HIGHLIGHTS OF THE 5th INTERNATIONAL COLLOQUIUM ON EUCALYPT PULP

Jorge L. Colodette, Fernando J. B.Gomes, José L. Gomide, Teresa C. F. da Silva
Federal University of Viçosa, Viçosa, MG Brazil, colodett@ufv.br

ABSTRACT:

The 5th International Colloquium on Eucalypt Pulp was held in Porto Seguro, Bahia, Brazilon May 9-12th, 2011. The event focused on the integration of eucalypt based pulp mills with production of liquid and solid fuel, materials and chemicals. In other words, the vision of the kraft mill functioning as biorefineries was thoroughly discussed.The main technological advances in the production of printing & writing and tissue grade eucalypt pulps, from the forestry to the end product were also discussed. The eventlasted for three days and gathered almost 300peoplefrom 16 different countries. The most important topicswere covered in twelve oral and two postersessions gathering more than one hundred papers.This manuscript presents the highlights of the 5th International Colloquium on Eucalypt.

Key words: Biorefineries, eucalypt, kraft pulp, forest to end product.

INTRODUCTION

Eucalypt is becoming the most important fiber source for papermaking worldwide. It is predicted that by the end of this year, market pulp production will reach about 65 million tons, with about 33 million coming from hardwoods, and 55% of this coming from eucalypt. Eucalypt is the largest single global source of market pulp. The major interest in eucalypt wood comes from its low production cost in certain regions, due mainly to high forest productivity and high pulping yield. However, more recently the outstanding quality of eucalypt fibers has been recognized. The use of bleached eucalypt fibers to manufacture paper grades previously made only with bleached softwoods is growing rather fast. The ongoing scientific and technical advances achieved in production of eucalypt fibers, from forest to product, and the increasing understanding of their applications in various paper grades have made these the preferred fibers worldwide. Unlike mixed species pulps, single species offer specific benefits and well-defined attributes. In this regard, eucalypt pulp fibers produced from clonal plantations have emerged as the most desired fibers in the market, not only for the production of tissue and printing & writing papers but also for the manufacture of "new products".

South America is currently the largest producer of bleached eucalypt market pulp worldwide (14 million tons in 2010). Furthermore, most of the new eucalypt pulp mill projects are predicted to be installed in South America, with an 11.5 million tons output predicted for the next 5 years. Our continent is becoming the nervous center for eucalypt pulp production globally. Therefore, South America must lead the initiatives in research, development and innovation on eucalypt pulp production and utilization. One important initiative in this direction was the creation of the International Colloquium on Eucalypt Pulp in the year of 2003, which has become an important forum for discussions on production and utilization of pulp from this important raw material. The 5th ICEP was held in Porto Seguro, Brazil, in May of 2011. This event focused on the integration of eucalypt pulp mills with liquid and solid fuel production, materials and chemicals units. In other words, the vision of the eucalypt kraft mill functioning as bio-refinery was thoroughly discussed in this important event.

This event gathered about 300 peoplefrom16 countries, lasted for three days and had twelve oral and two poster sessions, gathering more than one hundred papers, where new developments on various topics related to eucalypt were discussed, including: (1) advances in eucalypt forest improvement, (2) eucalypt wood quality and chemistry, (3) biotechnology applied to the pulp and paper industry, (4) wood biorefineries, (5) novel wood deconstruction techniques for biofuel and bio-products, (6) mechanical and bio-mechanical pulping, (7) kraft pulping chemistry and technology, (8) advances in black liquor

recovery focused on biorefineries, (9) pulp bleaching chemistry and technology, (10) fiber quality for tissue paper grades, (11) fiber quality for printing and writing paper grades, (12) eucalypt pulp industry environmental issues; (13) new products from eucalypt wood fibers. This paper presents the highlights of each session that contributed to the success of 5th ICEP.A complete list of all the manuscripts presented during the event is available in Appendix.

SESSION ONE

Thissession presented the advances on Eucalypt forest improvement. In hiskeynote speech, Dr. Dario Grattapaglia from EMBRAPA –Brazil, showed the results of his research on the genomic selection (GS). He highlighted the most important mechanisms of GS, and showed that gains in forest productivity through the increase in height andwood density. In his analyses the gain in selection efficiency, measured as the ratio of GS and phenotypic selection exceeds 300% by reducing breeding generation time from 8 to 2 years with early flower induction. Another important fact cited by Dr. Dario is that these are the first experimental results of GS in forest trees and among the first public ones in plants in general. With the technological advances and declining costs of genotyping methods, a cautiously optimistic outlook is that GS has true potential to be implemented operationally and revolutionize tree breeding practice. Another positive point to GS may be choosing the disease-resistant tree contributing to maintain the productivity of the mill [1]. Dr. AcelinoCoutoAlfenas from Federal University of Viçosa – Brazil – showed that tree infection by a new pathogenic fungireducedpulping yield by 14% in some Brazilian Northeast eucalypt plantations [2]. The infection also caused reduced forest growth and productivity. In two other lectures the importance of lignin structural characteristics on pulping yield were highlighted. Dr. Yuji Matsumoto from University of Tokyo – Japan, showed that the type of linkage affects the pulping reactions. Wood containing lignin of higher erythro/threo β-O-4 linkages are less condensed and easier to remove during kraft pulping [3]. Dr. Ana Gabriela Bassa from ArborGen – Brazil also showed that an increased level of syringyl type lignin improvesEucalypt pulping efficiencyand produce higher gravimetric yields [4].

SESSION TWO

Session two was entitled “Eucalypt Wood Quality & Chemistry”. In his keynote speech, Dr.José Carlos Del Río from IRNAS/CSIC – Spain presented the most recent advances in Eucalypt wood chemistry. Dr. Del RIO highlighted the importance of eucalypt wood chemical characterization and the study of the evolution of its main components (lignin and lipids) during pulping and bleaching. It was claimed that the deep understanding or the wood chemistry foster a better and sustainable industrial use of eucalypt for biofuels, bio-products and pulp and paper manufacturing [5].Contributing to advances in biorefineries study Dr. TarjaTamminenfrom VTT – Finland presented her study on thecharacterization of xylans and lignins isolated from various Eucalypt species by organosolv process. She showed thatEucalypt wood chips can be cooked using the phosphinic acid aided LGF organosolv method with acetic acid as solvent. Lignin can be recovered from the cooking liquor [6]. Other interesting lecture was presented by Dr. Claudio Ferreira from Veracel – Brazil, that presented his work about the influence of wood quality in alkali consumption and pulp production. He showed that the basic density and wood age are directly proportional to the consumption of alkali in the cooking process and that the rainfall index significantly affects the wood quality, and in this survey, in forests planted further from the coast, with lower rainfall, wood grows under the regime of excessive stress and this causes difficulty in cooking and raising alkali charge. Precipitation and age of the wood should be included in the specification of wood quality to the mill [7].

SESSION THREE

The session three was entitled “Biotechnology Applied to the Pulp and Paper Industry”. In his keynote address, Dr. Angel Martinez from CIB/CSIC – Spain presented his paper about biotechnology for eucalypt paper pulp and showed that it is possible to apply oxidative enzymes to obtain a double benefit in eucalypt pulp quality, due to the simultaneous removal of lignin and lipids. He pointed out that works in progress in different laboratories include the structural-functional characterization and improvement of oxidative enzymes (both laccases and peroxidases) by molecular biology and protein engineering tools [8]. In this way, new oxidative biocatalysts being more adapted to application conditions in current pulp

manufacture will be produced [7]. Also collaborating with this research line Dr. Auphelia Burnet from CTP – France presented pilot-plant results on the use application of oxidative enzymes . In this study she showed the industrial feasibility of the latter concept by using Eucalyptglobuluskraft pulp (100 kg o.d.) that was bleached in a TCF sequence incorporating an enzymatic stage (stage L). This stage included 0.1% of a recombinant fungal laccase and 0.2% of methyl syringate as mediator, and was followed by an extraction stage and double peroxide bleaching (after metal chelation). The final brightness (85% ISO) at the end of the enzyme-containing sequence, L-(EP)-Q-P-P was similar to that obtained with the O-O-Q-P-P sequence currently used in the mill. The results obtained demonstrate that the two high-temperature oxygen delignification stages (98ºC) can be substituted by a single enzymatically-catalyzed delignification stage (carried out at only 55ºC). Moreover, this substitution allows improving the mechanical properties of the final bleached pulp [9]. Another interesting lecture was presented by Dr. Peter Hart from MWV Corporation – USA, in his work he made a comparison between bleaching plants using enzymatic stagesin North Americanand South American, aiming to determine why South American mill experiences have been poor while North American mills have good results. He concluded byLaboratory work performed with fungal based enzymes has shown that eucalyptus fiber is extremely susceptible towards xylanase application and produces significant levels of chlorine dioxide reduction with small dosages of xylanase resulting in significant economic savings for the eucalyptus mills. The deterioration of the oxygen delignification stage performance resulting from increased chemical oxygen demand (COD) entering the stage eliminates this savings. The mill scale trials that have been conducted in South American so far have been performed with bacterial based xylanase enzymes instead of fungal based enzymes. Laboratory work has shown that these bacterial based enzymes are more aggressive in sugar removal than corresponding fungal based enzymes. Significant levels of kappa number reduction are reported when fiber is treated with bacterial based enzymes versus no or minimal reported kappa number reduction with fungal based enzymes. By cleaving the xylan molecules at a location that liberates substantial lignin-carbohydrate complexes (LCCs), the bacterial based enzymes substantially increase the total organic carbon (TOC) in the resulting enzyme stage effluent. It would appear that these LCCs are highly resistance towards oxygen attack under typical oxygen delignification operating conditions. It is speculated that these LCCs are highly resistant towards oxidation because they are complexed with xylose oligomers and thus unreactive towards oxygen delignification due to electron delocalization within the many oxygen atoms present in the xylose oligomers. It may be possible to employ a less aggressive, fungal based enzyme in a low dosage application and mitigate the COD/TOC caused oxygen stage deterioration. If this is possible, the potential for economic savings through enzyme application may still be realized in South American mills [10].

