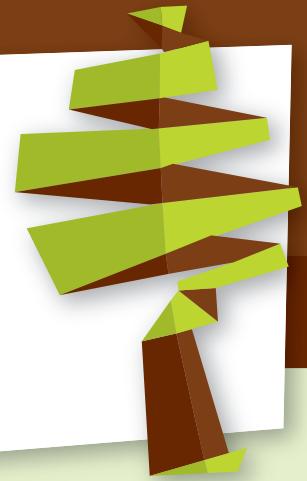


# 6<sup>th</sup> International Colloquium on Eucalyptus Pulp

NOVEMBER 24 – 27, 2013 · COLONIA DEL SACRAMENTO, URUGUAY



## Program

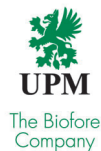


Organized by:



UNIVERSIDAD DE LA REPÚBLICA URUGUAY

Co-Organized by:



kemira

ANDRITZ Pulp & Paper



# SCHEDULE

6<sup>th</sup> International Colloquium on Eucalyptus Pulp

NOVEMBER 24 – 27, 2013 · COLONIA DEL SACRAMENTO, URUGUAY



Sunday 24		
19:15 to 20:00   <b>Opening Conference</b> Impact of Forest Industry on Earth's sustainable development Keynote speaker: <i>Magnus Diesen (Finland)</i> P.05		
Monday 25		
08:00 to 09:00   <b>Registration</b> Registration P.05		
09:00 to 09:45   <b>Session 1: Eucalyptus tree engineering for wood quality improvement</b> Chairman: <i>Andrés Dieste (Uruguay)</i> Clonal Selection for the Cellulose Industry Keynote speaker: <i>Claudio Balocchi (Chile)</i> P.05		
09:45 to 10:30   <b>Session 2: The quality of eucalyptus wood for pulp</b> Chairman: <i>Carlos Mantero (Uruguay)</i> Wood Quality: A Key Element for Production of High Yield and High Bleachability Eucalypt Kraft Pulp Keynote speaker: <i>Jorge Luiz Colodette (Brazil)</i> P.06		
10:30 to 11:00   <b>Coffee Break / Posters</b>		
11:00 to 13:00   <b>Session 2: The quality of eucalyptus wood for pulp</b> 001 STUDY ON WOOD AND PULP PROPERTIES FROM DIFFERENT EUCALYPTUS SPECIES GROWN IN URUGUAY AND MAIN DIFFERENCE COMPARED TO E.UROGRANDIS Ulla Jansson 002 EFFECT OF FIBER WALL CHEMISTRY ON ENERGY DEMAND IN EUCALYPTUS WOOD DEFIBRATION Marcelo Coelho dos Santos Muguet 003 EUCALYPTUS HYBRIDS CLONES EVALUATION BY STATISTICAL MULTIVARIATE TECHNIQUES: A FUNDAMENTAL TOOL FOR MILL QUALITY AND STABILITY GARANTY Leonardo de Caux 004 EFFECT OF LIGNIN CARBOHYDRATES COMPLEXES OF HARDWOODS HIBRIDS ON KRAFT PULPING PROCESS Vanessa Silva 005 SIMULTANEOUS DETECTION OF LIGNIN STRUCTURE, S/G RATIO AND CARBOHYDRATE COMPOSITION FROM EUCALYPTUS HYBRIDS BY ANALYTICAL PYROLYSIS-GC/MS Taina Ohra-aho 006 THE RELATIONSHIP AMONG EUCALYPTUS WOOD PYROLYSIS PRODUCTS AND PULPING YIELD. Luis Reina P.06		
13:00 to 14:30   <b>Lunch</b>		
14:30 to 16:00   <b>Session 3: Advances in kraft pulping technology</b> Chairman: <i>Kari Kovasin (Finland)</i> Biotechnological strategies for lowering yellowing in hardwood pulps Keynote speaker: <i>Mikael Lindström (Sweden)</i> 007 PROVEN SOLUTIONS TO MINIMIZE INORGANIC PROCESS SCALING IN PULP AND RECOVERY Kraig Kent 008 REDUCTION OF SOLID WASTE FROM PULP MILL FIBERLINE Viridiane Vianna P.08		
16:00 to 16:30   <b>Coffee Break</b>		
16:30 to 17:30   <b>Session 4: Eucalyptus fiber quality and products</b> Chairman: <i>Jorge Luiz Colodette (Brazil)</i> Funkalyptus: Towards a new eucalyptus fibre technology Keynote speaker: <i>Pedro Fardim (Finland)</i> 009 NANOMECHANICAL CHARACTERIZATION OF WOOD FIBERS FOR PULP AND PAPER William Gacitua 088 PRODUCTION SCHEDULING OF COMPLEX INTEGRATED PULPMILLS Uri Enzer, Leandro Gómez P.09		
17:30 to 18:00   <b>Special Conference</b> UPM in Uruguay: 20 years of R&D in Eucalyptus pulp and energy Keynote speaker: <i>Bruno Vuan (Uruguay)</i> P.09		
Tuesday 26		
08:30 to 09:45   <b>Session 5: Biotechnology applied to the pulp and paper industry</b> Chairwoman: <i>Dayana Travers (Uruguay)</i> 2D-NMR of Lignin in the Eucalypt Pulp Mill Biorefinery: General Aspects and Enzymatic Delignification Studies Keynote speaker: <i>Angel T. Martínez (Spain)</i> 010 G.TRABEUM AND POSTREATUS ENZYMES TO CHANGE LIGNINES AND OBTAIN HIGH VALUE PRODUCTS FROM E. GRANDIS RESIDUAL LIGNOCELLULOSE Mary Lopretti P.10		
09:45 to 10:30   <b>Session 6: The pulp mill biorefinery and bio-products</b> Chairwoman: <i>Maria Cristina Area (Argentina)</i> The kraft pulp mill bio-refinery Keynote speaker: <i>Peter Axegård (Sweden)</i> P.11		
11:00 to 12:30   <b>Session 6: The pulp mill biorefinery and bio-products</b> 011 SODA-O2, SODA-AQ AND ORGANOSOLV PULPING AS PRETREATMENTS OF EUCALYPTUS FOR BIOETHANOL PRODUCTION Tarja Tamminen 012 MODIFICATION OF WOOD FIBRE SURFACES USING FUNCTIONAL BIO-BASED POLYELECTROLYTES AS A TOOL FOR THE PRODUCTION OF HIGH-ADDED VALUE MATERIALS Beatriz Vega 013 EFFECT OF THE EXTRACTION CONDITIONS ON THE CHEMICAL COMPOSITION OF EUCALYPTUS HEMICELLULOSES Denison da Silva Perez 014 HEMICELLULOSES EXTRACTION FROM EUCALYPTUS SP. SAWDUST BY HYDROTHERMAL TREATMENT Jesús Rangel 015 DETAILED CHARACTERIZATION OF BLACK LIQUOR (LIGNIN) DERIVING FROM KRAFT AND SODA-ANTRAQUINONE PULPING Florian Zikeli P.11		
12:30 to 13:00   <b>Special Conference</b> Management of social aspects during the construction of a greenfield pulp project Keynote speaker: <i>Carolina Moreira (Uruguay)</i> P.12		
13:00 to 14:00   <b>Lunch</b>		
14:00 to 18:00   <b>Visit to Montes del Plata (Registration required - Limited Capacity)</b>		
14:30 to 16:00   <b>Session 9: Advances in dissolving pulp technology</b> Chairman: <i>Olavi Pikka (Finland)</i> Advances in Dissolving Pulp Technology Keynote speaker: <i>Kyösti Ruuttunen (Finland)</i> 022 MANUFACTURING OF DISSOLVING HARDWOOD AND SOFTWOOD PULP WITH CONTINUOUS COOKING AND NOVEL FIBERLINE TECHNOLOGY; LABORATORY RESULTS AND A COMPARISON TO MILL RESULTS. Janne Vehmaa 023 REACTIVITY OF EUCALYPTUS DISSOLVING PULPS: A MEASURE BASED ON ACETYLATION KINETICS Fernando Bonfiglio P.16		
16:00 to 16:30   <b>Coffee Break</b>		
16:30 to 18:45   <b>Session 10: Advances in pulp bleaching technology</b> Chairman: <i>Leif Robertsen (Finland)</i> Insights in eucalyptus pulp bleaching technology Keynote speaker: <i>Tapani Vuorinen (Finland)</i> 024 CATALYTIC OXIDATION OF RESIDUAL LIGNIN AND HEXENURONIC ACID IN PULP Naveen Kumar Chenna 025 EFFECT OF EUCALYPT PULP PRETREATMENT WITH HOT ACID HYDROLYSIS ON (AZE)DP BLEACHING PERFORMANCE André Guimaraes 026 REDUCTION OF CHEMICAL CONSUMPTION AND EFFLUENT GENERATION BY RECYCLING ALKALINE FILTRATE AT AD BLEACHING STAGE Andreea Busnello 027 NEW POSSIBILITIES AND GAINS WITH STRONG EQUILIBRIUM PERACETIC ACID FOR EUCALYPTUS PULP Marcelo Costa 028 TCF BLEACHING OF EUCALYPTUS KRAFT PULP: THE ROLE OF HEXENURONIC AND MUCONIC ACIDS ON PULP VISCOSITY. Frederic Pouyet P.17		
18:45 to 19:00   <b>Closing Ceremony</b>		
Wednesday 27		
08:30 to 10:30   <b>Session 7: Advances in kraft black liquor recovery technology</b> Chairman: <i>Norberto Cassella (Uruguay)</i> Recent Advances in the Black Liquor Recovery Boiler Furnace Process Keynote speaker: <i>Mikko Hupa (Finland)</i> 016 DESIGN CHALLENGES IN BLACK LIQUOR EVAPORATORS Otto Greis 017 OPERATIONAL EXPERIENCES OF HIGH-ENERGY RECOVERY BOILERS Keijo Salmenoja 018 EUCALYPTUS FOR PULP AND CARBON CREDITS: EXPERIENCE FROM REAL CASES IN URUGUAY Agustin Inthamoussu P.13		
11:00 to 13:00   <b>Session 8: Environmental Control Aspects Regarding the Pulp and Paper Industry</b> Chairwoman: <i>Gladys Vidal (Chile)</i> Pulp and paper making wastes treatment and environmental effects Keynote speaker: <i>Liliana Borzacconi (Uruguay)</i> 019 DEFOAMER - DRAINAGE AND BEYOND Bill Miskimins 020 REMOVAL OF STIGMASTEROL CONTAINED IN KRAFT MILL EFFLUENTS USING MBBR SYSTEM Juan Pablo Vergara 021 FATE OF CHLORATE DURING ECF BLEACHED PULP WASTEWATER TREATMENT Ma. Noel Cabrera P.15		
13:00 to 14:30   <b>Lunch</b>		



## 6th International Colloquium on Eucalyptus Pulp

The Organizing Committee is delighted to welcome you to the Sixth International Colloquium on Eucalyptus Pulp (6th ICEP) during the next days in Colonia del Sacramento, Uruguay.

South America is currently the largest producer of bleached eucalyptus market pulp. Furthermore, most new projects of eucalyptus pulp mills are being installed in South America, specifically concentrated in Brazil, Chile and Uruguay. Our continent is becoming the world hub for bleached eucalyptus pulp production. Therefore, eucalyptus is a relevant raw material for South America and promotion of initiatives in research, development and innovation about eucalyptus pulp production and uses, as well as biorefineries for biofuels, energy and chemical production are focus of interest in our countries.

Under the main subject of “back to basics: taming wood raw materials and processes”, specialists from all over the world are coming to share and discuss the latest developments on eucalyptus processing and products, associated technologies and their future.

We very much hope you enjoy the Colloquium and your visit to the city of Colonia del Sacramento while reconnecting with old friends and meeting new ones.

Best Regards from the Organizing Committee,

**Erwin Kaufmann**  
Colloquium President  
Montes Del Plata,  
Uruguay

**Patricia Gerla**  
Program Chairman  
Universidad de la República,  
Uruguay

**Jorge L. Colodette**  
Program Co-Chairman  
Universidade Federal de Viçosa,  
Brazil





## ORGANIZING COMMITTEE

### Colloquium President

---

#### **Erwin Kaufmann - Montes del Plata, Uruguay**



*Erwin Kaufmann* is Economist. He is the General Manager at Montes del Plata (Stora Enso & Arauco), and he leads the Steering Group of Montes del Plata Project, a new Pulp Mill with a capacity of 1.300.000 ton/year, located at 50km from Colonia. Currently in construction, the mill will be starting operation in the next months.

### Program Chairman

---

#### **Patricia Gerla - Universidad de la República, Uruguay**



*Patricia Gerla* graduated in Chemical Engineering in Uruguay and PhD in Chemical Engineering from Universidad del Litoral, Argentina. She is a Professor in the Department of Units Operations in Chemical Engineering at School of Engineering, Universidad de la República, Uruguay. She established the Units Operations Department and created Forest Process Engineering Group as well as is the Uruguayan Coordinator of the postgraduate program in Pulp and Paper Technology, in cooperation with Aalto University.

### Program Co-chairman

---

#### **Jorge Colodette - Universidade Federal de Viçosa, Brazil**



*Jorge Colodette* is graduated in Forestry Engineering in Brazil and Ph.D. in Environmental Resources Engineering at the State University of New York. He is a Professor at Universidade Federal de Viçosa and he established the Pulp and Paper Laboratory as well as the specialization course in Pulp and Paper Technology at UFV. He is the coordinator of an Euro-project on Bio-refinery of eucalyptus and elephant grass and coordinate a project on bio-refinery of bamboo and sugar cane bagasse aiming at cellulosic ethanol production. Currently, he is editing a book on Bio-refinery of eucalypt wood and sugar cane bagasse. He has created the International Colloquium on Eucalyptus Pulp (ICEP) in 2003.

### Technical Secretariat

---

#### **María Noel Cabrera**

#### **Leonardo Clavijo**

**Forest Process Engineering Group - School of Engineering - UDELAR, Uruguay**



## SCIENTIFIC COMMITTEE

**María Cristina Area**, Universidad Nacional de Misiones, Argentina.

**Gustavo Balmelli**, INIA, Uruguay.

**Marcos Battezzore**, UPM, Uruguay.

**María Noel Cabrera**, Universidad de la República, Uruguay.

**Marcelo Cardoso**, Universidade Federal de Minas Gerais, Brasil.

**Norberto Cassella**, Universidad de la República, Uruguay.

**Carmelo Centurión**, UPM, Uruguay.

**Charlie Clarke**, Sappi Southern Africa, South Africa.

**Leonardo Clavijo**, Universidad de la República, Uruguay.

**Andrés Dieste**, Universidad de la República, Uruguay.

**Javier Doldán**, Laboratorio Tecnológico del Uruguay, Uruguay.

**Monica Ek**, KTH Royal Institute of Technology, Sweden.

**Daniel Ferrari**, Universidad de la República, Uruguay.

**Celso Foelkel**, Celsius Degree, Brasil.

**Kari Kovasin**, Metsä Fibre, Finland.

**Iván López**, Universidad de la República, Uruguay.

**Mary Lopretti**, Laboratorio Tecnológico del Uruguay, Uruguay.

**Lucián A. Lucía**, North Carolina State University, USA.

**Carlos Mantero**, Universidad de la República, Uruguay.

**Claudio Mudado Silva**, Universidade Federal de Viçosa, Brasil.

**Michel Petit-Conil**, Centre Technique du Papier, France.

**Olavi Pikka**, Andritz, Finland.

**Leif Robertsen**, Kemira, Finland.

**Kimmo Ruohoniemi**, Stora Enso, Finland.

**Kyösti Ruuttunen**, Aalto University, Finland.

**Bodo Saake**, University of Hamburg, Germany.

**Keijo Salmenoja**, Andritz, Finland.

**Gabriele Schild**, Lenzing, Austria.

**Hans Ulrich Suess**, Germany.

**Esa Vakkilainen**, Lappeenranta University of Technology, Finland.

**Laura Villalba**, Universidad Nacional de Misiones, Argentina.

**Juan Carlos Villar**, INIA, España.



## KEYNOTE SPEAKERS

### **Peter Axegård**



Vice President at Innventia; Director of Innventia's business area Biorefining, Sweden.

### **Claudio Balocchi**



Genetic Division Manager at Bioforest S.A -Arauco, Chile.

### **Liliana Borzacconi**



Professor at Chemical Reactors Department at Universidad de la República, President of National Council of Science and Technology, Uruguay.

### **Jorge Luiz Colodette**



Professor at Department of Forest Engineering and head of the Pulp and Paper Laboratory, Universidade Federal de Viçosa, Brazil.

### **Pedro Fardim**



Professor, Biomass Chemical Engineering, at Åbo Akademi University, Finland.

### **Mikko Hupa**



Professor at Faculty of Technology at Åbo Akademi University, Finland.

### **Mikael Lindström**



Professor, Dean of the School of Chemical Sciences and Engineering at KTH, Sweden.

### **Angel T. Martinez**



Research Professor at CSIC-CIB, Spain.

### **Kyösti Ruuttunen**



Senior Lecturer at Department of Forest Products Technology, Aalto University, Finland.

### **Tapani Vuorinen**



Vice-head of the Department of Forest Products Technology and Vice Dean of School of Chemical Technology at Aalto University, Finland.

## SPECIAL CONFERENCES

Special Conference 1: "Impact of Forest Industry on Earth's sustainable development"

### **Magnus Diesen**



Former Executive Vice-President at Stora Enso as well as Chairman of Company Investment Committee. Retired from this Company in 2009, he joined Aalto University as Senior Advisor. He is the author of a book entitled "ECONOMICS OF THE PULP AND PAPER INDUSTRY" (2005 and 2009).

Special Conference 2: "UPM in Uruguay: 20 years of R&D in Eucalyptus pulp and energy"

### **Bruno Vuan**



He joined Fray Bentos Pulp mill at Metsa-Botnia in 2005. Since 2009, is Technical Manager at UPM Fray Bentos Pulp Mill, Uruguay, one of the newest mills with a capacity over 1.000.000 tons/year and currently provides between 20 MW and 40 MW per day to the electric public company (UTE) in Uruguay. Previously, Bruno Vuan was Plant Manager of two different Hydro Power Plants at UTE.

Special Conference 3: "Management of social aspects during the construction of a greenfield pulp project"

### **Carolina Moreira**



She is the Sustainability and Corporate Affairs Manager of Montes del Plata, a joint venture of Arauco and Stora Enso that is developing its pulp mill near Conchillas, Colonia, which will produce 1.300.000 ADT/year, engaging up to 6.500 workers during its construction and influencing the development of several local communities.





# Scientific Program

**SUNDAY 24**  
**CEVALLOS ROOM**

18:30 to 19:15 **Opening Ceremony**

19:15 to 20:00 **Opening Conference:**

## **IMPACT OF FOREST INDUSTRY ON EARTH'S SUSTAINABLE DEVELOPMENT**

Keynote speaker: *Magnus Diesen* Finland

In the world of uncertainty one thing is sure, rising population and income increases the need for energy and materials. Global population has almost doubled since 1970 to today's 7,1 billion and is expected to increase further and exceed 10 billion before 2050. The consumption of earth's population will put an increasing strain on most natural resources. Most important tangible, physical resources, that also determine the limits to growth on earth, are arable land, water, energy and materials. Necessary ingredients are social resources like peace, social stability and employment. These are more difficult to assess and predict. Arable land is the key to food production. The best areas have been cultivated for centuries. Some areas suffer from soil erosion. To bring new, unused arable land to agricultural use, requires often high investments and require expensive fertilizers, i.e. fossil resources. Of global water resources only 2,8 % are sweet water. Three quarter of this is tied to glaciers. Agriculture is the main consumer. Water overdraft exists in many regions, as global water consumption has doubled with population since 1970. There are notable inequalities in global water use, as 20 % or 1.5 billion people have no access to own or public water supply. Also energy consumption has doubled since 1970 to 2300 Mtoe (million ton oil equivalents). About 80 % of this is fossil, increasing the CO<sub>2</sub>-content in the atmosphere. Wood has historically been the most important fuel and still is in certain developing countries as 2.7 billion people use biomass for cooking. Half of the global harvest is used as fuel wood providing 10 % of total global energy. Wood demand for energy increases rapidly, faster than for industrial wood. This trend is particularly strong in Europe, where renewable energy policies may result in big wood deficit. Wood based forest industry provide many important materials: Timber for construction, pulp for paper, board and textiles, paper for printing, packaging and hygiene, energy for heat, electricity and fuel, chemicals and medicine. Forests cover 30 % of global land area. Forests are an important carbon sink as growing stock, including soil, contain more carbon than the entire atmosphere. Forests are the largest, recyclable natural resource, that can be utilized in a large, industrial scale. All this put a heavy responsibility on forestry and forest industry. It requires balancing economic, social and environmental aspect in all its activities. At the same time it provides a competitive advantage when developing new products as well as the future of earth in a sustainable way.

20:00 **Opening Cocktail**

**MONDAY 25**  
**CEVALLOS ROOM**

08:00 to 09:00 **Registration**

09:00 to 09:45 **Session 1: Eucalyptus tree engineering for wood quality improvement**

Chairman: *Andrés Dieste* Uruguay

## **CLONAL SELECTION FOR THE CELLULOSE INDUSTRY**

Keynote speaker: *Claudio Balocchi* Chile

The final products of Tree improvement programs are: clones to be used on the establishment of new plantations. These plantations normally have the objective to supply the raw material required in an industrial facility. This presentation describes the biological and economical bases for breeding and selection of clones for the cellulose industry. In order to define the attributes for the best clones for the cellulose industry, it is important to understand the minimum requirements for a trait to be incorporated in breeding programs. Each trait need to be variable, heritable and have an economic value for the industrial process. Consequently, not all traits can be incorporated in tree improvement programs; even they have a large economic impact on the industry. Most of the properties identified to be important for clonal selection for the cellulose industry have shown to fulfill the requirement for a breeding program. In general wood properties, in comparison with growth traits, have more genetic control but less variability. An example, using a clonal population of *Eucalyptus globulus* in Chile, is used to illustrate the process of breeding and clonal selection for the cellulose industry. Base information on clonal variability for different traits, including plantation performance (growth, form, adaptability, others) and industrial productivity and quality (wood density, pulp yield, fiber length, tensile index, tear index, others), is presented. The definition of the attributes required for the selected clones will define the expected gain for each trait. An increase in the number of traits in the clonal selection program, will result in a reduction of expected gain for each trait; consequently, maximum biological gain is always in single trait selection programs and It is important that the extra value gained with the incorporation of a new trait need to be larger than the reduction on gain on the other traits. Having the genetic and economic information for all the traits of interest, a selection index can be developed in order to improve the aggregated value of the clones. Finally, to make the breeding and clonal selection process more efficient, new biotechnology tools can be incorporated in the program. Genomic tools will help to identify candidate genes, responsible of some of the traits, and this knowledge will help to guide breeding and to combine favorable genes on selected clones. Molecular markers, gene expression or genomic wide selection, allows clonal characterization at early ages and consequently increase gain per unit of time. In summary, breeding and clonal selection for the cellulose industry is a team work, including tree breeders, industry people and biotechnologist. This is the only way to generate "top of the line clones" that fulfill plantation and industrial requirements.



09:45 to 10:30 **Session 2: The quality of eucalyptus wood for pulp**

Chairman: *Carlos Mantero* Uruguay

**WOOD QUALITY: A KEY ELEMENT FOR PRODUCTION OF HIGH YIELD AND HIGH BLEACHABILITY EUCALYPT KRAFT PULP**

Keynote speaker: *Jorge Luiz Colodette* Brazil

The two major costs in the production of bleached eucalyptus Kraft pulp derive from wood and chemicals, with the first being more significant. Within the industrial domain, the most effective way of decreasing wood costs is by increasing overall fiber line yield and decreasing wastes in the wood preparation room. The decrease of chemical costs is more effectively done through optimization of the pulp bleaching operation where most of the unrecoverable chemicals are used. Many alternatives have been investigated aiming at increasing fiber line yield. These have included many modifications in the Kraft cooking technology with adoption of processes such as low-solids and compact cooking, the use of cooking aids such as anthraquinone, polysulfides and surfactants, and the optimization of the pulp final degree of delignification. Perhaps, the most studied of all alternatives has been the latter, for which the focus has been the establishment of the optimum degree of delignification (kappa number) that cooking shall actually terminate before other means of delignification take over. Most studies have inferred that is always better to terminate the cook at a higher kappa number, within the limits of equipment runnability, and continue the delignification for example with an oxygen stage. Of course, the accomplishment of such goal is always hampered by large amounts of rejects that derive from operation with excessively high kappa numbers out of digester. Recently, the extended impregnation technology has been developed to minimize the amount of rejects in high kappa pulping. Of course, the ideal kappa to terminate cooking is highly dependent on the wood type. For hardwoods, the approach of terminating the cook at the highest possible kappa number is likely not the right one because the defiberization point for such woods depends upon the syringyl/guaiacyl ratio of their lignins. Some studies have indicated that wood lignin S/G ratio may play a role in wood defiberization point during Kraft cooking. Therefore, the ideal kappa number to terminate the cook is highly dependent on the wood itself. Instead of terminating the cook at the highest possible kappa number, this study proposes that the cook shall terminate at the point where the pulp achieves maximum HexA/Lignin ratio, regardless of the kappa number. Maximization of pulp HexA/Lignin ratio signifies maximization of hemicelluloses retention and as consequence maximization of yield. Independent studies carried out with various wood species have shown different HexA maxima at very different kappa numbers. In spite of some controversies, it is mostly accepted that pulps containing maximum HexA/Lignin ratios at a given kappa number will present highest bleachabilities in ECF bleaching processes. The removal of HexA from pulp tends to consume less oxidant than lignin itself. In addition such acids may be removed from the pulp by simple hot acid hydrolysis, thus lowering overall bleaching cost. The hot acid hydrolysis stage is becoming common practice within bleached eucalypt Kraft pulp mills. The exact kappa number at which the HexA/Lignin ratio maximizes is dependent on the wood type and pulping process/ pulping conditions. There is no universal rule to identify such kappa number. Therefore, this study aimed at determining the exact kappa number at which the HexA/Lignin ratio maximizes for three different eucalyptus woods (*E. globulus*, *E. urograndis* and *E. camaldulensis*) and how this affect pulp yield and bleachability. It was observed that maximum HexA/Lignin ratio occurs at kappa 14 for *Eucalyptus globulus* whereas this ratio maximizes at kappa 20 for *Eucalyptus camaldulensis*. The maximum HexA/Lignin ratio at a given kappa also coincides with maximum pulp yield. The kappa number where HexA/Lignin ratio maximizes depends upon wood lignin syringyl/guaiacyl ratio (S/G). The impact of other wood quality parameters such as density and lignin, extractives, xylan and uronic acid contents on bleached eucalypt kraft pulp production will also be addressed in this work.

