CLUSTER RESEARCH PROGRAMME 2012-2014

Short version 2013

INNVENTIA

The Innventia Cluster Research Programme 2012 - 2014

The Cluster Research Programme 2012 – 2014, CRP2012 in short, comprises 13 project clusters. The *Clusters* are based on promising ideas, matching the industrial needs and interest expressed in discussions with our *Partner Customers* (see definition below) both individually and in the on-going Cluster Research Programme. They are presented in an approximate value chain order starting from wood and fibres.

The basic idea is that the clusters are pre-competitive but can lead to or include concept demonstrators in the form of mill-trials, products, materials, chemicals, etc. Implementation, products, etc, will be done outside the Cluster Research Programme.

Innventia is also aware of the trend towards more bilateral projects but still think there are great opportunities for our industry with our renewable raw material to improve competitiveness and gain market shares from e.g. other fossil-based packaging materials. By working together in pre-competitive projects we get leverage by joining forces and better success in public funding. During the feed-back meetings we have also felt that the Partners agree on this as long as the research areas are chosen carefully.

About the Cluster Research Programme

The *Cluster Research Programme* comprises several thematic clusters of projects, each cluster addressing problems of great interest to a consortium of Innventia customers. Such a cluster normally operates over several years.

Some important characteristics for a *Cluster* are that they:

- consist of several projects with a common theme
- carry out application-oriented research, thereby developing new knowledge or new combinations of knowledge to be used for new technical solutions and applications
- give results and knowledge that can be developed further to industrial reality together with customers through client projects

Definition of Partner Customer and Invitee

The short definition of *Partner Customer* is a customer that has signed a 3 year or longer agreement to invest in the Cluster Research Programme at Innventia at a minimum level based on the Company's Annual turnover. In short *Partner* is used. At 2013 the following *Partners* have an agreement:

Andritz Papermachine division, BillerudKorsnäs, Evergreen Packaging, Holmen, Mercer Pulp, Mondi Uncoated Fine & Kraft Paper, Stora Enso, Södra, and Tetra Pak.

There are also a number of *Invitees* which participate in one or a few clusters on a 3 year agreement. They are involved in the process to develop new clusters in the area where they are participating. The Invitees are:

Borregaard, Celbi, De la Rue, Eka Chemicals, Fibria, Hansol Paper, Hayat, ITC, Kemira, Klabin, Metsä Board, Metsä Fibre, SCA, SmurfitKappa, UPM and WEPA.

Intellectual Property Rights

In order to increase the possibilities for our customers to turn the research results into business, the Innventia Board of Directors has aligned our patent policy to meet this objective. This alignment affects the Cluster Research Programme and the agreements have been modified accordingly.

In the new Cluster Research Programme the customers will have direct access to the invention disclosures relevant to each cluster and they will have the opportunity to a direct ownership in each patent application. This will enable a better utilization of the knowledge in writing patent applications and other decisions related to patenting. The objective is to give the companies participating in each cluster the best possible patent protection. Further information regarding the Patent policy is published on our web http://www.innventia.com/en/Our-Ways-of-Working/The-Cluster-Research-Programme/IPR/ and a revised model Cluster agreement have been developed.

Innventia, December 2013

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Summary

Innventia´s customers represent producers of pulp, paper for print, paper and board for packaging, energy, materials, packaging and print companies, and suppliers of machine equipment and chemicals, i.e. companies active along the value chains of the forest-based industrial sector.

The common base for the customers to join the Cluster Research Programme is access to world-class application-oriented research and the simultaneous efficient scanning of ongoing research all over the world. This is what the research yields as a by-product and it also emanates from the scientific networks in which Innventia is active. At the same time the customers enjoy a considerable leverage on their research investments by working together with other partners and public research funding agencies in the programme.

The size and needs of the customers vary. Some of the customers have separate R&D facilities of their own. Others give the responsibility for process and product development directly to the mills. Thus, the requirements for R&D support from Innventia vary and the form for delivery of the results will therefore be adjusted to the specific conditions of each customers.

