VIPP VALUES CREATED IN
FIBRE-BASED PROCESSES
AND PRODUCTS

WELCOME TO THE FIRST ISSUE OF THE VIPP NEWSLETTER

VIPP STANDS FOR **VALUES CREATED IN FIBRE-BASED PROCESSES AND PRODUCTS** AND IS AN INTERDISCIPLINARY, INDUSTRIAL GRADUATE RESEARCH COLLEGE LOCATED AT KARLSTAD UNIVERSITY.

Research focus is mainly on the pulp and paper industrial branch and around key technologies of importance for this industry. It is a joint initiative between Karlstad University, the Service Research Center at Karlstad University and the following enterprises: Asko Appliances AB, Billerud AB, BTG Instruments AB, Eka Chemicals AB, Metso Paper Karlstad AB, Domsjö Fabriker AB, MoRe Research AB, Innventia AB, Korsnäs AB, Pöyry Sweden AB, Stora Enso Group R&D, SSG Standard Solutions Group AB, Stora Enso Skoghall AB and Kemira Kemi AB. Together these partners share a wide variety of complementary expertise, covering the whole value chain from pulp to final product. The program is financed by the participating partners and the Knowledge Foundation.

The aim of the VIPP research college is to create a research environment where PhD students not only specialize in one area but gain, through close collaboration and courses, skills in other research areas as well. It is based on three strong research themes, addressing different aspects within industrial R&D and related to fibre-based products and services:

- pulp, paper and graphic technologies
- environmental and energy research
- service-oriented, customer-research activities

All of these are well established at Karlstad University and form, together with the expertise from the collaborating enterprises, a robust research platform to start from.
The content of this research is focus of this newsletter where our PhD students present themselves and also their projects.
If you want to learn more about us, you are also welcome to browse our new **homepage** with information about:

- General information about VIPP
- VIPP's organisation
- News and Events, including a report about VIPP's kick-off in October 2011
- VIPP partners and financers

WE WISH YOU HAPPY READING!

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KK-stiftelsen

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A NEW SENSOR FOR IMPROVED FIBERLINE CONTROL

A new pulp mill sensor that measures the content of dissolved lignin in pulp slurry has been developed by BTG Instruments. This sensor uses a unique method for the analysis of dissolved lignin that results in a robust and accurate lignin determination. By using this state-of-the-art sensor it will be easier to control the washing efficiency of the different washers in the pulp mill, which will lead not only to reduced energy consumption and lower production cost but also a lower environmental impact.

Several individual sensors will be tested in different positions at a number of kraft and sulphite mills in Sweden and abroad during 2011 and 2012. The sensor will at the same time be evaluated at BTG Instruments' R&D laboratory in Säffle, where a pump loop will be used to simulate various process conditions.

The objectives of the PhD project are: 1) to establish a deep knowledge of how the new information generated by the sensor correlates with conventional pulp mill parameters, 2) to determine the optimum position for the new sensor, 3) to analyse the improvements that can be obtained in a pulp mill and 4) to investigate the underlying process mechanisms.

BTG Instruments is a leading supplier of state-of-the-art sensors and analyzers for the global pulp and paper industry. It is the company's ambition to have a close relationship with Karlstad University and the VIPP Research School to create new knowledge useful both for academic-scientific purposes and for the support of further product development activities.

Name:	**Caroline Wilke**
Background:	**Degree of Master of Science in Chemical Engineering (June 2011)**
Company:	**BTG Instruments, Säffle, Sweden (start: May 2011)**
Supervisors:	**Prof. Ulf Germgård (Karlstad University) and Dr. Niclas Andersson (BTG Instruments)**
Examiner:	**Prof. Ulf Germgård**

RAISING YOUR PRODUCTIVITY

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EFFICIENT DRYING OF TISSUE PAPER

This PhD project is a co-operation between Metso Paper and Karlstad University. Financial support is given by the Swedish Knowledge foundation.

The paper production process is in essence a dehydration operation. Stock flow enters the machine at low consistency and water is removed during forming, by mechanical compression and by thermal drying. Mechanical dewatering is energy efficient, but the amount of water that can be removed is restricted by press technology limitations and by desired paper quality which makes the final thermal drying necessary. Problematically this latter process is very energy demanding and is today accountable for approximately 70% of the energy used by a tissue mill.

The purpose of this project is to reduce the amount of energy used for thermal drying in production of tissue paper. Main areas to be investigated are:

- Influence of losses on the amount of used energy
- Effect of increased yankee hood air humidity and consequences for runnability
- Energy efficiency for possible future drying equipment
- Alternative equipment for energy recovery
- Adaption of drying system to higher ingoing dryness level of paper sheet

Proposed system modifications will be analyzed with regards to impact on the papermaking process.