SESSION FOUR

The session four focused in the new concept of biorefineries and its potential integration witheucalypt pulp mills and it was entitled “Wood Biorefineries”. In his Keynote address, Dr. Peter Axegård from INNVENTIA - Sweden summarized the main objectives of the forest biorefinery. The focus is on the development of value chains for the wood polymers cellulose, xylan and lignin including efficient separation processes, upgrading and final applications. Xylan can be extracted from several locations in the mill and can be used as a fiber surface modifier, in gas barriers and thermoplastics. Lignin can be produced from black liquor and can be used as fuel, additive to wood pellets, feedstock for carbon fibers and other value added applications. Specialty pulps with high alpha-cellulose content being produced in a modified alkaline process are another interesting option. Forestry residues can be co-processed in a kraft pulp mill as feedstock for ethanol, lactic acid or specialty cellulose and sulfur-free lignin production.In order to achieve the objectives described above, different papers were presented and showed in details the different process and raw materials [11].Dr. Hebert Sixta from Aalto University – Finland presented results on the comparison among three different processes (autohydrolysis, alkaline pre-extraction, alkaline post-extraction) prior and subsequent to alkaline cooking of *Eucalyptusglobulus* were investigated. The author concluded that the processes are feasible, in special the alkaline post-extraction one [12]. Also contributing to the development of biorefineries Dr. TiinaLiitia from VTT – Finland presented discussed theorganosolv pretreatment of lignocellulosicsaimed at bioethanol production, where she compared two different raw materials, namelyeucalypt wood and elephant grass. She concluded that

thephosphinic acid based LignofibreOrganosolv cooking in ethanol solvent is a promising pre-treatment method for lignocellulosics, producing well hydrolysable biomass at high yield for fermentation [13].

SESSION FIVE

The session five was entitled "The Pulp Mill Biorefineries". In his Keynote speech Dr. Michael Paleologoufrom FPInnovations – Canada presented discussed forest biorefinery on a Canadian perspective. He showed that the new Canadian forest sector is in the process of profitably transforming its renewable, sustainably-managed resource into a full suite of valuable products, including novel, high-value chemicals and materials, traditional products such as pulp and paper or construction materials, and energy products such as heat, biogas, power and transportation fuels. These products are based on Canada's advantages, which include large volumes of certified sustainable wood harvests combined with innovative technologies and industrial know-how, along with advantages that bio-based materials have over their petroleum-based analogues. The petroleum refinery model, where 4% of the feedstock is extracted and converted to high-value products generating 42% of the benefits, is the model for this new forest sector. Examples of such options include: dissolving pulp production (especially in the case of hardwood mills with batch digesters), nanocrystalline cellulose production from bleached kraft pulp, hemicellulose extraction from wood chips prior to pulping (especially in the case of pre-hydrolysis kraft pulp mills), lignin recovery from black liquor (especially in the case of softwood kraft pulp mills where the recovery boiler is the production bottleneck), methanol recovery from evaporator and/or digester condensates and biogas production from sulphite mill condensates and/or biological sludge [14].The Ph.D. candidate Ricardo Bailerini Santos from North Caroline University State – USA presented his paper about the impact of hardwood species characteristics on enzymatic hydrolysis efficiency and on the overall ethanol cost. He discussed and showed the ideal wood quality and operational conditionsforwodenzymatic hydrolysisaimed at ethanol production [15]. Contributing also to the advance of new products Dr. Lucian Amerigo Lucia from North Caroline University State – USA presented his paper about nanofibrillated cellulose-based aerogels, showing a new chemical approach for tuning their micro-architectures. In his work freeze-dried nanofibrillated cellulose based-aerogels were produced using *Eucalypturograndis* as a raw material. Nanofibers were isolated under high pressure and modified with TEMPO-mediated oxidation and/or hydroxyapatite. Different degrees of oxidation were reached and measured by conductimetric titration (~ 0.1 and 0.2). Oxidized and non-oxidized samples were modified with hydroxyapatite (HPa) in a level of HPa : cellulose ratio of 0.2:1. Morphology, rheological and physical properties were used to characterize produced aerogels. His results shown a well-organized morphology and a greater mechanical strength for aerogels fabricated with oxidized nanofibers [16].

SESSION SIX

The session six was entitled "Mechanical and Bio-mechanical Pulping". In his keynote lecture Dr. Eric Xu from Andritz – USA presented his paper about the latest developments and trends in chemical Mechanical pulping of hardwoods. According to Dr. EricXu's reporta number of different system designs have been developed to meet challenges in the industry and for different commercial or economic situations, under the basic P-RC APMP concept, (AP pretreatment→ refining → AP treatment → Refining). Most of those designs are already proven in commercial operations. As the industry moves towards more diversified hardwood resources, wider range of paper/paperboard products and tougher effluent regulation, the pulping process development will also have to be in the direction of being more flexible and more efficient. With fast growth rate (high wood yield) and superior pulp properties, eucalypt woods will play more and more important role in chemical mechanical pulp industry, as has already been evidenced by significant increase in their commercial installations and capacity in recent years [17].Another highlight of this session was the lecture by Dr. André Ferraz from São Paulo University – Brazil. In his lecture Dr. Ferraz showed Biomechanical pulping of *Eucalyptusgrandis* on a pilot scale was able to promote 18% and 27% energy savings during industrial thermo mechanical pulp and chemical thermo mechanical pulp processing, respectively. The strength properties of biomechanical pulps did not increase on a mill scale refining as has been observed in previous studies performed using lab-scale disk refiners. Economicalfeasibility of biopulping depends on the levels of energy savings obtained as well as on energy prices and biotreatment costs [18].

SESSION SEVEN

Session seven was entitled “Kraft Pulping Chemistry and Technology”. In his Keynote lecture Dr. Mikael Lindström from KTH – Sweden presented a paper called “From simple theory to industrial application – extended impregnation kraft cooking”. In his presentation he showed that the potential to increase the overall yield of bleached *Eucalyptusurograndis*kraft pulps has been investigated by cooking to higher kappa number with the novel Extended Impregnation Cooking (EIC) technique. The extended impregnation results in considerable lower shive content and enable the kraft cook to be terminated at kappa number 27. His result showed that it is possible to extend the oxygen delignification of higher kappa number pulps. By extending the oxygen stage to kappa number 12 followed by bleaching to 90.5 % ISO brightness with a D*(EPO)D sequence, a total yield gain of 2.5 % on wood can be obtained.Dr. Mikael also showed applications for “nano pulp” as in paper and board products, where thenano pulp is expected to enhance the bond strength between fibers and is expected to have a strong reinforcement effect on paper materials. Other applications possible are: (1) Composite Applications: high-strength material using nano pulp in combination a thermosetting resin or other polymers; (2) Food Applications: low calorie replacement and thickener, flavor carrier and suspension stabilizer for a wide variety of food products. (3) Cellulose derivate and regenerated fibers:the large area available may be very suitable for chemical modification and dissolution in different liquors [19]. Another interesting presentation of this session was made by Eng. FlávioCorreia from Cenibra – Brazil, he presented his work aimed to improving digester operational equilibrium, by clustering different key cooking process information that affect *Eucalyptus* chip compaction disturbance in a vapor phase continuous digester, evaluating the interaction between them and determining their effects on chip bed retention disturbances. The results achieved allowed for a better understanding of chip bed packing and turned possible the optimization of digester liquor and chip flows. Through modifications and advances on the main manipulated inputs, digester hanging and flow channeling were minimized with consequent improved fiber quality and production efficiency [20].

SESSION EIGHT

The session was entitled “Pulping and Bleaching Chemistry and Technology”. In his keynote address Dr. Marco Antonio Andrade from Andritz – Brazil discussed the fiberline of the future for Eucalypt kraft pulp. He pointed out that the trends to Eucalypt kraft pulp mill is the constant search for scale economics, production integration, life cycle assessment, new fiber products and development of the bio-technology [21].As highlight of this session Dr. Marcelo Moreira Costa from Kemira – Brazil presented his work about the use of peracetic acid assisted (PAA) ECF-light bleaching of eucalypt pulp adapted to partial bleach plant closure. He showed through laboratory results that PAA application in post-bleaching increased pulp brightness ceiling and decreased brightness reversion. The PAA-stage application is attractive for pulp mills with limited ClO_2 generation capacity; they can potentially increase production capacity since desired brightness can be achieved with very low ClO_2 charges. Another positive point was thatfor pulp and paper mills with limited water and effluent treatment capacities, the PAA-stage as pre-bleaching technology can save investments in these plants [22].

