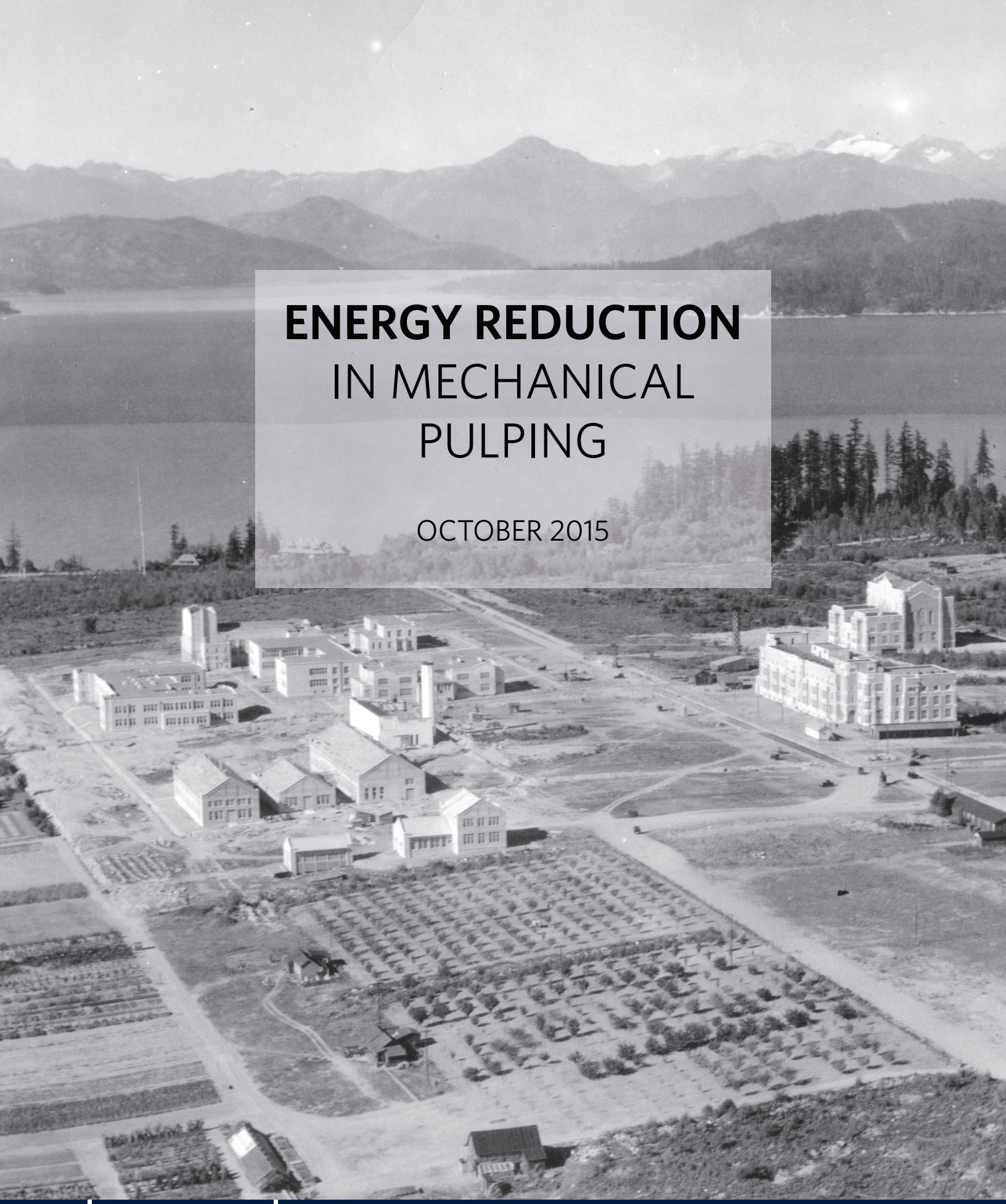

ENERGY REDUCTION IN MECHANICAL PULPING

OCTOBER 2015

UBC100

THE UNIVERSITY OF BRITISH COLUMBIA

Welcome Message

Dear partners in the Energy Reduction in Mechanical Pulping research program,

It is my pleasure to welcome you to UBC's Centennial. It is an exciting time on campus and we are proud that this exemplary research group is part of this historic time. I encourage all of you to explore all that UBC has to offer during its Centennial.

This past year we have seen considerable opportunity thanks to the exciting $100M BC Hydro TMP incentive program. I believe that this opportunity will enable our BC partners implement many of the concepts that the research program have been advocating and actively working to demonstrate, for example the broader application of multi-stage low consistency refining.

It has however, also been a challenging time for us - Paper Excellence announced the closure of Howe Sound Pulp and Paper due in part to the severe drought British Columbia experienced this past summer. The program has made a significant commitment to reducing energy consumption and continues to be ideally positioned to work together with industry to address today's greatest challenges. Our Alumni also continue to make a significant and positive difference in the real world – I encourage you to read the industry update on page 15 from Ali Elahimehr on West Fraser's recent Line 3 upgrades. We are also pleased to welcome Chetwynd Mechanical Pulp (Paper Excellence) as the newest member of the program.

The Pulp and Paper Centre will be celebrating its 30th anniversary in 2016. We invite all of our partners to come out on May 28th and join the celebrations. UBC has also recently announced a new Master of Engineering Leadership degree. The 1-year intensive program in Green Bio-Products is designed to prepare students to work as valued leaders and sector specialists in this exciting and emerging industry. It is a strong signal that the University and government continue to support and invest in the advancement of this important sector.

I hope to see many of you at the November 19th Steering Committee meeting where we can discuss these new initiatives and also continue our discussion on the future of the program.

Sincerely yours,

James Olson
Principal Investigator, Energy Reduction in Mechanical Pulping Research Program
Professor and Associate Dean, UBC

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ON THE COVER
Aerial view of the UBC campus in September 1925. Looking north across Burrard Inlet towards West Vancouver, Howe Sound and Coast Mountains. *c/o UBC Historical Photograph Collection.*

NICHOLAS McINTOSH

1.1 - COMPRESSION SCREW FEED OPTIMIZATION AND ENERGY SAVINGS IN HC REFINING

Compression of woodchips prior to refining has been shown to be an effective method by which to reduce refining energy requirements [1]. If coupled with an impregnation process following compression, refining energy requirements have been observed to be further reduced [2]. To better understand the relationship between compression conditions and product properties (e.g., liquid uptake capacity of compressed chips), Nick has taken an optical approach involving microscope imaging and image analysis to obtain pore-size distributions of the treated chips. The obtained pore-size distributions allow for liquid uptake capacities to be predicted and the microstructure of the chips to be related to the compression conditions which produced them. A second, complementary, method has also been developed which directly measures liquid uptake capacity. The combination of the two compressed-chip characterization methods will allow for a fuller picture of chip destructuring mechanism and allow for an optimum (in terms of enhanced liquid uptake) to be determined in regards to compression conditions and screw press operating conditions.

Liquid Uptake of Compressed Wood

By using the developed image analysis technique to determine the pore-size distribution from a compressed wood sample, it is possible to estimate a liquid uptake capacity and thus predict impregnation effectiveness of a given compression process by making geometrical assumptions about the structure of wood. In contrast to this method, liquid uptake rate will also be directly measured (Fig.1) and, using the obtained data, a pore-size distribution will be estimated. In a sense this method works backwards relative to the image analysis technique in characterizing woods structure. The direct measurement of liquid uptake rate of a treated sample offers several advantages: firstly, no assumptions need to be made in determining the effectiveness (in terms of liquid impregnation) of a compression process and, secondly, the results may be compared to those from the image analysis procedure with any discrepancies, allowing for three dimensional effects of the destructuring/compression process on the structure of wood to be derived.