Name:	**Anders Ottosson**
Project start:	**January 2012**
Supervisors at Karlstad University:	**Prof. Lars Nilsson and Jonas Berghel, Associate Professor**
Supervisors at Metso Paper:	**Ingvar Klerelid, VP Product Management, Michael Bjerke, Senior Process Engineer, Hans Ivarsson, Project Manager R&D and Olli Saikkonen, R&D Manager**
Examiner:	**Roger Renström, Associate Professor**

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INVESTIGATION OF THE NON-UNIFORMITY DURING DEWATERING AND DRYING OF TISSUE PAPER GRADES

A sheet of paper possesses a local variation in grammage, usually termed formation of the sheet. The extent of this variation is mainly defined by the fibre morphology, the process chemistry and the operating conditions during the forming of the sheet. For a web with a low grammage, for example a tissue sheet, the relative extent of this variation is pronounced. Consequently, this variation will have considerable effect on the efficiency of dewatering and drying processes. For example, during suction-box dewatering, much more air will flow through areas with lower grammage in comparison to areas with higher grammage. This implies energy inefficiency in terms of air consumption. It will most likely also result in a variation in dewatering result, i.e. the locally achieved dryness will vary.

Another effect relates to the drying of these low grammage webs. On the Yankee cylinder or a through air drying (TAD) unit, areas with lower grammage will be dried much faster than areas with higher grammage. This implies that, towards the end of the drying process, the areas with the higher grammage delay the overall drying process. The low grammage areas will be overdried, and, equally important, the process has to be operated at a lower speed than it could be if the formation of the sheet was more even.

The above-described effects have been known to paper and tissue makers for some time; however, very little quantitative information is available. Furthermore, the quantitative influence of fibre morphology, the process chemistry and the operation conditions has not been studied. Therefore, the main objective of the project is to understand and quantify the effect of the sheet non-uniformity on dewatering and drying efficiency. Furthermore, the quantitative influence of some of the most relevant parameters will be determined. A particular focus will be put on the influence of the fiber morphology, for example fiber length and coarseness. Furthermore, energy-related issues of dewatering and drying will be addressed in order to propose modifications to the existing process.

Various experimental equipment and methods are available in both Karlstad (at Karlstad University and at Metso) and Stockholm (Innventia AB). Examples of equipment at Innventia are the high pressure difference laboratory former, the laboratory suction box including rewetting device, the MTS-pressing and drying simulator, the high-speed infrared imaging system, and the FEX pilot paper machine. In Karlstad, the following equipment is of interest: dynamic suction box (Karlstad University) and pilot tissue paper machine (Metso).

Name:	**Aron Tysén**
Dissertation:	**Planned September 2016**
Company:	**Innventia AB**
Supervisors:	**Christophe Barbier, PhD, and Hannes Vomhoff, PhD**
Examiner:	**Prof. Lars Nilsson**

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SYSTEMS ANALYSIS OF BIOREFINERIES

Professional profile:
20 years experience in technical engineering & consulting, mainly in the pulp & paper industry
Current position: Vice President, Biorefining Pöyry Scandinavia.

Area of research
Biorefining - Systems analysis of new bio-based products, as well as direct and indirect biomass supply to new sectors.

Background
Biomass is foreseen to be an increasingly demanded resource. Over time, new industries such as the chemical, petroleum and petrochemical industries will gradually base an increasing share of their production on renewable raw materials. The biomass may be supplied in unrefined form as round wood or wood chips, or indirectly from the forest industry or the power industry that are the dominant players in the market today. For the traditional users of biomass, this development thus poses both threats and opportunities.

Several factors influence the development: Technology, economics and authority incentives.

Objectives and Strategy
The goal of my research is to systematically identify, analyze and evaluate products, processes and platforms for industrial biorefineries, primarily wood-based ones. The research will involve a variety of possible products and processes. Great interest will be paid to combinations of chemical, biochemical and thermochemical conversion. The work will not primarily be based on experimental work, but rather on industrial experience and the great amount of laboratory results that are developed at universities and research institutes worldwide.

In particular, research focusing on how today's users of forest resources can add value and how different stakeholders can co-operate to make optimum use of a limited amount of wood, in an environmentally-, resource-, business- and socio-economically optimal way.

With nearly 20 years experience as a process consultant, I plan to carry out this analysis with a strong industrial perspective, taking into consideration actual economic conditions, business models and profitability requirements.

