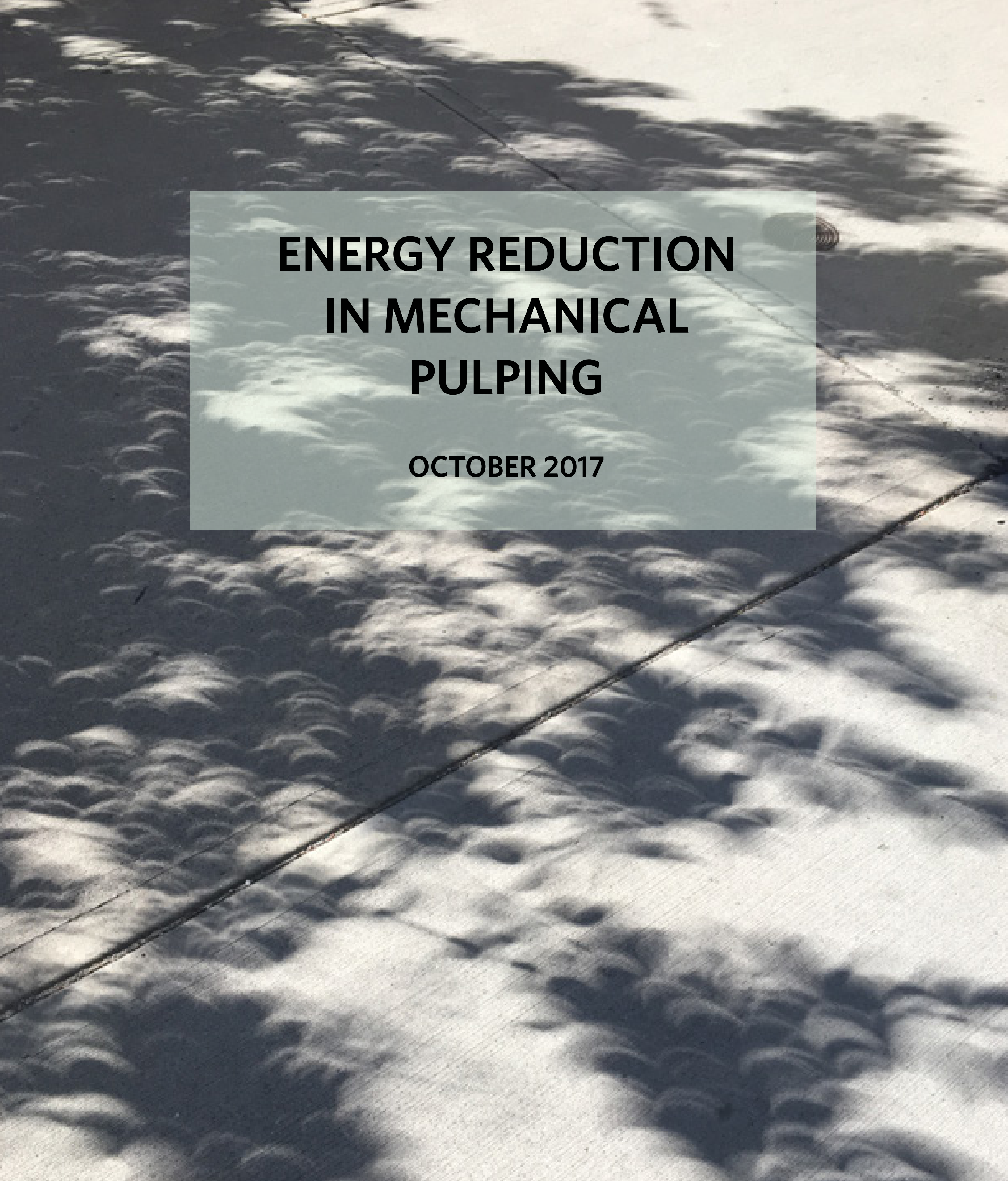

ENERGY REDUCTION IN MECHANICAL PULPING

OCTOBER 2017

THE UNIVERSITY OF BRITISH COLUMBIA

WELCOME MESSAGE

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

As the lead of UBC Bio-Products Institute (BPI), I am pleased to share that the research position in forest bio-products created through a $3 million UBC President's Excellence Chair fund has now been advertised and the recruitment process is well underway. The Chair will commence duties mid 2018. We have been successful in obtaining Canadian Foundation for Innovation (CFI) funding for a proposal of $11.6 million for infrastructure related to synthetic biology enabled materials for high performance biocomposites (BiMat), as well as CFI funding for a $6 million proposal for a Biofuels Research and Innovation Centre (BRIC). The funding will enable BPI to purchase Advanced Biopolymer Conversion and Materials Characterization Infrastructure, as well as Feedstock and Biocatalyst Development Infrastructure. This new infrastructure will include tools for advanced pulp and paper characterization, such as micro-computed tomography (micro-CT) x-ray scanning equipment valued at $2 million, powerful technology for our future research initiatives. BPI's application for a Canadian Excellence Research Chair award—which would provide $20 million from the federal government and UBC to bring a world-leading researcher to UBC and the BPI—is still pending.

Since our last newsletter, two valued members of our Energy Reduction research group have moved on to pursue their goals. Harry Chang, who worked with ERMP at BCIT for more than ten years, is now an Assistant Instructor in the Chemical and Environmental Technology department at BCIT. Emilia Jahangir, who worked as a technician at UBC Pulp and Paper Centre for four years, has relocated to the United States. We sincerely thank Harry and Emilia for their many excellent contributions to ERMP and wish them all the best in their future endeavours.

Zhaoyang Yuan has joined the program as a Post-doctoral Fellow working with Rodger Beatson at BCIT on chemical treatments, carrying on Harry Chang's work. We welcome two new students to the program, Bryan Bohn, MASc student at UBC and Matthias Aigner, PhD candidate at UVic. We have also recently hired a new ERMP laboratory technician, Vanessa Van Aert, who will support low consistency refining and screening trials at UBC-PPC. Please see pages 16, 17 and 23 for brief introductions to these new members and their work.

We held a successful Steering Committee meeting in June in Whistler as a prelude to the PACWEST conference, where we reviewed research project progress, and discussed the draft of a proposal for the future research consortium developed in consultation with program partners. We are currently seeking comments and commitments on this proposal. I invite you to read more about our project updates and publications in the following pages, and we look forward to meeting with all of our partners at our next Steering Committee meeting at UBC on November 9, 2017.

Sincerely yours,

James Olson

James Olson, PhD, P.Eng., FCAE
Principal Investigator, Energy Reduction in Mechanical Pulping Research Program
Professor and Pro Tem Dean, Faculty of Applied Science, UBC

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The initial stage of the total solar eclipse on 21 August 2017 shows the moon's cresent shape reflected in the many shadows cast by a Japanese maple tree that James captured on his iPhone on the way to an ERMP internal meeting.

Photo: James A. Olson

MIGUEL VILLALBA

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

In the thermomechanical pulping process, compression has been used as a method to improve the chemical uptake properties of wood chips. A combination of compression and chemical impregnation prior to refining leads to a reduction of energy requirements in the subsequent refining stages (Nelsson et al. 2012). The use of enzymes as a chemical agent in impregnation has been shown to have positive effects in energy reduction, as well as improved pulp properties (Mårtensson 2012). This project focuses on understanding the effects of screw press operating conditions (i.e. screw speed, power input and geometries) on wood chip morphology, which can be related to its chemical uptake ability. Therefore, we focus our efforts on developing a simple screw press model that will characterize the operation of a modular screw press device for wood chips. Additionally, we aim to understand the effect of the compression on the accessibility of enzymes on wood chips.

Screw press model

We reviewed the literature on screw press models applied for sawdust. While the model by Zhong (1991) provided good insight on the effect of geometries and operating conditions on the pressure applied on biomass materials, it does not fully characterize the compression of wood chips in a realistic industrial setting. Industrial modular screw devices compress wood chips as they are fed forward through a narrowing gap in a pressurized environment. This allows water and extractives to be squeezed out through a barrel while increasing the surface area of the wood chip fibres due to compression. The model will represent a simple geometry of a tapered screw shaft (see Figure 1). The model is derived from the basic equations of motion of solids and fluid parts of the process, along with conservation of mass, stress and Darcy's filtration equation (Equations 1-4, respectively).

$$\nabla \cdot [\phi \hat{u}_s] = 0 \qquad (1)$$

$$\nabla \cdot [(1-\phi)\hat{u}_f] = 0 \qquad (2)$$

$$(1-\phi)(\hat{u}_s - \hat{u}_f) = \frac{k(\phi)}{\mu}\nabla p \qquad (3)$$

$$\nabla \cdot [\sigma - PI] = 0 \qquad (4)$$

Here, we assume that the solid and liquid parts move at the same machine speed U_m. Based on these assumptions, the equations can be combined to obtain the following differential equation (Equation 5).

$$\frac{\partial \phi}{\partial z} = \frac{d}{dr}\left(\frac{D(\phi)}{U_m}\frac{\partial \phi}{\partial r}\right) - \frac{\Delta H}{L}\frac{\partial \phi}{\partial r} \qquad (5)$$

where $D(\phi) = \frac{\phi k(\phi)}{\mu} P_y$

The stress acting on the material at the barrel surface is a function of the solidity, according to Alaqqad et. al. (2011). (Equation 6).

$$\sigma = \sigma_t = P_y(\phi) = P_y\left(\frac{\phi_o H_o}{H(z)}\right) \qquad (6)$$

$$F_f = \mu \sigma A_b \qquad (7)$$

$$P = \omega T \qquad (8)$$

Knowing the stress function as a function of solidity, the frictional force can be determined by multiplying the stress and area by the friction coefficient (Equation 7). Power consumption is then related to the torque caused by this force and the rotational speed of the screw shaft (Equation 8).