SESSION NINE

The session nine also focused the bleaching chemistry and technology. In his Keynote lecture, Dr. TapaniVuorinen from Aalto University – Finland presented the future perspectives about the ECF bleaching of Eucalypt kraft pulp. According to his opinion and research, it is possible to bleach eucalyptus pulp with half the amount of ClO_2 currently being used in the most efficient mills. The possibilities and principles that lead him to believe that this target is viable were presented in details in his lecture [23].In another study about the impact of bleaching history on the efficiency of final chlorine dioxide stage in ECF-type bleaching of eucalypt kraft pulps, Dr. OlenaSevastyanova from KTH – Sweden concluded that in eucalypt pulps, the structure of xylan undergoes gradual modification during the delignification process, oxygen pre-bleaching and various types of ECF bleaching. The structurally modified xylan seems to play a more important role than residual lignin content in the higher chemical

demand and efficiency of the final D_2 bleaching stage. For pulp samples with identical lignin content, but with differing structure of xylan, target brightness could be achieved by adjusting final pH (NaOH charge) in the D_2 bleaching stage [24].

SESSION TEN

The session ten was entitled "Advances in Black Liquor Recovery". In hiskeynote address Dr. Honghi Tran from University of Toronto – Canada presented the challenges in black liquor recovery in modern kraft pulp mills. In his presentation he focused in the high energy and chemical costs and stringent environment regulations that limit emissions, solid waste disposal and mill effluent discharge, the need for improved energy and that chemical recovery efficiencies from black liquor have become a criticaleconomic and environmental factor in kraft mill operation. Mills must maximize the steam and power production capacity, reduce fossil fuel consumption, minimize chemical losses, and reduce non-process elements and dead-load chemicals that circulate in the recovery cycle. The reliability and efficiency of process equipment such as evaporators, recovery boilers, causticizing equipment and lime kilns have a direct impact on the quantity and quality of white liquor, and ultimately the quantity, quality and costs of the pulp produced [25].Contributing for this advance Dr. PerTomani from Innventia – Sweden presented his work about the integration of lignin removal into a kraft pulp mill and use of lignin as a biofuel. In his study Dr. PerTomani showed through LignoBoost process thatit is possible to increase power delivery to the grid with high efficiency of power boiler close to the mill and power boiler close to users. The Na/S balance is possible to optimize and in the near future high value products (carbon fibers, active carbon etc.) will be produced in a commercial scale [26].

SESSION ELEVEN

The session eleven was entitled "Fiber Quality for Papermaking I". In his keynote speech, Dr. Paulo Pavan from Fibria – Brazil presented the state of the art technologies for tissue paper grade pulps and also presented the market demands. According to Dr. Paulo the tissue market scenariois very promising and the demand in the next years will be higher than production [27]. Applying biotechnologies in the paper production Dr. Ali Esteghalian from Verenium Corporation – USA presented a work about the applications of high performance enzymes in fiber quality improvement. In his study he concluded through results of laboratory and pilot scale trials have shown that enzymes of Lipase type can increase paper tensile strength by10-18%, depending on enzyme dosage and pulp used. Another positive point was the reduction of pitch deposition on fiber surfaces [28].Contributing to the advance of the use of enzymes in paper production Ph.D. candidate OriolCusola from Polytechnic University of Cataluña – Spain presented his work about the effect of the laccase mediator system on the fiber properties of TCF bleached kraft pulp. His results showed that the use of a laccase mediator system was found to reduce the hexenuronic acid content of TCF kraft pulp from *Eucalyptusglobulus*. This can open up new prospects for increasing brightness stability. Also, laccase treatment reduced the content of carboxyl groups of TCF pulp by up to 27% by removing hexenuronic acids. Lowering the carboxyl content additionally alters the charge on fiber surfaces. This may be useful with a view to reducing pulp processing costs inasmuch as a decreased content in ionizable groups can be expected to reduce consumption of cationic additives used in papermaking processes[29].

SESSION TWELVE

The session twelve was the last technical session of the event and also focused the fiber quality for papermaking. In his keynote speech Dr. IiroPulkkinenfrom Aalto University – Finland presented a paper discussing the most important eucalypt fiber properties for fiber network strength and structural property development and how to predict these properties. He concluded that multidimensional fiber analyzers give new possibilities to combine traditional lab methods for predicting product quality. The most important thing is that they are comparable to some physical properties that can be easily measured. From a practical and engineering point of view it is important that all parameters of a given model could be easily measured in the laboratory in order that the model could be widely applicable [30].Dr. Joana Curto from Beira do Interior University – Portugal showed the fiber flexibility influence on paper structure and

mechanical properties, for relevant eucalyptpaper fibers base, and investigated the corresponding influence using a computational 3D paper model. Her conclusions pointed out that, with the optimal refining degree, reinforcement pulps improved tearing and tensile strength of the Eucalypt based paper. There is a need to find the optimal process conditions depending on the raw material to be used, being possible to obtain equivalent performances. The experimental results were compared with simulation results and the same evolutions were observed. By using the 3D paper model it was possible to separate the influence of different fiber properties, like fiber flexibility and fiber collapsation. Also a broader range of inputs can be tested and web properties, like relative bonded area andcoverage that are traditionally difficult to obtain experimentally can be determined [31].

CONCLUSIONS

The 5th International Colloquium on Eucalypt Pulp reached its goals. All papers presented during this eventarecurrent and have been seeking alternatives to improve pulp & paper production and quality. This event has also contributedfor the dissemination and advance of the scientific research aiming not only the production of pulp but also of other products that can be obtained by integrating and taking advantage of every opportunity that pulp mills can offer, thus contributing to a more economically and environmentally sustainable production.

The International Colloquium on Eucalypt Pulp has emerged as the most important scientific event of the eucalypt pulp and its sixth version will be held in the city of Colonia, Uruguay, on August 21-23, 2013.

AKNOWLEDGMENTS

The generous support provided by the Brazilian Scientific (CNPq)and Training (CAPES) Research Agencies is greatly appreciated.

REFERENCES

1. GRATTAPAGLIA, D., FARIA, D. A., RESENDE, M. D. V., PETROLI, C.D., SANSALONI, C. P., JUNIOR, M. F. R., MISSIAGGIA, A. A., TAKAHASHI, E. K., ZAMPROGNO, K. C. and KILIAN, A., “Genomic Selection for growth and wood traits in tropical Eucalypt: a paradigm shift in forest tree breeding”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
2. ALFENAS, A. C., FERREIRA, M. A., BINOTI, D.H.B, ZAUZA, E. A. V. and MAFIA, R. G., “Volume and pulp yield of healthy and infected trees of Eucalypt urophylla x E. grandis by Ceratocystisfimbriata”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
3. MATSUMOTO, Y., “Stereo structure of β-O-4 linkage of Eucalypt lignin and its relation to pulping reaction”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
4. HINCHEE, M., BASSA, A. G., ROTTMANN, W., CHANG, S. and KWAN, B., “Biotech enhanced levels of syringyl lignin improves Eucalypt pulping efficiency”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
5. DEL RÍO, J. C., RENCORET, J., MARTÍNEZ, A.T. and GUTIÉRREZ, A., “Recent Advances in Eucalypt Wood Chemistry”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
6. TAMMINEN, T., LIITIÄ, T., HYVÄRINEN, S., MIKKONEN, H., HAKALA, T., OHRA-AHO,T., ROVIO, S., SUURNÄKKI, A. and COLODETTE, J. L., “Characterization of xylans and lignins isolated from various Eucalypt species”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
7. FERREIRA, C. , LEITE, H. G. and MARCATTI , G., “The influence of wood quality in alkali consumption and pulp production - Case Study”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.

8. MARTÍNEZ, A. and GUTIÉRREZ, A., “Biotechnology for eucalypt paper pulp”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
9. BURNET, A., MEYER, V., PETIT-CONIL, M., MARTÍNEZ, A., GUTIÉRREZ, A., KALUM, L., LUND, H., ROMERO, J., “Upscaling TCF bleaching of Eucalypt globulus pulp using an enzyme-catalyzed oxygen delignification stage”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
10. HART, P., “Enzyme bleaching experience in North America and Brazil”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
11. AXEGÅRD, P., “The kraft pulp mill biorefinery platform”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
12. SIXTA, H., “Progress and challenges in the separation and purification of xylan from Eucalypt wood”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
13. LIITIÄ, T., MIKKONEN, H., UUSITALO, J., TAMMINEN, T., COLODETTE, J. L., “Organosolv pretreatment of lignocellulosics for bioethanol production”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
14. PALEOLOGOU, M., “The forest biorefinery: A Canadian Perspective”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
15. SANTOS, R.B., CAPANEMA, E. A., BALAKSHIN,T. M., CHANG,M.H. and JAMEEL, H., “Hardwoods Morphology and Lignin: Content and structure impact on Kraft Pulping”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
16. LUCIA, L. A., FONSECA, T. C. and HABIBI, Y..A new chemical approach to developing aerogels from cellulose”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
17. XU, E., “Latest developments and trends in chemical mechanical pulping of Hardwoods”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
18. FERRAZ, A., MASARIN, F., CUNHA, G. G. S. and PAVAN, P. C., “An overview of technology and biochemical basis of the biomechanical pulping process”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
19. LINDSTRÖM, M. E., LI, J.,SHI, C. and HENRIKSSON, G., “A genetic strategy for avoiding formation of hexenuronic acid in kraft pulping?”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
20. CORREIA, F, COLODETTE, J. L., REGAZZI, A. J. and GOMIDE, J. L., “Eucalyptus chip compaction disturbance analysis in a vapor phase continuous digester”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
21. ANDRADE, M. A. and PIKKA, O., “The Fiberline of the future for Eucalypt kraft pulp”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
22. COSTA, M., VUORENPALO,V. M., HÄMÄLÄINEN, H., NYMAN, M., RÄSÄNEN, E. and MORAES, P., “Peracetic acid assisted ECF-light bleaching technology adapted to partial bleach plant closure of eucalypt pulps”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
23. VUORINEN, T., “ECF bleaching of eucalypt kraft pulps”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
24. SEVASTYANOVA, O., LINDSTRÖM, M. E., FORSSTRÖM, A. and WACKERBERG, E., “Impact of bleaching history on the efficiency of final chlorine dioxide stage in ECF-type bleaching of eucalypt kraft pulps”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
25. TRAN, H. and VILLARROEL, R., “Challenges in black liquor recovery in modern kraft pulp mills”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
26. TOMANI, P., BERGLIN, N., AXEGÅRD, P., NORDGREN, D. and LOVELL, A., “Integration of lignin removal into a kraft pulp mill and use of lignin as a bio-fuel”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.

