



Production process under the watchful eye of science and technology

Get acquainted with the researches leading to the ten technical papers highest scoring by the Scientific Committee of the 46th Pulp and Paper International Congress, reflecting breakthrough discoveries on the pulp and paper production process.

Dedicated to cast a watchful eye to the practices of the pulp and paper industry, ABTCP 2013 – the 46th Pulp and Paper International Congress – conducted last October by ABTCP in a partnership with the Finnish Paper Engineers' Association (PI) and the Institute of Forestry Research and Studies (IPEF) – brought together congressmen, exhibitors and students to discuss, with the central theme *Clean Technologies and Eco-Efficiency*. The discussion is relevant. Although in recent years it has gained a prominent position regarding the implementation of sustainability concepts and minimization of environmental impacts, the sector experiences a continued commitment



By Caroline Martin
Special for O Papel





with technological increments and management models that lead to a manufacturing process increasingly clean and efficient. "There will always be opportunities for new technologies and procedures able to make the pulp and paper production more and more eco-efficient and with more appropriate sustainability level" states Celso Foelkel, writer at Graus Celsius and president of the Congress. José Luciano Penido, President of the Deliberative Board of the Brazilian Pulp and Paper Association (Bracelpa), reinforced that the planted forest based products industry is of fundamental importance for a sustainable future. "In 2050, we will be more than 9 billion people. For living well, within the planet limits, the forest companies group of the World Council for Sustainable Development estimates that, until there, we should have an additional 400 million hectares of forest plantations. So we will have the sustainable supply of biomass that we will need, preserving native forests."

The long-term goal would allow the planet to regain 30% of its area covered by forests and forest plantations, so important for the preservation of biodiversity and water. A sum of 400 million hectares of planted forests also would act in carbon sequestration, fundamental strategy to deal with climate changes currently seen, capable of affecting the lives of future generations.

Significant contributor weight in winning this major environmental goal, the pulp and paper industry tends to increase their participation in society. Penido highlighted that the sector portfolio has, by far, the best ecological footprint: "Our products are renewable; they can be recycled up to eight to ten times, in different applications."

On top of that, we have already seen a significant transition phase, which will culminate in industry rebirth. The studies and findings related to nanotechnology and biotechnology suggest promising paths to a modern sustainable life. "In a few years, cellulosic biofuels will be usual, as well as new carbon based materials and products, several cellulose based nanoproducts and a large number of new applications", Penido prospected.

In such context, of so important changes, ABTCP positions itself as a sector technical entity, able to promote relationships that stimulate the generation of knowledge and the sharing of information on the routes the pulp and paper industry has pursued towards a sustainable growth. "We move consistently towards a greater alignment with our mission of promoting the



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technology development and the technical training of the sector production processes", stated Darcio Berni, Executive Director of the association.

The commitment of ABTCP in holding the annual meeting to promote discussions and make reflections on the future of this industry is the same of those who are part of and represent the industry. Scattered throughout the supply chain, these professionals are dedicated not only to the day-to-day operations, but also to the production of technical papers, valuable to the industry. This year, an average of 100 articles was enrolled in the Congress. Among the participants, the ten authors who received the best scores of the ABTCP Scientific Committee present the results obtained in their studies and disclosed the details to the congressmen. Check out the highlights of these contents and technical abstracts published right after this story.

Watchful eyes on pulp production

Maurício Miranda Pereira, Engineering Projects Manager at Fibria, focused on the technical-economic evaluation of bleaching carried on by techniques D(EPO) and A/D(EPO)DP. The subject of the paper - a monograph for the Pulp and Paper Manufacturing Technology Specialization Course offered by Viçosa Federal University (UFV) - was chosen with the purpose of obtaining a more accurate evaluation of bleaching solutions with three and four stages, due to the need



to opt for an alternative every time a new investment in expansion or modernization is planned.

The author shows that, for technical parameters, the study was based on the analysis of results obtained in performance tests of the two last projects carried on at Fibria. For the economical analysis, as the manufacturing plants have different production capacities, parameter models for plants with 1 million tons annual capacity were developed, aiming at achieving an equivalent comparison. "15 years of plant operation were considered. Since we used information from performance test reports and final values of investments and updated supplies cost, we proceed with cost adjustments for the same production, presenting specific values for cost and consumption per ton of production", Miranda detailed.

