

## Introduction

Canada's Mechanical Pulping Energy Reduction Network was established in 2007 by partnering the pulp and paper industry with academia, government and supporting industry to conduct research with a goal of reducing the energy consumption of the mechanical pulp industry by 50 per cent before 2020. Mechanical pulping is the most yield effective pulping process; nearly 99% of the wood introduced into the process is transformed into pulp suitable for products ranging from tissue to paper. Nevertheless, it is a highly energy intensive process. For mechanical newsprint grades, energy input can be as high as 3,600 kWh/t of pulp produced. This is more than 5 times the energy needed to produce the same amount of pulp through the chemical process. With increasing energy prices, there is a need for process improvements. More than six years have been invested into this effort (Phase I: 2007-2012 & Phase II: 2013-present). As a result of research, members of the consortium have had access to technology that has proven to reduce the energy input in their process (ANC, QRP). Phase II will build on research developed during Phase I, and the research strategy will now be to reduce the consumption through: process optimization, development of advanced sensors and controls and low energy product development. This newsletter provides an update on the ongoing progress of the research program.

## "One-on-one" Mill Meetings

Six months have passed since our Steering Committee meeting on June 12, 2013. One of the outcomes of the meeting was to establish *one-on-one* contact with the mills. Thus, the research team involved in the projects has visited some of them, to narrow the involvement of each member in the program.

The mills visited include both market pulp and paper grade mills that work with different chip supply. The following are mills visited to date:

1. Howe Sound Pulp and Paper - Aug 29<sup>th</sup> 2013
2. Canfor Taylor Pulp - Sept 18<sup>th</sup> 2013
3. Millar Western Pulp - Nov 21<sup>st</sup> 2013
4. Alberta Newsprint Company - Nov 21<sup>st</sup> 2013

Various interests were captured during these visits. Some of these include:

- Low consistency refining of shive laden-coarse fibres (softwoods and hardwoods).
- In-refiner chemical treatments as well as chemical treatments at the impregnation stage.

We hope to continue our site visits to the rest of the partners through 2014.

## Optimizing Low Consistency Refining

Following our meeting at Howe Sound in August, the UBC Research team has performed a series of trials towards finding the optimal conditions to refine coarse softwood mechanical pulps. Francisco Fernandez, Marion Loubet and Nici Darychuk worked on designing the experiments and testing the pulp on different refining conditions. Nearly one ton of never dried wet pulp was sampled at one of the partner's facilities.



Nici Darychuk and Francisco Fernandez sampling pulp.



Refining this type of pulp is generally performed at high consistency for the preservation of length. Advances in fabrication methods have allowed the development of low intensity plates that are capable of refining the pulp to the same quality targets as high consistency refining but at lower energy consumption. This was shown in the trials. From the three different intensity levels tested (0.15 J/m, 0.45 J/m & 0.65 J/m) it was shown that low intensity refining was capable to develop pulp properties matching those of HC refined pulp. Results from trials show that an energy saving of 50% is possible. A report of this work is under review and will be published on the group website in the coming months.

## Recruitment

Our recent efforts have concentrated on strategic recruitment of the best and brightest students and researchers to add to the research team. They will work on specific projects in their field with supervising faculty members. The following are some of our recently enlisted recruits.

### Nicholas McIntosh

Working with **Professor Mark Martinez** on Project 1.1: Compression screw feed optimization & energy savings in HC refining

Nicholas was born and raised in Calgary, AB and received his BSc in Chemical Engineering from the University of Calgary in 2013. He is currently a MSc student in Chemical Engineering at UBC. While an undergrad, Nicholas was an intern in the 'fluid dynamics' team at NOVA Chemicals Research & Technology in Calgary. While at



NOVA, he worked on improving and creating chemical processes with the focus on how the design of the machinery and equipment affected the flow of fluids and vice versa; the physical properties of the polymer resins which NOVA manufactured made this a challenging but enjoyable job.

### Yu Sun

Working with **Professor Rodger Beatson** on Project 1.3: Optimization of chemical charge distribution throughout the process.

Yu received her BSc in Environmental Science from Beijing Forestry University, followed by a MSc in Environmental Engineering from the Chinese Academy of Forestry, in 2005 and 2009 respectively. Yu recently received her PhD from Quebec University at Trois-Rivières where her research focused on reducing the high-energy consumption of TMP by introducing  $O_3$ , with pulp qualities maintained or ameliorated. Yu is currently a Postdoctoral Research Fellow and she will continue to work in the area of mechanical pulping technology.



### Xue Feng (Harry) Chang

Working part-time with **Professor Rodger Beatson and Mark Martinez** on Project 1.3: Optimization of chemical charge distribution throughout the process.

