



**2008
Engineering
Pulping
& Environmental
Conference

ABSTRACT BOOK**

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Table of Contents

<u>Session #</u>	<u>Session Title</u>	<u>Page #</u>
3	Optimizing Chemical and Energy Use in Mechanical Pulping	3-4
4	Nonwood Fibers from Pulp to Bleaching to Papermaking	4-5
5	Air Tutorial: Permitting for Non-Environmental Mill	5
6	Investment, Maintenance and Enterprise Transformation	5-6
7	Advances in ECF Bleaching	6-7
8	Materials from Nonwood	7-8
9	Air Emissions Control	8-9
10	Process Control - Energy Optimization	9-10
11	New Technology Showcase	10-12
12	Panel on Oxygen Delignification Operating Experience	12
14	Odor Control From ASBs	12-13
15	Reliability	13
16	Recovered Paper Quality	14
17	Pulp Bleaching Topics	15
18	Recovery Boiler Fouling and Sootblowing	16
19	Update on Nutrient Issues	16-17
20	Black Liquor and Recovery Boiler Corrosion	17-18
21	Pulping and Fiber Quality Issues	18-19
22	Micro-stickies Panel	19

Table of Contents

<u>Session #</u>	<u>Session Title</u>	<u>Page #</u>
23	Recovery Boiler Operations & Emissions	20
24	Water: Will we be able to keep using all we want? Panel Session	20-21
25	Reliability Workshop	21
26	Pulping Issues with Mountain Pine Beetle Killed Wood (I)	21-22
27	Recycling Research	23-24
28	Evaporator Design & Operation	24
29	Water & Air Quality: Sustainability Panel	25
31	Pulping Issues with Mountain Pine Beetle Killed Wood (II): Panel Discussion	25
32	Recycling Developments	25-26
33	BioRefinery & Kraft Pulping: Hemicellulose Extraction Operations	26-27
34	Bioenergy	27-28
35	Protecting Your Assets: Managing Corrosion and Cracking	29
37	Biomass Gasification & Pyrolysis I	30
38	Ask the Recycle Mill Gals	31
39	Biomass Gasification & Pyrolysis II	31-32
40	Materials Issues Not to be Overlooked	32
Bridge Session II	EPE/IBBC Bridge Session II	32-33
Bridge Session III	EPE/IBBC Bridge Session III	34

3.1 “Process and Chemical Synergies for Reducing Southern Pine TMP Energy Consumption”

Marc Sabourin, Andritz Inc.; **Bill Elliott, D. Dreisbach**, Southern Ionics

Thermomechanical pulps were produced from southern pine on the pilot-scale using a combination of pressurized chip destructuring (RT-), high intensity refining (RTSTM) and neutral sulfite chemical treatments. Significant energy savings were available with the chemical treatments applied to the RT-RTSTM process. Additional energy savings were realized, up to 27%, when substituting a stage of high consistency refining with multiple stages of low consistency refining. Conventional TMP pulps produced with neutral sulfite treatments applied at the primary refiner inlet demonstrated a reduction in pulp tensile strength, most probably related to inefficient sulphonation. The neutral sulfite treatments had a positive impact on extractives content and pulp brightness. A 3% increase in brightness compared to the control pulps was obtained for each 1% application of neutral sulfite (as SO₃). Alkaline peroxide post bleaching of the neutral sulfite treated series resulted in a higher final brightness relative to the control pulps. Results from this investigation reveal that process and chemical synergies are available for reducing three of the most costly components associated with thermomechanical pulping of southern pines: energy consumption, wood extractives, and bleaching chemicals.

3.2 “Refining Energy Reduction and Pulp Characteristic Modification of Alkaline Peroxide Mechanical Pulp (APMP) through Enzyme Application”

Peter W. Hart, Darrell M. Waite, MeadWestvaco Corporation; **Luc Thibault, John Tomashek, Marie-Eve Rousseau, Christopher Hill**, IOGEN Corporation; **Marc J. Sabourin**, Andritz Corporation

Eucalyptus wood chips were subjected to impregnation with various blends of novel fiber modifying enzymes prior to chemical pretreatment and two stages of refining using the PRC-APMP process. All of the wood chip impregnation and pulp processing was conducted at the Andritz Pilot Plant in Springfield, Ohio. When compared under constant chemical application and at a constant 350 mL CSF, an enzyme treatment was found to reduce specific refining energy by at least 25%. Several physical properties including bulk, tensile, and tear were monitored for the enzyme and the non-enzyme runs. Brightness of each of these pulps was also measured.

3.3 “Use of Urea as an Additive in Kraft Pulping of Eucalyptus”

Pratima Bajpai, Thapar Centre for Industrial Research & Development; **Sandeep Tripathi, Nirmal Sharma, Om P. Mishra, Pramod K. Bajpai**, Thapar Centre for Industrial Research & Development

Due to the increasing cost of raw materials and tough competition in the paper market, it is desirable to increase the yield as well as quality of the product. Some new technologies are available in the market to improve pulp quality and pulp yield during pulping like RDH, SuperBatch and modified continuous cooking, but they require huge capital investments. Another approach for improving pulp quality and pulp yield is the use of some cellulose protectors as pulping additive. Chemicals like polysulfide, anthraquinone and surfactant combinations, aromatic diamines, phosphonates and borate/sodium borohydride are reported to increase the pulp yield by 2-6%.

In this study, use of urea as an additive during kraft pulping of eucalyptus has been studied. Impact on unbleached pulp properties, black liquor properties, refining energy requirement and physical strength properties of unbleached pulp, bleachability of pulp, refining energy requirement and physical strength properties of bleached pulp has been studied in detail. Using 0.2-1.0% urea during pulping, unbleached pulp yield increased to 47.6-48.2% from 47.2% (control); unbleached pulp viscosity increased to 15.4-15.5 Cp from 13.4 Cp. Black liquor properties also improved after using urea; viscosity of black liquor at 52% solids reduced to 72.4-75.8 Cp from 105.2 Cp and swelling volume ratio increased to 92.1-93.2 ml/g from 86.7 ml/g. Refining of unbleached pulps

produced with and without urea in pulping to different CSF levels showed that urea pulp required 12-20% less refining energy to get 500 ml CSF. Pulps produced with urea showed better physical strength properties particularly tensile index, burst index and stiffness.

Bleachability of pulps produced using urea was better compared to the reference pulp (without using urea). There was improvement in final pulp brightness by 0.6 -1.2%, whiteness by 1.9 -2.9% and increase in bleached pulp viscosity by ~1 Cp. Refining energy requirement was lower in case of urea pulps (at same CSF level) as compared to the pulp produced without urea. Physical strength properties of urea pulps were found to be better than the pulp produced without urea. Urea pulp required 12-20% less refining energy to get 500 ml CSF. Tensile strength and bursting strength of urea pulps was ~10% higher and stiffness was 13-30% higher in comparison to the pulps produced without urea.

It can be concluded that use of urea as an additive in kraft pulping of eucalyptus improves pulp yield, pulp viscosity and physical strength properties of unbleached and bleached pulp. It also improves black liquor properties, and bleachability of the pulp and reduces refining energy requirement.

4.1 “Determination of the Permeability Parameters of Bagasse Pulp from Two Different Sugar Extraction Methods”

Thomas J. Rainey, W.O.S. Doherty, R.J. Brown, N.A. Kelson, Queensland University of Technology; **D.M. Martinez**, University of British Columbia

The permeability, the specific surface area and the swelling factor have been determined for Australian bagasse pulp derived from bagasse from two different sugar extraction processes. The sugar extraction process was not found to affect the permeability of the pulp. The results for bagasse pulp are compared to those of eucalypt pulp, which is widely used in Australia for paper manufacture. The fibre length distribution showed a high fraction of small fibres in all of the bagasse pulp samples. Surprisingly, the permeability properties of the bagasse pulp samples were better than that of eucalypt. It is presumed that this is due to the relatively large fraction of longer fibres in the bagasse pulp compared to the eucalypt pulp.

4.2 “Effect of Cooking Conditions and Oxygen-Delignification on Bamboo”

Hayedeh Rahmati, P. Ebrahimi, Farshid Faraji, M. Sedghi, Gorgan University

Bamboo is fast growing and has long, thin fibers and therefore has potential as a raw material for pulping and papermaking. The study concerned on the influence of cooking liquor parameters as independent variables, i.e., active alkali (18, 21 & 24%) and sulfidity (0, 15 & 30%) on the properties of pulp produced with kraft pulping from Thai bamboo (*Bambusa Tulda*) by means of multivariate analysis. Besides that, oxygen delignification were studied in this research. The multiple linear regression (MLR) of independent and dependent variables were conducted with SPSS software using least square method. Then, in order to optimize process, Pareto-Optimality method was employed. The obtained regression models were characterized by both descriptive and predictive ability ($R^2 \geq 95\%$ and $R^2_{cv} \geq 93\%$) and allowed the kraft pulping process with a acceptable viscosity (1110-1190 ml/g) and a total yield about 50% at a sulfidity level of 15-30% with 18% AA. Higher alkali charge can get lower yield, lower kappa number, lower viscosity. Higher sulfidity can obtain lower yield, higher viscosity. In general, higher sulfidity at lower Active alkali was caused higher yield and vice versa. Also It was further shown that bamboo kraft pulp was easily delignified by Oxygen delignification to a low kappa number (11-13) without any significant loss in yield.

4.3 Industry Update of Nonwood Usage in Papermaking

Shijie Liu, SUNY College of Envr. Science & Forestry

A roundtable discussion on the status and current efforts in expanding the use and role of nonwood fiber in paper related products.

5.1 PSD Regulatory Update Training

Tammy R. Wyles, Georgia-Pacific LLC

This session presents an overview of air permitting triggers and concerns for projects at forest products facilities. There will be extensive discussion around the new applicability accounting rules and the narrowing of the routine maintenance, repair, and replacement (RMRR) exclusion under the federal PSD rules. The tutorial will also present information on the overall impact of air permitting on project timing and construction activities that may be allowed to take place prior to issuance of a PSD permit.

6.1 “Equilibrium with Time-To-Build in a Competitive Investment Environment: A Real Options Approach to Investment Decision Making in the Pulp and Paper Industry”

V.R. Parthasarathy, Weyerhaeuser Company

The financial objective of a corporation is to maximize shareholder value. Assuming that basic premise is nearly completely true, investment project analysis is synonymous with investment project valuation: investment in projects should be accepted if and only if their value exceeds their cost, so as to increase the wealth of shareholders. Investment in new plants or new products or new markets always happens under conditions of uncertainty. Most of the corporate investment decisions are made with the assumption that investment strategies can be formulated fairly well by accounting for the underlying risk (uncertainty) through Discounted Cash Flow – Net Present Value (DCF-NPV) analysis. Making use of two of the fundamental characteristics of many real-world investments - (i) investment takes time to build, and (ii) investment strategies take place in a competitive context and cannot be formulated in isolation - Real Options Method (ROM) provides a better approach to derive a dynamic competitive equilibrium for investment decisions in an industry like Pulp and Paper. However, such equilibriums are complicated by a potentially infinite state space, as future prices depend not only on completed supply, but also on the previous entry times of units in the supply pipeline. This paper synthesizes the equilibrium with time-to-build with competitive strategy in a real options valuation model as a realistic approach to making investment decisions in the Pulp and Paper Industry. Several interesting aspects of equilibrium are discussed and conclude that equilibrium asset values are path dependent, and equilibrium entry strategies are always conditional on a finite transformation of the original state space.

6.2 “Beyond RCM”

Roger Borycki, Georgia-Pacific

The manufacture of pulp and paper is evolving. Concepts such as TPM, Six Sigma, Lean, RCA, RCM, have been integrated in to the business processes of the industry. All these improvements support one final goal that of ensuring the survival of the company by making profitable products that customers purchase.

To this extent, improvements in maintenance systems to reduce production downtime and maintenance cost have been a primary focus. The current best practice is reliability centered maintenance with its disciplined approach to evaluating equipment risk and the application of mitigating programs (predictive and preventative measures).

Downtime is just one of the elements of a site's loss function. The concept of overall equipment efficiency (O.E.E) involves 100% availability at 100% speed producing 100% quality product, 24 hours per day for 365 days a year. The technical aspects of equipment capability and condition have for the most part been neglected when discussing speed and more so for quality.