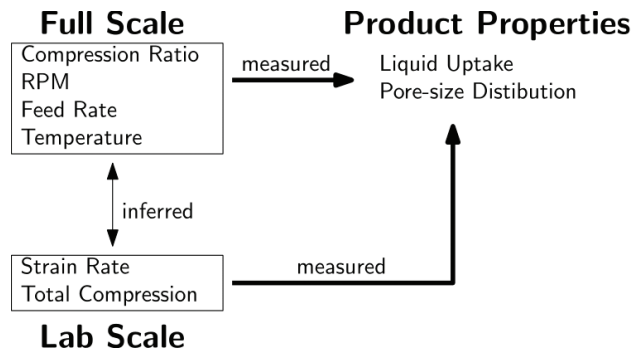

Figure 2: Mapping full-scale operating conditions to lab-scale experimental conditions using wood's structural identifies measured by image analysis/liquid uptake methods.

Mapping of Results

The complex nature and inherent variability of a full-scale compression screw obscures some of the more fundamental physics occurring at the fibre scale which affect the destructuring/liquid uptake efficiency of the device. To remove experimental and operational variability while still obtaining scalable results, Nick is currently conducting a full matrix of lab-scale compression tests. These tests, which compress a single wooden sample at a known rate and for a known time to simulate screw-press treatment, will provide the basis upon which pilot and mill scale results may be mapped to. This mapping of results will allow for the process-governing physics to be explored while allowing for full-scale takeaways to be created and information as to the optimum operational ranges of a real machine to be found.

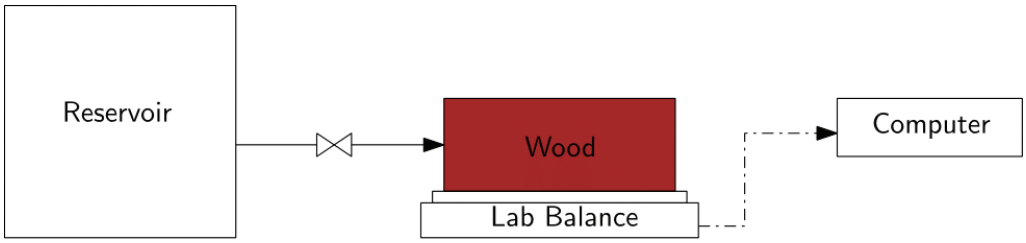

Figure 1: Schematic of the experimental setup for liquid uptake measurement. A wood sample is connected to a fluid reservoir and the fluid uptake with time is monitored by a lab balance connected to a computer.

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[1] Dmitri Gorski. ATMP Process: Improved Energy Efficiency in TMP Refining Utilizing Wood Disintegration and Targeted Application of Chemicals. PhD thesis, Mid Sweden University, 2011.

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YU SUN & HARRY CHANG

1.3 - OPTIMIZATION OF CHEMICAL CHARGE DISTRIBUTION THROUGHOUT THE PROCESS

The team's recent research has focused on evaluating the response to bleaching of the high-freeness TMPs prepared from chemically treated chips in the October 2014 trials conducted at the Andritz pilot plant. Two separate studies have been carried out using the bleaching agents' alkaline peroxide and sodium dithionite.

Response of thermomechanical pulps produced from chemically treated chips, to peroxide bleaching

In this lab work, two pulps from the 2014 Andritz trials have been evaluated: one was a control TMP with no chemical treatment and the other was a TMP made from alkaline peroxide treated chips (4%NaOH+2%H2O2). Before the bleaching stage, both pulps were low-consistency refined using UBC's pilot LC refiner. LC refining alone showed a positive effect on pulp brightness as a result of increasing scattering coefficient. The two LC refined pulps were bleached with peroxide using a range of hydrogen peroxide charges, sodium hydroxide charges, reaction temperatures and times. It was found that the best bleaching condition for the control pulp is 5% H2O2, 4% NaOH at 70 oC for 150 minutes. Under this bleaching condition, the brightness of the control pulp could be increased from 54% ISO to 77% ISO, and the pulp from alkaline peroxide treated chips could be increased from 39% ISO to 67% ISO.

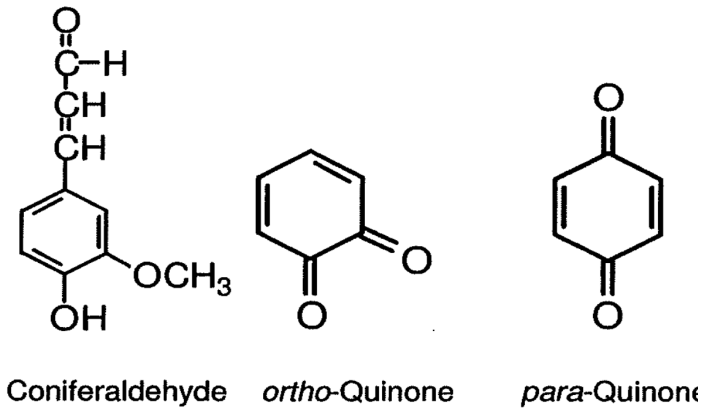


Figure 1: Common Mechanical Chromophores that react with Sodium Dithionite

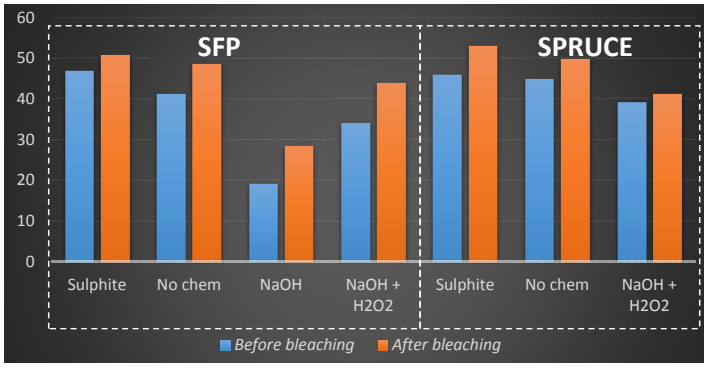


Figure 2: Response of thermomechanical pulps, produced from chemically treated chips, to sodium dithionite bleaching.

Response of thermomechanical pulps produced from chemically treated chips, to sodium dithionite bleaching

Yu has also evaluated the bleaching response of high-freeness TMP, produced in the Andritz pilot plant from chemically pretreated SPF chips, to sodium dithionite. In contrast to hydrogen peroxide which is an oxidising agent, dithionite is a reducing agent and thus would be expected to react differently to the chromophores in the pulps (Figure 1). In this preliminary work, only one dithionite reaction condition, 1% sodium dithionite, 4% pulp consistency at 70 oC for 1 hour, was investigated. Results show that for SPF, the gains in brightness by dithionite bleaching of the pulp from the chemically treated chips, is between 4 to 9 ISO units, as shown in Figure 2. The highest brightness gain after dithionite bleaching was observed for pulp from alkaline peroxide pretreated chips, which increased in brightness from 34% ISO to 43% ISO. Further work is needed to better understand the correlation between dithionite bleaching and different types of chemical chip pre-treatments.

JORGE RUBIANO

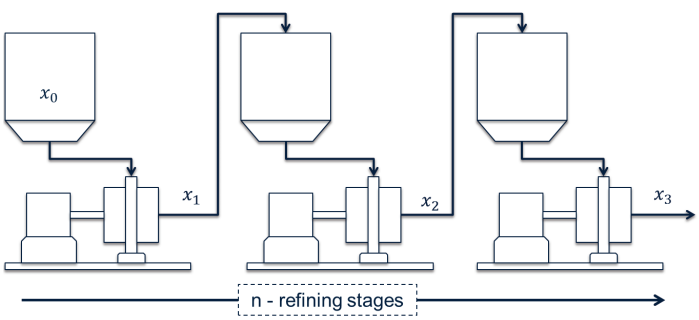
1.4 - OPTIMAL LC REFINING

One of the most important properties of pulp is the fibre length and its distribution. The majority of studies in past literature have used only fibre length average values and the assessment of the fibre shortening was done by relating those average values to the refiner conditions. However, this is a limited explanation of a complex phenomenon since some studies have shown that refiners cut fibres at different rates depending on their length, suggesting that it is a more complex mechanism than a simple and random cutting process.