Through this model, we will attempt to describe the effect of the operational parameters, and screw press geometries on the compression applied to the wood chips. Experimental work is required to relate the screw press operation to changes in

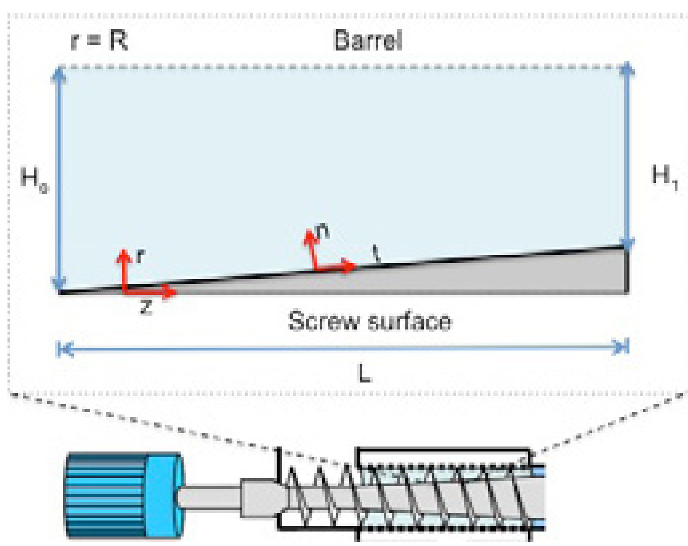

Figure 1: Screw press geometry

PROJECT 1.1

morphology of wood chip fibres and to their ability to uptake chemicals in the TMP process. Our focus in the near term will be on the experimental work of characterizing the accessibility of wood chips to post-compression enzymatic impregnation.

Sugar quantification to measure accessibility

The experimental part of the work involves compressing wood chips to different degrees and impregnating them with enzymes (see Figure 2).

To assess the accessibility of the biomass to the enzymatic treatment, we will measure enzymatic hydrolysis during impregnation. First, an intensive analysis of the structural composition of the wood chips will be carried out in order to characterize the feedstock of SPF (spruce, pine, and fir). Instead of a compression step, two extreme cases of mechanical treatment will first be compared (raw wood chips and sawdust) to determine the validity of the method. Sugar contents of solids and liquid fractions will be monitored before and after impregnation.

For this purpose, we will use protocols established by the National Renewable Energy Laboratories (NREL). Released sugar is measured by high performance liquid chromatography (HPLC) (Sluiter et al. 2006), while structural sugar compositional analysis is carried out according to the Klason lignin protocol (Sluiter et al. 2010). The Klason lignin protocol involves measuring the weight of biomass before and after a two-step acid hydrolysis. Training on the protocols and preparation of wood chip samples have been done in the past months. The structural composition analysis of SPF wood chips samples was intensively practised with the goal of obtaining consistent results. The next step is to perform analysis of sugars released into liquid samples after enzymatic treatments. This enzymatic treatment will be carried out in the lab at UBC using incubator shakers at suitable temperatures. Liquid samples will be extracted every 30 minutes. At the end of enzyme hydrolysis, the structural composition of the remaining solids may be determined for mass closure.

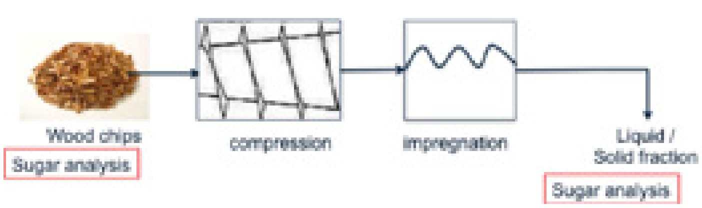

Figure 2: Experimental layout

Trial Plans

While the experimental methods are being evaluated in the labs at UBC, trials at FPInnovations are being planned. A chip juicer will be used to compress wood chips at different compression ratios. The compressed samples will then be sent back to UBC for enzymatic treatment and sugar quantification. The objective of the trial is to compress wood chips at different levels and determine its effect on wood chip morphology and chemical uptake.

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ZHAOYANG YUAN

1.3 - OPTIMIZATION OF CHEMICAL CHARGE DISTRIBUTION THROUGHOUT THE PROCESS

This project is focused on determining the best conditions and locations for chemical treatment of mechanical pulp for electrical energy savings while producing pulp with the desired properties. Based on the results of our previous work, alkaline peroxide treatment of high freeness thermomechanical pulp (TMP) when combined with subsequent low consistency (LC) refining can considerably reduce electrical energy consumption while also improving pulp tensile strength. In addition, work by Emilia Jahangir and James Olson (presented at the ERMP Steering Committee meeting in June 2017) has shown that the addition of micro-fibres, produced through high intensity low consistency refining of high freeness TMP, to primary-stage TMP could improve the tear strength and bulk of the subsequently formed handsheets. With the aim of further improving the benefit obtained by the addition of micro-fibres and also to reduce electrical energy consumption, alkaline peroxide treatment of micro-fibres was carried out. The effects on handsheet properties of the addition of alkaline peroxide treated TMP micro-fibres to primary-stage TMP were determined with respect to brightness, tensile strength gain and bulk preservation.

During the treatment of wood pulp and TMP micro-fibres, alkaline peroxide has proved to be a promising chemical that can reduce total refining energy consumption at a given tensile index. However, transition metals present in wood pulps negatively affect the treatment effectiveness of alkaline peroxide by decomposing hydrogen peroxide. Within this context, chelation of transition metals was also carried out to study the effects of chelation agents and washing prior to the alkaline peroxide treatment on pulp brightness and metal content.

Effect of alkaline peroxide treatment of micro-fibres on the properties of TMP

We used the same highly refined TMP micro-fibres produced by Emilia Jahangir, which were obtained by further LC refining of conventionally refined TMP using 12.90 km/rev BEL plates to a total of 2242 kWh/t. One-stage and two-stage alkaline peroxide treatments were conducted on the obtained TMP micro-fibres under conditions optimized in our previous work. The one-stage treatments were carried out at 70 °C with 4 per cent hydrogen peroxide (H_2O_2) and 6 per cent sodium hydroxide (NaOH) for 90 minutes. During the two-stage alkaline peroxide treatments, the first stage was conducted using 4 per cent H_2O_2 and 2.5 per cent NaOH at 70 °C for 60 minutes, and the second stage was carried out with 3.5 per cent NaOH at 50 °C for 30 minutes. Pulp suspensions for handsheet testing were prepared by mixing TMP micro-fibres with unrefined primary-stage TMP at levels of 5, 14, and 22 per cent giving total equivalent LC refining specific refining energies of 113, 315 and 493 kWh/t respectively.

Figure 1 shows that by increasing the amount of TMP micro-fibres added to the primary-stage TMP, which can be compared to an increase in equivalent specific refining energy, the tensile index increases for both the treated and non-treated micro-

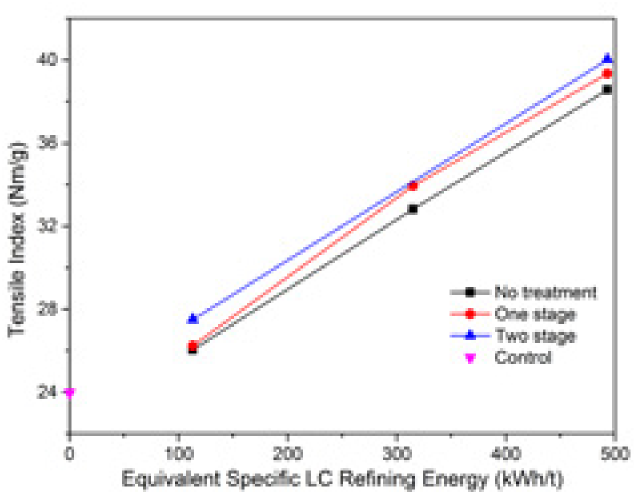

Figure 1: Effect of chemical treatment of TMP micro-fibres on the tensile index of the pulp.

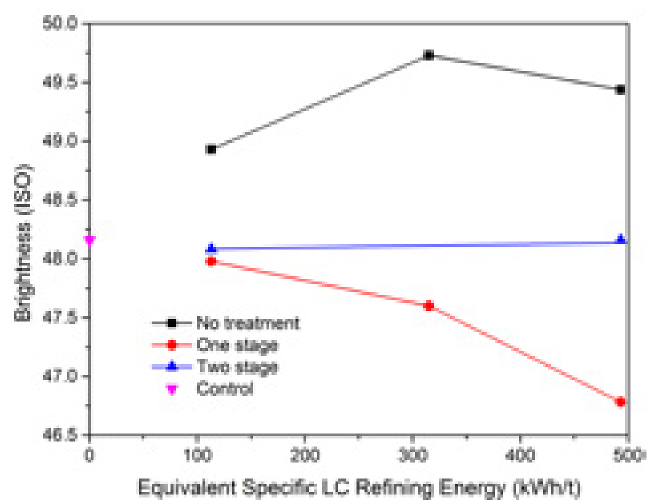

Figure 2: Effect of chemical treatment of TMP micro-fibres on the brightness of the pulp.

PROJECT 1.3

fibres. The likely reason might be that the addition of TMP micro-fibres increased the bonding capabilities, resulting in strong network building. With regards to the effect of alkaline peroxide treatment on tensile index, both one-stage and two-stage alkaline peroxide treated samples yielded only slightly higher tensile gains than the non-treated samples, with two-stage yielding the highest tensile gain. The lack of a significant increase in tensile gain in the one-stage and two-stage alkaline peroxide treated TMP micro-fibres mixtures is likely because micro-fibres were already so highly refined and well developed that the additional chemical treatment had only a small effect on further increasing tensile strength.

Figure 2 shows that by increasing the proportion of untreated TMP micro-fibres, the brightness of TMP increased. Also, the brightness decreased with the increased addition of one-stage treated TMP micro-fibres while the pulp brightness remained almost constant with the addition of two-stage treated micro-fibres. One possible explanation for this variance might be that alkaline peroxide treatment makes the micro-fibres softer and more flexible, in turn, improving their binding to the fibre surface and reducing light scattering. Figure 3 illustrates that no significant decreases in bulk could be observed among different chemical treatments of TMP micro-fibres compared to that of non-treated micro-fibres.