10:30 to 11:00 **Coffee Break / Posters**

11:00 to 13:00 **Session 2: The quality of eucalyptus wood for pulp**

**001 STUDY ON WOOD AND PULP PROPERTIES FROM DIFFERENT EUCALYPTUS SPECIES GROWN IN URUGUAY AND MAIN DIFFERENCE COMPARED TO E.UROGRANDIS**

*Jansson, Ulla*<sup>1\*</sup>; *Näsman, Mats*<sup>1</sup>; *Ferreira, Francisco*<sup>2</sup>

<sup>1</sup> Sweden - <sup>1</sup> Stora Enso Biomaterials; <sup>2</sup> Montes del Plata

With the aim to learn more about the different Eucalyptus species available in Montes del Plata (MdP) plantations and later forthcoming as raw material for the pulp mill, an extensive raw material mapping has been carried out. The sampling was planned and performed in order to reflect the current raw material holdings (2009) and to cover different growing conditions and different ages of the planted material. Based on MdP's inventory data, 62 different stands was selected to represent the wood for the mill. The sampling covered five species, *Eucalyptus globulus*, *E. grandis*, *E. maidenii*, *E. dunnii* and *E. bicostata* ranging from 8 to 18 years and growing on four different soil types (CONEAT classification). The sampled area corresponded to 44% of the total planted area on the selected soils and 55% of the total planted area with ages between 8-18 year. Analysis showed that *Eucalyptus* specie was the parameter having major influence on the wood basic density and bark amount. The chemical composition (carbohydrates, lignin and extractives) showed big differences between the species. Especially *E. grandis* differed from the others. Laboratory pulps were produced from 42 selected samples for determination of yield, fibre properties, brightness etc. A sub-set was further evaluated for physical properties after PFI-beatings. In a second part, pulp from pure *E. dunnii* and a mixture of four of the species was compared to pulp from *E. urograndis*. In this part more industrial-like conditions in cooking and bleaching were used. Beating was done on dried pulps with Voith-Sulzer refining. The refining evaluation showed that most Uruguayan pulp properties interesting for fine paper and board will be at the same level as *E. urograndis* pulp. However some differences were also seen in e.g. tensile stiffness and bulk, which were lower for Uruguayan pulps at constant SR level. However, since tensile stiffness is a pulp property very sensitive to beating conditions this might be compensated for with adapted conditions. Uruguayan eucalyptus pulps had higher initial strength, both wet and dry, which are especially important for tissue production. Drainage resistance were the same at low beating energy input but lower than *E. urograndis* at high energy input (100-200 kWh/t).

**002 EFFECT OF FIBER WALL CHEMISTRY ON ENERGY DEMAND IN EUCALYPTUS WOOD DEFIBRATION**

*Coelho dos Santos Muguet, Marcelo*<sup>1\*</sup>; *Ruuttunen, Kyösti*<sup>1</sup>; *Jääskeläinen, Anna-Stiina*<sup>2</sup>; *Colodette, Jorge Luiz*<sup>3</sup>; *Vuorinen, Tapani*<sup>1</sup>

<sup>1</sup> Finland - <sup>1</sup> Aalto University, School of Chemical Technology, Department of Forest Products Technology, P.O. Box 16300, 00076 Aalto, Finland; <sup>2</sup> VTT Technical Research Centre of Finland, Tietotie 2, 02044 Espoo, Finland; <sup>3</sup> Universidade Federal de Viçosa (UFV) - Viçosa/Brazil

Wood refining experiments were carried out in laboratory scale, with and without chemical pretreatment: alkaline peroxide mechanical pulping (APMP) and thermomechanical pulping (TMP) processes, respectively. The most important finding was the direct influence of the lignin structure on the defibration energy. Especially, the relative contents of the guaiacyl moieties in the wood lignin seem to play a crucial role. The results showed that the higher the amount of guaiacyl structures in the lignin, especially in the middle lamella between the fibers, the higher the specific energy consumption (SEC) in the APMP process. However, for the TMP process the correlation was not as clear. This is most probably due to the fact that in the APMP process the defibration takes place in the middle lamella while in the TMP process other mechanism prevails. However, in the samples with very low amount of guaiacyl structures, SEC decreased substantially also in the TMP process. A different approach was promoting fiber wall deconstruction via autohydrolysis of wood. The autohydrolysis process changed notably the mechanical properties of the *Eucalyptus* chips, with impressive SEC decrease. Although autohydrolysis was performed under mild temperature (120 oC), lignin structure was changed. Changes in lignin were confirmed after analyzing the fiber surfaces, which was highly covered with lignin, indicating that the defibration of autohydrolyzed *Eucalyptus* wood chips takes place along the middle lamella. This behavior differs from the traditional thermomechanical pulping, where the rupture occurs mostly in the fiber wall (especially in the S1 layer) being similar to chemi-mechanical processes (APMP, CTMP).



**003 EUCALYPTUS HYBRIDS CLONES EVALUATION BY STATISTICAL MULTIVARIATE TECHNIQUES: A FUNDAMENTAL TOOL FOR MILL QUALITY AND STABILITY GARANTY**

*de Caux, Leonardo<sup>1</sup> \*; Dalvi, Leandro<sup>1</sup>; Colodette, Jorge<sup>2</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Celulose Nipo-Brasileira - CENIBRA; <sup>2</sup> Universidade Federal de Vicosa

Ensuring the quality of pulp at a competitive production cost represents an interesting challenge for industries. In this context the quality and availability of the wood appears as a decisive factor. Therefore, the genetic improvement programs associated with good silvicultural practice are always present in the pulp industry. However, even with a high level of development, the improvement programs usually do not cover the whole range of variables which involves the cellulose pulp production. The recommendation of a hybrid or clone often follows an orientation focused on silvicultural factors such as resistance to pests, annual growth, soil and climatic conditions. Therefore, a second evaluation of the wood based on industrial factors such as yield, bleachability and pulp quality becomes an important tool both for the mill, supplying their expectations regarding the raw material, and for the forest area that can use this information to planting accelerate or withdraw a clone or hybrid from the program. In this paper we demonstrate the results of the program conducted by CENIBRA since 2006 to evaluate the available wood for pulp production, highlighting their characteristics for the process and the quality of the pulp produced. Nine variables were used to define the relationship between the wood quality and the process and seven to define the pulp quality for paper making. The data evaluation was performed by multivariate statistical techniques such as principal components (PCA) and cluster analysis. The PCA and cluster analysis were very clear and powerful to show the possibility of production oriented regarding cost, quality or market based on separation of raw material into groups by statistical similarity.

**004 EFFECT OF LIGNIN CARBOHYDRATES COMPLEXES OF HARDWOODS HIBRIDS ON KRAFT PULPING PROCESS**

*Silva, Vanessa<sup>1</sup> \*; Colodette, Jorge<sup>2</sup>; Jameel, Hasan<sup>3</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Department of Forest Engineering, Federal University of Vicosa, Vicosa, Minas Gerais, Brazil, 36570-000; <sup>2</sup> Laboratório de Celulose e Papel - DEF Universidade Federal de Viçosa; <sup>3</sup> Department of Wood and Paper Science, North Carolina State University, Raleigh, North Carolina, USA, 27695-8005

Many investigations have been conducted to elucidate the nature of lignin-carbohydrates complexes (LCC) but few studies were carried out about the relationship between LCC and pulping. Lignin-carbohydrates complexes influence many chemical properties in the wood, e.g., difficult to remove lignin from kraft pulps at the end of pulping due the occurrence of lignin carbohydrates bonds. Therefore, this study aimed to study the influence of lignin-carbohydrate complexes on kraft pulping. Four different eucalyptus samples (E. grandis; E. grandis X E. globulus (GxGL); E. urophylla X E. camaldulensis (UxG) and [(E.dunni x E. grandis) X E. urophylla] (DG x U)) from Brazil was used for chemical characterization and pulping. Spectroscopic techniques (13C NMR and HSQC-2D) were applied for the determination and quantification of the lignin-carbohydrate complex structures, and then evaluated the effect of LCC on kraft pulping of hybrid eucalyptus. Application of 13C NMR and HSQC-2D (Heteronuclear Single Quantum Correlation) combination of spectroscopic techniques allowed the identification and quantification of the benzyl ether,  $\beta$ -ester, and phenyl glucoside linkages of the lignin-carbohydrate complexes in eucalyptus hybrid wood. The glycosidic phenyl and  $\beta$ -ester linkages are, respectively, the more and least significant to the quantitative point of view. The xylose content of the isolated lignin (MWL-milled wood lignin) was very high, suggesting that the lignin-carbohydrate complex linkages are preferably bonded to xylose. The study did not confirm a correlation between the lignin-carbohydrate complexes content and the kraft pulping yield. Analysis of 13C NMR of the samples showed that the eucalyptus hybrid GxGL (E. grandis X E. globulus ) contained high  $\beta$ -O-4 linkages content and also higher pulping yield than the others samples, suggesting that the linkages between lignin is more important than LCC linkages in pulping.

**005 SIMULTANEOUS DETECTION OF LIGNIN STRUCTURE, S/G RATIO AND CARBOHYDRATE COMPOSITION FROM EUCALYPTUS HYBRIDS BY ANALYTICAL PYROLYSIS-GC/MS**

*Ohra-aho, Taina<sup>1</sup> \*; Gomes, Fernando<sup>2</sup>; Colodette, Jorge<sup>2</sup>; Tamminen, Tarja<sup>1</sup>*

<sup>1</sup> Finland - <sup>1</sup> VTT-Technical Research Centre of Finland, Espoo, Finland; <sup>2</sup> Departamento de Engenharia Florestal, Universidade Federal de Viçosa, Brazil

Lignin structure, the ratio between syringyl (S) and guaiacyl (G) lignin units and carbohydrate compositions of various Eucalyptus hybrids were determined by analytical pyrolysis-GC/MS (Py-GC/MS). S/G ratios and relative carbohydrate compositions determined by Py-GC/MS were compared with the traditional wet chemical methods: alkaline nitrobenzene oxidation and acid hydrolysis followed by High Performance Liquid Chromatography (HPLC), respectively. The results among Py-GC/MS and acid hydrolysis were close to each other, but the correlation was not satisfactory when comparing different wood raw materials. However, when applying the Py-GC/MS to samples from one wood raw material after cooking to varying kappa number levels, significantly better correlation between the methods was verified. Thus, Py-GC/MS cannot be recommended for the comparison of carbohydrate composition between different raw materials, but it is applicable in research aiming at developing processing methods for a defined wood raw material. On the other hand, lignin analysis, including S/G ratio, was found to be more widely applicable for the comparison of wood raw materials. Both lignin structure and S/G ratio varied among the Eucalyptus crossings indicating the variation in lignin original structure between the samples.

**006 THE RELATIONSHIP AMONG EUCALYPTUS WOOD PYROLYSIS PRODUCTS AND PULPING YIELD.**

*Reina, Luis<sup>1</sup> \*; Galetta, Alejandra<sup>2</sup>; Vinciguerra, Vittorio; Resquin, Fernando<sup>3</sup>; Mantero, Carlos<sup>4</sup>; Menéndez, Pilar<sup>5</sup>*

<sup>1</sup> Uruguay - <sup>1</sup> Departamento de Tecnología Química, Facultad de Química, Universidad de la República, Avenida General Flores 2124, Montevideo 11800, Uruguay.; <sup>2</sup> Departamento de Química Orgánica, Facultad de Química, Universidad de la República, Avenida General Flores 2124, Montevideo 11800, Uruguay.; <sup>3</sup> Programa de Producción Forestal, Instituto Nacional de Investigación Agropecuaria Tacuarembó, Ruta 5 km 386, Tacuarembó 45000, Uruguay.; <sup>4</sup> Estación Experimental Prof. Bernardo Rosengurt, Facultad de Agronomía, Universidad de la República, Uruguay.; <sup>5</sup> Departamento de Química Orgánica, Facultad de Química, Universidad de la República, Avenida General Flores 2124, Montevideo 11800, Uruguay.

The use of Eucalyptus wood for different applications has been increasing during the last two decades in Uruguay. This is a consequence of the increment of Eucalyptus plantations. The principal use of Eucalyptus wood in Uruguay is pulp production. Pulping and bleaching performance depend on the structure and quantity of the principal wood polymers as cellulose, hemicelluloses and lignin. Different Eucalyptus species require different pulping conditions to obtain pulps with the same content of lignin. It is known that lignin structure is an important factor in pulp production (1). There are many techniques to study it; one of them is analytical pyrolysis (Py-GC/MS). It is a fast method when it is applied to analyze wood samples. It has also been used to study lignin structure in Eucalyptus wood (2). In this work is shown the use of Py-GC/MS to study wood samples of Eucalyptus species grown in Uruguay. It was observed a relationship among wood pyrolysis products and kraft pulping yield. 1.J.C. del Río, A. Gutiérrez, M. Hernando, P. Landón, J. Romero, A.T. Martínez, Determining the influence of eucalypt lignin composition in paper pulp yield using Py-GC/MS, J. Anal. Appl. Pyrolysis 74 (2005) 110-115. 2.F.J. González-Vila, G. Almendros, J.C. del Río, F. Martín, A. Gutiérrez, J. Romero, Ease of delignification assessment of wood from different Eucalyptus species by pyrolysis (TMAH) - GC/MS and CP/MAS 13C-NMR spectrometry, J. Anal. Appl. Pyrolysis 49 (1999) 295-305.



**14:30 to 16:00 Session 3: Advances in kraft pulping technology**

Chairman: *Kari Kovasin* Finland

**BIOTECHNOLOGICAL STRATEGIES FOR LOWERING YELLOWING IN HARDWOOD PULPS**

Keynote speaker: *Mikael Lindström* Sweden

The purpose of the talk is elaborate on the mechanisms behind the loss of brightness in chemical pulps, and also presents technical interesting ways to diminish the problems. The theory for brightness reversion (yellowing) is today that mainly carbohydrate derived structures, of which hexenuronic acid is the most important, reacts during the ageing and first form intermediates like reductic acid, which are further converted to dicarboxylic acids that form strongly coloured complexes with transition metal ions. It shall therefore mainly be xylan structures that are involved in the brightness reversion. The theories do not explain the details in the process and the support for it is relatively weak. The effect of an enzymatic post-treatment of bleached hardwood kraft pulp in order to improve the brightness stability has been studied using commercially available endoxylanases. The results clearly show that the yellowing was significantly reduced for pulps of different origins and bleached in different ways. The beneficial effect on the brightness stability was linked to a removal of hexenuronic acid (HexA) from the pulps. The practical applicability of the results needs to be considered in relation to the cost of the enzyme and to indications that there is some yield loss due to the treatment. Another possibility is to use genetic strategies for preventing the formation of HexA itself. Studies using model compounds and isolated xylan suggest that the methyl group in the 4-O-methyl glucuronic acid residue side group in xylan play a central role in the formation of HexA during alkaline conditions, since HexA seems not to be formed in any extend from non-methylated glucuronic acid residues in simulated pulping. This is most likely due to that methanoate ion is a better leaving group than hydroxyl during alkaline pH. This opens up for a strategy where genetically modified trees are made that lacks the enzyme system for emthylating this residue. In support for that such an organism should be healthy enough to be cultivated, there are reports of healthy plants where the methylation of the glucuronic acid residues is incomplete.

**007 PROVEN SOLUTIONS TO MINIMIZE INORGANIC PROCESS SCALING IN PULP AND RECOVERY**

*Kent, Kraig<sup>1</sup>; Laurito, Jean<sup>2</sup>*

<sup>1</sup> United States - <sup>2</sup> Ashland Hercules Water Technologies - NA; <sup>2</sup> Ashland Hercules Water Technologies - LA

The buildup of inorganic scale on pulping and liquor recovery equipment and in process piping has been a perennial problem in the pulp and paper industry. Within pulp and recovery operations, inorganic scale buildup can negatively impact overall mill profitability by compromising the efficiency of digesters, heat exchangers, brown stock washers, evaporators, smelt dissolving tanks, green liquor piping, scrubbers and the bleach plant. Specific issues caused by scaling include reduced flow of process liquors, reduced heat transfer efficiency, unscheduled downtime, and increased cleaning costs and safety risks. All of these issues directly impact unit operation efficiency and stability, and ultimately reduce the competitiveness of the asset. The quantity and the chemistry of the scale buildup depend upon process inputs such as wood and water as well as operating process parameters and the degree of system closure. System closure, which has become increasingly important due to environmental regulatory bodies imposing even stricter constraints on fresh water usage and effluent discharge, makes inorganic scaling even more severe. This paper discusses the common issues caused by inorganic scaling and highlights a number of proven operational methods and specialty chemical treatments that effectively inhibit the different types of scale that occur in pulp and recovery operations. Results from several commercial applications are also described.

**008 REDUCTION OF SOLID WASTE FROM PULP MILL FIBERLINE**

*Pikka, Olavi<sup>1</sup>; Grotzner, Mariana<sup>2</sup>; Vianna, Viridiane<sup>2</sup>; Ribeiro Alves Junior, José Rinaldo<sup>3</sup>; Pimenta, Leonardo<sup>4</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Director of Technology, ANDRITZ; <sup>2</sup> Process Engineer, ANDRITZ; <sup>3</sup> Fiberline Coordinator, ELDORADO; <sup>4</sup> Process Consultant, ELDORADO

As modern pulp mills are reaching higher production, the waste generation amount has increased along the years. Modern eucalyptus pulp mills in Brazil generate solid waste in a range of 50-250 kg/adt and ecoefficient solutions are utilized to reduce waste. Recently, mills are sending waste to: cement industry, soil amendments and recycling. Pulp mills contain different processing areas and varied kinds of residues are generated. For Fiberline, solid waste is constituted by uncooked chips, fines from chips, knots, shives, bark, coarse, sand and fibers. This work describes the state-of-art of solid waste reduction in Fiberline, where the concepts of having all screenroom operations located after oxygen delignification and fiber recovery from Bleaching effluent are applied. A reject profile has been built in brownstock area and the reject recirculation benefit could be evaluated. Mill and laboratory results will be presented. According to results, reduction of solid waste and gain in pulp production could reach up to 3 MUS/y savings in a high production mill. Additionally, the efficiency of sand separation in screenroom and fiber recovery from Bleaching effluent were investigated. Improvements related to the location of oxygen delignification before screenroom promotes reject minimization higher than 50%. Coarse and shives rejects are recirculated back to Cooking and oxygen delignification, respectively. Shives recovery generates more net production. Therefore, the benefits of recirculating knots and shives are: improved solid waste reduction, higher pulping yield as rejects are processed into good fibers, 2-3 times lower sodium content in rejects to be burnt at Power Boiler, less material to be removed to disposal, less emissions to environment and the possibility to convert wood rejects into valuable product by a Reject Handling System. Sand residue is also reduced in screenroom with the utilization of new sophisticated sand removal equipment. Besides developing the benefit of removing sand efficiently from the system, this kind of equipment also avoids liquid effluent generation. Bleaching effluent has contributed for solids content in the effluent treatment. Due that, in order to recover fibers, which are valuable product, filters or new in-built filtering are utilized and they improve solid waste minimization in fiberline.



16:30 to 17:30 **Session 4: Eucalyptus fiber quality and products**

Chairman: *Jorge Luiz Colodette* Brazil

**FUNKALYPTUS: TOWARDS A NEW EUCALYPTUS FIBRE TECHNOLOGY**

Keynote speaker: *Pedro Fardim* Finland

Eucalyptus fibre technology has a great potential to be exploited. Processing steps such as impregnation, cooking, bleaching, wet-end and papermaking involves a multitude of interfacial interactions between fibres, polymers, molecules and inorganic components. Intermolecular bonds mostly drive the interfacial interactions. Consequently, different natural supramolecular assemblies are disrupted in fibre separation while new ones are created in fibre processing to pulp, paper and composites. The knowledge and control of the chemistry and character of the supramolecular assemblies allows development of strategies to prepare new functional eucalyptus fibres under current process technology. This strategy has a great potential to be exploited by industrial innovation and it will be named here as Funkalyptus. In this work, we present the concept of Funkalyptus based on supramolecular assemblies in fibre processing using four platforms: 1) Biopolymer assemblies 2) Topochemical activation 3) Biomolecule assemblies and 4) Nanohybrid assemblies. Biopolymer assemblies involve the formation of cellulose-cellulose assemblies during pulping, controlled sorption of hemicelluloses during bleaching and charge driven assembly of functional biopolymers as fibre post-treatment such as drying and wet-end. This approach allows introduction of smart capabilities to fibres, for example for addition of photoresponsive mechanical properties to fibre products. Topochemical activation focuses on in-situ generation of reactive chemicals at fibre interfaces for improving selectivity in oxidative bleaching stages and removal of hexenuronic acid in oxygen delignification. This method allows shortening of bleaching sequences and reduction of dosage of chemicals. Biomolecules assembly exploits the role of wood extractives on fibre surfaces and their behavior during low-consistency refining as mimic to create new functional fibre products with controlled release of chemicals. Nanohybrid assemblies are presented based on functionalization of fibres using layered double hydroxides (LDH) and their application in papermaking and preparation of composites. Nanohybrid assemblies can be the future of papermaking, allowing development of processes with less additives and lower water consumption. The characterization of supramolecular assemblies were performed by a combination of different advanced spectrometric and imaging techniques such as X-ray Diffraction (XRD), Cross Polarization Magic Angle Carbon-13 Nuclear Magnetic Resonance (CP/MAS 13CNMR), Near Infrared Spectrometry (NIR) combined with Principal Component Analysis (PCA), X-Ray Photoelectron Spectroscopy, Time-of-flight Secondary Ion Mass Spectrometry, Field-Emission Scanning Electron Microscopy (FE-SEM) and Atomic Force Microscopy (AFM). Functionalisation of eucalyptus fibres in large scale is still in its infancy. Challenges are usually related on how to add value to fibre products to be used in available value chains and also on how to identify functionalization needs of fibre users. Eucalyptus pulp is traditionally seen as a commodity product. Funkalyptus approach has the potential to exploit several strategies for the design of supramolecular assemblies in conventional fibre technologies and support the development of a new technology where much fewer process steps and consumption of chemicals and water are required. This approach can make the commodity product even more cost competitive and in addition allow the development of products with higher added value with lower capital investment.

**009 NANOMECHANICAL CHARACTERIZATION OF WOOD FIBERS FOR PULP AND PAPER**

*Gacitua, William<sup>1</sup> \*; Bustos, Cecilia<sup>1</sup>; Valenzuela, Paulina<sup>2</sup>; Chavez, Jorge<sup>3</sup>; Ochoa, Cristian<sup>4</sup>*

<sup>1</sup> Chile - <sup>\*</sup> Associate Professor Departamento de Ingeniería en Maderas Centro de Biomateriales y Nanotecnología, CBN Universidad del Bío-Bío; <sup>2</sup> Researcher, Centro de Biomateriales y Nanotecnología, CBN Universidad del Bío-Bío; <sup>3</sup> Graduate student, Departamento de Ingeniería en Maderas Centro de Biomateriales y Nanotecnología, CBN Universidad del Bío-Bío; <sup>4</sup> Graduate student, Departamento de Ingeniería en Maderas Centro de Biomateriales y Nanotecnología, CBN Universidad del Bío-Bío

Nowadays, there are an important number of genetic varieties to produce significant volumes of short fiber cellulose. One of the species that have been in focus, in terms of searching of a high performance genotype for cellulose, is Eucalyptus globulus Labill. This species grows at important rates and gives pulping yields that are profitable for the cellulose industry. During the last decade, the use of spectroscopy techniques has allowed to approach to a definition of the requirement for chemical and morphologic properties for the ideal genotype to produce cellulose of high quality from Eucalyptus globulus. Nevertheless, many are the factors that have limited the profits with this species in the goal to develop a better genetic selection of clones for cellulose production. Among these are the own limitations of the technologies used, which are based on predictions and in spite of its high factors of correlation, they do not allow a precise selection of clones that can add greater value to the short fiber cellulose. Another important factor related to the quality of the cellulose, is the damage that undergoes in wood fibers during thermal, mechanical and chemical processes during cellulose production. Our R&D is based on the use of nanotechnologies for clones selection based on the complete characterization from the plant to the adult clone. The technologies allow the establishment of empirical models for pulp yield and cellulose quality, which are based on nanomechanical properties and fiber morphology. Another aspect related with cellulose sheet quality is the damage factor that is affecting fiber mechanical performance during processing. On this line, the reduction of fibers damage factors during the manufacturing process, will allow to improve the quality of the cellulose sheet, with the consequences of a higher competitiveness of the industry and owners of Eucalyptus globulus plantations.

