steadily higher than that (90.6%) of  $\text{D}_0-\text{E}_p-\text{D}_1$  sequence. When the dosage of chlorine dioxide was increased during  $\text{D}_0$  stage or  $\text{D}_0$  with MPS ( $\text{D}_0/\text{MPS}$ ) stage at 60 °C, the pulp yield was decreased. When the temperature of  $\text{D}_0$  stage or  $\text{D}_0/\text{MPS}$  stage was increased to 70 °C, the yield of  $\text{D}_0$  stage was decreased more than that of  $\text{D}_0/\text{MPS}$  stage. On the other hand, the total organic carbon (TOC) concentration of the filtrate from  $\text{D}_0$  stage was also higher than that from  $\text{D}_0/\text{MPS}$  stage. The glucan and xylan contents of the  $\text{D}_0/\text{MPS}-\text{E}_p-\text{D}_1$  bleached pulp were higher than those of  $\text{D}_0-\text{E}_p-\text{D}_1$  bleached pulp. It was clarified that decomposition and denaturation of carbohydrates in LOKP during ECF bleaching were reduced by the  $\text{D}_0/\text{MPS}$  treatment, and this would effect on the increment in bleached pulp yield of the  $\text{D}_0/\text{MPS}-\text{E}_p-\text{D}_1$  sequence.