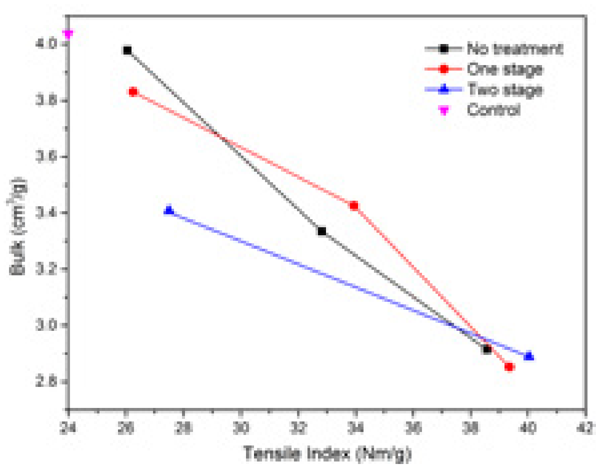

Figure 3: Correlation between bulk and tensile index.

Effect of chelation agents on metal content and brightness of TMP

Chelation of wood pulps with ethylene diamine tetra-acetic acid (EDTA) is a critical step to improve the effectiveness of alkaline hydrogen peroxide treatment. Figure 4 shows that with increased dosage of EDTA, the amount of metals removed increased. For example, when using 0.4 per cent EDTA for the chelation, about 75 per cent of original metals, which were having negative effects on hydrogen peroxide, could be removed from the pulp by filtering the chelated pulp. To further assess the effect of chelation, the chelated pulp was washed with deionized water. The results showed that more than 90 per cent of transition metals was removed from the pulp after water washing. The chelated pulps were subjected to alkaline hydrogen peroxide treatment to determine the brightness gain. Figure 5 shows that with the increase in chelation agent the pulp brightness increased, while the brightness gain of washed pulps was lower than that of filtered pulps. One likely reason might be that compared to the filtered chelated pulp, the amount of fines in the water-washed pulp was lower, resulting in less light reflection.

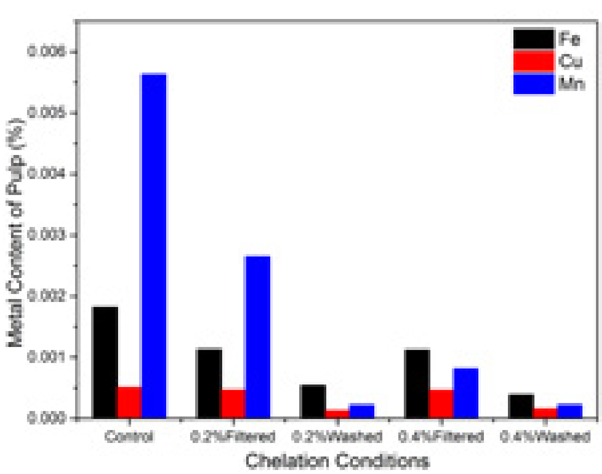

Figure 4: Metal content of pulp samples after chelation.

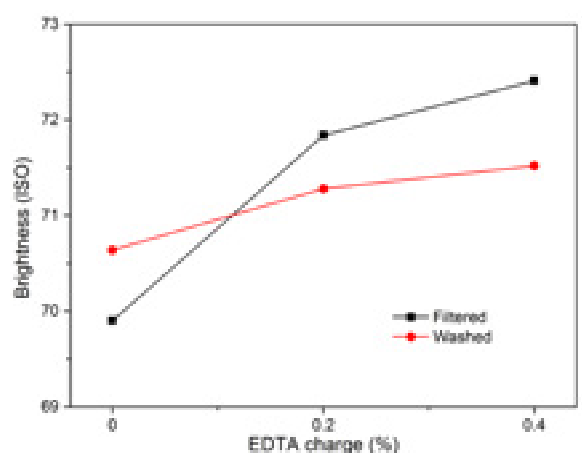

Figure 5: Effect of chelation process on the brightness of pulp after alkaline peroxide treatment.

JORGE RUBIANO

1.4 - OPTIMAL LOW CONSISTENCY REFINING

Our current efforts are devoted to developing a correlation to predict refining power in terms of gap and fibre length. The mathematical framework, developed and previously presented at the June 2017 Steering Committee Meeting in Whistler, used pilot plant-scale refining data, and we estimated the fitting constants of the correlation. At this stage in our project, we are in the process of validating the developed correlation.

In the mathematical framework, key assumptions were made to simplify the solution of the problem. Recalling from the derived equations, refining power can be described by:

$$P_{net} = \frac{2\pi\omega}{(B+G)^2}\int_{r1}^{r0} f_s r^2 dr$$

Where ω is the rotational speed of the refiner, B and G the bar width and groove width, respectively, and f_s the shear forces. It is imperative to realize the shear force dependency with the radius to solve the integral. At this point, based on Eriksen et al. (2008), it was hypothesized that shear forces were dependent on the square of the linear velocity of the bar-bar crossing and the area of the bar-bar crossing as: $f_s \propto (\omega r)^2$

Although from a theoretical point of view, this assumption is sound, the question is whether it can be supported by physical evidence. Within ERMP project 2.2, "LC refiner bar force sensor based control strategies", our colleague Reza Harirforoush of the University of Victoria has measured bar forces at different gaps and rotational speeds using the pilot-scale LC refiner at UBC-PPC. We have used those results to draw a comparison with our previously mentioned hypothesis. Figure 1a shows the measured shear forces f_s as a function of gap and ω. As expected, the latter two have a strong influence on the measured forces. However this particular plot does not allow us to elucidate the dependency of shear forces with rotational speed. Further data analysis showed that the relationship between shear forces and rotational speed was indeed as hypothesized. This can be seen in Figure 1b where ω/gap were plotted against the ratio $f_s \propto \omega^2$ in a log-log scale. Data points from different rotational speeds showed a linear behaviour over the range of the x-axis where the slope of the straight line was approximately 1.96. Although the f_s dependency with radius is still to be determined, the fact that $f_s \propto \omega^2$ leads us to believe that shear forces are proportional to the radius square.

On a second front, we intend to validate the correlation using industrial-scale data to check if the developed correlation is able to predict refining outcomes. At the moment we have only a couple of power-gap curves, from 58 inches and 72 inches diameter refiners (see Figure 2). These partial results seem

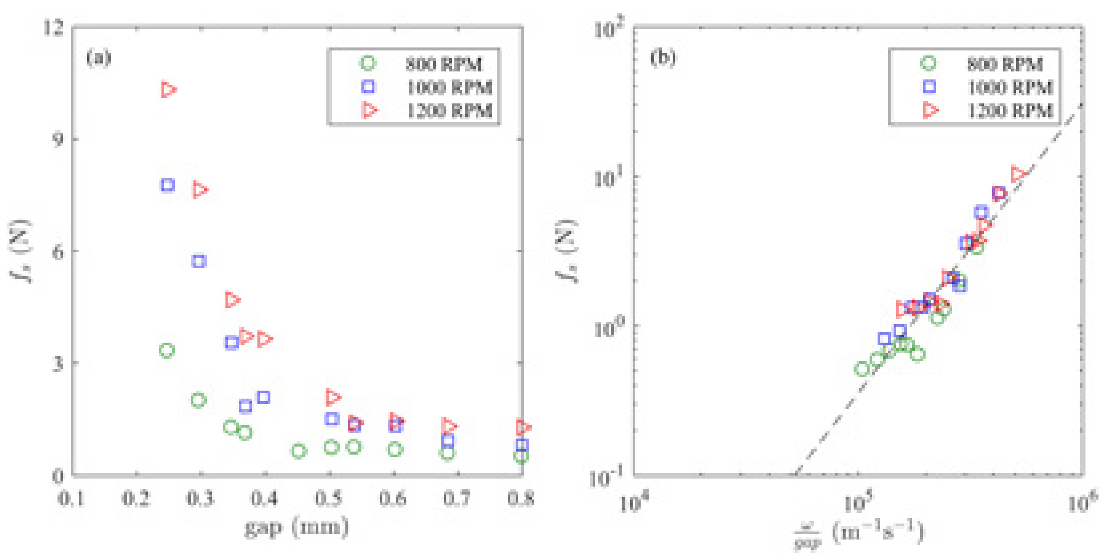

Figure 1: (a) Shear forces measured by Reza Harirforoush (University of Victoria) using a custom designed and fabricated bar force sensor at different gaps and 800 RPM, 1000 RPM and 1200 RPM as rotational speeds. (b) Log-log plot of f_s and ω/gap of the data presented in the left hand side plot. The dashed-line's slope is approximately 1.96. These results support the hypothesis that $f_s \propto \omega^2$.

PROJECT 1.4

promising, as we see that data points fit well the contours plots drawn based on the developed correlation.

A consequence of our hypothesis is that after the mathematical solution of the governing equation, it is possible to rewrite the solution in terms of a dimensionless power number as:

$$\frac{P_{dim}}{\alpha^2} = 0.013\frac{l_w{}^3}{gap^{1.5}} \text{ where } P_{dim} = \frac{P_{net}}{\rho\omega^3\,(r_o{}^5 - r_i{}^5)}$$

and $\alpha = \frac{B}{B+G}$

This is a very important result, because it demonstrates that it is possible to compare refining operations at different scales on the same grounds by using a well-defined dimensionless quantity such as P_{dim}/α^2 .

In the pulp and paper field, there is generalized and strong interest in developing a framework capable of assessing and scaling up data from pilot plant refiners to industrial-scale refiners. Researchers have been partially successful in this milestone by developing refining theories (e.g., SEL, C-factor). Perhaps the missing link between these two scales is a well-defined dimensionless number.

In the near future, we hope to gather more industrial-scale refining data from our industrial partners in order fully validate the developed correlation.

