World Pulp & Paper

THE INTERNATIONAL REVIEW FOR THE PULP AND PAPER INDUSTRY

2012

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Clarifier and secondary pulper, GL&V

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REM PRODUCTIONS

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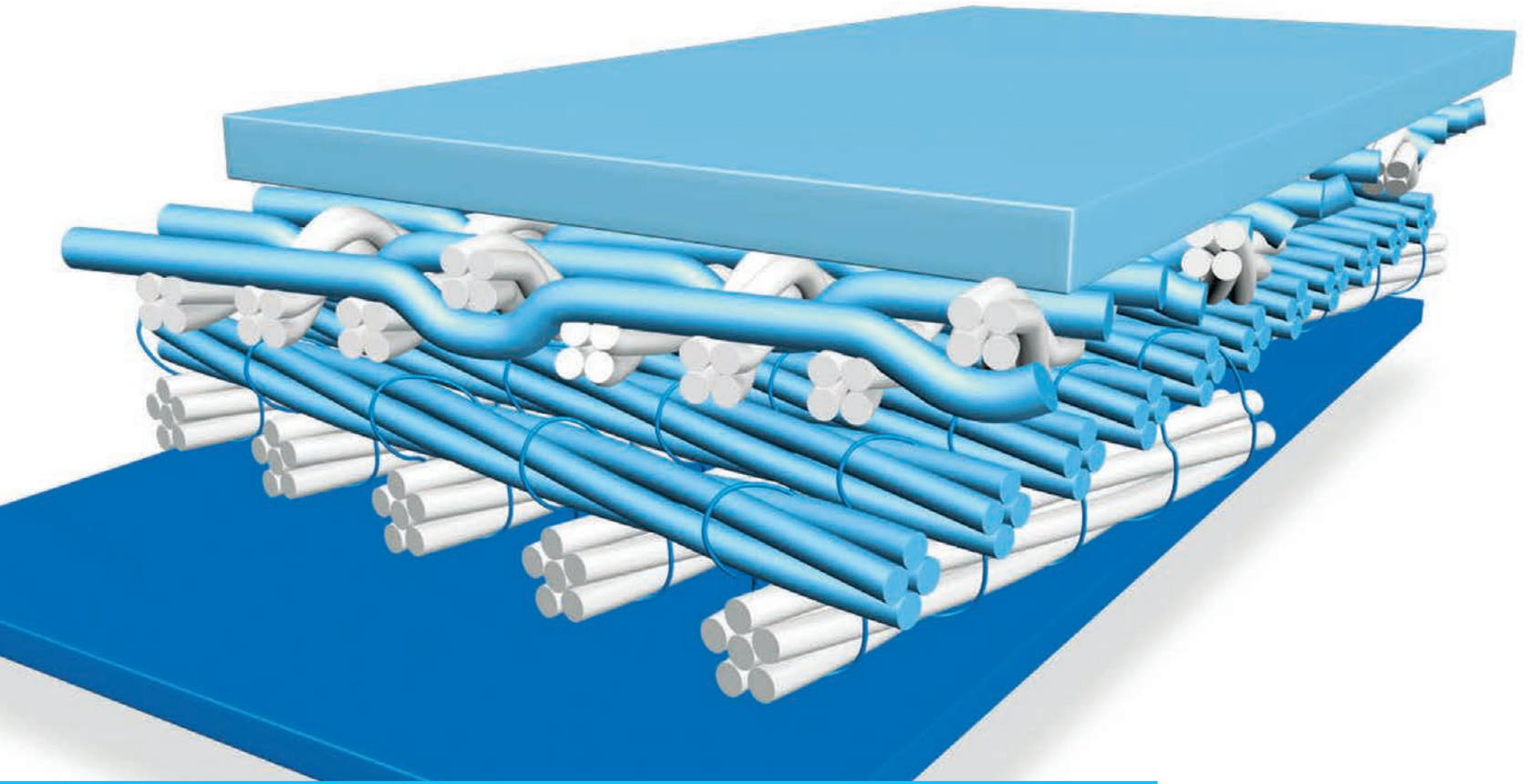
TransRoll stacker crane, Pesmel Oy

PHOTOGRAPH:PESMEL



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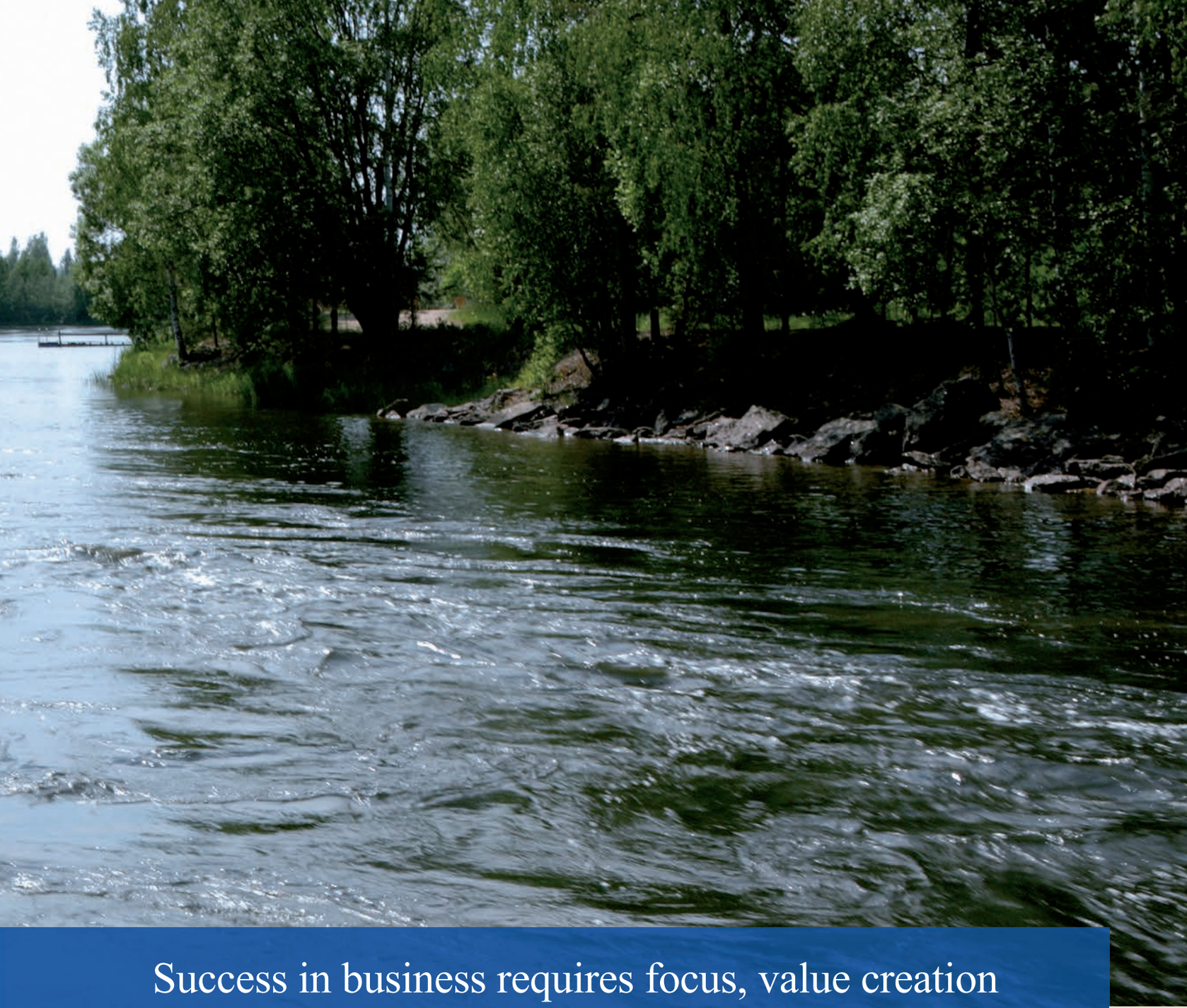

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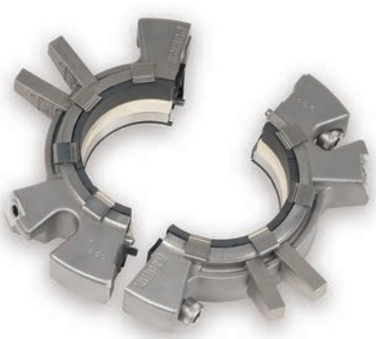

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Welcome to World Pulp & Paper 2012

World Pulp & Paper 2012

As you will see from the excellent articles contained in this fourth edition of World Pulp & Paper, innovation in the international pulp and paper industry continues unabated despite another less than easy year for most.

The tumultuous economic booms of the past few years, in countries like China and India in particular, continue to have an effect on supplier focus, emphasising again the absolute need for industry professionals to stay ahead of the curve.

Although many people have been asking us about it for ages, and the market offers great opportunities of growth, we have been holding back on a dedicated Chinese edition of World Pulp & Paper until we had a really perfect circulation list for the country.

We are delighted to announce that World Pulp & Paper, Chinese Edition, printed in Mandarin, will be published and circulated in August 2012. The circulation will, as for World Pulp & Paper, be provided by Fisher International. The new edition will be presented on our dedicated stand at the China Paper exhibition in Shanghai in September. If you would like more information on this initiative, please contact me directly.

I would like, as always, to thank all those dedicated individuals and companies who have given their time to provide our readers with such interesting and informative editorial content to World Pulp & Paper.

Colin Smith, Publisher

The tumultuous economic booms of the past few years, in countries like China and India in particular, continue to have an effect on supplier focus, emphasising again the absolute need for industry professionals to stay ahead of the curve

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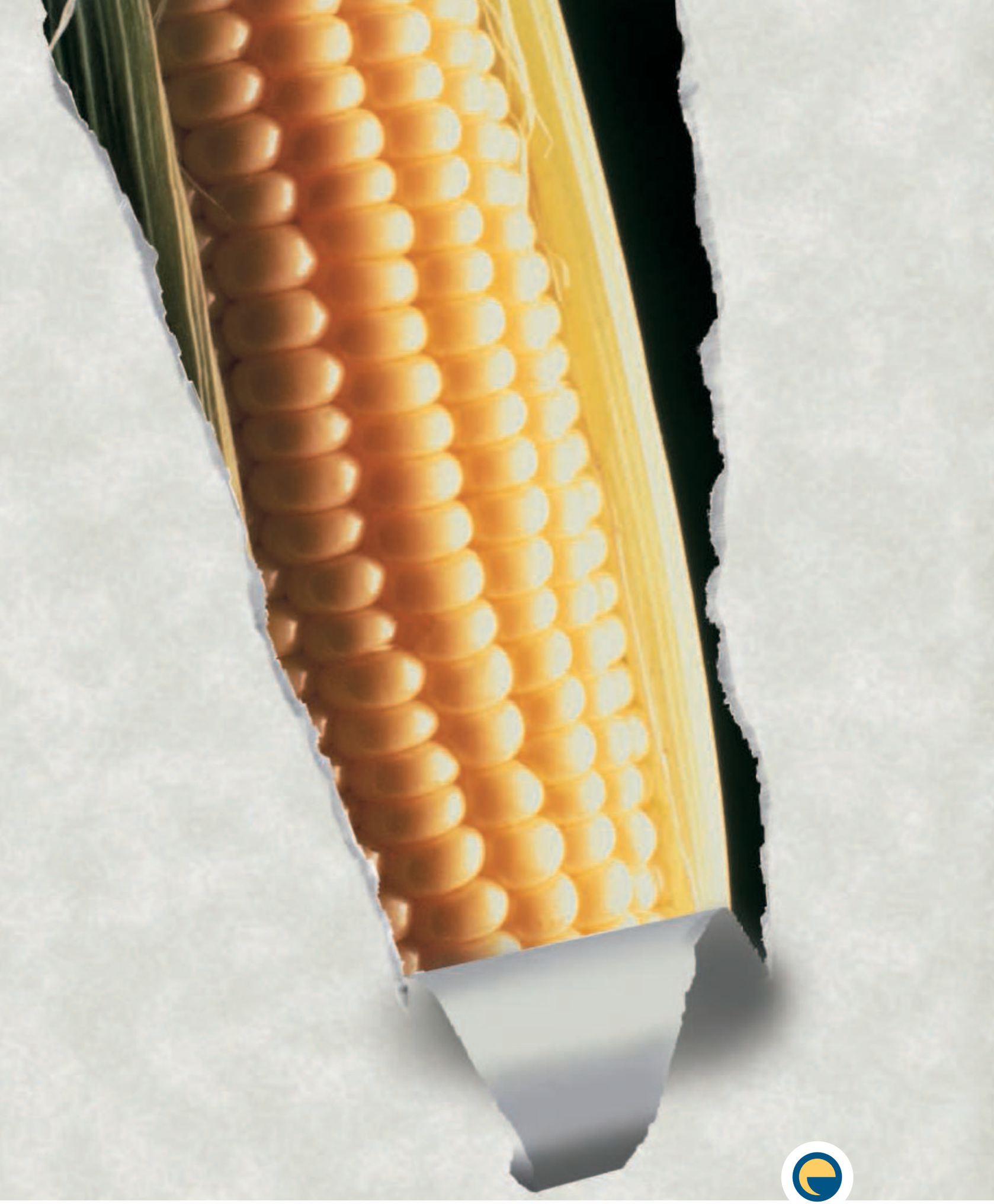

ROQUETTE

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Who owns the paper industry?

By **Rod Fisher**, President, Fisher International, Inc.

In last year's 2011 edition of World Pulp & Paper, we profiled the global paper industry in terms of how much it produces, what it makes, and where its capacity is located. This year, we'll look at who owns the industry's production and what impact patterns of ownership have on the industry. Ownership patterns are important because they influence how the industry and its segments behave and how profitable its participants are. The questions we'll be asking are:

- How global is industry ownership?
- How concentrated is ownership?
- How large are paper companies compared to their suppliers and customers?
- What is the balance between private and public ownership?

To look at the industry's ownership patterns from these different angles requires a comprehensive database with the ability to slice the data in many different ways. Fisher*Solve*™, an analysis tool created by Fisher International to support data-driven decision-making in the pulp and paper industry, provided this capability. Fisher*Solve* contains Fisher International's proprietary database of all mills in the world producing 50+ TPD with details about assets, production, operations, costs, competitive position, economic viability, etc.

Fisher*Solve* is used for strategic planning and tactical implementation by producers and their suppliers, financial investors, and customers in investment strategy, pricing, sales, marketing, product development, capacity planning, investment recovery, procurement, and other disciplines.

Fisher*Solve* is used for strategic planning and tactical implement-ation by producers and their suppliers, financial investors, and customers in investment strategy, pricing, sales, marketing, product development, capacity planning, and other disciplines

Figure 1

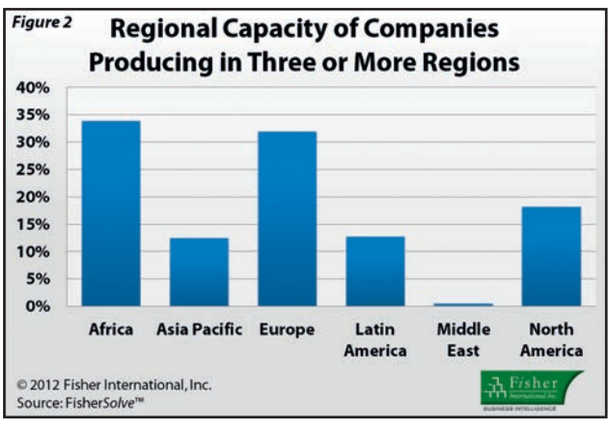


Figure 2

HOW GLOBAL IS INDUSTRY OWNERSHIP?

Are the paper industry's companies regional or global players? Global players tend to bring consistency to product quality, brands, and manufacturing methods. For example, in electronics products, globalisation has nearly completely standardised products such as smart phones and computers. However, in products such as furniture and processed food, which are also consumer goods like electronics, companies tend to be more local. In those products, consumer tastes cause differentiation and there is much less standardisation in products, product quality, and production methods. Where does the paper industry sit on this spectrum?

Most paper companies are essentially regional players. Of the over 1,300 companies in the industry, only 46 produce pulp or paper in more than one region of the world. These companies, however, are mainly large ones so they account for one-quarter of the industry's output. Africa, Europe,

and North America have the largest percentage of their capacities in companies that produce in more than one region. Just over 60% of Africa's capacity, for example, is in companies with papermaking operations outside Africa (Figure 1).

However, even among companies having some exposure to international markets, most have very limited exposure. Only 22 companies in the entire global industry have more than 25% of their papermaking capacity outside their home region and only a couple of companies have a majority of their capacity outside their home region.

In volume terms, less than 6% of the industry's capacity is in mills located outside their owner's home region. Kimberly-Clark may be the most global of the industry's large players with production spread around the world in some relation to each region's economic activity. There are very few other companies that have papermaking operations in each of the four major regional markets (Asia Pacific, Europe, Latin America, and North America). Figures 2 and 3 show how little of the industry's papermaking capacity is in the hands of companies whose production is spread around the world in proportion to regional economic activity.

One impact of predominantly regional ownership in the industry is that there are few global brands. Product standardisation is derived not so much from pulp and paper producers but rather from the suppliers of manufacturing technology. The industry's suppliers are more responsible for any consistency there is in worldwide production than the industry's producers.

Companies such as Andritz, Metso, and Voith – large pulp and paper mill suppliers; Honeywell and ABB – large automation suppliers; as well as the industry's large chemical and mineral suppliers are global in reach and have a major influence on product and manufacturing consistency.

HOW CONCENTRATED IS OWNERSHIP?

Concentration is important because it affects how markets behave. Concentrated markets tend to have supply discipline, adding and removing new capacity as demand changes, more readily than fragmented markets. Once an industry matures, this can be an important determinant of the efficiency with which producers serve their customers. Larger companies that result from concentration typically have the financial strength to invest in efficient new capacity and to close old capacity when needed. For smaller companies, which are typical of fragmented markets, each paper machine can represent a large percentage of the company's revenue making capacity closures a much more painful event. Consequently, supply discipline is more difficult to achieve in fragmented markets.

By extension, it goes without saying that larger companies in concentrated markets also tend to be more profitable than producers in fragmented markets. Larger market shares tend to allow for efficiencies not available to smaller companies. Industry segments with concentrated ownership also can be more difficult to enter as incumbents have relatively greater power.

There are many ways to measure

Figure 3

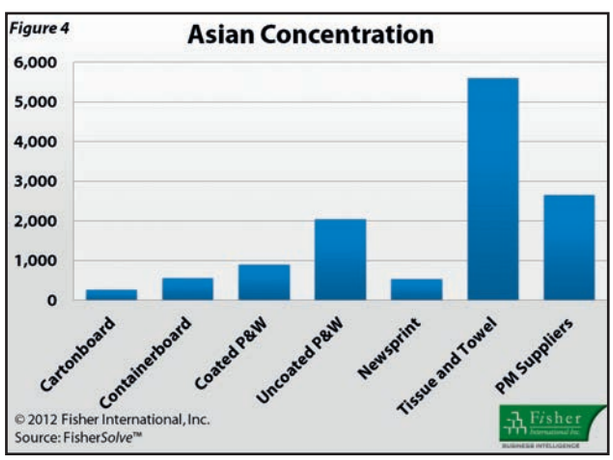


Figure 4 *Asian concentration as measured by consolidation HHI score*

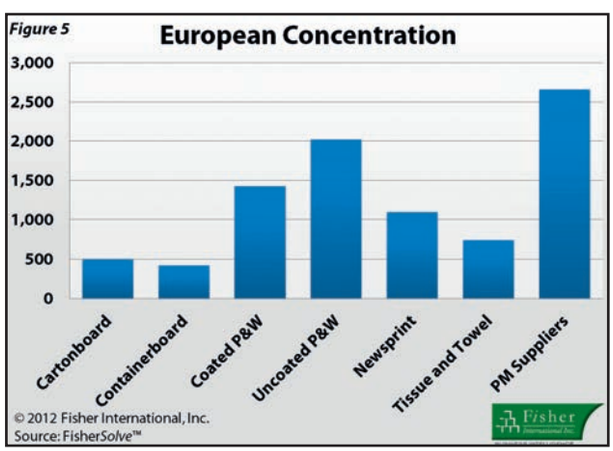


Figure 5 *European concentration as measured by consolidation HHI score*

industry concentration. For the purposes of this article, we'll use the Herfindahl-Hirschman Index (HHI) which is often used by regulators evaluating the likely impact of proposed mergers and acquisitions. HHI measures concentration by considering the market shares of every producer, weighting the larger ones more heavily. The maximum score an industry segment can have – if there is only one player with 100% market share – is 10,000. Regulators often consider an industry with a score of 1,800 to 2,000 to be concentrated enough to cause regulators to take measures to protect against the possibility of anti-competitive behaviour.

In evaluating industry concentration, it is important to choose the regional and grade scopes carefully. In this article, we select paper grades that tend to act as substitutes of each other and group them in geographies which tend to behave as a single region. It is often necessary to evaluate more than one configuration of grades and regions to come to a complete understanding of concentration. For the purposes here, we'll use only one set of definitions.

In the paper industry, there is considerable variation in consolidation across regions and grades. North America has recently achieved a level of concentration not yet equaled anywhere else.

Europe remains a mature, fragmented market. Grade markets in Asia and Latin America, with a couple of exceptions, are fragmented but still growing.

As Figure 4 shows, Asia's Tissue and Towel segment is very highly concentrated. This is due to APP and a handful of other players who own a high share of the region's capacity. Other than Uncoated Papers, the region's industry lacks concentration. This is typical for a market that is growing rapidly. Concentration could be expected to increase in the future after growth slows down.

Europe's industry, with the possible exception of Uncoated Papers, cannot be considered concentrated. Even the region's large companies have relatively small shares of major markets (Figure 5).

Uncoated Papers in Latin America have a reasonably high degree of concentration. Packaging and tissue grades still are fragmented (Figure 6).

In terms of concentration, North America's paper industry has evolved to be different from that of the rest of the world. Nearly every segment approaches a high enough degree of concentration that the dynamics of the segment changes, as described in Figure 7.

North America's paper industry was not always concentrated. For years, the news has carried stories covering M&A activity, trumpeting the consolidation of the paper industry. Using Linerboard as an example (Figure 8), we show how concentration rapidly accelerated only in the last 5 years to the point where true consolidation was achieved. Other segments, such as Uncoated Papers, Coated Papers, Containerboard, and Newsprint have followed similar trajectories in North America. In contrast, Europe's Linerboard concentration is lower today than North America's industry was in 1992.

The North American Linerboard industry has now just reached the level of consolidation comparable to the

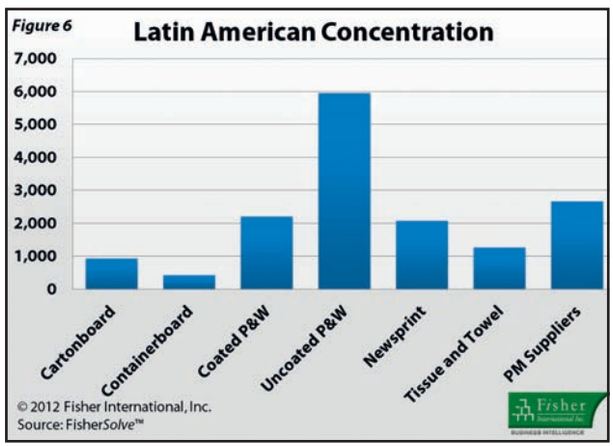


Figure 6 *Latin concentration as measured by consolidation HHI score*

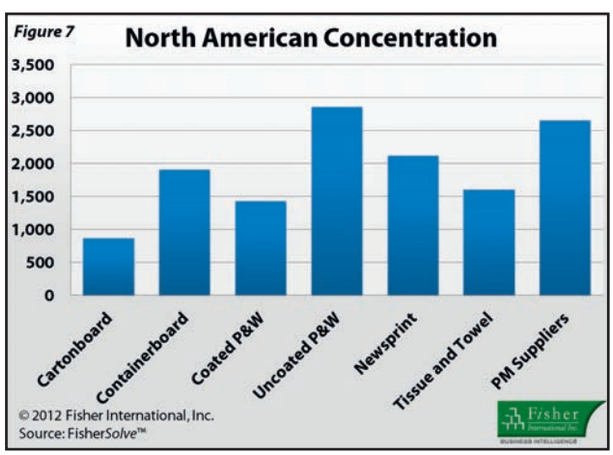


Figure 7 *North American concentration as measured by consolidation HHI score*

Figure 8 *Linerboard concentration as measured by consolidation HHI score*

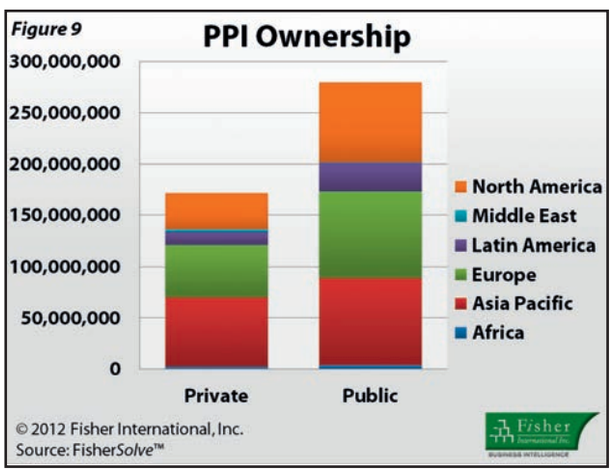


Figure 9 *Privately held vs. publicly traded PPI ownership by region and TPY capacity*

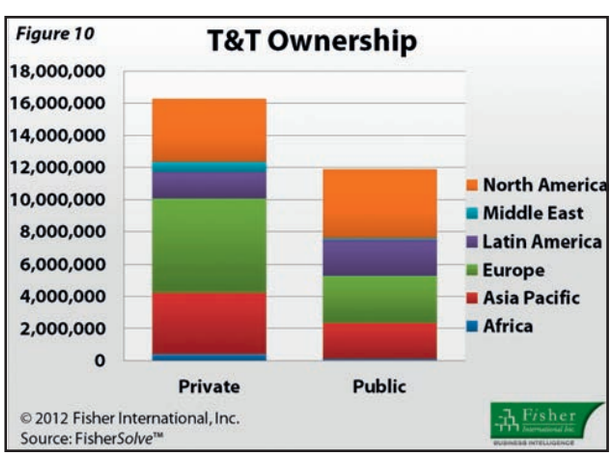


Figure 10 *Privately held vs. publicly traded T&T ownership by region and TPY capacity*

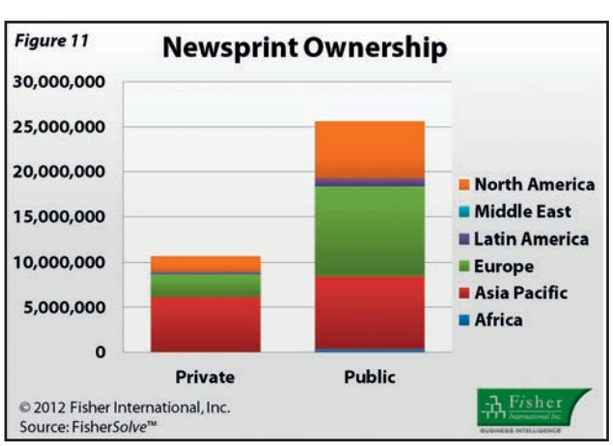


Figure 11 *Privately held vs. publicly traded newsprint ownership by region and TPY capacity*

"The relative size of producers to other players in the supply chain is important because it determines the relative power of buyers and sellers..."