This paper introduces concepts such as process mapping and a method of linking customer quality specifications, operator controls and adjustments, through to equipment performance and critical part condition.

6.3 “Value Destruction, Creation and Capture”

Jacquelyn McNutt, Colleen Walker, CPBIS

Declining performance over the past three decades plus has culminated this decade in the paper industry gaining a poor reputation among investors as a result of its ineffective and inconsistent record of meeting return on capital minimal needs and the resulting burgeoning debt loads. This has led to widespread pessimism, both within and outside the industry. Yet there is light at the end of the tunnel: Existing conditions mitigate in favor of growing paper, paperboard, and pulp supply constraints, a circumstance the industry can turn to its advantage. To do so, however, we need to go beyond short-term fixes such as consolidation and intermittent fixes such as periodic capital asset management steps. We must place greater emphasis on understanding externalities that impact the industry's bottom line and, more important, we must pursue the goal of enterprise transformation by changing *the way we work from the shop floor up and across the entire enterprise across time and in a sustainable way*. A case study is presented to demonstrate that this is indeed possible. We must also be vigilant regarding the current domestic economic stagflation potential impacts on this newfound paper industry potential in terms of possible short term end products demand drops and escalating energy related cost pressures.

7.1 “Chlorate Reduction in Eucalyptus Pulp Bleaching”

Authors: **Jose Medina, Tuula Lehtimaa, Tapani Vuorinen**, Helsinki University of Technology; **Pekka Tervola, Janne Vehmaa, Olavi Pikka**, Andritz Oy

An oxygen delignified eucalyptus kraft pulp was bleached with four alternative sequences (D-E_p-D_ND, A/D-E_p-D_ND, D_{HT}-E_p-D_ND, A-E_p-D_ND) to a target 90 % ISO brightness. Among these sequences, A-E_p-D_ND was characterized by the lowest values for active chlorine consumption (19.5 kg/adt), AOX formation (0.10 kg/adt) and chlorate formation (2.3 kg/adt). The extent of chlorate formation was unaffected by its initial concentration in the bleaching filtrate. Relatively more chlorate was formed in the final bleaching stage which indicated that a reaction between hypochlorous acid and chlorite was the main source of chlorate. In the A-E_p-D_ND sequence chlorate is enriched in a single filtrate which makes its biological or chemical treatment attractive for reducing chlorate to harmless chloride.

7.2 “Balancing Chlorine Dioxide and Peroxide in North American ECF Bleaching Sequences for Softwood Kraft Pulps”

Brian N. Brogdon, FutureBridge Consulting & Training, LLC

This investigation examines how oxidative alkaline extraction can be augmented through process condition changes, and how this augmentation can be leveraged to optimize chlorine dioxide usage and bleaching costs with elemental chlorine-free (ECF) sequences. The effects peroxide reinforcement and elevated extraction temperatures (>70°C) are not additive when both are used to lower post-extraction kappa number. This likely reflects competing physical and chemical mechanisms involved, and which modes are dominant at 70 to 80°C versus 90°C. The economic advantages of peroxide reinforcement in 70°C (EOP) or 90°C (EO) are predisposed by the

brightness targets, short or long bleach sequences and mill energy costs. It is observed that approximately 55 to 65% of the total chlorine dioxide used in an ECF sequence should be applied in the D0-stage.

7.3 “Mixed Brazilian Eucalyptus and Pinus Species - Bleaching Evaluation”

Francides Gomes da Silva, Flavia Schmidt, University of São Paulo; **Ana Gabriela Monnerat Carvalho Bassa, Marcelo Rodrigues da Silva, Alexandre Bassa, Vera Maria Sacon**, Votorantim Celulose e Papel

Eucalyptus fiber is shorter in relation to softwood species. These short fibers are useful in improving paper formation, but strength properties are better when long fibers are used. Most Brazilian pulp production uses eucalyptus species as raw material. Pulp production from softwood is concentrated in the south of Brazil due to the suitability of its climate for growing pine species. Looking for the possibility of obtaining pulp with adequate properties for formation and strength, this paper analyzes results of kraft pulp bleaching by the (OO)(AD)EopDP bleaching sequence, using pulps produced with mixtures of *Eucalyptus grandis* x *Eucalyptus urophylla* hybrid and *Pinus taeda* wood chips, and *Eucalyptus globulus* and *Pinus taeda* wood chips. Target brightness was 88.5 ± 1 % ISO. Chlorine dioxide consumption of the *Eucalyptus* tested was around 10 kg ClO₂/odt. For the mixtures of eucalyptus and pine in the proportions of 10% up to 50% pine, it varied from 11.2 up to 16.2 kg ClO₂/odt, increasing as the proportion of pine wood chips increased in the mixtures. Hydrogen peroxide consumption varied from 5 to 8 kg H₂O₂/odt for the pulps analyzed. Total active chlorine consumption for *Eucalyptus globulus* was 40.4 kg/odt, while for the *Eucalyptus grandis* x *Eucalyptus urophylla* hybrid it was 41.1 kg/odt. In the mixtures it varied from 41.9 up to 64.5 kg/odt, the consumption of the mixture of the *Eucalyptus grandis* x *Eucalyptus urophylla* hybrid and *Pinus taeda* being higher. For *Pinus taeda*, active chlorine consumption was 76.5 kg/odt. Viscosity values had a tendency to decrease as the proportion of pine increased in the mixtures. Brightness reversion varied from 1.7% to 2.5% ISO in the mixtures. In conclusion, manufacturing units that want to produce a differentiated kind of pulp with a high resistance to tearing, to get higher productivity from paper machines, or even to produce special, low-gram papers, must consider the addition of small proportions of *Pinus* to *Eucalyptus*.

8.1 Lignin From Formic Acid Hydrolysis of Wheat Straw

Shijie Liu, Department of Paper and Bioprocess Engineering, SUNY ESF

Conversion of lignocellulosic biomass to chemicals and energy is imperative to the future of our economy. 86.24 wt% formic acid solution with 0.2 M H₂SO₄ as catalyst was used to isolate the lignin of de-waxed wheat straw at different residence times and reaction temperatures. Lignin was extracted and purified separately from hydrolysates and residual solids after treatment. The lignin obtained has been characterized by FTIR (Fourier transform infrared), GPC (Gel permeation chromatography), and ¹H NMR (Nuclear magnetic resonance). Results from these analyses indicated that oxidative cleavage of bonds in the lignin macromolecule has occurred during the formic acid treatment, leading to formation of oligomers of lignin with lower molecular weight. Moreover, it was found that guaiacyl unit is the main structure, the content of syringyl unit is higher than that of the hydroxybenzyl unit and β -O-4 together with β -5 ether bonds is also identified in the molecular structure of lignin of wheat straw obtained from the formic acid process.

8.2 “Study on the Cuticle of Reed Stem by Means of SEM-EDXA”

Chunxia Chen, Hailong Ou, Dongguan Supervision Testing Institute; **Yugui Qiu**, South China University of Technology

The ultra-structure and distribution of the mineral elements of the cuticle of reed stem are studied by means of SEM-EDXA. The results show that, the surface layer of the cuticle of reed stem consists of three structures, i.e. the flake-like structure, the conjunctive tissues between flake-like structures and the granular structure. The outer-surface of the cuticle is composed of three major elements, i.e. C, O & Si. The silicon content is very high in different structures of the outer-surface of the cuticle, up to 50~55%. There are two sorts of longitudinal-sections of the cuticle, one with a stiff structure, the other porosity. The aforesaid flake-like structures are practically the longitudinal tube-form cells with thickened wall. Obviously, these are quite different from the cuticle of stem of bamboo or wheat straw. The marked distinctions of atomic ratio of Si and other mineral elements in different parts of the cuticle of the internodes indicate the evident differences among the silicides and chemical states of elements concerned, and the silicides in outer-surface of the reed stem cuticle are mostly inorganic.

8.3 Material Resources from Nonwood

Jairo Lora, GreenValue S.A.

A roundtable discussion on the material resources of nonwood.

9.1 “Experimental Study of Dioxin Formation and Emissions from Power Boilers Burning Salt-Laden Wood Waste”

Wenli Duo, Vic Uloth, Ibrahim Karidio, Denys Leclerc, Joe Kish, Doug Singbeil, FPInnovations - Paprican

Dioxins (PCDDs) and furans (PCDFs) are groups of substances known to be toxic. The Canada Wide Standard (CWS) has set a stack emission limit of 0.1 and 0.5 ng TEQ/m³, respectively, for new and existing facilities. To help the affected Canadian mills meet these limits, an extensive research project was carried out between 2000 and 2003. The investigations involved experimental and survey studies on nine full-scale power boilers. This report presents the survey results obtained from eight coastal mill boilers and one interior boiler. In addition to stack PCDD/F emissions, many other stack emissions and ash analyses were also tested.

A total of 112 stack dioxin tests were reported. Dioxin emissions varied significantly between individual tests on a given boiler and between boilers at different pulp mills. Stack dioxin emissions for the power boiler at the interior mill are 2 to 3 orders of magnitude lower than typical emissions from a coastal mill. However, a lower hog salt content does not mean lower dioxin formation and emissions. The average emission levels tested in 2002 were generally lower than those tested in the previous two years. Measures taken to control PCDD/F emissions include improved boiler operations, minimized gas/oil firing, adding coal and TDF, and successful trials of other dioxin control techniques.

9.2 “Membrane WESP-The Lowest Cost Technology for Fine Particulate Control to Meet Boiler MACT”

Hardik G. Shah, John C. Caine, Southern Environmental, Inc.

Multi-pollutant control technologies will become more important in the future. This new membrane wet electrostatic precipitator (WESP) system is ideally suited to and very cost effective for, removing PM_{2.5} and SO₃ after industrial boilers and wood products dryers.

WESP can readily collect acid aerosol and fine particulate due to greater corona power and virtually no re-entrainment. The main historical limitation associated with wet precipitators has been the higher cost of special alloys and stainless steel material used in their manufacture. This new technology WESP, based on fabric membrane for the collecting electrodes, dramatically reduces weight and cost, compared to conventional, metallic WESPs.

Cleaning of the corrosion resistant fabric membranes, is facilitated by capillary action between the fibers, providing even water distribution, & continuous flushing, which removes collected material without spraying, so the entire precipitator remains on line.

Operation of several pilot units using the membrane technology has demonstrated excellent PM removal efficiency. The first commercial size unit, collecting fine particulate and sulfuric acid mist after two boilers firing No. 6 oil with 4% sulfur, shows high SO₃ removal as well. The operation and performance of this two-module, upflow, membrane, single-field unit, along with some of the problems encountered and overcome in the start-up, will be described.

9.3 Boiler MACT Standards - A Status Report

Tammy R. Wyles, Georgia-Pacific LLC

The Boiler MACT rule is a major rule impacting many industrial sources, as well as potentially municipalities and institutions. The original rule, promulgated in 2004, was challenged and ultimately vacated. This presentation will discuss the new schedule and the activities that are underway in developing a new Boiler MACT rule.

10.2 “Energy Management and Reporting System (EMRS) Provides Sustaining Performance Improvements in Energy Intensive Industries”

Cliff McClain, James E. Robinson, DES Global, LLC

Experience has shown that significant opportunity for performance improvements exists in energy intensive operations such as a Pulp & Paper Powerhouse. Often, efforts to improve efficiency focus on vendor-led initiatives to improve operations of particular equipment. This approach assumes the overall efficiency of the system is simply a function of the individual units. However, many more factors contribute to overall performance improvement. These external factors contribute greater weight to poor performance than do equipment efficiency issues. A common example is operator discretionary actions that can cause a very efficient process to run ineffectively. Rulebased Energy Management and Reporting Systems (EMRS) have proven themselves capable of overcoming the human factors that limit overall system performance. The EMRS is capable of applying the process manager’s judgment at all times, capturing transient opportunities as they arise. Reporting systems change the process performance reporting paradigm from “How did we do?” to “What prevented us from doing better?” Changing the reporting perspective is key for maximizing performance over time as well as forming an operating culture that is focused on continuous improvement. Typical returns on this class of system are in excess of US\$1.5 Million/Year.