Main results obtained show that solutions with three or four stages may reach, after brightness reversion, typical pulp classification ECF standard (88.5% ISO), meeting, therefore, the technical specifications for market pulp. "The initial investment for three stages bleaching is lower, precisely due to the lower number of equipment and systems involved. On the other hand, operational costs are higher, particularly with chemicals, of greater consumption", concluded the author.

Another concept studied by the Engineering Projects

Manager at Fibria: even without a fourth stage - normally the one with oxygen peroxide (P) - there was no difference between the final bleachings regarding the stability of brightness for the pulp treated with hot chlorine dioxide in the first stage, what demonstrates the compensation in final results of pulp quality.

Miranda highlighted that, although the present work presents values proven on an industrial scale, results are indicative, since the comparative analysis were made with pulps coming from different processes, both considering the raw material (wood from geographically different origins) and the pulping process itself. "It is relevant to revisit the points of comparison in order to make the best decision about a new investment, either an expansion or a modernization project", he mentioned to professionals interested in the practical application of the study.

Pia Jour, AkzoNobel Pulp and Performance Chemicals AB researcher, also enriched ABTCP 2013 technical sessions with explanations on pulp manufacturing process. When talking about the plans leading to the investigation on the use of bleaching chemicals, she highlighted that AkzoNobel is a company with high ambitions for sustainability. "We work continuously in the improvement of the sustainability performance of our products under the perspective of life cycle."

The study was conducted in cooperation with pulp bleaching and environmental system analysis company specialists. "The method we used was the Life Cycle Assessment (LCA) system analysis, performed in accordance with ISO 14040 (2006) and 14044 (2006) standards and, to the extent possible, in compliance with the requirements of ISO standard on carbon footprint of products presently under preparation (ISO/DIS 14067.2)", detailed the researcher, informing that the decision of emphasizing the environmental effect of climate change, expressed as carbon footprint, did not limit the inclusion of other environmental effects in the study.

The LCA, which took about one year to be concluded, also counted on a critical revision process carried on by the Finland Research Center (VTT). Talking about the main results, Pia informed that the alternative bleaching sequences were compared for two different scenarios: the first is related to the Chemical Island (an AkzoNobel concept), reflecting Brazilian conditions; the second refers to Ecoinvent, representing LCA generic data for bleaching chemical products. "Three different ECF (elementary



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"In order to create even more sustainable production systems, a cooperation between the different players in the value chain - including suppliers and customers - is mandatory", Pia encouraged



chlorine free) bleaching sequences were studied. One of them counted on ozone addition”, she reported.

Still, according to the researcher, the main difference between the two scenarios under investigation is the magnitude of carbon footprint contribution brought by the bleaching. “For the Chemical Island scenario, the contribution is 15%-17% of total carbon footprint, whilst in Ecoinvent the corresponding proportion is 34%-41%. The alternative bleaching sequences studied showed great similarity in bleached pulp carbon footprint.”

Pia emphasized that, due to the large extent in carbon footprint of chemical products used in pulp bleaching, it is crucial to choose datasets which are relevant when one considers geography and technology. “The most dominant contributors for unbleached pulp carbon footprint are silviculture and pulp production”, she highlighted.

As a conclusion, the researcher brought into evidence that the evaluation of the environmental impact of pulp and paper industry products generates knowledge on the magnitude of contributions brought by different parts of the value chain, being useful as a basis for further enhancements on carbon footprint. She highlights, however, that the availability of environmental footprints of relevant products for different locations and technologies establishes a prerequisite for the use of LCA in decision-making. “In order to create even more sustainable production systems, it is mandatory to establish a cooperation between the different players – including suppliers and customers – in the value chain”, Pia says, encouraging the team work.

The author of the best ranked technical paper of this Congress edition, Lucas Recla Lombardi, from the Process Development area of Klabin, devoted himself to evaluate the ECF bleaching of pulp of *Acacia mangium* from mixed plantation with eucalyptus. “The idea came up at the beginning of my master’s degree studies, at Viçosa Federal University (UFV), when the possibility of investigating a different material arose, slightly abandoning the routine of studying eucalyptus wood”, he explained.