"The relative concentration of suppliers probably gives suppliers additional leverage in procurement negotiations"

supplier of its major equipment (Figure 8). European producers may feel at a disadvantage vis-à-vis the industry's equipment suppliers.

HOW LARGE ARE PAPER COMPANIES COMPARED TO THEIR SUPPLIERS AND CUSTOMERS?

The relative size of producers to other players in the supply chain is important because it determines the relative power of buyers and sellers. All else being equal, relative power in this relationship leads to greater profitability for players in the segment.

Looking back at the concentration charts above, you'll see that the right-hand bar 'PM Suppliers' represents the concentration of companies selling paper machines to the industry. In nearly every case, the paper machine equipment segment is considerably more concentrated than their customer segments (paper producers who buy paper machine).

This also tends to be true for other supplier segments such as automation systems, chemicals, and minerals. The relative concentration of suppliers probably gives suppliers additional leverage in procurement negotiations.

On the customer side, the largest paper companies are often smaller than their largest customers. The printer RR Donnelley, newspaper chains such as Hearst, and packaged goods producers such as Coke, PepsiCo, Kraft, and Nestle are larger in size than the largest paper companies which may give those particular customers at least an advantage in paper procurement.

Of course, there is great variation in the relative size of paper companies and the range of their actual customers.

WHAT IS THE BALANCE BETWEEN PUBLIC AND PRIVATE OWNERSHIP?

The type of ownership – public or private – that dominates in an industry is important because private owners tend to behave differently than the management of public companies. Privately-owned companies may be more nimble than public companies that have more regulatory burdens and reporting requirements. Private owners also may have the ability to invest for longer-term benefits than public companies whose investors tend to focus more closely on quarterly earnings. What types of owners does the paper industry have and how is it changing?

Overall, ownership of the paper industry's capacity is more public than private. However, private ownership has grown recently both as a result of private equity takeovers and growth driven by entrepreneurs in developing countries.

Figure 9 shows that North America has the largest proportion of publicly held ownership and Asia has the least. The Asian industry's rapid growth is today dominated by private companies despite the fact that China's paper industry, until relatively recently, was entirely state-owned.

The Tissue and Towel segment is the only one where private ownership outweighs publicly-held ones. This may be a result of lower amounts of capital required for entry into the tissue industry (Figure 10).

As the charts show, Printing & Writing grades seem to be proportionally more concentrated in publicly-owned companies (Figures 11, 12, and 13) with packaging grades more like the industry average (Figure 14).

With some exceptions, the global paper industry is essentially regional, fragmented, and small compared to its customers and suppliers

CONCLUSIONS

With some exceptions, the global paper industry is essentially regional, fragmented, and small compared to its customers and suppliers. These factors tend to give the industry's suppliers and customers relatively more power in negotiations and give the industry fewer opportunities to achieve efficiencies. Ownership tends to reside in publicly-traded companies that, therefore, may have somewhat less flexibility than if the industry were largely privately-held. While there are many other forces shaping the industry – we may address more of them in future articles in this space – the pattern of ownership in the paper industry partly explains the industry's typically lacklustre financial performance.

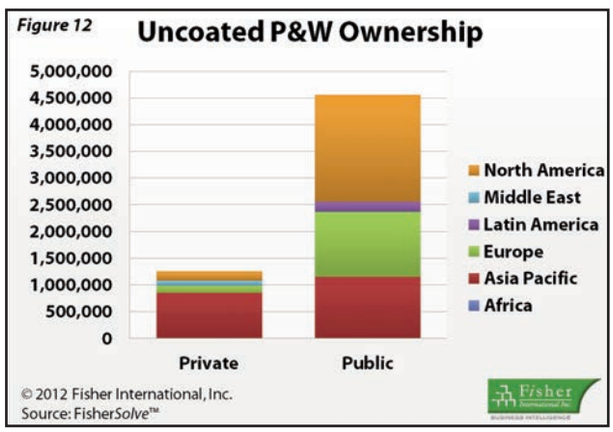


Figure 12 *Privately held vs. publicly traded uncoated P&W ownership by region and TPY capacity*

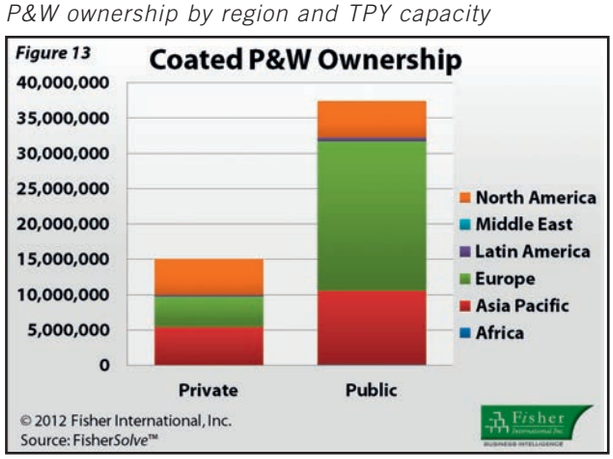


Figure 13 *Privately held vs. publicly traded coated P&W ownership by region and TPY capacity*

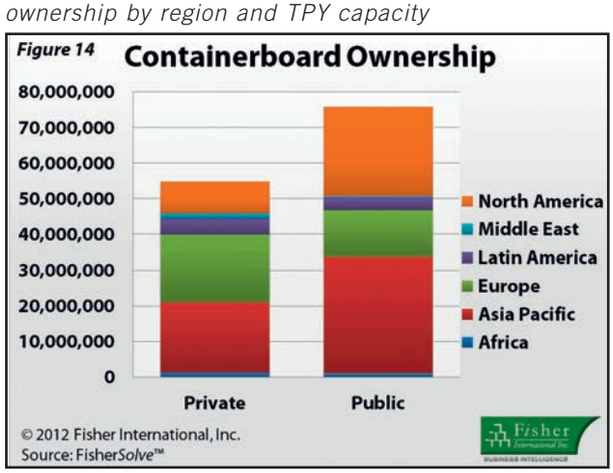
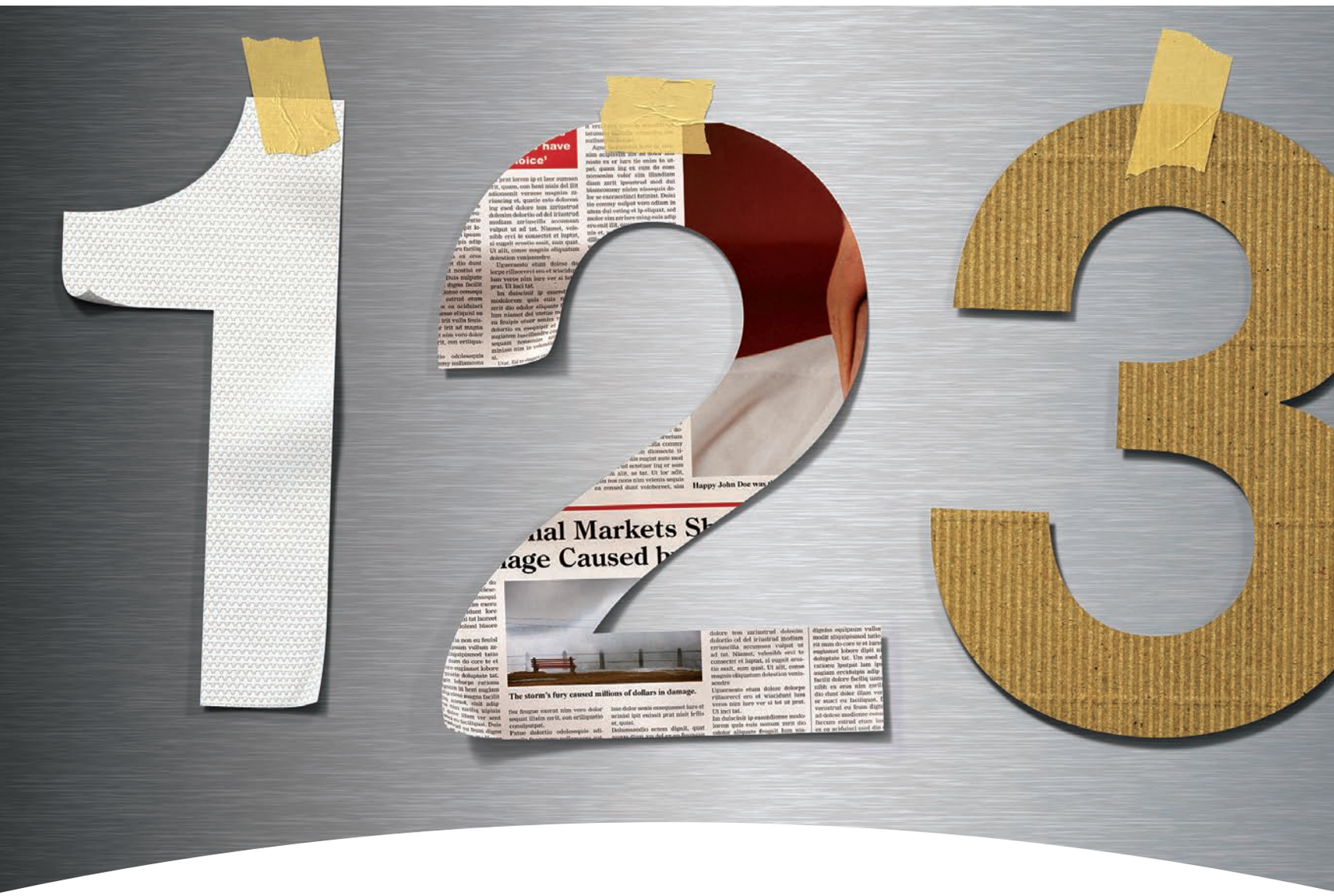


Figure 14 *Privately held vs. publicly traded containerboard ownership by region and TPY capacity*

easy as



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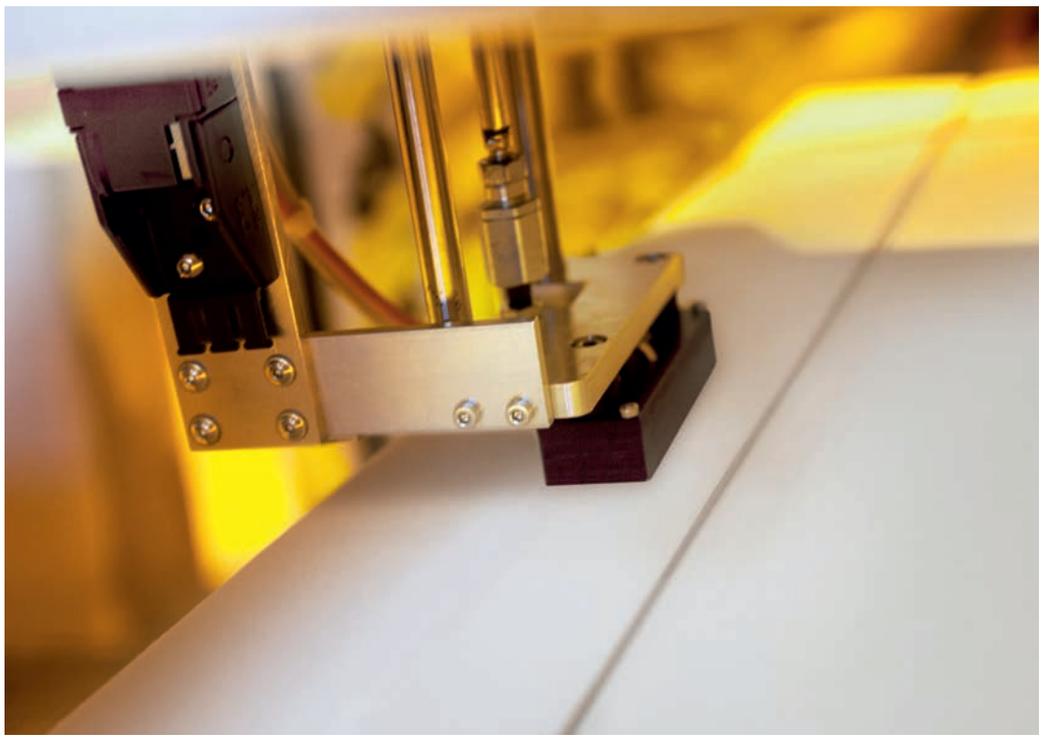
Welcome to a new era

By **Niko Kilkki**, Recommended Finland, on behalf of Metsä Fibre

Pulp industry businesses are vitally dependent on smooth logistics. This is a matter of identifying and tracking the products that leave the mill to make sure that the right pulp is always sent to the right customer at precisely the right time. The industry has been waiting for a new approach that would eliminate the need for visual inspection of pulp unit labels and scanning of bar codes, and the solution to this challenge at Metsä Fibre (formerly known as Botnia) is to adopt RFID or Radio Frequency IDentification technology throughout the supply chain. This new approach is bringing benefits for everyone involved in the supply chain, including logistical partners and Metsä Fibre's customers. RFID speeds up material handling stages and improves the reliability of deliveries. It also helps to minimise human error through automation, and provides continuously updated real-time information on warehouse and raw material levels and on pulp quality.



RFID tags are attached automatically to a predetermined point between the bales inside each pulp unit

HERE'S HOW IT WORKS

An RFID system comprises tags and remote readers, which communicate using radio signals. The tags are coded and attached automatically to a predetermined point between the bales inside each pulp unit that comes off the production lines at the four Metsä Fibre mills in Finland.

One RFID tag is used for each tonne of pulp, meaning that a tag will be placed on both sides of a two-tonne export unit to improve readability.

The tags used at Metsä Fibre apply passive RFID technology. This means that the tag has no built-in power source. Instead, it derives its energy from the signal sent by the reader appliance when this is received by the tag antenna. The tag includes a microchip that retains a record of the type of pulp in the unit and the production batch number.

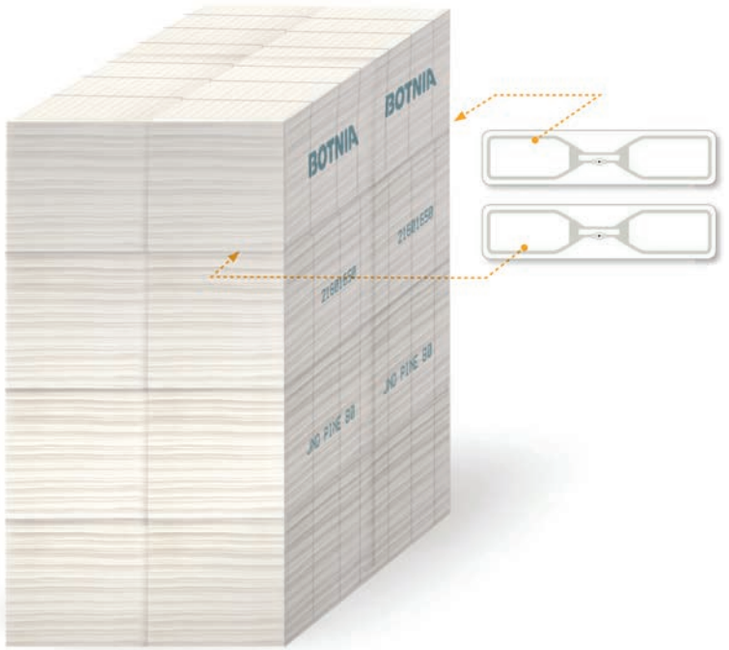
The industry has been waiting for a new approach that would eliminate the need for visual inspection of pulp unit labels and scanning of bar codes

The tags attached to pulp units may be read using portable readers, forklift readers and a variety of gate readers at several points along the journey from the Metsä Fibre mill to the customer. The applicator and reader appliances were supplied and installed by Vilant Systems, Metsä Fibre enterprise partner in the RFID project.

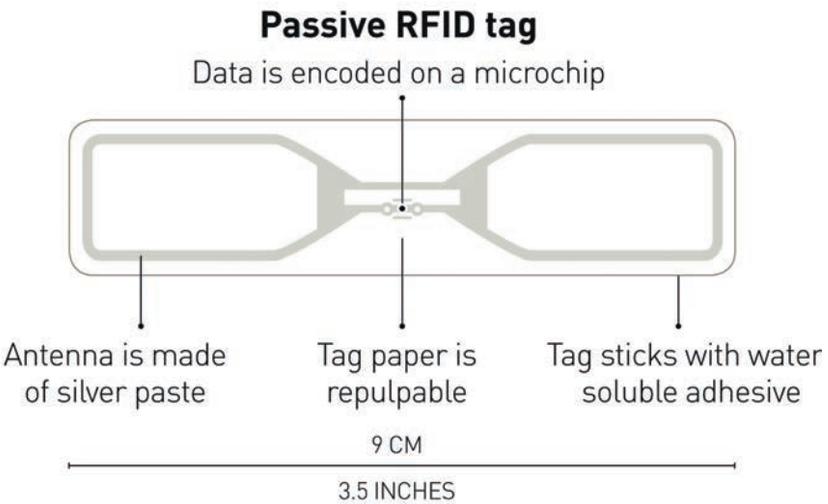
Once each pulp unit has been assigned its own 'identity', it can be recognised at all key points along the supply chain: at the Metsä Fibre mill warehouse, on loading at the harbour, at the discharge port warehouse in Central Europe, and at the customer's paper mill. The electronic tracking information collected by reading RFID tags is saved in the Metsä Fibre reporting system.

THE RFID TAG

- Dimensions: 27 x 92 mm
- Microchip: 0.6 x 0.6 x 0.1 mm
- The tag paper is repulpable (grammage 81.4 g/m^2)
- The antenna is made of silver paste
- The tag is fastened with water-soluble adhesive



Above: RFID tag placement



Above: RFID Tag diagram

CONTROLLING THE ENTIRE LOGISTICS CHAIN

So why did Metsä Fibre invest in such a far-reaching and time-consuming project? RFID brings two kinds of benefit: Better control of the supply chain; and advantages that can be offered to the customer. In fact, RFID will completely revolutionise the way we think about pulp logistics and provide customer service.

An RFID system enables efficient, reliable and highly automated tracking of products as they move around the world.

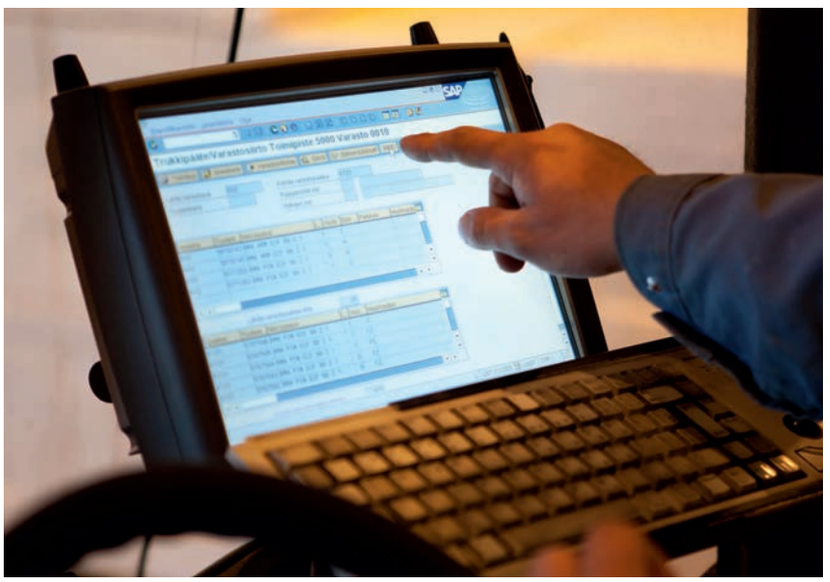
Pulp units are normally counted at ports and warehouses either visually or by scanning individual bar codes. RFID is clearly superior to these methods. Unlike other identification methods, there is no need for a direct line of sight between the reader and the tag, and several units can be identified with a single sweep. As the tag is inside the pulp unit, its exposure to soiling, physical stresses and other external disturbances is minimised.

RFID will finally eliminate delivery errors and unplanned, excessive handling of pulp units. The system will help to optimise warehouse management, improving the efficiency of labour and automating functions that were previously performed manually. For example, the system generates required documentation such as delivery notes and goods invoices, and all tracking information is available in real-time.

A UNIQUE OPPORTUNITY FOR CUSTOMERS

While there is no need for customers to respond with any special measures of their own, the RFID system does give them new opportunities for enhancing warehouse and materials management, and other aspects of their operations. RFID can help the customer to improve production efficiency and

Precise knowledge of the quality obtained from fibre in an identified pulp unit provides a unique opportunity for customers to optimise their own production



Bottom left: Collecting electronic tracking information with a forklift reader
Left: A forklift reader at the Metsä Fibre Rauma mill's warehouse
Below: A portable RFID reader

achieve clear savings of energy and raw materials.

In practice this means that customers can also install RFID hardware at their mill, and the information thereby obtained can be integrated into local operating and production control systems. Metsä Fibre reporting then also enables the inclusion of quality data in the tag information. The electronic trail left by RFID is easily traced all the way back to processes in the pulp mill itself.

Precise knowledge of the quality obtained from fibre in an identified pulp unit provides a unique opportunity for customers to optimise their own production.

We may consider the property of brightness as one example of this. RFID reporting advises the customer that a pulp batch is at the top end of the quality spectrum, meaning that there is no need for standard chemical quantities in bleaching. Or electric power consumption can be reduced by applying lower furnishing efficiency on learning that the latest batch of fibre has good furnishing properties. The solid pulp and paper expertise of Metsä

PHOTOGRAPHS: ALEKSI KOSKINEN

Fibre's technical customer service unit supports such optimisation by type and batch in the customer's processes.

PERFECTING PRODUCT SAFETY

The RFID tags used by Metsä Fibre were specially developed for identifying pulp, but as they are essentially an addition to the pulp unit, a question naturally arises as to how they affect the final product. The RFID tags used by Metsä Fibre have been thoroughly tested by leading research authorities and standardising organisations. Both the Technical Research Centre of Finland (VTT) and the prestigious German accreditation organisation ISEGA have found that RFID-tagged Metsä Fibre pulp is entirely safe as a raw material for manufacturing food packaging. The tags were tested to FDA and BfR standards.

Packaging made from RFID-tagged Metsä Fibre pulp also complies with the HACCP system requirements that guide systematic and preventive self-supervision to ensure the safety of food and pharmaceutical products.

In addition to these third-party tests, Metsä Fibre has also already spent more than half a year working with several customers to study the impact of RFID tags on the paper manufacturing process and on the quality of the end product. The results of this work have been wholly favourable.

It was found that the tags entirely disperse at the pulping stage. In relation to the huge scale of the paper manufacturing process, a single tiny tag in each tonne of pulp was considered a negligible foreign body in the resulting paper or end product. The relative proportions are evident when considering that an RFID tag microchip is the size of a single grain of sand.

The materials technology of RFID is also continually evolving, with the pilot stage of the current Metsä Fibre project using third generation tags. The direction of progress is clear: tags are becoming smaller, thinner and less complex while retaining excellent readability.

A PROJECT WELL ON SCHEDULE

Beginning with a preliminary study in 2009 of the prospects for applying RFID in pulp logistics, this project is now scheduled for completion by the end of 2012. This is the deadline for appropriately equipping all of the four Metsä Fibre production plants at Joutseno, Kemi, Rauma and Äänekoski, including their warehousing functions and port operations at embarkation and destination harbours, and training staff in consignment tracking methods.

The first two trials were completed at the Metsä Fibre mill in Joutseno with the production and delivery to the customer of 2,400 tonnes of RFID tagged pulp. Even at this early stage the results of using the new technology were very encouraging.

Following these test batches, the RFID project continued with a pilot stage that has been essential for overall success, with tests of system functionality under normal operating conditions at the Rauma pulp mill and at the port of Bremen in Germany.

Large projects of this kind call for systematic piloting simply because of the need to assess such a large number of major and minor detailed variables. For example, substantial progress has been achieved in the techniques used for fastening RFID tags to pulp units. They must be near enough to the outer surface of the pulp unit to enable efficient reading, but sufficiently deeply embedded to ensure that they remain undamaged. The pilot stage also provided an excellent opportunity to optimise the operation and positioning of reader devices. The experiences gained at the pilot stage may be readily applied throughout the supply chain.

The company has also done a great deal of pioneering work in solving several technical and practical problems, but the results are now available for all to use

The new RFID system faced a major test just before Christmas 2011 when a pulp shipment was carried all the way from a Metsä Fibre to a customer in Central Europe. The purpose of this successful trial was to test the efficiency of the system, the effectiveness of the technology, and the ability of logistics partners to handle the shipment at both ends.

An RFID tagging device for the production line of the Metsä Fibre mill in Kemi was installed in January 2012, and the other mills will soon be following suit.

A COMPREHENSIVE SOLUTION BASED ON A MATURE TECHNOLOGY

Although Metsä Fibre is the first pulp manufacturer to adopt RFID on this scale, this technology is far from unique. The solution was selected because it has been tried and tested for various purposes in many other industries. Metsä Fibre has been entirely open about its RFID solution with customers and rival pulp manufacturers. The company has also done a great deal of pioneering work in solving several technical and practical problems, but the results are now available for all to use.

The entire pulp industry will benefit when RFID tags and readers become an industry norm. This common, highly automated and much more reliable logistical solution will show its true worth particularly in stock maintenance and at large ports around the world that need to manage pulp units from several manufacturers.

The main winners when other pulp suppliers join in and RFID becomes an industry standard will ultimately be the customers, who will enjoy a better, smoother service, and prospects for optimising their own production processes. Why would anyone choose to pass up such an opportunity?