27. PAVAN, P., “Tailoring Eucalypt Fibre for Tissue Paper Production”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
28. ESTEGHLALIAN, A. R., “Applications of high performance enzymes in fiber quality improvement”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
29. AUMEDES, O. C., GARCIA, J., VALLS, C., RONCERO, B. and VIDAL, T., “Enzymatic treatments of eucalyptus sheets surface using laccase, hydrophobic compounds and lignin”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
30. PULKKINEN, I., KUITUNEN, S. and ALOPAEUS, V., “The most important eucalypt fiber properties for fiber network strength and structural property development”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
31. CURTO, J., CONCEIÇÃO, E., PORTUGA, A. and SIMÕES, R., “The influence of *eucalypt*’s and reinforcement’s fibers flexibility on paper properties: Experimental and 3d paper model evaluation”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.

APPENDIX

Complete list of all the manuscripts presented during the 5th ICEP:

1. AGUAYO, M. G., MENDONCA, R. T.,PEREIRA, M., RODRÍGUEZ,J. and FREER,J., "Kraft pulping and pulp properties of tension and opposite wood of *Eucalyptus globulus*", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
2. ALBARRÁN, E., NAVA, A. and COLODETTE, J. L. M., "Evaluation of the hexenuronic acid groups in the efc bleaching of eucalyptus KRAFT pulping", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
3. ALFENAS, A. C., FERREIRA, M. A., BINOTI, D.H.B, ZAUZA, E. A. V. and MAFIA, R. G., "Volume and pulp yield of healthy and infected trees of Eucalypt urophylla x E. grandis by Ceratocystisfimbriata", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
4. ALMEIDA, D. P. and GOMIDE, J. L., "Kraft pulping of eucalyptus to the optimum technical and economical level", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
5. ANDRADE, M. A. and PIKKA, O., "The Fiberline of the future for Eucalypt kraft pulp", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
6. ANDRADE, M. F. and OLIVEIRA, F. N., "Evaluation of bleachability on pine and eucalyptus kraft pulps", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
7. AUMEDES, O. C., GARCIA, J., VALLS, C., RONCERO, B. and VIDAL, T., "Enzymatic treatments of eucalyptus sheets surface using laccase, hydrophobic compounds and lignin", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
8. AXEGÅRD, P., "The kraft pulp mill biorefinery platform", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
9. AZEVEDO, M. A. B., PASA, V. and FONTES, M., "Effect of bleaching of cellulose pulp crystallinity of Eucalyptus grandis and E. dunni", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
10. BARBOSA, B. M.,GOMES, F. J. B. and NASCIMENTO, J. L., "The effect of eucalypt pulp brightness level and bleaching process on paper optical brightener demand", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
11. BATALHA, L. A. R.,JARDIM, C. and OLIVEIRA, R. C., "Effect of ultrasound and cellulase application on physical and mechanical properties of handsheets", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
12. BATALHA, L. A. R.,JARDIM, C. and OLIVEIRA, R. C., "Impact of ultrasound and enzymatic treatment on the physical-mechanical properties of bleached eucalyptus kraft pulp", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
13. CARVALHO, D. M., SILVA, M. R. and SACON, V. M., "Bleachability of eucalyptus kraft pulp with the sequences OA(Ze)DP, OA/D(EOP)DP and OD(EOP)DP", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
14. BOLTON, T. and LOBO, L., "Brownstock washing fundamentals enhancing drainage through chemistry", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
15. BONFIGLIO, F., FARIÑA, I., PIERI, S. and DOLDÁN., "Prediction of pulp yield and basic density of Eucalyptus spp. using Near Infrared Spectroscopy (NIR", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
16. BURNET, A., MEYER, V. and PETIT-CONCIL, M., "Morphological characteristics of hybrid eucalyptus clones", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
17. BURNET, A., MEYER, V., PETIT-CONIL, M., MARTÍNEZ, A., GUTIÉRREZ, A., KALUM, L., LUND, H., ROMERO, J., "Upscaling TCF bleaching of Eucalypt globulus pulp using an enzyme-

catalyzed oxygen delignification stage", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
18. CARVALHO, D. M. and LINO, J. M., "Optimization of the secondary acid hydrolysis procedure for quantification of the eucalyptus wood components", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
19. CARVALHO, D. M., SILVA, M. R. and SACON, V. M., "The effect of cooking conditions on bleached pulp properties", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
20. CARVALHO, M. G., MENDES, C. V. T., ROCHA, J. M. S. and SOARES,B. I. G., "Valorization of lignocellulosic biomass for an integrated biorefinery in the pulp and paper industry", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
21. CHAMORRO, E. D. M., VIDAL, T., TORRES, A. and CUSOLA, O., "Effect of the laccase mediator system on the fibre properties of TCF bleached kraft pulp", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
22. CLAVIJO, L., VUORINEN, T. and JÄRNEFELT, C., "Optimization of novel bleaching sequences for eucalyptus kraft pulp", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
23. COMELATO, J. S.,VENTORIM, G. and CARASCHI, J. C., "Effect of bleaching reagents on physical and mechanical properties of kraft pulp", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
24. CORREIA, F, COLODETTE, J. L., REGAZZI, A. J. and GOMIDE, J. L., "Eucalyptus chip compaction disturbance analysis in a vapor phase continuous digester", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
25. COSTA, M., VUORENPALO,V. M., HÄMÄLÄINEN, H., NYMAN, M., RÄSÄNEN, E. and MORAES, P., "Peracetic acid assisted ECF-light bleaching technology adapted to partial bleach plant closure of eucalypt pulps", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
26. CUNHA, G. G. S. and FERRAZ, A., "Bio-mechanical pulping of Eucalyptus grandis using co-cultures of Ceriporiopsissubvermispora and Phanerochaetechrysosporium", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
27. CURTO, J., CONCEIÇÃO, E., PORTUGA, A. and SIMÕES, R., "The influence of *eucalypt*'s and reinforcement's fibers flexibility on paper properties: Experimental and 3d paper model evaluation", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
28. DEL RÍO, J. C., RENCORET, J., MARTÍNEZ, A.T. and GUTIÉRREZ, A., "Recent Advances in Eucalypt Wood Chemistry", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
29. DIETZ, T. and FILHO, C. L., "New Opportunities for Molybdate Catalyzed Hydrogen Peroxide Delignification in Eucalyptus Kraft Pulp Bleaching", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
30. ESTEGHLALIAN, A. R., "Applications of high performance enzymes in fiber quality improvement", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
31. FALKOSKI, D. F., ALFENAS, A. C., "GUIMARÃES, V. M., ALMEIDA, M.N. and REZENDE, S.T.. Production and characterization of enzymes from basidiomycetes and phytopathogenic fungi for use in biorefinery", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
32. FERRAZ, A., MASARIN, F., CUNHA, G. G. S. and PAVAN, P. C., "An overview of technology and biochemical basis of the biomechanical pulping process", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
33. FERRAZ, A., MENDONÇA, R. and SILVA, J. M., "Chemithermomechanical pulping of Eucalyptus globulus clones that contrast in density, lignin content and thioacidolysis yield", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
34. FERREIRA, C. , LEITE, H. G. and MARCATTI , G., "The influence of wood quality in alkali consumption and pulp production - Case Study", proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.