10.3 “Advanced Tie Line Control for Real Time Pricing (RTP) and Waste Fuel Cogeneration”

James E. Robinson, DES Global, LLC

Industrial cogeneration facilities are finding electrical procurement contracts with Real Time Pricing (RTP) tariffs attractive. Under RTP tariffs electricity consumers are charged prices that vary over short periods of time, typically an hour, to reflect the actual cost of generation and transmission. By accepting a portion of the variable energy cost risk, the industrial can reduce the average cost of electricity procurement. From the utility perspective, RTP pricing signals can

shape load demand profiles by clipping demand peaks and filling valleys to reduce generation variability and reduce cost. For the regulatory organizations RTP applied to facilities with biomass or waste heat applications may provide a utility loading order of resources to satisfying emerging statutory or regulatory mandates. While this may be a Win-Win for all parties, it does increase operating complexity at a time of a decreasing number of operators making an increasing number of decisions without adequate training or management oversight. This paper presents an effective solution consisting of an expert rule based fuzzy logic control system with an operator advisory and constraint reporting systems. These projects are known to return in excess of \$1M/Year.

10.4 “Combustion By Design - Practical Kiln Optimization”

Richard Manning, Chris Sansom, Zhi Xu, Kiln Flame Systems

For many years, recaust specialists have used empirical "trial-and-error" techniques to optimize lime kiln operation. In reality, for a wide range of reasons, every kiln operates differently, even if mechanically they appear to be identical. This paper discusses the process simulation tools and techniques which are available to analyze and optimize the lime kiln operation including the use of mass and energy balances, aerodynamic and combustion modeling, 2 dimensional heat transfer modeling and computational fluid dynamic.

11 New Technology Showcase

“Screw Presses That Fly”

Fred White, Vincent Corporation

As mills look for more ways to reduce and/or utilize mill, residuals, liquids/solids separation equipment becomes even more important. Our new line of economical presses and fiber filters provide cost-effective solutions for white water rejects, knots, shives, sludge, broke-tank thickening, etc. P.S. They don't really fly.

“Luminescent Oxygen Sensor”

Speaker – TBA, Hach Company

Traditional dissolved oxygen analyzers use polarographic sensors and require membrane and electrolyte replacement. These instruments were known for their maintenance complexity, as well as flow dependence and frequent calibration needs. A new oxygen sensor has been developed based on luminescent technology. The main advantages of luminescent technology over electrochemical cells are the operator independence of the calibration, the low flow requirement, the absence of flow dependence, and of course the drastic reduction of the maintenance activities. LDO (Luminescent Dissolved Oxygen) is now available in ppb range for boiler water, ppm range for wastewater and lab version for BOD5.

“Water is the Key- Lifeblood of the Pulp and Paper Industry”

Pierre F. Rutz, Algas FTS

Algas Microfilters, newcomers to North America offer super clear filtrate to replace fresh water even on HP showers – instant fiber recovery – similar application for primary effluent treatment. Major savings in operating and maintenance costs, power and chemicals savings-role of gmd possible.

“New Feedstock Technologies for Biomass”

D. E. White, Herty Advanced Materials Development Center

Each “energy conversion process” requires a different and unique feedstock for optimum cost effective energy production. Optimizing the biomass value chain from field to conversion is key to ensuring a profitable, renewable energy industry. Combustion, pelletization, torefaction, synthetic gas, fermentation, liquid fuels – all require unique and optimum characteristics of moisture, particle size/shape/density, ash, BTU, carbon, sugar- yielding consistent, abundant and cost effective feedstocks

Herty provides a hub location to develop at pilot and full commercial scale, the processes and equipment required to develop this new and growing industry, where financial energy yield rather than financial fiber yield is the primary objective. Herty’s capabilities include:

- Harvest and Pre-Processing
 - Pilot wood yard
 - Chippers, grinders
 - Chip pile investigation
- Fuel Laboratory
 - Particle size analysis
 - Thermal analysis
 - Physical and elemental analysis
 - Extractives
- Densification, Drying and Resizing; Dry Processing
 - Hammer mill
 - Air and radiant

“Nalco SCALE-GUARD® PLUS Complete Scale Management Technologies for Bleach Plant Scale Control”

S.M. Shevchenko, P. Y. Duggirala, B.P.Duffy, Nalco Company

Nalco complete scale management technologies for bleach plants (SCALE-GUARD® PLUS technologies), are based on a new synergistic approach combining deposit monitoring **and** control technology. Nalco combines tailor-made, proprietary chemical programs, new monitoring and control technology, and most importantly mechanical, operational, and chemical (M-O-C) best practices. Deposit inhibitors are developed for major scale types (such as calcium carbonate, calcium oxalate, barium sulfate). Application of chemical inhibitors allows reduction of the operational cost and minimizing the effect of wood supply variability on the mill operation, and prolongs the time between shutdowns for cleaning.

“The New Techpap NIR spectroscopy for Recycled Bale Inspection”

Yan Luo “Pheobus”, Techpap Inc.

It has become increasing necessity for papermakers to control, at delivery, recovered paper bales to ensure raw material quality and to pay the right price. This means that the papermaker is crucially interested in such things as measurement of humidity in the bale, the detection of unusable materials (metals, plastics, etc) and finally the distinction of different raw materials (paper / board). The objective of the CTP/Techpap NIR Spectroscopy project is to develop an easy-to-use sensor to detect humidity and unusable materials in recovered paper bales at delivery. This device would also need to determine the recovered paper type, board or paper. The NIR Spectroscope would need to be direct in application, give rapid information, be objective, be reliable and of course affordable. To do that, we are developing a sensor based on a new approach for this industry. This approach is to implement a core-drilling device take a sample from the bale

and to use Near Infra-Red (NIR) Spectroscopy technology to evaluate the sample. Our objective in this important CTP / Techpap / SMS project has been met and instruments are demonstrations or testing. Techpap also offers a special evaluation program to look at moisture and contaminants at bale receiving.

“Direct Steam Injection”

David Strick, Hydro-Thermal Corporation

The Solaris®, an inline Direct Steam Injection heater uniformly heats stock consistencies up to 14%. High velocity steam, injected into the stock provides uniform temperature throughout the stock without requiring mechanical mixing apparatus. Uniform heating of medium consistency stock, improving runnability and bleaching and reducing energy needs for these processes by 30% has been demonstrated. In addition, the Solaris is being used in pilot and research programs for cellulosic pre-treatment of wood fibers and mill residues during Biofuels production.

12.1 Panel on Oxygen Delignification Operating Experience

Mitzi England, Weyerhaeuser, **Andrew Kulchin**, Evergreen, **Tom Harms**, Potlatch, **Phil Campbell**, Georgia-Pacific, **Richard Penn**, Domtar

This panel discussion has been designed to foster a free exchange of information on operating oxygen delignification systems. Topics to be discussed will include system features and performance, solutions to operating problems, and any plans for modifications or expansion. The five panelists represent mills having various types of oxygen stages. To set the stage for the discussion, each panelist will make a brief presentation on his or her system. After all of the panelists have made their presentations, audience members will be invited to make further contributions or to elicit more information by asking questions of the panel. The goal of the session will be to educate all present, providing both the presenters and the audience with information they can use to improve their operations.

14.1 “The Sulfur Cycle and Regulatory Limits”

Michael R. Corn P.E., **John Michael Corn, P.E.**, **Paul J. Marotta, P.E.**, AquAeTer Inc.

Sulfur dioxide ambient air standards have been established for many states across the country. The primary driver for these is odor control. Discussion on hydrogen sulfide formation, regulatory limits which might impact your mill, and how to control hydrogen sulfide emissions will be presented. Bench Scale study data on how controlling hydrogen sulfide emissions may also provide additional improvements in effluent BOD5 concentrations will also be presented.

14.2 “Update on NCASI Sulfide Oxidation Research”

Steve Stratton, **Ken Ramage**, **James Palumbo**, NCASI; **Lin Brown**, Tufts University

Hydrogen sulfide (H₂S) emissions from a variety of operations including wastewater treatment plants have come under increased scrutiny of late due to their potential to create nuisance odors and other impacts. Quantifying H₂S emissions may be important where such issues occur, to establish a basis for evaluating both impacts and potential remedies. However, emissions from ground level area sources such as wastewater treatment plants are difficult and expensive to measure directly. Models based on mathematical descriptions of the relevant physical, chemical and biochemical transformations can be used to predict emissions more cost-effectively than making such measurements. Understanding and characterizing these transformations is the first step towards building useful predictive models. NCASI is working to develop such information with respect to H₂S and has recently completed an assessment of the stoichiometry and kinetics of the chemical and biochemical oxidation of dissolved sulfide in aerobic wastewater treatment

systems used to treat pulp and paper industry wastewaters. Bench scale studies were performed using mill wastewaters to develop rate equations and parameters for sulfide oxidation occurring in these biological systems. This presentation will discuss the design and results of these studies and the resulting mathematical model development.

14.3 WWTP Reduced Sulfur Emission Measurements

Ashok Jain, NCASI

As a part of a study aimed at quantifying the emissions of reduced sulfur gases from wastewater treatment system components, NCASI measured ground level concentrations of hydrogen sulfide, methyl mercaptan, dimethyl sulfide and dimethyl disulfide at a number of mills. Most of the tests were carried out using passivated canisters followed by GC/PFPD analysis. Three on-site hydrogen sulfide measurement instruments, including a Jerome Analyzer, a Cavity Ring-Down Spectrometer, and an open-path tunable diode laser spectrometer, were also used to measure the hydrogen sulfide concentrations during some of the tests. The results of the study showed that in most instances, the levels of the reduced sulfur compounds around the wastewater treatment systems were well below 50 ppb. The results of the Jerome Analyzer and the Cavity Ring-Down Spectrometer agreed reasonably well with the canister measurement. The open-path tunable diode laser spectrometer generally did not have the sensitivity to quantitatively measure the hydrogen sulfide concentrations around the wastewater treatment systems. This paper will discuss the findings of this study.

15.1 “Rotary Kiln Alignment Methods - A Comparative Study”

John H. Ross, Metso Minerals Inds., Inc.

In today's business climate, it is important to make wise investments in the area of spending maintenance dollars and it falls upon maintenance planners/managers to understand the value of predictive and preventive maintenance. In the various industries that employ rotary kilns, a kiln alignment is an important aspect of determining the mechanical efficiency of this valuable component. The purpose of this paper is to discuss and compare the various types of alignments that are being performed in the industry; with the intentions of assisting the maintenance department in making the right decision on when and why to do kiln alignments.

15.2 “A Roadmap for Reliability Excellence”

Wayne Long, BE&K Industrial Services

To establish a reliable maintenance program for new equipment, a number of activities have to be performed. These activities are complimentary for all industries, and include the following:

- Define and develop maintenance strategies and programs
- Establish parts/stores control programs
- Determine maintenance management support systems
- Develop/implement the maintenance training and certification processes
- Manage maintenance participation in commissioning and start-up activities

A company recently performed this effort on a \$440,000,000 modification of a power plant. An overview of their successful activities, including identified savings is presented below.

16.1 “Measurement of Microstickies”

Mahendra Doshi, Robert de Jong, Salman Aziz, Doshi & Associates; **Carl Houtman**, USDA Forest Products Laboratory

Stickies continue to pose considerable problems to the paper industry. Adequate management and control of stickies is necessary for the economic health of the industry. In order to properly manage and control stickies a reliable, reproducible and quick method is needed to measure the concentration of stickies.

Recent technological advances allow modern mills to efficiently remove macrostickies. Most current stickies problems are caused by microstickies that pass through slotted screens. Microstickies tend to accumulate and agglomerate in the paper machine water loop followed by deposition on paper machine wires, felts and dryer cans.

Our objective here is to demonstrate the applicability of a new macro/ microstickies measurement method. A special feature of the method is that the concentration of macrostickies and microstickies can be measured from a single pulp slurry or white water sample. The method worked successfully in the laboratory. Here we plan to demonstrate the applicability of the method with mill samples.

The test method can be quite useful in evaluating the impact of various unit operations such as pulping, screening, cleaning, washing, flotation and dissolved air flotation on microstickies generation and removal. Additionally, the effect of synthetic adhesives, coating chemicals and pacifying additives on paper recycling may also be evaluated by using this method.