**088 PRODUCTION SCHEDULING OF COMPLEX INTEGRATED PULPMILLS**

*Enzer, Uri<sup>1</sup>; Gómez, Leandro<sup>1</sup>*

<sup>1</sup>Greycon Latin America

In capital-intensive industries such as pulp and paper, maximum utilization of assets is essential. The design capacities of production units in a pulp mill/recovery complex are often matched such that under steady state conditions, the whole mill can run at maximum. However, because of the dynamic nature of breakdowns, restrictions and varying demands, the steady state scenario is rarely achieved in complex integrated mills. Breakdowns of equipment, or constraints in other interdependent areas, often reduce the utilization of key production units. When there is a breakdown, and a plant area shuts down, domino effects follow as other plant areas, upstream and downstream units are forced to shut. Smart selection of targets for stock levels, tank levels and unit production rates can maximize the utilization of key assets despite unplanned breakdowns and restrictions. Constraints or bottlenecks determine the maximum throughput of the mill, but short-term variations in each production area are required to achieve the optimal storage levels, which will minimize the domino effect of failures. Competition for finite resources, such as white liquor supply, black liquor processing capacity and steam availability, requires that priorities across the different lines of the mill are defined and followed. Similarly, the scheduling of evaporator washes must be optimized in order to reduce the production lost both by the evaporator performance decay and the downtime required for the maintenance. This principle applies to maintenance shutdowns in general. Brownstock washing efficiency is also a concern of the production scheduling. The optimal dilution factor is often calculated to minimize costs for a particular pulp line. This usually considers cost functions of bleach chemical consumption, soda loss and evaporator steam versus dilution factor. However, optimal dilution factor may change when evaporator performance threatens to reduce the throughput of the whole mill, and thus it depends on the dynamic load of the recovery system as well as the paper machine block schedule. A scheduling engine that produces a production plan managing the problems described above was developed. The system uses a mathematical model of the whole pulp mill in order to predict storage level evolution. The main inputs of the system are the current inventory levels, process rates and failure probabilities in the mill, and the main outputs are the process rate set points to be set across the mill. The system has What-if capabilities that can be used by the production managers to schedule maintenance tasks and changes in the block schedule. Surveys conducted in pulp mills have shown that production increases of up to 5% could be achieved by better scheduling of the pulp mill and recovery circuits. The thesis is that missed opportunities to increase production exist in complex mills. These opportunities could be taken by ensuring that the various production areas of the mill are coordinated in a way that matches the paper mill demands and positions the mill to the best possible state to deal with unplanned shutdowns and disturbances. In addition to the economic value of increased output, there are other operational and quantity benefits that would result from more stable operation. Less variability in pulp quality should result from fewer and smaller production rate changes (i.e. stabilizing continuous digesters, washers and bleach plant operation). Operating costs are also expected to be reduced by better pulp inventory management.

17:30 to 18:00 **Special Conference**

Keynote speaker: *Bruno Vuan* Uruguay

**UPM IN URUGUAY: 20 YEARS OF R&D IN EUCALYPTUS PULP AND ENERGY**







09:45 to 10:30 **Session 6: The pulp mill biorefinery and bio-products**

Chairwoman: *María Cristina Area* Argentina

**THE KRAFT PULP MILL BIO-REFINERY**

Keynote speaker: *Peter Axegård* Sweden

Wood bio-refining can be defined as full utilization of wood into a wide range of products. A modern kraft pulp mill is a wood based bio-refinery and today up to 500-700 kWh of electricity can be produced per tonne of bleached pulp. The bio-refinery concept can be further developed by extracting lignin and xylan from the black liquor. Additionally there are possibilities to process internal pulp mill process streams such as solid by-products and black liquor evaporation condensate as well as bark, forestry residues and agro-based fibers such as sugar cane bagasse into various products. There are many more or less sophisticated bio-refinery processes under development. The kraft pulp process is in a unique position as it is well developed, industrially implemented and only minor modifications are needed to convert it into a bio-refinery with production of new products. Lignin removal from kraft black liquors has been developed to a commercial process (the LignoBoost process) in cooperation between Innventia and Chalmers. The LignoBoost technology is since 2008 owned by Metso. The first commercial LignoBoost plant started production early 2013 in the US. Lignin applications have since 2003 been a focus area at Innventia. Successful energy applications such as fuel oil replacement in lime kilns, coal replacement, use in biomass boilers and mixtures with pyrolysis oil have been evaluated. LignoBoost lignin is successfully used in scale industrial dispersing applications. Promising results have recently been obtained with carbon fibres from LignoBoost lignin. Due to its high aromatic content lignin is also an interesting feed-stock for phenols and other aromatics. Specialty cellulose with high purity and high reactivity can preferably be produced from wood by pre-hydrolysis followed by alkaline treatment. This approach is especially interesting for the development of environmentally benign processes for regenerated cellulose. The approach allows for dissolving pulp for cotton fiber replacement and other advanced cellulose products. Hemicelluloses in polymeric form can be separated from a pre-hydrolysis stage of wood, from pulp fibers and from black liquor. The specific properties are interesting when used as raw material in applications such as paper chemicals, composites and gas barriers. It has been shown that barriers with excellent oxygen barrier properties even at high humidity and sufficient strength can be produced from wood hydrolysate. Wood hydrolysate can also be co-produced with production of dissolving pulp. There are many other opportunities for bio-products in a kraft pulp mill such as production of specific bark components, methanol from black liquor evaporation condensates, wood based pellets, methanol/dimethyl ether from syngas, biodiesel from lignin, torrefied wood/biomass and pyrolysis oil. It has to be understood that the economic attractiveness in production of biofuels from woody raw materials in most cases only can be achieved if it is combined with production of more value added products. One such example is the POLYNOL concept where low cost biomass such as forestry residues and sugar cane bagasse is delignified with alkali in a side stream in a kraft pulp mill. The resulting cellulose is hydrolyzed to glucose and fermented to intermediates such as acetic acid, lactic acid and ethanol, while the lignin is purified separately. Compared to other technologies for second generation glucose, alkaline treatment has a unique capability to separate the wood components into relatively pure streams making further processing less complicated. This concept for 2G glucose can economically be integrated in a kraft pulp mill provided the recovery boiler is off-loaded with a lignin plant. There are also other synergies that combined make the concept economically viable. The concept is since 2013 developed in the POLYNOL project.

10:30 to 11:00 **Coffee Break / Posters**

11:00 to 12:30 **Session 6: The pulp mill biorefinery and bio-products**

**011 SODA-O2, SODA-AQ AND ORGANOSOLV PULPING AS PRETREATMENTS OF EUCALYPTUS FOR BIOETHANOL PRODUCTION**

*Tamminen, Tarja<sup>1</sup> \*; Milanez, Augusto<sup>2</sup>; Andreotti, Juliana<sup>2</sup>; Gomes, Fernando<sup>3</sup>; Colodette, Jorge<sup>3</sup>; Barth, Dorothee<sup>1</sup>; Liitiä, Tiina<sup>1</sup>*

\* Finland - <sup>1</sup> VTT Technical Research Centre of Finland; <sup>2</sup> Suzano Papel e Celulose SA; <sup>3</sup> UFV Universidade Federal de Viçosa

Three types of pretreatments were tested for Eucalyptus for the production of bioethanol: alkaline oxidative cooking (Soda-O2), soda-antraquinone cooking (Soda-AQ) and organosolv cooking in ethanol/phosphinic acid (LGF process). Eucalyptus hybrid *E. grandis* x [*E. urophylla* x *E. globulus*] (G1xUGL) was used as raw material. Optimal kappa level for the bioethanol production was screened and no rejects were removed from any of the pulps. Soda-O2 cooking was found to be more suitable for bioethanol production than Soda-AQ cooking. Soda-AQ required kappa number 15 for best performance, whereas after Soda-O2, pulps at kappa numbers 35 and 50 were enzymatically well hydrolysable. Soda-AQ is probably more potential as a sulphur-free cooking method for the production of paper grade pulps than as pretreatment for the biotechnical routes. The LGF type organosolv cooking was found to be a promising pre-treatment method for lignocellulosic raw materials, producing hydrolysable biomass with high yield for fermentation. Alkaline extraction after cooking further improved the glucose yield in enzymatic hydrolysis.

**012 MODIFICATION OF WOOD FIBRE SURFACES USING FUNCTIONAL BIO-BASED POLYELECTROLYTES AS A TOOL FOR THE PRODUCTION OF HIGH-ADDED VALUE MATERIALS**

*Vega, Beatriz<sup>1</sup> \*; Fardim, Pedro<sup>1</sup>; Heinze, Thomas<sup>2</sup>; Wondraczek, Holger<sup>3</sup>; Keikkilä, Elina*

\* Finland - <sup>1</sup> Åbo Akademi University; <sup>2</sup> Friedrich Schiller University of Jena; <sup>3</sup> Laboratory of Fibre and Cellulose Technology, Åbo Akademi University

molecular assembly namely polyelectrolyte complex (PEC) composed of a negatively charged xylan-based derivative and a novel positively charged cellulose derivative (CN+) was prepared via "one shot addition method". The prepared PEC was used for interfacial modification of bleached Kraft eucalyptus and pine fibers by charge directed self-assembly. The adsorption process was studied using polyelectrolyte titration and elemental analysis. Time of flight secondary ion mass spectrometry (ToF-SIMS) was used as advanced technique for the characterization of the modified eucalyptus (and pine) fiber surfaces. The measurements from polyelectrolyte titrations revealed that higher amount of PEC can be adsorbed on eucalyptus fibers and at the same time, that stronger interaction of the adsorbate with this type of fibers took place. The information gathered on this paper is essential for a better understanding of the adsorption process, and might contribute to the basis for the development of new value added products by the use of underutilized biomass.





**013 EFFECT OF THE EXTRACTION CONDITIONS ON THE CHEMICAL COMPOSITION OF EUCALYPTUS HEMICELLULOSES**

*da Silva Perez, Denison<sup>1</sup>; PETIT-CONIL, Michel<sup>2</sup>; Guillemain, Audrey<sup>3</sup>; Janodet, Arthur<sup>4</sup>; Soranzo, Adrian<sup>3</sup>; Schelcher, Matthieu<sup>5</sup>*

<sup>1</sup> Institut Technologique FCBA Domaine Universitaire BP CS90251 38044 Grenoble Cedex France; <sup>2</sup> Centre Technique du Papier and Institut Technologique FCBA Domaine Universitaire BP CS90251 38044 Grenoble Cedex France; <sup>3</sup> FCBA InTechFibres, New Materials Division; <sup>4</sup> Centre Technique du Papier, UST3/InTechFibres; <sup>5</sup> Centre Technique du Papier, UST3.

The effect of extraction conditions of *E. urograndis* wood on the quality of recovered hemicellulose fractions is reported. Different aqueous extraction liquors were used in acidic (sulfuric or acetic), water (near-neutral) and alkaline conditions (soda, soda-AQ or soda-peroxide). Depending on the extraction conditions, hemicelluloses having very different chemical composition can be obtained. In acidic or near-neutral conditions, galactoglucomannans-rich fractions (up to 73 %) are obtained. Contrarily, the fractions obtained in alkaline conditions are rich in arabinoxylans (up to 65 %). However, all the fractions obtained are importantly contaminated with residual lignin, but when acetic acid is used, this contamination is still more important, because of its lignin solvation ability. The contamination of eucalyptus hemicelluloses with residual lignin is more important than for other wood species and can be connected with the nature of the lignincarbohydrates complexes

**015 DETAILED CHARACTERIZATION OF BLACK LIQUOR (LIGNIN) DERIVING FROM KRAFT AND SODA-ANTRAQUINONE PULPING**

*Zikeli, Florian<sup>1</sup>; Coldette, Jorge Luiz<sup>2</sup>; Borges Gomes, Fernando José<sup>3</sup>; Del Rio, José Carlos<sup>4</sup>; Tamminen, Tarja<sup>5</sup>*

<sup>1</sup> Austria - <sup>1</sup> 1) Royal Institute of Technology, KTH, Fibre and Polymer Technology SE-100 44 Stockholm 2) Vienna University of Technology, Institute of Chemical Engineering, Getreidemarkt 9/166, A-1060 Vienna; <sup>2</sup> Universidade Federal de Viçosa; <sup>3</sup> Federal University of Viçosa; <sup>4</sup> Instituto de Recursos Naturales y Agrobiología de Sevilla, Spain; <sup>5</sup> VTT Technical Research Centre of Finland · Division of Bio- and Chemical Processes

Further usage of the side streams in pulp producing biorefineries - like black liquor (BL) which is an excellent source for the production of value-added chemicals and bio-materials - helps for increasing process integration but requires also detailed analysis of the side streams. This work is focused on BL analysis from two different alkaline processes - Kraft and Soda-Antraquinone (AQ) pulping - under simulated industrial conditions using a commercial eucalypt clone. The chemical composition (solids content, elemental composition, lignin and carbohydrate and ash content) as well as the heating value of the BLs were investigated. The molar mass distribution of the lignins isolated from the BLs was determined using alkaline SEC. The structure of the isolated BL lignins (phenolic content, syringyl/guaiacyl ratio, relative abundances of linkages) was analyzed using <sup>31</sup>P- and 2D NMR spectroscopy, Py-GC/MS and compared to the milled wood lignins and residual lignins isolated from the respective pulps. The results demonstrate various changes in the composition and structure of the main BL components as a result of different pulping conditions. The main findings of our study are: (1) the BL's heating value is higher for the Kraft and Soda-AQ process stopped at kappa 20 than at kappa 15; (2) the heating value of BL deriving from the Soda-AQ process is generally higher than from Kraft pulping BLs. (3) isolated Kraft BL lignin is richer in phenolic OH than the BL lignin from the Soda-AQ process and contains less condensed OH; (4) lignin from BLs is heavily degraded and oxidized; (5) the syringyl/guaiacyl ratio is higher in the BL lignin and it is enriched in β-β resinol structures compared to milled wood lignin and residual lignin from the respective pulp.

**014 HEMICELLULOSES EXTRACTION FROM EUCALYPTUS SP. SAWDUST BY HYDROTHERMAL TREATMENT**

*Rangel, Jesús<sup>1</sup>; Hornus, Marina<sup>2</sup>; Felissia, Fernando E.<sup>3</sup>; Area, María Cristina<sup>2</sup>*

<sup>1</sup> Escuela de Ingeniería Forestal, Facultad de Ciencias Forestales y Ambientales. Universidad de Los Andes. Mérida, Venezuela; <sup>2</sup> Programa de Celulosa y Papel - Instituto de Materiales de Misiones (CONICET-UNaM). Facultad de Ciencias Exactas Químicas y Naturales, Félix de Azara 1552 (3300) Posadas, Misiones, Argentina; <sup>3</sup> Programa de Celulosa y Papel - Instituto de Materiales de Misiones (CONICET-UNaM). Facultad de Ciencias Exactas Químicas y Naturales, Félix de Azara 1552 (3300) Posadas, Misiones, Argentina

The eucalyptus sawdust is the main waste of the primary processing of wood, being usually burned as it is. The objective of this work is to optimize the conditions of hydrothermal pretreatment of eucalyptus sawdust for hemicelluloses extraction. This treatment also removes water-soluble substances, obtaining a solid fraction consisting of cellulose and lignin, which follow other separation processes for their use. The sawdust was the waste of a sawmill and carpentry, which processes 12-50 years-old *Eucalyptus rostrata*, *grandis*, and *saligna*. A factorial design was initially applied to verify the influence of the time of treatment (30, 45 and 60 min), temperature (120, 150 and 180°C) and liquid / solid ratio (5, 10, 15). This last variable was not significant. A Central Composite Face-Centered Design was used for the optimization, varying time (20, 30 and 40 min) and temperature (170, 180 and 190°C). Treatments were performed in 200mL digesters in glycerin bath. The chemical characterization was performed according to LAP's National Renewable Energy Laboratory (NREL) standards. The best point obtained was validated with a change of scale using a 4.6 L digester. The temperature was the most influential factor on the autohydrolysis pretreatment of sawdust. The higher extraction of hemicelluloses (89% of initial hemicelluloses) was obtained at 190°C and 20 min, but when the intention was to minimize the generation of furfural by optimizing multiple responses, the best condition was found to be 180°C and 20 min. The response surface showed that similar results could be achieved at 170°C, extending the treatment time to 50 min.

12:30 to 13:00 **Special Conference**

**MANAGEMENT OF SOCIAL ASPECTS DURING THE CONSTRUCTION OF A GREENFIELD PULP PROJECT**

Keynote speaker: *Carolina Moreira* Uruguay

13:00 to 14:00 **Lunch**





## WEDNESDAY 27 CEVALLOS ROOM

### 08:30 to 10:30 Session 7: Advances in kraft black liquor recovery technology

Chairman: *Norberto Cassella* Uruguay

#### RECENT ADVANCES IN THE BLACK LIQUOR RECOVERY BOILER FURNACE PROCESS

Keynote speaker: *Mikko Hupa* Finland

Black Liquor Recovery Furnace is one of the most complex large scale industrial reactors around. On one hand it takes care of recovery of the cooking chemicals sodium and sulfur in a chemically suitable form - as a mixture of alkali carbonate and sulfide - to be tapped from the furnace floor as a smelt. On the other hand it is a reactor for clean combustion of the organic part of the liquor to generate heat and power in a steam boiler cycle. This presentation briefly reviews some of the most important advancements of the furnace process. In addition, some examples are presented of our most recent research at Åbo Akademi focused on deeper understanding of the furnace process in modern large scale boilers. During the last two decades or so recovery boilers have experienced a number of changes: (1) Increase in the liquor dry solids content (high solids firing, 80-90 % DS) (2) Dramatic increase in the furnace size (boiler sizes up to 6.000 ton/d) (3) Novel air delivery technologies (fewer stronger jets, many air levels) (4) Improved emission control (SO<sub>x</sub>, TRS and NO<sub>x</sub>) (5) Higher superheated steam temperatures

#### 016 DESIGN CHALLENGES IN BLACK LIQUOR EVAPORATORS

*Greis, Otto*<sup>1</sup>

<sup>1</sup> ANDRITZ Oy, Kraft Recovery and Power, Tammasaarenkatu 1 FI-00180 Helsinki, Finland Finland

This work focuses on process design challenges for large 1500t/h black liquor evaporators in eucalyptus based pulp mills. Particularly, when paying attention to safety, energy efficiency, availability and environmental issues like water footprint and flue gas emissions. One way to improve the overall energy efficiency is to increase the dry solid content and temperature in strategic parts of the mill sub processes, but this then challenges the process design. Optimal process conditions, e.g. high dry solid content, requires a combination of implemented measures with dedicated wash of the high dry solid evaporator effects and dedicated material selection for these units. Changed process conditions, also require, that the state of art evaporator has integrated condensate fractionation to separate the higher methanol loads from eucalyptus pulping. This work will show that the overall energy efficiency of a pulp mill is increased by increasing the dry solid content in strategic parts of the mill sub processes. We can for example today, increase the recovery boiler fired black liquor dry solid content, from DS 75 % to DS +85 %, obtaining following benefits: Produced steam flow is increased with less fumes and clearly reduced SO<sub>2</sub> emission. So, increased dry solid content reduces mill emissions without compromising overall costs. The higher process temperature, process pressure and higher residual alkali places together with fresh water closure challenges on the process materials, i.e. austenitic stainless steels (AISI304L) and duplex stainless steels (UNS S32101, UNS S32304 and UNS S32205). Test results will show that use of higher temperatures and dry solid content in the final evaporation stage make duplex stainless steels preferable over austenitic stainless steels, while having better resistance to corrosion and stress corrosion cracking (SCC). A 21st century developing forest industry with tightening environmental regulations seems to include endless opportunities of new products and processes, which are in a need of high efficiency recovery systems. The final aim will hence be to enlighten why liquor evaporator design might become more a must than simply a challenging subtask when aiming for sustainable eucalyptus based products.

#### 017 OPERATIONAL EXPERIENCES OF HIGH-ENERGY RECOVERY BOILERS

*Salmenoja, Keijo*<sup>1\*</sup>; *Wikstedt, Henrik*<sup>2</sup>

<sup>\*</sup> Finland - <sup>1</sup> Technology Director ANDRITZ Oy Tammasaarenkatu 1 FI-00180 Helsinki; <sup>2</sup> General Manager ANDRITZ BRASIL LTDA Av. Vicente Machado, 589 - Centro 80420-010 Curitiba-PR - Brasil

The first ANDRITZ High-Energy Recovery Boiler was started up in 2004 in Finland and presently nine such recovery boilers are in operation. This concept was the answer to the demand to increase the power-to-heat-ratio and power production of recovery boilers. With a modern high-energy recovery boiler, mills can easily double their power production compared to an old recovery boiler. There are several ways to increase the power production from a recovery boiler and some of those may also include operational risks. The main factor limiting the increase of power production from recovery boilers is corrosion. Therefore, increasing steam outlet temperature and pressure requires a sound knowledge of recovery boiler fluegas chemistry, fly ash behavior, and the control of heat transfer surface temperatures. By knowing all these factors, high availability together with high power production can be realized in practice. This paper is based on over 300 000 hours operational experiences from highenergy recovery boilers. Main features to maximize the power output as well as some operational experiences will be presented









14:30 to 16:00 **Session 9: Advances in dissolving pulp technology**

Chairman: *Olavi Pikka* Finland

**ADVANCES IN DISSOLVING PULP TECHNOLOGY**

Keynote speaker: *Kyösti Ruuttunen* Finland

The industrial processes for dissolving wood pulp, prehydrolysis kraft (PHK) and acid sulfite (AS), experience severe yield losses when the demand for cellulose purity is increased beyond the typical rayon grade quality[1]. Consecutive treatments in acidic and alkaline conditions induce carbohydrate losses by peeling reactions that are proportional to the amount of reducing end groups formed during the hydrolytic cleavage of glycosidic bonds in the acid pre-step. During recent years, cold caustic extraction (CCE) treatments have been directly applied to paper-grade pulp, predominantly after the O-stage, to convert it to a dissolving pulp[2]. In this way, the cellulose yield can be largely retained while substantial amounts of short-chain carbohydrates are removed[3]. However, hemicelluloses that are closely associated with the cellulose molecules-in particular, glucomannans and long-chain, low-substituted xylan-are only partially extracted by aqueous sodium hydroxide[4]. In addition, CCE treatment with a sodium hydroxide concentration higher than 8 wt% is associated with a gradual conversion to a cellulose II crystal structure that, together with the high residual hemicellulose content, prevents the use of CCE-treated paper pulp as acetate-grade pulp. The amount of alkaline-resistant xylan depends very much on the wood species. In hemicellulose-rich wood species, such as birch wood, a residual xylan content of 7.1 % is obtained upon a CCE treatment with an aqueous caustic solution of 100 g/L at room temperature, while under the same conditions the residual xylan content in CCE-treated E. globulus kraft pulp amounts to only 3.8 % [1]. Another drawback of the CCE treatment of a kraft pulp is the poor viscose reactivity of the resulting pulp. This has been explained by the rigidity of the largely preserved outer cell wall layers, which restrict the swelling capacity of the S2 layer[5]. Consequently, the reduced swelling capability results in reduced accessibility, which is expressed by lower filterability and the high particle content of the resulting viscose[1]. It has been shown that measures weakening the primary wall, such as endoglucanase or acidic post-treatments, can improve viscose pulp reactivity[6]. Unlike the traditional PHK-CCE method, the K-CCE process offers a significantly more rewarding source for polymeric xylan because its molar mass and available quantity are much higher than in a CCE filtrate of a PHK pulp.

**022 MANUFACTURING OF DISSOLVING HARDWOOD AND SOFTWOOD PULP WITH CONTINUOUS COOKING AND NOVEL FIBERLINE TECHNOLOGY; LABORATORY RESULTS AND A COMPARISON TO MILL RESULTS.**

*Ramark, Hannu*<sup>1\*</sup>; *Vehmaa, Janne*<sup>2</sup>

<sup>1</sup> Finland - <sup>1</sup> Director of Technology, ANDRITZ OY; <sup>2</sup> R&D Manager, ANDRITZ OY

Sulphite cooking has dominated the production of dissolving pulp in the past. Because of environmental reasons, sulphite cooking has decreased and instead has become pre-hydrolysis Kraft cooking. Earlier it was done only with batch cooking technology, but due to increasing demand of dissolving pulp, a process based pre-hydrolysis Kraft cooking done with continuous cooking technology has been developed. This new solution has been through extensive laboratory trials and subsequently installed and operated within an existing pulp mill originally designed for bleached Kraft market pulp. The new process and equipment design have addressed the negative experiences encountered on previous attempts to apply continuous cooking technology for dissolving pulp manufacturing. Both new and existing pulp mills can benefit from the new process solution, which is also allowing campaign production of dissolving pulp or paper grade pulp with the same fiber line.