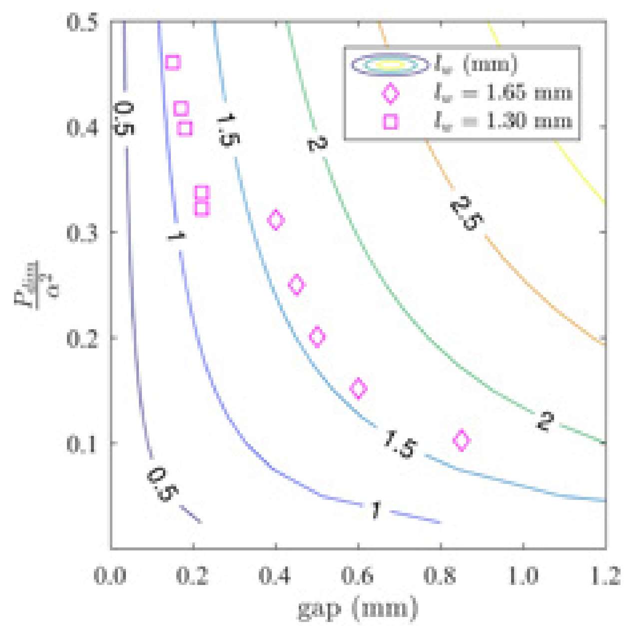

Figure 2: Contour plot of dimensionless quantity P_{dim}/α^2 as a function of gap. Lines correspond to constant values of length-weighted fibre length l_w as indicated. The plot was constructed using the developed correlation. Data points correspond to industrial-scale data used to validate the correlation. The data points where l_w=1.65 mm were obtained using a 72" diameter refiner. Data points where l_w=1.30 mm were obtained with a 58" diameter refiner.

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HUI TIAN

2.1: OPTIMIZATION AND CONTROL OF INTEGRATED HC AND LC REFINING

Summary of previous work

In the previous work, we have integrated our proposed multi-objective economic model predictive controller (*m-econ* MPC) and moving horizon estimator (MHE) for a two-stage high consistency (HC) mechanical pulping (MP) process. Our techniques have been validated through simulations of the closed-loop MP process. From the simulation, we demonstrated that the proposed *m-econ* MPC controller can significantly reduce the specific energy consumption compared with the traditional tracking MPC technique. The MHE, which estimates the unmeasurable state variables using a moving window of data, can provide a good estimation of measurable but noisy states (production rate and motor loads) and unmeasurable states (consistency) for both primary and secondary HC refiners.

Current work on the scenario-based stochastic m-econ MPC

Our current work is focused on the scenario-based stochastic m-econ MPC. The traditional MPC in the literature, both for linear and nonlinear processes, is usually based on the assumption that the process model is accurate and that the future disturbances are constant. However, these assumptions are not valid in practice and it can result in poor closed-loop performance if the disturbances are varying over time and/or the model–plant mismatch is present. In the scenario-based stochastic *m-econ* MPC techniques, the system dynamics are of a stochastic nature and an additive disturbance is introduced to represent the uncertainties in the system model. This additive disturbance is a continuous random variable and its true probability distribution is often approximated by discrete probability scenarios. Stochastic optimizations, which are complex to solve, are usually employed for the control design with the stochastic models. However, with scenario-based optimization techniques, we can avoid the challenges associated with stochastic optimizations, by decomposing the problem into a set of similar deterministic optimizations which can be efficiently solved using parallel computation.

Stochastic system description

We consider a non-linear time-invariant discrete-time system with additive disturbance described by

$$x_{t+1} = f(x_t, u_t) + w_t \quad (1)$$

$$y_t = g(x_t) + v_t, \quad (2)$$

where $x_t \in R^{n_x}, u_t \in R^{n_u}$, and $y_t \in R^{n_y}$ are the state, manipulated input and measured output vectors at time *t*, respectively. $f(\cdot,\cdot)$ and $g(\cdot)$ are the non-linear functions. The vector $v_t \in \Psi$ is a random disturbance or model uncertainties. $w_t \in \Omega$ is the measurement noise. Ω and Ψ are compact, convex and contain the origins. In the scenario-based optimization, a scenario is defined as a realization $\{w_i, v_i\}$ of a random scenario $\{w, v\}$, where $i \in I$ and *I* is an index set whose elements are specific indices of the members (or outcomes) of the sample space Ω and Ψ. We assume that in the MP process, $\{w_i, v_i\}$ are normally distributed with zero mean and constant covariance,

$$w_i \sim N(0, Q_w), \text{ and } v_i \sim N(0, Q_v) \quad (3)$$

where Q_w and Q_v are the covariance matrices of w_i and v_i respectively.

Scenario-based m-econ MPC

The basic idea of scenario-based m-econ MPC is to compute an optimal finite-horizon input trajectory for each sampled 'scenario' of the uncertainties. A coordination procedure that combines the scenario solutions into a single feasible solution will be conducted to form an overall best solution for the original stochastic problem.

More concretely, let $\{w_{i|t}^{(1)}, \dots, w_{i|t}^{(K)}\}$ and $\{v_{i|t}^{(1)}, \dots, v_{i|t}^{(K)}\}$ be independent and identically distributed (i,i.d) samples of w_{t+i} and v_{t+i}, drawn at time *t* for the prediction steps $i = 0, \dots, N-1$. For convenience, we will define a scenario set $\{w_t^{(K)}, v_t^{(K)}\}$ where $w_t^{(K)} := \{w_{0|t}^{(1)}, \dots, w_{N-1|t}^{(K)}\}$ and $v_t^{(K)} := \{v_{0|t}^{(1)}, \dots, v_{N-1|t}^{(K)}\}$. Then for each particular scenario $w_{i|t}^k$ and $v_{i|t}^k$, $i = 0, \dots, N-1, k \in K$ the scenario-based *m-econ* MPC at time *t* can be formulated as:

$$\min_{u_{0|t}^{(k)}, \dots, u_{N-1|t}^{(k)}} \sum_{i=0}^{N-1} L^{ec}(x_{i|t}^{(k)}, u_{i|t}^{(k)}), \quad (4)$$

$$\text{s.t.} \quad x_{i+1|t}^{(k)} = f(x_{i|t}^{(k)}, u_{i|t}^{(k)}) + w_{i|t}^{(k)}, \quad \forall i = 0, \cdots, N-1, \quad (5)$$

$$y_{i|t}^{(k)} = g(x_{i|t}^{(k)}) + v_{i|t}^{(k)}, \quad \forall i = 0, \cdots, N-1, \quad (6)$$

$$x_{0|t}^{(k)} = x_t, \quad x_{i+1|t}^{(k)} \in \mathbb{X}, \quad \forall i = 0, \cdots, N-1, \quad (7)$$

$$u_{i|t}^{(k)} \in \mathbb{U}, \quad \forall i = 0, \cdots, N-1, \quad (8)$$

$$\sum_{i=0}^{N-1} L^{tr}(x_{i|t}^{(k)}, u_{i|t}^{(k)}) \le \varepsilon_{t+1}(\sigma), \quad \forall i = 0, \cdots, N-1, \quad (9)$$

with $$\varepsilon_{t+1}(\sigma) := \bar{V}_{t+1}^{tr} + \sigma(V_t^{tr} - \bar{V}_{t+1}^{tr}) \quad (10)$$

PROJECT 2.1

where $x_{i|t}$ and $u_{i|t}$ denote predictions of the state and manipulated variables at time *t*, for *i* steps into the future. The current measured state x_t is introduced as an initial condition for the system dynamics. $L^{tr}(\cdot)$ and $L^{ec}(\cdot)$ are tracking stage cost and economic stage cost, respectively.
$\bar{V}^{tr}_{t+1} := \sum_{i=t+1}^{t+N} L^{tr}(\bar{x}_{i|t+1}, \bar{u}_{i|t+1})$ is the value function of the optimal trajectory $\{\bar{x}_{i|t+1}, \bar{u}_{i|t+1}\}_{t+1}^{t+1+N}$ for the tracking MPC at time instant *t* + 1. $\sigma \in [0,1)$ is a weighting scalar trading off between the tracking speed and the economic objectives. The dynamics (Equations 5–6) are state and output trajectories over the prediction horizon corresponding to a particular scenario
$\left\{w_{i|t}^{(k)}, v_{i|t}^{(k)}\right\}, i = 1, \dots, N-1$.

At each time instant *t*, we will draw K samples of $\{w_t^{(K)}, v_t^{(K)}\}$ from their distribution (3), i.e. K scenarios. For each scenario, $\{w_{i|t}^{(k)}, v_{i|t}^{(k)}\}$ $k = 1, \dots, K, i = 1, \dots, N-1$ the optimal manipulated input $\bar{u}_{0|t}^{(k)}$ and the optimal value function $\bar{V}_t^{ec}(k|k)$ are calculated by solving the optimization problem (Equations 4–10). Note that for each scenario, the above optimization is reduced to a deterministic constraint optimization problem. We assume that the feasibility and calculation of a single scenario optimization subproblem pose no difficulties. Given the calculated optimal manipulated input $\bar{u}_{0|t}^{(k)}$ for the *k*-th scenario, the value functions $V_t^{ec}(k|j), j = 1, \dots, K, j \neq k$ for the other scenarios of $\{w_{i|t}^{(j)}, v_{i|t}^{(j)}\}$ $i = 1, \dots N-1$ $j = 1, \dots, K, j \neq k$ will be assessed under $\bar{u}_{0|t}^{(k)}$. In order to combine the solutions from the difference scenarios and find a single and overall best solution for the original stochastic problem, we constitute a coordinating matrix V_{set}^{ec}. The best optimal overall input is selected as the one corresponding to the row which contains the minimal median among all the rows in the matrix V_{set}^{ec}.

Preliminary simulation results for a two-stage HC MP process

We have applied the proposed scenario-based stochastic *m-econ* MPC to a two stage HC refining process. The objective of this simulation is to show the effectiveness of this new control technique. The parameters used in the simulation for the controller are shown in Table 1.

Table 1: Simulation parameters for the scenario-based stochastic MPC controller

Symbol	Values	Description
T	250s	Simulation length
N	30	Prediction horizon for the *m-econ* MPC controller
K	{0, 5, 29}	Number of the scenarios
Q_w	0.1	Variance of the disturbance/model uncertainty
Q_v	0.1	Variance of the measurement
σ	0.7	Weighting scaler in (9)-(10)

In the simulation, the production rate, motor loads and consistencies for both primary and secondary refiners are considered as the discretized differential state variables. The chip-transfer screw speed, plate gap and dilution water flow rates of each refiner are taken as the manipulated variables. The process linear dynamics for the discretized differential state variables and disturbances are modelled through identifications for the industrial process.