Name:	**Christer Gustavsson**
Department:	**Department of Energy, Environmental and Building Technology**
Supervisors:	Associate Prof. **Roger Renström, Prof. Lars Nilsson**
Examiner:	Associate Prof. **Jonas Berghel**

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FOOD-PACKAGING BARRIERS FROM RENEWABLE RESOURCES

Food packaging is widely used today and, depending on the application, different barrier materials are applied to the board surface. The function of the barrier is to protect the packaged food from oxygen and other gases, water and moisture, light, and grease. Another important function is to protect the packaging itself from water, moisture, and grease.

The carbon footprint measures the impact our activities have on the environment, in particular on climate change. With regard to food packaging it has become clear that the highest contribution to the carbon footprint comes from the barrier materials, which are based on plastic and/or aluminium. To reduce the carbon footprint today's barrier materials should be replaced with a renewable barrier material with sufficiently good barrier properties to protect the packaged goods.

The aim of this project is to study the oxygen barrier function to make food-packaging barriers from renewable resources. The barrier materials studied in this project are composite-based materials that have the potential to be used as barrier on board packaging material in the future. First, the barrier materials will be characterised and their important properties identified. Based on the results, a mathematical model will be developed for the penetration of oxygen through the barrier.

Name:	**Åsa Nyflött**
Education:	**MSc in engineering physics, KaU**
Company:	**Stora Enso**
Started:	**September 2011**
Supervisors:	**Prof. Magnus Lestelius, Prof. Ellen Moons and Dr. Gunilla Carlsson**
Examiner:	**Prof. Lars Järnström**
Mentor:	**Lic. Tech. Torbjörn Wahlström**

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FRESH FRUIT AND VEGETABLE WASTE IN THE FOOD SUPPLY CHAIN – QUANTIFICATION AND CAUSES

The result of several international studies suggests that more than 30 percent of the food produced for human consumption is lost or wasted globally. In addition to the economic value of the food produced, food losses also represent waste of resources used in production such as land, water, and energy (transportation, fertilizers, man hours, etc.). Of the total food losses, the share of fresh fruit and vegetables losses amount to a significant part.

The primary purpose of packaging is to protect and preserve the food, to provide good durability, good quality, and facilitate efficient transportation as it transits through the food supply chain. If the packaging cannot handle this adequately, it will cause food losses and environmental impact with no benefit. The importance of appropriate packaging design is therefore critical and the impact of using too much packaging material must be put in relation to product losses that may result from the use of too little packaging material. Often, the environmental impact of the packaging itself is relatively small compared to the environmental impact of the production of food. Hidden costs associated with handling the waste are often overlooked. Hidden costs can be caused by poor packaging, inadequate handling of the produce or the box, and/or an ill-performing cold chain. A more scientific and systematic approach in this process would significantly reduce these costs and increase profitability.

The aim of this research is to quantify how much fresh fruit and vegetable are lost and wasted in the food supply chain, how much the losses cost (calculated both in terms of economic and environmental cost), and identify how these losses can be prevented. Furthermore, the study aims to identify any other economic gains that improved packaging solutions would yield, such as lower handling costs, define where waste/inefficiency problems occur and who is paying the cost, and identify cost saving opportunities.

Vibrations during transportation, transshipment, high humidity, and temperature differences contribute to collapse of the boxes and/or fall. This results in destroyed or damaged products, additional handling, production stops and delays, and lost time in the entire supply chain. A large part of the problem is due to inefficient packaging.

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Education:	**MSc Environment and Energy System, 2003, Karlstad University**
Department:	**Energy, Environmental and Building Technology**
Supervisor:	**Associate Professor Fredrik Wikström**
Examiner:	**Prof. Lars Järnström**
Financed by:	**Billerud, The Knowledge Foundation**

BILLERUD

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ENERGY EFFICIENT WASTEWATER-TREATMENT IN PULP- AND PAPER MILLS THROUGH PRETREATMENT USING SEPARATION.

The energy use in wastewater treatment in a pulp and paper setting is affected by the chemical makeup of the wastewater. Different production units at pulp and paper mills produce various chemical compounds that negatively affect wastewater treatment. Wood extractives, lignin, bleaching agents and residual sulphite are common such chemicals. These compounds increase the costs associated with wastewater treatment by increasing energy demand and lowering treatment efficiency.

In this project, the means and effects of removing wood extractives and suspended solids from wastewater will be investigated. Several different separation technologies such as skimming, filtration, selective chemical flocculation and adsorbtion have the capability to perform this function. Specifically, determine how such technologies can be used to separate said compunds from forest industry wastewaters and to quantify the effect separation would have on the energy efficiency of aerobic and anaerobic wastewater treatment.