35. FIGUEIREDO. L., “Optimization of lime kilns based on strategies of advanced process control - Case Study”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
36. FRANCIS, R.,NICHOLSON, D. J. and DUARTE, G., “Special Lecture: Understanding and quantifying LCC – one key step in transforming a pulp mill into a biorefinery”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
37. GOMES, R. M., SANTOS, N. B. C., RESENDE, T. M., ZANUNCIO, A. J. V., LINO and J. M., LINO, A. G., “Alternative methods to evaluate yield losses during pulp bleaching”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
38. GOMES, V. J., RIBEIRO, R. A., “The influence of pulp xylan content on tissue paper production”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
39. GRATTAPAGLIA, D., FARIA, D. A., RESENDE, M. D. V., PETROLI, C.D., SANSALONI, C. P., JUNIOR, M. F. R., MISSIAGGIA, A. A., TAKAHASHI, E. K., ZAMPROGNO, K. C. and KILIAN, A., “Genomic Selection for growth and wood traits in tropical Eucalypt: a paradigm shift in forest tree breeding”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
40. GUTIÉRREZ, A., DEL RÍO, J. C. and MARTÍNEZ, A., “Oxidative modification of paper pulp lipophilic extractives by laccase-mediator system”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
41. HART, P., “Enzyme bleaching experience in North America and Brazil”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
42. HINCHEE, M., BASSA, A. G., ROTTMANN, W., CHANG, S. and KWAN, B., “Biotech enhanced levels of syringyl lignin improves Eucalypt pulping efficiency”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
43. JARDIM, C., BATALHA, L. A. R. and OLIVEIRA, R. C., “Impacts of the carboxymethylcellulose adsorption onto eucalyptus bleached fibers and their effects on paper properties”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
44. KUITUNEN, S., PULKKINEN, I., VILLE, T. and ALOPAEUS, V., “Modeling of fiber swelling”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
45. LAURITO, J., “Cooking additive agents to improve the impregnation”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
46. LIITIÄ, T., MIKKONEN, H., UUSITALO, J., TAMMINEN, T., COLODETTE, J. L., “Organosolv pretreatment of lignocellulosics for bioethanol production”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
47. LINDSTRÖM, M. E., LI, J.,SHI, C. and HENRIKSSON, G., “A genetic strategy for avoiding formation of hexenuronic acid in kraft pulping?”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
48. LINO, A. G., GRUNEWALD,G., SILVA, V. L., AZEVEDO, M. A. B., GOMES, R. M. and PAULA, O. J. C., “Improving eucalypt kraft pulp yield and quality through black liquor xylan deposition”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
49. LOUREIRO, P, EVTUGUIN, D. V. and CARVALHO, M. G., “A comprehensive study on the final bleaching of eucalyptus kraft pulps with hydrogen peroxide”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
50. LUCIA, L. A., FONSECA, T. C. and HABIBI, Y..A new chemical approach to developing aerogels from cellulose”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
51. MAGATON, A. S., CUNHA, C . M. DA, MILAGRES, F. R. and NETO, H. F., “Isolation and chemical characterization of hemicelluloses sisal fibres (agave sisalana”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
52. MAGATON, A. S., VELOSO, D. P. and MILAGRES, F. R., “Characterization of 4-o-metilglucuronoxylans isolated from eucalyptus grandis wood and kraft black liquors”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.

53. MAGATON, A. S., VELOSO, D. P. and MILAGRES, F. R., “Structure of eucalyptus xylans and its effects on kraft pulp retention”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
54. MANFREDI, M., SILVA, J. C. and OLIVEIRA, R. C., “Development of recycled paper properties by ultrasonic treatment and xylans addition”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
55. MARANESI, G., OLIVEIRA, R. C. and COLODETTE, J. L., “The influence of industrial process conditions on the quality properties of eucalyptus kraft pulp across the fiberline”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
56. MARTIKKA, M., GERLA, P.A andRuuttunen, K., “Strategic opportunity of education in Uruguay: master program in pulp and paper technology”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
57. MARTÍNEZ, A. and GUTIÉRREZ, A., “Biotechnology for eucalypt paper pulp”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
58. MARTINEZ, P., PEREIRA, M., AGUAYO, M. G. and MENDONÇA, R. T., “Effect of hemicelluloses extraction of eucalyptus globulus on the kraft pulping process”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
59. MARTINO, D. C., “A bleachability comparison among eucalyptus pulps produced in laboratory and mill scale”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
60. MATSUMOTO, Y., “Stereo structure of β-O-4 linkage of Eucalypt lignin and its relation to pulping reaction”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
61. MAURICI, M., GOMES, F. J. B.,COLODETTE, J. L. andSAAVEDRA, S. H. M., “Hydrogen peroxide bleaching of eucalypt kraft pulp in the high density Tower”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
62. MÉTAIS, A., HOSTACHE, J. C. and GERMER, E.. Achievements in Industrial Ozone Bleaching”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
63. MORAIS, P. H. D., JÚNIOR, D.L. and COSTA, E. H., “Eucalyptus clone age influence in the chemical composition and wood pulping”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
64. MOREIRA, L. J., MOUNTEER, A . H., COLODETTE, J. L. and SILVA, C. M., “Effluent minimization in a Lo-Solids® bleached eucalyptus kraft pulp mill”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
65. MUGUET, M. and JÄÄSKELÄINEN,A. S., “Effect of eucalyptus wood characteristics on alkaline peroxide mechanical pulping (APMP) energy consumption and pulp properties”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
66. MUGUET, M., PEDRAZZI, C. and OLIVEIRA, R. C., “Behavior of deposited xylans during oxygen delignification across pulp bleaching and refining, and their influence on paper properties”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
67. NASCIMENTO, A. C., SANTOS, R. A., MARQUES, R. G. and MOREIRA, J. V., “The influence of recycled fiber in the mechanical and physical properties of paper”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
68. NETO, H.F., MILAGRES, F. R., GOMIDE, J. L. and FARIA, B. F.H., “NIR Spectroscopy and external validation of eucalypt wood”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
69. NETO, H.F., MILAGRES, F. R., GOMIDE, J. L. andMAGATON, A. S..“NIR Spectroscopy prediction of eucalyptus kraft pulp characteristics”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
70. OHRA-AHO, T., TAMMINEN, T., GOMES, F. J. B. and COLODETTE, J. L., “Structural differences in lignin between Eucalyptus clones determined by analytical pyrolysis-gas chromatography/mass spectrometry”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.

71. OLIVEIRA, F. N., SILVA, T. C. F. and ANDRADE, M. F., “Interaction energy of various metals with 4-o-methylglucuronoxylans and hexenuronoxylans”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
72. OSSES, M., “Effects of extended kraft cooking times in the Eucalyptus globulus and Eucalyptus nitens pulp production”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
73. PALEOLOGOU, M., “The forest biorefinery: A Canadian Perspective”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
74. PALMA, F. A., PEREIRA, M., ZAROR, C. and LUENGO, M., “EXTRACTION and characterization of E. Globulus hemicelluloses, using sodium sulphite as a stabilizer agent, for biofilms fabrication purposes”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
75. PAULA, D. M. L. and MARTINO, D. C., “Characterization of high and low bleachability woods”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
76. PAVAN, P., “Tailoring Eucalypt Fibre for Tissue Paper Production”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
77. PENNA, L. S., CARVALHO, D. M. and LINO, J. M., “Technological characterization of sugar cane straw and bagasse aiming at pulp production”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
78. PEREIRA, B. L. C., OLIVEIRA, A. C., CARVALHO, A. M. M. L., CARNEIRO, A. C. and SANTOS, R. C., “Chemical characterization of four eucalyptus clones from commercial plantations”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
79. PEREZ, D., GUILLEMAIN, A., THÉ, N.N, MELUN, F. and PETIT-CONIL., M., “Evaluation of biomass quality of eucalyptus gundal for biofuels production”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
80. PEREZ, D., NGUYEN THÉ, N., NICOLAS, FRANCIS MELUN, PETIT-CONIL, M., GAUTRY, J.Y.,FRAYSSE, J.Y., GRULOIS, S., HARVENGT ,L. and TRONTIN, J.-F., “Frost tolerant eucalyptus clones : micropropagation tools and wood and pulp quality”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
81. PULKKINEN, I., KUITUNEN, S. and ALOPAEUS, V., “The most important eucalypt fiber properties for fiber network strength and structural property development”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
82. RESENDE, J. O. and LONGUE, D. J., “Effect of pH, temperature and concentration of ClO2 on the formation of chlorate during bleaching with chlorine dioxide”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
83. RESENDE, T. M. R., AZEVEDO, M. A. B. and GOMES, R. M., “The effect of washing efficiency on bleachability of eucalypt kraft pulps”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
84. RIBEIRO, R. A. and GOMES, V. J., “A comparison of methods for quantification of eucalypt pulp xylan content”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
85. SANHUEZA, K., “Evaluating the Application of Analytical Method for the Determination of hexenuronic acid in eucalyptus pulp”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
86. SANTOS, N. B. C., GOMES, R. M., RESENDE, T. M., ZANUNCIO, A. J. V., LINO, A.. G. and LINO, J. M., “A comparison of methods for eucalypt wood extractives removal”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
87. SANTOS, R.B., CAPANEMA, E. A., BALAKSHIN,T. M., CHANG,M.H. and JAMEEL, H., “Hardwoods Morphology and Lignin: Content and structure impact on Kraft Pulping”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
88. SEVASTYANOVA, O., LINDSTRÖM, M. E., FORSSTRÖM, A. and WACKERBERG, E., “Impact of bleaching history on the efficiency of final chlorine dioxide stage in ECF-type bleaching of eucalypt kraft pulps”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.