The bleaching stage was chosen because it is considered as a critical step of the production process, creating a relation between costs and final product quality. “The mixed plantation came up as an option to investigate how far it is possible to go in replacing eucalyptus with acacia in tree plantation”, he commented, explaining his approach.



Lombardi stressed that the studies of alternative sources to eucalyptus used in the pulp and paper industry should be seen as opportunities for final product differentiation

In practice, the conclusion of the investigation – developed at UFV and in Klabin’s Monte Alegre facilities – took two years. Lab steps of pulping, scrubbing, washing, oxygen delignification, bleaching, refining and physical tests of the bleached pulp, from acacia chips, were carried out.

Results disclosed that *Acacia mangium* wood has satisfactory characteristics to meet the wood demand in a pulp and paper plant. Lombardi highlighted that such specimen is widely used in Indonesia for pulp and paper production. “Patently the eucalyptus wood is different from the one obtained from acacia; however, in ECF chemical bleaching, the performance of the acacia pulp was similar to what was noticed with eucalyptus pulp”, he said.

For the author, studies of alternative sources to the eucalyptus used by the pulp and paper industry must be considered as opportunities for a differentiated final product, as a consequence of the different characteristics of acacia fibers. “On top of that, the work showed that the plantation of two tree species potentially used in the industry is possible, and this may contribute for reducing the political-environmental pressure on eucalyptus monoculture, a situation which occurs in some Brazilian states with large forest area dedicated to the pulp and paper industry.”



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Bloembergen investigated the effects of biolatex binders in dynamic water retention, as a means of enhancing the understanding of performance and operability of the coating machine

Paper manufacturing process comprises a number of improvements

The steps of paper manufacturing also received attention from industry researchers. Steven Bloembergen, Technology Vice President of EcoSynthetix, for example, investigated the effects of biolatex binders on the dynamic water retention. The work builds on the findings presented by the authors at the PaperCon 2012, when they demonstrated interesting rheological properties of biolatex agglutinant dispersions and their coating colors compared to the conventional coating starches and SB latex agglutinants.

According to the author, the previous work indicated that the rheological performance of the biolatex agglutinant is significantly different from the performance of conventional cooked starches of coatings and formulations with fully synthetic latex. The study, therefore, aimed at the investigation of the dynamic water retention and the wall slipping properties of the same materials, in order to improve the understanding of the performance and the operability of the coating machine.

It is important to assure the right rheology and water retention of coating colors, as far as the coating equipment speed rises and adequate levels of operability, productivity and final product quality are pursued. The

author also highlighted that usually the problems of quality and operability originate from the interaction between the base paper and the water phase of the coating color. The lack of control of this interaction may lead to an excessive migration of the coating color to the base paper, resulting in low machine operability, system instability and lack of uniformity in coating layer.

An ACA ultra high shear rate viscometer (ACAV) was used in the evaluations, in order to provide a further understanding of the wall slipping properties of coating colors exhibiting relevant shear rates for the paper coating processes in industrial scale. Results of such experiments, in combination with obtained results from rheological studies previously presented, help to explain some of the fundamental differences between these binding systems.

Vitor Nascimento, Special Account Manager at Cargill, on his turn, presented a paper about the replacement of oil-based binders with biopolymer binders from renewable natural source in the formulation of coating color. "The initiative came from the opportunity to exhibit an innovative technology, meeting the central theme of ABTCP Congress", he said.

Still according to the author, the study started about one year ago, when Cargill Brazil and Cargill Europe started to share information. The first step consisted of technical visits and monitoring of applications at Cargill Technical Center in Germany. The second stage was the definition of the most appropriate product to local conditions, aiming at maximum performance of the application in lab tests and in specially chosen industries.

Among obtained results, Nascimento highlighted savings of up to 40% of the synthetic latex (oil-based) used in the coating formulation, besides the reduction of up to 50% of natural or synthetic thickener and still an improvement in water retention properties (desirable in some processes). "One must consider yet the greater satisfaction and customer engagement for contributing to sustainability". The increase of solids content in coating color without affecting the coating quality is a sustainable alternative for the segment", completed the manager.