Since May 2015, Jorge has used the typical framework of a comminution model to rigorously analyze fibre shortening. Fibre length distribution changes can be described by coupling two concepts: (1) a selection function describing the fibres cutting rate and (2) a breakage function which describes generation of shorter fibres due to cutting and their proportions. These two concepts imply a large number of parameters. For instance, if we consider 20 bins in a traditional fibre length distribution, one will end up with 210 different parameters to determine. However, based on heuristics and expertise of those in the mining industry where the comminution model was originally conceived, it can be simplified to three parameters that are fully able to describe the fibre shortening phenomena as described in the two concepts above.

Performing mass balances over a differential element of a refiner, the equations of the comminution model are easily written where the refiner's dimensions and plate geometry are included, leading to a complete model describing fibre shortening in terms of the comminution model parameters and the refining variables.

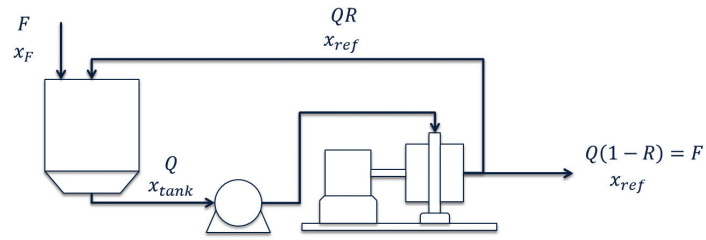
The comminution model applied to low consistency refining is useful to describe the fibre cutting in a single refining operation (ie one stage). From this groundwork, three different refining setups have been analyzed since July 2015 and the governing equations have been derived (see Fig. 1-3).



$$\boldsymbol{X}_n = n\,\beta \boldsymbol{A} \boldsymbol{X}_0$$

Figure 1: Refining in stages. In the equation, n represents the number of stages, β is an operational parameter, A is the comminution model matrix, X is the initial and final pulp fibre length distributions.

With this, all the operational parameters (flow rate, tank volumes, recirculation ratios, number of stages, etc) are included and their impact in the refining outcome is also accounted.

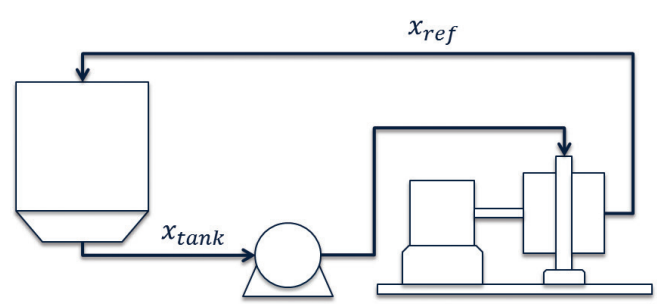


$$\boldsymbol{X}_{ref}^{\infty} = (1-R)\,[R\beta \boldsymbol{A} - \boldsymbol{I}]\boldsymbol{X}_F$$

Figure 2: Refining with recirculation. In the equation, R is the recirculation ratio, β is an operational parameter, A is the comminution model matrix, I is the identity matrix, X is the initial and final pulp fibre length distributions.

The equation of the closed loop-batch refining case (see Fig. 3) has been used to analyze six trails performed in the Pulp and Paper Centre's low consistency refining facility. These preliminary results show that the cutting rate is almost a linear function of fibre length, intensity and refiner speed (RPM). Also, it was a found that in general, fibres get cut more in the middle than in the tails. Also, the ratio between cuttings in the middle over the tails depends on the refiner characteristics and pulp type.

In addition to the six completed trials, Jorge plans to perform at least 30 more over the next six months in order to get more comprehensive results and to find a general trend between traditional refining variables and the behaviour and evolution of fibre length.



$$\boldsymbol{X}_{tank}(t) = \frac{Q}{V} t\,[\beta \boldsymbol{A} - \boldsymbol{I}]\boldsymbol{X}_0$$

Figure 3: Closed loop refining – batch refining. In the equation, Q is the flow rate, V is the tank volume, t is time of refining, β is an operational parameter, A is the comminution model matrix, I is the identity matrix, X are the fibre length distributions at different time intervals.

HUI TIAN

2.1 - OPTIMIZATION AND CONTROL OF INTEGRATED HC AND LC REFINING

The objective of this project is to reduce the energy consumption and the pulp quality variability by developing an advanced nonlinear economic model predictive control (econ MPC). In Hui's previous studies, dynamic nonlinear models for each operational unit of a conventional TMP process were built - which included a primary refiner, a secondary refiner, a latency chest and a low consistency refiner (see Fig.1).

In the previous simulation study, we have demonstrated the potential energy reduction in the TMP process by using econ MPC techniques. In that work, we used Matlab to simulate the nonlinear TMP model, and a Matlab solver (fmincon) to solve the nonlinear optimization problem. However, due to the severe nonlinearity and the complexity of the TMP model, solving the nonlinear optimization using Matlab was time-consuming and strongly dependent on the initial guess.

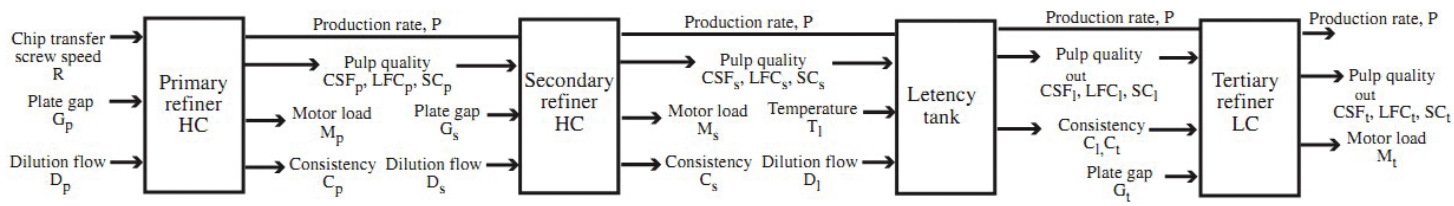


Figure 1: Flow chart of the conventional TMP process

In the economic MPC, the specific energy, defined as the ratio of production rate to the motor load, is the objective function. To guarantee the convergence and closed-loop stability of the nonlinear system, regularization terms are added to the nonlinear econ MPC objective function. Moreover, in order to meet the process safety and pulp quality requirements, the constraints for both the manipulated variables and the controlled variables have to be taken into account in the control of the TMP process. Simulation results show that, compared with the traditional MPC, the proposed economic MPC technique provides an approximately 10% drop in the total specific energy consumption while maintaining the same pulp qualities.