**023 REACTIVITY OF EUCALYPTUS DISSOLVING PULPS: A MEASURE BASED ON ACETYLATION KINETICS**

*Bonfiglio, Fernando*<sup>1\*</sup>; *Sixta, Herbert*<sup>2</sup>

<sup>1</sup> Uruguay - <sup>1</sup> Departamento de Proyectos Forestales Laboratorio Tecnológico del Uruguay Unidad Tecnológica Fray Bentos Parque Industrial, Barrio Anglo Fray Bentos; <sup>2</sup> Department of Forest Products Technology School of Chemical Technology Aalto University FIN- 02015 Espoo

The reactivity of cellulose is usually one of the most important parameters determining the quality of dissolving pulps. It is a main input in the production of cellulose derivatives, such as viscose or cellulose acetate, and also a key parameter in the production of bioethanol. Reactivity is a concept related to the accessibility of hydroxyl groups in a defined conversion process. Pulp reactivity towards the viscose process is, for example, determined through Fock's method or the viscose filter value. However, these methods are time-consuming and they are not clearly inter-related. In this study, the reactivity of cellulose samples was determined by the kinetics of acetylation. For the development of this method, two Eucalyptus dissolving pulps were selected; one was produced by the Acid Sulfite (AS) process and the other one by the pre-hydrolysis Kraft (PHK) process. The study of the acetylation kinetics involved the reaction of cellulose with acetic anhydride catalyzed by sulfuric acid at a defined temperature. The degree of substitution (DS) was determined by HPLC and separately by the FT-IR technique. In conclusion, the acetylation method proved to be adequate to determine the reactivity of pulp samples in a reproducible manner. The results revealed a clear difference in the reactivity of the two pulps, which is consistent with the results obtained by determining viscose filterability according to Treiber.

16:30 to 18:45 **Session 10: Advances in pulp bleaching technology**

Chairman: *Leif Robertsen* Finland

**INSIGHTS IN EUCALYPTUS PULP BLEACHING TECHNOLOGY**

Keynote speaker: *Tapani Vuorinen* Finland

Current eucalyptus kraft pulp mills produce typically oxygen delignified pulp with kappa number of ca. 12 corresponding to a residual lignin content of ca. 1 % and hexenuronic acid content of ca. 1 %, too. Due to the relatively high content of hexenuronic acid, prebleaching of oxygen delignified eucalyptus pulps includes a hot acid treatment during which most of the hexenuronic acid is hydrolyzed without consuming oxidative bleaching chemicals. This can be realized in two alternative ways: either by starting with a long hot acid treatment followed by a short treatment with chlorine dioxide (A/D) or starting with chlorine dioxide and continuing the same stage with a long retention time at high temperature (DHot). The initial hot stages are continued with alkaline extraction (EP or EOP) followed by the final bleaching. Recently it was proposed that use of chlorine dioxide in the initial bleaching could be totally eliminated. In that case the hot acid treatment should be followed by an alkaline extraction stage with additions of oxygen and peroxide (A-EOP). One of the advantages of this alternative is lower consumption of chlorine dioxide, corresponding to less than 1.5 % active chlorine dosage in comparison with typically 2.0-2.5 % active chlorine use in the existing sequences. The final bleaching of eucalyptus pulps is typically carried out using chlorine dioxide in two consequent stages or even more often using a single stage with chlorine dioxide followed by a treatment with alkaline peroxide. When the sequence is ended with the peroxide stage, the brightness stability of the pulp is typically higher. The high efficiency of chlorine dioxide in pulp bleaching is based on the fact that hypochlorous and chlorous acids are formed in the reaction system when chlorine dioxide oxidizes lignin's phenolic structures. Hypochlorous acid reacts preferentially with hexenuronic acid but also with the residual lignin while chlorous acid oxidizes aldehydic groups formed in hexenuronic acid and lignin. Since the content of phenolic units in the residual lignin is limited, chlorine dioxide shows high selectivity (relative to kappa number reduction) only when there are still phenols left in the pulp. This is why adjusting the lignin-to-hexenuronic acid ratio by the acid stages is so important in bleaching of eucalyptus pulps. Although the need of chlorine dioxide has reduced by half during the developments in the last 15 years, there is continuous need for improvement in the bleaching technology. Chlorine chemicals are still wasted in overoxidation of hexenuronic acid, chlorination of residual lignin and formation of chlorate. To overcome these deficiencies we recently proposed to use tertiary amine catalysis in prebleaching of pulps with hypochlorous acid. With little use of oxidation power we were able to accomplish in seconds what requires now hours in the hot acid treatments in combination with chlorine dioxide. It may be that in the future the bleaching lines will look quite different from today.

**024 CATALYTIC OXIDATION OF RESIDUAL LIGNIN AND HEXENURONIC ACID IN PULP**

*Chenna, Naveen Kumar*<sup>1</sup> \*; *Jaaskelainen, Anna-Stiina*<sup>2</sup>; *Jarnefelt, Christian*<sup>3</sup>; *Lehtimaa, Tuula*<sup>4</sup>; *Vuorinen, Tapani*<sup>5</sup>

\* Finland - <sup>1</sup> Doctoral student, M.Sc. Laboratory of Forest Product Chemistry Department of Forest Product Technology School of Chemical Technology Aalto University P.O. Box 16300, FI-00076 Vuorimiehentie 1, Espoo Finland; <sup>2</sup> Principal Research Scientist, D.Sc. Team Leader, Biomass Fractionation VTT Technical Research Centre of Finland P.O.Box 1000 (Tietotie 2), FI-02044 VTT; <sup>3</sup> Research engineer; <sup>4</sup> process design engineer; <sup>5</sup> Professor Laboratory of Forest Product Chemistry Department of Forest Product Technology School of Chemical Technology Aalto University P.O. Box 16300, FI-00076 Vuorimiehentie 1, Espoo Finland

Oxidation of residual lignin and hexenuronic acid (HexA) in pulp fibres forms the basis of efficient kraft pulp bleaching processes. Many of the oxidation reactions in bleaching are slow and they consume excess of chemicals. In order to improve the selectivity of oxidation, it is important to consider the reactive species of the bleaching chemicals and how they undergo beneficial reactions with HexA and lignin or lead to unwanted side reactions. Stoichiometric amounts of chlorite and hypochlorous acid (HOCl) are formed in chlorine dioxide bleaching during oxidation of phenolic lignin. HOCl further oxidizes residual lignin and HexA which leads to their degradation. However, a significant part of HOCl is consumed in chlorination of lignin, overoxidation of HexA and formation of chlorate in a reaction with chlorite. The present study focusses on increasing the catalytic selectivity of HOCl towards the lignin and HexA oxidation. HOCl can act as an electrophile or nucleophile. One way to increase the selectivity of HOCl is to suppress its nucleophilic nature which is responsible for the overoxidation of HexA. In this paper we report on oxidation of residual lignin and HexA in pulp by a quaternary ammonium chloride cation (R3N+-Cl) which is a much stronger electrophile than HOCl but lacks the nucleophilic nature. The cation is formed in an instantaneous reaction of HOCl with a catalytic amount of a tertiary amine. We applied the catalytic reaction for oxidation of oxygen delignified eucalyptus pulp. The variables in our experiments were the amounts of the catalyst and HOCl, pH, pulp consistency, temperature and time. The oxidation took place rapidly (< 1 min) even at room temperature and was more selective towards HexA than lignin that was also reacting. With this method a marked decrease in kappa number was achieved with a low amount of active chlorine. Formation of R3N+-Cl took place within 10 ms. Oxidation of HexA model compound with R3N+-Cl was also very fast. The half-time of the reaction was about 100 ms. We believe that the oxidation of HexA occurs within a second in the pulp suspension.

**025 EFFECT OF EUCALYPT PULP PRETREATMENT WITH HOT ACID HYDROLYSIS ON (AZE)DP BLEACHING PERFORMANCE**

*Guimaraes, André*<sup>2</sup>, *Gómes, Valéria*<sup>1</sup> \*; *Coldette, Jorge Luiz*<sup>3</sup>; *Metais, Alexis*<sup>4</sup>; *Wennerström, Maria*<sup>5</sup>; *Silva, Marcelo*<sup>6</sup>; *Sjodin, Lars*

\* Brazil - <sup>1</sup> Federal University of Viçosa, Viçosa, Brazil.; <sup>2</sup> Fibria S/A Jacarei, Sao Pablo, Brazil; <sup>3</sup> Universidade Federal de Viçosa; <sup>4</sup> Xylem Inc. Paris, France; <sup>5</sup> Metso Paper, Sweden AB, Sweden.; <sup>6</sup> Fibria S/A, Jacarei, Sao Pablo, Brazil.

The main goal of this study was answering some critical questions regarding the effect of pulp pretreatment with hot acid hydrolysis (A-stage) on high consistency (HC) ozone bleaching, namely: (1) Are the significant chemical savings caused by the A-stage in industrial practice due to HexA removal by the A-stage or actually due to a substantial decrease of pulp COD across the A-stage (acid washing)? (2) Could the HexA removal in the A-stage be actually done in the Z-stage without any penalty? (3) Is the high reactivity of ozone towards HexA due to topochemical effects? (4) Would the chemical savings derived from the A-stage addition pay for the high capital investment of such stage? To answer the aforementioned questions, an experimental plan was set up involving full optimization of A-stage and its application in the A/(aZe)DP, A(aZe)DP, A/(aZe)(EP)P and A(aZe)(EP)P sequences for eucalypt Kraft pulp bleaching. It is concluded that the insertion of an A-stage before HC ozone bleaching is justifiable. The main benefit of the A-stage is due to its significant lignin and HexA removal from the pulp, which decreases kappa number by over 6 units, but it also decreases pulp COD by about 10 kg/adt, which is equivalent to 0.5 kappa units. The Z-stage remains efficient in a pulp pretreated with an A-stage. The HexA present in the pulp is apparently well distributed in the cell wall and not concentrated on the fiber surface. The chemical savings caused by the A-stage followed by washing are very significant and afford the high capital costs required to install such stage. The washing between the A- and HC Z-stages is beneficial but not a requirement. The optimum conditions for the A-stage are pH 3.0, 90oC at 120 min reaction and 10% consistency. The use of an extraction at pH 10.5 after the Z-stage is beneficial for chemical savings; in addition an extraction stage is advantageous for environmental reasons as the alkaline filtrate can be recirculated back to post oxygen washer. The strength properties of pulps bleached with the (aZe)DP (reference) and A/(aZe)DP sequences were similar but the sequence A/(aZe)(EP)P delivered slightly lower strength properties, particularly tear index.









## POSTERS

### 029 URUGUAY FORESTRY BUSINESS, MAIN REASONS TO EXPLAIN FAST DEVELOPMENT

*Tamosiunas, Martha*<sup>1</sup> \*; *Vassallo, Miguel*<sup>2</sup>

<sup>1</sup> Uruguay - <sup>1</sup> Ing. Agr. Mag. Gestión de Empresas Forestales - Departamento de Ciencias Sociales, Facultad de Agronomía, Universidad de la República. Garzón 780, CP 11200, Montevideo, Uruguay; <sup>2</sup> Ing. Agr. Miguel Vassallo Prof. de Economía Agraria y Desarrollo Rural Departamento CCSS, Facultad Agronomía

Uruguay has not native forests suitable for industrial use. The Uruguay forest industrial complex went into the global wood market, exclusively through industrial plantations, started in the 90 decade. With the State policy support, which involved tax exemptions and subsidies, more than 950 thousand hectares of industrial forest were registered to the 2010. And the exports went from US\$ 12 million in 1990 to close US\$ 500 million in the year 2010. Through the statistical information analysis and interviews to qualified persons was explored the importance of the following explanatory hypothesis about the causes of this development: 1. International market role (prices, inclusion of Uruguay, global changes) 2. The forest dynamics of neighbor countries (Brazil, Argentina) 3 Investment and technical change 4. Macroeconomic policies. The literature review was carried out between 2010 and 2012, the hypothesis were contrasted with the opinion of the sector concerning through 10 interviews carried out at the end of 2012. The result showed that, the main hypothesis that explains the dynamics are macroeconomic policies and the global market. The same conclusion was reached in the review of secondary information. The set of macroeconomic policies, are considered important by its direct effect and its time stability. The global financial crisis and the necessity of replacement of obsolete industrial assets in Europe, was an incentive to the establishment of forest investments in South America, especially in Uruguay between 2000 and 2010 the institutional and political frame contributed to the establishment here. The technical change was a consequence of the industrial investments establishment; as a result, the new plantations were focused in the compliance with the international standards requirements of harvest logistics systems and industrial supply. The Argentinean and Brazilian industrial forest dynamics were seen with little influential under the study term, but the qualified persons agreed with that the decision of investment in Uruguay involved the analysis of Brazil advantages.

### 031 EUCALYPTS CLONES CHEMICAL COMPOSITION REGARDING THEIR RESISTANCE TO WIND ACTION IN THE FIEL

*Natalino Oliveira, Flávia*<sup>1</sup> \*; *Coldette, Jorge Luiz*<sup>2</sup>; *J. B. Gomes, Fernando*<sup>1</sup>; *M. Barbosa, Bianca*<sup>1</sup>

<sup>1</sup> Brazil - <sup>1</sup> Universidade Federal de Viçosa (UFV) - Viçosa/Brazil; <sup>2</sup> Universidade Federal de Viçosa

This study aims to investigate a correlation between the wood chemical composition of eucalypt clones and their resistance to wind action. In this way, nine eucalypt hybrid clones from *Eucalyptus urophylla* x *Eucalyptus grandis* clones with different degrees of resistance to wind action (susceptible, intermediate, and tolerant) from two regions with different altitudes (high altitude and low altitude) were investigated, concerning their chemical composition (carbohydrates, acetyl groups, uronic acids, both acid soluble and insoluble lignin, syringyl/guaiacyl ratio, total extractives content, and ash). It was observed that the breaking susceptibility of trees studied for the wind action does not seem to be related to their wood chemical composition, although differences among clones were found.

### 030 EFFECT OF FERTILIZATION ON THE QUALITY OF THE EUCALYPTUS SP WOOD

*Barbosa, Bianca*<sup>1</sup> \*; *Coldette, Jorge Luiz*<sup>2</sup>; *Cabral, Carla*<sup>1</sup>; *Gomes, Fernando*<sup>3</sup>; *Souza, Gustavo*<sup>1</sup>

<sup>1</sup> Brazil - <sup>1</sup> Federal University of Viçosa Avenida Peter Henry Rolfs, s/n Campus Universitário 36570-000 VIÇOSA - MG - BRAZIL; <sup>2</sup> Universidade Federal de Viçosa; <sup>3</sup> Universidade Federal de Viçosa Viçosa - MG Brazil

This current paper has the objective of evaluating the effect of two levels of fertilization (NPK) on the chemical composition and on the basic density of the wood of clones from the *Eucalyptus* genre, assessing its possible consequences in the production of cellulosic pulp. Four clones were evaluated, two of those being of the *Eucalyptus grandis* species and the other two proceeding from hybrids of *Eucalyptus grandis* x *Eucalyptus urophylla*, at the age of 72 months. The assessed treatments were: with fertilization (without irrigation or being irrigated) and the Control treatment, with three repetitions, each treatment totalizing 36 samples. The analyzed chemical features were associated with the level of fertilization and the type of genetic material at stake. For the statistical analyses, the STATISTICA 7.0 software was used, where the analysis of variation was made and, in the case of significant interaction, there was decomposition through the Tukey test, at the level of 5% probability. There was significant difference for the following properties: basic density, manganese, syringyl/guaiacyl ratio (S/G) in lignin and acetyl group content. For the remaining analyzed properties such as carbohydrate content, total lignin, uronic acids, extractives, ashes, Fe, Ca and Mg, no statistical difference was noticed. Based on the results of this paper, fertilization from the quantitative viewpoint should be inadvisable on the plantings of the pulp and paper industries.

### 032 EUCALYPTUS WOOD CHIPS DRYING: A SIMPLE MODEL OF THE PROCESS

*Martínez Garreiro, Jorge*<sup>1</sup> \*

<sup>1</sup> Uruguay - <sup>1</sup> Dpto. de Operaciones Unitarias en Ing. Química y de Alimentos Instituto de Ingeniería Química-Facultad de Ingeniería Universidad de la República Montevideo-Uruguay

Due to the concerns of global warming and the worry of fossil fuel depletion, use of biomass as a renewable energy source is attracting more and more attention nowadays. The high moisture content of biomass reduces the combustion temperature causing incomplete combustion and undesirable reaction products. Most of the newest biomass power plants are integrated with drying facilities. While biomass with moisture levels of 55-65 wt% can sustain combustion, the optimum moisture contents are 10-15 wt%. For the case of wood chips, bed dryers are utilized as a good drying technique in several industrial applications. The technique has several advantages, especially when low temperature waste heat sources are employed. The objective of this study was to build a simple model of the process, based on the method of the number of mass transfer unit??Ts, a one-dimensional steady state model that could be used in prediction of drying time for different conditions of drying as well as different thick of the wood chips??Ts layer in the dryer. *Eucalyptus Grandis*??Ts wood chips obtained from a saw mill in northern Uruguay were used in drying assays, performed in a small batch through-circulation dryer. The main components of the equipment are a centrifugal fan, an electrical air heater and a cylindrical drying chamber. Homogenous airflow distribution in the drying chamber was obtained through a strainer plate that also functions as support of the layer of wood chips. The wood particle size distribution was evaluated through screening analysis of the dried material. Drying assays were done in pre-heated equipment, up to the experimental drying temperature (76-80??C). Sensors were employed for measuring and recording the temperature and air flow rate across the chips layer. Variations in weigh were used to determine the wood moisture decrease during drying time. Parameters of the drying model were determined by fitting with experimental data as well as the number of mass transfer units of the process. Relative errors between 0,6% and 2% were obtained in the model fitting, showing the kindness of this focusing of process analysis in this case.











**041 CALCIUM EFFECT ON THE KRAFT DELIGNIFICATION OF EUCALYPTUS SPP.**

*Fariña, Ismael<sup>1</sup> \*; Jansson, Ulla<sup>2</sup>; Cabrera, María Noel<sup>3</sup>; Doldán, Javier<sup>4</sup>*

<sup>1</sup> Uruguay - <sup>1</sup> Laboratorio Tecnológico del Uruguay, Departamento de Proyectos Forestales, Avenida Italia 6201 Montevideo; <sup>2</sup> Stora Enso Research Centre Karlstad SE-650 09 Karlstad; <sup>3</sup> Universidad de la República, Facultad de Ingeniería, Instituto de Ingeniería Química, Ingeniería de Procesos Forestales J. Herrera y Reissig 565 Montevideo; <sup>4</sup> Departamento de Proyectos Forestales LATU - Montevideo Av. Italia 6201

Previous studies indicate that in *Populus tremula* and *Betula pendula* the cooking process could be affected by calcium content. It is suggested that calcium ions decrease Kraft delignification rate by formation of calcium-lignin interaction, which lead to decrease solubility of lignin during the process. In the instance of *Eucalyptus globulus*, formation of different bindings between calcium and substances released from this species during Kraft cooking delignification is exposed as explanation for the absence or reduction of the calcium effect in this species. The *Eucalyptus* genus in Uruguay because of its high growth rate is presented as great soil nutrients demanding but considerable nutrient content variations exist between different eucalyptus species and also within the same species. Calcium is the nutrient most extracted by trees, but its amounts vary considerably depending on the part of tree, being found in very high concentrations in bark and significantly smaller in logs. This work studies the effect of calcium on the Kraft delignification of five *Eucalyptus dunnii*, four *Eucalyptus globulus* and three *Eucalyptus grandis* of different age, soil type and geographical uruguayan areas. Each sample is processed in three different combinations of effective alkali and H factor, keeping fixed others cooking conditions (maximum temperature, time to maximum temperature, load of dry wood, sulfidity and liquor to wood ratio). A leaching process is performed in some samples in order to compare the cooking behavior before and after extraction of calcium in wood. Important differences among species are founded in calcium wood content: *E. dunnii* presents higher values and a wider range than *E. globulus* and *E. grandis*. Also are found differences among species in the final distribution of calcium among pulp and black liquor. Regarding cooking behavior at constant conditions *E. dunnii* shows clearer results, where higher calcium wood content implies higher kappa number. These high calcium wood content *E. dunnii* Kraft cookings also show lower yield at constant kappa number.

**043 EFFECT OF KRAFT PULPING VARIABLES IN ECF BLEACHABILITY**

*Ventorim, Gustavo<sup>1</sup> \*; Comelato Favaro, Jaqueline<sup>2</sup>; Frigieri, Tania<sup>2</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Sao Paulo State University Itapeva Campus; <sup>2</sup> Sao Paulo State University

The evaluation of pulp bleachability has been extensively studied, but it has been analyzed time as it??Ts residual lignin, and time as it??Ts hexenuronic acid content. In this study, we analyzed kraft pulps subjected to oxygen delignification, cooked with different alkali charges and temperatures. After cooking, the pulps were characterized according to their residual lignin content, by the free phenolic groups content, using the periodate technique, the sirigil/guaiacyl ratio by nitrobenzene oxidation method and hexenuronic acid content. All pulps were oxygen delignified to the same conditions: 10% consistency, 95 °C, 60 minutes and alkali charge of 20 kg/t.o.d. and 18 kg/ t.o.d. of oxygen at 500 kPa. The temperature decrease reduces phenolic groups levels and the residual lignin sirigil/ guaiacyl ratio. Nonetheless, lower kraft cooking temperature resulted in a higher oxygen delignification. Lower alkali charge used in cooking increased pulp??Ts oxygen delignification and brightness. The different temperatures used in cooking did not influence oxygen delignification yield. The alkali charge decreasing in kraft cooking had minimum effect on oxygen delignification yield. The effect of hexenuronic acid concentration after oxygen delignification was higher than the residual lignin specimen present in eucalyptus kraft pulp.

**042 CHARACTERIZATION OF EUCALYPTUS UROGRANDIS URONIC ACIDS**

*Magaton, Andréia<sup>1</sup> \*; Coldette, Jorge Luiz<sup>2</sup>; Lopes, Onel<sup>3</sup>; Gomes, Fernando<sup>4</sup>*

<sup>1</sup> Brazil - <sup>1</sup> UFRB; <sup>2</sup> Universidade Federal de Viçosa; <sup>3</sup> UFV; <sup>4</sup> Universidade Federal de Viçosa Viçosa - MG Brazil

This paper aimed to identify the glucuronic acid, 4-O-methylglucuronic acid and galacturonic acid of the species of *Eucalyptus urograndis*. The acid methanolysis was used (2M HCl/MeOH) in wood meal sample, proceeded by silylation. After the sample was analyzed by gas chromatography-mass spectrometry (GC-MS). The used methodology allowed excellent separation, besides the identification of the wood uronic acids of the *Eucalyptus urograndis*. It was possible to observe that the *E. urograndis* presents the three uronic acids commonly found in hardwoods, and the 4-O-methylglucuronic acid appears to be the most important of them, since it is present in higher proportion than the others.

**044 IMPACT OF BIOLOGICAL TREATMENT AND SURFACTANT ADDITION ON CAPILLARITY OF EUCALYPTUS WOOD: EFFECT ON ALKALINE IMPREGNATION.**

*Inalbon, María C.<sup>1</sup> \*; Mocchiutti, Paulina; M. Demonte, Luciano; Zanuttini, Miguel A.; Montagna, Pablo N.*

<sup>1</sup> Argentina - <sup>1</sup> Instituto de Tecnología Celulósica, Facultad de Ingeniería Química, Universidad Nacional del Litoral, Argentina

The effect of biological treatment and the presence of a surfactant in alkali impregnation on the relative ion transport capacity of wood -the effective capillary cross sectional area (ECCSA) is shown. Capillarity is determined on basis of the analogy with the relation between the electrical conductivities of wood and liquid medium. When wood was biologically treated with three white rot fungi, the capillarity value in radial wood direction was clearly increased which can explain the advantages reported in the literature for biopulping and bioincising. On the other hand, the favorable effects of different surfactants in wood capillarity during alkali impregnation are also discussed. Surfactant clearly enhanced the increment that alkali treatment produces. Finally, alkali profiles in wood show the faster impregnation induced by surfactant.



**045 ON COOKING AND TCF BLEACHING OF DRY EUCALYPTUS CAMALDULENSIS CHIPS**

*Fiskari, Juha<sup>1</sup> \*; Vihela, Tuomas<sup>2</sup>; Ruuttunen, Kyosti<sup>2</sup>; Ali-Rekola, Ville<sup>2</sup>; Hautala, Sanna<sup>3</sup>; Sixta, Herbert<sup>2</sup>*

<sup>1</sup> Finland - <sup>1</sup> University of Helsinki Department of Chemistry P.O. Box 55 FIN-00014 University of Helsinki; <sup>2</sup> Department of Forest Products Technology School of Chemical Technology Aalto University FIN- 02015 Espoo; <sup>3</sup> Finnish Forest Research Institute (METLA) P.O. Box 18 FIN-01301 Vantaa

The objective of this research was to gain a better understanding of cooking and bleaching of *Eucalyptus camaldulensis* grown in arid and semi-arid regions of South Asia. Pulping of *E. camaldulensis* is known to be challenging due to its high lignin content. In addition, South Asian *E. camaldulensis* chips tend to have a very low moisture content which further complicates their cooking. In this study, dry chips obtained from a South Asian kraft pulp mill were first screened, after which they underwent a pressurized soaking treatment. The soaking treatment dissolved minor amounts of carbohydrates, extractives and lignin which were characterized. The soaked chips were then cooked to kappa number 18, oxygen delignified, chelated and bleached with hydrogen peroxide. Viscosities after cooking, oxygen delignification, and hydrogen peroxide bleaching were 830, 700, and 600ml/g, respectively. Relatively high active alkali charge in cooking resulted in the low viscosities. On the other hand, the residual alkali concentration was very low. In addition to having high lignin content, *E. camaldulensis* apparently contains other polyphenolic compounds in significant amounts which further consumed cooking chemicals. Apparently, these properties make the species less suitable for conventional batch cooking. Kappa number reduction in the oxygen delignification was 47.5%, which was in a relatively normal range. Bleaching with chelation and hydrogen peroxide stages yielded pulp with reasonable brightness for Totally Chlorine Free pulp, about 85.5% ISO.