16.2 “The Fate of Silver from Recycled Printed Electronic Circuits”

John H. Cameron, Nural Yilgor, Jan Pekarovic, Western Michigan University

Printed electronic circuits will significantly decrease the cost of radio frequency identification devices (RFID). Since printed circuits are relatively inexpensive, Das and Harrop (1) estimate that printed devices can capture over 60% of the RFID market by 2017. Silver is currently the conductive material used in these printed circuits. Possible printing processes include either silver flake or silver nanoparticles with solvent based, water based or UV curable binders. This research studies the fate of flaked or nano particle silver printed with the different binders. Methods for analyzing silver from a paper sample were developed. It was found that the silver separates from the fibers during repulping and becomes part of the fine fraction.

16.3 “Incoming Recovered Paper Quality Control”

Robert de Jong, 2 Fiber Consulting

Reviews of some different incoming recovered paper quality control methods, procedures and tests are provided based on visits to mills in the USA and Europe. Visual inspection, bale audits, laboratory tests, and source monitoring are discussed. Contaminant levels in recovered paper from multiple stream versus single stream collection are compared. Recovered paper inspection procedures can help reduce downtime for stickies; help identify sources with too many contaminants; and can help calculate yield and improve final quality. The value of these benefits should be tracked to justify the expense of more incoming recovered paper quality control.

17.1 “Towards Overcoming the Brightness Ceiling of Mechanical Pulps Prepared from Blue-Stained Lodgepole Pine Chips”

Thomas Q. Hu, Trevor Williams, Shabnam Yazdi, Lars Wallbacks, FPInnovations – Paprican;
Paul Watson, Canfor Pulp Limited Partnership

The initial brightness of TMP and CTMP prepared from chip blends containing mountain pine beetle-infested (kill date = 2-3 years), blue-stained lodgepole pine is up to 5.0 ISO points lower than that of the pulps made from the green chips. Paprican’s VIS-NIR system is capable of accurately predicting the blue-stained chip content in the chip blends on a pilot-plant conveyor.

TMP made from chip blends with various blue-stained chip contents all have lower sodium hydrosulfite (Y) bleach response than pulp made from the green chips. A method to overcome the brightness ceiling of Y-bleached TMP made from a chip blend with 25% blue-stained chip content has been developed. The method involves the addition of 0.2% (o.d. pulp) of sodium borohydride to Y bleaching of the pulp.

A high bleaching end pH (~10.0) in alkaline hydrogen peroxide bleaching removes most to all of the blue stain in TMP made from the blue-stained chips. Under optimal peroxide bleaching conditions, TMP made from 50% blue-stained chips or CTMP made from 100% blue-stained chips was bleached to the same brightness as TMP or CTMP from green chips. TMP from 100% blue-stained chips was bleached to within 0.8 brightness points of TMP from green chips.

17.3 “Caustic Extraction in Elemental Chlorine-Free Bleaching Sequences for Softwood Kraft Pulps: A Fundamental Review and Analysis”

Brian N. Brogdon, FutureBridge Consulting & Training, LLC

The alkaline extraction stage plays a pivotal role in the residual lignin removed from the pulp during Elemental Chlorine-Free (ECF) bleaching. The goal of this paper is to review and analyze the fundamental research work of alkaline extraction concerning ECF bleaching sequences. Comparisons will be made to past knowledge of extraction with chlorinated pulps, as well as how ECF extraction differs. Approximately 50 to 65% of the Klason lignin removed from softwood kraft pulps during a DOE sequence occurs within extraction. The delignification process is governed by physico-chemical phenomena, such as oxidized lignin solubility and lignin diffusion, as well as chemical modifications to the D0 oxidized lignin by oxygen and/or peroxide. Other physico-chemical processes, such as alkaline fiber swelling, do not significantly contribute to the lignin removal process. It is observed that the oxidative reinforcement of E stages with oxygen (EO), peroxide (EP) or their combinations (EOP) significantly lowers the post-extraction kappa number and increases the post-extraction brightness. Oxygen reinforcement does not afford a pulp that contains less lignin compared to an E stage. Oxidative reinforcement modifies the post-extraction residual lignin such that it consumes less ClO₂ in the subsequent D1 stage to reach a given brightness target. The benefits of H₂O₂ reinforcement and elevated extraction temperatures ($\geq 90^{\circ}\text{C}$) are not additive, indicating that competitive processes are involved. This may be caused by the boost in lignin diffusivity at temperatures $>70^{\circ}\text{C}$ versus the H₂O₂ degradation of the lignin structure. An alternative explanation is the greater instability of H₂O₂ at elevated temperatures due to alkali-induced decomposition reactions.

18.1 “Energy Efficiency and Cost Reduction Through the Implementation of Low Pressure Sootblowing System”

Danny S. Tandra, Clyde Bergemann, Inc.; **Jim Hinman**, **Marc Olson**, **Steve Breaux**, Weyerhaeuser Company

Sootblowers in a kraft recovery boiler consumes a large amount of valuable high-pressure steam to maintain high thermal efficiency and prevent costly unscheduled shutdowns due to plugging of flue gas passages. For the past eight years, extensive research and mill trials have been carried out to explore the feasibility of utilizing less expensive low pressure steam for sootblowing. Results of numerous laboratory experiments, Computational Fluid Dynamic (CFD) simulations, and several mill trials have shown that low pressure sootblowing is technically and practically feasible, providing that the sootblower is properly designed and its nozzles are engineered to produce a cleaning power that is comparable to that of high pressure sootblowers. Weyerhaeuser has implemented the first complete low pressure sootblowing system on a new 6.3 million lb/day (2,860 ton/day) DBLS recovery boiler. The steam pressures at the sootblower poppet valve range from 107 psig (7.4 bar) in the economizer sections to 170 psig (12 bar) in the superheaters. This paper discusses the underlying technology of low pressure sootblowing, its full implementation at Weyerhaeuser –Valliant Mill, the cleaning performance, and the economic benefits of the system.

18.2 “Breakup Mechanisms of Brittle Deposits in Kraft Recovery Boilers – A Fundamental Study”

Honghi Tran, **Ameya Pophali**, **Morteza Eslamian**, **Andrei Kaliazine**, **Markus Bussmann**, University of Toronto

The breakup mechanism of brittle deposits removed by sootblower jets in kraft recovery boilers is studied in the laboratory by blasting model deposits made of gypsum with an air jet, and documenting the process using high-speed cameras. The results show that thin brittle deposits fail quickly as an axial crack forms and propagates through the sample. In thicker deposits, the jet first drills a small hole in the deposit. As the hole becomes wider and deeper, an axial crack forms, allowing the air jet to penetrate into the deposit. This causes the front side of the deposit to split, and subsequently the back side of the deposit to be blown apart. The mechanism implies that in order for a sootblower jet to effectively remove a brittle deposit, it must be able to drill a deep hole and form axial cracks in the deposit within the short blowing time.

18.3 “Monitoring Kraft Recovery Boiler Fouling using Principal Component Analysis”

Honghi Tran, **Peter Versteeg**, University of Toronto

High resolution operational data from three recovery boilers was analyzed using the Principal Component Analysis (PCA) feature of a multivariate statistical analysis program to identify major operating variables that caused fouling and plugging in three kraft recovery boilers. The results show that not only can PCA be used to visualize the variability related to long-term fouling trends in the boilers, it also can be used to visually distinguish changes in the boiler fouling condition caused by operational variability over a short period of time. This represents a major step forward in identifying operating variables that may be adjusted to minimize fouling, and in developing an on-line fouling monitoring technology based on PCA.

19.1 “Developing Numeric Nutrient Criteria: Impacts on the Pulp and Paper Industry”

Elaine B. Darby, QEA, LLC

In 1998, the U.S. Environmental Protection Agency (USEPA) released the “National Strategy for Development of Regional Nutrient Criteria,” which called for states and authorized tribes to

establish numeric criteria for nutrients (nitrogen and phosphorous) in their water quality standards. Currently, most states are in the process of developing numeric criteria. Until such criteria is established, a wastewater discharge permit writer or person developing a total maximum daily load (TMDL) is responsible for assembling site-specific data and developing appropriate permit limits for nutrients on a site-by-site basis. Pulp and paper mills have been strategic stakeholders in several recent nutrient and dissolved oxygen (DO) TMDLs, which have been used to set discharge permit limits on phosphorus and nitrogen. This presentation focuses on TMDL projects in three states: the Androscoggin River TMDL (Maine), the TMDL for nutrients in the Lower St. Johns River (Florida), and Draft TMDL and Managed Implementation Plan (MIP) for the Spokane River and Long Lake (Washington), as concrete examples of setting site-specific numeric nutrient criteria. Comparison of the methods used in each of these TMDLs and MIPs to determine nutrient criteria to existing and proposed state and federal methods is presented. In many cases, states will look to federal guidance, recent and existing TMDLs, and watershed management plans to guide the development of state-wide numeric nutrient criteria. Active participation by pulp and paper industry representatives in related TMDL developments and understanding and participating in work groups involved in setting state numeric criteria for nutrients is critical.

19.2 “Nutrient Management in Pulp and Paper Wastewater Treatment Systems”

Michael H. Foster, Environmental Business Specialists, LLC

Pulp and paper mill wastewater is almost always deficient in one or both of the key biological macronutrients – nitrogen and phosphorus. Consequently, most mills add supplemental nutrients in the form of liquid fertilizer to ensure optimum biological activity and BOD/TSS compliance. Drastically escalating domestic fertilizer prices have resulted in nutrient addition becoming a significant part of the operating budget for many mills’ utilities or environmental budgets. This presentation will discuss the driving forces behind escalating nutrient prices and present several operating and control strategies for reducing overall nutrient usage.

20.1 “Corrosion Concerns Related to Firing Petroleum Coke with Black Liquor in Kraft Recovery Boilers”

Preet M. Singh, H. Jeff Empie, Georgia Institute of Technology; **Christopher T. Dietel**, DTE Energy Services

Petroleum coke is being considered as an auxiliary fuel for kraft recovery boilers because it is a relatively cheap source of energy while being compatible with black liquor. However petcoke typically contains impurities like vanadium and sulfur, which originate from crude oil and petroleum refining. One concern that this presents is that the ash particles from combustion of petcoke may deposit some of these impurities on the cooler waterwall surfaces or superheater tubes in a form containing complex mixtures of vanadium pentoxide (V_2O_5) and sodium sulfate (Na_2SO_4). These may then form low melting point compounds like vanadates and influence corrosion of boiler walls and superheater tubes. Lab tests have been carried out in synthetic recovery boiler smelt and superheater deposit compositions, without and with varying amounts of vanadium. The tests have been carried out at different temperatures typical of boiler wall tubes and superheater tubes. Results indicate that the corrosion rates for carbon steel (SA210) do not show any effect of vanadium presence. Corrosion test results for different materials commonly used in the recovery boiler furnace and superheater are discussed in this paper.

20.2 “Effect of Solids Content on Black Liquor Corrosivity”

Preet M. Singh, Jamshad Mahmood, Georgia Institute of Technology; **Margaret Gorog**, Weyerhaeuser

Accelerated corrosion problems have been reported in storage tanks, evaporators, oxidation vessels and pipes carrying heavy black liquor to the recovery boiler. Corrosion rates around 70-

100 mpy or higher were found on carbon steel equipment in heavy black liquors. Laboratory tests were conducted to understand the effect of %solids and wood species on black liquor corrosivity. Black liquors with different %solids were collected separately from a pulp mill. Hardwood and softwood black liquors with similar % solids were collected from similar points in the pulp mill so that the differences in the two liquors could be directly correlated. Corrosion behavior of austenitic stainless steels and three duplex stainless steel grades was also evaluated. Corrosion rates for all un-stressed stainless steels tested were significantly low compared to the carbon steel samples in black liquors with up to 70% solids. Corrosivity of black liquors, as determined by the corrosion rate of carbon steel, increased with an increase in the %solids up to ~50% and then decreased till ~70%. Corrosion results will be discussed along with the electrochemical behavior of tested steels in this paper.

20.3 “Technical Review: Laboratory Testing and Boiler Trials Fail to Produce Evidence that Studs Mitigate Corrosion of Recovery Boiler Tubes”

David C. Bennett, Corrosion Probe Inc.