For comparison purpose, we selected three cases with different number K=0, 5, 29 of scenarios. When K=0, it is assumed that no sample is drawn. From the simulation, it can be observed that by increasing the scenario number from 0 to 29, the variance of the state variables, manipulated input variables and the specific energy can be reduced dramatically, see Figures 1–3.

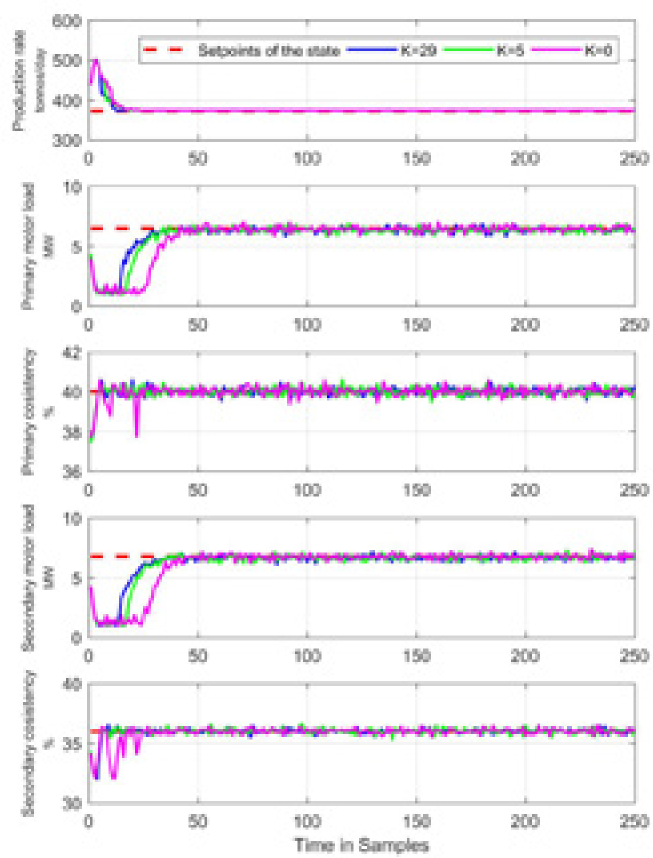


Figure 1: State trajectories for the scenarios K=0, 5, 29.

PROJECT 2.1

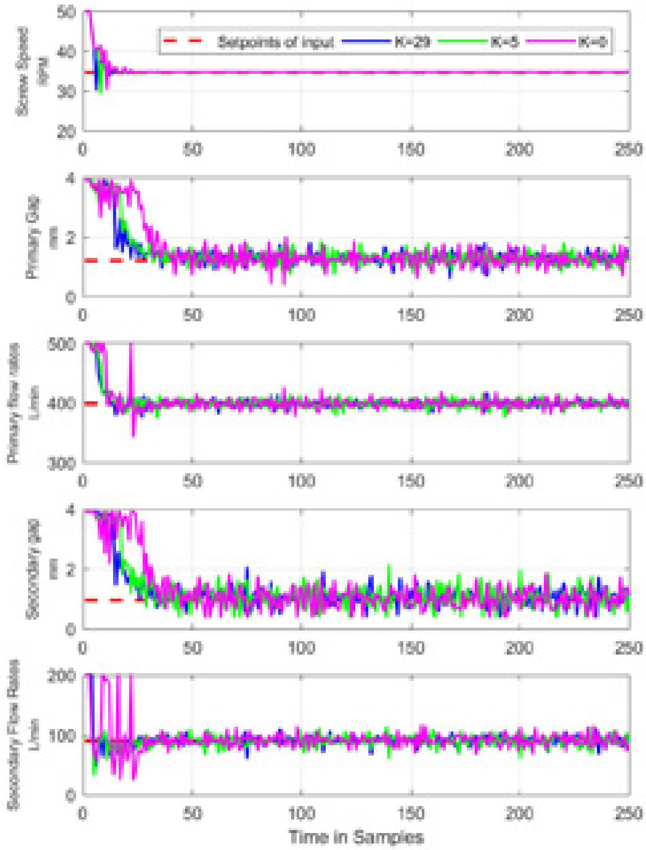


Figure 2: Manipulated input trajectories for the scenarios K=0, 5, 29.

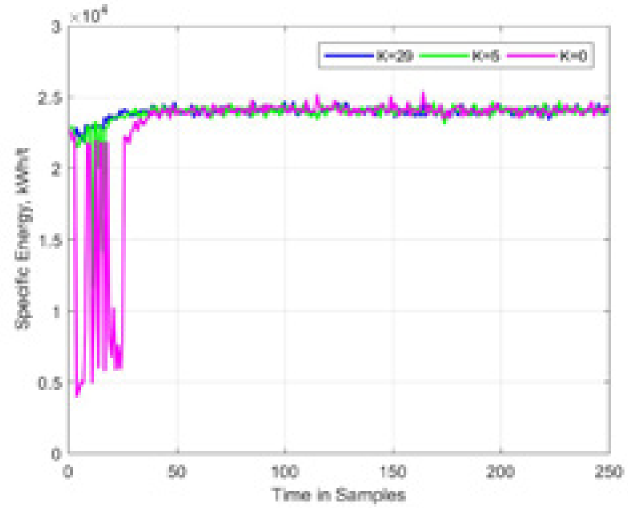


Figure 3: Specific energy comparison for the scenarios K=0, 5, 29.

REZA HARIRFOROUSH

2.2: LOW CONSISTENCY REFINER BAR FORCE SENSOR BASED CONTROL STRATEGIES

Low consistency (LC) refining of mechanical pulp has been shown to be more energy efficient than conventional high consistency (HC) refining. However, the degradation of mechanical properties due to fibre cutting happening at high refining energies has limited the widespread adoption of LC refining. In current strategies, fibre cutting is determined based on post-refining measurement of pulp properties and, typically, this approach does not enable rapid adjustment of refiner operation in response to the onset of fibre cutting. The objective of this study is to detect the onset of fibre cutting, in real time, using custom-designed piezoelectric refiner force sensors (RFS) that measure normal and shear forces applied to pulp fibres by the refiner bars. Moreover, the effect of pulp furnish and plate pattern on measured bar forces and, more specifically, on the detection of fibre cutting are studied.

To find the real time fibre cutting metrics and investigate the effect of pulp furnish and plate pattern on bar forces, a set of pilot-scale trials were conducted in 2015, 2016, and 2017 using an AIKAWA 16-inch single-disc LC refiner at the Pulp and Paper Centre, University of British Columbia. Trials were run using different pulp furnishes and plate patterns at 3.5 per cent consistency for different rotational speeds and a wide range of plate gaps. The results of the pilot-scale trials are presented in the following sections.

Fibre Cutting Metrics

In our previous work (Harirforoush et al. 2017a), we observed distinct transitions in the parameters that characterize the distributions of peak normal and shear forces, namely mean peak force and the Weibull scale parameter, as measured by the RFS during LC refining. These transitions consistently correspond to the onset of fibre cutting. In addition, the analysis of the power spectrum of the sensor data shows that the magnitude of the dominant frequency can be used as an indicator of fibre cutting.

We investigated the generality of these findings by performing further trials measuring forces during LC refining of a range of pulp furnishes (i.e. softwood and hardwood TMP, and chemical pulp) with two different plate patterns (BEL=2.74 km/rev and BEL=5.59 km/rev). The results show that the RFS-based indications of the onset of fibre cutting apply to all of the tested pulp furnishes and plate patterns (Harirforoush et al. 2017b).

The power of the time domain signal of the normal force is shown to be the most reliable and consistent indication of the onset of fibre cutting. Note that this term is a signal processing term and is not equal to the mechanical power that is dissipated on the sensor probe. This parameter consistently identifies the critical gap, as determined by fibre length data, for all tested pulp furnishes and plate patterns.

The Effect of Pulp Furnish on Bar Forces

The mean peak normal and shear force at the onset of fibre cutting depend on pulp furnish. At the onset of fibre cutting, the mean peak normal force of the softwood (SW) pulp is much higher than for the hardwood (HW) pulp (Harirforoush et al. 2017b), as tabulated in Table 1. The level of compressive strain in fibres imposed by fibre forces depends on the properties of the fibres (i.e., modulus of elasticity and fibre geometries such as length, diameter and wall thickness) as well as applied forces (Kerekes and Senger 2006). HW and SW have quite different geometries (i.e. SW fibres are longer than HW fibres) which

Table 1- Mean peak normal force, mean peak shear force and coefficient of friction at the onset of fibre cutting for all pulp furnishes at 1200 rpm for plates of BEL=5.59 km/rev and BEL=2.74 km/rev

	Mean peak normal force (N)	Mean peak shear force (N)	Mean coefficient of friction
SPF SW TMP HF / Plate BEL=2.74 km/rev	5.69	1.69	0.54
SPF SW TMP HF / Plate BEL=5.59 km/rev	0.95	0.58	0.92
SPF SW TMP LF / Plate BEL=2.74 km/rev	6.85	3.68	0.74
SPF SW TMP LF / Plate BEL=5.59 km/rev	0.94	0.56	0.99
NBSK / Plate BEL=2.74 km/rev	6.50	1.60	0.41
NBSK / Plate BEL=5.59km/rev	3.84	1.45	0.68
Aspen HW TMP / Plate BEL=2.74 km/rev	3.32	1.38	0.49
Aspen HW TMP /Plate BEL=5.59km/rev	1.38	0.95	0.91

*HF: high freeness, LF: low freeness

PROJECT 2.2

result in different normal forces at the onset of fibre cutting. However, for the refiner plate with BEL=2.74 km/rev, the mean peak shear force for HW and SW pulps at the onset of fibre cutting are approximately equivalent (Harirforoush et al. 2017b), as tabulated in Table 1.