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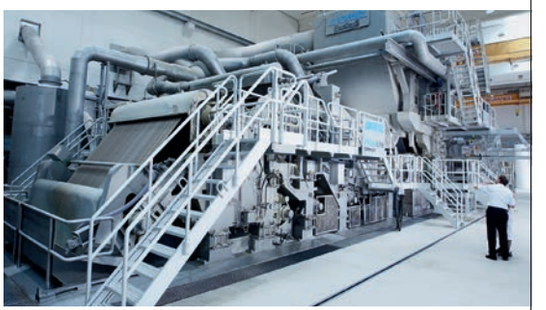
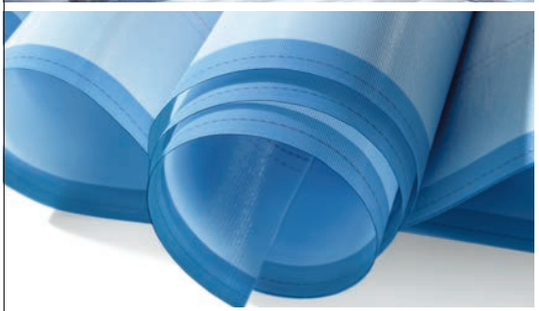
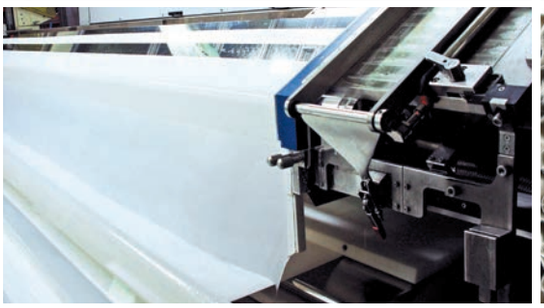
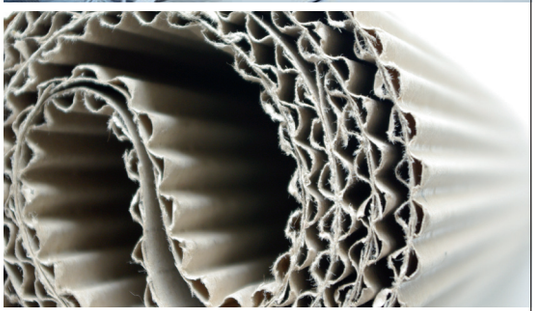



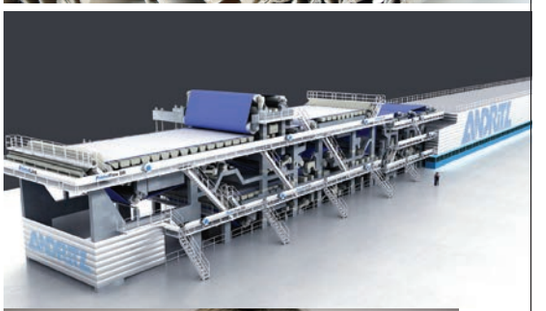

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We accept the challenge!

High efficiency OCC pulping without the high costs

By **Drew Humphries**, Vice President,Global Business Management, GL&V Pulp & Paper and **Tero Jussila**, Sales Manager, GL&V Recycle Systems

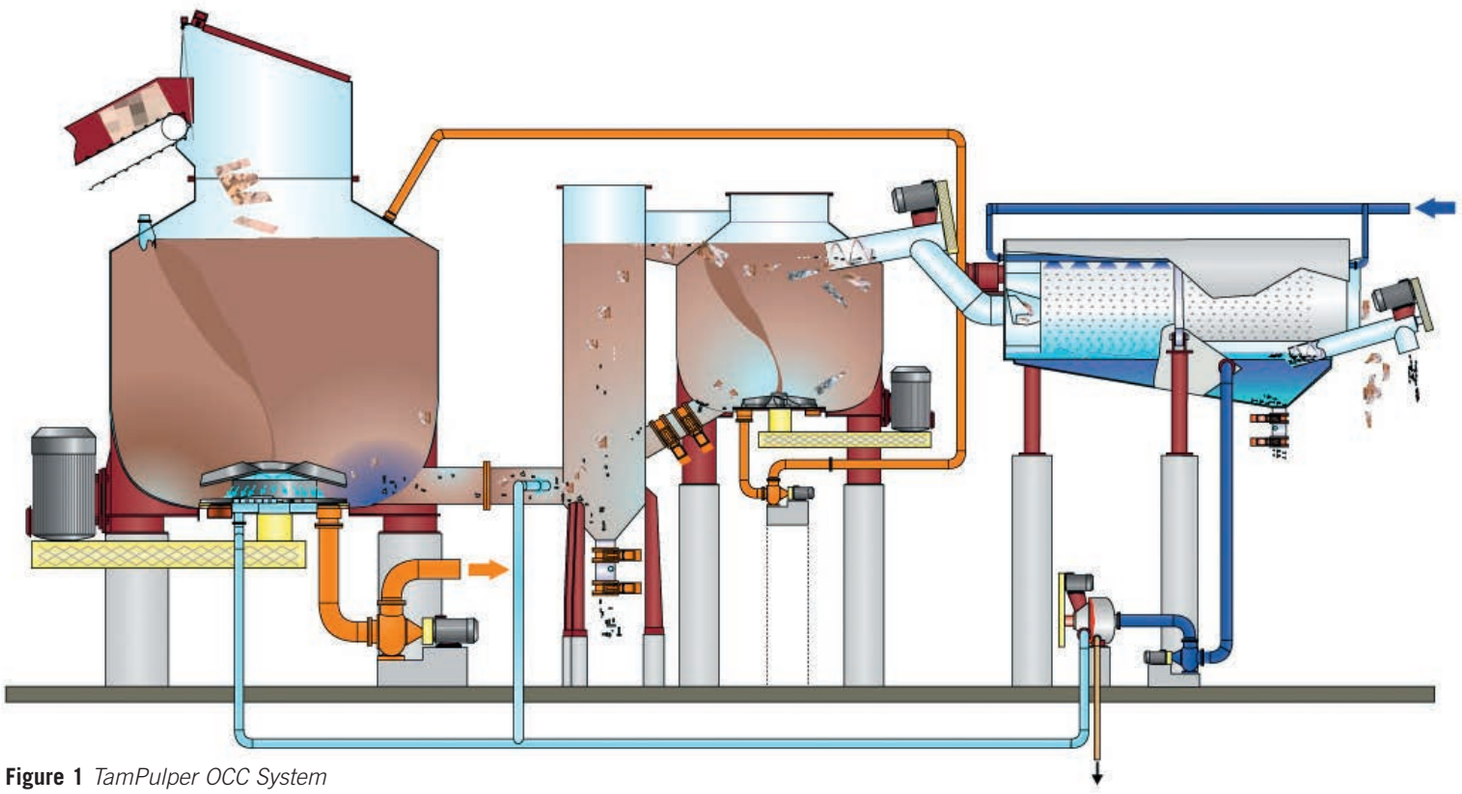

Figure 1 *TamPulper OCC System*

Traditional Old Corrugated Cardboard (OCC) recycle systems operate with a series of pulping, cleaning and screening stations connected by storage tanks and process pumps. Since the quality and debris content of the incoming OCC raw material can vary widely from source and bale to bale, the operator must continuously optimise the amount he rejects from the system to produce high quality pulp without losing too much usable good fibre to landfill.

As a consequence of tightening up their rejects, many of these traditional systems suffer from process and equipment reliability issues through circulating too high a level of contaminants within the system. Production losses, good fibre lost to landfill, equipment wear and high connected power all combine to reduce the owner's profitability.

This patented design eliminates the coarse screens and associated pumps, tanks, agitators and motors

GL&V's new TamPulper™ OCC System is a unique and patented approach, designed with the philosophy of simplicity and reliability. Through the use of new and innovative ideas and technology, we combined process stations and eliminated process pumps to reduce both the amount of equipment required and the overall energy consumption in the system. The following describes the system design and mill experiences.

HIGH EFFICIENCY OCC PULPING

The backbone of the high efficiency OCC system is the TamPulper two-layer rotor together with a perforated or slotted screen plate. The TamPulper system merges the primary pulper and coarse screening stations. The top layer is a traditional pulper rotor designed to turn over the tank and defibre the raw OCC material. The second layer is a series of foils similar to a coarse screen rotor to keep the

Figure 2 *Clarifier and Secondary pulper*

screen plate clean. Dilution is added between the layers to adjust the outlet pumping consistency. The screen plate has smaller, coarse screen size holes or slots rather than the relatively large holes normally associated with a pulper. Primary pulper accepts are clean enough to go forward without a separate coarse screening station. This patented design eliminates the coarse screens and associated pumps, tanks, agitators and motors.

Contaminants and smaller pieces of coarse rejects are continuously discharged from the primary pulper into the adjacent clarifier by gravity. The clarifier is essentially a standpipe between the primary and secondary pulper stations with no motor or moving parts. Dilution is added to

MILL EXPERIENCE: KOTKAMILLS OY, KOTKA, FINLAND

In early 2011, Kotkamills Oy commissioned a new 200tpd TamPulper OCC System configured as described above. The mill produces paperboard on one machine and magazine paper over the other. The goals for the investment were to respond to customer requests for higher recycle content and also to reduce their fibre costs.

The project was challenged by the mill operators having no prior experience with OCC pulping. Regardless, the system start-up went exceptionally well with both production and quality goals being achieved in the first days. Seven months later the plant is operated remotely with little direct operator intervention. The plant also remains very clean; evidence of the reliability of the equipment and simple automated control strategy.

Mr. Jukka Lyyra, production manager, states: "We decided on the TamPulper system after careful study and many reference visits. The quality of the OCC being used in GL&V's reference was very bad and yet the mill people had no issues with plugging in the secondary pulper. From the beginning we found our new OCC system to be very easy to operate and able to produce top quality pulp."

Figure 3 *Rejects Washing Drum*

lower the consistency. Heavy contaminants naturally sink to the bottom of the clarifier where they collect and are periodically dumped in an automated cycle. Lighter contaminants and smaller pieces of coarse rejects are discharged continuously into the top of the secondary TamPulper pulper again without the need of a process pump.

The secondary TamPulper station is atmospheric for easier and more reliable defibering of coarse rejects. The atmospheric secondary pulper has the advantage of longer retention time in comparison to the traditional pressurised secondary and is also open for the operator to inspect. This allows for the use of more heavily contaminated raw materials than in

The goals for the investment were to respond to customer requests for higher recycle content and also to reduce their fibre costs

MILL EXPERIENCE: CORENSO UNITED OY LTD, PORI, FINLAND

Mill Experience: Corenso United Oy Ltd, Pori, Finland

Corenso Pori has been working on a phased rebuild of their existing 400 tpd OCC system. The mill produces industrial core board and targeted reduced operating cost through a simplified process and the elimination of unnecessary equipment.

Phase one was commissioned in the fall 2009 to increase production up to 600 tpd. An existing batch pulper was converted to continuous operation with a TamPulper™ two-layer rotor functioning as the primary pulper. A new secondary pulper and filtrate screen were also installed. GL&V Celleco Twister® cleaners were installed and the existing CDP Filter was rebuilt in the tail end of the system.

Phase two was completed in the March 2011 with the bypass of the existing coarse screening. Both phases were considered very successful and the coarse screens remain off-line with no impact to final pulp quality.

According to Mr. Kimmo Nyberg, production manager: "The elimination of the need for coarse screening has significantly reduced our power costs. We are able to use very dirty OCC furnish without operating or pulp quality problems."

traditional systems where the pressurised secondary pulper easily plugs. Plastics and other light contaminants are continuously pulled from the top of the vat into the washing rejects drum through a screw conveyor. Smaller medium density contaminants (staples, paperclips) are collected at the bottom of the vat and periodically flushed back to the clarifier. The pulper screen plate again has smaller coarse screen size holes or slots; enabling the secondary pulper accepts to go forward without a separate coarse screening station. The flow through the clarifier and secondary pulper is set by the accept discharge flow from the secondary pulper and remains relatively constant regardless of the quality of the raw OCC furnish.

The washing reject drum is a two stage machine combining rejects washing and thickening. Plastics and other light contaminants are washed in the first stage by rotating under submergence in a bath of filtrate. In the second stage, these contaminants leave submergence for drying, but are washed again to maximise fibre recovery using a high pressure shower. Discharged contaminants are virtually fibre free. Filtrate from the drum passes through a pressurised filtrate screen with small perforations to remove any contaminants small enough to pass through the washing reject drum. Clean filtrate with recovered fibres is reused as dilution in the system.

Primary and optionally secondary pulper accepts are pumped forward to cleaning, fine screening, and thickening stations. Depending on the desired final pulp quality, GL&V can offer various configurations of forward and reverse cleaning, fractionation, fine screening with very fine slots, refining and disc filter thickening.

GL&V can offer forward and reverse cleaning, fractionation, fine screening with very fine slots, refining and disc filter thickening

CONCLUSION

In summary, GL&V's new TamPulper OCC System has proven to be reliable and easy to operate. The merger of the pulping and coarse screening operations has proven practical even with heavily contaminated incoming OCC furnish. The elimination of traditional process equipment and connected power reduces operating costs, both in lower energy consumption and on-going equipment maintenance requirements.

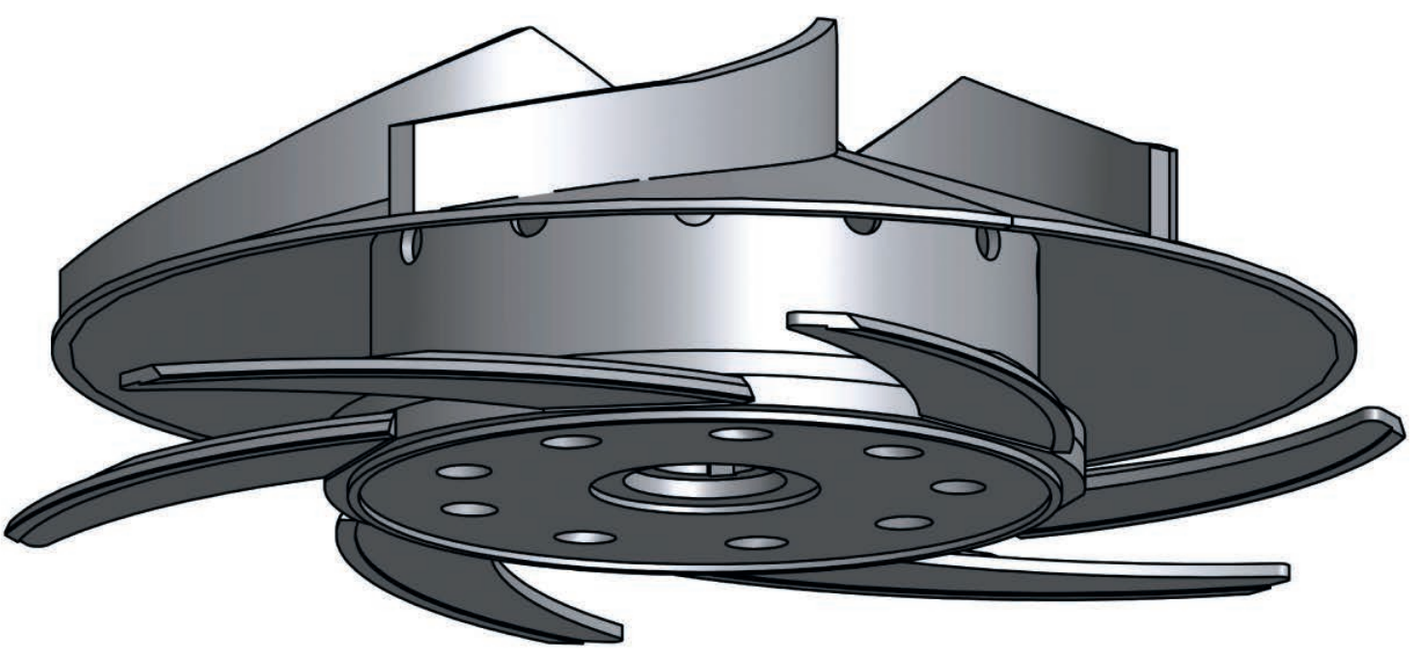

Figure 4 *Two-layer rotor*

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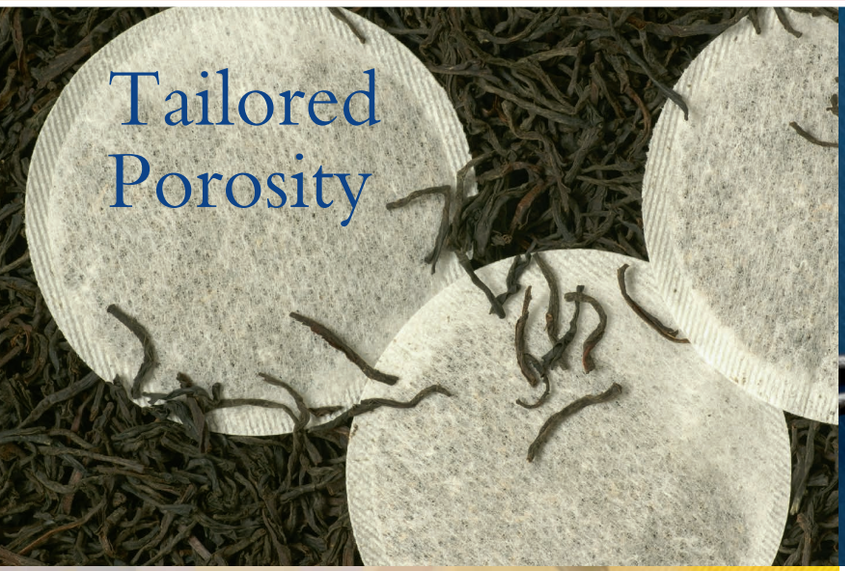

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Drumming up big smiles at Alier

If paper quality remained the same before and after a capital investment, why are these people at Alier S.A. smiling? By **Robert Puhr**

Ask Pilar Carnicé of Alier S.A. when the new FibreFlow Drum pulper from ANDRITZ started up. Based on her test data, she cannot tell you.

Carnicé, the mill's QC Manager, knows the date of course; after all, it was an important investment. "But, if you look at the paper test results, you cannot see a change," she says. "Concurra tests for carton, tensile tests for sacks, tensile and ply bond tests for gypsum – all the tests show no variability."

A big disappointment to Alier's top management? "No, not at all," says CEO Florentino Nespereira. "We celebrate it as a big success."

Ok. Perhaps we are missing something here? There must be more to the story.

"From day one, there were no concerns about the Drum. Within a month, we were able to substitute lower quality raw materials to help with our cost structure." Florentino Nespereira, Chief Executive Officer

MORE THAN 35 FURNISH QUALITIES

"It's no mystery really," says Nespereira. "We are a 100% recycled mill and we produce a wide range of products from 50-450 g/m^2. We use a very wide range of wastepaper qualities, including liquid packaging board. When we use lower cost raw materials and maintain the quality our customers expect, we improve our margin. And, when we use considerably less energy and improve our productivity, we reduce costs further. This we have been able to do with the FibreFlow Drum."

When asked to quantify the economics, Technical Director José Pulido is a little hesitant. "Let's just say that we had five batch pulpers that were old," he says. "Maintenance and repair was a daily activity. Three high-consistency pulpers used about 45-50 kWh per tonne. Two low-consistency pulpers cut the plastics in the furnish into very small bits that were difficult to remove downstream.

"When we use considerably less energy and improve our productivity, we reduce costs further. This we have been able to do with the FibreFlow Drum"

"Compare that to today where the FibreFlow Drum consumes less than half that energy. Plastics and other contaminants come out whole. We get continuous production up to 750 t/d without much variability, even when substituting lower cost furnishes. And, we still keep our quality high."

HARDER, BUT MORE OPPORTUNITIES

Being a 100% recycle mill with dozens of end products, and even more grades of incoming furnish to manage, Alier has done a masterful job of managing the complexities and opportunities it faces. "At times," Nespereira says, "this makes our life harder, but also gives us more possibilities."

Alier, near Lleida in Spain, is small by international standards. Nespereira sees this as an asset. "We are very

close to our customers and markets," he says. "We are nimble and not afraid to try new things if we believe it will help our customers. Of course, with our size, we can't afford to make big mistakes."

Nespereira is a mechanical engineer by training who rose through the ranks of Sonae (the largest private employer in Portugal) for 20 years before being recruited to Alier in 2002. His experience is varied (production, start-ups, logistics and general management), which gives him a good foundation for managing the complexities of Alier.

The product mix at Alier consists of various types of packaging papers (40-50%), sack papers (20%), gypsum papers (20%), and paper for shopping bags (10%). "Our strategy is to grow in the sack, gypsum, and paper bag segments," Nespereira says. "With a new large 400,000 t/a machine being announced every year in the corrugated segment, it is clear that over time we will not be competitive."

A big push in helping to make the grade change to the new niche segments was Alier's investment in the pulp preparation area.

IMPROVING THE SATELLITES

Five years ago, Alier began a programme to improve what Nespereira calls the 'satellite' areas of the mill. "We started by improving our water treatment system, then the pulp screening and cleaning area and then debottlenecking the machine itself," he says. By 2007-2008, the focus shifted to the pulping area. "In our opinion, this was clearly the worst area for our mill," says Pulido. "We had five pulpers, two low-consistency and three high-consistency. Each was a different model and from a different period, but on average they were 20-30 years old. This area not only became a production bottleneck in terms of capacity, but we had significant problems with maintenance, which affected the stability of our operations. Also, the energy costs were also extremely high."

The three HC pulpers required steam and chemicals. Specific energy consumption was in the range of 45-50 kWh/t of production. In addition, one of the pulpers was dedicated to a specific

From left to right: Kimmo Vanhala, ANDRITZ Fibre Flow Drum Product Manager; José Pulido, Alier's Technical Director; Enrique Navarrette, recently retired Mill Manager at Alier; Florentino Nespereira, Alier's CEO, and José Corominola of Copapres, ANDRITZ'S local representative.

raw material. “If the pulper was down for repair, we had to switch the product on our paper machine to accommodate this,” Pulido explains. “This caused disruptions in the stability of our process.”

The team at Alier came to the conclusion to purchase a continuous pulper that would be dedicated to producing pulp for 70-80% of its product mix, and to keep two out of the five batch pulpers for other specific products. “Even though the cost of a continuous pulper is higher than the traditional batch units, we wanted to get out of this nightmare of having to maintain five old pulpers,” says Nespereira. “The critical issues for us at the beginning were low maintenance and low energy consumption.”

Pulido is a 36-year veteran of Alier, first starting in the electrical maintenance department. Over the years, he has worked in virtually every department. Today, he is responsible for new projects and optimisation activities. “When I first became involved with the project, I have to admit that I didn’t know ANDRITZ,” he says. “But after some conversations with José Corominola, ANDRITZ’s sales agent in Spain, and some meetings with their technical people, I became convinced that ANDRITZ had the simpler, more effective, and less costly solution. They also demonstrated to us that we could move to lower cost furnishes and still achieve our quality targets.”

Pulido and his colleagues visited an installation of the FibreFlow Drum that has been operating for more than 10 years at Stora Enso (Barcelona). “We were impressed with the equipment construction and the reliability of the system.” Alier signed the contract with ANDRITZ in April 2008 and the line started up in August 2009.

“With five old batch pulpers, the pulping area had become a production bottleneck which affected the stability of our operations. Also, the energy costs were also extremely high.” José Pulido, Technical Director

The FibreFlow Drum processing line at Alier. About 30-40 different grades of wastepaper are processed into a variety of paper products at the mill.

SMOOTH PROJECT

The erection went very well, but the biggest problem was in transport of the Drum itself from Finland. It left the workshop on time, but according to Nespereira, “Everything was great until the truck got to the Spanish border. There we discovered that there is not one Spain, but 17 different Spains when it comes to getting permits to transport such a large piece of equipment (31.6 m long by 4.7m in diameter) over the Spanish roads. Each community had to give a permit. This process took time.”

Still, Alier is pleased with the overall project execution and the choice of local subcontractors for ANDRITZ’s EPC delivery. The Drum started up easily with no problems.

SLUSHING AND SCREENING

The FibreFlow Drum pulper has two zones inside it: one to gently slush and defiberise wastepaper and one to remove trash and major contaminants from the pulp. Over 200 Drums have

"The new generation design is better at deflaking and defiberising hard-to-pulp wastepaper furnishes." Kimmo Vanhala, FibreFlow Drum Product Manager at ANDRITZ, inspects the screening zone of the Drum.

Pilar Carnicé performs a paper tensile strength test.

"Paper quality remained the same. The only difference I could see was less variability after the Drum was installed." Pilar Carnicé, Quality Control Manager

"This substitution of raw materials and elimination of chemicals in the pulping process contributes around two-thirds of the annual savings. Yet energy savings are also significant"

been sold worldwide.

The Drum defiberises wastepaper by gentle dropping and rolling actions. There are no moving parts inside and nothing to cut the fibre, so strength properties are retained. This also avoids disintegration of the contaminants.

NEW ENHANCEMENTS

According to Kimmo Vanhala, ANDRITZ's FibreFlow Drum Product Manager, the Drum has been on the market for 30 years. The applications experience has resulted in new enhancements for hard-to-pulp wastepapers sometimes found in OCC lines. "This Drum design is better at deflaking and defiberising difficult furnishes," Vanhala says. "It still retains the benefits of all FibreFlow systems: gentle pulping action, efficient trash removal, and low energy consumption."

NOTEWORTHY RESULTS

"From day one, there were no concerns about the capacity of the drum, the quality of the pulp, and the consumption of energy," Nespereira says. "All these things were accomplished very easily, without taking months to fine-tune. Within a month, we were able to substitute lower-quality raw materials to help with our cost structure.

"This substitution of raw materials and elimination of chemicals in the pulping process contributes around two-thirds of the annual savings. Yet energy savings are also significant."

"When running at design capacity, energy consumption is less than 20 kW/t," says Pulido. "This is half of what we consumed with the HC batch pulpers."

According to Pulido, operators easily adapted to the Drum and find it easy to handle. "Everything is automatic," Pulido says. "The operator only needs to set the production setpoint and the Drum does the rest."

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Maximyze your fibre basket

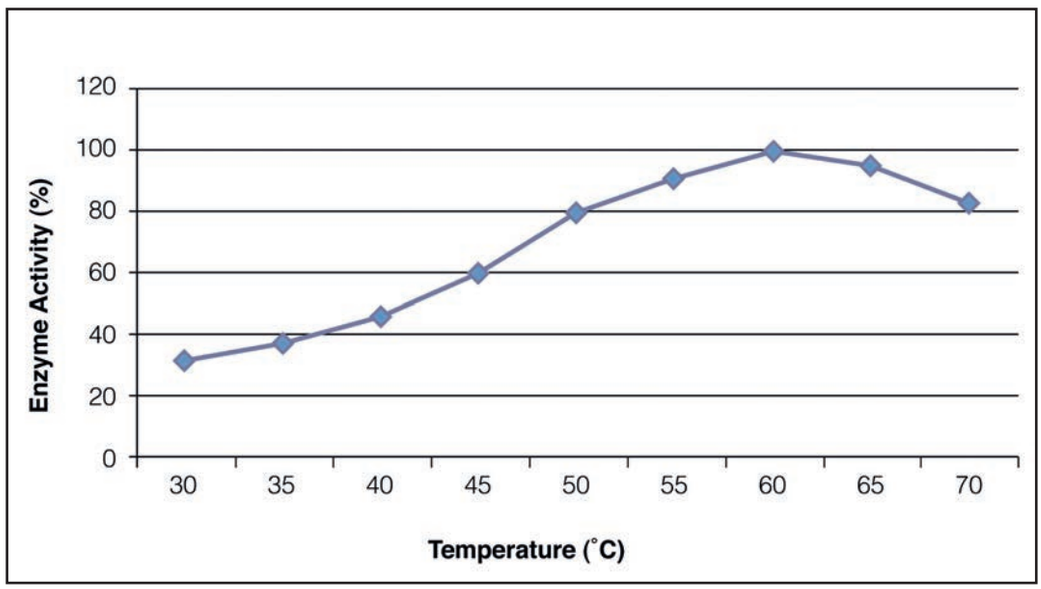
By **David R. Jones**, Industry Specialist, Paper Technologies - Buckman

"Buckman GREEN. Our color. Our commitment". This statement conveys Buckman's dedication to being a sustainable company. It is an important part of our culture and a cornerstone of our business model.