Standard descriptions of mechanisms and claims of effectiveness in mitigating corrosion of recovery boiler tubes by applying metal studs to the tubes require careful scrutiny, especially in the absence of systematic evidence that shows studs effectively mitigate corrosion. To the contrary, fundamental research on recovery boiler corrosion mechanisms - namely the 12-year, multi-million dollar, AF&PA/DOE research program at FP Innovations PAPRICAN and IPST investigating recovery boiler tube corrosion mechanisms - presents basic reasons why studs cannot mitigate tube corrosion and may increase tube corrosion.

Additional support comes from extensive field testing and experience – namely in eight recovery boilers with studded carbon steel tubes in mills previously operated by Champion International, where the author was employed until 2001. This paper describes empirical and laboratory results that contradict the concept that studs inhibit corrosion of recovery boiler tubes by retaining a smelt layer on the tube surface that reduces the tube temperature and prevents sulfur gases from reaching the tube. It also proposes a simple and safe method for testing the efficacy of studs in any recovery boiler, as the basis for cost-benefit analysis of continued studding, which costs the industry millions of dollars a year.

21.1 “Effects of Wood Properties on Yield, Fiber and Sheet Characteristics for Loblolly Pine”

Charles Courchene, David E. White, Thomas McDonough, IPST @ Georgia Tech; **Laurie Schimleck**, University of Georgia; **Gary Peter**, University of Florida; **Jim Rakestraw, Gopal Goyal**, International Paper Co.

This research continues work to develop a critical quantitative understanding of the effects of wood properties (chip specific gravity, composition, microfibril angle) on the kraft pulp yield and sheet strength from loblolly pine pulpwood grown in Georgia.

This project reports on the fiber and paper properties for 13-year old loblolly pine (*Pinus taeda*) trees from a genetic selection study. Eighteen trees were selected with a range of specific gravities and cellulose:hemicellulose:lignin contents. Chips from these trees were pulped for both bleachable and linerboard kraft grades. Correlations between pulp yield, wood composition, and Near Infrared (NIR) spectra were reported previously. For the work reported here, additional wood characteristics were measured by SilviScan and NIR. For both grades of pulps, the pulp composition, fiber properties, and handsheet strength were also measured. Statistical analysis was done to determine the wood and pulp properties that had a significant effect on handsheet strength. Wood density, fiber coarseness and length were found to have the greatest effect on sheet properties. NIR measurements were also found to correlate well with microfibril angle. These measurement systems offer the promise of rapid and comprehensive analysis that can enable foresters and wood procurement personnel to tailor a wood furnish to specific pulp or paper end-use requirements.

21.2 “Evidence for the Occurrence of Polymerized Wood Resin in Pulp and Paper Samples from Various Analytical Techniques”

Bruce Sitholé, Jorge Pimentel, Beth Ambayec, Alain Gagné, Maurice Douek, Larry Allen,
FPInnovations – Paprican

Questions have been raised about the origin or cause of wood resin polymerization and its possible role in contributing to pitch deposition problems. It has been speculated that polymerization occurs during wood seasoning and/or in mill processes; this polymerization results in pitch deposition problems. These questions and speculations can only be addressed by application of appropriate analytical techniques to characterize the polymerized wood resin. In this report, we review the application of such techniques and their relative merits for demonstrating the presence and nature of polymerized wood resin in a variety of pulp and paper samples. This sets the stage for future research on the formation of polymerized wood resin in mill processes, the results of which could help in better control of pitch deposits and in production of pulps with very low levels of lipophilic extractives.

21.3 “Effects on Kraft and Mechanical Pulping and Pulp Quality when Utilizing Mountain Pine Beetle-Killed (MPB) Wood: An Overview”

Barbara Dalpke, Paul Bicho, FPInnovations – Paprican

Increased salvage harvesting of lodgepole pine due to the current mountain pine beetle infestation in British Columbia’s interior forests is changing the fibre supply for B.C.’s pulp mills. Green pine has been replaced by beetle-killed lodgepole pine of red and, increasingly, grey stage of attack, and the species balance of spruce:pine:fir (SPF) pulps has shifted from the traditional 30/65/5 ratio to a ratio of 80 to 90% pine. This study summarizes work that evaluated the impact of these changes on pulp quality. The influence of time-since-death and increasing pine ratio in SPF mixtures was evaluated through pilot plant kraft and mechanical pulping experiments using wood samples of different stages of attack and from different areas within the province. The use of red and grey stage wood does not impact kraft pulp quality, but for TMP, brightness and also sheet structural properties are affected. The increasing pine content in SPF mixtures has only a small influence, and the extent of possible changes varies with wood origin. Therefore red and grey stage beetle-killed wood can be used to produce kraft pulp with little concern, but for TMP, some concerns exist. Also, process-related impacts of using beetle-killed wood are not discussed in this paper.

22.1 Micro-stickies Panel

Mahendra Doshi, Progress in Paper Recycling, **Robert de Jong,** 2 Fiber Consulting, **Salman Aziz,** S&A Int. LLC, **Danny Haynes,** Eka Chemicals Inc., **Prasad Duggirala,** Nalco

Stickies continue to pose considerable problems to the paper industry. Adequate management and control of stickies is necessary for the economic health of the industry. In order to properly manage and control stickies a reliable, reproducible and quick method is needed to measure the concentration of stickies.

Recent technological advances allow modern mills to efficiently remove macrostickies. Most current stickies problems are caused by microstickies that pass through slotted screens. Microstickies tend to accumulate and agglomerate in the paper machine water loop followed by deposition on paper machine wires, felts and dryer cans.

Panel members plan to discuss issues facing the paper recycling industry with respect to microstickies.

23.1 “Effects of Neutralization of Recovery Boiler Ash in Ash Leaching”

Cláudia Goncalves, Martin Wimby, Margareta Lundberg, Metso Power AB

Over the last five years, many Kraft mills have been equipped with systems for chloride (Cl) and potassium (K) removal from recovery boiler ash. The positive effects of removing these elements are reduced boiler corrosion, less boiler plugging and reduced dead load in the liquor cycle. Metso Power’s solution for ash treatment is a leaching process. Today the company has eight Ash Leaching plants in operation. Plants that operate with ash of high carbonate (CO₃) content have shown lower efficiency in comparison with those that operate with lower CO₃ content. This finding has prompted development work with a view to removing the negative effects of high CO₃ content. The focus of this paper is the pH-control of the ash, where the results from one full-scale application of pH-control are presented. Said results show that properly exercised pH-control can eliminate the negative effects of high carbonate concentrations on solid/liquid separation.

23.2 “Characterization of Black Liquor Sprays from Splash Plate Nozzles”

Honghi Tran, Nasser Ashgriz, Mahmoud Ahmed, University of Toronto

Spray characteristics of black liquor from splash plate nozzles were studied through numerous experiments in the laboratory using corn syrup solutions as a model fluid, and a laser diagnostic system (PDPA) to obtain data on droplet size distribution. Results shows that for a given nozzle size, the spray characteristics depend strongly on the fluid properties and flow rate, with a mean droplet size increased with an increase in fluid viscosity and nozzle diameter; but decreased with an increase in flow velocity. Correlations for calculating mean droplet sizes have been developed for a wide range of fluid properties and nozzle operating conditions.

23.3 “Effect of Ammonia Injection on Black Liquor Recovery Boiler NO_x Emissions and Ash Chemistry”

Margareta Lundberg, Metso Power AB; **Piia Niemi**, Metso Power OY; **Luc Maitrejean**, Burgo Ardennes; **Patrik Yrjas, Tor Laurén, Anders Brink, Mikko Hupa**, Åbo Akademi University

Selective Non-Catalytic NO_x reduction based on ammonia injection has been tested in a 2000 tds/d recovery boiler. The results showed good reduction rates with limited ammonia slip over the load range 60-100%. For the other emissions, ammonia addition had no or minor impact. Special attention was paid to the ash chemistry to evaluate the potential for ammonium salt formation on the heating surfaces. Analyses of deposit samples together with thermodynamic equilibrium calculations show that this potential is limited and will not affect the deposit characteristics.

23.4 “Update of the American Forest & Paper Association Recovery Boiler Program”

Thomas J. Grant, AF&PA

The AF&PA Recovery Boiler Program continues to strive for the safe and reliable operation of recovery boilers. Training, maintenance and supervision are required to accomplish this task. The AF&PA Program has developed an industry-wide safety audit program, updated its reference manuals, its training program and guidelines for the safe operation of recovery boilers, in addition to continuing to sponsor research for these objectives.

24.1 “Looking Into the Future/Water Use Trends”

Paul Wiegand, NCASI

The structure of NCASI is such that it members, those manufacturing forest products, owning forestland or with a vested interested in these industries, determine the direction of NCASI

program activities. The inception of NCASI was, indeed, predicated on the industry's desire to better understand the influence of forest products manufacturing operations on water quality. Past challenges now solved through technology or resolved through the use of science are too numerous to mention, and testify to the industry's vision and commitment to proper management of water resources. However, new challenges continue to appear. The evolution of water management is suggestive of some of the challenges ahead. This presentation will explore recent trends in water management research focusing on those which may signal major new challenges for the future.

24.2 “Water Use and Effluent Treatment in Canadian High Yield Pulp Mills”

Michael Paice, FPInnovations – Paprican

In Canada, there are currently nine mills producing market high yield pulps (HYP), mainly BCTMP from hardwoods and spruce. Together their annual production is around 2.2 million tonnes. The water usage is typically low, or in the case of two mills, zero effluent. For the mills which discharge effluent, the effluent properties represent a challenge for biotreatment, particularly the high concentrations of extractives and chemical oxygen demand. These challenges have been met in a number of ways including activated sludge treatment, anaerobic treatment, and more recently biofilm activated sludge. The effluent properties and biotreatment technologies will be reviewed in this presentation.

25.1 Reliability Workshop

Nancy Hoffman, Equipment Reliability Solutions, LLC; **Doug Kieley**, QAL; **Dennis White**, JLM Advanced Technical Services; **Jeremy Orr**, ATS

The Future of Managing Equipment Reliability - a workshop on new inspection techniques, engineering applications and asset management tools available for tomorrow's mill maintenance engineers and managers.

Managing Equipment Reliability is costly. Our responsibility as engineers and technical specialists is to draw from our expertise and experience to ensure equipment reliability at the least possible cost.

This workshop reviews some of the technologies currently available to manage equipment reliability. Presentations will cover inspection and engineering options. New inspection equipment, current inspection methodologies and engineering practices will be discussed.

26.1 “Effects of Mountain Pine Beetle Grey-Stage Infestation and Chip Moisture Content on TMP Pulping of Lodgepole Pine, and Water Uptake Studies”

Thomas Q. Hu, **Michelle Zhao**, **Surjit Johal**, **Bernard Yuen**, **James Drummond**, FPInnovations – Paprican; **Paul Watson**, Canfor Pulp Limited Partnership

We performed pilot-plant thermomechanical pulping on green and dry, mountain pine beetle-infested, grey-stage lodgepole pine (LPP) sapwood chips with different moisture contents. The energy requirements and the tensile strength of the thermomechanical pulps (TMPs) from the dry, early-grey chips were similar to those from the green chips, while there was an indication of slightly higher energy requirements and lower tensile strength of the pulps from the late-grey chips. The late- or early-grey TMP had lower sheet density due to the lower moisture content of the chips, and lower ISO brightness and higher handsheet surface roughness than the green TMP.

Water-uptake studies indicated that it was possible to significantly increase the moisture content of the dry, earlygrey LPP chips by soaking the chips for 8-10 min at optimal conductivity (~200 µS/cm) and pH (~6.0). The Environmental Scanning Electron Microscopy (ESEM)-Energy

Dispersive Spectroscopy chemical tracer technique provided qualitative information on water movement within 10 min of water soaking of the green and late-grey LPP blocks. ESEM studies also showed the presence of fissures, fungal hyphae and incipient decay in the late-grey blocks.