The Effect of Plate Pattern on Bar Forces

For tested pulp furnishes and at all plate gaps, the plate with higher BEL (which has smaller bar width and groove width) resulted in lower mean peak normal force. An example is shown in Figure 1 for SPF SW high freeness TMP and aspen HW TMP at 1200 rpm for the plates of BEL=5.59 km/rev and BEL=2.74 km/rev. A similar trend is seen in the relationship between mean peak shear force and the inverse of plate gap. The plate with higher BEL resulted in lower mean peak shear force for all tested pulp furnishes and plate gaps. Mean peak normal and shear force at the onset of fibre cutting depend on pulp furnish and plate pattern and it is lower with the plate pattern that has higher BEL, as tabulated in Table 1.

For the plate of BEL=5.59 km/rev, the mean peak shear force at the onset of fibre cutting is different for HW and SW. We expect that the magnitudes of the two components of shear force (i.e. “corner” force or “ploughing” force at the bar edge and friction force on the bar surface) will be different for different plate patterns. For the plate with BEL=2.74 km/rev, these two forces vary such that their sum is approximately equivalent for HW and SW pulps, at the onset of fibre cutting. But, for the plate of BEL=5.59 km/rev, the magnitude of either the friction force or corner force for HW pulp will be different from SW pulp that cause different mean peak shear forces at the onset of fibre cutting.

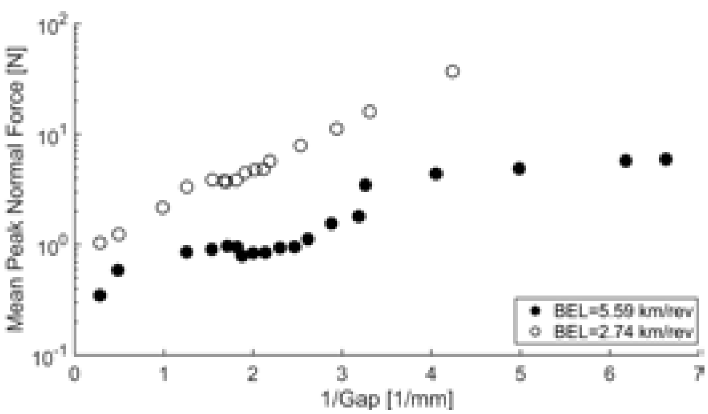
As shown in Figure 2, at all plate gaps and for tested pulp furnishes, for the higher BEL plate, the mean coefficient of friction was higher, as tabulated in Table 1. Our results also show that the mean coefficient of friction at the onset of fibre cutting is a function of function of plate gap, pulp furnish, and plate pattern. The plate with smaller bar width and groove width resulted in higher mean coefficient of friction at the onset of fibre cutting.

In addition, since the mean coefficient of friction is the ratio of peak shear force to peak normal force and it decreases with reducing the plate gap, we hypothesize that the changes in pulp and paper properties may be caused by an increase in compressive forces rather than by an increase in shear forces on fibres. We expect that normal forces are dominant forces in LC refining.

Mill-Scale Refiner Trials

We continue to work towards mill-scale refiner trials that will be performed at Catalyst Paper mill in Crofton, BC. Specially-designed refiner force sensors will be installed in an Andritz R52 Twin-Flo LC refiner with 58-inch diameter discs and typical operating speed of 425 rpm. The objectives of this project are:

- To detect the onset of fibre cutting in real time by employing the indications of the onset of fibre cutting previously found in the data from the pilot-scale refiner trials;
- To provide indication of refining zone imbalance;



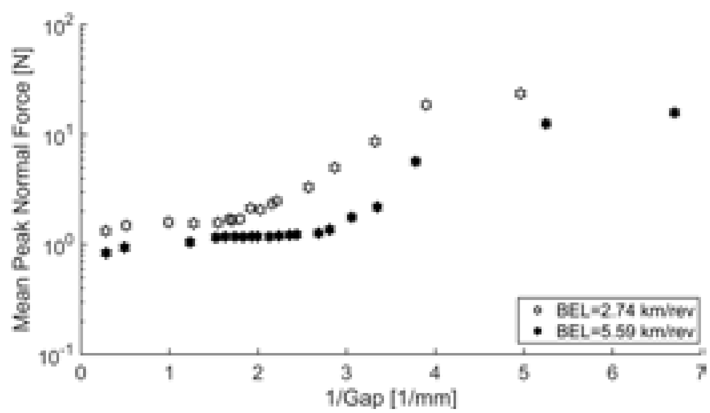


Figure 1: Mean peak normal force versus the inverse of plate gap for (a) SPF SW high freeness TMP, and (b) aspen HW TMP at 1200 rpm for the plates of BEL =5.59 km/rev and BEL=2.74 km/rev.

PROJECT 2.2

- Investigate the radial distribution of bar forces;
- To detect real time plate clash.

The sensor components for this installation have been designed and machined, and the data acquisition system and experimental set up have been specified. It is anticipated that the project will commence in 2018.

References

Harirforoush, R., J. Olson, and P. Wild. “In-process detection of fiber cutting in low consistency refining based on measurement of forces on refiner bars”. *Tappi Journal,* 16 no.4(2017a): 189–199.

Harirforoush, R., J. Olson, and P. Wild, “Indications of the onset of fiber cutting in low consistency refining using a refiner force sensor: the effect of pulp furnish”. Under review by *Nordic Pulp and Paper Research Journal* (2017b).

Kerekes, R.J., and J.J. Senger. “Characterizing refining action in low consistency refiner by forces in fibres”. *Journal of Pulp and Paper Science*, 32 no.1(2006): 1–8.

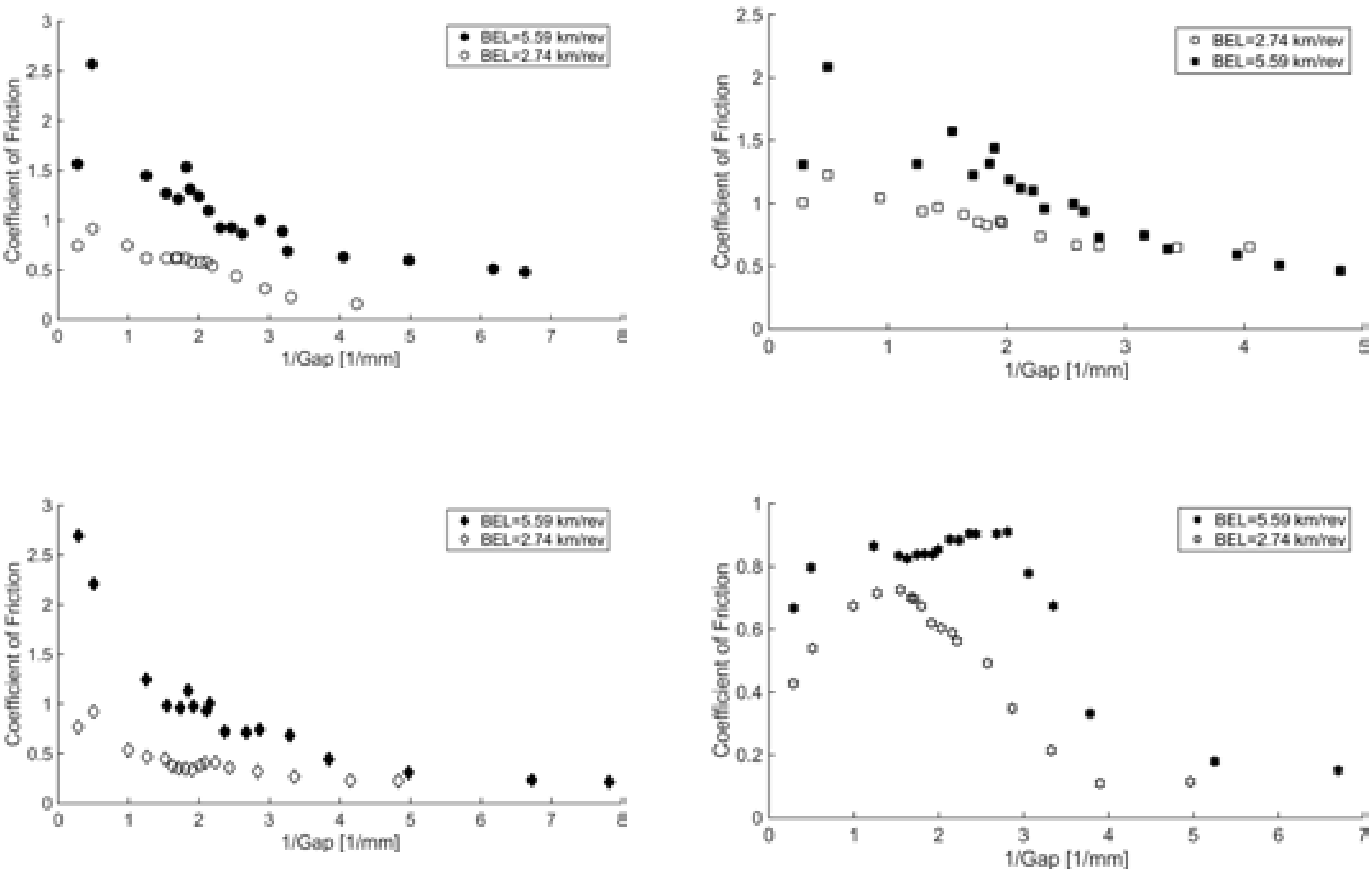


Figure 2: Mean coefficient of friction versus the inverse of plate gap for (a) SPF SW high freeness TMP, (b) SPF SW low freeness TMP, (c) NBSK, and (d) aspen HW TMP at 1200 rpm for the plates of BEL =2.74 km/rev and BEL=5.59 km/rev.

MATTHIAS AIGNER

2.2: LOW CONSISTENCY REFINER BAR FORCE SENSOR BASED CONTROL STRATEGIES

Matthias Aigner joined the ERMP research program in September 2017 as a Ph.D. candidate under the supervision of Professor Peter Wild at the University of Victoria (UVic). Matthias completed his B.Sc. and M.Sc. degrees in Mechanical Engineering at the University of Leoben in Austria in 2015 and 2016, respectively.