Buckman has been front and centre in the development of enzyme-based products for the pulp and paper industry. This started many years ago with the introduction of the Neoteric® products for microbial deposit control. The Neoteric product range includes enzyme-based products and biodispersants that break down the microbial slime that form deposits. Another important advancement in enzyme-based solutions was the introduction of the Optimyze® product line for stickies control. Since then, this range of products has been expanded with the new Optimyze Plus products. Buckman has enzyme-based products for other applications including cleaning, deinking, bleaching, and starch conversion, to name a few.

One of the newest enzyme based-product lines is the Maximyze™ family. Maximyze is composed of enzyme-based products that modify or fibrillate fibre to give the same effect as mechanical refining with less of the negative aspects.

The Maximyze products' mode of action is discussed and case studies presented.



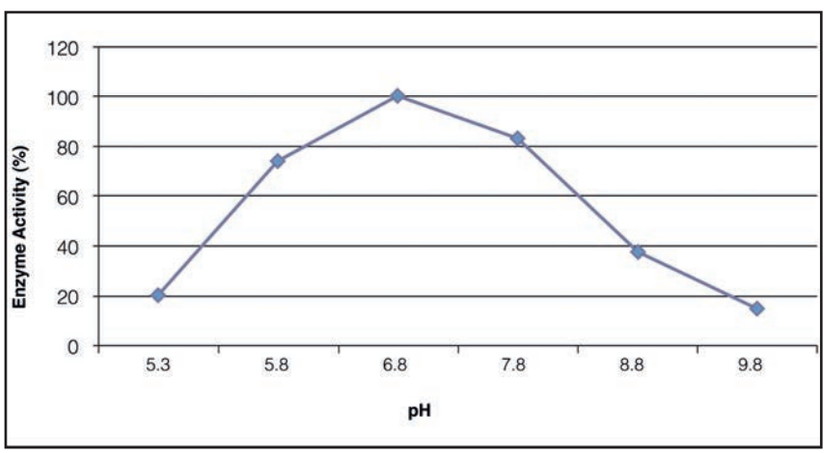


Figure 1 *Typical Enzyme Temperature and pH Curves*

"Buckman GREEN. Our color. Our commitment" This statement conveys Buckman's dedication to being a sustainable company. It is an important part of our culture and a cornerstone of our business model

MAXIMYZE YOUR FIBRE BASKET

Enzymes have been used in various industrial processes for hundreds of years. The yeast used in beer and wine making, for example, contains enzymes that produce fermentation. Now, enzyme products can be and are produced that contain one specific enzyme. This has allowed the industrial use of enzymes to expand. One area where the use of enzymes is expanding is in the pulp and paper industry. Some pulp and paper processes that utilise enzymes include deinking, bleaching, deposit control and starch conversion. An innovative use of enzymes is in fibre modification. Buckman introduced the Maximyze product line six years ago. Since the introduction of Maximyze, over 60 mills around the world are reaping the benefits of this technology.

What are enzymes? They are nature's catalysts. Enzymes are protein-based molecules that catalyze the various reactions in all living things, i.e., respiration, nutrients and

growth. Enzymes are true catalysts in that they are not consumed in the reaction, and each enzyme molecule can catalyze thousands and thousands of reactions per second. Enzymes are very specific to the reaction that they drive. Each individual type of enzyme does one thing and one thing only. Enzymes are complex molecules and their shape determines their function.

The reaction rate of an enzyme varies with pH and temperature. In the case of temperature, as the temperature increases, the reaction rate or enzyme activity rate increases. This increase is fairly linear until a temperature comes to a point where the enzyme molecule breaks down. This breakdown is called denaturing and is not reversible. The pH effect is different; each enzyme type has a pH where the activity is at the highest. As the pH goes up or down from that point, the enzyme activity decreases. The effect of this is that each enzyme type has an effective pH range. The pH effect is reversible. For example, if a given enzyme has a maximum activity at pH 7 and the enzyme is in a part of the process that has a pH of 5, then the activity will be lower than the maximum. However, if you change the process pH to 7, then the enzyme will once again be at maximum activity.

The temperature and pH activity curves vary from enzyme to enzyme. The curves above are examples and are not specific to any of the Maximyze products. It is important to know the temperature and pH curves for the enzymes that you are utilising to ensure that system parameters match the product. Other factors that affect the activity of enzymes are inhibiting and denaturing compounds. A good example of a denaturing compound is chlorine; most enzymes can only tolerate a fairly low level of free chlorine. This denaturing is irreversible. Inhibiting compounds block the activity of the enzyme. The inhibiting compound can block the site of the reaction or attach to the enzyme. Inhibiting compounds do not denature the enzyme; they just inhibit the enzyme's activity. The compounds that inhibit activity vary from enzyme to enzyme.

Figure 2 *Buckman's 8 Business Management Standards*

In any enzyme application system, system knowledge is essential. Temperature, pH and process additives need to be known and documented. Other essential information includes tank and chest volumes, levels and flows. This information is important to calculate retention time in the system. The more contact time there is the more each enzyme molecule can do. System knowledge is one of the Buckman 8 Business Management Standards that ensure communication and a true partnership between all stakeholders.

Replacing softwood kraft with hardwood kraft and reducing mechanical refining gives improved softness, an important quality for tissue grades

The Maximyze products are enzymes that work on the cellulose chain in the fibre. Mechanical refining is used to impart various characteristics to fibre, depending on the grade and type of wood. Mechanical refining is employed to increase tensile, internal bond and other sheet properties. The mechanical refining 'beats' the fibre, damaging the fibre wall. This weakening leads to wall stripping, delamination, collapse and fibrillation. This increases the sites for fibre-to-fibre bonding and, therefore, increases sheet strength properties such as tensile.

Maximyze does on a molecular level what mechanical refining does on a macro level. By breaking bonds in the cellulose chain the fibre is weakened and wall stripping, delamination, collapse and fibrillation occur. The Maximyze is working at the bond level so there is less fibre cutting and fines generation than with mechanical refining. You can think of the fibre as a rope made up of many strands. A blade can cut the rope. This is similar

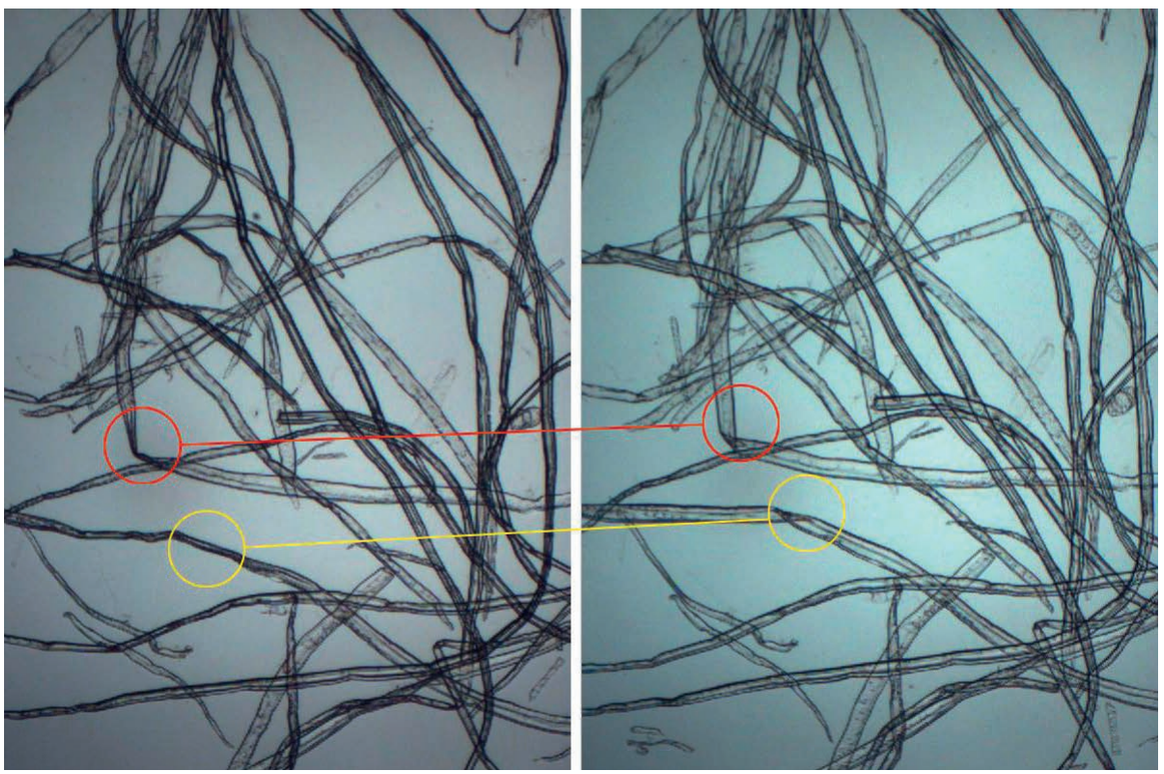


Figure 3 *Maximyze Activity – Before (left) and After (right)*

to what occurs in mechanical refining to some extent and is one of the downsides. Thinking about the same rope, Maximyze would have to cut each individual strand to cut all the way through the rope. Given enough time, this could occur, but a well-designed application will prevent this from happening. In most cases, Maximyze is added before the mechanical refining. Maximyze preconditions the fibre and widens the window of refining. In some mills, mechanical refining has been completely bypassed and all refining is done with Maximyze. The photomicrographs above show the effect of Maximyze on fibre. It can be seen that fibres are collapsing and flattening out. Maximyze is providing positive ROI to many mills using bleached kraft. These mills produce a number of different paper grades. Tissue mills can especially benefit from the use of Maximyze. The benefits include reduced production cost by the replacement of softwood kraft with hardwood kraft or by replacing virgin kraft with deinked MOW (mixed office waste) pulp. Another benefit for tissue mills is improved sheet characteristics. Replacing softwood kraft with hardwood kraft and reducing mechanical refining gives improved softness, an important quality for tissue grades.

CASE #1 – MAXIMYZE 2545 APPLICATION IN A NAPKIN GRADE

One of the first applications for Maximyze was a tissue mill producing a napkin grade using virgin kraft and deinked MOW pulp. The furnish mix was targeted at 33% kraft and 67% MOW. To meet sheet strength targets required increasing kraft content up to 40%. Maximyze 2545 was introduced into the pulper at 1.0 kg/tonne and now this napkin grade is produced with 100% MOW and no refining. The cost differential between the virgin kraft and the deinked pulp results in a very positive ROI (return on investment).

CASE #2 – MAXIMYZE 2545 APPLICATION IN A PREMIUM BATH GRADE

Maximyze has also allowed a tissue mill to improve sheet qualities on a premium bath grade. To meet sheet strength targets the mill needed to mechanically refine a 100% virgin kraft furnish. The refining resulted in a loss of sheet softness. Maximyze 2545 was again the product of choice, and its application resulted in the elimination of mechanical refining. This resulted in an increase in bulk to basis weight ratio and improved sheet softness. Maximyze 2545 was added to the pulper at 1.0 kg/tonne.

CASE #3 – MAXIMYZE 2530 APPLICATION IN A PREMIUM BATH GRADE

A mill is producing a premium bath tissue grade with a mix of virgin kraft and deinking MOW pulp. To meet the target for tensile the mill had to overweight the sheet by 0.5 g/sqM and use a dry strength additive. The use of

the dry strength additive required the addition of a cationic coagulant for charge control. The coagulant resulted in a brightness loss and, therefore, it was necessary to use an optical brightening additive (OBA) to meet the brightness target.

Maximyze 2530 was introduced and the results were dramatic. The mill is now able to produce this grade at target basis weight with no dry strength additive, no cationic coagulant and no OBA. Furthermore, the mill has been able to eliminate mechanical refining. The application rate for the Maximyze 2530 is 0.25 kg/tonne. All of the benefits from the introduction of Maximyze 2530 add up to a reduction in production costs of US$30/tonne.

CASE #4 MAXIMYZE 2535 APPLICATION IN AN UNCOATED FREE SHEET

A mill has to mechanically refine at a high level to meet its targets for strength and porosity. The high refining levels caused excessive cutting and fines generation. This led to reduced drainage and loss of strength. The strength loss meant that filler levels were limited and a higher percentage of softwood kraft was needed in the furnish mix. When Maximyze 2535 was started the mechanical refining was decreased. This allowed the following results to be achieved: reduced softwood kraft by 5% (based on total softwood), increased filler content by 1% and increased production rate by 6% This was all achieved with improvements in sheet qualities such as internal bond and smoothness. Overall, the total ROI is equal to US$29/ tonne.

CASE #5 MAXIMYZE 2563 APPLICATION TO CONTROL VESSEL ELEMENTS

Maximyze is proving to be a great asset to pulp and papermakers in many areas. One area that has been a challenge to many papermakers is vessel elements. Vessel elements are a big problem in mills using fast-growing tropical hardwoods. In printing papers vessel elements can cause picking and linting. In the printing process these vessel elements can be pulled from the sheet and deposited on printing rolls. This leads to breaks and problems with print quality.

Maximyze has proven to be a successful solution to vessel elements. The enzymes in Maximyze work on the vessel elements to weaken them. The effect on the vessel elements is greater than on the fibre as the vessel elements have a greater surface area. The weakened vessel elements are then more susceptible to being broken up in mechanical refining.

A mill is producing offset paper with a furnish of 100% tropical hardwood. Vessel elements were causing issues with picking. To control this picking the mill needed to increase mechanical refining and use increased levels of starch at the size press.

Maximyze 2563 was introduced at an application rate of 0.5 kg /tonne. The results were a reduction of 20% in mechanical refining energy and reduced size press starch usage. Picking as measured with the IGT test was reduced by 60%.

The reduced picking allowed the mill to increase the selling price of its paper. The increased revenue, along with the starch and energy savings, is estimated to be worth at least US$1,000,000 per year.

One important aspect of the use of enzymes in industrial processes is the ‘green’ aspect. Enzymes are naturally occurring in nature and have low environmental impact. Enzymes have a low health hazard to workers when compared to many industrial chemicals. Buckman is heavily involved in supplying enzyme solutions to pulp and paper, and our R&D Department is working on expanding existing applications and developing new innovative applications for enzymes. Being a sustainable company is important to Buckman.

This innovative enzyme based product line works on the fibre to produce the same effects as mechanical refining with less of the downside of mechanical refining, such as fibre cutting and the production of fines

Buckman’s sustainability message is captured with “Buckman GREEN. Our color. Our commitment.” As well as ensuring that Buckman’s internal processes are sustainable, we work as partners with our customers to assist them to reach their sustainability goals. A good example of this is replacing a dry strength additive with Maximyze. This reduces toxicity to the effluent and also has ROE (return on the environment) for reduced shipping. The volume of a dry strength additive is much greater than for Maximyze, so trucking costs and the use of fossil fuel is greatly reduced.

Maximyze is proven technology that has delivered ROI and ROE to many mills around the world. This innovative enzyme based product line works on the fibre to produce the same effects as mechanical refining with less of the downside of mechanical refining such as fibre cutting and the production of fines. Maximyze is delivering benefits in pulp substitution, improved sheet qualities and elimination of other strength additives. Mills experiencing issues with vessel picking are also benefiting from the application of Maximyze.

Other pulp and paper grades that are investigating the potential benefits of a Maximyze program are market kraft pulp mills and lightweight coated operations. Buckman continues to research further applications of the Maximyze product line, an example of which is use in mechanical pulps such as TMP.

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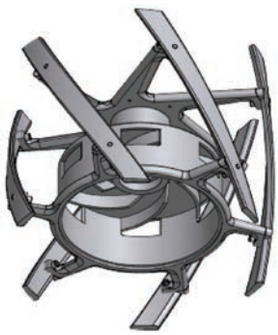

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How advanced rotating equipment sealing technologies help improve operational efficiency

By **Zoltan Homoky**, Key Account Manager Pulp & Paper Industry and **Marco Hanzon**, Marketing Manager, AW Chesterton

MAINTENANCE TRENDS AND RELIABILITY OVERVIEW

As many mills struggle to maintain profitability, plant management is continuously looking for ways to increasing their internal efficiencies. The biggest impact in overall cost reduction will be to focus on the operating costs of production equipment. For rotating equipment, the primary variables are equipment component reliability and maintainability - the time and effort required to maintain the equipments, increasing equipment reliability lowers component usage which directly leads to reduced acquisition costs.

There is a tremendous opportunity at many mills to increase efficiencies by increasing the reliability of rotating equipment. In many situations, a simple shift in focus can help to improve the sealing reliability at the plant at minimum costs. Advanced sealing technologies exist today that can improve sealing reliability at plants tremendously. Maintainability is greatly improved with today's split sealing technology leading to further reduction in maintenance costs. Reducing component failure further reduces mills' downtime, purchasing and maintenance activity and inventory levels. The total costs associated with equipment failure can be extremely large relative to the acquisition cost of the failed component and are typically considered to be two to 20 times larger than the acquisition costs. It is evident that for mills to continue to make strides in reducing operating costs, increased equipment reliability needs

It is evident that for mills to continue to make strides in reducing operating costs, increased equipment reliability needs to be the key area of focus

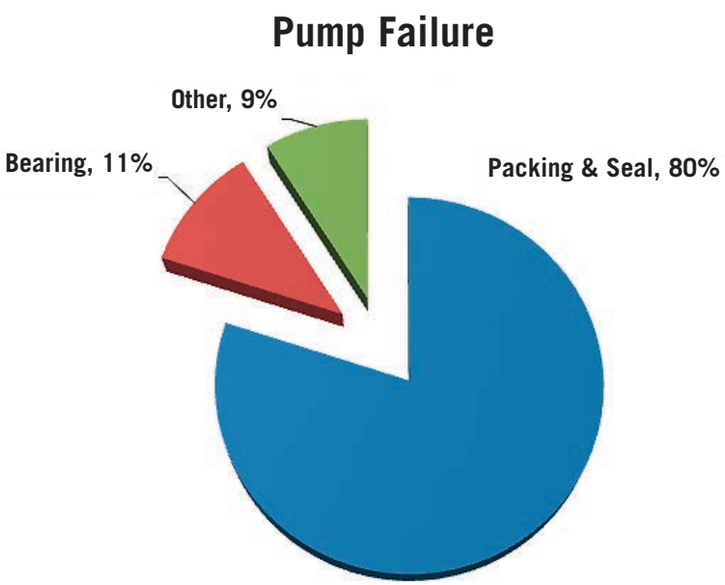

Figure 1 *Pump failure analysis*

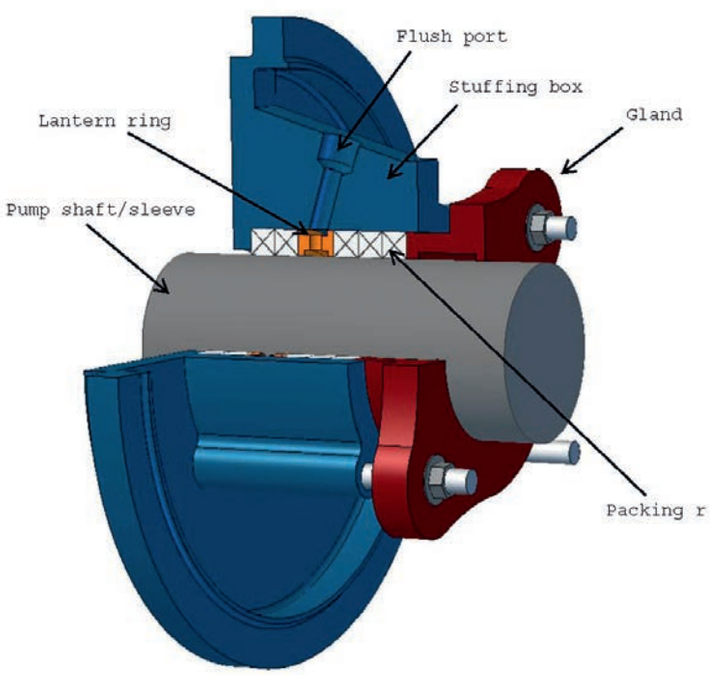

Figure 2 *Gland packing*

to be the key area of focus.

Today, many mills have embarked on reliability improvement programmes. Failure prevention programmes are in place supported by vibration analysis and laser alignment techniques. In some cases, training programmes and procedures have been put in place to insure proper equipment start-up, operation and maintenance practices.

While a systematic approach is the key to any improvement program, basic pump reliability starts with some basic considerations. Any discussion about pump reliability has to contain three elements:

1. You must have a clear picture of what life you should be expecting from the pump's mean time between repairs. Life expectancy, however, has nothing to do with your past pump history. It should be based on industry best practices.

2. You must maximise the life of the pump components. They should be wearing out, not failing prematurely. Unlike the airlines, you should not be replacing seals and bearings just because they have a certain number of running hours on them. With exception of some key critical positions, the shut down and labour cost of replacing parts is too high.

3. You should not run to failure and be faced with component failures during process. Predictability is a key variable towards reliability.The good news is that predictability comes with improved reliability.

Let's take a look at those three requirements:

The two items that have the highest probably of failing your pump are the packing or mechanical seal and shaft bearings.

Packing or seals and bearings account for 90% of your premature pump failures. Years ago, most pump shafts were sealed using rings of soft packing, compressed by a packing gland, but this type of shaft seal required a fair amount of leakage just to lubricate the packing and keep it cool. With the development of mechanical seals, the industry was provided with a technology that did a far better job of restraining product leakage around the pump shaft using two very flat surfaces (one stationary and one rotating). Even though these mechanical seal faces also require some (very small) leakage across the faces, to form a hydrodynamic film, this leakage normally evaporates and is not noticeable.

Mechanical seals are designed to last until the sacrificial surface (carbon face) is worn away. However, even today many seals fail before this occurs. They fail prematurely.

Mechanical seals fail for only two reasons. If you damage a component (the damage can be either corrosion or physical damage), or if the lapped seal faces open.

PACKING VS. MECHANICAL SEALS:

Packing sealing technology features:

1. Easy and fast to install and exchange
2. Damages the sleeve
3. Designed to leak (lubrication film between the sleeve and the packing)
4. High energy consumption (because of the friction between the sleeve and the packing)
5. Needs continuous maintenance action, adjustments to control the leakage

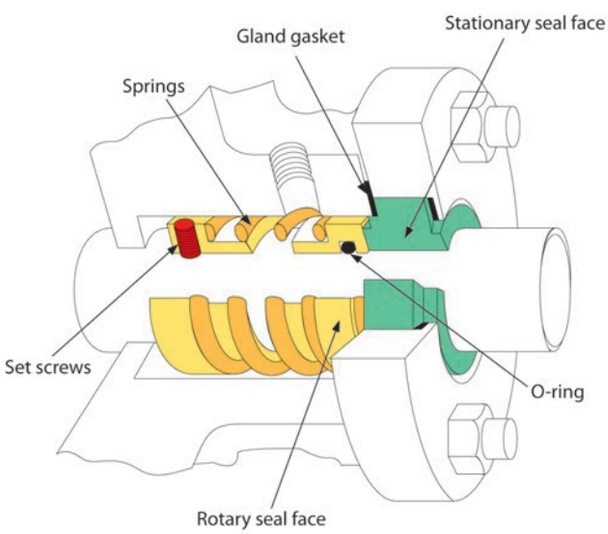

Figure 2a *Basic Mechanical Seal*

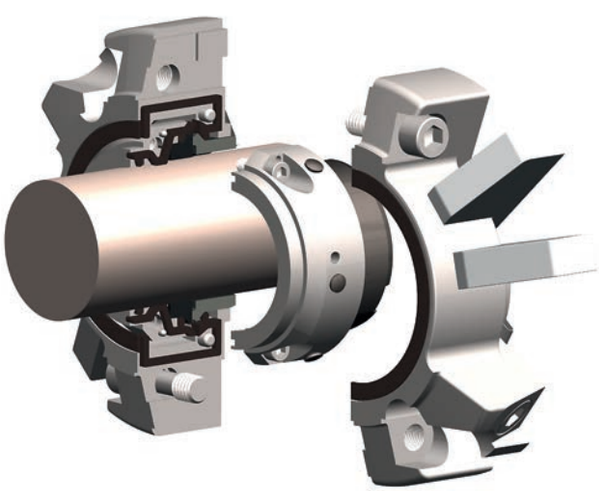

Figure 3 *Chesterton 'Off the shelf' Split Mechanical Seal*

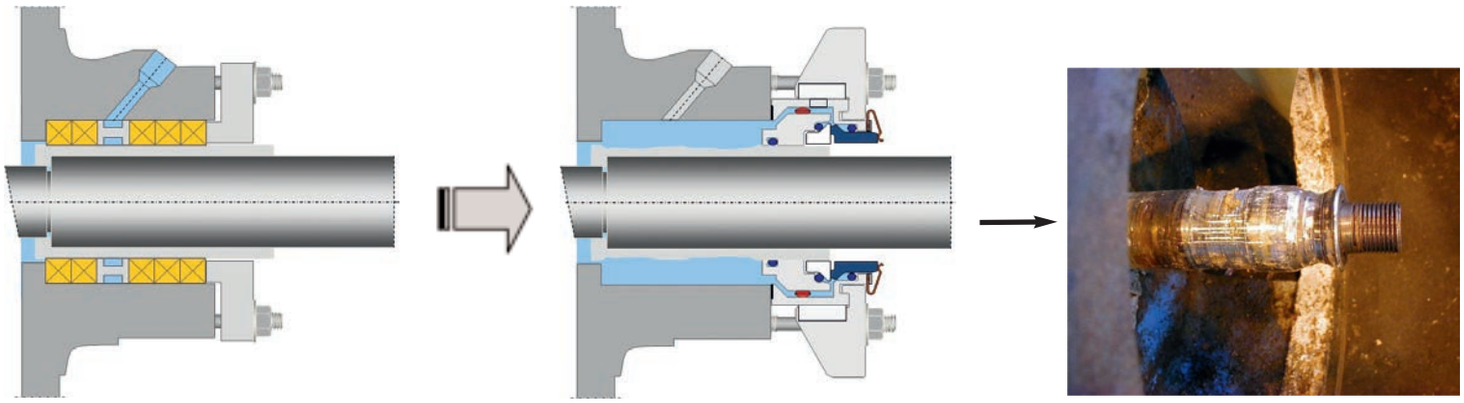

Figure 4. *Packing conversion to Split Seal*

Mechanical sealing technology features:

1. Needs equipment disassembly to change the seal
2. A well-designed mechanical seal does not damage the sleeve
3. Leak-free operation
4. Low energy consumption
5. Maintenance free

Mechanical seals provide superior performance compared to packing but still have one major disadvantage: The equipment has to be disassembled for mechanical seal installation. This should not be a major concern if we are talking about small or medium sized centrifugal pumps, but for larger equipments like Fan pumps, Mixers, Agitators, Screw Feeders this could be complicated, time consuming and expensive. Because of this specific reason, in 1986 the first off-the-shelf Split Mechanical seal was introduced to the market.