In his vision, the main challenge in the practical application of this finding is related to the paradigm break within the paper industry regarding the utilization of natural based bindings. "In the past, similar initiatives brought cost reductions, but did not guarantee



maintenance or improvements in quality and machine running. The present technology, however, testified the cost reduction and also assured excellent results in quality and machine running”, he stated, encouraging the acceptance of the substitute.

Marco Polverari, Researcher at Kemira, dedicated his attention to the development of a highly structured polymer, with the objective of meeting customers and market demands as a whole. The work took two years to be concluded, a period of time involving from the birth of the idea till the commercialization. “It was a tight collaboration between Kemira Polymers R&D department and the customers”, disclosed Polverari, stating that the final alternative discovered is the best one in terms of class technology available for paper makers. “It is the most advanced micropolymers technology available for the industry.”

The justification relies on the improved mechanical efficiency and the enhanced properties of the sheet. “The new micropolymers do not only improve the formation, but also increase sheet strength, allowing the manufacturing with lower grammage”, detailed Polverari. “There is an urgent need for this property in writing and printing papers, for a higher ash retention, as well as improved rigidity in paperboard/cardboard”, he completed. Manufacturing, however, is still a challenge. “While the technology was new to us, we took some time to develop the necessary expertise.”

The researcher Márcia Barreto Cardoso, from the Pulp and Paper Laboratory for Technological Researches Institute (IPT – São Paulo), looked at the other extreme of paper production chain, trying to understand the influence of homogeneity of paper wastes in paper recycling.

According to her, the present environmental pressures are placing emphasis in materials recycling. In the case of paper, particularly, such pressures lead to the expectation of an increase in recovery rates of fibers of products used in paper and in the obtainment of recycled fibers with better quality. It is important to remember that the utilization of wastes of similar products allows the use of recycling technology designed for the material profile and the achievement of higher quality and less contaminated fibers.

Starting from this principle, the investigation proposed by the IPT researcher had the objective of checking the behavior of wastes from textbooks in

recycling process. It is estimated that about 150 tons of paper from textbooks coming from public schools are discarded annually in Brazil.

Two samples were prepared for the work: one composed exclusively by wastes from the internal pages of the books (Sample A) and another composed by wastes from the internal pages and from the covers of the books, in the proportion normally found in books (Sample B). Both were subjected to two different procedures: disintegration in water and pulping followed by flotation deinking. In relation to the recycling processes, the author explained that through water disintegration, one obtains papers with high dirt content, which limits its application to products without appearance requirements. On the other hand, pulping followed by deinking, in the case of wastes from internal pages only, results in pulps with low dirt and brightness equivalent to the average found in such textbooks, which are manufactured from bleached virgin fibers.

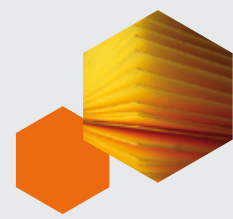
Another point made by the author: the recycling by pulping and flotation deinking operations, under the conditions used during the study, have no significant influence on paper strength properties, although the flotation process brings some improvement in such properties due to a partial elimination of fines in the cellulosic stock.

Results led to the conclusion that books have similar characteristics which lead to homogeneous wastes and, thereby, facilitate the recycling processes. There is, however, the need for a specific logistic in order to make



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"The new micropolymers not only enhance the formation, but also increase sheet strength, allowing paper manufacturing with lower grammages", detailed Polverari

their use as wastes source possible, since the textbooks discarding is pulverized and practically concentrated in a certain period of the year.