Harry worked as a Research Scientist during Phase I of the project and as a result, he and Professor Rodger Beatson hold a patent in chemical processing using alkaline peroxide and had five papers published in relation to the project. One of the papers was awarded the Douglas Attach award for best paper



a place of mind



presented at the 2011 PAPTAC annual conference.

Harry received his MASc in Wood Science from UBC in 2007 and worked as a Research Scientist until the end of 2011. Harry is currently working as a Research Associate.

### **Jorge Enrique Rubiano Berna**

*Working with **Professor Mark Martinez** on Project 1.4: Advanced fractionation and low consistency refining.*

Jorge earned his BSc in Chemical Engineering from the Universidad de Valle in his home country of Columbia. He then worked in the pulp and paper industry for three years as a production supervisor of a paper mill (printing and writing grades), a time during which he learned most of the practical details about the field.



In 2011 he began his studies at the prestigious KTH - Royal Institute of Technology and received a MSc in Chemical Engineering with a minor in Energy and Environment. His thesis investigated pulp morphology and its changes after refining and fractionation processes. The work was performed at Innventia, a research institute that works with innovations based on forest raw materials. Jorge is currently a PhD candidate in Chemical and Biological Engineering under the supervision of Professors Mark Martinez and James Olson. He is also a Research Assistant at the Pulp and Paper Centre.

### **Hui Tian**

*Working with **Professor Bhushan Gopaluni** on Project 2.1: Optimization and control of integrated HC and LC refining.*

Hui received her BE and MASc degrees in Control Science and Engineering from Harbin Institute of Technology, Harbin, China, in 2011 and 2013 respectively.



Her research interests include robust and model predictive control, estimation and fault detection and diagnosis. Currently a PhD candidate in Chemical and Biological Engineering at UBC under the supervision of Professor Bhushan Gopaluni, she is working on designing a model predictive controller for the refining process in thermo-mechanical pulping industry. A central goal of her research is to use novel economic and distributed model predictive control strategies to reduce energy consumption in multistage low consistency refining. By May 2014, Professor Gopaluni and Hui intend to perform controller audit at one of the partner mills.

### **Reza Harirforoush**

*Working with **Professor Peter Wild** on Project 2.2: LC refiner bar force sensor based control strategies.*

Reza received his BSc and MSc degrees in Mechanical Engineering from Islamic Azad University, Tehran, Iran in 2001 and 2003 respectively. After several years working as a R&D manager, he joined



Mechatronic Systems Engineering at Simon Fraser University (SFU) in 2010 and worked as a research and teaching assistant. He received his MASc in 2012, specializing in modal analysis, FEM and modelling.

Reza is currently a PhD candidate in Mechanical Engineering at the University of Victoria under the supervision of Professor Peter Wild. The research involves collaboration with UBC in advanced system integration, sensing and control strategies. He is working on developing an advanced sensor based control strategies for application in the pulp and paper industry in order to reduce electrical energy consumption in the mechanical pulping sector.

#### Ramin Khoie

Working with **Professor Boris Stoeber** on Project 2.3: Advanced Pump performance monitoring system.

Ramin received his BAsC in Mechanical Engineering, Mechatronics option from UBC in 2003. He is currently a MASc candidate in the same department.



During his undergraduate studies he took several courses focused on sensors, their design and implementation techniques. His involvement in several undergraduate projects has given him engineering insight on a range of sensors and their characteristics. He is currently working on the development of a sensor set to be implemented on a centrifugal pump in mechanical pulping facilities as part of his Masters project. The sensors will log information on pump including wear on impeller blades and vibration and also on the fluid upstream and downstream of the pump. This information will later be used to measure pump efficiency during operation.

#### Project details:

Pumping plays a major role on the TMP process. The goal is to develop a sensor set to measure pump efficiency in real time and relate that to wear on the pump's impeller blades. Ramin is currently working on the development of a system that is capable of measuring wear on the impellers based on the clearance between the impeller blades and the pump housing. The first approach for accomplishing this task uses a permanent magnet model where the varying magnetic flux density relative to the impeller's rotational speed is being correlated to the gap size between impeller vanes and the housing. This design does not require any modifications to the interior of the pump and is therefore easier to implement. For an initial proof of principle study with this approach, Ramin has simulated a preliminary design in COMSOL Multiphysics (Figure 1) and ran simulations by varying the gap size and measuring the magnetic flux density.