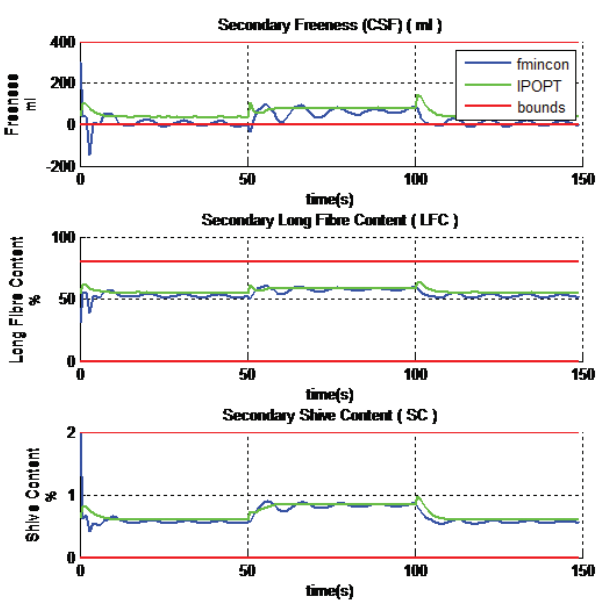


Figure 2: Pulp properties after the secondary HC refining process

In order to reduce the computational time and improve the robustness of the algorithm, we have now modeled the TMP process and the controller using AMPL (A Mathematical Programming Language) and IPOPT (Interior-point OPTimizer). AMPL is a modeling language that provides a user-friendly interface to model large-scale nonlinear systems, and IPOPT is an open-source solver with efficient algorithms to solve large-scale nonlinear optimization problems. Using the new software and the solver, the simulations run much faster, as shown in Fig. 2.

Moreover, the pulp qualities, including Canadian Standard Freeness (CSF), long fibre content (LFC), and shive content (SC) are controlled within their respective limits (see Fig. 3). Fig. 4 demonstrates that by using the new IPOPT solver, the economic MPC can further reduce the specific energy by 4% to 5%.

Based on the rather encouraging simulation results, Hui is planning to conduct a pilot trial on a conventional HC refining process. We invite interested partner companies to contact us.

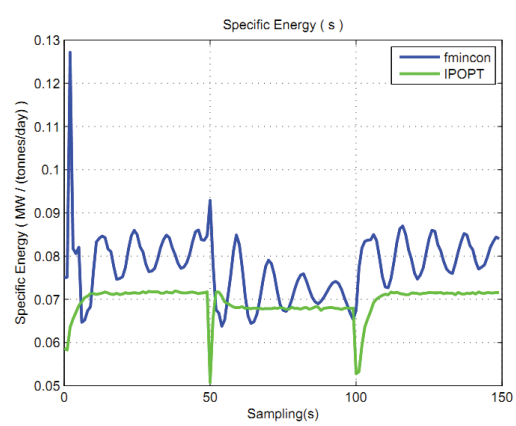


Figure 3: Specific energy comparison by using IPOPT and fmincon

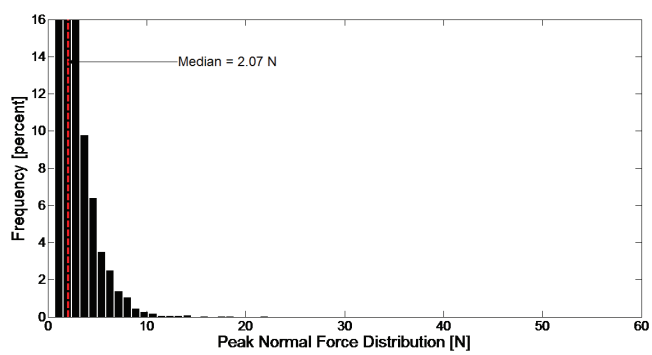
REZA HARIRFOROUSH

2.2 - LC REFINER BAR FORCE SENSOR BASED CONTROL STRATEGIES

Low consistency refining has been demonstrated to reduce energy consumption in mechanical pulping [1–3]. However, a key limitation of LC refining is the degradation of mechanical properties due to fiber cutting at high refining energies [4]. This issue has limited the widespread adoption of LC refining.

Since the last newsletter, Reza has investigated the relationships between local bar forces, measured with the refiner force sensors (RFS), plate gap and fibre length in the refining zone with UBC's Pulp and Paper Centre's AIKAWA 16'' single-disc LC refiner.

Fig. 1 shows normalized distributions of peak normal force values measured with the RFS in those trials for two different plate gaps, 0.4 mm, and 0.7 mm, at 1200 rpm. It shows that both the median magnitude and the spread of the peak normal force distributions increase as the gap decreases.



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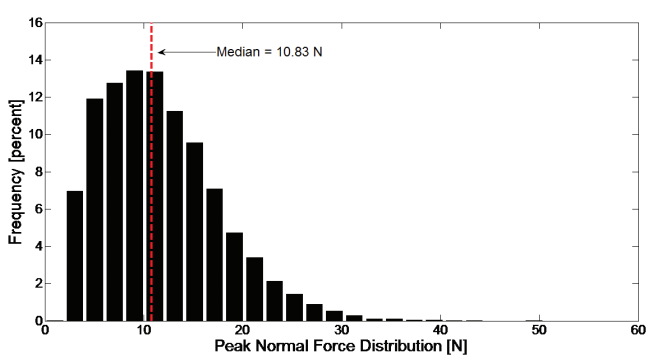


1 (b)

Figure 1 (a) and (b): Normalized distributions of peak normal force for plate gaps of 0.7 mm (a), and 0.4 mm (b) for 1200 rpm rotational speed.

The relationships between the net power and the inverse of the plate gap for three rotational speeds: 1200 rpm, 1000 rpm, and 800 rpm, are shown in Fig 2. These relationships are similar to the results of Elahimehr [5]. As the plate gap is reduced, the net power increases. However, the effect of increasing the net power is more significant for gap sizes of less than 0.5 mm (2 mm^{-1}). The critical gap at which the transition from linear to nonlinear behaviour occurs is not apparent in these plots as has been shown in previous work [5].

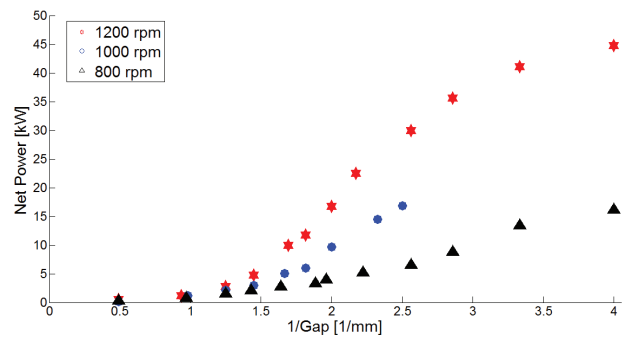


Figure 2: The net power versus the inverse of the plate gap for three rotational speeds of 1200rpm, 1000 rpm, and 800 rpm.

The relation between the Length-weighted fiber length1 (Lw) and the inverse of plate gap is shown in Fig. 3 for rotational speed of 1200 rpm. To explore the relationship between forces and pulp properties, Lw is also plotted against the mean of peak normal forces and the mean of peak shear forces (Fig. 4).

1 $$L_w = \frac{\sum n_i L_i^3}{\sum n_i L_i^2}$$

When n_i and L_i are the number of the fibres and length respectively. This is the key pulp property that was used in the analysis.