SPLIT MECHANICAL SEAL TECHNOLOGY

Since their introduction in 1986, off-the-shelf split seals been used throughout all process industries and application throughout the world.

Convinced of the advantages of split seals on larger rotating equipment, the pulp and paper industry also quickly adopted split seal technology on a wide variety of applications including fan pumps, agitators and screw feeders.

Since the first generation split seal was introduced, many technological improvements have been made and introduced into the latest generation of split seals. These improvements such as vacuum and high-pressure capability up to 30 barg have greatly expanded the window of operation and application of split seals in mills. Rotating equipment such as large agitators and hydropulpers that exhibit large radial play can now be reliably sealed with split seals that feature extended motion capabilities. In addition to these advancements in split seal technology, a revolutionary environmental control bushing has been introduced to the industry that actively evacuates paperstock from the stuffing box. The combination of the split seal and this SpiralTrac environmental controller allow a strong reduction in seal water usage addressing while mean time between planned maintenance is further extended.

HOW SPIRALTRAC WORKS

During operation, SpiralTrac converts some of the rotating flow in the seal cavity into a strong axial flow component. This axial flow is driven along the seal cavity bore in the direction from the gland towards the throat. Since contaminants are centrifuged to the bore during pump operation, the flow sweeps them in the direction of SpiralTrac, and along a shallow angled lead in ramp, increasing velocity, and therefore centrifugal force on the abrasives. A small groove, machined at the end of the lead in ramp, is then able to collect the particulate because the increased centrifugal force holds them in place.

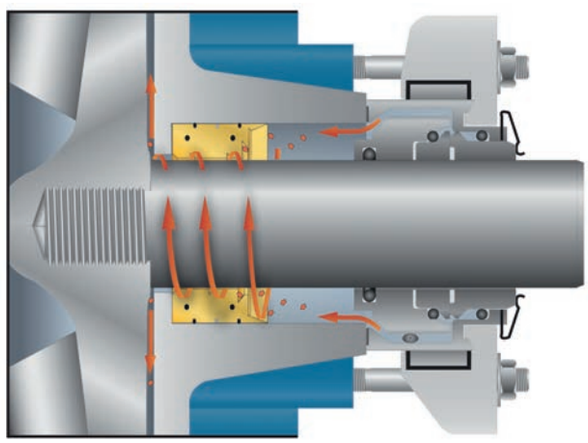

Figure 5. *SpiralTrac working principle*

The collection groove leads directly into the main spiral, which conveys the contaminants radially inward, and out through the exit groove at the shaft. The main spiral continually decreases in diameter and the steadily increasing angular acceleration forces abrasives deeper and deeper into the groove. This enables the groove design to decrease in depth and width as it approaches the shaft, spilling most of the excess fluid to drive the axial flow pattern in the seal cavity. Only the apex of the spiral needs to continue out to the exit, to expel the abrasives.

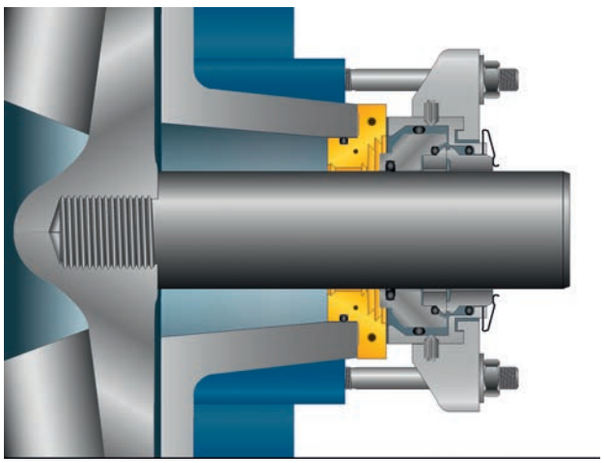

Figure 6 *Split Seal & SpiralTrac on Fan Pump*

FAST REPLACEMENT AND REPAIR

For double-suction Fan Pumps it is normally necessary to split the pump at the halves, remove the rotating element, replace the necessary sleeves or seals then re-assemble the pump. This was done in the field, requiring special equipment on-site during the repair process.

Split seals eliminated the need for removing anything from the pump except the seal. As the split seal can be installed, in place and by one installer, without removing the pump, motor or coupling, simplifying the repair process, eliminating associated costs, and most often can be installed in the conversion from packing to seals right on the existing packing sleeve regardless of sleeve condition. Thus it allows upgrading from packing without the necessity and expense of replacing the existing packing sleeve.

These advantages resulted in huge cost savings as well as correspondingly large savings in time, material and personnel. Generally speaking, within the paper mill, a split seal is an excellent replacement for any product containing stock and currently using packing.

The conversion from packing to the latest generation of split seals is extremely cost effective by eliminating thousands of litres of flush water per year, improving equipment reliability, reducing downtime and overall maintenance costs.

A small groove, machined at the end of the lead in ramp, is then able to collect the particulate because the increased centrifugal force holds them in place

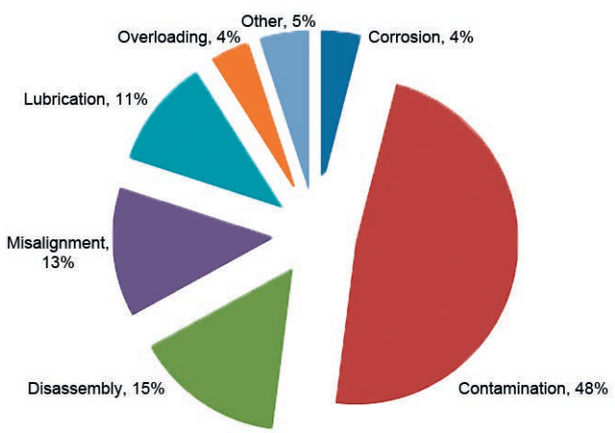

Figure 7 *Reasons of bearing failure*

BEARING PROTECTION

As pointed out above, the second leading cause of pump breakdowns is bearing failures. This is because fewer than 10% of all ball bearings run long enough to succumb to normal fatigue failure. Bearings should last for their L10 life. Check with your pump supplier. The B10 life of most centrifugal pump ball bearings is in the order of tens of years, and you are probably not getting that kind of life.

Most bearings fail at an early age because of static overload, wear, corrosion, lubricant failure, contamination, or overheating. Particle contamination and corrosion related failures account for 52% of all of these bearing failures. Bearing housing seals, and more specifically the seal type, play a crucial role in this centrifugal pump reliability component.

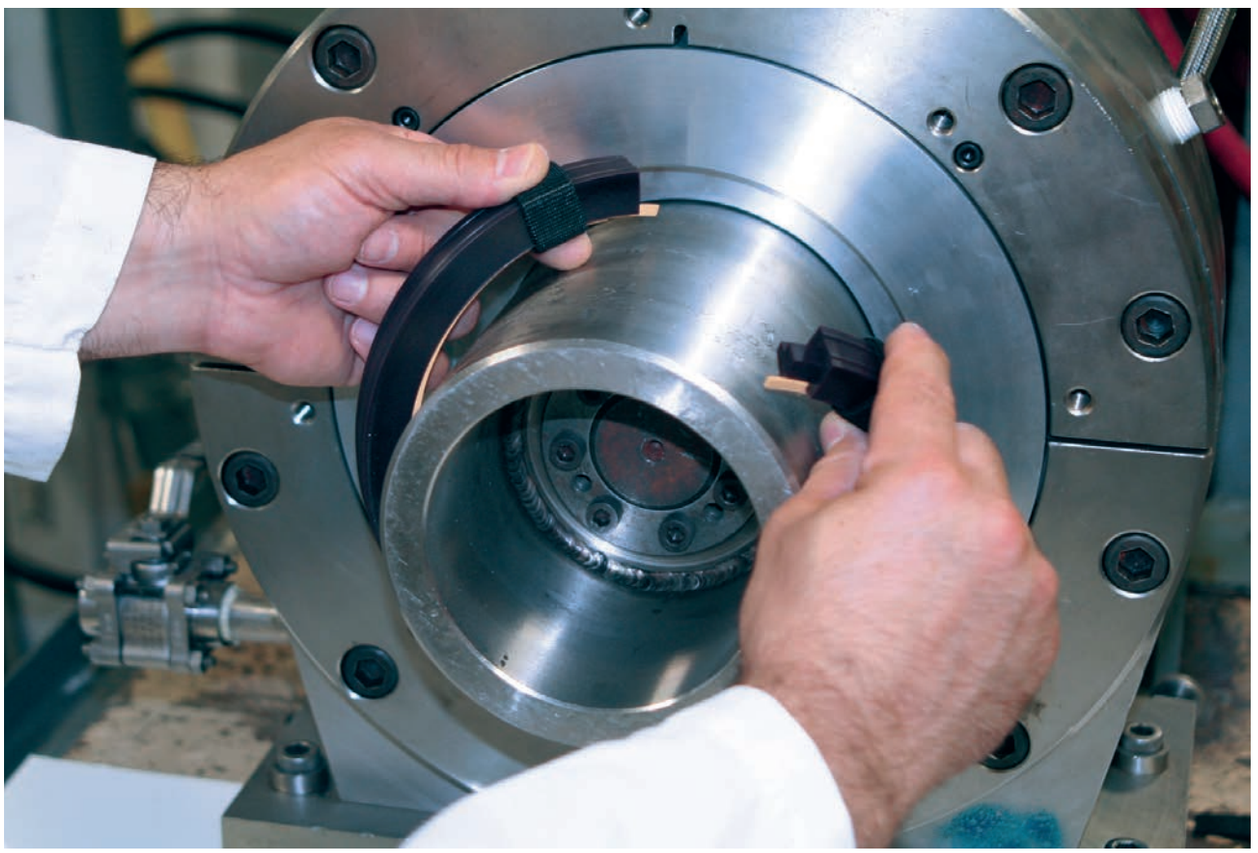

Figure 8 *Chesterton 33K Split Bearing Protector*

They serve to both retain the lubricant within the bearing housing and to exclude both solid and liquid contaminants that can find openings to infiltrate both the lubricant and the bearings.Following the logic of split sealing technology for the pump shaft, advanced split bearing protectors were introduced to the market in 2008. The split bearing protector design eliminates the need and associated cost for equipment disassembly while improving on the seal performance of conventional lip seals.

This innovative split technology prevents penetration of external contaminants from entering the house to provide excellent service in bearing and gear box applications. The seal can be installed in either direction which allows the user to locate the sealer rings away from a previously damaged shaft.

With added support from a qualified seal supplier, mills can achieve the savings that contribute to the bottom line

There is a tremendous opportunity at many plants to increase efficiencies by increasing the reliability of rotating equipment.

The benefits of the split sealing technology in assembly, disassembly and repair makes the repair of a leaking pump a single man, within the hour, job, instead of the several day, several man expensive proposition it traditionally is. For Fan pumps, Mixers, Agitators, Screw Feeders and such, split sealing technology is the simple answer to improved reliability and lower cost. Mill-wide reliability improvements require involvement from maintenance, production and procurement to form a seal team that focuses on improving the critical and costly failures first. With added support from a qualified seal supplier, mills can achieve the savings that contribute to the bottom line.

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RESPONSIBLE CARE®

Standardised pulp and paper quality testing for process optimisation and control

By **Håkan Karlsson**, Product Manager, Fibre Analysis, Lorentzen & Wettre

In all types of mature production, constant improvements are required for a company to stay competitive. Today it is more important than ever. Search for cost reductions and improved efficiency is always on the agenda. In the pulp and paper industry the goal is to produce a product within given specification at the lowest possible cost – quality testing and monitoring of the process is one way getting there.

MONITORING AND CONTROL OF PRODUCTION TARGETS IN THE PROCESS

Real time data directly from the process line makes it possible to monitor and optimise the process over time – to stay within specification. Real time data can reveal where in the process the quality changes take place and what has an influence on what. Real time data can be integrated in the DCS and QCS systems for monitoring together with other process data. Integrated data is an excellent base for application of modelling and prediction tools, which can further improve the information to the operators. Without accurate and reliable process data, operators and other staff cannot optimise the process and thereby not utilise the full potential of the process.

INTEGRATED QUALITY TESTING ALONG THE PROCESS LINE

Lorentzen & Wettre provides automatic quality testing systems close to the process (both on pulp and paper) for control and optimisation, based directly on relevant and accessible data, in the operator systems. This means that skilled personnel no longer need to perform repetitive routine work, giving them more time to improve the quality and process. Integrated quality testing along the process line makes it possible to change the production target over time and thus save money. Return on investment is often less than one year.

Constant small improvements lead to huge improvements in the long run. Many disturbances origins in the wet end and these can be measured online to predict the final paper product from wet pulp properties, which is the main purpose of pulp quality testing. Further, if we know the impact from the pulp properties on the final product, we can optimise and control the process for best economy.

L&W Pulp Tester is an online automatic wet laboratory for pulp quality and stock preparation. It

In the pulp and paper industry the goal is to produce a product within given specification at the lowest possible cost. Quality testing and monitoring of the process is one way of getting there

	Average	High
Production increase	0.17%	1.5%
Additive usage reduction	2.2%	5%
Claims reduction	9.12%	20%
Fibre usage reduction	0.23%	1.5%
Breaks reduction	7.21%	30%
Cull reduction	8.24%	20%
Manpower reduction	1.24 per shift	3 per shift

Table 1 *Typical savings according to customer survey*

Handsheets	Less than 1 test/day
Other manual wet tests	Less than a few per shift
Online automatic laboratory	One every fifth minute

Table 2 *Measurement frequency of pulp quality*

The following properties and methods can be used to characterise the pulp quality:

- **Freeness (CSF/SR)**
- **Fibre properties (length, deformations, width, coarseness, fines)**
- **Strength potential (burst index, soft-sensors from fibre properties and freeness)**
- **Chemical composition (soft-sensor from NIR spectra)**
- **Optical properties (brightness, whiteness, colour, fluorescence, estimated residual ink)**
- **Cleanliness (vessel cells, shives)**

operates according to established standards for specified properties and uses the latest technique for optical measurements. It is designed to cover pulp quality for different pulps and it combines different techniques in order to get a solid base for modelling of sheet properties.

L&W Autoline 400 is an automated paper testing laboratory that has become a vital part of the production control in many mills. Data from the automated quality systems in these mills are the foundation on which the operators build their control of product quality. The main advantage from introducing automatic laboratories is not cutting staff costs, but the fact that moving laboratory testing closer to the production does improve both quality control and production efficiency. Further the compliance with international standards facilitates comparing results from different equipment.

Picture 1 *Paper machine and stock preparation; Automatic quality testing of both pulp and paper quality are integrated and monitored in real time in the operator systems*

Picture 2 *A fibre quality transmitter admits continuous sampling and makes it possible to monitor the process*

Picture 3 *A paper sample is fed into the system and measurements start automatically*

Picture 4 *Automatic pulp testing according to industry standards*

AUTOMATIC WET LABORATORY TESTING

A comprehensive online pulp quality testing system needs to be stable and reliable, present data from repeatable testing, and be available at all times. To maintain high uptime, maintenance work and cost must be limited. This is achieved by using proven components of high quality and an automatic cleaning system. Furthermore, the pulp samplers need to be robust with a unique design to prevent the samplers from jamming. The sample is diluted directly at the sampling point and transported at low consistency in separate tubes to the testing system. All this, and much more is L&W Pulp Tester. Reliability is very important, and it is achieved when international standards are met and little or no calibration is needed. Calibration of online units has been regarded as a major problem, but L&W Pulp Tester uses methods close to, or exactly following established standards in order to improve reliability.

With manual testing, measurement frequency is very occasional, as illustrated in table 2. Manual testing generates more of historical data. An automatic system measures continuously and with a system like L&W Pulp Tester, based on six samplers, complete data can be reported every 30 minutes. Single point measurements can be reported every five minutes. If faster response time is required an inline fibre quality transmitter (for example L&W Fibre Quality Transmitter) can be installed, for reporting every minute or even faster.

AUTOMATIC PAPER TESTING

L&W Autoline 400 is an automatic paper testing laboratory providing reliable, accurate and precise information about the quality and condition of the paper. It can perform almost all quality testing, prepare reports, archive data, and communicate with other devices that monitor process parameters. Furthermore, most of the measurement methods conform to well-established industry standards, thus maintaining the continuity of information obtained from previous testing instruments. All this while generating positive cash flow by improving quality and reducing costs. Connection to a mill-wide information network ensures that the crucial information can be in the papermaker's hands within minutes of reel turn up.

In order to get the results as soon as possible it is necessary to measure all properties directly in the process. This is of course not possible for tests of strength properties, since those measurements are destructive and therefore offline testing is still required. At every shift of tambour, profiles from the reel are cut out manually, after that everything is automatic and operator independent.

It has long been recognised that the traditional system of manually gathering and testing paper samples can produce unacceptable levels of measurement uncertainty. With L&W Autoline 400, the sample preparation is always done in the same way; it is always the same position in the profile that is tested. Testing is done in true MD (machine direction) and CD (cross direction), and it is possible to measure several data points in each profile.

Significant reductions in test variation have been reached. This reliability improvement, combined with quick access to test results, allow the paper maker to shift production targets, and achieve a more consistent performance. The capacity to quickly measure and report more than 50 different paper properties means that one L&W Autoline 400 can serve several paper machines with a minimum of manpower.

For example, an optimised testing program of an eight metre wide web, in 20 positions, takes approximately eight minutes. As soon as the measurements are completed the results are displayed directly on the screen as cross-direction profile graphs or in table form. Data from each measured reel of paper can be documented just as easily. The results are used to verify paper quality and optimise the process. The fast feedback enables the machine operator to correct any faults in the paper machine during operation, thereby preventing the next reel from also being outside specifications.

Important objectives for automatic pulp and paper testing are:

- **Automatic sample preparation leads to; accurate measurement of MD/CD properties**
- **Correct positioning in CD**
- **Cost reduction**
- **Meet increasing customer demands for more measurements and measurements related to each roll in CD**
- **Enough statistics for optimisation of the process**
- **Enough statistics for calibration of QCS systems**

With standardised quality testing the process operators can produce a product within given specification at the lowest possible cost. Reliable, rapid and cost-effective measurements of pulp and paper properties throughout the process are necessary for product optimisation – and measurements according to established standards is the best way getting there.

Calibration of online units has been regarded as a major problem, but L&W Pulp Tester uses methods close to, or exactly following established standards in order to improve reliability

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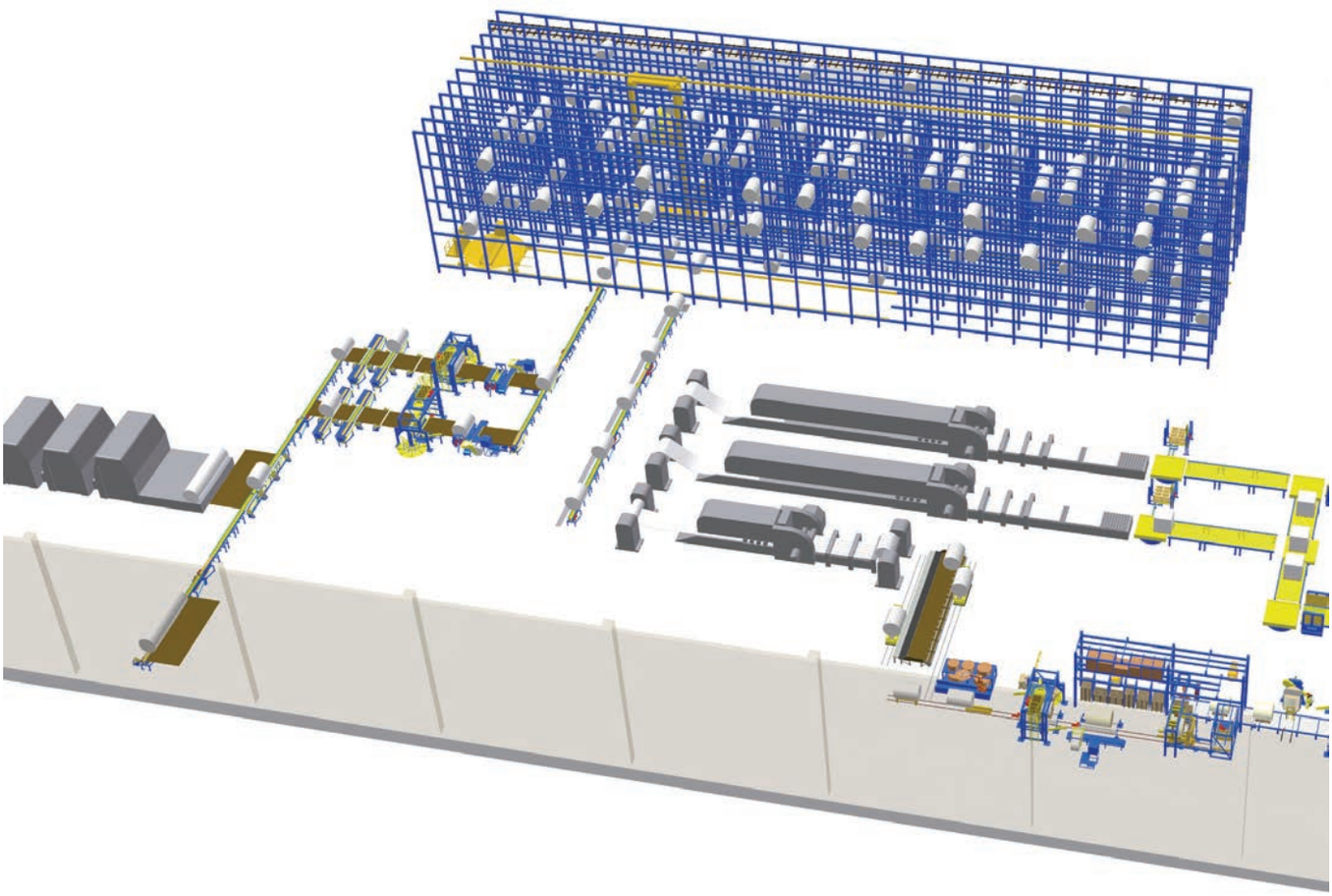

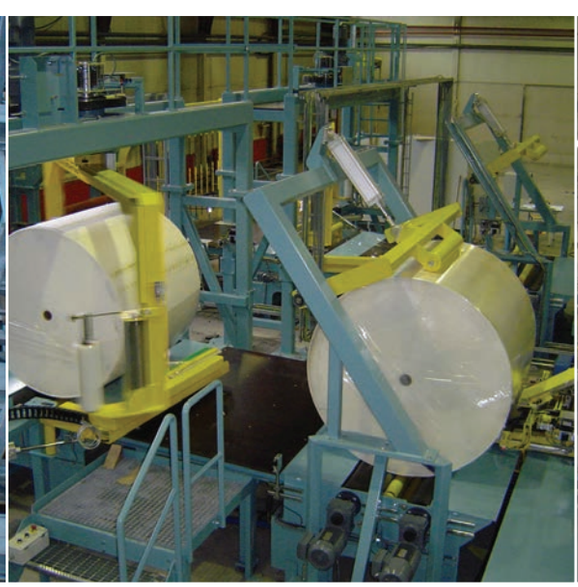

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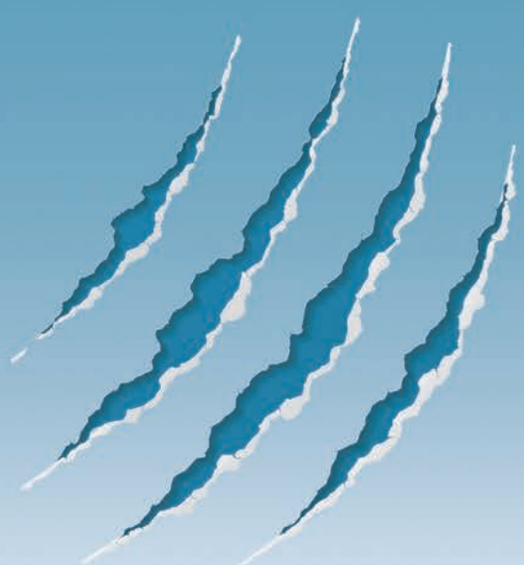


ZELLCHEMING, BRIDGING THE GAP BETWEEN RESEARCH AND INDUSTRY

Dry strength chemicals help paper producers to achieve sustainability targets

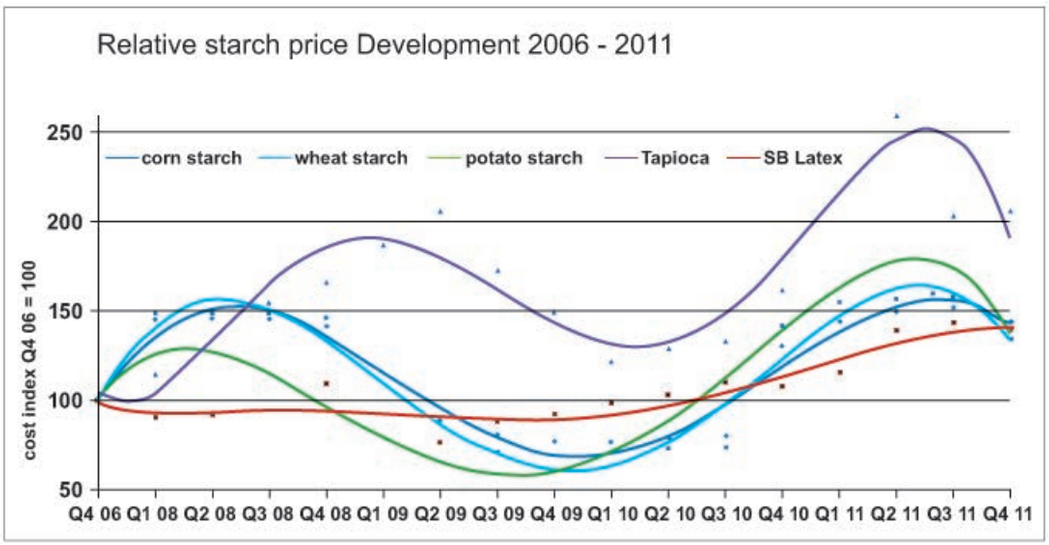
By **Jan-Luiken Hemmes**, Sr Manager, Business Development for Printing and Writing, Kemira Oyj

Recent developments in dry strength markets for the global paper industry, traditionally dominated by natural binders, is the starting point for a review of synthetic dry strength chemicals. Kemira's newly developed grade specific dry strength concepts and the value for the paper producer is analysed and future perspectives discussed.

STRENGTH MARKET

Although dry strength additives have been used in paper and board production from the beginning, more recently, the need for increased volumes and better products has developed. High fibre cost and increased recycled fibre usage have become dominating factors for cost competitiveness of paper producers globally. For graphical paper grades, higher filler levels and changes in the fibre mix as well as increased speed of paper production and printing and converting operations drive strength chemicals demand. In packaging grades, reduced strength of incoming recycled fibres, high filler carry over from mixed office waste and the trend to decreased material weight of the packaging boxes require more dry strength.