Magnetic Flux Density (T) at Time = 0.1 sec

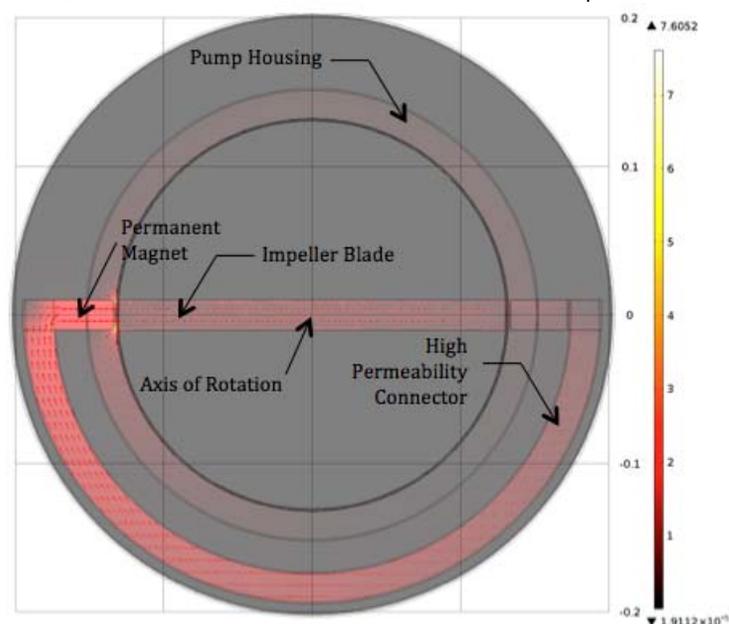


Figure 1: Simplified Cross-Section Model of a Centrifugal Pump

**PUBLICATIONS**

Significant publications and reports from the sponsored research are expected to continue as the project progresses. The following records have been archived online and/or emailed to the partners prior to being included in this newsletter.

X.F.Chang, J.A. Olson, R.P.Beatson, "Optimization of Alkaline Peroxide Treatments on Primary Refined TMP prior and subsequent to low consistency refining", submitted to Paper Week 2014, February 3-6, Montreal, QC.

Rajabi Nasab, N., T. Mithrush, James A. Olson and D. Mark Martinez, "Turbulent Couette flow between corrugated walls: The case with motion of one wall perpendicular to the corrugation cavities", Canadian Journal of Chemical Engineering, 2013

Elahimehr, A., J.A. Olson, Martinez, D.M., "Understanding LC refining: The effect of plate pattern and refiner operation", Nordic Pulp and Paper Research Journal, Vol 28 no (3), 2013

Gao, J., Bennington, C.P.J., Martinez, D.M. and Olson, J.A., "Latency Removal of Mechanical Pulps: Phenomenological Observations", Nord. Pulp Paper Res. J. 28(2), 198, 2013

Rajabi Nasab, N., Olson, J.A., Heymer, J. & Martinez, D.M., "Understanding of No-load Power in Low Consistency Refiners", Canadian Journal of Chemical Engineering, DOI: 10.1002/cjce.21818, 2013

Rajabi Nasab, N., Mithrush, T., Olson, J.A. & Martinez, D.M., "Turbulent flow between two parallel corrugated walls: The case with motion of one wall perpendicular to the corrugation cavities", Canadian Journal of Chemical Engineering, 2013

Rajabi Nasab, N., Mithrush, T., Olson, J.A. & Martinez, D.M., On the relationship between plate pattern and the flow field in LC refiners: Insight into to the groove depth effect and no-load power, Submitted to TAPPI Journal, 2013

Gao, J., Bennington, C.P.J., Martinez, D.M. and Olson, J.A. (2012): A Kinetic Model of Latency Removal in Mechanical Pulping Processes, Paperweek Canada 2012 – the 98th PAPTAC Annual Conference, Montreal, Canada, January 31 - February 2, 2012, Montreal, Canada.

Gao, J., Bennington, C.P.J., Martinez, D.M. and Olson, J.A. (2011): Latency Removal of Mechanical Pulps: Phenomenological Observations, Paperweek Canada 2011 – the 97th PAPTAC Annual Conference, Montreal, Canada, February 1 - 3, 2011, Montreal, Canada.

**CONFERENCE POSTERS AND PROCEEDINGS**

Rajabi Nasab, N., Mithrush, T., Olson, J.A. & Martinez, D.M., "Insight into the Flow Field of LC Refiners: The Relationship to the Beating Effect", January 29-31, Are, Sweden, 2013

Rajabi Nasab, N., J.A. Olson, J. Heymer & D.M. Martinez, "Experimental Study of Low Consistency Refiner No-load Power", PAPERCON Conference Proceedings, New Orleans, LA, April 21-25, pp. 1539-1551, 2012

## EVENTS

### UPCOMING:

*PACWEST Conference, Jasper, AB  
May 28-31, 2014*

## IN THE NEWS

Following the media release in September 2013 via *UBC News* of the additional \$2.7 million grant, the story was picked up by several media outlets, including:

- Pulp and Paper Canada
- BC Business
- UBC Applied Science News
- UBC Engineering News
- SPARC Connects
- The Ubyyssey
- UBC News: The Next Big Thing 2014

## SPONSORS

The supporting organizations of this research are: AFT-Aikawa Group, Alberta Newsprint Company, Andritz, Arkema, 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, and Westcan Engineering.

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