26.2 “Effect of Pulping Mountain Pine Beetle-Killed Wood on Tall Oil Soap Recovery”

Vic Uloth, Ron van Heek, FPInnovations – Paprican; **Paul Watson**, Paprican

Soap solubility tests and soap analyses, using black liquor and soap samples from four British Columbia mills and one Alberta mill pulping very little beetle-killed wood, indicate that tall oil production at mills pulping beetle-killed wood could drop substantially due to higher soap solubility in black liquor, a reduced tendency for the soap to “float” off in storage vessels and skimmers, and lower soap quality (acid number). The changes in soap solubility, and a reduced tendency to float to the surface of the black liquors, are largely a result of changes in the fatty acid (FA) and resin acid (RA) content of the wood, resulting from beetle attack and subsequent fungi infestation. The FA:RA ratio in tall oil produced from soap skimmed in the mills pulping beetle-killed wood has dropped from 1.49:1.86 in the mid-1980s to 0.72:1.28. The solids concentrations at which soap solubility is minimized are now consistently in the 35 to 49% solids range. In the 17 to 32% solids range, where most British Columbia mills try to skim soap, soap solubility increased significantly. While little soap would be recovered in these mills, soap could be expected to precipitate at higher solids concentrations, aggravating evaporator and concentrator scaling problems and accumulating in strong liquor storage tanks, where it could cause further operating problems. Increasing soap concentrations in fired black liquor were found to increase the viscosity and heating value of the black liquor while decreasing the swelling propensity of the liquors, making them much more difficult to burn. Tests in two recovery boilers indicate that without operating modifications, high concentrations of soap in the fired black liquor lower the char bed temperature and increase carryover in the upper boiler.

26.3 “Effects Of Extractives from Mountain Pine Beetle Attacked Lodgepole Pine On Kraft Mills”

Larry Allen, Alain Gagné, FPInnovations – Paprican; **Paul Watson**, Paprican

This report addresses the impact of mountain pine beetle infestation on several extractives-related issues in kraft pulp mill operation: extractives in pulp, pitch control, and effluent treatment. The work, funded by the Mountain Pine Beetle Initiative of Natural Resources Canada, involved visits to five western Canadian kraft mills to observe operating conditions, collection of samples for subsequent laboratory measurements, and overall analysis of the combined information. Work in separate reports has shown that the use of infested wood usually causes higher extractives (especially increased resin acid content) in the wood to the digester and this results in an increased solubility of fatty and resin acid soaps in black liquor. Hence the use of infested wood resulted in a greater extractives load to be removed in brownstock washing for good pitch control. Use of green- and red-stage wood did not cause a significant change in the normal quantities of extractives in pulp across the bleach plant and at the pulp machine. In the mill using grey-stage wood, the solubility of extractives in black liquor was even higher and brownstock washing was more important for their removal. The quantity of extractives, especially the unsaponifiables, in the final pulp was significantly higher in the mill using grey-stage wood. In this mill, the resin acid concentration in the final effluent was high. The grey-stage results require further confirmation in more mills.

27.1 “Deinking of Flexographic Newsprint”

Jeffery S. Hsieh, Akpojotor Shemi, School of Chemical & Biomolecular Engineering, Georgia Tech

A semi-continuous flotation cell, which incorporates an electrolytic cell, was used to collect inks from newsprint pulp slurry. In one case, 100% flexographic newsprint was treated. The effect of pulping time, temperature, and an electric field on deinking efficiency was investigated. Increasing the pulping time from 5 to 20 minutes drastically reduced the percent reduction in effective residual ink concentration (ERIC) by 5% percent. The deinking efficiency is improved by 3% and 5% when the temperature from 25oC to 43oC and when an electric field is used respectively. In another case, 48% flexographic newsprint was treated. The effect of float consistency, sodium hydroxide dosage, surfactant concentration, and electric field on deinking efficiency was investigated. An electric field treatment improved deinking efficiency, as much as 7% compared to when electric field is not used. Thermogravimetric analysis was used to corroborate ERIC measurement. Deinking selectivity was discussed using a Z-weighted factor parameter.

27.2 “Cavitation Jet Deinking: A New Technology for Deinking of Waste Paper”

Shisei Goto, Hiromichi Tsuji, Isao Onodera, Keigo Watanabe, Katsumasa Ono, Nippon Paper Industries Co., Ltd.

A new method and in-house device for treating secondary fiber has been developed. This method is based on the fluid-jet cavitation technique. In this apparatus, pulp suspension was injected into the reacting vessel by using a high-speed jet, and cavitation bubbles were produced around the jet. The impact of the breakage of cavitation bubbles detached contaminants, like ink and binder, from the surface of fibers. The effects of cavitating jet (hereafter called CV-jet) treatment on deinking of the pulp from mixed office waste (MOW) and old newsprints/old magazines (ONP/OMG) mixture were studied.

The basic experiments on cavitation control showed that the intensity and region of cavitation were controlled by the jet velocity and the pressure difference in the reacting vessel. It was found that the CV-jet generated broad ultrasound waves while the conventional ultrasonic apparatus generated an intrinsic frequency. The results from MOW test showed that CV-jet, even without chemicals and high temperature, decreased dirt speckles and reached almost the same dirt reduction level of the mill kneader. Moreover, CV-jet minimized fiber damages during the process and this resulted in the handsheets of the pulp giving much higher paper strength than those of kneader. The ONP/OMG test revealed that CV-jet was superior to mill disperser in terms of ink detachment and stickies dispersion. It is considered that CV-jet is a new, environmentally friendly, method in deinking and stickies treatment.

27.3 “Treatment of Deinking Wastewater”

Akpojotor Shemi, Jeffery S. Hsieh, School of Chemical & Biomolecular Engineering, Georgia Tech

A filtrate obtained from wash deinking of flexographic newsprint were clarified with electro-coagulation and electroflotation mechanisms in an electrochemical cell. Ink concentration was calibrated with turbidity measurement. The clarification efficiency was determined with turbidity measurement and corroborated with cationic demand. The flexographic ink dispersions are pH responsive dispersions.

Higher current densities and acidic conditions had higher clarification efficiency. The destabilization of inks dispersions was attributed to their interactions with metal ions and protonation at acidic pH. Under acidic environment, it was suggested that

the carbon black ink particles are more hydrophobic and bubbles generated by the electrolysis of water easily collect these inks. COD and cationic demand is reduced with electroflotation treatment. Finally, hardness was used to measure the selected metal ions concentration.

28.1 “Review of Sodium Salt Scaling in the Liquid Streams of the Chemical Recovery Cycle of Kraft Pulp Mills”

Nikolai DeMartini, William J. Frederick Jr., IPST @ Georgia Tech

Sodium salt scaling is common in black liquor evaporators, smelt dissolving tanks and green liquor lines. Sodium salts that precipitate include burkeite, sodium sulfate dicarbonate, sodium carbonate sulfate, sodium carbonate, sodium oxalate, pirssonite and sodium aluminosilicates. This paper provides an overview to understand when these various sodium salts will precipitate and provides mills with guidelines to avoid scaling problems associated with these salts.

28.2 “Evaporator and Concentrator Design Considerations for Troubleshooting”

David T. Clay, Jacobs Engineering

Design of kraft black liquor evaporation systems is primarily focused on achieving maximum system capability and overall performance. Black liquor flow rates vary to these systems and often include unplanned lower flow rate periods due to operating problems. When such periods occur it is critical to identify the problem location and quickly resolve it. Evaporation system designs that incorporate troubleshooting tools enable faster resolution of operating problems. The objective of this paper is to discuss design principles that facilitate rapid resolution of operating problems by taking into account both the tools used and the resources available. Industry examples are used to illustrate the significance of this approach. Continuous improvement of the operations staff is also supported with this approach by providing more insight and understanding into process interactions.

28.3 “Flash or Foul”

Wilson T. Gautreaux, MeadWestvaco Corporation; **Greg Wass**, A.H. Lundberg Associates, Inc.

Condensate stripper preheater fouling is a significant problem in the pulp and paper industry. Fouling reduces energy efficiency, increases maintenance costs for cleaning, and lowers availability in condensate stripping systems. High condensate stripper availability is needed to comply with environmental regulations. The preheater is often the major cause of downtime in condensate strippers. Many types of heat exchanger designs have been used as preheaters, including plate-and-frame, shell-and-tube, and spiral heat exchangers. All of these designs have been plagued by the reaction-type fouling that occurs on both the foul and the stripped condensate sides of the exchangers. A new preheater design was developed and implemented at the Charleston mill. It consists of a series of flash tanks and shell-and-tube heat exchangers. Stripped condensate is cooled by flashing in the flash tanks, and the flash steam is used on the shell side of the shell-and-tube heat exchangers. The flash steam is clean and does not cause the shell side fouling that occurs when condensate itself is used on the shell side. The foul condensate is heated in the tube side of the exchangers, and results in fouling that is easily removed by chemical cleaning. The preheater avoids the high temperatures on heat exchanger surfaces which promote chemical reaction-type fouling. The new preheater was installed in 2006 in the Charleston mill condensate stripper system, which has a flow rate of 3.8 m³/min and a bottoms temperature of about 150 °C. It has performed well and has resulted in excellent preheater availability.

29.1 Water & Air Quality - Sustainability Panel

Dale K. Phenicie, Environmental Affairs Consulting; **Reid Miner**, **Brad Upton**, NCASI; **Tom Pollock**, Metafore

This sustainability panel builds on the discussion held during the two previous EPE conferences and seeks to advance the task of defining sustainability within the forest products industry. Panelists will discuss the latest views on what components contribute to a definition of sustainability for the industry, including: environmental performance, forest and product stewardship, carbon footprints, and water use. Recent data reporting the environmental performance of the industry will be presented.

Presentations include:

- What is Sustainability? – Dale K. Phenicie, Environmental Affairs Consulting
- Developing Carbon Footprints for the Forest Products Industry – Reid Miner/Brad Upton, NCASI
- Forest Products Industry Environmental Performance Trends – Dale K. Phenicie
- Defining Environmental Preferable Paper – Tom Pollock, Metafore

31.1 Pulping Issues with Mountain Pine Beetle Killed Wood (II): Panel Discussion

Vic C. Uloth, **Paul Bicho**, **Gail Sherson**, FPIInnovations – Paprican; **Steve Schneider**, Cariboo Pulp and Paper; **Dave Harrison**, Mountain Pine Beetle Initiative – Canadian Forest Service (MPBI-CFS)

The Mountain Pine Beetle infestation currently ravaging British Columbia's pine forests has spread into Alberta and into the western United States. Most pine species are susceptible. This panel will share their experiences in using beetle killed wood for pulping, and discuss some of the current and future impacts of this epidemic on pulping and pulp quality.

32.1 “Polymer-Based Peroxide Stabilizer for Recycle Fiber Bleaching”

Jacob Huang, Kemira Chemicals Inc.

Silicate is a widely used peroxide bleaching enhancing agent in the pulp and paper industry. In some cases this additive can also contribute to process issues such as impacts on the wet-end of the paper machine (anionic trash), sheet properties (picking, linting, etc.), and at times scaling in the system. Thus there is industry interest in complementary stabilizers in the bleaching of recycled fiber (RCF).

Kemira has developed a novel polymer based peroxide stabilizer technology to address this need. Originally developed for use in virgin pulp bleaching, Fennobrite technologies have been adapted for use in RCF processing. In this work, research was conducted with 100% recovered old newspapers. The results show a clear synergistic effect when these polymers are introduced in the presence of silicate into the RCF bleaching system. Specifically, when Fennobrite was added without reducing silicate dosage the ISO brightness significantly improved. These improvements were further observed and enhanced under a variety of other conditions in which silicate was also present during the RCF processing. Extensive developmental work continues to optimize this potentially beneficial concept as it applies to RCF processing.

32.2 Understanding and Controlling Colloidal Organics when Mixing TMP and DIP

R. Daniel Haynes, Eka Chemicals, Inc

Several developers have used the tendency for deposit formation that occurs when mixing TMP and DIP together to develop new and novel testing procedures to understand the consequences of this phenomena. IPST has developed a detection method based on fractionation and measurement of Total Organic Carbon (TOC) for colloidal micro-stickies and colloidal pitch. This technology has been licensed by Eka Chemicals Inc. The interaction observed between TMP and DIP using this technology is typically seen as a reduction in the amount of colloidal organics after mixing. This TOC procedure has been used to help mills understand the role of TMP/DIP mixing in the formation of deposits and runnability issues. The principal objective of this work is to report on how the measurement of colloidal organics can be used to manage and control deposition when mixing TMP and DIP.