Patricia Kaji Yasumura, also researcher of the Laboratory for Technological Researches Institute (IPT), investigated the changes in quality of toilet paper and towel paper in Brazil. The paper presented during ABTCP 2013 is, indeed, a continuation of the first version, published in the Proceedings of VI Ciadicyc – Ibero-American Congress of Research on Pulp and Paper. "The first work had the objective of investigating the impact of the introduction of the series of standards for classification of tissue papers ABNT NBR 15464, adopted by Brazil in 2007", she justified, emphasizing that such standards represented a progress, mainly in the public and private bids, lacking of technical criteria for the resolution of conflicts of interest. The continuing work aimed to verify the evolution of tissue papers quality in period 2009 to 2013, after the initial impact caused by the introduction of the standard. In practice, the study was based on the overall results of all analyzes for classifying tissue papers conducted by the IPT Pulp and Paper Lab during the considered period. "The procedures followed were those described in the standards series ABNT NBR 15464 – Parts 1 to 15. In general, classifications are based on the sum score obtained for the tests of appearance (brightness, spots and holes), strength (dry and/or wet tensile) and absorption (absorption capacity and time)", described the researcher.

As results, Patricia noticed an improvement in dry and wet tensile strength, number of spots and holes and time for water absorption parameters. "The parameter brightness, however, remained near 88% in ISO standard. Such brightness stability may be explained by the limit imposed by the standard. The highest score is given to the paper with above 80% brightness (for toilet paper) and 85% (for towel paper). Once the cost of bleaching agents is high, paper brightness is, therefore, kept as close as possible to the limit, and no significant improvements are observed", she said.

Still according to her, a difference appears when one considers the brightness of toilet paper in rolls for home use. In this case, brightness is higher than the one presented by institutional products, because the sale is direct to the consumer, factor determining the products quality.

Another difference noticed between papers for domestic use and institutional papers refers to the average softness index, higher in the case of domestic use paper. "By the standard, the softness index is calculated by dividing the weighted wet tensile strength by the grammage. The institutional toilet paper must have 120 N/m minimum tensile strength, whilst the limit for the domestic toilet paper is 90 N/m. Based on the calculations for softness and for the limit of tensile strength established by the standard, the institutional toilet paper will have, then, lower softness."

The author of the paper believes that the Brazilian consumer demand for quality has driven a significant improvement in tissue papers. The use of ABNT 15464 NBR standard also influences the quality of tissue papers available in the marketplace and sets limits for the parameters covered by the standard. "Due to the importance of the standard and to the dynamics of quality requirements, the established limits must be revised frequently", she enforced. "Revisions must consider the importance of each parameter chosen for each type of paper, the technical limitation for improving each property and the development of new test methods and equipment", concluded.

The tissue paper segment was also investigated by Mário Eduardo Correr, Mechanical Engineer at SKF Reliability Systems. From Santher's need to understand the reason for the increase in vibration levels of operational systems at 1,300 meters of paper per



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minute, arose the initiative of making a dynamic analysis of the Yankee cylinder of company Paper Machine 3 (PM3). "The technique of dynamic analysis allows us to understand the vibration behavior of the system and identify the root-cause of the high vibration levels in the system", he explained.

For carrying out the study, the completion of which took about two months, vibration measurements were made at the Yankee drive and bearings. According to Correr, such measurements were useful for the determination of frequencies with higher vibration level. From this, the conventional technique for vibration analysis was used to identify not only the frequencies, but also the amplitudes and the characteristics of the vibration in Yankee drive and bearings.

The mechanical engineer of SKF still detailed that a 3D model of the analyzed system was built. This model was used in further analysis of the work. Another technique used was the Operating Deflection Shape (ODS), to visualize the deflections of the system under operating condition. "In addition to these analyses of vibration measurements performed in the field, we proceeded to numerical simulation to identify the natural frequencies of the system", completed Correr.

The jointly use of the three techniques enabled the identification of the root cause of the problem, which was related to the system resonance. "Resonance is a phenomenon occurring when the operation frequency coincides with the system natural frequency. This is an undesirable phenomenon as it causes high vibrations levels and failures in the system."

The author described that, once the root cause of the problem was identified, it was possible to propose improvements for the system. "There was no difficulty to implement the proposed solution, which brought significant gains to Santher, with production increase and reduction of maintenance costs", he told about the final result. Correr emphasized, yet, that using this technique, which does not require the machine shutdown, it is possible to effectively identify the cause for failures occurring in the pulp and paper industry, and to propose improvements that assure productivity gains, without any need of limiting machine speed due to the problem found.