Name:	**Mattias From-Aldaron**
Education:	**M.Sc Energy and Environment systems, KaU 2009**
Company:	**Stora Enso Skoghall AB**
Supervisors:	Associate Prof. **Karin Granström,** **MSc. Ann-Kristin Magnusson** **Prof. Ulf Germgård**
Publications:	**Sandberg Maria, From-Aldaron Mattias** Energieffektiv aerob rening av skogsindustriella avloppsvatten 2011. **Published in: VÄRMEFORSK rapportdatabas**

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PREDICTING FLEXOGRAPHIC PRINT QUALITY FROM SUBSTRATE PROPERTIES WITH SPECIAL FOCUS ON LIQUID PACKAGING BOARDS

Innventia, Karlstad University and Tetra Pak are collaborating on this project. Its aim is to gain a better understanding of print quality and how the interaction among substrate, ink and flexographic printing press affects quality. It is very important to be able to predict print quality from an unprinted substrate in production control and when working with product improvements.

Focus will be on:
• Liquid absorption uniformity.
How can this be measured in a realistic way with respect to absorption of water-based flexographic inks? What is its impact on print mottle?
• Ink transfer and print density. Are there limitations in using print density as a measure of ink transfer?
• Local variations and point-to-point matching. Variations in the thickness of a coating layer are expected to cause variation in porosity, absorption and white-top mottle. Can this be shown? How does it affect print quality?
• Dot uniformity and half-tone mottle.
Can dot uniformity explain the negative correlation often observed between dot gain and half-tone mottle?

When interpreting the results it could also be beneficial to study ink penetration in cross sections of board. The first task will be to study liquid absorption uniformity and how to measure it.

I have been working with aspects of print quality for eight years at Innventia and earlier at Stora Enso. I am now looking forward to my doctoral studies and the possibility of focusing in depth on predicting the quality of flexographic printing.

Name:	**Sofia Thorman**
Company:	**Innventia**
Supervisors:	**Assoc. Prof. Göran Ström (Innventia)**
	Assoc. Prof. Li Yang (Innventia)
	Professor Magnus Lestelius (KaU)
Examiner:	**Professor Magnus Lestelius (Karlstad University)**
Mentor:	**Assoc. Professor Anita Teleman (Innventia)**

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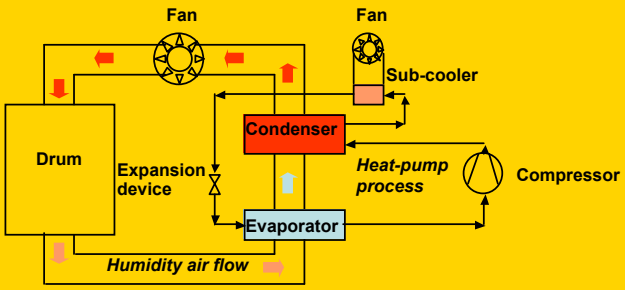
REDUCTION OF THE ENERGY USE IN A TUMBLE DRYER WITH HEAT-PUMP TECHNOLOGY

Drying clothes is a large power consumer in a modern home. The majority of all tumble dryers today are based on old technique. To reduce the power consumption, heat-pump technology can be used, and there are already some heat-pump tumble dryers available on the market. The purpose of this paper is to present two future studies regarding a heat-pump tumble-dryer process.

The first study focuses on the importance of the heat-pump compressor capacity in relation to the power consumption of a complete heat-pump tumble-dryer process with refrigerant 134a.

A heat-pump tumble-dryer includes two processes: humidity air flow and the heat-pump process. The two processes will be modelled separately in an Engineering Equation Solver (EES), and also in combination to study a complete heat-pump tumble-drying process. The model will be validated against a lab setup. Important parameters to consider will be Specific Moisture Extraction Rate (SMER) of the complete heat-pump tumble-drying process, Coefficient Of Performance (COP) of the heat-pump process.

The second study will investigate the possibility to reduce the impact on the environment with other types of refrigerants. The model and the lab setup from the first study will be used to study R134a and two more refrigerants where at least one should be natural. Important parameters to consider would be SMER of the complete heat-pump tumble-drying process, COP of the heat-pump process and Total Equivalent Warming Impact (TEWI).



Name:	**Peder Bengtsson**
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Supervisor at Asko:	**Anders Sahlen**
Supervisor at KAU:	**Jonas Berghel, Associate Professor**

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