**046 CHANGES IN XYLAN CONTENT TO EVALUATE ITS EFFECT ON PULP FOR TISSUE PAPER PRODUCTION**

*Gomes, Valéria<sup>1</sup> \*; Ribeiro, Adriana<sup>1</sup>; Longue Junior, Dalton<sup>2</sup>; Coldette, Jorge Luiz<sup>3</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Federal University of Viçosa - UFV; <sup>2</sup> Federal University of Viçosa; <sup>3</sup> Universidade Federal de Viçosa

Hemicelluloses are polysaccharides present in the cell wall and are associated with lignin and cellulose. In the manufacture of tissue paper, hemicelluloses has the great advantage of helping the liquids absorption, quality much appreciated in this type of paper. However, this same advantage can be detrimental to manufacture these papers, since the hemicelluloses hinder the drainage of water in dryer??Ts machine, severely reducing production speed. In addition, the hemicelluloses are capable of forming gels, which creates serious problems of blockages in the paper machine. Therefore the content of hemicelluloses must be carefully studied, so there is no loss in quality of liquids absorption and is not a source of problems in papermaking machines. Thus, the main objective of this work was to produce pulps with different amounts of xylans and after bleaching, assess their bleachability and potential for absorption of liquids by determining the water retention value (WRV). Samples of the unbleached pulp from *Eucalyptus urograndis* were treated with various NaOH charges, and a reference sample, which was not subjected to the treatment, thereby obtaining pulps with different xylan content. The pulps were then bleached by the sequence OD(EP)D. The amount of total active chlorine applied in the pulps decreases and the pulp bleachability is little affected with lower xylans content. The WRV values for the samples decreases with lower xylans content, indicating that with the removal of xylans, the pulp had its water retention capacity reduced. Therefore, the content of xylans has little influence on pulp bleachability, and the WRV decreased with the decrease in xylan content.

**047 GENERATIONS OF FINES IN EUCALYPTUS KRAFT PULP BLEACHING AND THEIR EFFECT ON PAPER PROPERTIES**

*Comelato Favaro, Jaqueline<sup>1</sup> \*; Ventorim, Gustavo<sup>2</sup>; Caraschi, José Cláudio<sup>2</sup>; Rodrigues dos Santos, Ivan<sup>3</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Doctoral Candidate M.Sc. in Mechanical Engineering Faculdade de Engenharia de Guaratinguetá UNESP - Univ Estadual Paulista Itapeva - Brazil; <sup>2</sup> Full Professor Campus Experimental de Itapeva UNESP - Univ Estadual Paulista Itapeva - Brazil; <sup>3</sup> Doctoral Candidate M.Sc. in Mechanical Engineering Faculdade de Engenharia de Guaratinguetá UNESP - Univ Estadual Paulista Itapeva - Brazil

The objective of this work was to evaluate the generation of fines by different bleaching reagents and its effect on physical and mechanical properties of eucalyptus kraft pulp. The pulp was bleached by four different sequences. Some of these samples was classified in Bauer-McNett equipment. The unclassified part of the pulp (global) was refined to 40 °SR in a laboratory PFI mill. The two major classified portions of each sample were also refined at the same revolutions as its global sample. Physical and mechanical tests were performed for both classified and unclassified samples, and their fibers were analyzed in FQA (Fiber Quality Analyzer), before and after refining. The greater amount of fines was observed for the refined pulp and the reference sequence. The tensile results were more significant for the global sample, classified pulps showed no difference between them being given the highest tensile strength to the presence of fines. The tear resistance was affected by the length of the fibers and not by the content of fines. The highest values of Klemm capillarity were for classified pulps due to its fines absence and presence of longer fibers.

**048 GRINDING OF A PFI MILL: A COMPARISON BETWEEN TWO PFI MILLS BY EVALUATION OF EUCALYPTUS PULP PHYSICAL PROPERTIES**

*Bonfiglio, Fernando<sup>1</sup> \*; Curbelo, Viviana<sup>1</sup>; Santana, Eloísa<sup>1</sup>; Doldán, Javier<sup>2</sup>*

<sup>1</sup> Uruguay - <sup>1</sup> Departamento de Proyectos Forestales Laboratorio Tecnológico del Uruguay Unidad Tecnológica Fray Bentos Parque Industrial, Barrio Anglo Fray Bentos; <sup>2</sup> Departamento de Proyectos Forestales LATU - Montevideo Av. Italia 6201

The traditional methods for cellulose pulp evaluation require a transformation into laboratory hand sheets in conjunction with drainability tests. In this evaluation, as a previous step, the pulp undergoes a treatment of the fibers by a laboratory refining procedure, which simulates the process made at paper mills. The PFI mill method is still the most used in laboratories, as it provides a uniform treatment of pulp giving more homogeneity in the refined fibers and uses a small quantity of sample. The PFI mill traditionally used in the Forest Projects Department of the Technological Laboratory of Uruguay (LATU) provides robustness and confidence along with control charts and historical data already well established. This confidence is based on inter and extra reference analysis. Recently, our laboratory has acquired a new PFI mill. The objective of this study was to achieve a similar beating effect of the new PFI mill as the effect of the one habitually used, in order to have interchangeable mills. The adjustments were made over the new mill by using mixtures of silicon carbide powder. To evaluate the beating effect a reference Eucalyptus pulp was refined. After each adjustment a refining was made and the Canadian Standard Freeness (CSF) measured. When the CSF reached the approximate desired value, hand sheets were made to determine the physical properties. Finally, when the results were comparable to those of the long-established mill, several refinings were made to evaluate their stability. The results proved that both mills were equivalent, thus concluding that the grinding procedure was successful allowing an optimized indistinct use of them.





**049 HEMICELLOSES EXTRACTION FROM AGAVE SISALANA AND HYBRID 11648**

*Magaton, Andréia<sup>1</sup> \*; Cunha, Camila<sup>1</sup>; Peixoto, Magaly<sup>1</sup>; Queiroz, Thaís<sup>1</sup>; Gomes, Léa<sup>1</sup>*

<sup>1</sup> Brazil - <sup>1</sup> UFRB

Despite the importance of sisal to the Brazil, is not found in the literature of chemistry detailed information of the three main constituents of fiber, cellulose, hemicelluloses and lignin. Among these compounds, the hemicelluloses is the most studied, due to the variety of industrial applications. Within this context, the present work aims at the appreciation of sisal fibers, from its full chemical characterization and isolation and detailed study of the chemistry of hemicelluloses. The hemicelluloses were isolated from sisal fibers by extracting with KOH 10%. Carbohydrate analysis indicated that the xylans are the main sisal fibres hemicelluloses and the second most abundant polysaccharide after cellulose. With development of this work, it was possible to define the chemical composition of the fibers of Agave sisalana hybrid 11648 and verify that have very similar compositions. With respect to the structure of xylans, the molar proportion of 4-O-methylglucuronics acids and xyloses, determined by 1H NMR, was 1.70: 10 and 3.40: 10 to the 4-O-methylglucuronoxylans isolated from Agave sisalana and and hybrid sisal, respectively. In relation to the composition of neutral monosaccharides, the xylans of both samples showed the presence of monosaccharides galactose, arabinose and glucose. The weight average molar mass of 4-O-methylglucuronoxylans was 36093 g. mol<sup>-1</sup> for the 4-O-methylglucuronoxylans from Agave sisalana and 36557 g. mol<sup>-1</sup> for the fibers of hybrid sisal.

---

---

---

---

---

---

---

---

**051 INFLUENCE OF WOOD FIBER LENGTH IN THE RING CRUSH TEST (RCT) OF KRAFT PACKAGING PAPER**

*Machado, Fernanda Marcondes<sup>1</sup> \*; Machado, Carla Goncalves<sup>2</sup>; Resene, Francine Carla Rodrigues Capelli<sup>1</sup>; Comelato, Jaqueline<sup>3</sup>; Santos, Rafael<sup>3</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Orsa International Paper Embalagens S/A; <sup>2</sup> PUCPR - Pontif?cia Universidade Católica; <sup>3</sup> Unesp - Universidade Estadual Paulista

In paper and packaging manufacturing business, the final product characteristics became constant worries, thus encouraging studies directed to physical, mechanical and chemical properties of wood and the paper provided. One concern related to this worries is the RCT test (Ring Crush Test), which comprises assessments of perpendicular compression to the fibers both for paper and packaging. This article examines the influence of wood fiber length of Pinus taeda and P. elliotti and the influence of inserting Eucalyptus, turning it into a ???mix???, on the paper RCT development. The results show that fiber length impacts the RCT kraft paper, as well the percentage of fines generated in process and, most significantly, the inclusion of hardwood (Eucalyptus) in wood mix during kraft cooking. Good RCT results deliver competitive advantage to the company, as well ensures an improvement in standardization and monitorization on the production process.

---

---

---

---

---

---

---

---

**050 INFLUENCE OF WATER CONDUCTIVITY ON THE DRAINABILITY OF EUCALYPTUS BLEACHED KRAFT PULP**

*Bonfiglio, Fernando<sup>1</sup> \*; Curbelo, Viviana<sup>1</sup>; Santana, Eloísa<sup>1</sup>; Doldán, Javier<sup>2</sup>*

<sup>1</sup> Uruguay - <sup>1</sup> Departamento de Proyectos Forestales Laboratorio Tecnológico del Uruguay Unidad Tecnológica Fray Bentos Parque Industrial, Barrio Anglo Fray Bentos; <sup>2</sup> Departamento de Proyectos Forestales LATU - Montevideo Av. Italia 6201

The drainage capacity of cellulose pulps is an indicator of the surface conditions of the fibers, as well a measurable efficiency index of a refining process. The drainability depends on the refining process and the water quality. Temperature, pH and conductivity of water influence the drainability by affecting fiber and fines swelling; bleached chemical pulps are more sensitive to these variations. According to ISO 5267-2, the Canadian Standard Freeness (CSF) method provides a measure of the rate at which an aqueous suspension of pulp may be drained using deionized water, in a similar manner to the determination of the Schopper-Riegler grade (SR°). As different studies show, the variation in freeness of pulps is higher at conductivities near to zero than at higher conductivities. The objective of this study was to verify this behavior in Uruguayan pulps and to establish the conductivity values where the freeness stabilizes. This work examines the performance of the CSF and the SR° while the conductivity of a dilute suspension of pulp varies. The sample used is a Eucalyptus reference pulp, which is a Kraft bleached pulp. The conductivity was changed by adding different amounts of Magnesium Sulfate to deionized water in the suspensions. As expected, the results show a remarkable increase on the drainability values while the conductivity rises until a maximum value where it remains almost constant, despite the uprising in the conductivity. This study may be indicating the convenience of a modified CSF and SR method with high water conductivity where the variations are minimized.

---

---

---

---

---

---

---

---

**052 LO-SOLIDS SODA PULPING OF EUCALYPTUS WITH ADDITIVES**

*Almeida, Diego<sup>1</sup> \*; Gomide, José Livio<sup>1</sup>; Faria, Bruno<sup>1</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Universidade Federal de Viçosa

The Kraft pulping process purpose is the individualization of cellulosic fibers and removal of lignin by white liquor, that the main components are sodium hydroxide and sodium sulfide. This process based especially on the hydroxyl group (OH-) and hydrosulfide ion (HS-) action. The OH- is implicated on degradation of lignin and also aggressive to carbohydrates, while the HS- ion, derived from the sodium sulfide hydrolysis, is selective for lignin. Additives such as surfactants and anthraquinones (AQ) can be used to improve the Soda pulping and compensate the lack of hydrosulfide ion. The Soda process is an alternative for pulp production without sulfur compounds, which cause odorless pollution and increase the black liquor recovery system costs. This study has made a comparison between Soda control pulp, Soda pulp with additives (AQ, Surfac. and AQ+ Surfac.) and Kraft control pulp. Anthraquinone allowed higher pulping yield to Soda process than Kraft control pulping, however increased the rejects content for the same kappa number. Anthraquinone mixtures of surfactant (AQ-S and AQ-S 2) added to Soda pulping also got higher yield than Kraft control pulp. However, the surfactant did not produce good results for yield as AQ, but kept low the shive content. AQ decrease the alkali charge and residual for Soda pulping, especially for mixtures AQ-S and AQ-S 2. No additive tested has got better viscosity results than Kraft control pulp.

---

---

---

---

---

---

---

---



**053 OFFICE PAPER RECYCLABILITY: FIBROUS CHARACTERISTICS**

*Benitez, Julieta B.<sup>1</sup>\*; Koga, Mariza E.T.<sup>2</sup>; Otero de Almeida., Maria L.<sup>2</sup>; Felissia, Fernando E.<sup>3</sup>; Area, María Cristina<sup>1</sup>*

<sup>1</sup> Argentina - <sup>1</sup> Programa de Celulosa y Papel - Instituto de Materiales de Misiones (CONICET-UNaM). Facultad de Ciencias Exactas Químicas y Naturales, Félix de Azara 1552 (3300) Posadas, Misiones, Argentina; <sup>2</sup> Instituto de Pesquisas Tecnológicas de São Paulo (IPT). Brasil; <sup>3</sup> Programa de Celulosa y Papel - Instituto de Materiales de Misiones (CONICET-UNaM). Facultad de Ciencias Exactas Químicas y Naturales, Félix de Azara 1552 (3300) Posadas, Misiones, Argentina

Recyclability is the ability of a material to reacquire the same properties it had originally. The aim of this work was to verify the recyclability of three printing and writing papers, from the characteristics of their fibers after two recycles. Three ECF bleached kraft eucalyptus bond commercial papers from Argentina and Brazil were studied (A, B, C). The papers were repulped and refined using different levels and intensities of energy (1st recycle). Laboratory sheets were produced, and they were repulped and refined again (2nd recycle). The microscopic characteristics of repulped papers were obtained by automatic equipment based on image analysis. Differences found in the behavior of the different samples can be explained by fiber parameters. The fiber length was significantly different in the three papers (A > B > C) and globally decreased in the second recycle (about 6%). Sample A had the highest initial fiber length and length/width, but it largely decreased with refining conditions in the 1st recycle (length fall 12%, generating fines by cutting), whereas it fall 9% between the 1st and 2nd recycles, and nothing with refining conditions in the 2nd recycle. Sample B fall by 5% with refining conditions in the 1st recycle, and 9% between the 1st and the 2nd recycle, but suffered few alteration in the second recycle. Fiber length of sample C was unaffected by refining conditions and only decreased 9% between the 1st and 2nd recycles. In all cases, the generated fines increased lightly with refining in the first recycle, but were two-fold higher in the second recycle than in the first one. The fiber coarseness of the 3 samples was similar in the first recycle, but decreases significantly in the 2nd recycle.

**055 EVALUATION OF ENZYMATIC TREATMENT ON PHYSICAL AND MECHANICAL PROPERTIES OF PAPERS**

*da Silva, Juliana<sup>1</sup>\*; Chaves de Oliveira, Rubens<sup>1</sup>; Amorim, Allan<sup>1</sup>; Cunha, Vanessa<sup>1</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Universidade Federal de Viçosa

This work was developed in order to analyze the development potential of the properties of bleached kraft eucalyptus pulp, by enzymatic treatment in joint operation with refining. Also check the behavior of the pulp submitted to three enzymes different and analyzes the dosage that provides greater increases the mechanical strength of the papers with respect to the reference. Three different enzymes were applied at the doses of 0, 0.15, 0.30 and 0.45 kg / ton, under conditions of pH 7.5 - 7.8, temperature of 45 ° C, pulp consistency of 4 %, for 2 hours. Subsequently, handsheets were formed and tested their physical and mechanical properties. In general, the enzymatic treatment prior to refining afforded increments with respect to the mechanical strength of the pulp as compared to the reference. This positive trend indicates of the use potential of enzymes prior to refining providing increase in quality of papers from bleached kraft pulp eucalyptus. The increases observed from the treatments permit to refine a constant level (keeping the consumption of energy applied), and thus gain in terms of physical and mechanical resistances of the paper or remain constant the paper specifications, leading to reduction of energy required to refining.

**054 SENSITIVITY ANALYSIS BY ARTIFICIAL NEURAL NETWORK (ANN) OF VARIABLES THAT INFLUENCE TWIST IN A PAPER BOARD INDUSTRIAL MACHINE**

*Schneid, Guinter<sup>1</sup>\*; Oliveira, Rubens<sup>2</sup>; Vieira, Osvaldo<sup>3</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Master degree student in Forestry Science at Universidade Federal de Viçosa/Brazil and Development Process Engineer at Klabin Monte Alegre/Brazil; <sup>2</sup> Ph.D and head researcher of technology and properties of paper at Universidade federal de Viçosa/Brazil; <sup>3</sup> Research and development coordinator at Klabin Monte Alegre/Brazil

The dimensional stability of the sheet may change due to humidity variation, releasing the stress latent acquired in the manufacturing process. One result of this release tension is named diagonal curl. This study aims to make a Principal Components Analysis (PCA) of different input variables of an industrial paper machine, along with couple of laboratory measurements, with the paper property called diagonal curl, or twist. We conducted a data collection of the historical referent to past year to observe the products with greatest losses. From this, correlated with the critical points of measurement profile along cross machine direction.

**056 EVALUATION OF THE APPLICATION MOMENT ENDOGLUCANASE AND XYLANASE IN DEVELOPMENT OF PAPER PROPERTIES**

*Neto, Armando<sup>1</sup>\*; Silva, Juliana<sup>1</sup>; Oliveira, Rubens<sup>1</sup>; Pimentel, Vanessa<sup>1</sup>; Amorim, Allan<sup>1</sup>; Ventorim, Priscila<sup>1</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Universidade Federal de Viçosa

The objective of this study was to evaluate the potential development of the properties of papers through enzymatic treatment, and also optimization the moment of application of these enzymes with respect to refining. The use of enzymes in conjunction with the refining operation is based on the occurrence of biochemical reactions promoting changes in the fiber structure, reducing the need for exposure of the fiber to mechanical refiner and consequently reducing the power consumed during this operation. Bleached eucalyptus pulp was submitted to four different dosages of enzymes applied before and after refining, and subjected to different intensities of refining. The same procedure was performed without the enzyme dosage, for comparison effect (Reference). The enzyme used in different dosages resulted in values for mechanical strength higher than the reference pulps, and in general, the enzymatic treatment after refining resulted in higher values for the mechanical strength of paper compared to the enzymatic treatment prior to refining. This positive trend indicates the used potential of the enzymes treatment, especially after the operation of refining, for gains in papermaking quality of pulps, making viable their utilization technical and economical as source of raw material for the paper industry.





**057 RESIDUAL LIGNOCELLULOSIC BIOMAS AND KRAFT LIGNIN FROM *E. GRANDIS* AS A GOOD MATERIAL TO OBTAIN MODIFIED PHENOLS AND APLICATIONS.**

*Lopretti Correa, Mary Isabel<sup>1</sup>\**

<sup>1</sup> Uruguay - <sup>1</sup> Laboratorio Tecnológico del Uruguay, LATU. Montevideo, Uruguay

The inclusion of lignocellulosic biomass into different materials such as printing inks, paints and polyurethanes, depends on the modification in the lignin structure. In the present work we studied the kinetic of modification of lignin in solid fermentation with 14C Ligno-cellulose, and two different samples, kraft lignin, and lignocellulosic materials from *E. grandis*. The objective of this work is to obtain modified phenols and polyphenols to use in polyurethanes. Two different processes to obtain phenols were done. Enzymatic modifications for the kraft lignins and solid fermentation to modify ligno-cellulosic materials. The enzymatic treatment was done during 72 h. at 37°C in agitation conditions. The enzymes utilized were obtained before from *L. edodes* and *G. trabeum*. The enzymatic extracts were formed by Lig-peroxidase 10UE/ml; Lacase 10UE/ml and Demethylation activity 10UE/ml. The solid fermentation process was done during 60 days at environmental conditions of temperature. The ligno-cellulosic materials were inoculated with *L. edodes* culture 5% w/w and *G. trabeum* culture 5% w/w. The humidity was 70% and was necessary to remove the materials every 5 days to incorporate oxygen. In both cases we recovered the modified phenols and the molecular weight was determined. We believed that this work showed a good approach in the standardized productions of modified phenols to be used in different macromolecular formulations. Same applications were done in co-polyurethanes with good characteristics. In the future we study the production of these polymers and different applications

Keywords : Depolymerization, phenols, lignocellulose, phenol.

**058 CHARACTERIZATION OF SULPHUR FREE LIGNIN OBTAINED UNDER MILD COOKING CONDITIONS**

*Noya, Carolina<sup>1</sup>\*; Tuominen, Kari<sup>2</sup>; Vuorinen, Tapani<sup>3</sup>*

<sup>1</sup> Uruguay - <sup>1</sup> Facultad de Ingeniería, Universidad de la República, Montevideo, Uruguay; <sup>2</sup> Andritz OY, Helsinki, Finland; <sup>3</sup> Aalto University, Department of Forest Products Technology, Espoo, Finland.

Lignin is a phenolic polymeric material, which is likely to be suitable for several uses based mostly on its chemical characteristics such as aromatic structures and reactive sites. Additionally, its availability as a byproduct of the widespread chemical pulp industry and its character of renewable resource place it on the spotlight as a possible starting point for the materials industry, considering primarily high added value products. Absence of sulphur in the lignin is almost a must for a major part of the high added value lignin uses. Consequently, it is compulsory to find and optimize sulphur free cooking processes and characterize the lignin obtained in order to achieve a starting material with optimum characteristics and high potential. The present work focuses on obtaining and characterizing lignin from mild NaOH and NaOH/Anthraquinone(AQ) cookings. Liquors samples were extracted at early cooking stages of two different temperature profiles. Dissolved lignin was isolated from the spent pulping liquors through acid precipitation using hydrochloric acid in order to avoid sulphur addition. Lignin originated in modern softwood and hardwood kraft pulp mills were also isolated with the same method and used as reference. The lignin sludge obtained was characterized with different techniques. Lignin extraction efficiency, phenolic hydroxyl and methoxyl content, lignin and carbohydrate content as well as molecular weight distribution (MWD) and glass transition temperatures (T<sub>g</sub>) were determined. Considering the results obtained in the whole isolation process applied, it is possible to claim that AQ addition, higher H-factors and longer cooking times result in higher lignin content in the precipitate, higher phenolic-hydroxyl and higher methoxyl content as well as narrower MWD. In order to achieve a good compromise between reactivity, yield and purity, even with the negative effect in lignin reactivity of the increasing methoxyl content with cooking time, higher H-factors and AQ addition are the conditions with the most promising results for lignin isolation from sulphur free pulping liquors based on a higher lignin content in the precipitate and the increment of the other properties also related with reactivity.

**059 COLD ALKALINE EXTRACTION APPLIED IN BIOMASSES.**

*Carvalho, Danila<sup>1</sup>\*; Coldette, Jorge Luiz<sup>2</sup>; Zanúncio, Antonio<sup>1</sup>; Lino, José Mauricio*

<sup>1</sup> Brazil - <sup>1</sup> Ph.D candidate, Federal University of Viçosa; <sup>2</sup> Universidade Federal de Viçosa

Eucalypt, sugarcane bagasse, and sugarcane straw could potentially be used for pulp and other bio-products. They present a great amount of hemicelluloses in its composition and studies that evaluate alternatives of hemicelluloses extraction are desirable. The main goal of this study was to investigate the cold alkaline extraction process for eucalypt, sugarcane bagasse, and sugarcane straw aiming at hemicellulose extraction optimizing, especially xylose extraction. A central composite factorial design was employed to examine the influence of the independent extraction variables: temperature (20, 30, and 40°C), reaction time (10, 35, and 60 min), and NaOH change (70, 90, and 110g/L). The optimum cold alkaline condition to achieve more xylose extraction to eucalypt was 40°C, 60 min, and 70 g/L NaOH change. Under this condition the solid yield and the xylose retention in the solid were 95.48 and 66.97%, respectively. The potential extraction of xylose was of 33.03%. For the sugarcane bagasse, the optimum condition was 33°C, 60 min, and 110 g/L NaOH change. Under this condition the solid yield and the xylose retention in the solid were 71.92 and 52.52%, respectively. The potential extraction of xylose was of 47.48%. For the sugarcane straw, the optimum condition was 31°C, 55 min, and 110 g/L NaOH change. Under this condition the solid yield and the xylose retention in the solid were 62.32 and 37.46%, respectively. The potential extraction of xylose was of 62.54%. Sugarcane straw was more adequate for cold alkaline extraction than the eucalypt and sugarcane bagasse, with the highest potential of xylose extractions.