Natural dry strength chemicals and mainly starch have and still are dominating this market. At the same time, higher conductivity and salt levels as a result of reduced fresh water consumption and water systems closures create a more and more demanding environment for these products to work. The dosage amounts of starch in the wet end are limited. The main reason for this is the water binding effect of the starch polymer which reduces the rate of water removal on the wire and in the press section of the paper machine at high addition levels and consequently reduces productivity. Technical starches come as a polydisperse mix with a wide molecular weight distribution. In practice this means that some amount of lower molecular weight material is poorly retained with the paper, accumulating in the water system, feeding the microbiology and giving rise to COD.



Graph 1 *Relative price development trend of different starch sources 2006-2011 (sources: Paper Chem Report, Tapioca Starch Association)*

It is widely known that starch has been an economically sound approach to enhancing the strength of paper and packaging material

It is widely known that starch has been an economically sound approach to enhance the strength of paper and packaging material. If one takes a closer look at the relative price development trend of different starches during the last five years (Graph 1) it can be noticed, however, that there is reasonable volatility as well as a longer term trend to substantially higher price levels. A standard latex as an example for a synthetic dry strength additive used in big volumes, when compared on these terms, is subject to much lower variation and overall increase in relative cost. The reasons are quite well known and can be summarised with demand from higher value added applications for starch in food and other markets as well as increased use for energy applications.

Finally, new requirements for fibre-based materials properties and improved functionality in usage and printing will dictate application of designed dry strength technology solutions also in the foreseeable future. All this is reason enough to have a fresh look at synthetic strength polymers – which although available for many years have not gained a lot of overall market share from the traditional starch products.

KEMIRA DRY STRENGTH PORTFOLIO

The efficiency of dry strength chemicals is strongly affected by molecular weight and available polar groups for bonding. As important, however, are the conformation, ionic charge and three-dimensional structure of the polymer because it affects the amounts which can be absorbed on the fibre and the sensitivity to other factors that impair dry strength development – namely high conductivity and competition of low molecular weight interfering organic substances.

Major progress has been made during recent years in understanding how different co-polymers, grafting of polyacrylamide on natural polymers, crosslinking and other chemical modification can be utilised to design the functionality necessary to achieve efficient dry strength performance in various paper grades.

As a result, a portfolio of modified polyacrylamide-based dry strength polymers is now available for various paper grades and fibre raw material compositions which find their application in tissue production, graphical and packaging grades (Table 1). The polymers can be pumped in liquid form, no additional make down equipment is usually necessary at the mill. The selection of the polymer for every case is dependent on the fibre and process chemistry, water quality and intended effect on drainage.

Kemira Fennobond strength polymers

Chemistry	Aionic solution PAM	Atmospheric solution PAM	Glycoxalated solution PAM	Low cationic polyacylamide graft polymer
Main fibre furnish	Kraft / RCF	RCF / SGW	Kraft / RCF / OCC	RCF / Kraft
Stability days at 25°C	180	365	60	90
Effect on drainage	+/-	++	++	+
Dosage kg/t	1-5	1-10	5-30	5-20

Table 1 *FennoBond strength polymers*

APPLICATION CONCEPT FOR DRY STRENGTH CHEMICALS

Our application approach for dry strength is based on three different cornerstones:

1. Optimised retention and formation

2. Load fibres with dry strength polymers to enhance fibre-to-fibre bonding efficiency

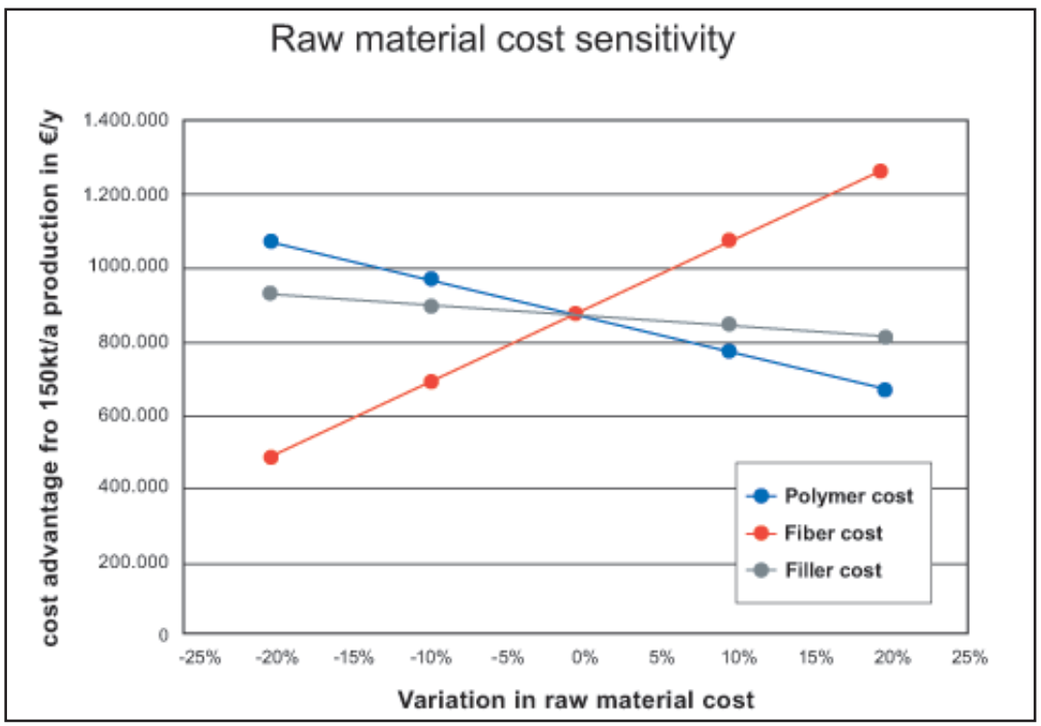
3. Load fines and fillers with additional polymers to control even formation, neutralise disturbing substances and further increase the number of bonds in the paper sheet

The retention and drainage system is an integral part of the dry strength concept in any individual case. Without the right selection of all chemical components, proper adjustment of polymer charge densities and dosing sequence of the individual products the retention polymer will not be absorbed to the fibre and thus be less or not efficient at all. In addition by applying the latest generation of retention chemistries like the KemForm technology higher strength by better formation is already achieved without additional dry strength chemicals. Increased filler levels of 1-3% points were realised in uncoated fine paper production lines.

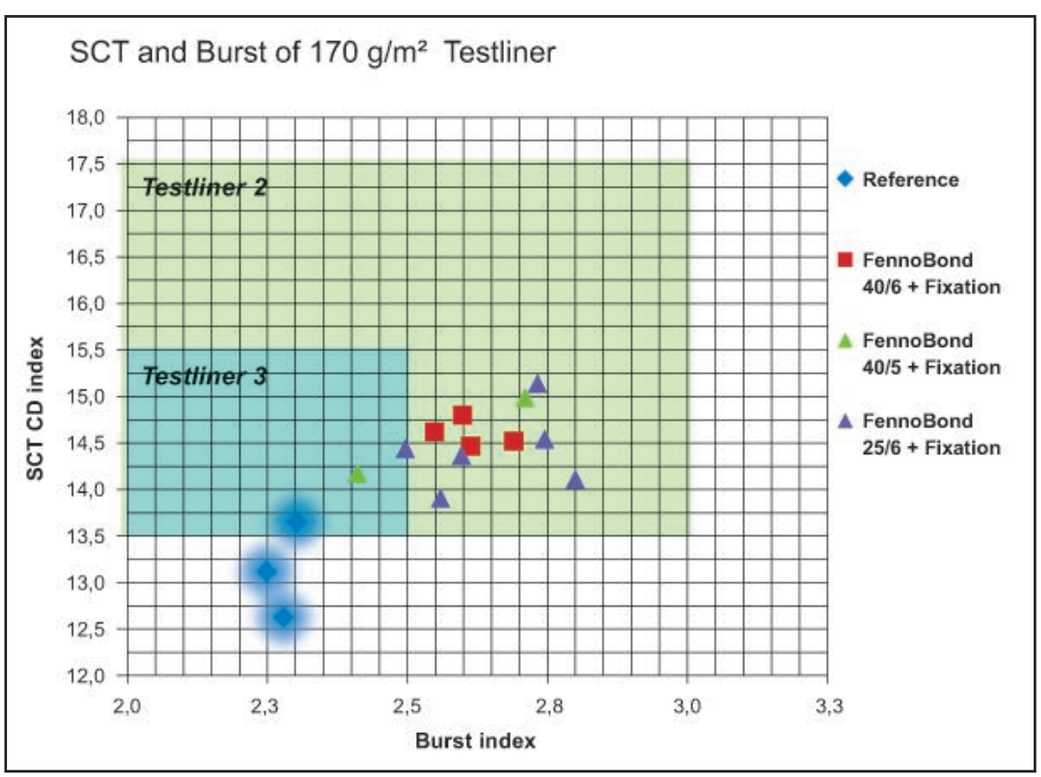
The main challenge is often that fines content, colloid charge and disturbing substances vary over time

Depending on the source and quality of the fibres, the dry strength polymer has to be tailored in structure and charge (and chemical composition). Anionic, amphoteric or combinations of different products can be used to achieve the necessary loading level to achieve the strength targets.

The third cornerstone of the application concept is the most difficult to achieve. The main challenge often is that fines content, colloid charge and disturbing substances vary over time. To selectively load that material with polymer, and then flocculate it to retain it to the fibres and finally create an even distribution inside the sheet requires more than a comprehensive understanding of the system. The variations must be measured and



Graph 2



Graph 3 *SCT and Burst of 170 gsm Testliner*

translated into the proper polymer dosage – which requires following the system chemistry by advanced monitoring and control tools.

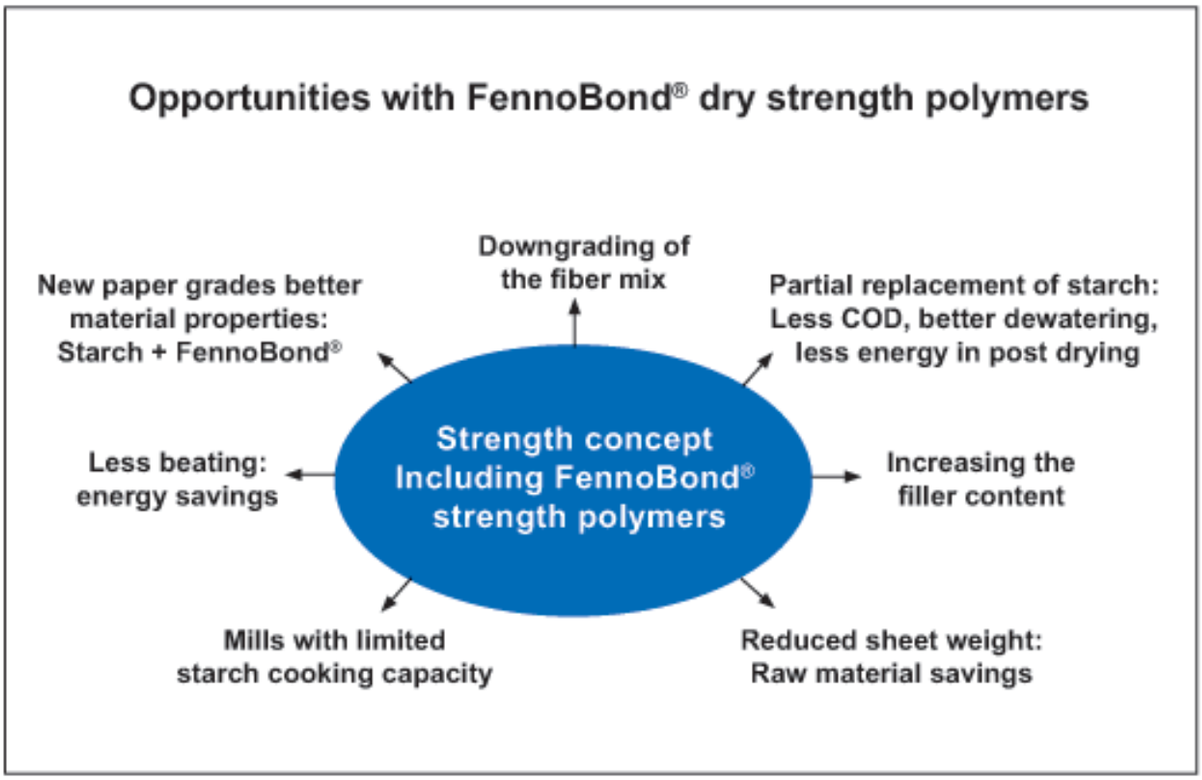
VALUE CONCEPT EXAMPLES

Higher filler in coating base paper

A significant increase in filler content of fine paper can be achieved when synthetic dry strength chemistry is combined with wet end starch. A mill was using around 10kg of wet end starch to run a coating base sheet with a filler content of 21%. By addition of 6kg of FennoBond synthetic dry strength agent breaking length could be increased by 500m. This gave room to increase the filler content by 2% which translates into raw material savings in the range of 900,000 €/a for 150 kt yearly production. Bulk, stiffness and other key properties of the base sheet remained within specification. As raw material prices tend to be volatile these days it is not enough to determine the value at a given time and market price. A cost sensitivity calculation helps to show how robust the concept behaves against cost variation in the raw materials (graph 2) and what are the achievable overall monetary benefits.

Testliner total Material cost improvement

Strength characteristics like SCT (short compression test) and Burst are the key material properties which define the specification and by that the value of testliners for OCC-based corrugating boxes in their market. Failure to achieve those specifications means downgrading and loss of value while reaching the minimum specification of the next higher grade results in upgrading and added value for the mill. The right dry strength chemistry



Graph 4 *Opportunities with dry strength polymers*

approach can help in several ways (see Graph 3); either to retain the value by compensating strength variations from the incoming OCC material so that the target specification can be reached safely; or by upgrading to the next higher value grade (e.g. Testliner 3 to Testliner 2).

Other possibilities are to reduce fibre raw material and weight of the final packaging or change to higher ash content with maintained strength characteristics. Depending on the quality and price of the available fibre, even substantial dry strength treatment cost can be justified by the higher market value of the packaging material.

Multiply board stiffness increase

Stiffness improvement of multiply board is another application area of dry strength chemistry which has caught our attention more recently. It has been found that combination of dry strength polymers in the outer layers can very efficiently raise the stiffness level of the board - and further to what has been possible with starch. Treatment cost of this approach is very moderate and our industrial trial experience so far suggests that through total fibre savings in the range of 0,5 and 1 Mio €/a are possible even for a smaller production unit with 100 kt annual production. For cartonboard grades where value is based on bending stiffness this concept gives significant fibre cost savings.

SUMMARY AND OUTLOOK

The closure of papermachine systems in order to use less fresh water, consume lower amounts of electrical and steam energy as well as the use of more mineral fillers in the production of graphical and packaging paper and board is a continuing trend. At the same time availability of high quality virgin and recycled fibres at price levels we were used to is questionable for the future. This development requires new and more advanced strength concepts than were available in the past.

A new generation of synthetic dry strength polymers specifically designed to the functional needs of fibre raw materials and paper processes used complements existing starch-based technology

A new generation of synthetic dry strength polymers specifically designed to the functional needs of fibre raw materials and paper processes used complements existing starch-based technology.

This not only enhances the flexibility of the paper and board maker to develop and adjust the material properties of his products but also enhance the sustainability of his process by saving raw materials, energy and water (see Graph 4).

A prerequisite to achieving these accomplishments in the most effective way and at the lowest chemical cost is an advanced application concept of process chemistry which includes retention and drainage control, process water and broke treatment.

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Play it safe!

By **Dipl.-Ing. Klaus Haiden**, R&D Manager Press Felts, Huyck.Wangner Europe
and Ing. **Christian Küberl**, Marketing Director Press Felts Europe, Huyck.Wangner Europe

Today's top priorities in paper production are quickly defined: 'Highest possible machine efficiency at maximum machine speed, reached with lowest possible energy consumption!'

The papermakers who meet these challenges best are the ones that will survive in this globally very tough economy. Paper machine clothing (PMC) suppliers have recognised these challenges and the high influence their products have on these key parameters at relatively low 'investment' costs with a fast ROI (return on investment).

In addition to operational and economic challenges, the most important priority in paper mills is safety. Paper machines still present numerous risks for the machine crew due to their huge dimensions, high operating speeds, dangerous chemicals and elevated temperatures required for the production process. The risk of an accident or health hazard during normal production is quite low because no human intervention is required in the areas of danger during normal operational periods. One of the highest risks still prevails when the clothing is changed.

On these occasions, up to 10 machine crew members are required to climb around in the open machine, at high elevations and slippery conditions, to install the endless felts. At some positions felts with weights up to 500kg have to be set up manually which requires the highest physical strain on the operators involved. With today's technology, this high potential risk is not necessary anymore!

In addition to operational and economic challenges, the most important priority in paper mills is safety! One of the highest risks still prevails when the closing in the press section is changed

HOW CAN PMC SUPPLIERS CONTRIBUTE TO INCREASING THE SAFETY ON THE PAPER MACHINE?

The development of seam felts fully addresses this safety aspect.
Driven by PMC suppliers in North America, where in 2010 the share of seam felts was already more than 65% of all felts consumed by the paper industry, Europe has been following this trend (Fig.1). A strong and steady growth of seam felts proves that European papermakers have become more and more aware of the safety benefit of seam felts, and they no longer want to miss this advantage.

Currently in Europe, 27.6% of the total felts shipped to the paper industry are seamed felts, which is an all-time high. The high demand suggests that the 30% limit will be exceeded within the next three years!

NO LIMITS FOR SEAM FELTS!

Xerium has had a strong focus on the seam felt developments over the past 15 years. Continuous optimisation of seam stability, flap anchorage and the development of new, high-performance base structures have substantially opened up the application field for seam felts. In addition to conventional applications, crescent former tissue machines, shoe presses on demanding graphical paper grades and high machine speeds are no longer an exclusion criterion for the use of seam felts.

The shoe presses in particular have been a big challenge for Xerium's R&D team, but this mission has also been completed successfully (Fig.2).

SHOE PRESSES REALLY CHALLENGE THE SEAM FELT!

A demand for seam felts in shoe presses – besides the marking freeness of the seam area – is the absolute stability and durability of the seam structure itself.

In the single felted shoe press nip the press felt has to transmit the drive load from the driven roll to the flexible shoe press belt and drag this one along. Because of this situation there is a significant tension difference in the felt between the press nip entrance and the nip exit. For endless felts this effect is not as critical due to its inherent structure.

For seam felts, the engineering and manufacturing techniques of the seam loops has advanced significantly to reduce these negative effects. The situation is even more demanding in a double felted shoe press. In this case, the drive load is transmitted from the roll to the bottom felt, which passes to the top felt, thereby turning the shoe press belt. Running such a configuration means that – in case of seam felts – the bottom felt has to sustain a lot of MD tension without opening up at the seam area.

CALCULATIONS ON SEAM YARNS

In the following calculation, the importance of sufficient yarn anchorage and material strength is demonstrated. We consider the situation in a double felted shoe press (Fig 3) which is more critical compared to the single felted shoe press with respect to the affecting loads.

Due to the felt tension and the connection via the pintle wire, the forces on every seam loop are defined. The forces in place lead up to a situation as follows:

At the seam loop the sum of all loads is zero:

$$\sum F = 0$$

The forces which are effective at the seam loop are F_L (Loop load coming from the felt tension) and the force F_Y (yarn anchorage) (Fig. 4):

$$F_L = 2 \times F_Y$$

The MD yarn anchorage is measured in the laboratory and is defined as the load which is necessary to pull a 9.0 cm long MD yarn out of the press felt construction. The diagram in Fig.5 shows the pull-out forces of the design ProSeam SP in comparison to a standard seam felt design under wet conditions.

To estimate the safety performance and security reserve of a seam felt in a double felted shoe press, it is necessary to calculate the risk. The safety factor is defined as:

$$S = \frac{bearable\ load}{present\ load}$$

and gives information on safety reserve. In this respect, values over 1.5 can be judged as safe and everything under 1.1 as critical.

SAFETY FACTOR CALCULATION FOR A STANDARD SEAM FELT

To calculate the force on each seam loop, the total felt tension has to be

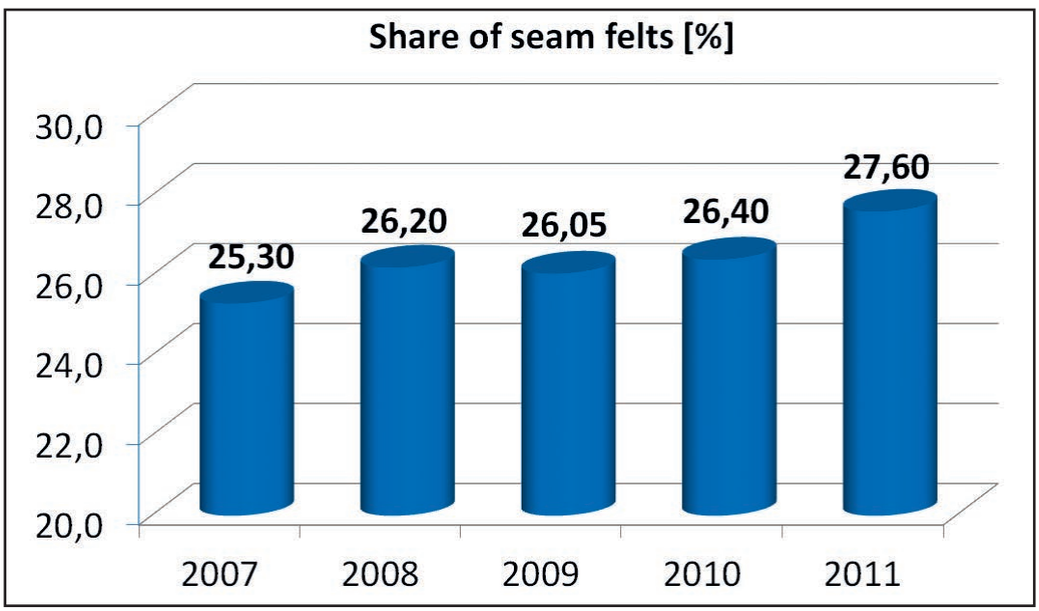

Figure 1 *Seam felt market share trend in Europe*

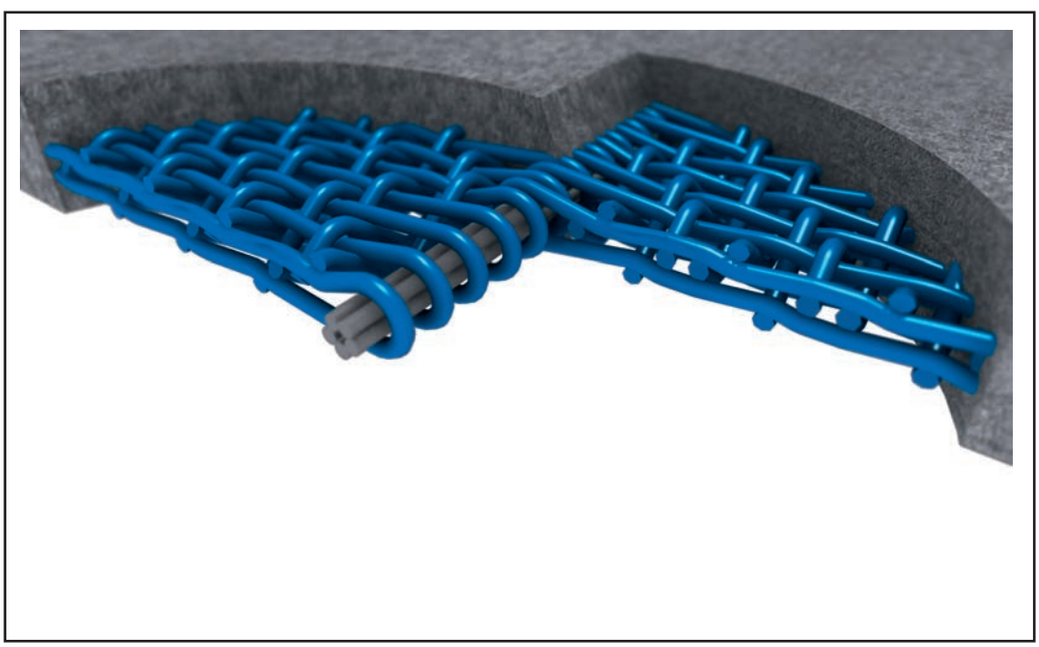

Figure 2. *ProSeam SP seam felt*

broken down to the load onto a single loop. The maximum force which can be applied to the yarn of a seam loop is equal to the yarn anchorage F_{YA} measured in the laboratory:

$$F_{YA,\ Std.} = 23{,}1\ N$$

The felt tension at the tension roll is considered to be 5.0 kg/cm.

$$5{,}0\frac{kg}{cm} = 49{,}1\frac{N}{cm}$$

The loop density of the seam felt is:

$$88\ \frac{loops}{10cm} = 8{,}8\ \frac{loops}{cm}$$

Load on one seam loop F_L:

$$F_L = \frac{49{,}1}{8{,}8} = 5{,}6\ N$$

Load per yarn of each seam loop F_Y:

$$F_Y = \frac{1}{2}\ F_L = 2{,}8\ N$$

Within the press position, the bottom felt has to carry additional rolls and drag by suction boxes. This circumstance results in a significantly higher felt tension at the entrance of the press nip. The felt tension can be up to 150 – 200 N/cm which is 3 – 4 times as much as the display in the control stand shows.