His studies and research in his undergraduate and graduate degree focused on the fatigue assessment of mechanical structures as well as manufacturing processes. This led to his Master's thesis, where he investigated the impacts of micro surface defects on the fatigue strength of mechanical parts.

Matthias will collaborate with Reza Harirforoush on ERMP project 2.2 to further develop the bar force sensor for pulp and paper refiners. This sensor is used to measure shear and normal forces of bar-passing events to investigate the mechanical interactions between the refiner bars and pulp fibres in low and high consistency refining. Matthias will investigate the effect of pulp furnish (i.e. softwood, hardwood) and plate pattern on the shear force along with the direction of the bar. He will also perform further analysis in investigating the effect of plate pattern on bar forces by designing and installing the refiner force sensor in different plate patterns (i.e. BEL=0.99 km/rev). The trials will be performed in the pilot-scale refiner at UBC. In addition, mill-scale trials will be conducted to validate the fibre cutting metrics previously found in pilot-scale trials.

Besides his current course work at UVic, Matthias has started his literature review to become familiar with previous work related to his research project, as well as topics related to his research such as the process and mechanics of mechanical pulping, bar forces in low consistency refining, fabrication of the sensor and signal processing.

BRYAN BOHN

2.3: ADVANCED PUMP PERFORMANCE MONITORING SYSTEM

Bryan Bohn joined the ERMP program in September 2017. He is currently pursuing an MASc degree at the University of British Columbia under the co-supervision of Professors Boris Stoeber and Bhushan Gopaluni. His research will focus on reducing energy consumption in mechanical pumping processes through the use of advanced performance monitoring systems. His academic interests are in sensor design and networking, intelligent process control, and signal processing.

Bryan received his BSc in Mechanical Engineering from the University of Connecticut in 2010. Since then, he has been working in aerospace and defence industries in the United States. His professional background centred on applied research and development of sensors systems for undersea applications. He also has experience in mechanical design, process development and improvement, and manufacturing.

Bryan's research will extend preceding efforts to minimize waste energy in pumps and pumping processes. Centrifugal pumps are a major source of electrical energy consumption in many industries. Previously in project 2.3, Ramin Khoie demonstrated the viability of using a magnetic sensor to monitor pump impeller blade wear and detect resulting reductions in pump efficiency. It has been proposed that an inexpensive and adaptable sensor suite could be developed to serve as a comprehensive pump performance monitoring system. This sensor network would generate continuous efficiency monitoring and allow for accurate maintenance scheduling through predictive pump failure analysis. Bryan is currently engaged in literature review of sensor network concepts and signal processing schemes, and is developing an approach to his project in addition to coursework.

TARANEH KORDI

3.2: LOW CONSISTENCY REFINER PULP FOR PACKAGING INDUSTRIES

This project focuses on the application of low consistency (LC) refining in producing multi ply folding boxboards (FBB). In the previous stage of this project, Taraneh focused on the application of LCR in producing multi-ply folding boxboards, continuing the project started by Chunyang Han on the application of screening in low consistency (LC) refining. The main objective of that work was to examine the effect of different screen designs as well as refining conditions, that is, specific refining energy (SRE) and specific edge load (SEL) on the physical and mechanical properties of FBB. The results were presented at previous ERMP Steering Committee meetings in November 2016 and June 2017.

Taraneh has recently started a computational project on modelling fibre networks, which is used to explain the experiments and provide better understanding of the effect of LC TMP/BCTMP blending on the plybond strength of FBB. In collaboration with Professor Tetsu Uesaka at Mid Sweden University, the effect of fibres and fibre network properties on fibre bonding and resulting plybond strength is studied. The approach is to use a particle-based method, in particular discrete element method (DEM) and ESyS-Particle software to model fibre networks and their performance.

ESyS-particle is an open source software which is ideal for the numerical modelling of discrete and non-homogeneous materials, complex geometries, and non-linear dynamic problems, such as large deformation, fracture and fragmentation as encountered in the plybond failure of FBB.

This project is all simulation work. The ESyS program is expected to allow us to predict the plybond strength from fibre properties and network properties such as average fibre length, fibre coarseness, fibre Young's modulus, fibre shear modulus, basis weight, network porosity and network size. Figure 1 shows the deposition of fibres of each ply of a 3-ply sheet. For our primary test, we started by generating a fibre network with total grammage of 20 gsm. After deposition of fibres, the network is compressed to reach the desirable thickness. Figure 2 shows the compression process using particle walls at top and bottom of the fibre network. After compression and generation of fibre-fibre bondings, the fibre network was subjected to z-direction tensile force for plybond test.

Several fibre networks with various grammages will be simulated and plybond tests will be conducted on the generated fibre networks. The results of force-strain will be compared with the previous experimental results for the folding boxboards. To speed up the computational process, especially for higher grammage networks, Taraneh will be using the supercomputing facility available at UofT (SciNet).

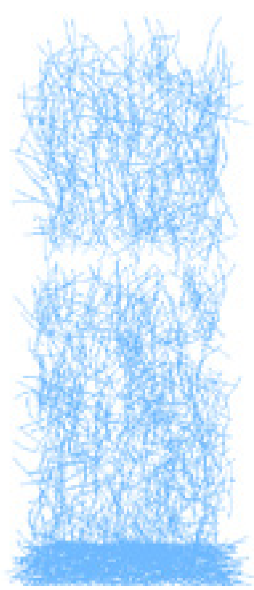


Figure 1: Deposition of fibres of a 3-ply sheet

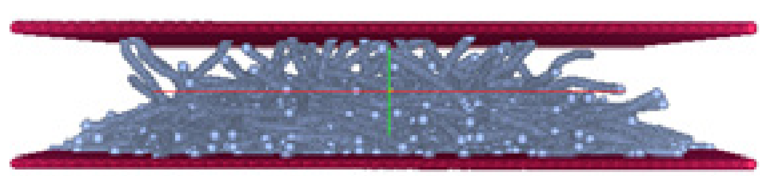


Figure 2: Compression of fibre network using particle walls

BAHAR SOLTANMOHAMMADI

3.2: LOW CONSISTENCY REFINED MECHANICAL PULP FOR PRODUCING FLEXIBLE PACKAGING PAPERS

The current flexible packaging papers available in industry, e.g. sack papers, are typically made of HCR-LCR sack kraft pulps. These pulps provide desirable mechanical properties such as high wet strength, and are produced with low energy consumption. Mechanical pulps, e.g. BCTMP, are energy-consuming and individually cannot provide enough mechanical improvement for flexible packaging systems. However, via energy reduction methods such as LC refining, adding even a small percentage of these pulps to sack kraft pulp can notably reduce the cost and improve the yield.

This project has been divided into two objectives. The first objective focuses on producing sack paper from various blends of sack kraft pulp and BCTMP. The second objective is based on improving oil and water barrier properties of packaging papers using non-fluorinated coating systems.

Sack papers from kraft and BCTMP

Since the last update, we have developed a trial plan with Canfor Pulp. Four different blends of BCTMP and HCR-sack kraft pulp consisting of 0%, 5%, 10%, and 20% BCTMP will be co-LC refined at Canfor's research lab in BC. Each pulp blend will be co-LC refined at two specific edge loads (SEL) and at least four specific refining energies (SRE), from 100 kWh/t to 200 kWh/t to achieve the target freeness of approximately 500 ml CSF. Among all samples of each composition, the ones with final freeness close to the target will be collected and be sent to the University of Toronto Pulp and Paper Centre. After preparing 80 to 100 gsm sack paper samples via a handsheet making process, each sample can be sent to a paper testing lab for further investigation on mechanical and physical properties. Various tests for determining grammage, moisture content, wet strength, tear strength, TEA, stretch, burst strength, porosity, and surface roughness will be conducted.

In future work, the effects of adding LC refined BCTMP to HCR-LCR-pure sack kraft pulp can be studied and the optimum percentage of substitution can be found.

Improving oil and water barrier properties of packaging papers

Attempts were made to find a non-fluorinated alternative for packaging paper while maintaining the performance and low amount of surface energy of existing fluorinated compounds in coating industries. The current fluorinated materials have poor recyclability, low biodegradability, and toxic nature. The toxicity can be a serious concern when it comes to packaging, especially for food packaging purposes. However, they are popular in industry due to their very low surface energy. This property can make them effective barriers towards water and oil penetration. Moreover, they can increase liquid contact angles on the cellulosic substrates, which leads to higher repellency.

In this study, a coating material made from trichlorooctyl silane and tetraethyl orthosilicate (TEOS) has been developed. This new coating formula can be a noticeable alternative to fluorinated materials from the same category such as trichloro (1H, 1H, 2H, 2H) perfluorooctyl silane in terms of hydrophobicity and oleophobicity. The contact angles of water and oil on the surface of this new modified coating system are almost as high as the traditional fluorinated ones. Therefore, with a relatively good approximation, it can be replaced with

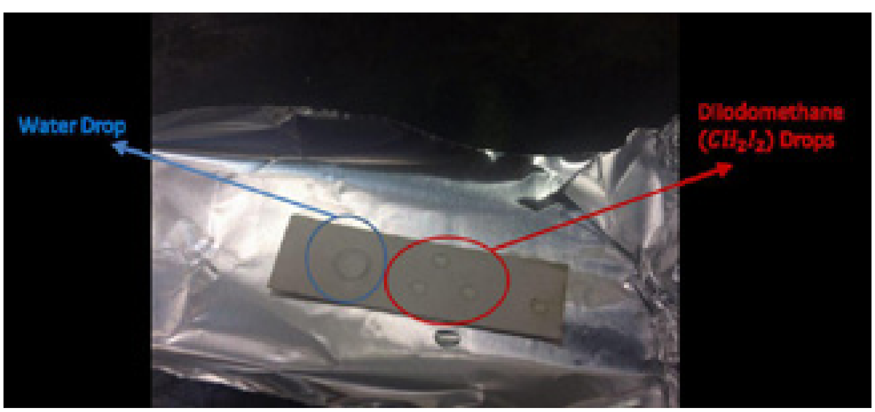


Figure 1: A non-fluorinated amphiphobic coating on FBB.