**060 EFFECT OF EUCALYPTUS GLOBULUS HEMICELLULOSE AS AN INTERNAL PLASTICIZER OF CELLULOSE ACETATE.**

*Reyes, Herna<sup>1</sup>\*; Peredo, Karo<sup>2</sup>; Berg, Alex<sup>2</sup>; Pereira, Miguel<sup>3</sup>*

<sup>1</sup> Chile - <sup>1</sup> Laboratorio de Productos Forestales, Departamento de Ingeniería Química, Universidad de Concepción; <sup>2</sup> Unidad de Desarrollo Tecnológico, Universidad de Concepción; <sup>3</sup> Laboratorio de Productos Forestales, Departamento de Ingeniería Química, Facultad de Ingeniería, Universidad de Concepción.

In the production of cellulose acetate from wood (dissolving pulp), both the lignin and hemicellulose are considered impurities. However, in recent years efforts have been made to obtain bioplastics from low-grade dissolving pulp, in order to expand the use of renewable lignocellulosic sources, where the presence of hemicellulose and lignin can provide other properties to the product (Rowell et al. 1994; Shaikh et al. 2009; Fundador et al. 2012; Loo et al. 2012). This study is aimed to determine the effect of the hemicellulose content on the acetylation process of cellulose pulp and thermal properties of the resulting material. To achieve this objective, xylan was extracted from *Eucalyptus globulus* holocellulose, which was incorporated to cotton in different percentages (0% to 30%). Those model compounds were prepared by mixtures of cellulose and hemicellulose were acetylated using acetic anhydride, acetic acid as solvent and sulfuric acid as catalyst (Sato et al. 2003). Acetates were characterized by yield, degree of substitution, solubility in chloroform, Fourier transform infrared spectroscopy, thermogravimetric analysis and differential scanning calorimetry. The results obtained confirm that the presence of hemicellulose does not influence the process of acetylation of cellulose. The experimental degree of substitution agrees with the theoretical degree of substitution, decreasing from 2.98 (pure cellulose) to 2.73 (30% hemicelluloses). The melting temperature of the acetate decreases from 268 °C to 213 °C, for the cotton sample and the sample with 30% of hemicellulose respectively. This result suggests that the content of hemicellulose would act similarly to a plasticizer. The results obtained with model compounds were compared with acetylated samples of bleached kraft pulp (PKBE) and holocellulose from *Eucalyptus globulus* (24 and 30% hemicelluloses, respectively). PKBE and holocellulose acetates exhibit a degree of substitution in accordance to what was found with the model compounds (2.85 and 2.76). On the contrary, the melting temperature was higher for PKBE acetates and holocellulose, 234 °C and 223 °C, respectively.



## 061 EFFECT OF INITIAL CONTENT OF LIGNIN ON THE EXTRACTION OF XYLANS FROM EUCALYPTUS GLOBULUS.

Hormazabal, Sujey<sup>1</sup>\*; Peredo, Karol<sup>2</sup>; Pereira, Miguel<sup>1</sup>; Zaror, Claudio<sup>3</sup>

<sup>1</sup> Chile - <sup>1</sup> Laboratorio de Productos Forestales. Departamento de Ingeniería Química. Facultad de Ingeniería. Universidad de Concepción.; <sup>2</sup> Laboratorio de Productos Forestales. Departamento de Ingeniería Química. Facultad de Ingeniería. Universidad de Concepción.; <sup>3</sup> Faculty of Engineering, Universidad de Concepción, Concepción-Chile

The present investigation examines the effect of the lignin content on the process of hemicelluloses extraction from *Eucalyptus globulus* wood. Wood with different lignin contents were obtained by selective delignification with sodium chlorite and acetic acid. During the delignification time variation was 0, 10, 30, 60, 90 and 120 minutes. The extractions were performed with solutions of KOH 5% (56% odw) and hemicelluloses were separated by precipitation with 1M HCl and methanol. We determined the extraction yield and the hemicelluloses characterization by total sugar analysis (HPLC-IR), molecular weight distribution by gel permeation chromatography (GPC), FT-IR analysis and scanning electron microscopy (SEM). The purity of the hemicelluloses varied according to the content of residual lignin in the wood in the same manner that the yield. These differences are also reflected in the molecular size of the obtained xylans and morphology of the films formed. The extraction yield of hemicelluloses varied from 34.6% to 96.7% (odw) with an initial content of 26.04% and 5.85% lignin, respectively. In a similar behavior, hemicelluloses purity increased from 88.44% to 97.39%. The average molecular weight of hemicelluloses decays from 50 (kDa) (Hemicelluloses obtained from raw wood) to 36 (kDa) (Hemicelluloses obtained from delignify wood with lower lignin content (5.85%)). The differences can be explained in part by the contribution of the residual lignin linked to carbohydrates and also due a deterioration of residual hemicelluloses because a most extensive delignification chemical treatment. The initial content of lignin in the wood affects not only the extraction yield but also the purity and molecular size of the hemicelluloses extracted. By forming films by casting was observed that those formed with a residual content of 4% lignin has a more homogeneous aspect (corroborated by SEM) than those formed with a high content of lignin or lignin containing lower than 4%. These results suggest that a small percentage of residual lignin in the hemicellulose could promote the plastic behavior and film forming properties of the extracted hemicelluloses.

## 063 ETHANOL PRECIPITATION MATERIAL CHARACTERIZATION FROM ALKALINE EXTRACTION PRIOR KRAFT COOKING

Longue Junior, Dalton<sup>1</sup>\*; Ayoub, Ali<sup>2</sup>; Jameel, Hasan<sup>2</sup>; Venditti, Richard<sup>2</sup>; Colodette, Jorge<sup>3</sup>; Chang, Hou Min<sup>2</sup>

<sup>1</sup> Brazil - <sup>1</sup> Federal University of Viçosa; <sup>2</sup> North Carolina State University; <sup>3</sup> Laboratório de Celulose e Papel - DEF Universidade Federal de Viçosa

Hemicellulose material is an abundant and relatively under-utilized hetero-polysaccharides material present in lignocellulosic materials. In this research, an alkaline treatment was applied to Sweetgum (*Liquidambar styraciflua*) and *Eucalyptus globulus* laboratorial chips in order to extract hemicelluloses to subsequently evaluate the final product and process. An extraction at 100°C during 1 hour, 10:1 water:liquor ratio, and 10% and 50% sodium hydroxide (NaOH) loads. Liquors with hemicelluloses were mixture to ethanol (1:1) at room temperature and the ethanol precipitation hetero-polysaccharide material (EPM) was precipitated and dried to be evaluated as thermal properties (Thermogravimetric Analysis ??) TGA and Differential Scanning Calorimeter ??) DSC) as well as molecular weight (Gel Permeation Chromatography - GPC) and chemical groups present in the compounds (FTIR ??) Infra-red Spectroscopic). The EPM recovered were 0.3/1.6% (eucalyptus 10/50%) and 1.1/4.3% (sweetgum 10/50%) of the biomass as a predominantly hemicellulose material with a number average degree of polymerization around 256/228 and 250/110 determined by GPC. The hemicelluloses extracted using low concentration of NaOH showed better thermal stability for both woods, however hemicelluloses from sweetgum showed higher stability than eucalyptus in that conditions. The temperature at which 10% weight loss determined for a 10°C/min heating ramp increased from 192°C to 245°C for eucalyptus at 10% and 50% NaOH, respectively. The temperature at which a 40% weight loss is observed for xylan provided by sigma (as reference) and sweetgum hemicellulose extracted by 10% NaOH occurred at 279°C and 310°C, respectively. The DSC results showed that the transition temperature for all materials was around 137°C with low variation among samples. FTIR spectroscopic analysis showed that the absorption characteristics are similar to the commercial xylans. The results obtained indicate a promising combination between the effective extraction of hemicellulose from wood and a distillation process which looks a very attractive alternative to recovery liquor and ethanol after hemicellulose precipitation. The results have showed a promising materials with high degree of polymerization for use in various industrial applications.

## 062 ETHANOL CELLULOSIC PRODUCTION: CHALLENGES AND PERSPECTIVES

Santos, Fernando<sup>1</sup>\*; Gomes, Fernando<sup>1</sup>; Coloette, Jorge<sup>1</sup>; Queiroz, José Humberto<sup>1</sup>; Batalha, Larisse A. R.<sup>2</sup>

<sup>1</sup> Brazil - <sup>1</sup> Universidade Federal de Viçosa Viçosa - MG Brazil; <sup>2</sup> Federal University of Viçosa, Viçosa-MG

Currently, the biorefinery concept has attracted a society interest, which aims a more sustainable and rational use of the natural resources for obtaining different products, such as biofuels and bioproducts. Since that the use of renewable sources for energy production are required for world sustainable development in the near future, and decreasing our dependency on fossil fuel reserves and boosting rural development are important goals of modern society. Thereby, biorefineries seems as a very promising route to meeting our aims for sustained prosperity and preserving the environment. Plant biomass is the main source of renewable materials in Earth and represents a potential source of renewable energy. In this context, the eucalypt wood appears as an interesting raw material for biorefinery application, especially in South America. For example, the average productivity of Brazilian eucalypt forests increased from 24 m<sup>3</sup>/ha/yr in 1980 to 41 m<sup>3</sup>/ha/yr in 2012, representing a 71% increase in productivity of planted forests in Brazil. However, in order for this technology to be feasible some challenges must be overcome, including establishment of appropriate conditions of pretreatment and hydrolysis of the lignocellulosic materials for fermentable sugar release. In this way, this paper aims to disseminate the state of the art of cellulosic ethanol production through a literature review. The main findings of this paper were: (1) the key technologies for the ethanol production from wood require pretreatment processes, being necessary to modify or remove the lignin and hemicellulose, increasing the surface area and decrease crystallinity and polymerization degree of cellulose; followed by hydrolysis treatments to release the sugars from cellulose and hemicellulose; and finally converting wood sugars (in monomers) to ethanol via fermentation and distillation; (2) eucalyptus wood present a hexose and pentose content of 18% and 48%, respectively, being possible to obtain 300 liters of ethanol (220 liters from hexose, and 80 liters from pentose); (3) the development of new technologies for using the energy eucalyptus wood potential are important and should be considered by the forest sector to attend a demand of the society by an industrial production more right concerning environmental, economic and social responsibilities.

## 064 EUCALYPTUS GRANDIS WASTES AS AN ATTRACTIVE RAW MATERIAL FOR BIOETHANOL PRODUCTION

Ramírez, María Belén<sup>1</sup>\*; Vázquez, Sylvia<sup>1</sup>; Buxedas, Luciana<sup>1</sup>; Bonifaccino, Silvana<sup>1</sup>; Lopez, Ana<sup>2</sup>; Lopretti, Mary<sup>3</sup>

<sup>1</sup> Uruguay - <sup>1</sup> Universidad de la República, Facultad de Ciencias, CIN, Laboratorio de Bioquímica y Biotecnología, Montevideo.; <sup>2</sup> Laboratorio de Bioprocesos y Biotecnología, Laboratorio Tecnológico del Uruguay.; <sup>3</sup> Laboratorio Tecnológico del Uruguay. Departamento de Proyectos Forestales. Avenida Italia 6201 Montevideo

The recently setting up of cellulose paste production industries in our country has considerably enhanced the *Eucalyptus grandis* waste production, capable to be used as biomass for biofuels production. In this way, wood has to be pretreated and saccharified before it is fermented. The aim of the present study is to evaluate the possibility of carry out simultaneous saccharification and fermentation (SFS) of the lignocellulosic substrate, avoiding with this strategy the enzyme inhibition by its hydrolysis products, minimizing the sugar concentration at which the fermenting yeast will be subjected, and decreasing reactor usage time and so the operating costs. It was carried out with two *Saccharomyces cerevisiae* strains, *S. cerevisiae* M522 (ATCC) and a mutated thermo tolerant *S. cerevisiae* obtained by gamma irradiation called SacSV-10. SFS were carried out in 500 mL flasks with 10 g/L of delignified eucalyptus sawdust (dry weight) and 1% w/v of Samsung cellulase. Yeasts were inoculated at 10% v/v after 48 h of saccharification. Fermentations were followed during 5 days, sugar concentration was evaluated by DNS technique, yeast biomass was counted in YPD plates, and the ethanol concentration was determined spectrophotometrically by potassium dichromate technique. Ethanol concentrations were 0.23 and 0.24% v/v with reaction yields of 71.5% and 73.6% for M522 and SacSV-10 respectively. Exponential phase end occurred close to 60 h of SFS. Cellulase enzyme worked adequately at 40°C. According to this results, SFS allow in a considerably way to enhance up to 50% the fermented sugar. Yeasts used in this study did not suffer any kind of inhibition by phenols present in the culture media. Future efforts have to be focused to reach out enhancing the wood concentration used with the aim to improve the bioprocess profitability.



**065 EVALUATION OF AN AUTOHYDROLYSIS PRETREATMENT FOLLOWED BY ENZYMATIC HYDROLYSIS OF EUCALYPTUS GLOBULUS WITH DIFFERENT CELLULOSE AND LIGNIN CONTENT**

*Araya Carvajal, Fabio<sup>1</sup> \*; Freer Calderón, Juanita<sup>1</sup>; Teixeira, Regis<sup>2</sup>*

<sup>1</sup> Chile - <sup>1</sup> Facultad de Ciencias Químicas, Universidad de Concepción, Concepción, Chile. Centro de Biotecnología, Universidad de Concepción, Concepción, Chile.; <sup>2</sup> Universidad de Concepción

Eucalyptus globulus wood chips with different cellulose and lignin content (49% - 52% of cellulose and 25% - 28% of lignin, respectively) were subjected to autohydrolysis pretreatment at 175° C and two different residence times (30 and 60 min). The pretreated materials were also subjected to an alkaline extraction (2% of NaOH in dry pulp basis, 40°C for 14 h) to remove lixiviable lignin. The pretreated materials obtained were enzymatically hydrolyzed at a substrate loading of 10% (w/v) using a cellulase enzyme complex supplemented with β-glucosidase. Hydrolysis was performed at 50°C and pH 4.8. The enzyme dosages used were 20 FPU and 20 CBU of cellulase and β-glucosidase, respectively, per gram of dry material. The yield of material recovered after different pretreatments were between 76% - 80% and 83% - 93%, respectively. More than 58%-64% of glucans were retained in the material, being more of the 70% of the hemicelluloses solubilized in the aqueous liquor. Lignin solubilization was between 24% and 27%, according to the pretreatment conditions. Regarding the enzymatic hydrolysis of the pretreated material, the yields of glucose, in dry wood basis, obtained after enzymatic hydrolysis for 48 h between 50% and 70%, depending on the reaction time of AHP. There was an increase in the yield of glucose during the enzymatic hydrolysis of the material submitted to the alkaline washing from 70% - 80%. Results obtained showed that there was no significant effect of the different initial chemical composition on the performance of the pretreatment and enzymatic hydrolysis of the two different E. globulus trees.

**067 LIGNIN SEPARATION FROM BLACK LIQUOR IN A KRAFT PULP MILL**

*Dotta Brugman, Ma Florencia<sup>1</sup> \*; Cassella, Francisco Norberto<sup>2</sup>; Gorni, Gustavo<sup>3</sup>*

<sup>1</sup> Uruguay - <sup>1</sup> Fanapel, internship for Universidad de la Republica; <sup>2</sup> Universidad de la Republica/Facultad de Ingeniería/Instituto de Ingeniería Química; <sup>3</sup> Fanapel

The purpose of our work is to find a method to separate lignin from black liquor derived from a Kraft pulp mill in order to increase pulp production by implementing this method in an industrial scale. This work was done in FANAPEL where the recovery boiler's current capacity limits pulp production. Separating lignin from black liquor reduces the heat load, thereby making it possible to increase the overall flow of black liquor, thus increasing the production of pulp. After a series of laboratory trials, we found a method for the precipitation of lignin utilizing sulfuric acid. The precipitation conditions include a maturation time and a subsequent settling time for particles to agglomerate. We applied this method for two different precipitation pH levels: 7.5 and 9. Initially, we obtained a percentage of Klason lignin below 90%. Applying a purification method based on re-suspending the cake with a new acidification and subsequent sedimentation, we obtained a final percentage of Klason lignin higher than 98%. This method was designed in a continuous fashion, using press filters to improve filtration. For pH 7.5 the following results were obtained: Recovery yield lignin present in the black liquor = 55.8% Solid recovery yield present in the black liquor = 24.6% In conclusion, it is possible to apply these two-step method of precipitation-purification in a Kraft pulp mill, in a continuous basis. We suggest treating 10, 15 and 20% of black liquor at pH levels of 7.5 and 9, which we expect will result in a 5 to 15% increase in pulp production and will yield between 3.2 and 10.3 tons per day of dry lignin, while maintaining the energy level in the recovery boiler. Due to the use of sulfuric acid it is necessary to evaluate sulfur levels in the recovery boiler. We studied the business case for this method considering various prices of lignin depending on its final use. In all occasions we observed positive economic gains. Specific values are closely related to the final price of lignin and cellulose market price.

**066 EXTRACTION, MODIFICATION AND APPLICATIONS OF HEMICELLULOSES**

*Magaton, Andréia<sup>1</sup> \*; Peixoto, Magaly<sup>1</sup>; Cunha, Camila<sup>1</sup>; Milagres, Flaviana<sup>2</sup>*

<sup>1</sup> Brazil - <sup>1</sup> UFRB; <sup>2</sup> UFV

Hemicelluloses are considered the second most abundant biopolymer in the plant kingdom. They are also the major non-cellulosic cell wall polysaccharide of angiosperms, grasses, herbs and cereals, where they occur in many different compositions and structures. Hemicelluloses have great potential in the pulp and paper industry: contribute significantly to the mechanical strength of wood fibers, acting as modifying agents, beyond being burnt in the energy recovery furnace. Hemicelluloses as value-added materials are relatively unexplored for many applications such as biofuels, chemicals and polymeric materials even though their potential use as raw feedstock has been receiving increasing attention recently. Hemicelluloses extracted from woody biomass are used in the hydrolyzed form to produce valuable chemicals and fuels via biological fermentation or other processes. In their polymeric form they can be used to produce sustainable films and coatings. This paper provides a review on hemicelluloses from lignocellulosic materials, especially in regard to their isolation, modification methods, and applications. Current isolation and purification strategies are summarized, including: alkali extraction, organic solvent extraction, steam explosion, ultrasound-assisted extraction, microwave-assisted extraction and membrane separation. In addition, the bioconversion of hemicelluloses including pretreatment, enzymatic hydrolysis, and fermentation are discussed.

**068 PRODUCTION OF PRINTING AND WRITING PAPER GRADE PULP FROM SUGAR CANE BAGASSE: A COMPARATIVE STUDY WITH EUCALYPTUS SPP.**

*Freitas Andrade, Marcela<sup>1</sup> \*; Coldette, Jorge Luiz<sup>1</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Universidade Federal de Viçosa

In recent years, there has been an increasing trend towards more efficient utilization of agro-industrial residues, including sugar cane bagasse. The main goal of this study was evaluating the potential of bagasse for production of printing and writing paper grade pulp and comparing its pulps with eucalyptus pulps that are traditionally used for this application. Industrial whole bagasse was separated into two fractions, here designated as pith (33%) and depithed bagasse (67%). The pith was only characterized chemically. The depithed bagasse was chemically and morphologically characterized and cooked by the soda process to two different degrees of delignification (kappa 17.5 and 10.8). The resulting pulps were fully bleached by the O-D\*-(EP)-D sequence and characterized for their beatability, drainability and physical-mechanical properties. The contents of cell wall structural constituents (cellulose, hemicelluloses and lignin) in the pith, depithed bagasse and whole bagasse varied significantly. The lignin S/G ratio for pith and depithed bagasse were similar in the range of 50/50%. The morphological analyses of the depithed bagasse (fiber fraction) indicated a short fibered material, similar to eucalyptus. The bleached soda pulps cooked at kappa 17.5 and 10.8 showed similar beatabilities and drainabilities, but the strength properties (tensile, burst and tear) were higher for the kappa 17.5 pulp at beating energy consumptions in the range of 2-7 Wh. The both kappa 10.8 and 17.5 pulps from depithed sugar cane bagasse are suitable for production of printing and writing paper grades, but the higher kappa 17.5 pulp is more economically attractive given its higher pulping yield, without significantly increased chemical demand for bleaching. In general, the bleached pulps derived from depithed bagasse (soda pulping to kappa 17.5 and 10.8) presented acceptable properties but they did not measure up against those of traditional eucalypt Kraft pulps.



**069 SELECTIVE PURIFICATION OF HIGH MOLECULAR WEIGHT EUCALYPTUS GLOBULUS HEMICELLULOSES WITH METHANOL PRECIPITATION AIMING TO PLASTIC FILMS PRODUCTION**

*Peredo, Karol<sup>1</sup> \*; Gallegos, Sergio<sup>1</sup>; Teixeira, Regis<sup>1</sup>; Pereira, Miguel<sup>1</sup>*

<sup>1</sup> Chile - <sup>1</sup> Universidad de Concepción

Hemicelluloses precipitation with methanol were carried out at concentrations of 4:1, 3:1 2:1, 1:1 and 1:2 (v/v) from liquors formed with solutions of hemicelluloses in deionized water. The hemicelluloses were extracted from three different raw materials: Eucalyptus globulus hollocelulose (H1), Dewaxed wood (H2) and bleached kraft pulp (H3) extractions with 5% NaOH solutions (56% odw). Precipitation yield was measured, HPLC analysis determined sugar compositions, thermogravimetric analysis (TGA), differential scanning calorimetry (DSC) were performed. Molecular weights were obtained by HPLC-SEC. There was an increasing trend in precipitation yield with the methanol concentration in the liquor. The hemicellulose sample H2 had higher molecular weight (125 kDa) than sample H1 (105 kDa aprox), due to the lignin content associated to the hemicellulosic fragments. The H3 sample presented the smaller molecular weight distribution (between 5 and 0.5 kDa) due to higher hemicellulose degradation during the alkaline pulping treatment. It was possible to produce a graded precipitation of the different molecular weight populations of hemicelluloses present in sample H3 varying the methanol concentration. Hemicelluloses based films were produced by casting with the three samples. Sample H3 had no ability to form stable films. The lignin content of H2 hemicelluloses give a higher stability and thermoplastic behavior to the film, corroborated by TGA and DSC. This phenomenon could be associated to a higher affinity between acetylated hemicellulose and lignin.

**070 UPGRADING OF PAPER-GRADE PULPS TO DISSOLVING PULPS BY COLD CAUSTIC EXTRACTION: A NOVEL USE OF RESIDUAL XYLANS ON PINE KRAFT PULP**

*Vega, Johana<sup>1</sup> \*; Pereira, Miguel<sup>2</sup>; Peredo, Karol<sup>3</sup>*

<sup>1</sup> Chile - <sup>1</sup> Laboratorio de Productos Forestales, Facultad de Ingeniería Química, Universidad de Concepción.; <sup>2</sup> Laboratorio de Productos Forestales, Facultad de Ingeniería Química, Universidad de Concepción.; <sup>3</sup> Unidad de Desarrollo Tecnológico, Universidad de Concepción.

Eucalyptus globulus bleached kraft pulp was used as a potencial raw material aiming to produce hemicelluloses and dissolving pulp, through an integrated process. A cold caustic extraction on bleached kraft pulp was carried out at 56% odp NaOH, 30°C during 1 hour for obtaining dissolving pulp and a liquor with hemicelluloses. Hemicelluloses were recovered from extraction liquor by neutralization. The solid residue had a yield of 83% and contained 96.6% of  $\beta$ -cellulose. The yield of recovered hemicelluloses was 11.2% basis on the initial BKP. The chemical characterization of hemicelluloses revealed that 91% of the weight corresponds to xylose, with trace amounts of galacturonic acid and galactose. The average molecular weight was 1.4 kDa. The isolated xylans were incorporated in Pinus radiata unblached kraft pulp in dose of 15 and 30% odp, prior to beating (8000, 9000 and 9500 PFI revolutions). Paper sheets were evaluated. The hemicellulose percent retention in the paper was 7%. The incorporation of xylans allowed decreasing pulp beating energy in 11%, than the pulp without hemicelluloses, measured as a decrease in the number of PFI revolutions to achieve the same Shopper-Riegler freeness. The tensile index also increased with the addition of xylans. The results showed the advantage of obtaining dissolving pulp by cold caustic extraction from paper-grade pulp in an integrated process to the manufacture of pulp or paper. This seems to be especially advantageous when there are production lines of softwood and hardwood pulp.

**071 WOOD RESIDUES VALORIZATION**

*Galetta Paz, María Alejandra<sup>1</sup> \*; Reina, Luis<sup>2</sup>; Mantero, Carlos<sup>3</sup>; Menéndez, Pilar<sup>1</sup>*

<sup>1</sup> Uruguay - <sup>1</sup> Departamento de Química Orgánica, Facultad de Química, Universidad de la República, Avenida General Flores 2124, Montevideo 11800, Uruguay.; <sup>2</sup> Departamento de Tecnología Química, Facultad de Química, Universidad de la República, Avenida General Flores 2124, Montevideo 11800, Uruguay.; <sup>3</sup> Director Estación Experimental Prof. Bernardo Rosengurt, Facultad de Agronomía, Universidad de la República, Uruguay

Eucalyptus plantations have widely increased in Uruguay during the last two decades as a result of the applied forest policy and the consequent growth of pulp industry. The principal use of Eucalyptus in Uruguay is pulp production as an outcome large amounts of residues (bark, branches and knots) are generated. In this work two different techniques (TLC/scanner and GC-FID) were develop to study the sterol contents in lipoholic extractives of bark and knotwood of Eucalyptus grandis and Eucalyptus dunniis grown in Uruguay. With both species, major contents of sterols were obtained, in bark's sample than knotwood's samples.