Load increase on the yarn

$$F_{Y,Press\ min} = 3 \times F_Y = 8{,}4\ N$$

$$F_{Y,Press\ max} = 4 \times F_Y = 11{,}2\ N$$

In the above mentioned double felted shoe press, the bottom felt has to drag along the top felt and the shoe press belt. The force on the bottom felt is thus increased and the seam of the seam felt is further stressed. We estimate that this increases the load on the felt by another 1.5 to 2.0 times.

$$F_{Y,SP\ min} = 1{,}5 \times F_{Y,Press\ min} = 12{,}6\ N$$

$$F_{Y,SP\ max} = 2{,}0 \times F_{Y,Press\ max} = 22{,}4\ N$$

The safety factor "S_{Std}" for a standard seam felt is calculated as

$$S_{Std} = \frac{F_{YA,\ Std.}}{F_{Y,SP\ max}} = \frac{23{,}1}{22{,}4} = 1{,}0$$

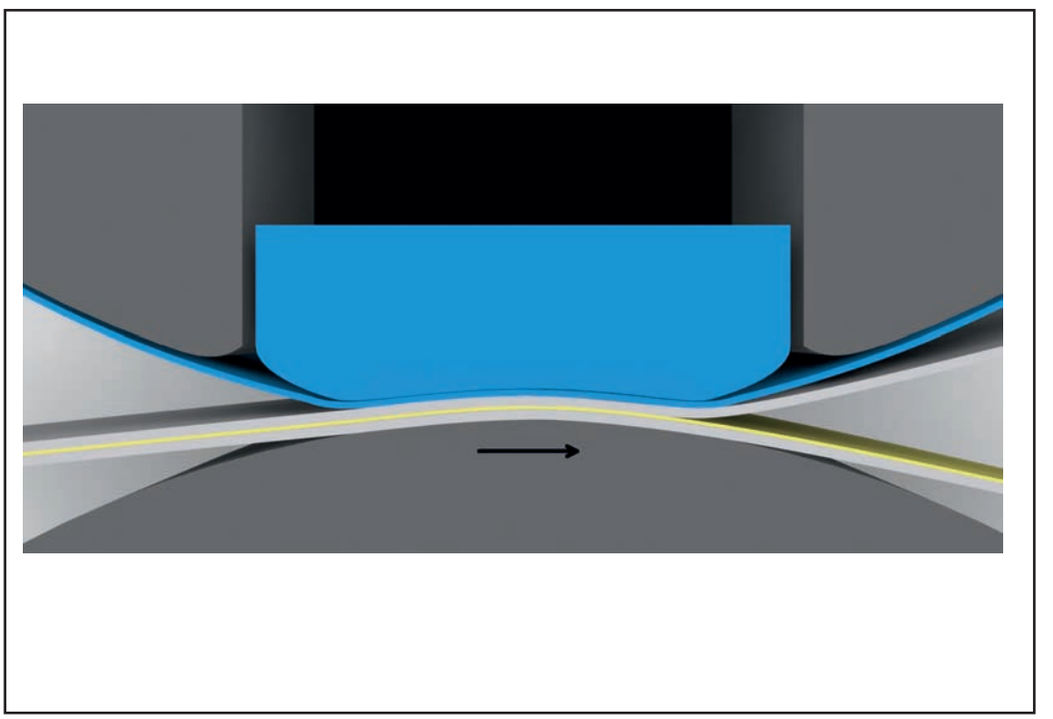

Figure 3. *Double felted shoe press*

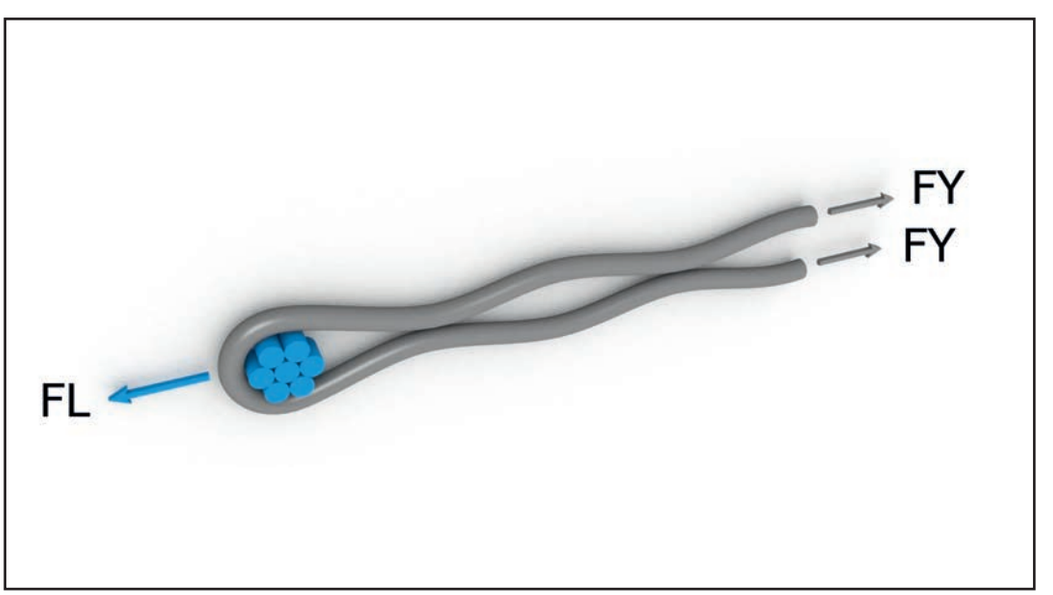

Figure 4. *Balance of forces on a seam loop*

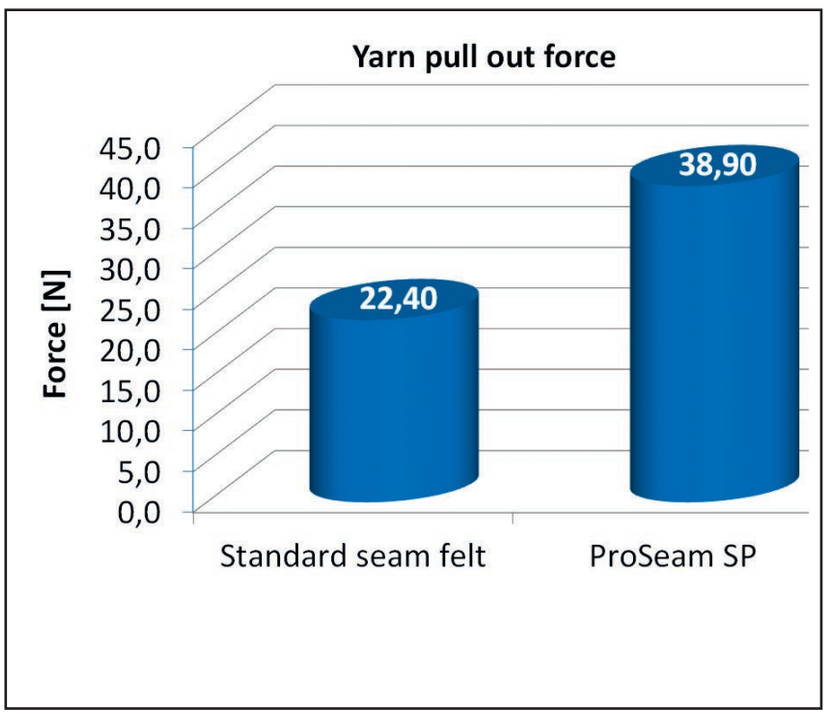

Figure 5. *Yarn pull-out forces of a standard seam felt compared to ProSeam SP (both under wet conditions)*

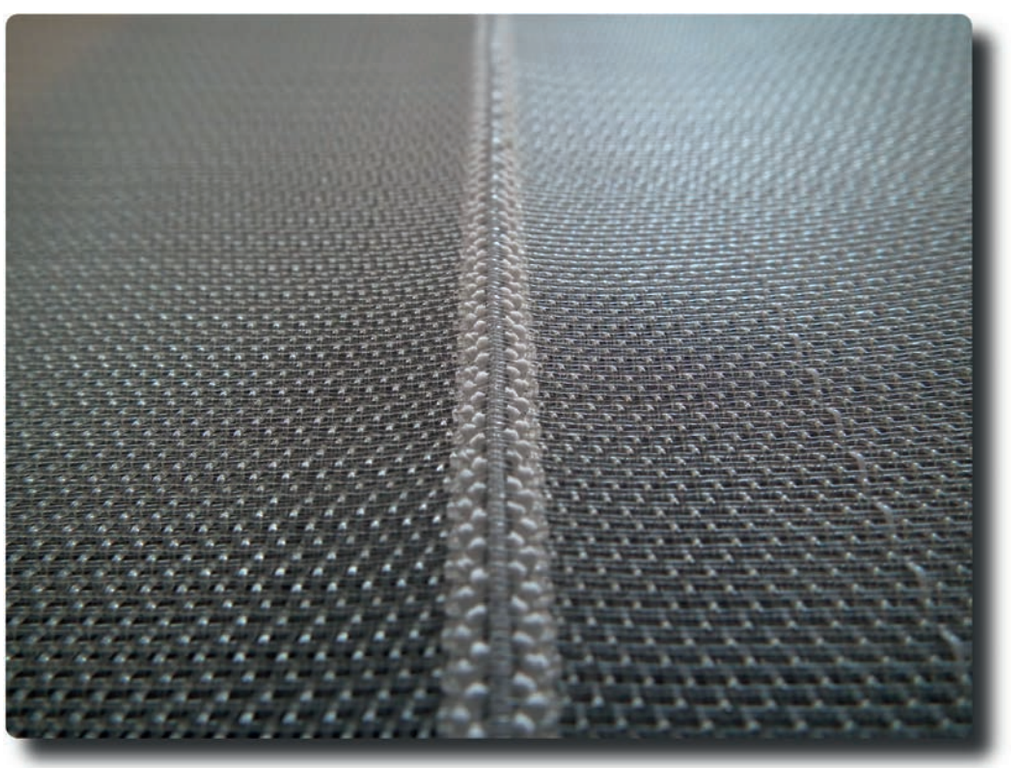

Figure 6. *Patented Leno seam reinforcement*

The special weave pattern in combination with highest material quality and proven manufacturing technology ensures the safe performance of the design ProSeam SP in single or double felted shoe presses

A safety factor of 1.0 means that there is no security reserve, and local tension differences during the run can lead to the seam opening. In this case the felt has to be removed. This happens in the first one or two days where the felt is not yet compacted. The lower specific load of a shoe press additionally delays the press felt compaction.

SAFETY FACTOR CALCULATION OF A PROSEAM SP FELT

The maximum force which can be applied on the yarn of the ProSeam SP seam loop is equal to the yarn anchorage F_{YA} measured in the laboratory:

$$F_{YA,ProSeam} = 38{,}9\ N$$

For the ProSeam SP calculation, the same felt tension and loop density as before are valid.
Felt tension: 5,0 kg/cm = 49,1 N/cm,
Loop density: 88 loops/10cm = 8,8 loops/cm
Load on one seam loop F_L:

$$F_L = \frac{49{,}1}{8{,}8} = 5{,}6\ N$$

Load per yarn of each seam loop F_Y:

$$F_Y = \frac{1}{2} F_L = 2{,}8\ N$$

Load increase on the yarn due to the situation in the press circuit:

$$F_{Y,Press\ min} = 3 \times F_Y = 8{,}4\ N$$

$$F_{Y,Press\ max} = 4 \times F_Y = 11{,}2\ N$$

Load increase due to situation in the double felted shoe press (dragging along the top felt and the shoe press belt):

$$F_{Y,SP\ min} = 1{,}5 \times F_{Y,Press\ min} = 12{,}6\ N$$

$$F_{Y,SP\ max} = 2{,}0 \times F_{Y,Press\ max} = 22{,}4\ N$$

The safety factor "S_{SP}" for the ProSeam SP seam felt is calculated as

$$S_{SP} = \frac{F_{YA,ProSeam}}{F_{Y,SP\ max}} = \frac{38{,}9}{22{,}4} = 1{,}7$$

The safety factor of the ProSeam SP felt is 70% higher compared to a standard seam felt. The special weave

pattern in combination with highest material quality and proven manufacturing technology ensures the safe performance of the design ProSeam SP in single or double felted shoe presses. Proven on some of the most critical double felted shoe presses in Europe, Xerium has collected a successful track record of experience within this application range.

SEAM REINFORCEMENT TECHNOLOGY

In addition to the strict requirements for yarn anchorage and seam stability for seam felts in shoe presses, the marking freeness of the seam is also critical. As previously mentioned, seam felts are no longer limited to "typical" positions. Therefore it was pertinent to develop a durable and marking-free seam. The patented Leno weave (Dreher) reinforcement technology (Fig.6) provides a high level of batt fibre anchorage directly behind the seam loops.

The batt fibres in the seam area are cut with a proprietary tool which provides the identical flap angle regardless of the ProSeam design. This precise cutting angle ensures uniform permeability over the seam and felt body.

CONCLUSION

With the share of seam felts in Europe steadily growing, production managers will continue to increase use of seam felts to avoid risk during felt changes. In addition to the safety improvement, modern seam felt technology provides economic benefits also by reducing downtime due to faster installation. Even within unplanned machine downtimes, seam felt changes are reduced to less than two hours shut down time requiring only two people for the complete installation. Compared to endless felts, this benefit alone is of high value! The continuous development focus on seam felts at Xerium provides high-performance solutions for basically all applications. Advancements in raw materials and base fabric structures already provide felt designs that fulfill the demands of marking-sensitive press applications for graphical paper grades.

ProSeamSP is the first seam felt design that was specially developed to manage the demanding conditions in the press nip of shoe presses. The main focus was the improvement of the seam yarn pull out force to avoid seam opening during operation because of very high local tension.

Additional research to improve seam flap anchorage has led to innovations like the patented Leno seam reinforcement technology, now a proven benchmark in our industry for all paper grades.

FUTURE OUTLOOK

In the coming years, machine suppliers will develop and deliver more machines without cantilever configurations, therefore requiring more seam felt designs and varied application. These machines will not only reduce initial capital investment for the manufacturer, but also promote safer paper mills.

To support this trend, Xerium will continue to develop industry-leading seam felt technology for the most demanding applications.

Proven on some of the most critical double felted shoe presses in Europe, Xerium has collected a successful track record of experience within this application range

Additional research to improve seam flap anchorage has led to innovations like the patented Leno seam reinforce-ment technology, now a proven benchmark in our industry for all paper grades

References

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How can energy savings be increased by press felts?

By **O. Kääpä** (Dipl.-Ing), Vice President Sales, Heimbach GmbH & Co. KG

Efforts towards energy savings have affected the whole paper industry and involve all aspects of the production process. The following article aims to highlight energy-connected facts from the area of press dewatering and the press clothing. In addition to the obvious and direct possibilities of savings, the complex net of indirect energy connections is examined.

FACTS ON ENERGY AND COSTS IN THE PRESS SECTION

In relation to total paper manufacturing costs the costs of press clothing at <1% are fairly insignificant. However, their significance for the production process, for paper quality and for the subject of 'energy saving' examined here, goes for both technological and economical reasons well beyond this cost relationship. From this fact it is clear that a low initial purchase price for the clothing is less important than the level of its efficiency. The felt which saves money to the greatest degree – by fulfilling all the required technical parameters – is the most economical, independent of its purchase price. This case is made here for Heimbach felts.

THE ROLE OF THE PRESS FELTS IN THE REDUCTION OF ENERGY CONSUMPTION

1. Influence of felt saturation on dewatering The degree of saturation of the felt before entering the press nip substantially influences the dewatering efficiency. Only an adequately saturated felt can achieve the maximum dewatering. With inadequate saturation the dewatering pressure in the nip is not sufficient to remove a large volume of water (from both saturation and the sheet) rapidly

It is clear that a low initial purchase price for the clothing is less important than the level of its efficiency

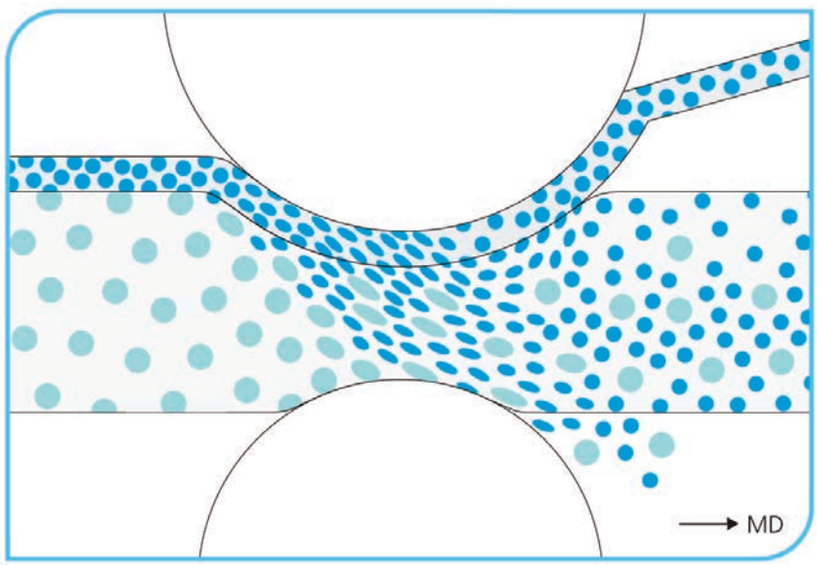

Figure 1 *Insufficient saturation: Uhle box dewatering*

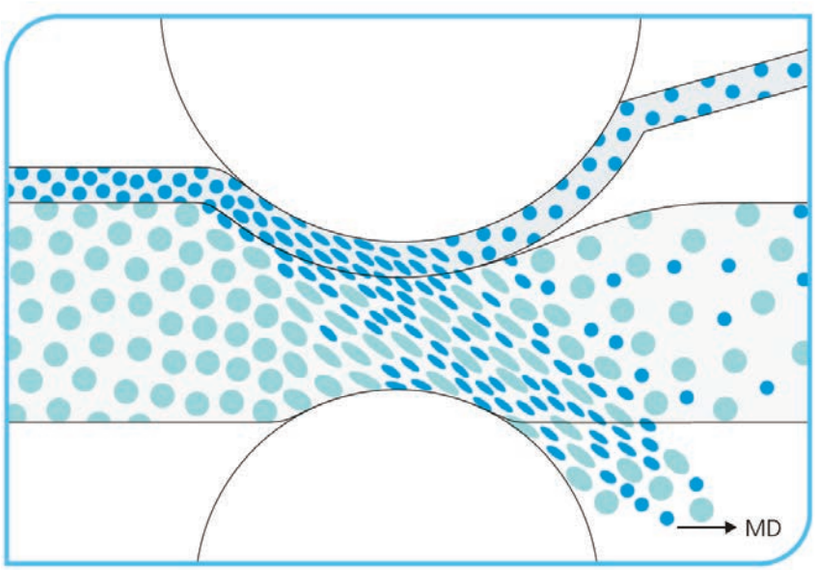

Figure 2 *Optimal saturation: Nip dewatering*

through the felt immediately after the nip. Instead, the insufficiently saturated felt is merely 'enriched' by the water volume from the sheet. This amount of water remains in the open void volume of the felt (Figure 1) and can only be removed by the Uhle Box. As a result nip dewatering is not initiated. Additionally the risk of rewetting is increased (Figure 1, previous page).

With the correct level of saturation (Figure 2) the capillarity of the felt structure is already optimally 'pre-activated' before entry into the press nip – and depending on felt type, now ready for nip dewatering. If the activation only commences within the press nip, the necessary time for the dewatering process is missing. Time frame required: at 1500 m/min and a normal roll press about 1/500th of a second.

2. Uhle box or Nip dewatering?

The laws of physics discourage Uhle box dewatering on fast running machines; there is just not sufficient time available. For example: at 1800 m/min with two Uhle boxes each 15 mm wide the total dewatering time is round two milliseconds. The initial objection: "…in the nip (of a roll) press it is similar". However, in contrast to the nip situation the water in the horizontally running felt has to be removed at an angle of 90° vertically into the slots of the Uhle box – and that at an air velocity of only 10-15 m/sec (Figure 3). In order to achieve adequate dewatering in this way more than two Uhle boxes combined with extremely high vacuum levels would be necessary. Result: higher rather than reduced energy consumption – and that without any increase in the dewatering! Explanation: at an Uhle box vacuum level of around 50 kPa the dewatering pressure is at 3 kN/m. In the nip with 75 to 1200 kN/m it is about 25 to 400 times higher.

This confirms the dewatering system for fast running machines in favour of

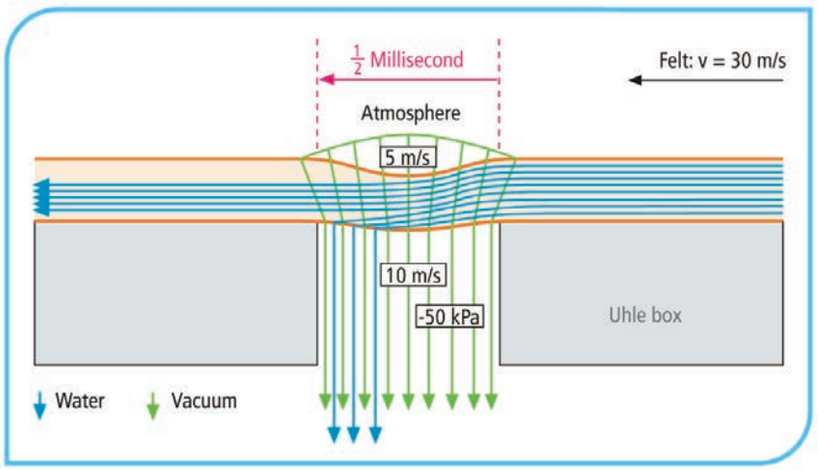

Figure 3 *Uhle box dewatering*

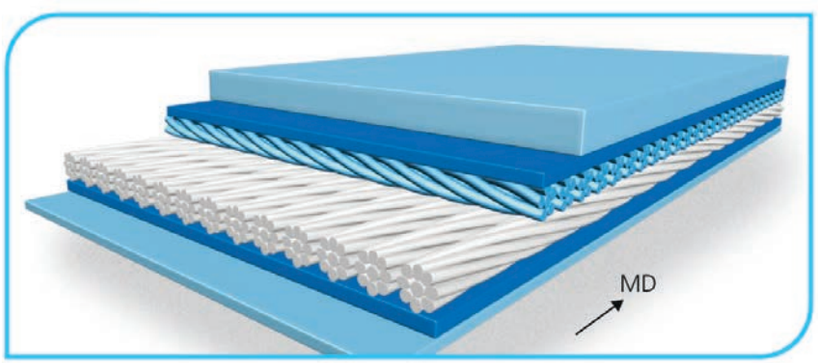

Figure 4 *ATROCROSS felt*

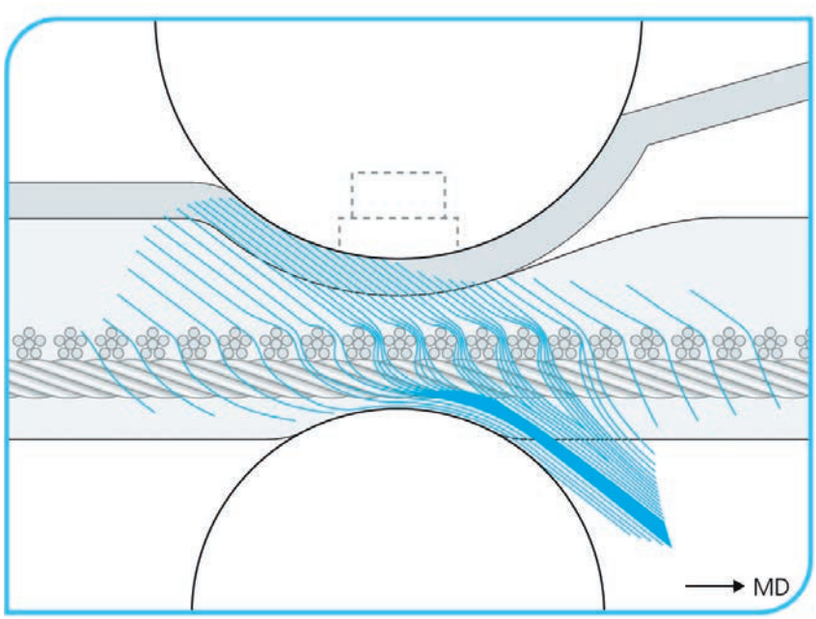

Figure 5 *ATROCROSS: Nip dewatering reduced rewetting*

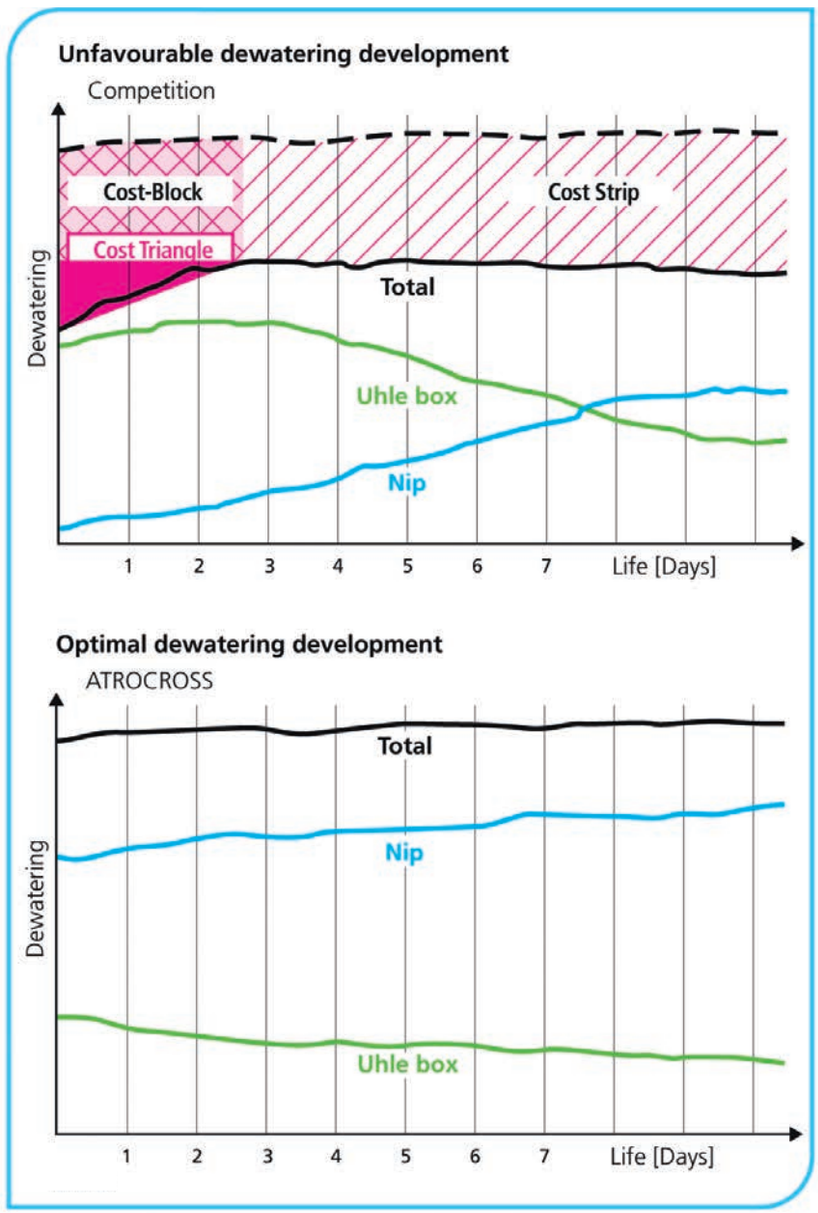

Figure 6A & 6B *Cause/elimination of "Cost Triangle"*

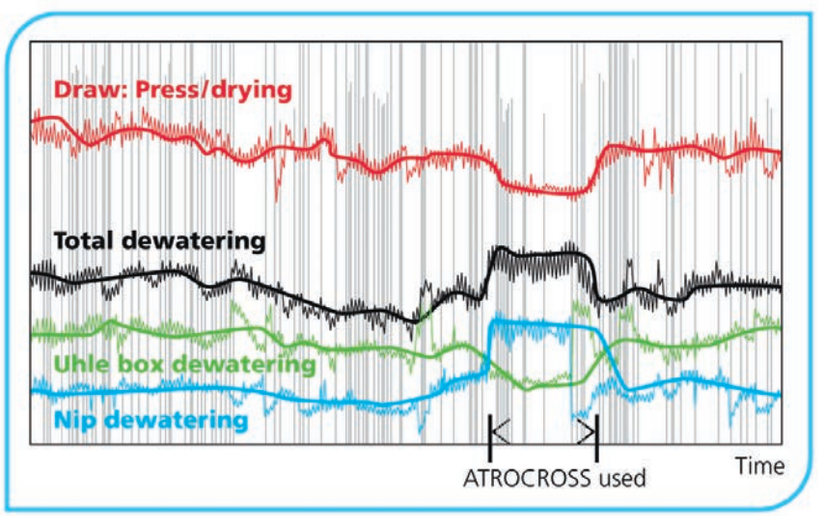

Figure 7 *Comparison dewatering –draw*

nip dewatering. In addition, the complete and intensive water flow through the felt creates a continuous felt cleaning. The Uhle boxes provide only – at significantly reduced vacuum – a residual dewatering combined with felt conditioning. In many cases it has been shown that, where there is successful nip dewatering, the Uhle boxes can be removed entirely.