Our business concept is to produce and refine research findings and ideas based on forest raw materials, for the benefit of customers throughout the entire value chain. We call this approach *Boosting Business with Science.*

The summaries below will hopefully indicate interest for the reader to take further contact with us for more information to evaluate the benefits for his or her company’s to join the programme for support of their own long term “productivity and profitability”.

Overview

The following table indicates some important areas covered in the Clusters. The areas are: *Energy savings, Raw material savings, Production efficiency/Runnability, New bio-based products*, and *Added market value*. It is only indicative and parts of the areas can be found in other clusters.

Tentative project matrix

Cluster	*Energy savings*	*Raw material savings*	*Production efficiency/ Runnability*	*New bio-based products*	*Added market value*
The kraft pulp fibre line		X	X		X
Chemical and energy recovery in the kraft pulp mill	X		X		
Biorefinery processes and products			X	X	X
Fibre, stock and product optimisation	X	X	X		X
Nanocellulose process	X		X	X	
Optimized production by advanced paper chemistry	X	X	X		
Process efficiency and variability in papermaking	X	X	X		X
Paper mechanics for improved quality			X		
Improved convertability of paperboard			X		
New wood fibre-based materials				X	
Bio-based barriers for packaging materials				X	
Tools to predict flexographic print quality for packaging			X		X
Tissue 2013-2014		X	X		X

Cluster summaries

The kraft pulp fibre line

The kraft pulping processes need constant refinement to stay competitive: improvement of the fibre properties and production efficiency of the kraft pulp mill both yield increased utilisation of the natural resources used in the given process. Thus, research performed within the area of chemical pulping should be driven by these areas.

Combining both improved properties for traditional pulp fibres and the current process along with the development of pulping strategies for new products, an improved version of the pulping fibre line is possible to obtain. This future fibre line involves the implementation of the correct pulping, bleaching and separation technology in order to secure a continued and increased profitability of the kraft pulping process. This is the main content within the proposed cluster, which is applicable for every kraft pulp mill, as the raw material and the employed process technology are very similar throughout the world.

Contact persons at Innventia

Lennart Salmén, Peter Axegård

Chemical and energy recovery in the kraft pulp mill

Energy efficiency is a major concern for kraft pulp mills and could be improved by an improved management of non-process elements, (NPE). Several examples exist: decreasing the scale formation in heat exchangers improve the heat transfer coefficients; decreasing scaling tendencies in process equipment decreases the need for heating after shut downs; decreased amount of deadload in lime cycle decrease the fuel consumption of the kiln while decreased levels of NPE in the black liquor improves the capability to produce electricity.

The basic idea is to gather, describe and propose solutions to well-known process disturbances induced by NPE in the recovery area and fibre line of the kraft pulp mill.

Contact persons at Innventia

Niklas Berglin, Åsa Samuelsson, Peter Axegård

Biorefinery processes and products

Rising wood and energy costs makes it increasingly urgent for the forest-based industry to find by-product uses with higher market value than the fuel value. This is also reflected in the quickly growing involvement by forest industry companies in biorefinery activities the last few years. Separation of lignin from black liquor does not only give a by-product with great potential, but is at the same time a possibility to cost-efficiently increase the pulp production when the recovery boiler is a bottleneck.

Pulp mills have unique prerequisites to make large volumes of value-added bio-based materials and chemicals that can substitute petroleum-based products – in parallel with the fibre production.

Contact persons at Innventia

Birgit Backlund, Peter Axegård

Fibre, stock and product optimisation

The fibre raw material and the energy required for its treatment are a very large share of the total cost of paper and board manufacturing and have often a strong influence on the product properties. For competitive papermaking, well-designed sheet structures of fibres with suitable properties have to be combined with efficient processing of fibres proper for the purpose. It is fair to say that the paper and board producing technology has come to a point where a further decrease in grammage at maintained or even improved product properties is difficult to achieve. A holistic perspective should be applied from paper products to wood raw materials, optionally also the trees planted.