**072 ANALYSIS OF WASH WATER REDUCTION ON BLEACHED PULP CHARACTERISTICS**

*Frigieri, Tania<sup>1</sup> \*; Comelato, Jaqueline<sup>1</sup>; Venterim, Gustavo<sup>1</sup>; Savi, Antônio Francisco<sup>1</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Universidade Estadual Paulista - Unesp - Itapeva

The main objective of this study was to analyze the fresh water costs reduction in the bleaching process, by using a press as the equipment that enables greater efficiency in washing; therefore making it easier to obtain the closed circuit and after the analyzes of its effects on the pulp quality were made. Oxygen delignified industrial pulp from Eucalyptus spp was used. The sequence D(E+P)DP was bleached ten times under the same conditions (temperature, consistency and time). The counter current washing was used in the bleaching stages, and each sequence was taken with different factor wash: 9, 6, 3 and 0m<sup>3</sup> of distilled water per ton of pulp, aiming to reach brightness of 92 ± 0,5% ISO. After bleaching, the following parameters were analyzed: brightness, viscosity, kappa number, brightness reversion, COD and apparent color. The evaluated results of ten different sequences and four washes showed an increase of COD, brightness reversion, but the kappa number and viscosity did not change. The apparent color increased, by increasing COD in the effluent during the cycles and by decreasing the wash water. In this paper the results of washing up to 3m<sup>3</sup>/t of pulp was tolerable and even recommended. It's known that industrially is used 9m<sup>3</sup>/t of fresh water, so water saving enables presses implementation in the process. As for the pulp without washing (0m<sup>3</sup>/t of pulp), it is commercially unviable, for not achieving sufficient brightness.



**073 INFLUENCE OF THE KRAFT MILL RAW MATERIAL AND TREATMENT TECHNOLOGY ON THE FINAL EFFLUENT QUALITY**

*Jarpa, Mayra<sup>1</sup> \*; Chamorro, Soledad<sup>2</sup>; Morales, Gabriela<sup>1</sup>; Vergara, Juan Pablo<sup>3</sup>; Vidal, Gladys<sup>2</sup>*

<sup>1</sup> Chile - <sup>1</sup> Environmental Biotechnology & Engineering Group, Environmental Science Center EULA - Chile, University of Concepción, P.O. Box 160-C, Concepción-Chile; <sup>2</sup> Environmental Science Center EULA - Chile, University of Concepción, P.O. Box 160-C, Concepción, Chile; <sup>3</sup> Environmental Science Center EULA - Chile, University of Concepción, P.O. Box 160-C, Concepción, Chile.

In Chile, the most widely used raw material for the production of kraft pulp is *Pinus radiata*, which represents 76% of forest plantations. However, modifications to the processing lines have led to the generation of cellulose based kraft *Eucalyptus globulus* or *nitens*, or mixtures thereof. The constitutive characteristics of the different species, especially regarding extractive, generate effluents that have different biological potential, after being treated by activated sludge type biological systems, aerobic lagoons or using biomass attached system. These biological systems are capable for removing biodegradable organic matter measured as BOD5 (Biological Oxygen Demand) from 73.5 to 99.2%. Nevertheless, there is a fraction of recalcitrant organic matter measured as COD (Chemical Oxygen Demand) between 30 - 50%, which is not removed by biological way. This fraction has lignin compounds with high molecular weight, which are not biologically active but may contribute to the effluent color. However, in this fraction remain recalcitrant compounds such as extractives from wood and / or compounds converted by the biological stage, the Kow of these compounds could be greater than 5, with high biological potential measured as estrogenic activity among others. The aim of this study was to assess the biological potential of effluents from different raw materials and consider the removal of this potential by physicochemical treatments. The results show that effluents from *Eucalyptus globulus* are more active than *Pinus radiata* effluent respect to estrogenic activity, posterior to be treated biologically. Moreover, this activity may be removed by physic-chemical treatment technologies. This work was partially supported by Fondecyt 1120664 and 3120216. M. Jarpa thanks to CONICYT for her Ph.D. grant.

**075 PURIFICATION OF THE CELLULOSIC FRACTION FROM THE FRACTIONATION OF EUCALYPTUS SP. SAWDUST BY OXIDATIVE TREATMENTS**

*Rodríguez Rivero, Gustavo E.<sup>1</sup> \*; Ehman, Nanci V.<sup>2</sup>; Area, María Cristina<sup>2</sup>; Felissia, Fernando E.<sup>2</sup>*

<sup>1</sup> Venezuela - <sup>1</sup> Escuela de Ingeniería Forestal, Facultad de Ciencias Forestales y Ambientales. Universidad de Los Andes. Mérida, Venezuela; <sup>2</sup> Programa de Celulosa y Papel - Instituto de Materiales de Misiones (CONICET-UNaM). Facultad de Ciencias Exactas Químicas y Naturales, Félix de Azara 1552 (3300) Posadas, Misiones, Argentina

Global demand for dissolving pulp in 2012 was 5.8 million tones and is estimated to reach a value of 6.9 million tons by 2014. Of the total, 4.3 million tones are used for viscous pulp and the rest for high grade alpha cellulose, for the production of acetates, ethers and other specialties. This work applies the concept of biorefinery to the purification of the cellulosic fraction of sawdust which has been subjected to a hydrothermal-alkaline treatment of *Eucalyptus sp.*, by using oxidative treatments in order to obtain dissolving pulp. The pulp was treated subsequently with oxygen, ozone and an alkaline extraction. The properties of the obtained pulps were evaluated and compared with a pulp of sugarcane bagasse subjected to the same treatment and with commercial dissolving pulps. The obtained pulps after applying an oxidizing treatment with ozone meet the requirements of dissolving pulps.

**074 POTENTIAL OF CELLULOSE NANOCRYSTALS AND BLEACHED EUCALYPTUS KRAFT PULP FOR WATER HARDNESS REMOVAL**

*Vitor Matoso, Colodette, Jorge<sup>1</sup> \*; Gomes, Fernando<sup>2</sup>; Superbi, Rita<sup>2</sup>; Brandao, Karla<sup>2</sup>; Peixoto, Rosana<sup>2</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Laboratório de Celulose e Papel - DEF Universidade Federal de Viçosa; <sup>2</sup> Laboratory of pulp and paper

Wood is the most used raw material for pulp mills worldwide, in special the eucalypt, which is becoming the most important feedstock for bleached kraft pulp production, especially in South America. Thus, the eucalypt wood appears as an interesting feedstock for applying the biorefinery concept, which aims a more sustainable and rational use of the natural resources for obtaining different products by using lignocellulosic materials, e.g., biofuels and bioproducts generation. In this context, many studies have been developed by bioproducts produced from pulp, such as nanomaterials known as cellulose nanocrystals (CNC), whose main process for its isolation from cellulose fibers is based on acid hydrolysis. CNC have interesting properties, such as low toxicity, low relative density and high mechanical strength. Considering these properties, CNC has a wide applicability for producing biomaterials, electronics, optics, and others. During the process of obtaining the CNC, the amorphous regions are broken, leaving only the highly organized crystalline sites. When sulfuric acid is used as a reactant in the hydrolysis step, CNC have negative surface charge. This property combined with a high superficial area of a material at the nanoscale is still little explored. Sulfonic groups can be used as active sites for ion exchange adsorbents. Such materials are used for the purification of liquids and gases. In this way, this study aims to investigate the applicability of CNC redeposited onto eucalypt bleached kraft pulp for water purification by removing of Ca<sup>2+</sup>, since this metallic ion in industrial water is responsible for fouling and corrosion in pipes beyond tamper consumption. For this, a kinetic study of a solution of Ca<sup>2+</sup> was performed, which was put in contact with the adsorbent material, being monitored the cation concentration over a period of 140 minutes. The results showed an effective ionic adsorption of the Ca<sup>2+</sup> starting after 30 minutes of contact. The cation adsorption exhibited a tendency to increase with the rise of retention time during the filtering process (9.1% - 62.6%), indicating a potential applicability of the system for water hardness removal.

**076 UPGRADING OF PAPER-GRADE PULPS TO DISSOLVING PULPS BY COLD CAUSTIC EXTRACTION: STUDY OF THE REACTIVITY OF A SOLUBLE PULP FOR THE ETHERIFICATION REACTION.**

*Baquedano, Axel<sup>1</sup> \*; Peredo, Karol<sup>2</sup>; Berg, Alex<sup>2</sup>; Pereira, Miguel<sup>3</sup>*

<sup>1</sup> Chile - <sup>1</sup> Universidad de Concepción, Departamento de Ingeniería Civil Química, Laboratorio de Productos Forestales; <sup>2</sup> Unidad de Desarrollo Tecnológico (UDT); <sup>3</sup> Laboratorio de Productos Forestales, Facultad de Ingeniería Química, Universidad de Concepción.

The purpose of this study is the evaluation of the reactivity of a *Eucalyptus* bleached kraft pulp after a cold caustic extraction process, to remove the hemicelluloses present in the pulp to obtain dissolving pulp (?±-cellulose 95%) aiming to an acetylation process. The sodium hydroxide load used for alkaline extraction of hemicellulose from the pulp were 10.5%, 25%, 45%, 56% and 157% bps, designed to obtain samples with different amounts of ?±-cellulose. The amounts of alpha cellulose reached were 89%, 90%, 95, 97% and 99.5% respectively. The pulp sample without extraction had an ?±-cellulose content of 85%. Carbohydrate analysis and intrinsic viscosity of pulp samples before acetylation was performed, to evaluate the effect of alkaline extraction on the pulp. The samples were acetylated in constant conditions. The cellulose acetate reactivity was assessed by heterogeneous saponification method (ASTM D 817-96) and the quantification of acetyl groups were performed by FTIR absorbance. Intrinsic viscosity was measured and thermal behaviour were evaluated through DSC and TGA. The reactivity of the pulp increases when the presence of hemicellulose is reduced. The maximum reactivity was achieved with 56% extraction bps (DS = 2.97 and C=O/C-O= 1.013). Further extractions causes a reduction in reactivity because extreme extractions makes the less accessible pulp acetylation reagents. Using a cold caustic extraction, with a load of less than 56% NaOH bps, makes possible to generate dissolving pulp which is able to be etherificated.



**077 BENEFITS OF CHLORINE DIOXIDE FINAL STAGE FOR EUCALYPTUS PULP BLEACHING OPERATING WITH PH NEAR TO NEUTRAL**

*Ribeiro, Robisnéa Adriana<sup>1</sup>\*; Borges Gomes, Fernando José<sup>1</sup>; Coldette, Jorge Luiz<sup>2</sup>; Pereira Damasio, Renato Augusto<sup>1</sup>; Fontes Demuner, Iara<sup>1</sup>*

\* Brazil - <sup>1</sup> Federal University of Viçosa; <sup>2</sup> Universidade Federal de Viçosa

Eucalyptus is becoming the most important fiber source for papermaking worldwide. Bleached eucalyptus kraft pulps are largely used for manufacturing tissue and print & writing (P&W) paper grades. To attend a demanding consumer market for quality products with lower prices and sustainable practices, it is necessary developing alternative production processes. In this context, many studies have been developed showing that the final stage of bleaching pulp using chlorine dioxide has a satisfactory performance, presenting significant brightness gain when it is operated at near neutral pH (5.5 - 6.0). Currently, there are many bleaching plants using H<sub>2</sub>SO<sub>4</sub> or NaOH in order to pH adjust, however, it is not suitable for pH control in this range, since it is difficult to control acid-base balance when strong acids or base are used. In this way, buffering agents have a potential applicability, since they are chemical compounds in solution which are used to ensure that the pH is constant, even with addition of acid or base solution, as long as the reaction balance is preserved. The use of an agent with desirable properties to form a buffering system in situ appears as an interesting alternative to pH control near neutral (5.5-6.0) during the whole bleaching process. Therefore, this study aims to investigate the effect of using carbon dioxide (CO<sub>2</sub>) in the D1 stage in the D0(EP)D1 sequence for eucalyptus bleaching pulp, by operating at near neutral pH due to the formation of a buffering system (H<sub>2</sub>CO<sub>3</sub>/NaHCO<sub>3</sub>). The performance of this system was evaluated taking into account the impact on chlorine dioxide consumption and pulp quality. For pulp bleaching at 90% ISO brightness, an economy of 3 kg/odt of ClO<sub>2</sub> per ton of bleached pulp was achieved, when a dosage of 1 kg/odt NaOH and 3 kg/odt of CO<sub>2</sub> was added. As expected, a slight reduction in the final viscosity was observed, which can be explained due to the compounds generated in this pH range. Another positive point of the operating the D1 stage in pH near neutral was an improvement in the brightness stability of the bleached pulp.

**079 COMPARISON OF TCF SEQUENCES IN THE BLEACHING OF EUCALYPTUS CAMALDULENSIS PULP**

*Fiskari, Juha<sup>1</sup>\*; Savela, Miikka<sup>2</sup>; Ruuttunen, Kyosti<sup>2</sup>; Ali-Rekola, Ville<sup>2</sup>; Kilpelainen, Petri<sup>3</sup>; Sixta, Herbert<sup>2</sup>*

\* Finland - <sup>1</sup> University of Helsinki Department of Chemistry P.O. Box 55 FIN-00014 University of Helsinki; <sup>2</sup> Department of Forest Products Technology School of Chemical Technology Aalto University FIN- 02015 Espoo; <sup>3</sup> Finnish Forest Research Institute (METLA) P.O. Box 18 FIN-01301 Vantaa

This research was undertaken to evaluate the bleaching response of Eucalyptus camaldulensis in different Totally Chlorine Free (TCF) bleaching sequences. The goal was to compare TCF bleaching sequences which include a peroxy acid stage to a simple hydrogen peroxide bleaching. The peroxy acids investigated were peracetic acid (Paa) and Caro's acid (Caa), as they are widely available or can be produced on-site, and could be charged to an existing bleaching sequence without any major modifications or additional equipment. E. camaldulensis kraft pulp was obtained from a South Asian pulp mill. The mill pulp sample had undergone conventional batch cooking and two stages of oxygen delignification. Its kappa number was about 11 and viscosity 1020 mL/g, respectively. E. camaldulensis is known to have very high lignin content, and therefore its bleaching with oxygen chemicals is known to be very challenging. The pulp was subjected to three different TCF bleaching sequences: hydrogen peroxide; Caro's acid and hydrogen peroxide; as well as peracetic acid and hydrogen peroxide. The goal was to compare these sequences while reaching approximately equal final brightness. The final ISO brightness, kappa number and viscosity, as well as brightness reversion were measured. According to the results, peracetic acid and Caro's acid proved to be potential additional alternatives for TCF bleaching with hydrogen peroxide alone. Both of these bleaching agents can be used between oxygen delignification and the final hydrogen peroxide stage for improved brightness stability, as well as reduced hydrogen peroxide consumption. Moreover, they can be used in a bleaching sequence without any major capital investment.

**078 BLEACHED PULP CHEMICAL COMPOSITION AND ITS IMPACT ON THE BRIGHTNESS STABILITY AND PULP ABSORPTION PROPERTIES**

*Rosa Vieira, Fernanda<sup>1</sup>\*; Borges Gomes, Fernando José<sup>1</sup>; Coldette, Jorge Luiz<sup>2</sup>; Pereira Damasio, Renato Augusto<sup>1</sup>*

\* Brazil - <sup>1</sup> Federal University of Viçosa; <sup>2</sup> Universidade Federal de Viçosa

To attend a demanding consumer market for bleached pulp of high quality and lower prices and sustainable practices, it is necessary developing alternative production processes. In this context, many studies have been developed for saving chemical reagents during the whole bleaching process, in special chlorine dioxide, which is the most expensive chemical bleaching agent, besides being unfriendly to the environment. However, the pulp chemical composition is directly affected by the sequence and bleaching conditions used, which affect the pulp brightness stability, for example. In this way, this study aims to investigate 4 eucalypt Kraft pulps with different chemical composition concerning their brightness stability and absorption properties. The pulps were obtained through different bleaching sequences (A/D(EP)DD, A/D(EP)DPDEHDD e DEHDP) and were measured regarding their brightness stability, drainability, water retention value, and Klemm capillarity for the fibrous final suspension in the pH range of 3-8. Pulps with different chemical composition were obtained (high hexenuronic acid and low carbonyl contents; and low hexenuronic acid and high carbonyl content). The results showed that the bleached pulps using hydrogen peroxide final stage technology showed best brightness stability. Concerning the pH effect on pulp properties, it was observed that the pulp brightness stability and absorptive properties are affected positively and negatively, respectively, by the increase of pH. Differences among the pulps were found, such as: (a) pulps with low hexenuronic acid content present best brightness stability; (b) pulps with high hexenuronic acid content showed high water retention value. It can be explained due to hydroxyl groups present in the hexenuronic acid; (c) concerning brightness stability, the impact of the hexenuronic acid content in the pulp seems to be more detrimental than high carbonyl content. However, it was not possible to conclude definitively this point in this paper, since the carbonyl content differences found in this work were not very representative, being slightly different among the pulps.

**080 EFFECT OF ACID EFFLUENT FROM CHLORINE DIOXIDE PLANT IN THE OXYGEN DELIGNIFICATION**

*Rafael Dos Santos, Vitorim, Gustavo<sup>1</sup>\*; Caraschi, José Cláudio<sup>1</sup>; Silveira Comelato, Jaqueline<sup>2</sup>*

\* Brazil - <sup>1</sup> Campus de Itapeva, UNESP - Univ Estadual Paulista; <sup>2</sup> Faculdade de Engenharia de Guaratinguetá, UNESP - Univ Estadual Paulista

This work has aimed to evaluate the effect usage of residual acid originated from the chemical plant of chlorine dioxide production as flowing part of oxidized white ligueur (OWL). Delignification processes were accomplished using as alkali OWL already dosed with residual acid and with NaOH, seeking to compare the results. Brown stock Kraft pulp of eucalyptus industrially produced was used for oxygen delignification accomplishment, being this bleaching stage studied in its particularities according to raw material supplying industry. The oxygen delignification, also named pre-O<sub>2</sub>, consists of accomplishing previously the bleaching an oxidation of lignin through the oxygen, and later proceeding with these oxidized compounds removal by alkaline media, seeking larger earnings of pulp bleaching this way. The oxygen delignification stages were accomplished in a laboratorial reactor RegMed provided with four electrically heated up capsules. The conditions maintained constants were: alkali load (19 kg/adt), consistence (11%), oxygen pressure (5.8 kgf/cm<sup>2</sup>), retention time (90 min.), initial DQO of stage (8 kg/adt) and MgSO<sub>4</sub> load (1.5%). The temperature was varied in four different levels (95, 100, 105 and 112°C) and the presence of residual acid in reaction media. For delignification accomplished at 112°C with NaOH was obtained brightness 62.2%ISO, selectivity 21.7% and delignification efficiency 41.7%. For the delignification accomplished with OWL dosed with residual acid was obtained brightness 59.7%ISO, selectivity 20.3% and efficiency 38.6%, also at temperature of 112°C. The results evidence the negative effect of residual acid presence over the delignification process, once brightness, selectivity and delignification efficiency were inferior in residual acid presence in reaction media. Although it has been evidenced its negative effect, the residual acid usage in bleaching is an interesting alternative regarding the factory chemical balance control.





**081 THE INFLUENCE OF PH IN THE CHLORINE DIOXIDE STAGE OF A A(EOP)DP BLEACHING SEQUENCE**

*Clavijo, Leonardo<sup>1</sup> \*; Piovano, Pablo<sup>1</sup>; Doldán, Javier<sup>2</sup>*

<sup>1</sup> Uruguay - <sup>1</sup> Universidad de la República. Facultad de Ingeniería. Instituto de Ingeniería Química. Ingeniería de Procesos Forestales. Montevideo - Uruguay.; <sup>2</sup> Departamento de Proyectos Forestales LATU - Montevideo Av. Italia 6201

In recent decades the pulp and paper industry has been reinventing to achieve an environmentally more friendly production process. The decrease in water consumption as well as a lower production of organochlorine compounds has been the key to this conversion. The concept of closed plant refers to recycling and reusing solid and liquid wastes from the plant, as well as the reduction of gaseous emissions to the minimum quantity and toxicity levels. The major problems found in plants that have tried to operate in these conditions, are due to corrosion caused by the presence of several chlorine species in various parts of the plant and the accumulation of non-process elements. In a previous work, the novel sequence A(EOP)DP was presented. With this sequence it is possible to fully bleach Eucalyptus Kraft pulps with only 5.5 Kg/ton of chlorine dioxide. Low brightness reversion and very low AOX content in the effluents are achieved. The ClO<sub>2</sub> conversion to ClO<sub>3</sub><sup>-</sup> is approximately 20%. However, as this sequence has only one stage that uses ClO<sub>2</sub>, the pH in which this stage is performed seems to be critical. In this work the influence of pH in D stage was studied. pHs from 3 to 7 were investigated, and pulp properties analyzed. For this sequence the optimal pH seems to be a compromise between the D0 and D1 common values for actual sequences as (A/D0)(EOP)D1P or D0hot(EOP)D1P. The best results were obtained when the final pH of the D-stage is between 4 and 5. This range arises when kappa number, final brightness, viscosity, brightness reversion and conversion to ClO<sub>3</sub><sup>-</sup> values are analyzed. The A(EOP)DP bleaching sequence has great potential to become an effective bleaching sequence at the mills because the lower chemical consumption, good pulp quality, better value for environmental parameters and the possibility to partially close the bleaching sequence by reusing the A-stage effluent.

**082 EVALUATING THE APPLICATION OF AN ANALYTICAL METHOD FOR THE DETERMINATION OF HEXENURONIC ACIDS IN EUCALYPTUS PULPS**

*Sanhueza Muñoz, Karem Viviana<sup>1</sup> \*; Colodette, J.L.<sup>2</sup>; De Almeida, L.O.<sup>3</sup>*

<sup>1</sup> Switzerland - <sup>1</sup> Celulosa Arauco y Constitución S.A Valdivia Mill, Chile; <sup>2</sup> Professor, UFV, Celulosa Arauco y Constitución S.A Valdivia Mill, Chile; <sup>3</sup> Full Professor, UFV, Celulosa Arauco y Constitución S.A Valdivia Mill, Chile

Optimized technologies at removing hexenuronic acids (HexA) are necessary to have a quick laboratory method for the quantification of these, allowing the analysis with the kappa number conduct a proper operational control for fiber line Kraft process. The aims of this study is define the most appropriate experimental conditions for applying the METHOD UFV, VALDIVIA MILL to determining HexA in Kraft process for eucalyptus Valdivia Mill. This method is based on the HUT method applied in the laboratory of the University of Viçosa (METHOD UFV, UFV) and was defined to be a simple method (low response time). Factorial design is performed which evaluates the effect of disintegration time, hydrolysis time, temperature and pH. The variables that significantly affect the determination of HexA are the temperature and pH. The best conditions for applying the method are pH 7, temperature 120 °C, hydrolysis time 30 min and 10 seconds of disintegration the pulp. The experimental conditions are validated with previous studies of analysis of eucalyptus samples observing trends HexA content with Process Variables such as kappa, sulfidity, temperature and time cooking. It is noted that HexA content decrease for eucalyptus increasing sulfidity and temperature. On the other hand, the HexA content does not follow the same behaviour with increasing cooking time attributed to cooking conditions (temperature, alkalinity). Finally, we get the equivalent of 10.2 mmol HexA / kg per unit of eucalyptus pulp kappa contributing approximately 50% of the kappa index Eucalyptus. These relationships allow us to obtain the corrected kappa number value and provide a new tool for personal control of operations planning for future optimization of chemical consumption in ECF bleaching process.

**083 INFLUENCE OF BLEACHING SEQUENCES OF EUCALYPTUS KRAFT PULP ON THE KAOLIN RETENTION AND ITS PAPER STRENGTH PROPERTIES**

*Santos, Ivan<sup>1</sup> \*; Venterim, Gustavo<sup>1</sup>; Caraschi, José Cláudio<sup>2</sup>*

<sup>1</sup> Brazil - <sup>1</sup> UNESP; <sup>2</sup> Campus de Itapeva, UNESP - Univ Estadual Paulista

The aim of this study was to evaluate the influence of bleaching sequences of eucalyptus kraft pulp on the kaolin retention and its paper strength properties. Three bleaching sequences were adopted, two ECF and one ECF-Light. The pulps were bleached to 90 ± 0.5% ISO brightness. Thereafter, repeated tests were made replacing fiber to kaolin filler, from 0 to 35% at intervals of 5% for each sample. The hand sheets formed were characterized physically, mechanically and optically. Fiber dimensions obtained from each bleaching sequence were also analyzed by Fiber Quality Analyzer equipment. The results showed that the amount of kaolin influences in both retention, as in optical properties, mechanical and physical properties of paper, and the best result was attributed to content of 20% (w/w). The ECF-Light sequence showed better retention index and smoothness, whereas the sequence OAHTD (E+P)DP showed higher Short-span compression resistance and higher Scott-bond strength. The reference sequence showed better results for tear index, viscosity, yield and fiber quality (length, width, coarseness and fines content).