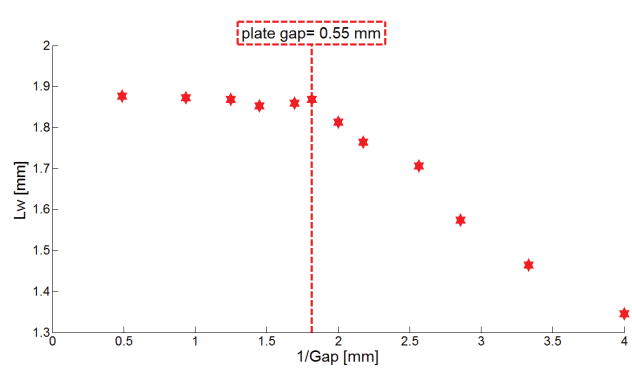
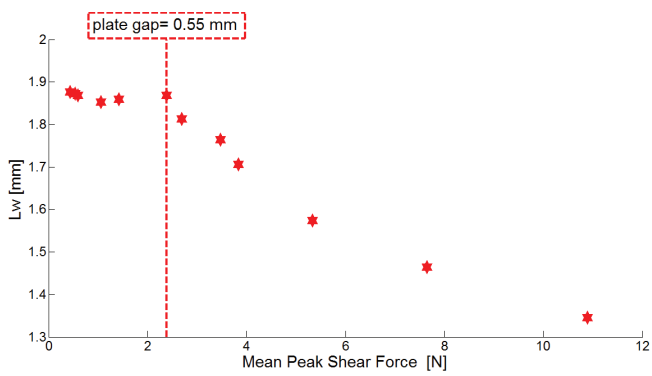


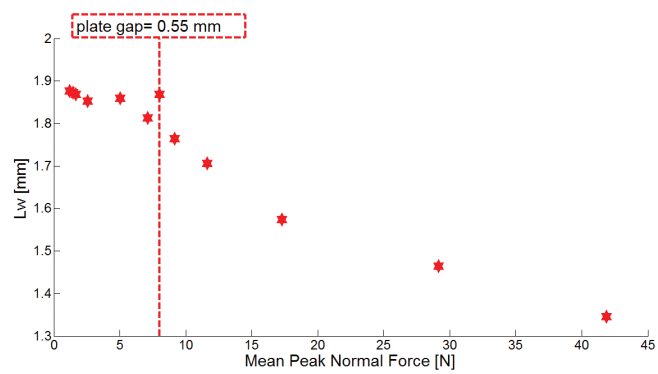
Figure 3: The L_w versus gap for rotational speeds of 1200 rpm

2.2 CONT.

As shown in Fig. 4, there is a nonlinear relationship between measured bar forces and L_w that mirrors the established relationship between L_w and the inverse of plate gap. As the plate gap is reduced, the L_w remains relatively constant while net refiner power and the mean peak normal and shear forces increase. These trends continue up to a threshold values of mean peak normal and shear forces of 8 N∓5% and 2.4 N∓5%, respectively. Above this threshold, mean peak normal and shear forces continue to increase but the Lw exhibits a negative linear relationship with these forces. These results suggest that the force sensor data can be used to detect the onset of fibre cutting and that these sensors have the potential to be used as the basis for advanced refiner control strategies. In the near future, more trials and analysis will be performed to study the relation between the shape of these force distributions and changes in pulp properties.



4 (a)



4 (b)

Fig 4. The L_w versus mean peak shear (a) and normal (b) force for rotational speed of 1200 rpm

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RAMIN KHOIE

2.3 - ADVANCED PUMP PERFORMANCE MONITORING SYSTEM

This project aims to reduce energy consumption of industrial centrifugal pumps inside mechanical pulping plants by developing a real-time predictive maintenance schedule for pump impellers. A main component of this project involved designing a novel magnetic sensor that allows for wear measurement while the pump is in operation. As wear occurs on the tip of the pump impeller, the thickness of the impeller blades decreases, leading to an increase in the gap width between the impeller and the side-plate. To measure wear, the magnetic sensor includes a magnetic circuit axially to the pump using a clamping assembly referred to as fluxguide and a magnetic coil, as represented in Figure 1. As the gap increases, the reluctance of the circuit also increases reducing the inductance of the coil. This design allows the sensor to be installed on any existing centrifugal pump without the need for further modifications to the pump it self.

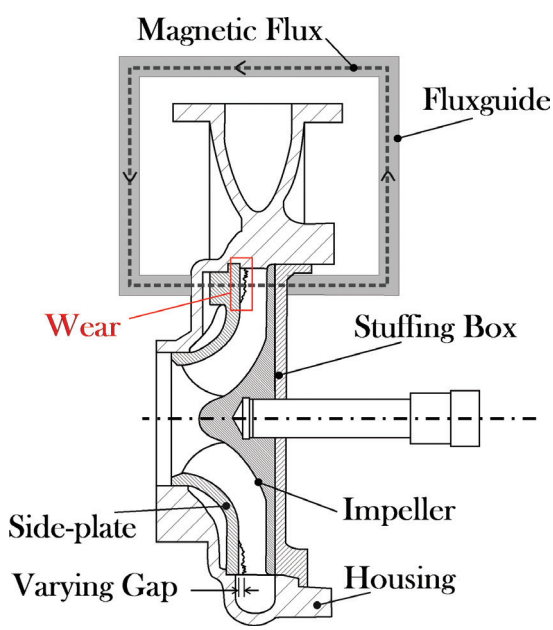

Figure 1 - The cross-sectional drawing of UBC's 40 HP WestCan centrifugal pump with the sensor attached axially to the pump creating a magnetic circuit. The location of the wear on the impeller is indicated on the drawing.

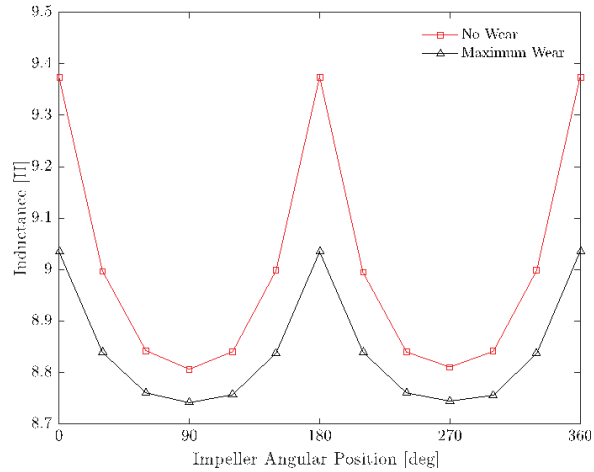

Figure 2. The inductance of the magnetic coil as a function of the impeller's angular position for both the no-wear and maximum-wear states.

During the past six months, multiple iterations of the sensor were designed and simulated using COMSOL Multiphysics. The geometry of the sensor, material used and circuit elements were selected based on the results of the numerical simulations in order to maximize the sensitivity of the sensor. In these simulations, the magnetic coil placed on the sensor was excited using 10 V AC at 5 kHz. The numerical analysis yielded the inductance of the coil as a function of impeller angular position, shown in Figure 2, and the maximum inductance as a function of the increasing gap width between the impeller and the side-plate as represented in Figure 3.

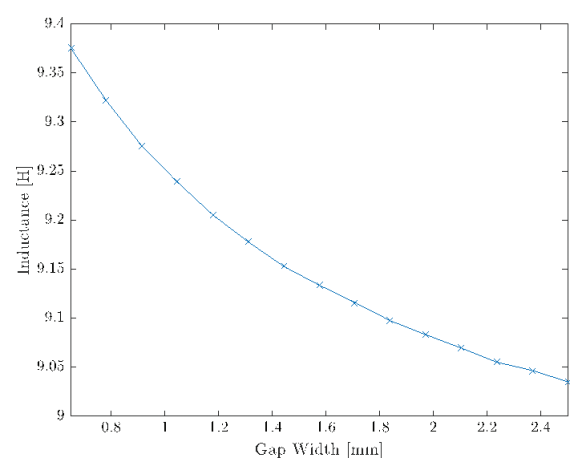

Figure 3. Maximum coil inductance as a function of the gap width and it varies from 0.65mm to 2.5mm.

