VIPP VALUES CREATED IN
FIBRE-BASED PROCESSES
AND PRODUCTS

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HOW RENEWABLE RAW MATERIAL CAN BE INCREASED IN THE COATING PROCESS

Asif Javed, PhD student in the industrial graduate school VIPP (value creation in fibre-based processes and products) at Karlstad University, has studied how the portion of renewable raw material, in this case starch, can be increased, in his Licentiate thesis, titled ”Effects of Plasticizing and Crosslinking on the Mechanical and Barrier properties of Coatings based on blends of Starch and Poly(vinyl alcohol).”

Asif Javed presented his licentiate thesis on December 17, 2015.

Starch has many advantages. It is renewable and it is a cheap product. In the study, starch was blended with poly(vinyl alcohol), which is a decomposable synthetic polymer. The result is a system that is completely decomposable.

– We have seen that through blends of starch and polyvinyl alcohol, a renewable raw material can make up 70 per cent of the blend and in principle have the same good properties as with 100 per cent synthetic polymer, says Asif Javed. We have also found that there is an enrichment of poly(vinyl alcohol) on the coating that opens to further surface modifications, such as making the paper or packaging extremely water resistant, i.e. super hydrophobic.

The choice of system can be seen as a model system, indicating the possibility to obtain the same good properties with a largely renewable system as that of a hundred per cent synthetic system.

Table data of mechanical properties
The study investigated three different plasticizers, one of which was citric acid. Citric acid differs from many other plasticizers by the ability to cross-link the system, i.e. create new chemical bonds, which can make the surface more water resistant. Positive effects on the barrier properties at high humidity have been seen earlier. What is new is that the mechanical properties have been studied. With the help of tensile tests and by analysing modules showing stiffness, the project has yielded interesting data for different types of plasticizers.

– There has been a lack of published table data on the mechanical properties of coatings, says Asif Javed. Many who work with plasticizers have settled for looking at changes in the glass transition temperature, which is not really as significant as how much the material can be deformed before there is a fracture. We have seen that there are differences in the barrier properties between the plane layers that are normally studied in the lab and those which have undergone a PE extruder machine.

In some cases, the increased stiffness of the crosslinking can lead to the material becoming sensitive to deformation during the conversion process compared with alternative plasticizers. Defects can arise, which reduces the barrier effect against diffusion.

Little cost for industry to go over to renewable coating
– There is a great interest in using renewable raw material in the industry but many have focused on materials research, says, Lars Järnström, professor of Chemical Engineering and head of the industrial graduate school VIPP. Materials research must go together with process research and this is unique to Karlstad University. We pursue process-related research concurrently, which can indicate the potentials of applying it to a quick paper web to get perfect barriers without defects.

Lars Järnström thinks that defects were common earlier since the process engineering knowledge was missing. But now research has advanced further. According to Lars Järnström, the industry could change now and start using more renewable systems in their coatings.

– They already have the machines but to make it work, the premises need to be slightly converted. Today, the backsides of all packaging are coated to avoid curling, often with starch or polyvinyl alcohol and then ca. 0.5 gram/m^2 is used. If they were to use 2 gram/m^2, they would get a good barrier with a blade coating process. Contrary to what many believe, barrier properties become better from thin rather than thick coatings. This means saving on the raw material but also starch, not to mention drying energy consumption. There are many advantages of a good application technique.

Asif Javed will now, for his doctoral thesis and in conjunction with Innventia AB, study cracks in the conversion stages of creasing and folding. The result will hopefully be presented at the TAPPI Advanced Coating Symposium in October this year.

Link to the Licentiate thesis: http://urn.kb.se/resolve?urn=urn:nbn:se:kau:diva-38337

BILLERUDKORSNÄS

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VIPP IS GROWING

The Knowledge Foundation (KK-stiftelsen) has granted VIPP funding for two additional licentiate students.

– We are really glad that two more students can join VIPP, says Lars Järnström, Program Director of the Industrial Graduate School. The network established here between doctoral students, business and the academy is a good platform for a future in the industry.

VIPP is funding the new licentiate positions through reallocating funds that became available after three students completed their licentiate degrees and chose not to continue with their doctorates.

Simon Lundevall has been appointed as one of the new licentiate students. Simon, who works as quality manager at Härjeåns Energi AB, will be investigating how the productivity of a biofuel dryer may be improved.

– I haven't really started the project yet, but I'm looking forward to combining my job with a research education. It'll be really interesting, says Simon Lundevall.

Anders Wiklund, director of Härjeåns Energi AB, welcomes this type of collaboration between industry and academy where the project is run and financed by both parties.

– Already at the start of Helena's project on increased availability and reduced energy consumption of the dryer during wood pellet production, we noticed that there is a much larger area that could be explored. When we were asked about another licentiate student it seemed appropriate to focus on the chemical component of the project.

Still one open position
The other licentiate student has not yet been appointed; at the moment we are talking to different companies and a decision is expected soon.

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VIPP AT TAPPI'S ADVANCED COATING SYMPOSIUM

TAPPI's Advanced Coating Symposium will be held on October 4-6 in Stockholm at the Innventia headquarters. TAPPI is offering a forum for researchers and coating technologists to present their findings concerning coating fundamentals and leading edge developments relating to paper surface treatment, printing operations & functional coatings. VIPP will be represented by doctoral students Åsa Nyflött and Asif Javed who will present their research.