Traditionally the stock treatment processes focus on the use of the entire pulp, or choosing a different fibre raw material. Instead, the focus should be shifted towards using and/or optimizing the components of a given stock e.g. fines, long fibers, short fibres, earlywood and/or latewood fibres. These components have largely varying properties and roles in the pulp, and certain product properties could be selectively controlled without influencing the remaining properties if this aspect is taken into consideration.

Opportunities are identified to decrease costs at the right product properties or to reach new properties defending a higher price. The way is better use of fibres and extended use of lower cost materials (pulps, fillers, etc.). The activities are also focused on stock composition control, optimization of stock preparation systems and extending property and process relationships.

Contact persons at Innventia

Elisabeth Björk, Hannes Vomhoff, Sven-Olof Lundqvist, Thomas Grahn

Nanocellulose process

Due to the high potential of nanocellulose in e.g. paper applications, there is a desire to make the nanocellulose process economically viable. Innventia’s laboratory scale processes have been shown to be very energy efficient and the processes have been upscaled in Innventia’s new nanocellulose pilot factory. However, there are several remaining challenges to be addressed like optimisation of the pre-treatment processes. The pilot will be utilized to further optimize the process including combinations of new process solutions.

Another important need is to be able to get high consistency nanocellulose in applications where dewatering is especially important. In for instance coatings for

barriers, there is a need to be able to coat paper with nanocellulose at a high concentration in order to reduce the need to evaporate water. Finally, there is a need to be able to produce nanocellulose films in larger scale.

Contact persons at Innventia

Eva Ålander, Tom Lindström

Optimized production by advanced paper chemistry

In order to increase the profit, paper and board producers strive to lower their raw material costs. Independent of quality, papermakers have to compromise between retention, formation, strength and dewatering. A fine paper producer might want to increase the filler content to decrease the use of the more expensive fibres or the board producer might want to use bulking fibres. In order to do so the retention has to be improved, which requires increased use of retention aids, which deteriorates the formation. The poor formation can be improved by formation aids, but these often deteriorate dewatering and the strength of the paper. The strength is also deteriorated by the increased filler content.

There is a need for new approaches that can decouple the retention/formation/ strength/dewatering relationships for a more cost-efficient paper production and a number of approaches will be utilized.

Contact persons at Innventia

Ida Östlund, Tom Lindström, Göran Ström

Process efficiency and variability in papermaking

In order to remain competitive with respect to energy and material consumption, the paper and board manufacturers need to continuously improve the efficiency of the production process and reduce the heterogeneity of the product.

Material utilization can be made more efficient by achieving the same product properties with less pulp. The potential for raw material savings can be in the range 10%. However, the uniformity in material/property distribution has to be improved, for example by better mixing of the stock components and additives, and a more even distribution of material in the product, both at small and large scale. A reduction of the overall energy utilization can be achieved by producing the same function with fewer fibres. Furthermore, dewatering processes can be more efficient, above all by reducing the share of the energy-intensive drying process by a larger share of mechanical dewatering, both in the wire and press sections. Furthermore, a reduction in the non-uniformity of dewatering implies both large energy savings and an improvement in the product uniformity.

Available know-how at Innventia on process efficiency and sheet structure variation will be applied to concrete cases in paper mills.

Contact persons at Innventia

Paul Krochak, Daniel Söderberg, Hannes Vomhoff

Paper mechanics for improved quality

Knowledge of the mechanical behaviour of paper materials constitutes a basis for ensuring that the paper exhibits runnability in production and converting operations and are capable of fulfilling end-use requirements. This knowledge relies on the availability of relevant, robust and reliable material test methods. Traditionally, quasi-static uniaxial testing at standard laboratory climate is used for material testing of paper materials. However, paper materials seldom encounter such ideal loading conditions in reality. Instead, they are generally subjected to e.g. multiaxial loading, different or varying climates, different strain rate and/or loading under extended time periods. There are severe gaps in the knowledge regarding demands on functional properties of paper materials as well as strategies for controlling these properties in papermaking.