2.3 CONT.

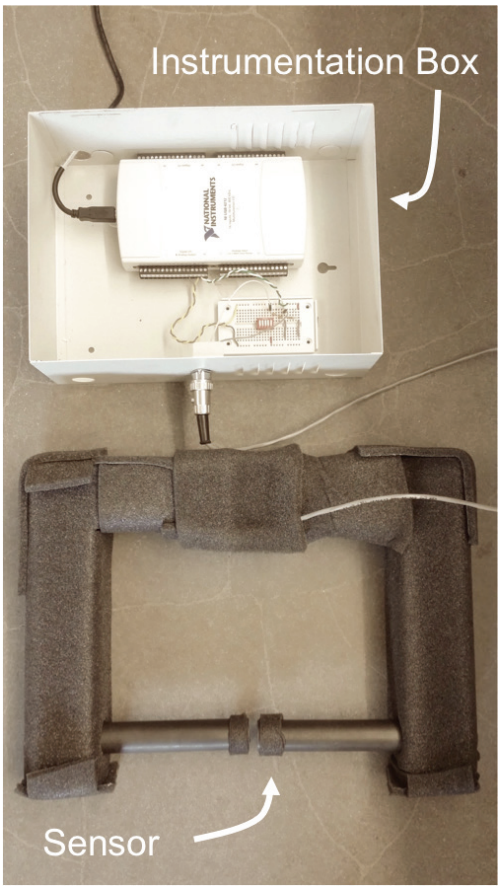

Figure 4. Second prototype of the sensor assembly connected to the instrumentation box.

To physically monitor the change in the inductance of the magnetic coil, a second prototype of the sensor was built. The sensor included a fluxguide clamping assembly made from M100 Manganese-Zinc ferrite material with initial relative permeability of 10,000 and a 150-turn magnetic coil assembly connected to a portable instrumentation box for continuous data logging, represented in Figure 4. In this prototype, eddy currents generated in the conducting plates of the pump became evident at high frequencies. As a result, the excitation frequency of the coil was lowered to minimize the effect of eddy current on the output of the sensor. Using the verified analytical model of the sensor along with the simulation results, the behaviour of the sensor was predicted as wear on impeller blade increased, shown in Figure 5. This study yielded a sensitivity of 0.53 V/mm.

In the next phase of the project, the final prototype of the sensor will be placed onto the pump in the UBC pilot plant to validate the predictions made using the analytical model and the simulations. For this, the gap between the impeller and side-plate needs to be manually varied to account for wear on impeller blades.

This work has also been accepted for presentation at the IEEE Sensor Conference 2015 in Busan, South Korea on November 3rd, 2015.

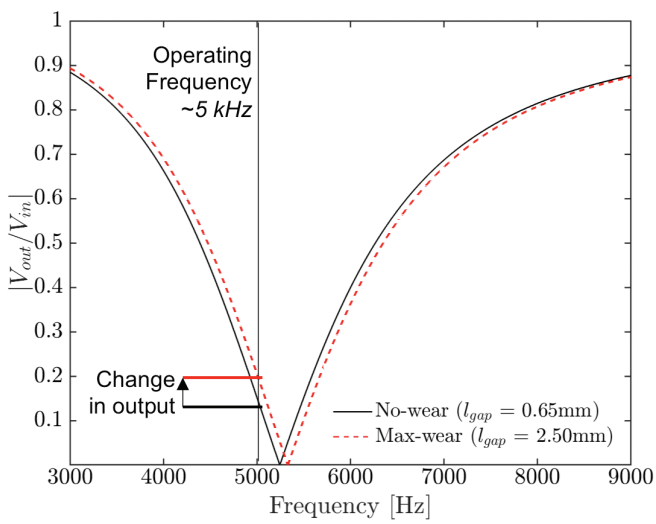

Figure 5. Predicted response of the sensor as wear increases from no wear to maximum wear.

HANYA ETTEFAGH

3.2 - LCR PULP FOR PACKAGING PAPERS

LC Refined Reject Pulp in Folding Boxboard

The team of researchers intends to determine the effect that the addition of LC refined reject pulp in the middle ply furnish of folding boxboards (FBB) has on mechanical, physical, and microscopic properties of the board. The reject pulp used in this study was provided by Winstone Pulp International (WPI). This project consists of two phases.

In Phase I, single-ply Dynamic Sheet Former (DSF) boards were made of a pulp blend containing reject pulps that had been LC refined at the UBC Pulp and Paper Center to varying degrees. The main objective of this phase was to assess of the effect of pulp freeness and LC refining intensity on board properties. The LCR pulp was combined with three other commercial pulps for making the middle layer of folding boxboards. Since the April report all board making has been completed and all the mechanical and physical tests, as well the microscopic studies, have been finalized on each of the 11 samples. The results for phase I of the project show that changing even 25% of the furnish caused changes to the prepared boards' physical and mechanical strength. It was observed that decreasing the LCR reject pulp freeness improves the boards' properties including burst index, tensile index, and compression strength by approximately 55%, 50%, and 12% respectively. However, according to the statistical analysis, ANOVA and Tukey, there was almost no significant difference between the mechanical properties of the samples containing LCR reject pulp with freeness between 375-155ml.

The second phase of the project was conducted between July and October 2015. This phase included the production of three-ply boards, with the top and bottom plies composed from a mixture of hardwood and softwood kraft pulps refined at FPInnovations in Pointe Claire, QC. (Table 1). Reject pulp was again LC refined at UBC under varying conditions, and included in the middle ply of the three-ply board samples - the ratio of LCR reject pulp to three commercial BCTMPs is shown in Table 2.

The results show that increasing the LCR reject pulp from 25 to 45 percent of the middle ply furnish did not have a significant effect on the boards' properties, however, increasing the LCR reject pulp slightly improves the mechanical strength such as tensile properties, stiffness, and internal bond of the boards.

	Trial #4			Trial #5		
WPI LCR rejected pulp	25%	35%	45%	25%	35%	45%
WPI commercial pulp	25%	21.7%	18.3%	25%	21.7%	18.3%
Aspen	25%	21.7%	18.3%	25%	21.7%	18.3%
Spruce	25%	21.7%	18.3%	25%	21.7%	18.3%

Table 2: Middle ply furnish for phase II

Effect of chip pre-treatment and LC refining on board properties

A second component of project 3.2 investigates the effect of chip pretreatment (sulphite and no treatment) and LC refining on three-ply FBBs' mechanical and physical properties. This project uses pulp provided by Quesnel River Pulp during UBC's 2014 Andritz trials, which was LC refined at UBC.

After completing LC refining trials at UBC in June 2015, the pulp was shipped to FPInnovations in Pointe Claire, QC. DSF board making and physical testing has started in October 2015, with result analysis to be completed shortly thereafter.

Pulp type	NBHK	NBSK	Mixed HW/SW
Source	12.5% SW Domtar Espanola	50% HW Domtar Espanola Maple	
Content	50%	50%	-
Freeness, ml	380	525	411
Consistency, %	4.88	3.6	4.15

Table 1: Chemical pulp specification used for top and bottom plies

CHUNYANG HAN

3.2 - LCR PULP FOR PACKAGING PAPERS

Chunyang Han joined the program as a Postdoctoral Research Fellow in July 2015, under the supervision of Professor Ramin Farnood at the University of Toronto. Chunyang received his BSc degree in Packaging Engineering from Dalian Polytechnic University, Dalian, China. After several years of working as a packaging engineering specialist at Shenyang Agricultural University, Shenyang, China, he received his MASc degree in Food Science and Engineering from the aforementioned university. He then went on to receive his PhD in Packaging Engineering from Tianjin University of Science & Technology, in Tianjin, China in 2013.

The goal of Chunyang's project is to enhance the mechanical properties of LCR-containing multi-ply folding boxboard (FBB). The main focus of this study will concentrate on tensile properties, ply-bond strength, compression strength, and bending stiffness.

Plybond strength of FBBs containing LCR reject pulp

In order to test the z-direction strength of the multi-ply folding boxboard, Chunyang designed a fixture that fits into the existing tensile machine. It performs the test according the TAPPI T541 standards. The fixture is "T" shaped and made out of one piece of steel. The test plate area is 2×2 inches and it is 3.5 mm thick. It was made at the UofT mechanical shop. The specific shape is shown in Fig. 1.