89. SHACKFORD, L.,SEZGI, U., AZEVEDO, M. A. B. and COLODETTE J. L., “Special Lecture: Alternatives to improve the O-Z/E-D-P bleach plant efficiency”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
90. SILVA, D., OLIVEIRA, R. C. and ALMEIDA, J. M., “The use of cationic starch and starch complexes as alternative to improve fiber quality for printing and writing grades”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
91. SILVA, E., ERAT, S. E., ANDRADE. A. DE and LOPES, O. R., “Influence the conductivity of the wet chemistry and properties of paper produced bleached eucalyptus kraft pulp in ECF and TCF sequences ”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
92. SILVA, J. C. and OLIVEIRA, R. C., “Recovering recycled paper properties by adding hemicellulose”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
93. SILVA, V. L., MENDONÇA, T. and BARBOSA, B. M., “Influence of hexenuronic content and pH at refining and physical-mechanical properties of pulps produced by ECF and TCF processes”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
94. SIMÃO, R. L., NARCISO, A.G.S.O. and SOMMER,S.M., “Characteristics of wood and pulp from Eucalyptus dorrigoensis trees”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
95. SIXTA, H., “Progress and challenges in the separation and purification of xylan from Eucalypt wood”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
96. SKOCIMSKI, S. and LACHENAL, D., “Advantages of using ozone in the bleaching sequence of eucalyptus pulp : Economical and environmental interest compared to conventional bleaching”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
97. TAMMINEN, T., LIITIÄ, T., HYVÄRINEN, S., MIKKONEN, H., HAKALA, T., OHRA-AHO,T., ROVIO, S., SUURNÄKKI, A. and COLODETTE, J. L., “Characterization of xylans and lignins isolated from various Eucalypt species”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
98. TOMANI, P., BERGLIN, N., AXEGÅRD, P., NORDGREN, D. and LOVELL, A., “Integration of lignin removal into a kraft pulp mill and use of lignin as a bio-fuel”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
99. TRAN, H. and VILLARROEL, R., “Challenges in black liquor recovery in modern kraft pulp mills”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
100. Ubasart, J. G.,Roncero, B. and Vidal, T., “A new approach to the internal sizing of paper via biotechnological processes”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
101. VIANNA, V., YAMAMOTO, C. I. and VIERA, O., “Modeling and Simulation of an Industrial Process of Oxygen Delignification and ECF Bleaching of Eucalyptus Pulp”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
102. VUORINEN, T., “ECF bleaching of eucalypt kraft pulps”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
103. WEDIN, H. and LINDSTRÖM, M. E., “From simple theory to industrial application – extended impregnation kraft cooking”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.
104. XU, E., “Latest developments and trends in chemical mechanical pulping of Hardwoods”, proceedings from the 2011, 5th International Colloquium on Eucalyptus Pulp, Porto Seguro – BA, Brazil.

HIGHLIGHTS OF THE 5th INTERNATIONAL COLLOQUIUM ON EUCALYPT PULP

Jorge L. Colodette, Fernando J. B. Gomes, José L. Gomide, Teresa C. F. da Silva

Pulp & Paper Laboratory
Forestry Eng. Department
Federal University of Viçosa
Viçosa, MG Brazil
www.ufv.br/lcp

International Pulp Bleaching Conference 2011 – October 5 – 7
Portland, OR -

“Stereo structure of β-O-4 linkage of Eucalyptus lignin and its relation to pulping reaction” by Dr. Yuji Matsumoto from University of Tokyo - Japan

lower S/V

more lignin

less β-O-4

lower *E/T* ratio

more condensed

worse pulpability

higher S/V

less lignin

more β-O-4

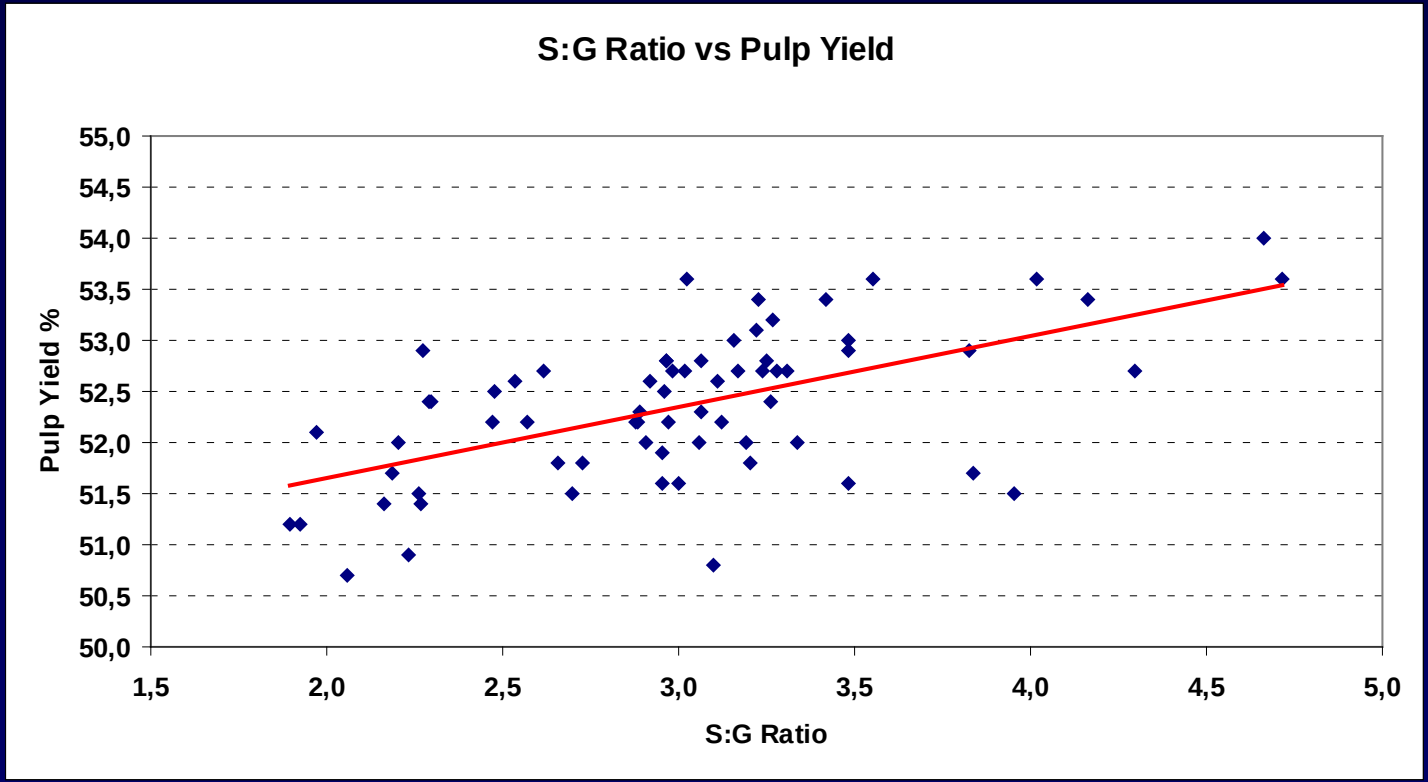
higher *E/T* atio

less condensed

better pulpability

“Biotech enhanced levels of syringyl lignin improves *Eucalyptus* pulping efficiency ” by Ana Gabriela from AborGen - Brazil

Eucalpytus **woods with high S:G ratios provide kraft pulping with higher yield and that are easier to bleach at a given kappa number.**



"Recent Advances in Eucalyptus Wood Chemistry" by Dr. José Carlos Del Río from IRNAS - Spain

- **Eucalypt wood is an excellent raw material for pulp and papermaking.**

- **Low lignin content (19-23% Klason lignin) in all the eucalypt species analyzed.**

- **High S/G ratios (1.9-2.6) and high percentage of β-O-4′ alkyl-aryl ether substructures (66-72% of side-chains) implies:**
  - ✓ **higher delignification rates,**
  - ✓ **less alkali consumption,**
  - ✓ **therefore higher pulp yields.**

“Characterization of xylans and lignins isolated from various Eucalyptus species” by Dr. Tarja Tamminen from VTT - Finland

- Xylan was extracted by alkali from ground wood chips or bleached kraft pulps and recovered as dispersion
  - ✓32 and 39% reduction of xylan content was reached for the chips and pulp, respectively
  - ✓The molar mass was high in both cases
- Lignin was recovered from the organosolv cooking liquors, whereas xylan was hydrolysed and mainly converted into furfural during cooking
- Lignin had high content of phenolic hydroxyl groups.

"Upscaling TCF bleaching of *Eucalyptus globulus* pulp using an enzyme-catalyzed oxygen delignification stage" by Auphelia Burnet from CTP - France

- Industrial sequence OOQPoP can be substituted by L(MES)EpQPoP sequence:
  - ✓ lower extractives: lower Sterol esters (95%) and free sterols (40%)
  - ✓ Similar brightness & cellulose DP for only addition of 0.1% laccase & 0.2% MES
  - ✓ lower temperature during bleaching stages
  - ✓ Improvement of mechanical properties
  - ✓ Energy savings in refining could be obtained by the paper producers

“Enzyme Bleaching Experiences in North America and Brazil” by Peter Hart from MWV Corporation - USA

- It is speculated that LCCs are highly resistant towards oxidation because they are complexed with xylose oligomers and thus unreactive towards oxygen delignification due to electron delocalization within the many oxygen atoms present in the xylose oligomers.

- It may be possible to employ a less aggressive, fungal based enzyme in a low dosage application and mitigate the COD/TOC caused oxygen stage deterioration.