32.3 “A Review of European Concerns with Deinking Inkjet Prints”

Jan Walter, Western Michigan University

February 2008, the International Association of the Deinking Industry (INGEDE), a European non-profit organization, declared, in a press release, “Inkjet Prints Are Not Deinkable.” This announcement has been a catalyst to a flurry of discussions and activities outside of the EU community. The INGEDE test protocol for determining the deinking results of a printed paper and its companion the European Recovered Paper Council’s (ERPC) Deinkability Scorecard will be reviewed.

33.1 “Technical Economic Evaluation of a Northern Hardwood Biorefinery using the “Near-Neutral” Hemicellulose Pre-extraction Process”

H. Mao, J.M. Genco, A. Van Heiningen, H. Zou, J. Luo, H. Pendse, University of Maine

The “near neutral hemicellulose extraction process”, involves the extraction of wood hemicellulose using green liquor prior to conventional Kraft pulping. Ancillary unit operations in the process include hydrolysis of the extracted carbohydrates using sulfuric acid, filtration of the extract to remove lignin that was extracted with the carbohydrates, liquid-liquid extraction of acetic acid and by-product furfural, liming of the hydrolyzed extract, separation of gypsum which is the product of the liming reaction, fermentation of C5 and C6 sugars and upgrading of the acetic acid and ethanol products by distillation.

Experimental data are presented for the extraction of northeast hardwood chips using green liquor. These data were used to perform a technical economic analysis for a Kraft mill located in the Northeastern U.S. An economic analysis was performed as a function of the size of the pulp mill being retrofitted to accommodate the hemicellulose extraction process. Discounted cash flow rate of return was used to judge the economic merits of the new process. Important cases include whether the extraction vessel is available at the mill site or must be purchased, and whether the utilities and waste treatment facilities are sufficiently large to handle the additional requirements for the new process or must be upgrades. Advantages and disadvantages of the process are discussed.

33.2 “Effect of Hot Water Extraction Conditions on the Subsequent Kraft Pulping of Pine Chips”

Allen Smith, Gopal Krishnagopalan, Harry Cullinan, Auburn University

Hot water extraction of wood chips is an effective method of separating fermentable sugars from wood prior to pulping. Potential difficulties with this practice include a reduction in yield and

strength of the final pulp. The possible reduction in strength is particularly problematic with southern pine since that pulp is included in paper and board products primarily for its strength contribution. Composition analysis of chips, extracted chips, pulp, and hydrolyzate are performed to assess the hemicellulose extraction efficiency and subsequent loss during kraft pulping of Loblolly Pine. On line control of the extraction conditions is used to influence the quantity of hemicellulose recovered in the hydrolyzate and the yield and properties of the final pulp.

33.3 “Kraft Pulping Integrated with Mild Alkaline Pre-Extraction of Southern Mixed Hardwoods”

Sung-Hoon Yoon, University of Maine & Auburn University; **Gopal Krishnagopalan**, Auburn University; **Adriaan van Heiningen**, University of Maine

Fresh southern mixed hardwood chips were extracted with alkaline solutions containing sufficient alkalinity to approximately neutralize the acids released upon treatment of the chip-liquor mass at various elevated temperatures. The effect of alkali charge in the form of NaOH, Na₂CO₃ or green liquor and the time and temperature of the pretreatment on the extract yield and composition was investigated. The mild alkaline extraction with 3% NaOH or 3% Na₂CO₃ at 140°C and 90 minutes led to the removal of about 6 - 8% of wood substance from the hardwood chips. When the extracted chips were pulped at different reduced effective alkali charges (12-13% EA), the pulp yield was approximately 1% lower than that of the kraft control at 15% EA. A modified pre-extraction by addition of 0.05% AQ with 3% Na₂CO₃ or 3% GL, however, increased the yield increase by up to about 1% higher than conventional kraft pulp. No significant difference in paper strength was found in handsheet tests except for a minor change in tear resistance.

34.1 “Boiler Upgrades to Increase In-House Power Generation”

Marcel D. Berz, **John F. La Fond**, **Samit J. Pethe**, Jansen Combustion and Boiler Technologies, Inc.

Pulp and paper mills operate industrial boilers that burn fossil fuels and/or waste fuels such as sawdust, bark, hog fuel, tires, clarifier sludge, municipal and agricultural waste, etc., to generate steam for manufacturing processes. With increased fossil fuel and power costs, more emphasis is being placed on minimizing fuel cost and maximizing mill in-house power generation. Typically, in-house electricity is generated in steam turbine generators from high pressure steam which requires raising steam to pressures and temperatures higher than required by the process users. All or a portion of the steam leaving the turbine can then be used at lower pressure as process steam for paper making.

In this paper, boiler modifications are discussed that can increase power generation in turbine generators by raising steam temperature, operating pressure, and/or boiler steaming rate. Cases are presented showing how superheater, economizer, and firing rate upgrades can impact boiler steam conditions and improve net power output. All cases represent either recently implemented modifications or studies that show economical promise.

34.2 “Co-firing Biomass with Coal in CFB Boilers”

Ari Kokko, Metso Power

CO₂ reduction has become a key objective around the world and the power industry has a big challenge to meet the reduction targets. This objective is even tougher where a large portion of generated power is already based on coal like in US power industry. All the large technology companies are continuing their long-term actions for CO₂ capture or reduction technologies, but there are still many challenges to be solved before these technologies are commercially available.

One approach to the same topic is to burn fuels, which net CO₂ emission is zero, like biomass. Biomass introduces new technical challenges however, including bed agglomeration and high temperature corrosion. One way to manage this effectively is to gasify the most challenging fuels and burn the easier ones in fluidized bed boilers. Burning the biomass together with coal makes the chemistry much easier to handle.

Metso Power has demonstrated experience providing coal and biomass co-combustion in CFB boilers. In Scandinavia the thinking was to make biomass fired CFB with coal backup. In coal dominant countries it could be reversed, coal is the base fuel and biomass is burned as can be purchased from local markets. The paper will introduce several operating co-combustion projects in Scandinavia, but also in the other part of the world. The sizes of these boilers are from 50 MWe up to 250 MWe. The paper will discuss about fuels, the chemistry and operating challenges as well as requirements for boiler design and equipment when co-firing biomass with coal.

34.3 “Using Waste Heat to Generate Electricity”

Matt Haakenstad, U.S. Energy Services, Inc.

This paper describes the cogeneration process at two recently constructed facilities in Colorado, which produces approximately 30% of required electric power.

Topics covered include project background, system concept and operation, economic benefits, carbon footprint implications and lessons learned.

This process recovers waste thermal energy through a turbine generator system and produces approximately 1 MW of electric power. This electricity is used on-site, thus reducing power purchases.

One or both of these plants are expected to receive green energy credits based on their qualification as “recycled energy.” The presentation will provide an update on the application process and credit valuation (which is currently being determined as of this writing).

Recovering waste heat and using it to generate power onsite offers the potential for some facilities to increase their energy utilization efficiency. This can provide both economic benefits in the form of lowered energy input costs, and environmental benefits resulting in less energy being consumed from the electric grid. Some plants are better candidates for this technology than others. Thus this presentation will also highlight key considerations for plant owners to evaluate prior to incorporating this process application into their new or existing plant.

34.4 “Biofuel Firing in Fluidized Bed Boilers - An Opportunity for Green Electricity”

Vesa Kulmala, Metso Power

Emission control and monitoring featured in the new fluidized bed technology meet the tight requirements regarding environmental issues, which have taken a giant leap forward during the past few years. New biofuels, such as forest fuels and short rotation coppice, different types of coals, tire-derived fuel as well as efforts towards improved effective parameters in the market also set increasing challenges, such as fouling, slagging and corrosion, for the technology.

Fluidized bed technology gives an opportunity for efficient and environmentally friendly electricity production. Bubbling fluidized bed boilers have established a good position worldwide in biofuel and renewable power generation. Deliveries of fluidized bed boilers with a thermal capacity ranging from 10 to 600 MWth provide experiences for fulfilling the needs of pulp and paper industry and green power producers worldwide.

35.1 “Stress Corrosion Cracking of Stainless Steel in Continuous Digesters”

Angela Wensley, Angela Wensley Engineering Inc., **Aaron Leavitt**, Andritz Inc., **Flávio Paoliello**, Celulose Nipo-Brasileira S.A.

Stress corrosion cracking (SCC) of the 316L stainless steel central pipe and the 304L stainless steel clad impregnation zone of a kraft continuous digester at a mill in Brazil prompted an investigation into the environmental conditions that could support the SCC of austenitic stainless steels. U-bends of 304L and 316L stainless steels were exposed in synthetic "weak white liquors" of different hydroxide levels (10 to 25 g/L NaOH) and sulfide content (0 to 40 g/L Na₂S) at 165°C. Four different metallurgical conditions were investigated: annealed, welded, stress relieved, and sensitized. SCC of all specimens was found after 712 hours immersion exposure in weak white liquors having an effective alkali (E.A.) greater than 30 g/L NaOH. No SCC was observed in a weak white liquor of effective alkali (E.A.) equal to 25 g/L NaOH without Na₂S. The SCC in all cases was both transgranular and intergranular. SCC initiated earlier (after 190 hours) in the stress relieved and sensitized specimens than in the annealed or welded conditions. The SCC of type 316L was often more severe than was the case for SCC of type 304L stainless steel.

35.2 “Inspection and Repair of Batch Digesters”

Max Moskal, M&M Engineering Associates, Inc.

Most kraft batch digesters in North America were constructed from carbon steel prior to 1980 with many dating to before 1950. The majority of these aging digesters have long since corroded to the point that owners and/or users have resorted to weld buildup to restore wall thickness and stainless steel weld overlays for additional corrosion resistance. Yet, these costly repairs and overlays often do not meet life expectations. In addition, inspections and/or testing of digester weld overlay can be problematic and are often limited to visual examination. In this paper, the author discusses engineering evaluation, inspection and stainless steel overlay repair options for batch digesters.

35.3 “Paper Machine Dryer Journal Fatigue Failure Risk Reduction”

Algis P. Mockaitis, **David R. Andersen**, **Bruce R. Manson**, Smurfit-Stone Container Corp.

Several failures of separately cast and press fit journals in a 1950's vintage paper machine were determined to be fatigue failures due to low strength cast iron. A stress analysis determined the operating stresses at failure and the tensile strength required to avoid fatigue. The journal stresses in a dryer full of condensate were found to be 79% higher than in a normally operating dryer. Weekly dryer temperature surveys were conducted to identify dryers with condensate removal problems for maintenance. A program to measure the Brinell hardness (BHN) of all the journals in the machine was developed to determine the tensile strength based on a correlation between BHN and tensile strength of journals removed from the machine. Journals were prioritized for replacement based on predicted tensile strength, operating stress levels, and risk of a dryer falling out of the machine. Journal replacements were conducted during several normally scheduled annual shutdowns. This program avoided an extended machine shutdown that would have been necessary to replace 123 journals if the low strength journals could not be identified and removed to eliminate the risk of their continued operation. Each removed journal was tested to determine its tensile strength to validate the replacement selection criteria.

37.1 “Current Status of Alternative Fuel Use in Lime Kilns”

Honghi Tran, Sabrina Francey, Andrew Jones, University of Toronto

Lime kilns consume large amounts of fossil fuels. Due to the steady rise in natural gas and fuel oil costs in recent years, there is a need for mills to find more economical fuel alternatives that have minimal impacts on lime kiln and chemical recovery operations. This paper examines the technical feasibility of various alternative fuels, including petroleum coke, directly fired or gasified wood residues, precipitated lignin, bio-oil and olein biofuel. Since each fuel has a different composition, heating value and burning characteristic, it is important to understand the pros and cons of burning each fuel before implementing it in the lime kiln.

37.2 “Alternative Fuel Impact on Lime Reburning Kiln Performance”

Terry N. Adams, Ph.D., T.N. Adams Consulting

Recent results of computer simulations of a lime kiln fired with alternative biofuels have been used to show that the Adiabatic Flame Temperature (AFT) is the dominant factor in determining kiln performance. Flame length (FL) has a modest impact on kiln performance, but has a strong impact on the maximum refractory temperature.

Investigation of the pathways for radiation heat transfer between the flame and the lime solids shows the limited impact of flame emissivity on the total radiant heat transfer. This is because higher emissivity flames have high direct radiation, but have less radiant heat transmitted through the flame from the refractory walls to the lime solids. Just the opposite is true for lower emissivity flames.