PROJECT 3.2

fluorinated coating materials. Figure 1 shows a folding boxboard (FBB) handsheet coated by TEOS, ethanol, hydrochloric acid, and trichlorosilane (each made of 1.59, 12.7, 2.89, and 1.135 ml respectively). Water and oil drops can remain on the surface of substrate with very little amount of absorption.

The water and oil contact angles of both fluorinated and non-fluorinated coating formulas were investigated at the U of T Forestry Centre via using Optical Contact Angle Measurement instrument. Figure 2 shows the contact angle results.

In future work, the effects of curing and coating time on surface energy can be studied. In addition, the surface properties and the amount of coating absorption on the substrate will be investigated and improved via SEM or other microscopic methods.

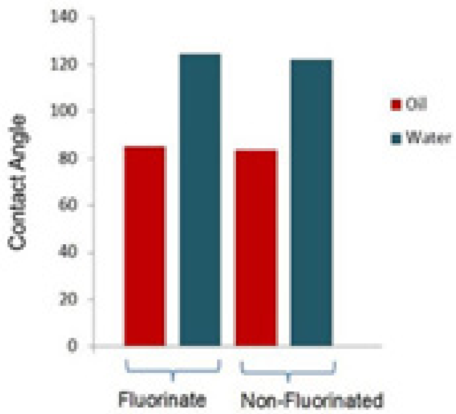


Figure 2: Water and oil contact angles of fluorinated and non-fluorinated coating samples.

CONFERENCE REPORT

Report on the 2017 Fundamental Mechanical Pulping Research Seminar in Finland

The 10th Fundamental Mechanical Pulp Research Seminar (FMPRS) was held at the University of Jyväskylä in Jyväskylä, Finland on June 13 and 14, 2017. It congregated about 100 researchers and industrial representatives from several countries, but primarily from Sweden and Finland; Professor James Olson and Jorge Rubiano represented UBC/ERMP and were the only attendees from North America. As the seminar was structured, it allowed all attendees to be in the same room at all times listening to the presentations, enabling more detailed and engaging discussions. Jorge presented his work from ERMP project 1.4 “Optimal LC Refining”, around fibre shortening of mechanical pulps during LC refining and the comminution model parametrization (please see “Conference Publications” on page 22, and find the files at files.workspace.ubc.ca).

Among the FMPRS presentations, we highlight some that are most relevant to the ERMP group:

Christer Sandberg from Holmen Paper (an ERMP partner) presented an interesting work “Energy Efficiency in Mechanical Pulping,” about how to assess and compare the efficiency of different TMP systems. He summarized that when defining mechanical pulping efficiency, refiner performance comparisons should be based on available property data, with similar feed material quality, and that refiner load should include no-load power. He also remarked that efficiency references should be state of the art technology, and that an understanding of production base, chemicals and yield loss is necessary.

As keynote speaker, Mikko Vuori from UPM Paper gave an interesting talk about the possibility of utilizing electricity market price variations in favour of pulp production, highlighting that demand side management provides a good opportunity for electricity intense pulping to decrease costs.

A research group from VTT, the Technical Research Centre of Finland, presented a method to produce fibrillary fines directly from wood. The idea behind the production of fines is to reinforce paper and board products and improve properties such as tensile strength and bulk. Interestingly, their results were very similar to the ones presented by former ERMP member Emilia Jahangir at the June 2017 Steering Committee Meeting, a presentation entitled “LC Refined TMP MFC for High Bulk, High Tear and High Tensile Mechanical Pulp ”.

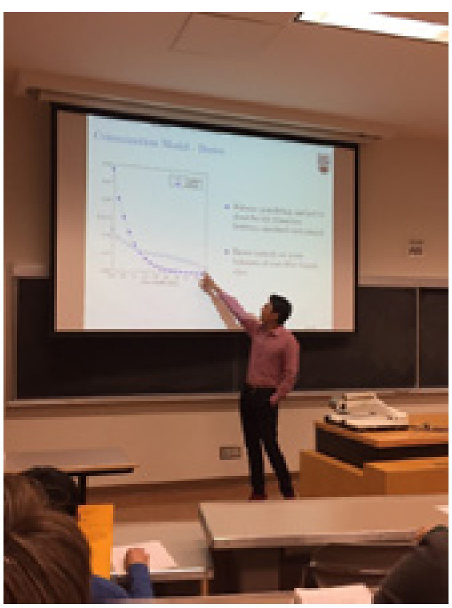
Jorge Rubiano’s presentation at FMPRS on June 13, 2017 in Jyväskylä, Finland.

TRIAL UPDATES AND PUBLICATIONS

Since the last newsletter, we have completed the analysis of the 2016 Andritz trials, which were presented at the Steering Committee meeting in Whistler, BC in June. We have published an internal report entitled "Effect of Bleaching Chemistry and LC Refining on Pulp Quality". We are now beginning the process of planning for the next set of trials at the Andritz R&D Center in Springfield, Ohio.

Reanna Seifert has been busy running several trials with the LC refiner and the MR8 pressure screen. She completed some contract work on fractionation for a company in Europe, which led to additional trials. Reanna and Meaghan have been collaborating with visiting PPC researcher Hui Cai to investigate the response of OCC (old corrugated cardboard) to various fractionation conditions, as well as LC refining conditions. They have also been working with Meadow Lake Pulp on trials around fractionation and LC refining.

As we previously reported, we successfully obtained NSERC RTI funding to purchase a Dynamic Sheet Former. This large purchase is underway with the help of UBC Procurement, and we hope to have it on site by early 2018. We also will be sourcing a dryer and press to complement the DSF sample preparation.



Jorge Rubiano gave a seminar presentation at UBC on September 22, 2017.

PUBLICATIONS

Journal Article:

Miller, M., A. Luukkonen, J.A. Olson (2017): "Effect of fractionation and refining intensity on pulp quality", *Nordic Pulp and Paper Research Journal*, 32 no. 3(2017): 386–94.

Internal Report:

"Effect of bleaching and LC refining on pulp properties", report on UBC at Andritz, Ohio, USA in 2016, and published in September 2017.

Conferences:

Harirforoush, R., J. Olson, P. Wild (2017): "The Correlation Between Pulp Properties and Bar Forces in LC Refining Using A Piezoelectric Sensor", Canadian Congress of Applied Mechanics, Victoria, BC, May 29–June 1, 2017.

Rubiano Berna, J.E., D.M. Martinez, J.A. Olson. "Analysis of fibre shortening during low consistency refining of mechanical pulps using a comminution model", Fundamental Mechanical Pulping Research Symposium, Jyvaskyla, Finland, June 12–13, 2017.

Seminars:

Rubiano Berna, J.E.: "Analysis of fibre shortening during low consistency refining of mechanical pulps using a comminution model", seminar presentation to UBC Chemical and Biological Engineering department, September 22, 2017.

AWARDS

Shayan Hosseinpour, who worked as a co-op student with Rodger Beatson and Harry Chang from January to August 2017, received the NSERC Undergraduate Student Award, which came with $4,500 in funding. Congratulations!

ERMP PERSONNEL CHANGES

A Few Farewells

In late August we said goodbye to Harry Chang, who worked with the ERMP group for over a decade. His research with Prof. Rodger Beatson focused on chemical pre-treatments of mechanical pulp, and he contributed to over a dozen publications and conference presentations, and collaborated with many ERMP staff and students.

Thankfully Harry isn't going far, as he has started in a new role at BCIT as Assistant Instructor in the Chemical and Environmental Technology department.

Zhaoyang Yuan, who completed his PhD at the UBC Pulp and Paper Centre earlier this year, has joined the ERMP group at BCIT as a Post-Doctoral Fellow for the next year and will continue some of Harry's work. Also in the BCIT group, Shayan Hosseinpour finished his 8-month co-op term, and a new co-op student Jayg Dimayacyac joined the group in September.

In August we also wished a fond farewell to Emilia Jahangir, who worked with ERMP for four years at UBC-PPC, first as a co-op student, and then as a technician, taking on many lab responsibilities and operating the LC refiner and MR8 pressure screen pilot plants. She collaborated with students, staff and partners, running hundreds of trials.

Emilia has relocated to the United States, but we hope she can visit us in Vancouver in the future. Reanna Seifert is now leading the LC refining and screening pilot plant trials at UBC-PPC, along with recently hired technician Vanessa Van Aert.

And a Warm Welcome

The program welcomes Vanessa Van Aert, a new Research Technician at UBC-PPC. She will be applying her knowledge and experience in the pulp and paper industry to collaborate with ERMP staff and researchers on low consistency refining and screening trials, conducting various pulp property testing, as well as participating in other PPC research projects.

Vanessa graduated from UBC in May 2017 with a Bachelor's degree in chemical engineering. Following graduation, she spent time travelling through Central America. Vanessa's previous work experience includes positions with Quesnel River Pulp and Econotech Services. As a process technician with QRP, she conducted quality assurance tests on the finished softwood BCTMP product to ensure it was on-spec, and she was also the primary technician for a low consistency refining project at the mill. As a lab technician at Econotech Services, a provider of testing services for pulp and paper products, Vanessa analyzed hardwood and softwood kraft pulp following TAPPI, PAPTAC, ISO, and SCAN standard methods.

In September we welcomed two new students to the program, Bryan Bohn, an MSc student working with Professors Boris Stoeber and Bhushan Gopaluni at UBC on project 2.3 "Advanced pump performance monitoring system", as well as Matthias Aigner, a PhD candidate working with Professor Peter Wild at UVic on project 2.2 "LC refiner bar force sensor control strategies."

Upcoming Event

STEERING COMMITTEE MEETING
Thursday, November 9, 2017
UBC, Vancouver Point Grey Campus
Chemistry and Biological Engineering Building
2360 East Mall, Room 202
8:30 a.m. to 4:30 p.m.

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