The cluster has the following aims: Provide relevant, robust, and reliable test methods. Identify mechanisms behind different types of paper behaviours. Clarify how furnish, papermaking strategy and chemical additives relate to paper properties. Define strategies to control and design paper properties.

Contact persons at Innventia

Mikael Nygårds

Improved convertability of paperboard

Converting of paperboard into packages involves creasing and folding operations. The aim of the creasing operation is to damage the paperboard in a controlled pre-defined pattern. The obtained delaminations reduce the bending stiffness of the board, providing a hinge that localises the deformation of the material in the subsequent folding operation. Furthermore, the delaminations redistribute the stresses during the folding operation compared to the uncreased board, so that the loading of the surface layers is reduced and become less likely to cause surface cracking.

The aim is to increase productivity, reduce customer complaints, and reduce waste caused by damaged packages by e.g. providing experimental methods for study of creasing and folding, developing generally applicable methods to assess convertability. Allowing optimisation in creasing and folding as well as avoidance of twist, curl, and delamination problems in printing.

Contact persons at Innventia

Johan Alfthan, Mikael Nygårds

New wood fibre-based materials

The margins for papers used in large-volume products such as newspaper and catalogues are quickly diminishing. At the same time, the sustainability debate has

increased the pressure on finding products made from materials based on renewable resources. This is a significant opportunity for the pulp and paper industry looking for new applications when it comes to wood fibres.

The biorefinery concept and recent process developments in wood fibre composites have provided new tools for extending the property space of a material beyond what has been possible before, e.g. improved processability of materials, 3D-formability, perceived material identity, barrier properties.

Our aim is to develop new wood fibre-based materials and show their potential in concept demonstrators.

Contact persons at Innventia

Fredrik Berthold, Hjalmar Granberg, Helena Halonen

Bio-based barriers for packaging materials

Many barriers in packaging materials are today made from petroleum-based raw materials, but the interest in renewable raw materials is rapidly growing. Almost all fibre-based packages require some kind of barrier, be it against fluids, vapours or gases. The end use of the package, and also the processing possibilities, determine the requirements put on this barrier or the barrier layers. With a growing interest in bio-based barriers, a deeper understanding of how and why they function and what requirements they should withstand is needed. Also important are legislation issues regarding these new materials, especially when dealing with food packaging materials.

The aim is to improve fibre-based packaging materials with bio-based barrier materials. By finding concept applications, defining process and product requirements, a base from which new barrier materials can be developed has been found. Concept demonstrators will be developed based on partners' requirements.

Contact persons at Innventia

Mikael Gällstedt, Olof Dahlman, Therese Johansson

Tools to predict flexographic print quality for packaging

The major driving forces for packaging printing are higher printing speed, better and consistent print quality and less environmental impact. The paper and board producers need powerful tools in-house for production control and to predict print quality. These will also facilitate development of improved quality of the printing surfaces and higher production efficiency. The printers and converters need substrates that behave as expected, to be able to increase their productivity and to produce packages with a uniform appearance, even though they have been printed on different occasions and/or on substrates that have been delivered at different times.

This cluster will work with hypotheses based on our sound expertise and determine the areas to investigate using the state-of-the-art measurement techniques. The focus is on

the use and development of tools that can be used when improving flexographic printability, in terms of high, consistent and predictable print quality.

Contact persons at Innventia

Li Yang, Anita Teleman, Sofia Thorman, Göran Ström

Tissue (2013-2014)

It is important for the pulp, paper and tissue industry to make efficient use of the required resources and to develop efficient production processes to remain competitive. Reducing the grammage with maintained product functionality by changing or modifying the pulp are ways of improving the cost efficiency.

Important product properties for most of the tissue products are strength, softness, and absorbency. When investigating a change or modification of the fibres at lower basis weights, the effect on crucial product properties cannot be sacrificed. For the tissue industry this will require increased knowledge and better understanding on how the product properties change at lower basis weights

Contact persons at Innventia

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