- If this is possible, the potential for economic savings through enzyme application may still be realized in South American mills

“The kraft pulp mill biorefinery platform” by Peter Axegard from Innvetia - Sweden

- Specialty cellulose – modified kraft process
  - ✓ Dissolving pulp for cotton replacement, MFC/nanocellulose
- Lignin from black liquor
  - ✓ Fuel, binder, activated carbon fibers, carbon fibers dispersants
- Xylan – different extraction positions points possible
  - ✓ Fiber surface modification, barriers and thermoplastics.
- Forestry residues - co-processing
  - ✓ Ethanol, lactic acid, special cellulose, sulfur free lignin
- Efficient and economical processing is essential
  - ✓ Separation/fractionation
  - ✓ Upgrading/modification
  - ✓ Conversion

"Progress and challenges in the separation and purification of xylan from Eucalyptus wood" by Herbert Sixta from Aalto University – Finland

- Xylan-based products:
  - ✓ Polymeric xylan: CCE (6%) > PRE (5%) >> AH (< 1%)
  - ✓ Oligomeric xylan: AH (8% max, theor.) 5% in practice
  - ✓ Monomeric xylose: acid-cat. prehydrolysis (12% max, theor), 6-8% in practice
- Technology:
  - ✓ CCE (viable) > PRE >> AH (immature)
- Pulp yield, pulp viscosity:
  - ✓ PRE >> AH (peeling)
- Pulp grade(s) (flexibility):
  - ✓ PRE: Paper + Dissolving;
  - ✓ AH, CCE: Dissolving only

"Organosolv pretreatment of lignocellulosics for bioethanol production" by Tiina Liitia from VTT - Finland

- The phosphinic acid based LGF organosolv cooking in ethanol solvent is a promising pre-treatment method for lignocellulosics, producing well hydrolysable biomass at high yield for fermentation.

- Alkaline extraction of hemicelluloses and lignin after cooking further increases the glucose yield.

- Phosphinic acid charges of 3.5-5 % at relatively low temperature of 130°C provided sufficient delignification and defibration without compromising cellulose yield

- For industrial processes higher cooking temperatures are required to reach reasonable cooking times
  - ✓ *20-24 h cooking times possible also with eucalyptus at 130 °C*

"The forest biorefinery: A Canadian Perspective" by Michael Paleologou from FPInnovations – Canada

- The Canadian forest sector can no longer compete in the traditional commodity products markets

- The petroleum model is the model to follow:
  - ✓ 4% of feed makes 42% of revenues
  - ✓ Doing something useful with the other 96% is equally critical

- The new Canadian forest sector has began the process of profitably transforming its forest resources into a full suite of valuable bioproducts (e.g. dissolving pulp, NCC, cellulose filaments, hemicellulose products, lignin products and other products from process and waste streams

- Heat and power will be a necessary part of the mix but only after all higher value materials have been extracted

"Impact of Hardwood Species Characteristics on Enzymatic Hydrolysis Efficiency and on the Overall Ethanol Cost" by Ricardo Santos from NCSU - USA

- Lignin content of pretreated wood was determined to be a significant factor effecting enzymatic hydrolysis (EH) efficiency. As lignin content decreases, EH conversion increases, and vice versa.

- When compared to Acid Hidrolysis, Auto Hidrolysis, and Ozone, Green Liquor pretreatment proved to be the most effective in terms of lignin removal and saccharification efficiency.

"A new chemical approach to developing aerogels from cellulose" by Lucian A. Lucia from NCSU – USA

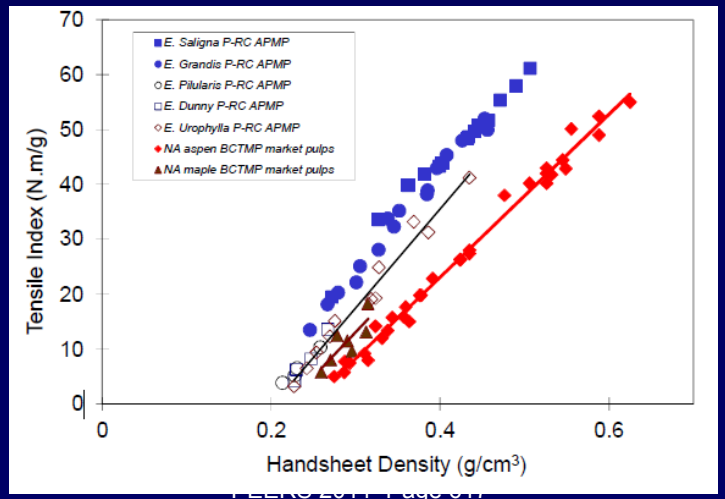
- Aerogels were successfully produced using Cellulose Nanofibrils (NFC) as starting material followed by vacuum freeze-drying
- TEMPO-mediated oxidation showed greater improvements for the strength and homogeneity (morphology) of the final aerogels
- Both hydroxyapatite HAp and TEMPO were able to enhance the strength of the aerogels
- HAp by itself tended to enhance the density of the aerogels, whereas TEMPO tended to reduce the density.

TEMPO or (2,2,6,6-Tetramethylpiperidin-1-yl)oxyl

“Latest developments and trends in chemical mechanical pulping of hardwoods” by Eric XU from Andritz – USA

Under basic P-RC APMP concept, (AP pretreatment → refining → AP treatment → Refining), a number of different system designs have been developed to meet challenges in the industry and for different commercial or economic situations.

With fast growth rate (high wood yield) and superior pulp properties, eucalyptus woods will play more and more important role in chemical mechanical pulp industry, as has already been evidenced by significant increase in their commercial installations and capacity in recent years.



"An overview of technology and biochemical basis of the biomechanical pulping process" by André Ferraz from USP – Brazil

- Bioulping at large scale has shown to be technically feasible.

- Economical feasibility of biopulping depends on the levels of energy savings obtained as well as on the energy prices and biotreatment costs.

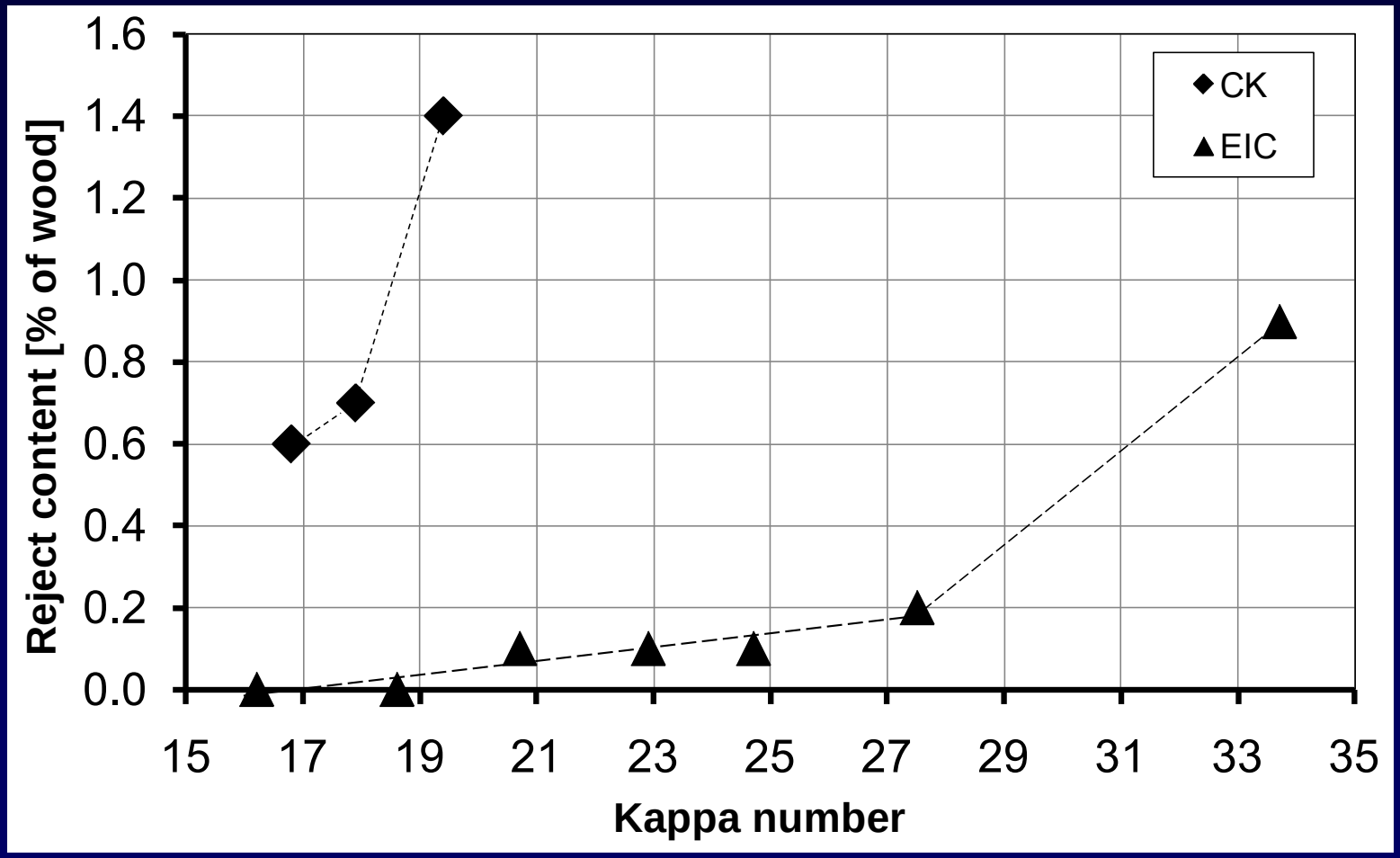
- Aryl-ether and C_{alpha}-C_{beta} cleavages are intense.