Initial tests will be performed using the three-ply board samples prepared using the dynamic sheet former at FPInnovations. Table 1 provides a list of middle ply furnish used in preparing samples for testing. For each furnish mix, two sets of samples were prepared containing LCR pulps with different refining conditions. A commercial chemical pulp is used for the top and bottom plies. The basic weight of top, middle and bottom ply were 45, 220, 45 g/m^2, respectively.

	Furnish (%)		
WPI LCR	25	35	45
Radiata	25	21.7	18.3
Aspen	25	21.7	18.3
Spruce	25	21.7	18.3

Table 1 - Middly-ply furnish. Data from Hanya Ettefagh

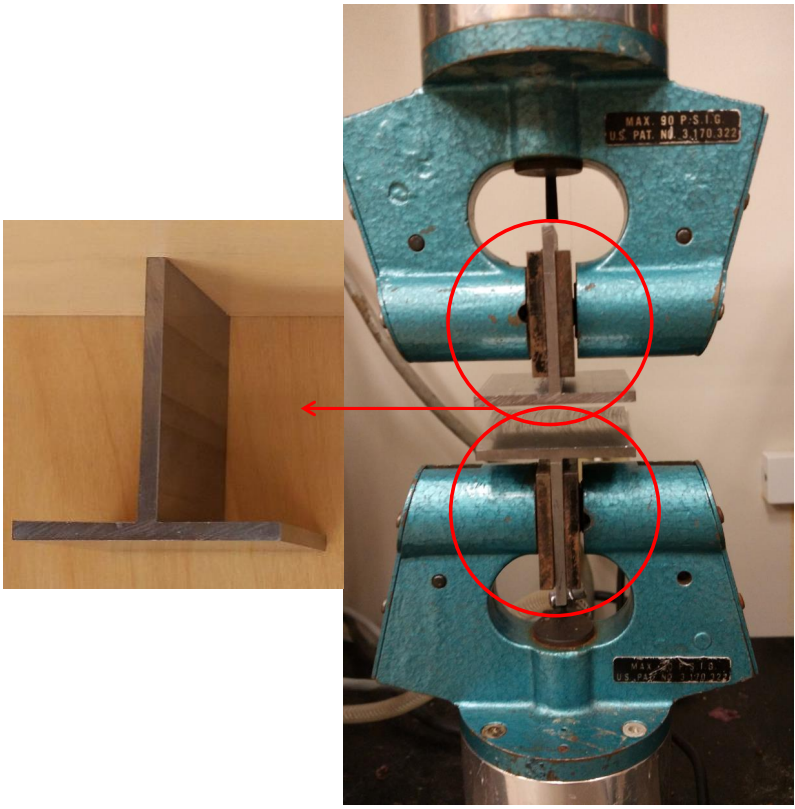

Figure 1: Steel "T" shaped fixture installed in the tensile machine; used for z-direction strength testing.

Enhance the mechanical properties of LCR pulp containing multi-ply FBB by adding strength additives

a) Multi-ply FBB using handsheet making machine

Researchers at UofT developed a laboratory procedure to prepare multi-ply board using handsheet making machine. Using this method, the team will investigate the effect of furnish on the mechanical properties of multi-ply board. Figure 2 shows a cross section of a multi-ply board sample prepared using this method.

3.2 CONT.

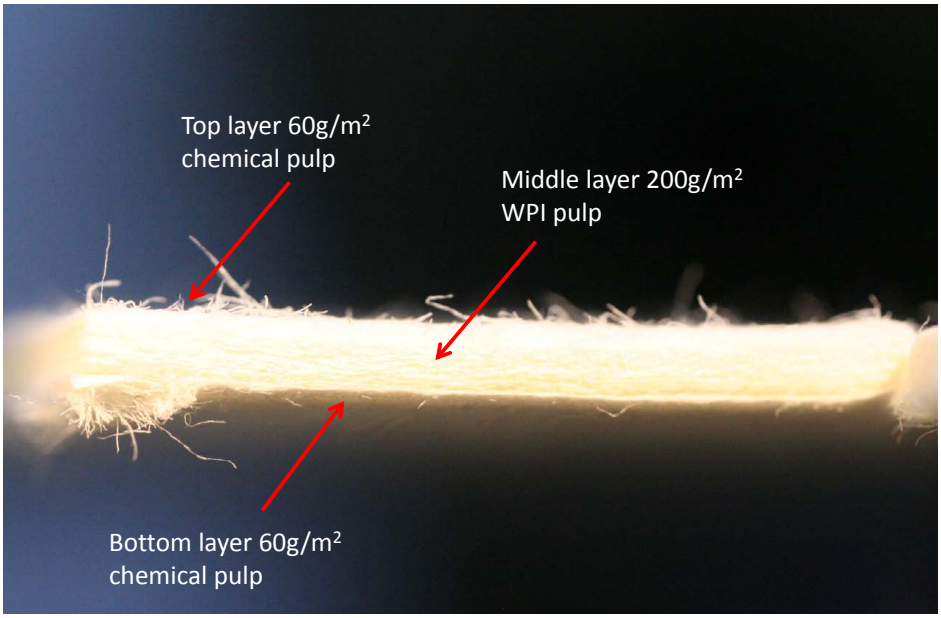

Figure 2: cross section of a multi-ply board sample prepared at the University of Toronto.

b) Enhancing the mechanical properties of LCR containing FBB

The mechanical properties of multi-ply FBB are significantly affected by the strength of joints between fibres. Addition of various strength additives can improve fibre-to-fibre bonding and especially the mechanical properties of FBB. Several commercially available strength additives will be selected and examined in this work. Effect of the application methods, dosage, and reaction time on tensile strength, ply-bond strength, compression strength, bending stiffness, tear index, and burst index of multi-ply board will be evaluated.

The team hopes to achieve these milestones and report findings by April 2016.

PARTNER UPDATE

West Fraser's recent line 3 upgrade at the Quesnel River Pulp TMP mill is a great example of industrial implementation of the research being conducted as part of the Energy Reduction in Mechanical Pulping research program. It also further illustrates the trend of high quality personnel trained at UBC transitioning to industry and continuing to have a great impact in their professional role.

Ali Elahimehr was a PhD student with the ERMP program from 2008 to 2013. Ali's research at UBC was focused on understanding the fundamentals of low consistency refining and in particular, the relationship between the operating conditions of LC refiners and final pulp qualities. In order to do so, he first characterized the geometry LC refiner plates by developing a computational simulation that could calculate the key geometrical parameters such as number of bar crossings and the area of refining. Pilot trials at UBC were conducted to better understand the role of refiner plate and other operating conditions such as consistency, rotational speed and plate gap on the performance of LC refining.

Based on research done by Ali and others (including pilot trials at UBC and Andritz), showing that HC refining followed by multi-stage LC refining would save energy up to 20% compared to two-stage HC refining, Quesnel River Pulp decided to upgrade their line 3 in order to achieve electrical energy savings. From the onset, BC Hydro was a strong supporter of the ERMP program , and QRP secured BC Hydro funding for the $16M project. As part of the upgrade QRP removed secondary HC refiners and replaced them with four new Andritz LC refiners, which are operated in series.

Ali joined Quesnel River Pulp as a process engineer soon after graduation. One of Ali's first roles at QRP was to optimize the newly installed LC system so that the mill could achieve the projected net energy saving while maintaining the target pulp quality. "It was a great team effort and commitment within QRP to optimize the LC system and, even exceed the anticipated energy savings", Ali said. QRP managed to save up to about 60% of its electrical energy consumption in the secondary stage refining once the system optimization was completed in September 2015.