Lars Järnström, Program Director of VIPP, is chair of the technical program at the Symposium. He is looking forward to the event, which he believes has an important position in the industry.

– The Symposium ought to be at the cutting edge of research and shall deal with the techniques and material of tomorrow, Lars Järnström says.

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PHD STUDENTS AND RESULTS

Christer Gustavsson is a postgraduate researcher at Pöyry, in Karlstad. His project focus on added value from biomass by broader utilization of fuels and CHP plants.

What are the results from your research?
In my research project I have until now modelled and analyzed four different novel production cases integrated with conventional Combined Heat and Power (CHP), namely (i) Pyrolysis liquid (ii) Energy gas (iii) Betulin and (iv)Transportation fuel. For the different cases the potential production capacity, efficiency and implications for power production have been analyzed. Each case has been presented in a scientific paper.

The results show that significant production capacity can be achieved and that there is a technical potential to broaden the production at the CHP plants. Obtainable efficiencies for production of pyrolysis liquids, energy gas and transportation fuels are generally higher than what can be achieved in stand-alone plants. A broadened production integrated in existing CHP plants could potentially enable cost efficient, distributed production of chemicals, fuels and other energy carriers. If such broad implementation takes place, this can significantly contribute to a transition towards a bio-based transportation system in countries with many FB Boilers in district heating and forest industry, e.g. Sweden, Finland, Denmark, and Austria,

What is the next step in your project?
In my last paper I will examine the perceived values, drivers and constraints for a broader utilization of combined heat and power plants in Sweden as well as the actors' interest and capacity to overcome identified barriers. This article is planned to be submitted for publication before the vacation period.

The planned title for my thesis is "Added value from biomass by broader utilization of fuels and CHP plants. Date for my dissertation is December 8, 2016.

Aron Tysén is a postgraduate researcher at Innventia, in Stockholm. His project focus on through air drying, a process used in the production of tissue paper.

What are the results from your research?
What we found most interesting during the first half of my PhD project, was the different nature of drying as we decreased grammage. It appeared as if the low grammage sheets dried equally fast regardless of the air volume streaming through them. This implies that not all energy put into the air by heating it, is used for evaporation. Heating the air is a major part of the cost in the through air drying process, so significant savings could be achieved if the air volume is reduced.

What is the next step in your project?
We have considered the function of the heated air in the drying process. It is used to supply energy to the evaporation of water, and to transport said water from the sheet. Our current idea is to decouple these functions. Large volumes of air could be needed for transport of water, but not all energy in that heated air is used up in evaporation. If the energy could be supplied in a different way, for instance by infrared heating, less energy would be wasted, since the air does not need to be heated.

More PhD Students and Results

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Caroline Wilke is a postgraduate researcher at BTG Instruments in Säffle. Her project focus on the importance of dissolved lignin in pulp slurries.

What are the results from your research?
My project is about the importance of dissolved lignin in pulp slurries. Presently, pulp mills have seen this as a minor disturbance but my research has shown that dissolved lignin in the filtrate affects the pulping processes more than anticipated.
The research has shown that dissolved lignin in the filtrate consumes as much chlorine dioxide in the first bleaching stage as the lignin bound to the fibers do. This new information enables mills to optimize the chemical charge by measuring the dissolved lignin with a new sensor. This study was carried out on softwood pulp.

What is the next step in your project?
The impact of dissolved lignin in the oxygen delignification stage is currently being investigated. Unoxidized and oxidized dissolved lignin are compared and the effect they have on fiber delignification is also being investigated. Further studies with chlorine dioxide bleaching will also be carried out where hardwood pulps are investigated. Further studies of filtrates will be conducted and compared to mill data to determine the impact of dissolved lignin.

Raghu Deshpande is a postgraduate researcher at Domsjö and MoRe Research AB. His work incorporates knowledge on softwood dissolving pulp production using sulfite pulping technology.

What are the results from your research?
In our project we were able to investigate the reaction kinetic for different softwoods during bisulfite pulping at different cooking time and temperature. The influence of pH during sulfite cooking and its impact on lignin removal and carbohydrate fraction was determined. The results were interesting and we calculated the activation energies for different wood components. Some new findings were obtained with respect to activation energies of certain carbohydrate fractions like glucomannan and xylan; which is useful information when producing pulps of different compositions. This new knowledge can be used to control the retention and removal of certain carbohydrate fraction when producing either a paper grade or dissolving grade pulp. The side reactions investigation using different types of cooking liquor at different cooking time and temperature was carried out and the results obtained will help the sulfite industries in selecting the right types of cooking liquor to avoid process upsets.

What is the next step in your project?
Certain resinous softwood species cannot be easily pulped under acidic sulfite cooking conditions because of phenolic resin content and the investigation of reaction kinetics for such wood species will be carried out in our future work. The lignin-carbohydrate linkages in resinous wood and their behavior at different cooking conditions will be explored in our project. The result from our study will help the sulfite industries to understand the different reaction mechanism during acidic sulfite cooking conditions and choose best cooking conditions for improved process operation in the pulp mill. The best cooking conditions for avoiding lignin condensation reactions and black cook when using resinous raw wood materials will be investigated in our next studies.

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