**084 INVESTIGATION OF THE IDEAL TIME REACTION AND PH RANGE FOR THE CHLORINE DIOXIDE FINAL STAGE FOR EUCALYPTUS BLEACHING PULP**

*Fontes Demuner, Iara<sup>1</sup> \*; Leandro do Nascimento, Juracy<sup>1</sup>; Borges Gomes, Fernando José<sup>1</sup>; Coldette, Jorge Luiz<sup>1</sup>*

<sup>1</sup> Brazil - <sup>1</sup> Universidade Federal de Viçosa

Currently, the eucalypt is the most important feedstock for bleached pulp production, especially in South America, which is the largest producer of bleached eucalyptus market pulp worldwide. The market demand for pulps with high quality and low environmental impact are drivers for developing technologies, and strategies for bleaching processes. In this context, many studies have been developed for optimizing the eucalypt pulp bleaching sequence, in special regard to chlorine dioxide stage. This is the most expensive and environmentally unfriendly bleaching chemical reagent, since it is the main responsible for the organochlorine compounds formation in the pulp mill. The reactions that occur on kraft bleaching pulp with chlorine dioxide have not been completely understood yet, and its reactions are not fully determined. This study aims to investigate the effect of pH and time reaction in the chlorine dioxide final stage for eucalyptus kraft bleaching pulp by the sequence D0(EP)D, using two levels of kappa factor (0.1 and 0.2) on brightness gain and chemical consumption. It was observed that there is an optimal pH range (5-6) for the operating of the chlorine dioxide final stage with benefits in brightness gains and chemicals consumption. It can be explained due to anions content according to pH range. The filtered anions analysis showed that in the pH range over 5 besides chloride, and chlorate ion formation, there is also a formation of chlorite ion, which has the capacity to regenerate chlorine dioxide, thus increasing its power of oxidation during bleaching. However, at pH ranges over 7, the formation of chlorite ion is even greater, but the regenerated chlorine dioxide does not seem to oxidize the lignin, since brightness gain is not observed. It seems to exist a preferential route to chlorine dioxide decomposition and regeneration in this pH range. Concerning the time reaction, there is an optimal point for each kappa factor (60 min. for 0.1 KF, and 210 min. for 0.2 KF); after this time, the brightness gains are stable.



**085 OPPORTUNITIES FOR SAVING HYDROGEN PEROXIDE IN MECHANICAL PULP BLEACHING USING ADDITIVES**

*de Oliveira Resende, Janaina<sup>1</sup>\*; Fontes Demuner, Iara<sup>2</sup>; Borges Gomes, Fernando José<sup>1</sup>; Coldette, Jorge Luiz<sup>2</sup>*

\* Brazil - <sup>1</sup> Federal University of Viçosa - Brazil; <sup>2</sup> Universidade Federal de Viçosa

The mechanical pulp is a lignocellulosic fibrous material prepared by mechanically separating cellulose fibers from wood or other fibrous raw material. The mechanical pulp is characterized by high yield; nevertheless its strength properties and brightness are low for the most paper applications, being used for specific paper grades. Softwood is the most common raw material for mechanical pulp production. However, the hardwood is becoming an important feedstock for mechanical pulp mill, especially in South America, where the wood production costs are very low due to proper climate and advanced forest and agricultural technologies. In this context, many studies have been developed for using eucalyptus for mechanical pulp production, which may also be used in mixtures with softwood pulp to improve their strength properties aiming at packaging applications such as multilayer cardboard. For mechanical pulp bleaching, hydrogen peroxide is the most used chemical reagent in alkaline medium. On the other hand, most of the transition metals harmful to peroxide stability should be removed in the previous stages, which facilitates the control of hydrogen peroxide decomposition; this precludes the need for dedicated acid washing or chelation stages as well as the use of stabilizers in the peroxide stage. In this way, this study aims to investigate a case study of a Brazilian Mechanical Pulp Mill Company, by the application of various additives and dosages for thermo groundwood pulp (TGW) bleaching in the hydrogen peroxide stage. The following stabilizers were evaluated: sodium silicate, sodium silicate plus magnesium sulfate, magnesium sulfate, and DTPA. The time and consistency were kept constant (7 days and 50%). The initial temperature was 60°C with natural decrease until room temperature. The sodium silicate showed the best performance. In this context, the alkaline charge of the hydrogen peroxide stage using sodium silicate was optimized. For the applications of 35 and 70 kg /odt of H<sub>2</sub>O<sub>2</sub> in the presence of 25 kg/odt of Na<sub>2</sub>SiO<sub>3</sub>, NaOH dosages of 0.5 and 1.5 kg/odt were necessary, respectively. Aiming 78% ISO brightness (reference brightness), it was possible to save 35 kg/odt H<sub>2</sub>O<sub>2</sub>, with better brightness stability.

**087 COMPUTATIONAL APPROACH TO THE UNDERSTANDING OF LIGNIN RESIDUES BLEACHING BY CHLORINE DIOXIDE**

*Irving, Kenneth<sup>1</sup>\*; Ventura, Oscar N.<sup>1</sup>*

\* Uruguay - <sup>1</sup> CCBG, DETEMA, Faculty of Chemistry, Universidad de la República, Montevideo-Uruguay

A theoretical chemistry study of the species involved in the oxidation of phenol and substituted phenol to quinones by chlorine dioxide has been performed at different computational levels. Model chemistry calculations employing complete basis sets methods and density functional calculations using one of the most recently derived exchange-correlation functionals and a medium size basis sets were employed for the purpose. Initial complexes, transition states, intermediates and final products in gas phase (or non-dissociating solvents) as well as in bulk water simulated using a polarizable continuum, were investigated. The results show that the reaction with one chlorine dioxide molecule affords a tight molecular complex, where the chlorite ion stays linked to the phenoxyl radical and water. Reaction with a second chlorine dioxide molecule produces several possible intermediates. From them, o- and p-quinone formation are equally probable for phenol, but para substitution is more likely when a methoxy group is present on an ortho carbon in phenol. In this case it is also observed the possible formation of formaldehyde and a ring-opening transition state that may lead to an intermediate which can proceed to muconic acid derivatives after reaction with hydroxide present in the basic media.

**086 STUDY OF THE ADDITION OF MGSO<sub>4</sub> ON PEROXIDE STAGES IN THE AEPDP AND AEOPDP BLEACHING SEQUENCES**

*Clavijo, Leonardo<sup>1</sup>\*; Franzoni, Patricia<sup>1</sup>; Doldán, Javier<sup>2</sup>*

\* Uruguay - <sup>1</sup> Universidad de la República. Facultad de Ingeniería. Instituto de Ingeniería Química. Ingeniería de Procesos Forestales. Montevideo - Uruguay.; <sup>2</sup> Departamento de Proyectos Forestales LATU - Montevideo Av. Italia 6201

An oxidant agent like hydrogen peroxide is commonly used during the extraction and peroxide stages in order to enhance Eucalyptus pulp bleaching treatment performance. Since peroxide is a source of harmful radical species in alkaline conditions and in the presence of transitional metals, some kind of stabilizing agent is required. In the present work, the stabilizing effect of MgSO<sub>4</sub> on the Ep stage in the bleaching sequence AEpDP and on the P stage in the AEopDP sequence were studied. Viscosity, brightness and brightness reversion of pulp were measured. For the prebleaching stage it was obtained that optimum MgSO<sub>4</sub> charge was on the range of 1-1.5 Kg/BDT and for the final P bleaching stage the optimum value was 1.5 Kg/BDT. Kappa number was also measured and it was concluded that there were not significant changes between pulps on which different MgSO<sub>4</sub> dosages were added and the trials with no addition of the stabilizer. The second sequence studied showed higher ISO brightness than the first one, stating that the best sequence conditions are those of the AEopDP bleaching sequence.





## INDEX

Aguayo, María Graciela .....	21	Coelho dos Santos Muguet, Marcelo .....	6	Fariña, Ismael.....	20
Aguerre, Ines .....	14	Coldette, Jorge Luiz.....	12	Fariña, Ismael.....	22
Ali-Rekola, Ville.....	23	Coldette, Jorge Luiz.....	17	Felissia, Fernando E. ....	12
Ali-Rekola, Ville.....	31	Coldette, Jorge Luiz.....	19	Felissia, Fernando E. ....	25
Almeida, Diego.....	24	Coldette, Jorge Luiz.....	19	Felissia, Fernando E. ....	30
Almeida Santos, Fernando.....	20	Coldette, Jorge Luiz.....	20	Ferraz, André.....	21
Amorim, Allan .....	25	Coldette, Jorge Luiz.....	20	Ferreira, Francisco.....	6
Amorim, Allan .....	25	Coldette, Jorge Luiz.....	21	Fiskari, Juha.....	21
Andreotti, Juliana .....	11	Coldette, Jorge Luiz.....	22	Fiskari, Juha.....	23
Araya Carvajal, Fabio.....	28	Coldette, Jorge Luiz.....	22	Fiskari, Juha.....	31
Area, María Cristina.....	12	Coldette, Jorge Luiz.....	23	Fontes Demuner, Iara.....	31
Area, María Cristina.....	25	Coldette, Jorge Luiz.....	26	Fontes Demuner, Iara.....	32
Area, María Cristina.....	30	Coldette, Jorge Luiz.....	28	Fontes Demuner, Iara.....	33
Axegård , Peter.....	11	Coldette, Jorge Luiz.....	31	Franzoni, Patricia.....	33
Ayoub, Ali .....	27	Coldette, Jorge Luiz.....	31	Freer Calderón, Juanita.....	28
Balocchi , Claudio .....	5	Coldette, Jorge Luiz.....	32	Freitas Andrade, Marcela.....	28
Baquedano, Axel .....	30	Coldette, Jorge Luiz.....	33	Frigieri, Tania.....	22
Barbosa, Bianca.....	19	Colodette, Jorge.....	7	Frigieri, Tania.....	29
Barth, Dorothee.....	11	Colodette, Jorge.....	18	Gacitua, William .....	9
Batalha, Larisse A. R.....	27	Colodette, Jorge.....	27	Galetta, Alejandra.....	7
Benitez, Julieta B.....	25	Colodette, Jorge Luiz.....	6	Galetta Paz, María Alejandra.....	29
Berg, Alex .....	26	Colodette, Jorge.....	7	Gallegos, Sergio.....	29
Berg, Alex .....	30	Colodette, Jorge.....	7	Gomes, Fernando.....	7
Bolton, Todd.....	21	Colodette, Jorge.....	11	Gomes, Fernando.....	11
Bonfiglio, Fernando .....	16	Colodette, J.L.....	32	Gomes, Fernando.....	19
Bonfiglio, Fernando .....	20	Coloette, Jorge.....	27	Gomes, Fernando José Borges.....	21
Bonfiglio, Fernando .....	23	Comelato, Jaqueline.....	24	Gomes, Fernando.....	22
Bonfiglio, Fernando .....	24	Comelato, Jaqueline.....	29	Gomes, Fernando José Borges.....	21
Bonifaccino, Silvana.....	27	Comelato Favaro, Jaqueline.....	22	Gomes, Valéria.....	23
Borges Gomes, Fernando José.....	12	Comelato Favaro, Jaqueline.....	23	Gomes, Léa .....	24
Borges Gomes, Fernando José.....	20	Costa, Marcelo.....	18	Gomes, Fernando.....	27
Borges Gomes, Fernando José.....	31	Costa da Silva, Jose Luiz.....	18	Gomes, Fernando.....	30
Borges Gomes, Fernando José.....	31	Cunha, Camila .....	24	Gómes, Valéria.....	17
Borges Gomes, Fernando José.....	31	Cunha, Vanessa .....	25	Gómez, Leandro.....	9
Borges Gomes, Fernando José.....	32	Cunha, Camila .....	28	Gomide, José Livio.....	24
Borges Gomes, Fernando José.....	33	Curbelo, Viviana.....	23	Gorni, Gustavo.....	28
Borzacconi , Liliana.....	15	Curbelo, Viviana.....	24	Greis, Otto .....	13
Brandao, Karla .....	30	Curbelo, Viviana.....	24	Grotzner, Mariana.....	8
Burnet, Auphelia.....	20	da Silva, Juliana.....	25	Guillemain, Audrey.....	12
Burnet, Auphelia.....	21	da Silva Perez, Denison.....	12	Guimaraes, André .....	17
Busnello, Andréa.....	18	Dahl, Olli .....	15	Hautala, Sanna.....	23
Bustos, Cecilia .....	9	Dalvi, Leandro.....	7	Heinze, Thomas .....	11
Buxedas, Luciana.....	27	De Almeida, L.O.....	32	Hirigoyen, Andrés.....	20
Cabral, Carla .....	19	de Caux, Leonardo .....	7	Hormazabal, Sujeý.....	27
Cabrera, Ma. Noel .....	15	de Oliveira Resende, Janaina.....	33	Hornus, Marina.....	12
Cabrera, María Noel .....	22	Del Rio, José Carlos.....	12	Hupa , Mikko.....	13
Caraschi, José Cláudio.....	23	Derkacheva, Olga.....	21	Inalbon, María C.....	22
Caraschi, José Cláudio.....	31	Diesen, Magnus .....	5	Inthamoussu, Agustin .....	14
Caraschi, José Cláudio.....	32	Dieste , Andrés .....	5	Irving, Kenneth.....	33
Carvalho, Danila.....	26	Doldán, Javier.....	20	J. B. Gomes, Fernando.....	19
Cassella, Francisco Norberto.....	28	Doldán, Javier.....	20	Jaaskelainen, Anna-Stiina.....	17
Chamorro, Soledad .....	15	Doldán, Javier.....	22	Jääskeläinen, Anna-Stiina.....	6
Chamorro, Soledad .....	30	Doldán, Javier.....	23	Jameel, Hasan .....	7
Chang, Hou Min .....	27	Doldán, Javier.....	24	Jameel, Hasan .....	27
Chaves de Oliveira, Rubens .....	20	Doldán, Javier.....	32	Janodet, Arthur.....	12
Chaves de Oliveira, Rubens .....	25	Doldán, Javier.....	33	Jansson, Ulla .....	6
Chavez, Jorge .....	9	Dotta Brugman, Ma Florencia.....	28	Jansson, Ulla .....	22
Chenna, Naveen Kumar.....	17	Ehman, Nanci V.....	30	Jarnefelt, Christian .....	17
Chirat, Christine .....	18	Enzer, Uri .....	9	Jarpa, Mayra.....	15
Clavijo, Leonardo .....	32	Fardim, Pedro.....	11	Jarpa, Mayra.....	30
Clavijo, Leonardo .....	33	Fardim , Pedro.....	9	Jorge Luiz, Colodette .....	6
		Faria, Bruno .....	24		



## INDEX

Jorge Luiz, Colodette .....	9	Oliveira, Rubens .....	25	Schneid, Guinter .....	25
Kari, Kovasin .....	8	Otero de Almeida., Maria L. ....	25	Silva, Vanessa .....	7
Keikkila, Elina .....	11	Peixoto, Magaly .....	24	Silva, Marcelo .....	17
Kent, Kraig .....	8	Peixoto, Magaly .....	28	Silva, Juliana .....	25
Kent, Kraig .....	21	Peixoto, Rosana .....	30	Silveira Comelato, Jaqueline .....	31
Kilpelainen, Petri .....	31	Peredo, Karol .....	26	Sixta, Herbert .....	16
Koga, Mariza E.T. ....	25	Peredo, Karol .....	27	Sixta, Herbert .....	23
Kulomaa, Tuomas .....	21	Peredo, Karol .....	29	Sixta, Herbert .....	31
Kyösti, Ruuttunen .....	16	Peredo, Karol .....	29	Sjodin, Lars .....	17
Lachenal, Dominique .....	18	Peredo, Karol .....	30	Soranzo, Adrian .....	12
Laurito, Jean .....	8	Pereira, Miguel .....	26	Souza, Gustavo .....	19
Leandro do Nascimento, Juracy .....	32	Pereira, Miguel .....	27	Sukhov, Dmitry .....	21
Lehtimaa, Tuula .....	17	Pereira, Miguel .....	29	Superbi, Rita .....	30
Leif, Robertsen .....	17	Pereira, Miguel .....	29	Tamminen, Tarja .....	7
Liittä, Tiina .....	11	Pereira, Miguel .....	30	Tamminen, Tarja .....	11
Lindström , Mikael .....	8	Pereira Damasio, Renato Augusto .....	31	Tamminen, Tarja .....	12
Lino, José Mauricio .....	26	Pereira Damasio, Renato Augusto .....	31	Tamosiunas, Martha .....	19
Longue Junior, Dalton .....	23	Petit-Conil, Michel .....	12	Tapani, Vuorinen .....	17
Longue Junior, Dalton .....	27	Petit-Conil, Michel .....	21	Teixeira, Regis .....	28
Lopes, Onel .....	22	Pieri, Serrana .....	20	Teixeira, Regis .....	29
Lopez, Ana .....	27	Pikka, Olavi .....	8	Teixeira Mendonça, Regis .....	21
Lopretti, Mary .....	10	Pimenta, Leonardo .....	8	Travers , Dayana .....	10
Lopretti, Mary .....	27	Pimentel, Vanessa .....	25	Tuominen, Kari .....	26
Lopretti Correa, Mary Isabel .....	26	Piovano, Pablo .....	32	Valenzuela, Paulina .....	9
M. Barbosa, Bianca .....	19	Pouyet, Frederic .....	18	Vassallo, Miguel .....	19
M. Demonte, Luciano .....	22	Queiroz, Thaís .....	24	Vázquez, Sylvia .....	27
Machado, Fernanda Marcondes .....	24	Queiroz, José Humberto .....	27	Vega, Beatriz .....	11
Machado, Carla Goncalves .....	24	Rachid, Cecilia .....	20	Vega, Johana .....	29
Magaton, Andréia .....	22	Rafael Dos Santos, Venterim .....	31	Vehmaa, Janne .....	16
Magaton, Andréia .....	24	Ramark, Hannu .....	16	Venditti, Richard .....	27
Magaton, Andréia .....	28	Ramírez, María Belén .....	27	Ventorim, Gustavo .....	22
Mantero, Carlos .....	7	Rangel, Jesús .....	12	Ventorim, Gustavo .....	23
Mantero, Carlos .....	29	Reina, Luis .....	7	Ventorim, Priscila .....	25
Mantero , Carlos .....	6	Reina, Luis .....	29	Ventorim, Gustavo .....	29
María Cristina, Area .....	11	Resende, Thalita .....	18	Ventorim, Gustavo .....	32
Martikka, Mikko .....	15	Resene, Francine Carla Rodrigues Capelli .....	24	Ventura, Oscar N. ....	33
Martínez , Angel T. ....	10	Resquin, Fernando .....	7	Vergara, Juan Pablo .....	15
Martínez Garreiro, Jorge .....	19	Resquin, Fernando .....	20	Vergara, Juan Pablo .....	30
Masarin, Fernando .....	21	Reyes, Herna .....	26	Vianna, Viridiane .....	8
Menéndez, Pilar .....	7	Ribas Batalha, Larisse Aparecida .....	20	Vidal, Gladys .....	15
Menéndez, Pilar .....	29	Ribeiro, Adriana .....	23	Vidal, Gladys .....	30
Metais, Alexis .....	17	Ribeiro, Robisnéa Adriana .....	31	Vidal , Gladys .....	15
Milagres, Flaviana .....	28	Ribeiro Alves Junior, José Rinaldo .....	8	Vieira, Osvaldo .....	25
Milanez, Augusto .....	11	Rodrigues dos Santos, Ivan .....	23	Vihela, Tuomas .....	23
Miskimins, Bill .....	15	Rodríguez Rivero, Gustavo E. ....	30	Vinciguerra, Vittorio .....	7
Mocchiutti, Paulina .....	22	Rosa Vieira, Fernanda .....	31	Vinha Zanuncio, Antonio José .....	20
Montagna, Pablo N. ....	22	Ruuttunen, Kyösti .....	6	Vitor Matoso, Colodette .....	30
Morais de Carvalho, Danila .....	20	Ruuttunen, Kyosti .....	23	Vuan , Bruno .....	9
Morales, Gabriela .....	30	Ruuttunen, Kyosti .....	31	Vuorinen, Tapani .....	6
Moreira, Bianca .....	20	Salmenoja, Keijo .....	13	Vuorinen, Tapani .....	17
Moreira , Carolina .....	12	Sanhueza Muñoz, Karem Viviana .....	32	Vuorinen, Tapani .....	26
Näsman, Mats .....	6	Santana, Eloísa .....	20	Wennerström, Maria .....	17
Natalino Oliveira, Flávia .....	19	Santana, Eloísa .....	23	Wikstedt, Henrik .....	13
Neto, Armando .....	25	Santana, Eloísa .....	24	Wilson, Bobby .....	15
Norberto, Cassella .....	13	Santos, Rafael .....	24	Wondraczek, Holger .....	11
Noya, Carolina .....	26	Santos, Fernando .....	27	Zanúncio, Antonio .....	26
Ochoa, Cristian .....	9	Santos, Ivan .....	32	Zanuttini, Miguel A. ....	22
Ohra-aho, Taina .....	7	Savela, Miikka .....	31	Zaror, Claudio .....	27
Olavi, Pikka .....	16	Savi, Antônio Francisco .....	29	Zikeli, Florian .....	12
Oliveira, Rubens .....	25	Schelcher, Matthieu .....	12		





## SOCIAL ACTIVITIES

24/11 - 20.00 hrs.

### WELCOME COCKTAIL

SHERATON COLONIA GOLF & SPA HOTEL

26/11 - 20.30 hrs.

### FAREWELL DINNER

LA CASA DE LOS LIMONEROS (THE LEMON HOUSE).

MEETING POINT FOR TRANSPORTATION: 20.00 HRS.

## COLONIA DEL SACRAMENTO

Colonia del Sacramento is one of the major exponents of Uruguay tourism, receiving thousands of visitors throughout the year.

Just an hour from Buenos Aires by boat, and two hours from Montevideo by road, Colonia del Sacramento is a haven where the visitor finds the culture, history and magic of an inescapable fate in the Río de la Plata.

The charm of the city is linked to the particularity of its history. Founded in 1680 by the Portuguese Manuel Lobo, the city went from Portuguese rule to Spanish rule several times, until the Declaration of Independence of the Eastern Band in 1825. These events made the old neighbourhood of Colonia a pot of architectural and urban styles, with typically Portuguese and Spanish buildings.

The historic centre of Colonia del Sacramento, declared World Heritage by UNESCO in 1995, attracts tourists from around the world and is the scene of countless photographic productions that try to capture the magic of the place.

Walking through its irregular and cobbled streets lets remember history, and enjoy a unique landscape with spectacular views of the Río de la Plata.

The enigmatic Street of Sighs, paved with stones wedge has a unique charm, able to transport the visitor to a dream world.

A guided tour of the historic centre of Colonia del Sacramento will dive the visitor into the history and approach the rich cultural heritage of the city.

Museums, theatres, art, crafts and good food complement a range of possibilities for the visitor.

In addition, the city offers visitors a vast range of quality hotels, with choices ranging from international hotel chains to typical inns, housed in old colonial houses and a variety of lively and quaint restaurants.

Continuing along the boulevard of the city, which many choose to do riding a bike, you get to Real de San Carlos, ancient Spanish military enclave. There is the church of San Benito, with its image of a black saint, and where entrepreneurship Nicolas Mihanovich in the early twentieth century developed a resort to the taste of the time and now has its icon in the main Plaza de Toros.

As part of the charm of the city, Colonia del Sacramento seduces with its sunsets over the Río de la Plata full of colour and magic. The view from the lighthouse or the old dock is definitely a show that appeals to the senses.



# AERIAL MAP

**THE LEMON HOUSE**  
Phone: (598) 4523 1028



VENUE  
**SHERATON COLONIA  
GOLF & SPA RESORT**  
Phone: (598) 4522 9000



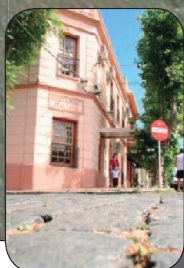
**REAL COLONIA  
HOTEL**

Phone:  
(598) 4522 1395



**LEONCIA  
HOTEL**

Phone:  
(598) 4522 2369



**ITALIANO HOTEL**  
Phone: (598) 4522 7878

Secretary:



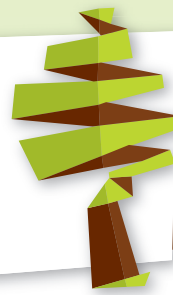
**GRUPO ELIS**  
MEETINGS MANAGEMENT

GRUPO ELIS | Meetings Management  
Palmar 2240, Montevideo-Uruguay | Tel/Fax: +598 2401 0534 al 36  
info@grupoelis.com.uy | www.grupoelis.com.uy



# 6<sup>th</sup> International Colloquium on Eucalyptus Pulp

NOVEMBER 24 – 27, 2013 · COLONIA DEL SACRAMENTO, URUGUAY



## Supported by:



## Sponsors:



## Media Partners:



[www.6thicep.org.uy](http://www.6thicep.org.uy)

[6thicep@grupoelis.com.uy](mailto:6thicep@grupoelis.com.uy) | [6thicep@fing.edu.uy](mailto:6thicep@fing.edu.uy)