Four Andritz TF58 LC refiners installed on line 3 at Quesnel River Pulp.
c/o Ali Elahimehr

MEETINGS & SITE VISITS

UPCOMING:
STEERING COMMITTEE MEETING
Thursday November 19, 2015
8:30-5:00 pm
Chem & Bio Engineering room 202
2360 East Mall
Vancouver-UBC Campus

**Please contact Anna Jamroz to RSVP*

James Olson, Meaghan Miller and Emiliano Vargas (former ERMP staff member) visited Holmen Paper in Norrkoping, Sweden from June 25-30, 2015. On June 25, Prof. Olson and Meaghan met with Christer Sandberg, Eva Svensson-Rundlöf, Anders Öquist, Karin Athley, and others from the technical team. They presented research progress updates, similar to what had been presented at the latest Steering Committee meeting. On June 29, Christer Sandberg led several mill trials that aimed to explore the differences between mill and pilot scale refining, as well as HC-LC energy splits. The energy split scope builds on work done during the ERMP group's Andritz trials conducted in 2014.

Paper Excellence representatives Cindy Muller, Collin Hii and Taegeun Kang visited the Pulp and Paper Center on September 8th. Following the closure of the Howe Sound Pulp and Paper TMP line , we are pleased to welcome Chetwynd Mechanical Pulp as the newest program member under Paper Excellence.

On October 14, 2015, Prof. James Olson, Prof. Rodger Beatson and Meaghan Miller travelled to the Chetwynd mill in Chetwynd, BC to introduce the Energy Reduction program work, tour the mill, and discuss future collaborations between UBC and Chetwynd. The UBC group met with Quinton Hayward, Brett Hitchcock, Sanjoy Saha, and Zafar Hussain.

The following day October 15, the same UBC group visited Canfor-Taylor in Taylor, BC to present recent work on LC refining and tour the mill. The visit timed well with a mill meeting to discuss TMP energy efficiency upgrades, and the group met with Bill Adams, Don Dymond, Ted St. John, Craig Thompson, Darren Guliov, Brett Douglas, Steven Bull, and Nick Finch.

The next Andritz trials are scheduled for November 30 – December 5, 2015 in Springfield, Ohio. The plan is to conduct screening/fractionation trials and to LC refine the reject pulp at various conditions. UBC's Prof. Olson, Meaghan Miller and Jorge Rubiano will attend.

We look forward to continued visits and trials with our program partners in 2016.

REPORTS

The Energy Reduction group recently circulated their report "Summary of Andritz Trials 2014", one of two reports on the 2014 Andritz trials. The report covers the chip impregnation, Impressafining, and HC refining work done at Andritz in October 2015. The second report will cover the subsequent LC refining work done at UBC and will be released in coming months.

A reminder that all program publications are available at files.workspace.ubc.ca – please contact Meaghan Miller or Anna Jamroz for access.

CONFERENCE PROCEEDING

James Olson was part of a panel discussion on "TMP/Energy", along with several partners of the ERMP program including Catalyst Paper, Alberta Newsprint, BC Hydro and Andritz. PACWEST Conference, 10-13, 2015, Whistler, BC.

Ramin Khoie, B. Gopaluni, J. Olson, B. Stoeber, "A Magnetic Sensor for Wear Detection in Centrifugal Pumps," accepted for presentation at the 14th Annual IEEE Conference on Sensors, Busan, South Korea, Nov. 1-4, 2015

Nicholas McIntosh, J.Olson, M. Martinez "Using Python to Characterize the Structure of Wood", accepted for presentation at PyCon Canada Conference, Toronto, ON, Nov. 7-9, 2015

PILOT PLANT TRIALS

Emilia Jahangir, Lab technician and Refiner Operator with Meaghan Miller at PPC's LC Refining Pilot Plant.

Meaghan Miller and Emilia Jahangir (lab technician and refiner operator) have collaborated on several trials with researchers and industry partners in UBC's Pulp and Paper Centre low-consistency refining pilot plant over the last several months, including:

Since the last newsletter, the ongoing LC refining trials with reject pulp from Winstone Pulp International have been completed. Sample testing is nearly complete and results will be presented at the November 2015 SC meeting, with a report to follow.

Following the previous SC meeting in June 2015, Hanya Hemasian (University of Toronto) visited the PPC to conduct LC refining trials with Andritz pulp for her project 3.2 "LCR pulp for packaging."

Following UBC's visit to Holmen Paper in June 2015, HC refined pulp was shipped to UBC and was LC refined at various conditions for a mill-pilot comparison study. Sample testing is ongoing and preliminary results will be presented at the next SC meeting.

As part of Reza Harirforoush's work on project 2.2, "LC refiner bar force sensor based control strategies", additional LC refining trials to test the bar force sensors are ongoing in October and November 2015.

Emilia Jahangir is leading several LC refining trials to compare the effect of consistency, which are ongoing in October-November 2015.

LC refining trials with high-freeness pulp are planned for Jorge Rubiano's project 1.4 "Optimal LC refining."

TOUR OF UBC'S BIOENERGY RESEARCH & DEMONSTRATION FACILITY (BRDF)

The ERMP group of researchers had the opportunity to tour the BRDF facility on June 16th to learn about other energy conservation initiatives, especially those so close to home. The group learned about the technical aspects of the facility, as well some of the current sustainability initiatives.

The Bioenergy Research Demonstration Facility (BRDF) at UBC is the first biomass cogeneration—or combined heat and power, CHP—project of its kind in North America. The facility is the first to clean and condition biomass (urban wood waste) into an engine fuel grade synthesis gas, or syngas, on a commercial scale.

The facility's heat and power system, fueled by biomass, creates syngas that's then burned, in raw form, to produce steam. Or, the syngas is conditioned to create ultra clean syngas that's injected into an internal combustion engine used to generate electricity.

To learn more about the facility, visit energy.ubc.ca/projects/brdf

100 YEARS: LOOKING BACK, LOOKING FORWARD

Over our first 100 years, UBC has built a strong and engaged community of alumni, students, staff, faculty, friends, donors and partners. Our Centennial is about honouring and renewing these connections.

The Centennial launched on September 30, 2015, in conjunction with the official opening of the Robert H. Lee Alumni Centre, 100 years to the day since we welcomed our first class of 379 students in 1915. Alumni Weekend on May 28, 2016, marks the Centennial's official close.

Over the next nine months, we are celebrating with old friends and embracing new ones through a host of activities that include performances, lectures, speakers' series and workshops focused on what we do best: research, teaching, learning and innovation.

Visit 100.ubc.ca for news, events & more!

In celebration of the 100th anniversary of the first day of classes, UBC came together to recreate the iconic "UBC" photo taken at the end of the Great Trek in 1922. Can you spot the ERMP group?
Photo: Martin Dee

30th ANNIVERSARY OF THE PULP AND PAPER CENTRE

Save the date! On May 28th, 2016, the Centre will host an Open House to mark the PPC's 30th Anniversary. We invite our past and current industrial partners, alumni and Centre supporters to join us for a day full of inspiring seminars, a student poster session, interactive lab tours and demonstrations. Come out and meet future industry leaders and see what innovative discoveries and applications they have been developing.
The Open House falls on Alumni weekend and the closing of UBC's Centennial – it will be a historic weekend on the UBC campus and we hope you can join us.

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PARTNERSHIP IS OUR STRENGTH

The supporting partners of this research program are:

AFT-Aikawa Group, Alberta Newsprint Company, Andritz, BC Hydro, BCIT, Canfor, Catalyst Paper, FPInnovations, Holmen, Howe Sound Pulp and Paper Corporation, Millar Western, NORPAC, NSERC, The University of British Columbia Pulp and Paper Centre, The University of Victoria, The University of Toronto Pulp and Paper Centre, West Fraser, Westcan Engineering, and Winstone Pulp International.