The work done by Leonardo Souza de Caux, from the Environmental and Quality Department of Celulose Nipo-Brasileira S.A. (Cenibra), focused on the

effluent treatment stage. "Cenibra is a manufacturer of eucalyptus bleached kraft pulp with 1.2 million ton annual capacity located in the State of Minas Gerais, at Rio Doce Hydrographic Basin. After the treatment, the monitoring is done by lab sampling and monitoring with on-line instruments", contextualized. "Despite complying with the legislation, the strategy reacts with the instability inherent to the pulp production process. In this way, we noticed that predictive models could help to anticipate such occurrences, making the decision making and the intervention in the process much easier", the researcher commented on the initiative of using the Artificial Neural Network (ANN) to predict the quality of the treated effluent from a kraft pulp mill. He informed that many statistical prevision models are used in process optimization, including temporal series and regression models. In such context, ANN appears as the alternative to the statistical procedure, when complex linear and non-linear relationships between the input and output variables are requested. "The need for closer monitoring of effluent discharges due to the maintenance of water quality and reduction of



Caux bet on Artificial Neural Network (ANN) to predict the quality of the treated effluent from a kraft pulp mill, identifying alternatives to the effluent treatment stage

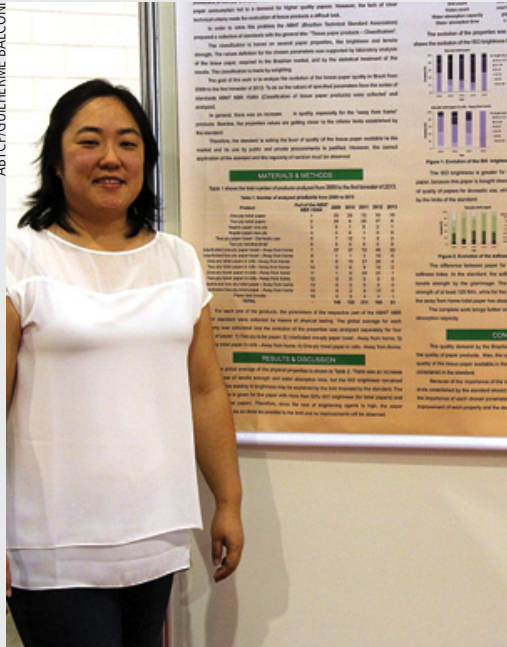


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Márcia: "Environmental pressures lead to the expectation of increased rates of fibers recovery from used paper products and the obtainment of better recycled fibers quality"



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Patricia noticed the quality improvement in tissue papers over the period from 2009 to 2013, after the initial impact caused by the introduction of the ABNT NBR 15464 standard

costs related to the laws of charging for the use and disposal of waste water and effluents, turns ANN into an interesting alternative”, he justified, highlighting that it is still possible to extend the network input variables till the places of effluents generation, enabling the most precise diagnostic of the causes of anomalies.

For running the investigation, Caux reported that input variables of the station were defined, in order to predict the Chemical Oxygen Demand (COD), solids content and output effluent temperature. “The historical

data of input and output of the treatment station were obtained from the company corporate systems (ERP and Pims) and statistically treated in order to build up a matrix to be modeled in ANN. After the modeling, data were validated.”

By going into details of the obtained results, the author mentioned that the models were efficient to predict data with an anticipation of 20 hours, allowing an operational convenience regarding to abnormalities, plus the assurance of sustainability of parameters controlled by law and a clearer view of problems. “The work may represent the beginning of a new way of plant integration, from the initial stages until the effluents discharge”, he emphasized.

Still according to Caux, an extension of this work may focus on ANNs in order to explain the input variables of the station, as a function of the modifications in the process and perhaps even of the wood quality. “The same concepts can apply for the integration of the fibers line and recovery cycle, building a large network of *data mining*, he exemplified. He recognized, however, that there is a major central challenge: raise the level of station automation so that the results of the ANN can be used in their full potential. ■

Note: *Read on this edition the summaries of the ten best ranked technical articles evaluated by ABTCP 2013 Scientific Committee and check out in this publication who are the other authors that participated of the researches.