- MnP seems to be a key enzyme.

- Peroxidation of unsaturated fatty acids by MnP is a good candidate to explain *in vivo* lignin degradation.

- Future attempts: Mimic systems exploiting organo-peroxyl radicals for lignin degradation.

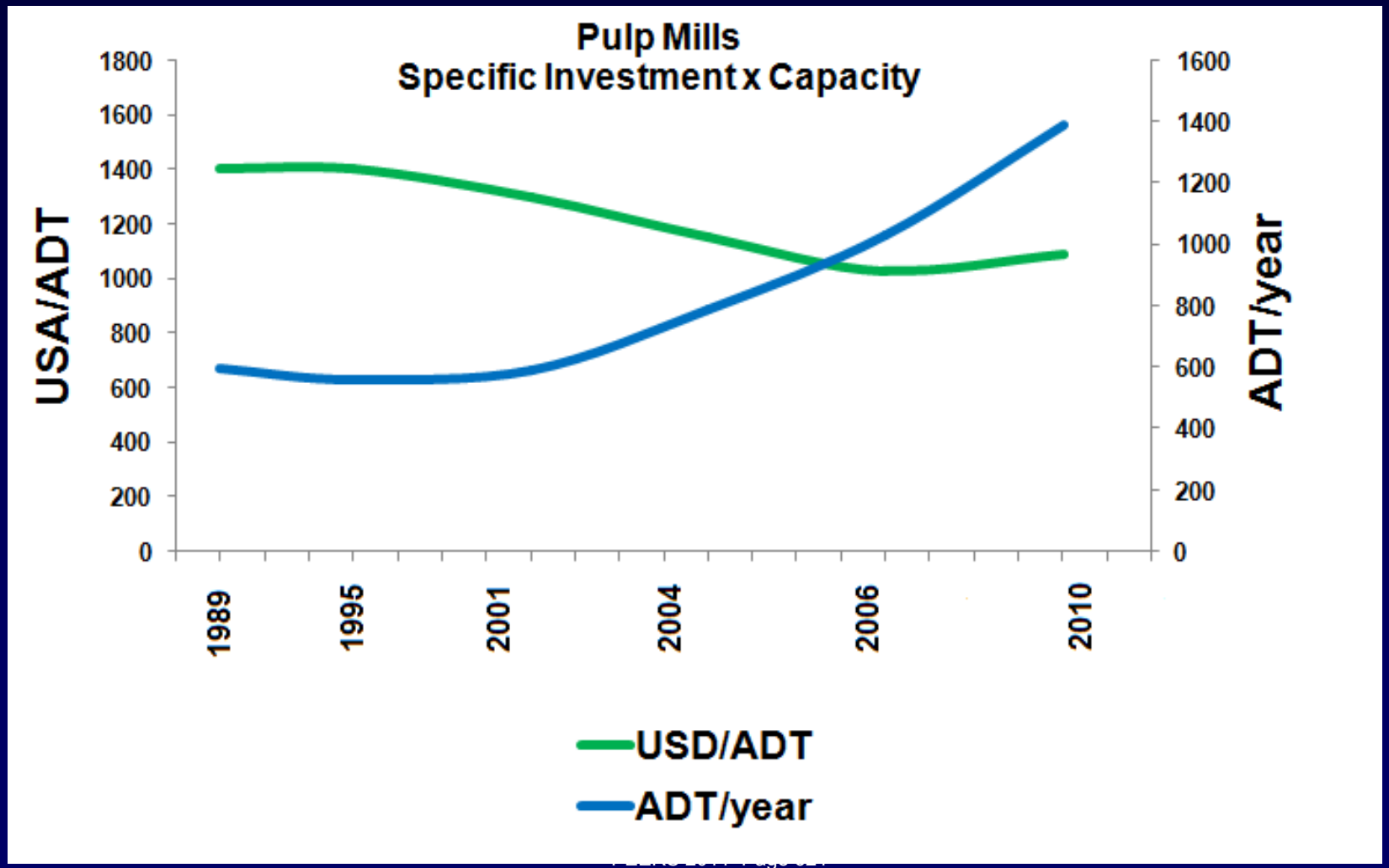
“From simple theory to industrial application – extended impregnation kraft cooking” by Mikael Lindström from KTH - Sweden



“From simple theory to industrial application – extended impregnation kraft cooking” by Mikael Lindström from KTH - Sweden

OD*(OP)D	CK 17.9	EIC 18.6	EIC 27.5	EIC 27.5
Kappa number after O	9.9	10.7	14	11.8
Total gravimetric yield, %	95.6	94.5	91.7	91.9
COD, kg/odt	26	28	44	36
Total overall yield, %	49.9	50.9	52.4	52.5

“The Fiberline of the future for Eucalyptus kraft pulp” by Marco Antonio from Andritz – USA



"Peracetic acid assisted ECF-light bleaching technology adapted to partial bleach plant closure of eucalypt pulps" by Marcelo Costa from Kemira – Brazil

- Peracetic acid assisted (PAA) application in pre-bleaching saved sodium hydroxide make up, steam and water, thus reducing environmental impact.

- For pulp and paper mills with limited Water and Effluent treatment capacities, the PAA-stage as pre-bleaching technology can save investments in these plants.

- PAA application in post-bleaching increased pulp brightness ceiling and decreased brightness reversion.

- For pulp mills with limited ClO_2 generation capacity, the PAA-stage application can potentially increase through put since full brightness can be achieved with very low ClO_2 charges (4.5 and 3.0 kg ClO_2/odt for samples A and B, respectively).

- Increase flexibility in the bleaching plant (Less off-specification)

“ECF bleaching of eucalyptus kraft pulps” by Tapani Vuorinem from Aalto university - Finland

- In principle it is still possible to decrease ClO_2 use by 50 % compared to the best current ECF bleaching sequences (< 15 kg active Cl *per* ton)

- This requires the following targets to be reached:

  - ✓ Eliminate chlorate formation (average 20 % conversion): potential for 30 % increase in efficiency

  - ✓ Block the secondary reactions of HexA: potential to save 2-5 kg active Cl *per* ton of pulp depending on the prior removal of HexA (A-stage)

  - ✓ Prevent formation of stable AOX: potential to save 1-2 kg active Cl *per* ton of pulp

"Impact of bleaching history on the efficiency of final chlorine dioxide stage in ECF-type bleaching of eucalyptus kraft pulps" by Olena Sevastyanova from KTH – Sweden

She concluded that:

- In eucalypt pulps, the structure of xylan undergoes gradual modification during the delignification process, oxygen pre-bleaching and various types of ECF bleaching.

- The structurally modified xylan seems to play a more important role than residual lignin content in the higher chemical demand and efficiency of the final D_2 bleaching stage.

- For pulp samples with identical lignin content, but with differing structure of xylan, target brightness could be achieved by adjusting final pH (NaOH charge) in the D_2 bleaching stage

“Challenges in black liquor recovery in modern kraft pulp mills” by Honghi Tran from University of Toronto – Canada

- Mills must maximize the steam and power production capacity, reduce fossil fuel consumption, minimize chemical losses, and reduce non-process elements and dead-load chemicals that circulate in the recovery cycle.

- The reliability and efficiency of process equipment such as evaporators, recovery boilers, causticizing equipment and lime kilns have a direct impact on the quantity and quality of white liquor, and ultimately the quantity, quality and costs of the pulp produced

“Integration of lignin removal into a kraft pulp mill and use of lignin as a bio-fuel” by Per Tomani from Innventia - Sweden

- LignoBoost: increased power delivery to the grid:
  - ✓ High efficiency power boiler close to the mill
  - ✓ High efficiency power boiler close to users
- The Na/S balance is possible to optimize
- Future high value products (carbon fibers, active carbon etc)

“Effect of the laccase mediator system on the fibre properties of TCF bleached kraft pulp” by Orio Cusola from UPC – Spain

- Lacase Mediator Sytem (L_{HBT}) produces an oxidation of the cellulose to carbonyl groups, and reduced the amount of carboxyl groups present in TCF pulp through partial removal of HexAs.

- L_{HBT} modifies the surface charge and ζ potential in the fibre suspension for the removal of ionizables groups in TCF pulp.

- L_{HBT} requires less mechanical energy than conventionally refined pulp to obtain an optimal tensile and tear index in handsheets.

- L_{HBT} open up new prospects for increasing brightness stability by HexAs removal.

“Applications of high performance enzymes in fiber quality improvement” by Ali Esteghalian from Verenium – USA

- Results of laboratory and pilot scale trials have shown that Verenium’s Lipase candidate can:
  - ✓ Increase paper tensile strength by10-18%, depending on enzyme dosage and pulp type
  - ✓ Reduce pitch deposition on SS surfaces
  - ✓ Enable mills to reduce kraft content by as much as 10% thereby reducing production costs

"The most important eucalypt fiber properties for fiber network strength and structural property development" by Iiro Pulkkinen from Aalto University – Finland

- In his work he concluded that:
  - ✓ Multidimensional fiber analyzers give new possibilities to combine traditional lab methods for predicting product quality.
  - ✓ The most important thing is that they are comparable to some physical properties that can be easily measured.
  - ✓ From a practical and engineering point of view it is important that all parameters of a given model could be easily measured in the laboratory in order that the model could be widely applicable