A simple change in the control volume used to evaluate the AFT can simplify the calculation of AFT for fuel-gases from gasifiers. By extending the control volume around the gasifier only the chemical composition of the feedstock going into the gasifier is needed, along with an estimate of the shell heat loss from the gasifier.

The results presented here suggest a practical means of testing the impact of alternative fuels on an operating kiln. Firing the kiln with its conventional fuel, but with higher than normal excess air, can be used to test the impact of an alternative fuel.

37.3 “Pilot-Scale Combustion Studies with Kraft Lignin as a Solid Biofuel”

Niklas Berglin, Per Tomani, STFI-Packforsk AB; **Hassan Salman**, Energy Technology Center; **Solvie Herstad Svård**, S.E.P. Scandinavian Energy Project AB; **Lars-Erik Åmand**, Chalmers University of Technology

Processing of kraft lignin precipitated from black liquor to produce a solid biofuel with high energy density and low ash content has been developed in research programs by STFI-Packforsk and partners. In preparation for full-scale combustion trials, tests were carried out on pilot scale in a 150 kW powder burner and in a 12 MW fluidized bed (CFB) boiler. Lignin powder could be fired in a powder burner with good combustion performance after some trimming of the air flows to reduce swirl. Lignin dried to 10 % moisture content was easy to feed smoothly and had less bridging tendencies in the feeding system than wood/bark powder. In the CFB boiler lignin was easily handled and co-fired together with bark. Although the filter cake was broken into smaller pieces and fines the combustion was not disturbed. When co-firing lignin with bark, the sulfur emission increased compared to bark firing only, but most of the sulfur was captured by calcium in the bark ash. Conventional sulfur capture with addition of limestone to the bed was also demonstrated. The sulfur content in the lignin had a significantly positive effect on reducing the alkali chloride content in the deposits, thus reducing the high temperature corrosion risk.

38 **Ask the Recycle Mill Gals**

Janet Malloch, Blue Heron, **Krista Cuddy**, Catalyst, **Eden Nicodimos**, White Birch

This session is an opportunity to hear from and ask question of recycle mill people in the North West. This year offers a unique opportunity with the panel made up of women working in the recycle industry. These mills face issues with single stream collection, the need to deal with environmental issues, the rising cost of recycle fiber and many other issues. The panel discussion will include a short introduction describing each mill location and give the opportunity to ask questions.

39.1 **“Characterization of Lignin Gasification and Pyrolysis”**

Vipul Kumar, **Kristiina Iisa**, **Sujit Banerjee**, **William J. Frederick**, Georgia Institute of Technology

Lignin is currently burned in recovery boilers. It can potentially be pyrolyzed or gasified to produce value added products. In this study pyrolysis and gasification characteristics of two kraft lignins have been evaluated. Characterization has been performed using a laminar entrained flow reactor (LEFR) and a thermogravimetric analyzer (TGA). The LEFR results show that initial devolatilization occurs very rapidly and the maximum possible residence time in the reactor is not long enough for complete gasification to occur. Pyrolysis of both lignins shows similar behavior until 600°C but secondary reactions occur at higher temperature with the higher ash lignin. Gasification reactions are catalyzed by Na₂CO₃ with the rate increase being proportional to the amount of sodium added.

39.2 **“Gasification of Bark: A New Opportunity to Reduce Fossil Fuel in Power Boilers and Lime Kilns”**

David Mackie, **Duncan Meade**, **Rick Vandergriendt**, **Dejan Sparica**, Nexterra Energy Corp.

Nexterra Energy Corp. has developed a simple, clean and efficient gasification technology, based on a fixed-bed updraft system, which converts wood residuals, such as bark, to synthesis gas, also known as “syngas”. The technology has been demonstrated in heat and steam applications at Tolko Industries in Kamloops, British Columbia and at the Columbia Campus of the University of South Carolina.

The next stage of product development is to investigate applications where syngas can be conveyed and directly fired into dual-fuel lime kiln or boiler burners. In 2006, the company formed a consortium with key industry partners to verify that syngas can be conveyed and fired directly into these end user applications. Nexterra made major modifications to its Product Development Centre in Kamloops, BC including the installation of a refractory lined firing chamber complete with a dual-fuel scroll burner and later a scaled down lime kiln burner.

This paper details the results of the company’s research program aimed at displacing fossil fuels with syngas in lime kilns and boilers.

39.3 **“Biomass Gasification for Lime Kilns”**

Juhani Isaksson, **Vesa Helanti**, **Reyhaneh Shenassa**, Metso Power

The most significant single fossil fuel consumer in a modern pulp mill is the lime kiln. Higher fossil fuel prices and the imposition of CO₂ allowances have made gasified biomass an economically competitive fuel alternative. Lime kiln gasifiers were introduced in the early 80s. Biomass gasification is a proven technology with positive operational experiences.

Fuel drying in a modern lime kiln gasification plant is more economical and energy efficient in comparison to first-generation plants. By utilizing secondary heat sources, the net energy efficiency of a pulp mill is improved and operating costs kept low.

Biomass gasifying produces considerable cost savings while reducing dependency on fossil fuels, which is a significant benefit. Gasification can also be applied to an existing mill, with no negative impact on production.

40.1 “High Energy Piping Evaluation”

Jonathan D. McFarlen, M&M Engineering Associates

High Energy Piping (HEP), for the most part, is often disregarded during planned outage inspection activities. However, failure would result in considerable costs and possible personnel injury. Steps for an effective evaluation method are presented, as well as, an overview of pipe supports and discussion of potential damage mechanisms.

40.2 “Dewpoint Corrosion of a Coastal Biomass Power Boiler Air Heater”

Neville Stead, J.R. Kish, D.L. Singbeil, FPInnovations – Paprican; **C. Reid, E. Johansson**, ACUREN Group Inc.; **R. Seguin**, Catalyst Paper Corporation; **F. Preto**, Natural Resources Canada, CANMET Energy Technology Centre

Significant corrosion of cold-end air heater tubes has occurred in a biomass (waste-wood) power boiler operated on the Canadian west coast. A field testing program was initiated to better understand the suspected dewpoint corrosion conditions, and to identify a more corrosion resistant alloy from which to construct replacement tube sections or sleeve tube inserts. This effort involved reviewing the non routine inspection results to document the damage history and extent, and the use of a custom-built, air-cooled corrosion/deposit probe to characterize the controlling environmental and material factors. This paper documents the results of this effort.

Bridge Session II

“Technical and Economic Analysis of Repurposing a Kraft Pulp and Paper Mill to the Production of Ethanol”

Richard B. Phillips, Hasan Jameel, North Carolina State University; **E. Calvin Clark Jr.**, BE&K Engineering

Attractive financial returns can be achieved by repurposing non-competitive kraft pulp mills to the production of ethanol. Under “Reasonable but Optimistic” assumptions, capital cost required to produce ethanol from Forest Biomass can be reduced by 40-50%, and cash costs of \$1.48 per gallon can be achieved.

Largely relying on laboratory results developed by others, we have prepared a rigorous process simulation model of a 6-step ethanol production process that includes: (1) hot water pre-cooking of the wood to extract hemicellulosic material; (2) high yield kraft pulping to reduce lignin content and physically open up the fiber structure; (3) enzymatic hydrolysis of the pulp stream using a cocktail of cellulose enzymes found in our lab to efficiently convert **hardwood** cellulosic material to simple sugars; (4) fermentation of the streams produced in Steps (1) and (3); (5) distillation of the ethanol produced in Step (4) to 95% (V/V) in water; (6) dehydration of the ethanol solution to 99% + concentration using molecular sieves.

Eight main simulations were prepared, and financial *pro forma* analysis was prepared on each case. The financial outcomes are most significantly impacted by assumptions for ethanol revenues per gallon and less so by fiber cost or cost of hydrolysis enzymes. Selection of accelerated

depreciation schedules can make the most financially attractive scenarios better, but in cases where before-tax earnings are negative, the most aggressive depreciation allowance is not helpful.

We conclude that our technical approach has significant financial merit, with only minor compromises for re-using existing mill equipment. Repurposing takes advantage of proven manufacturing equipment and skilled operating personnel in place, and, perhaps most important, takes advantage of existing supply chain of growth, harvesting and delivery of forest biomass, without creating new demand.

Bridge Session II

“Guided Tour: Implementing the Forest Biorefinery (FBR) at Existing Pulp and Paper Mills”

J. McNutt, CPBIS; **V. Chambost**, **P.R. Stuart**, École Polytechnique

The forest biorefinery (FBR) is being considered by many forest product companies as an option for improving their business models. FBR implementation implies significant challenges for mills related to key technological, economical, financial, cultural, and operational risks – and most importantly, related to enterprise transformation (ET). Product platform definition needs to be systematically considered in order to develop sustainable biorefinery strategies, which in turn precipitates corporate transformation while increasing overall profits. Foundation concepts with regards to ET and product design are presented in this paper. A hypothetical “guided tour” is given for the biorefinery implementation for the production of ethanol, in which a phased approach is proposed, and key issues that a given mill should consider for implementing the FBR are highlighted.

Bridge Session II

“Betting on Biorefinery and Positioning the Pulp and Paper Industry for Biorefinery Success”

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The emerging bio-energy industry, in particular, the bio-fuel segment, is attractive to many companies but full of uncertainty. Major factors affecting the industry’s performance and profitability – feedstock costs, regulations, and technologies - are in flux. Despite these uncertainties, waiting to enter under the classical “investment under uncertainty” rules may be costly because resources are in short supply and equity available for investments are in tight squeeze. While the ‘corn’ based bio-fuel program is getting all the attention and investment, life-cycle analysis indicates that there are pit-falls in overemphasizing just this program. There needs to be a sound alternative to this approach and that’s where the pulp and paper industry’s bio-refinery approach makes both financial and technological sense. Bio-refineries are examples of integrated processes for energy generation and production of goods, where energy (bio-fuels) and by-products (chemicals) production provide attractive “Value Proposition” to the revenue portfolio. Pulp and paper companies that decide to enter the ‘bio-fuel’ arena should have a sound strategy in place to hedge their bets and should start developing relationships that could help reduce uncertainty and volatility. This paper outlines a strategic approach to the bio-refinery concept in the Pulp and Paper industry and discusses in detail the financial model for the approach.

Bridge Session III

“Impact of the Integrated Pulp Mill/Biorefinery on the Chemical Recovery Cycle”

Nikolai DeMartini, Steven J. Lien, William J. Frederick, Jr., Georgia Institute of Technology

Integrated pre-extraction of hemi-cellulose in pulp mills will impact both the loading on the chemical recovery cycle and the black liquor chemistry. This paper uses the modeling results from the excel spreadsheet model BioRefinOPT™ to estimate the impacts on the chemical recovery cycle. This work is meant to compliment the pulping work and economic assessments being done for hemi-cellulose pre-extraction. For this study, pulp production was kept constant. Because pre-extracted chips are delignified more rapidly, it is possible to use lower EA:wood charges. For this paper we considered an EA:wood charge of 16% as the base case and modeled also 14% and 13%. Evaporation load will increase due to the saturation of the wood after pre-extraction and also due to cellulose decomposition. The black liquor chemistry will also change slightly, affecting the solubility limits of inorganic salts, viscosity, boiling point rise and heating value which will additionally impact both the evaporators and recovery boiler. The load on recausticizing will increase for an EA:wood charge of 16% because of the decreased yield due to cellulose decomposition and hemicellulose pre-extraction. However, reducing the EA:wood charge will reduce the load on recausticizing to below the level used for pulping wood chips at an EA:wood charge of 16 %.

Bridge Session III

“Production of Ethanol from Forest Residues and Hog Fuel in a Pulp Mill”

Kristiina Iisa, Kristina Knutson, Arthur Ragauskas, Nikolai DeMartini, Wm. James Frederick, Jr., Georgia Institute of Technology

The value of wood residue can be enhanced considerably above its fuel value by extracting carbohydrates from it before burning it and converting the carbohydrates to fuel-grade ethanol. The yields for extracting and fermenting carbohydrates from various southern pine residues (bark, needles, twigs, and branches) were evaluated and are reported here.

Bridge Session III

“Integrated Bio- & Thermo- Chemical Route for Mixed Alcohol Production in a Pulp and Paper Mill”

David Koch, Kristiina Iisa, Matthew Realff, W.J. Frederick Jr., Georgia Institute of Technology