3. Nip dewatering – the optimal clothing The achievement of maximum nip dewatering requires the use of specially developed press felts. The proven ATROCROSS non-woven felts from Heimbach (Figure 4) combine all the attributes required to achieve a high efficiency nip dewatering (Figure 5). They have proven themselves many times round the world. The experiences made from this brought nip dewatering to its current highly developed level. In this manner, Heimbach has pioneered the way to speeds of more than 2000 m/min.

CASE STUDY 'START-UP AND LIFETIME PERFORMANCE'

Already in the start-up phase of a felt energy savings can be made to a significant extent. In many cases, press felts require two to three days for the full activation of their dewatering efficiency. In the case of the measurement shown in figure 6A (newsprint), nip dewatering developed late with a long activation period and then remained only average over the felt life. The slow increase in total dewatering causes a 'Cost Triangle' which shows up in poor energy utilisation and reduced production. In addition, the relatively low water removal through the Uhle boxes during the whole felt life prevents the highest level of total dewatering from being achieved. In the measurement of the same position, after installation of an ATROCROSS 'fast starter' felt (Figure 6B), nip dewatering at a high level commences immediately after the start.

The Uhle boxes provide only – at significantly reduced vacuum – a residual dewatering combined with felt conditioning. In many cases it has been shown that, where there is successful nip dewatering, the Uhle boxes can be removed entirely

After continual increase, the level is maintained for virtually the whole felt life. The Uhle boxes remain at a low level and assist in residual dewatering.

Calculation of the economic advantages
Measurement 6A: During the 2.75 day start-up phase the average speed at 1632 m/min was 66 m/min below the later achieved maximum speed of 1698 m/min. This caused reduced production of 115 tonnes in the 2.75 days with a sales loss of around €63,000. Measurement 6B: Here over the same period with ATROCROSS the average speed of 1713 m/min was only 12 m/min below the later achieved maximum speed of 1725 m/min. The result was reduced production of only 21 tonnes or about €11,500 during the 2.75 day start-up phase. That means in comparison that the Heimbach felt solely as a result of the immediately almost on maximum level starting total dewatering in the first 2.75 days was able to achieve an additional production of 94 tonnes with a value of about €51,500 = elimination of the 'Cost Triangle'.

Furthermore the 'Cost Block' is also eliminated (see Figure 6A). This was achieved by the generally higher level of start-up dewatering and therefore of the dry content with the Heimbach felt in Figure 6B. This gave the felt an 81 m/min higher average speed during the 2.75 days. The outcome was a production increase of 140 tonnes with a value of approx. €77,000.

Taken in total, the facts in Figure 6B show that alone in the start-up phase an increase in production of 234 tonnes or €128,500 was obtained. And finally the felt also ensures the elimination of the 'Cost Strip', i.e. the life-long low dewatering level (see Figure 6A). In comparison with this the high dewatering level in Figure 6B brings a permanent additional speed of about 27 m/min and with it an additional daily production of approx. 16 tonnes or €9,000.

To recapitulate, these impressive economic advantages are based on the four described technical improvements in the production process: correct felt saturation plus adjustment to nip dewatering, and for this the appropriate clothing, i.e. fast start together with maximisation of dewatering by ATROCROSS.

Advantages for the Energy Balance:
Fast start to highest level –> more dewatering = optimal utilisation of start-up energy and a production increase in the start-up phase of 234 tonnes or €128,500, *in total higher dewatering level over the felt life with reduced Uhle box vacua* = permanently lower energy consumption resp. daily production increase of approx. 16 tonnes or €9,000 = about €2,880,000 per year.

CASE STUDY 'TOTAL DEWATERING'
The dryer section removes by far the lowest share of water from the sheet, but requires by far the highest share of energy. The following case study of a non-woven felt from Heimbach on a machine producing 45 g/m² wood content illustrates that this most cost intensive component can be significantly reduced already in the press section:
After the installation of this felt a dry content increase of 1% (= increased by 2.04%) was recorded after the press section. This apparently low increase – because of the clothing change solely in a single position – achieved over the period of a year an enormous steam saving.

Advantages for the Energy Balance:
Steam saving in the dryers of 5% = 46.2 tonnes per day or €2,310 = steam saving on 350 days per year of 16,170 tonnes or €808,500.

Alternatively the following is valid: If the previous steam usage is applied, then 1% higher dry content or 4% higher production would result. That could bring an increased value of about €8 million.

Positive answers to questions on reducing energy consumption in the press section are substantially determined by the appropriate clothing

CASE STUDY 'BREAK FREQUENCY'
The faster the paper machine, the more important is the role of nip dewatering combined with the most appropriate clothing – highlighted in measurement figure 7. The long-term trend on the previous mentioned machine shows over several installations of other felts comparatively stable curves for felt tension, total dewatering, Uhle box and nip dewatering.

After the installation of ATROCROSS, which dewatered predominantly in the nip, a dry content increase by 2.04% was achieved as a result of the higher total dewatering with the further consequence of an increase in the wet strength of the sheet by 6%. Simultaneously there was a reduction in the draw. As a result of these improvements the break frequency was reduced by 97 breaks (each approx. 20 min) per year.

Advantages for the Energy Balance:
Production time gained = 32.33 hours per year more full energy utilisation of heated dryer cylinders, increased production per year of 1260 tonnes = €781,200.

SUMMARY
The facts covered in this article and their relationships indicate the high degree of complexity on the subject of energy. Positive answers to questions on reducing energy consumption in the press section are substantially determined by the appropriate clothing – and the possible optimisation of dewatering techniques that the clothing permits. The solution of energy saving problems through the use of press clothing stands in direct conflict with the cost pressures on the clothing manufacturer as the supplier of these solutions. This cost pressure hides the risk of a 'braking' effect on new developments which are essential if further reductions in energy consumption and costs are to be achieved.

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Designing world speed record felts for high speed packaging paper machines

By **M.Quarti, M.Lampart -** Press Fabrics Designers, Cristini Group

Above: The Paper Mill Team and Cristini Group Engineers

In March 2010, in Eisenhüttenstadt, the ProPapier Group started up their PM2, the world's biggest and most performing paper machines for the production of brown grades.

The paper machine is a Metso Optipress™ configuration, with a speed of 1900 m/min, designed specifically for the production of Testliner/Wellenstoff from 60 to 125 g/m^2 using 100% recycling. The production capacity is 650,000 tons/year.

Since the start up, 67 fabrics have been installed, showing excellent performance

The press section includes two shoe presses, with a max linear pressure of 1300kN/m. Felt width: 11m (see Fig.1).

START-UP CLOTHING

In May 2009, Cristini Group was chosen as start-up supplier for both the press and dryer section.
The initial decision was to install endless fabrics on both top positions, and seamed fabrics on bottom.

Since the start up, 67 press fabrics have been installed, showing excellent performances and seaming easiness (for the seamed versions).

After this stage it has been decided to run 100% endless fabrics, because of the fabric change efficiency reached by the mill crews.

THE PRESS FABRIC DESIGN

The press fabric design must satisfy extreme production requirement, because of the production speed and size. The water volume to dewater was

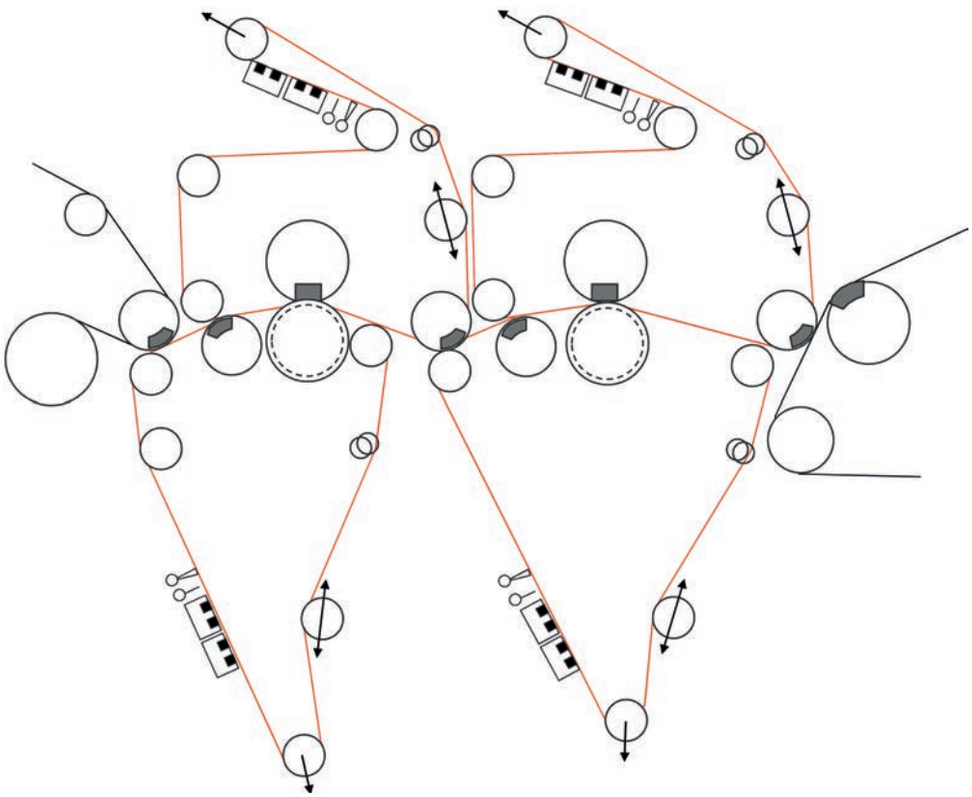

Figure 1. *Press section layout*

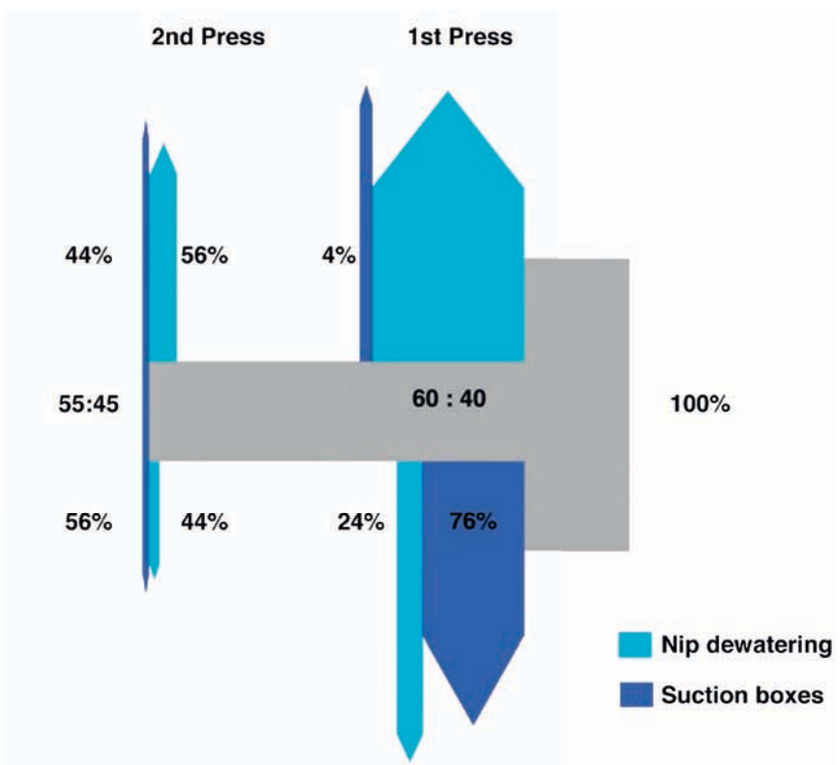

Figure 2. *Water balance in the press section*

an important challenge for the felt designers. The specifications forecasted a high dewatering in the first nip (75-80% of the total dewatering), and 20-25% on the second nip.

The water flows where designed as indicated in Figure 2.

Because of the press geometry, the top felts where required to dewater mainly at the nip, while the bottom mainly at the suction boxes.

The designer's choice was then orientated toward felts with mono-mono base, with high flow permeability and easy cleaning, with a caliper able to develop, in combination with the batt layers, high compressibility thus high 'nip dewatering'.

Press fabric compressibility is defined as the ratio in between the compressible part (normally batt and porous structures similar to fibres) and the incompressible part (traditionally the base fabric). If the ratio allows the compressible part to saturate hydraulically saturate also the incompressible one, the press fabric gains the most important characteristics of a 'nip dewatering' design.

To obtain a correct compressibility ratio along the whole fabric life, a key role is played by the non-woven, porous structures like Komprex™, behaving like a fine base fabric, but having very high compression elasticity (see Fig.3).

Combining these factors, the designer team was able to create for each position, a press fabric matching perfectly each single application requirement.

A typical of DuraFlex™ design, optimised for each position, is composed by a structure indicated in Figure 3 (overleaf).

By fine tuning the batt layering and type of Komprex™ layer, it has been possible to differentiate the behaviour of the top press fabrics (which require high nip dewatering capacity), from the bottom fabrics, which need to dewater

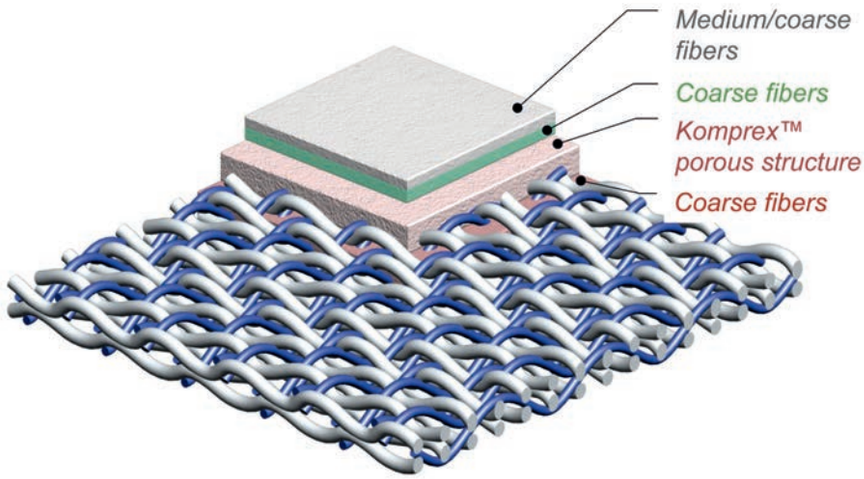

Figure 3. *Structure of a DuraFlex™ press fabric*

at the suction boxes. This difference in felt design takes under consideration the dewatering factors, but especially the machine run ability, which impacts tremendously on its efficiency and productivity.

On the pick-up position it is essential that the fabric surface does not trig 'sheet-stealing' phenomena, with consequent breaks in the size press.

In the bottom position it is capital to obtain a perfect planarity of the paper, not to trig sheet breaks in the second press. The achievement of these results have been obtained with a 'fine tuning' of the fabric structures and porous layers months before the world record speed. Figure 4 shows the void volume gradient of the two concepts. The change in the void volume distribution results into a better efficiency at the nip.

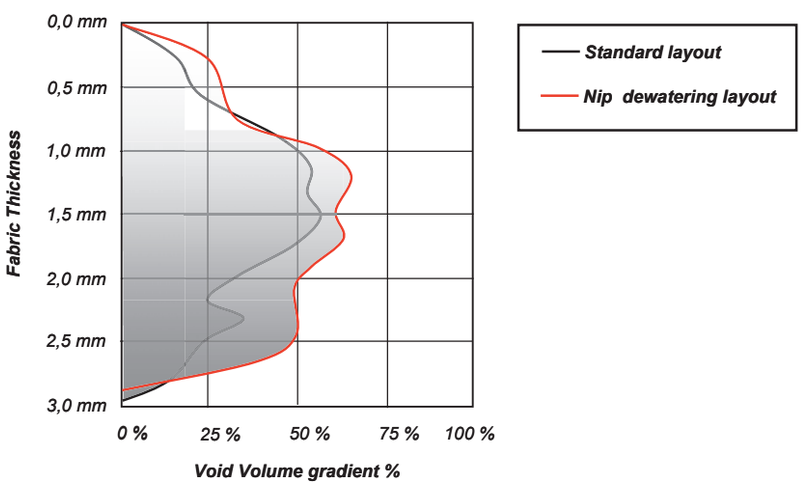

Figure 4. *void volume gradient across the press fabric caliper*

Examining some measurements taken on machine, it is possible to evaluate the dewatering of the various positions, at the moment of the world speed record, on April 14, 2011. The press section, was dewatering, while producing 80gsm, an average of 5800 l/min, an exceptional result.

The dewatering ratio in between the first and second nip was 79% - 21%, in line with the design requirements.

Concluding, today's know-how in press fabric design for high speed machines allows a precise prediction of the fabric performance in the different machine conditions.

This important factor permits the production of reliable and repeatable fabrics, which push ahead the limits, reaching higher levels of speed and efficiency.

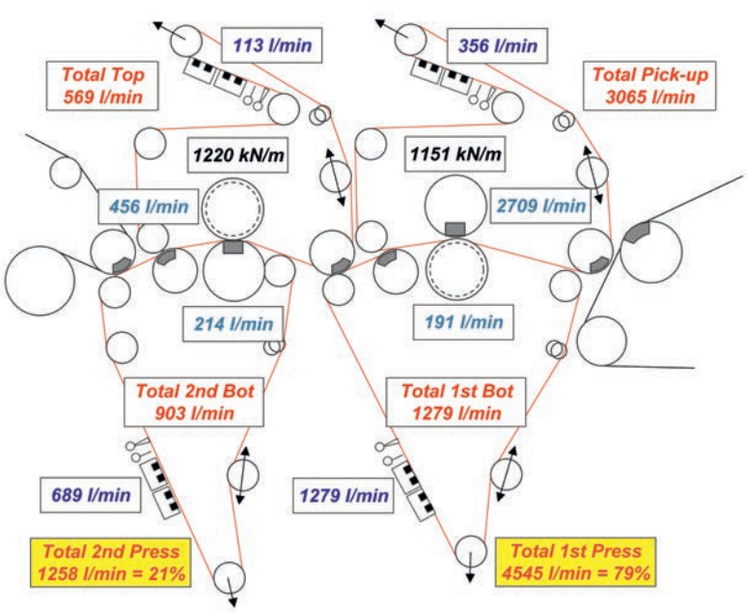

Figure 5. *Dewatering values during the World Speed Record*

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Driving performance improvement with aerodynamically active dryer technology

By **Roger Möller**, Technical Director Dryer Fabrics Europe, Albany International

Today's papermakers are challenged with the task of competing in a marketplace with global competition and rising costs driven up by ever increasing energy prices. Many are finding the task of obtaining money for upgrading equipment to meet the challenge very difficult. Albany International's philosophy has always been one that meets these challenges head-on by developing and supplying product technology that reduces a machine's total cost of operation. One example of this is a unique dryer fabric concept, developed for conventional top and bottom dryer groups, AEROPULSE.

What makes AEROPULSE different from any other dryer fabric? It is in the technology's non-sheet side construction. Yarn materials are woven in such a way that they are positioned in the structure to direct air through the fabric. All fabrics carry boundary air, but this technology has the ability to take the boundary air and utilise it to optimise pocket ventilation (see Figure 1).

The layer of boundary air is directed through the fabric at the converging nip of the pocket roll. The angled filler yarn on the backside of the design directs the air through the fabric in an unrestricted way. This unique characteristic of the AEROPULSE technology is the way the air moves in the pocket. It takes air into and out of the pocket by means of the fabric, unlike PV air and higher perm fabrics that create axial air flow from the pocket edges. Overall more air is moved in and out of the dryer pockets. This function of the design provides the means to improve drying efficiency, profiles and sheet handling.

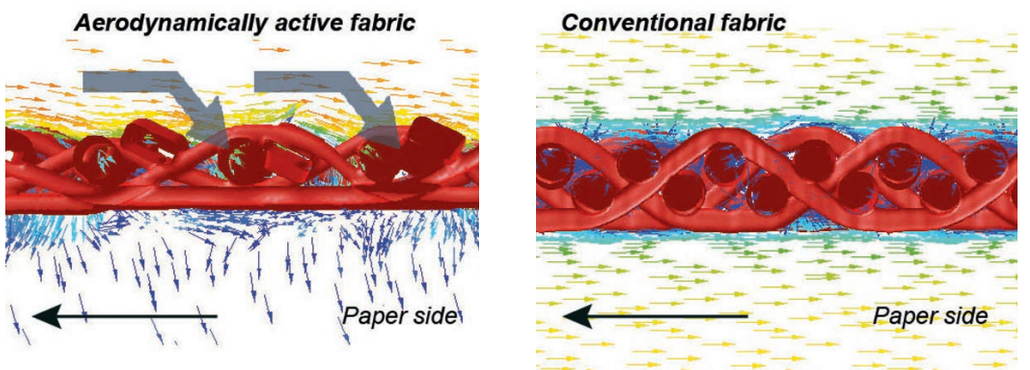


Figure 1. *Aeropulse impact on air movements (Computational Fluid Dynamics)*

Roger Möller, Technical Director Dryer Fabrics Europe, Albany International

This technology has the ability to take the boundary air and utilise it to optimise pocket ventilation

The structure also provides a new dryer fabric feature called 'dynamic permeability'. This is the effective permeability of a fabric as it travels through the machine at given speeds. Traditionally, permeability is measured in static condition on a non-moving dryer fabric. When a conventional fabric is moving, the real permeability is considerably lower because air has more difficulties to pass the fabric structure in higher speed. With AEROPULSE the permeability becomes higher due to the foil structure on the backside of the fabric. The higher the speed, the easier it is for the air to flow through the fabric structure.

It is a known fact that one of the costliest areas of the paper machine is the dryer section (see Figure 3). The cost of generating steam is very expensive, so effective steam use is imperative. The Tappi standard for ideal steam efficiency is 1.1 kg of steam per kg of water evaporated. With many machines today operating at less than optimum efficiency, there is ample opportunity to lower energy costs. For example, machines running at a steam consumption rate of 1.3 kg steam/kg water evaporated could annually potentially save big amounts in energy costs simply by lowering consumption to 1.2.

In a conventional top and bottom configuration, the dryer pocket is where drying action takes place (see Figure 4). This is the key area of the drying section for controlling the costs of drying, in the open transfer of the pocket where the sheet gives off the water (mass transfer).

For an efficient drying environment, the air in the pocket must be dry enough to cause the moisture to flash from the sheet. Moisture levels in the pocket are considered ideal at maximum 0.25 kg of water/kg of dry air but many machines fail to sustain this environment. If moisture levels are

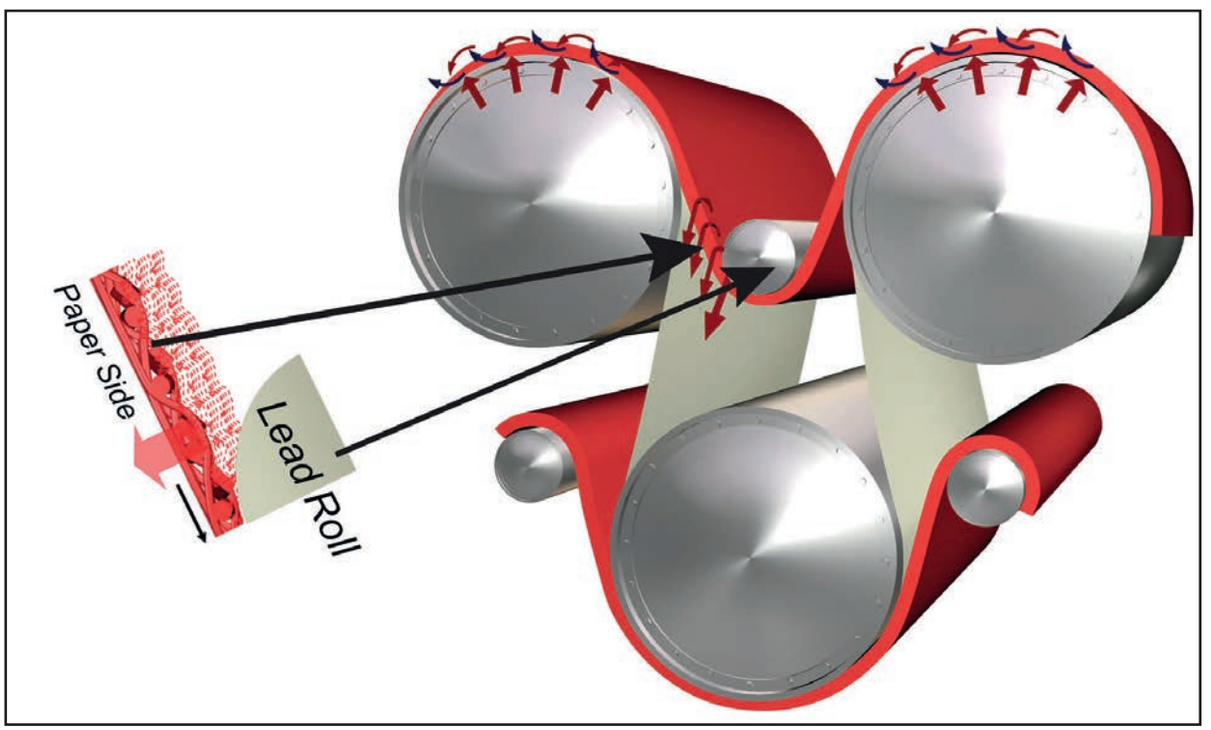


Figure 1.1 *Resulting Pocket Air Venting Improvement*

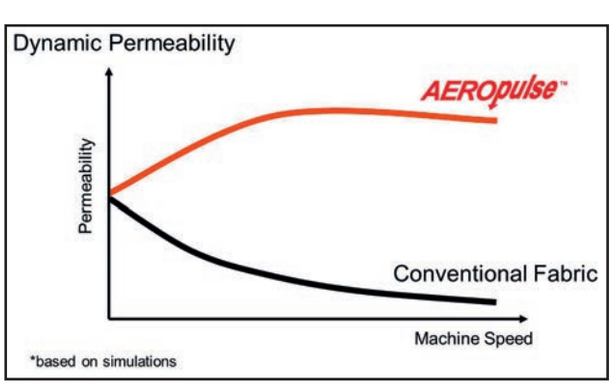


Figure 2 *Dynamic air permeability*

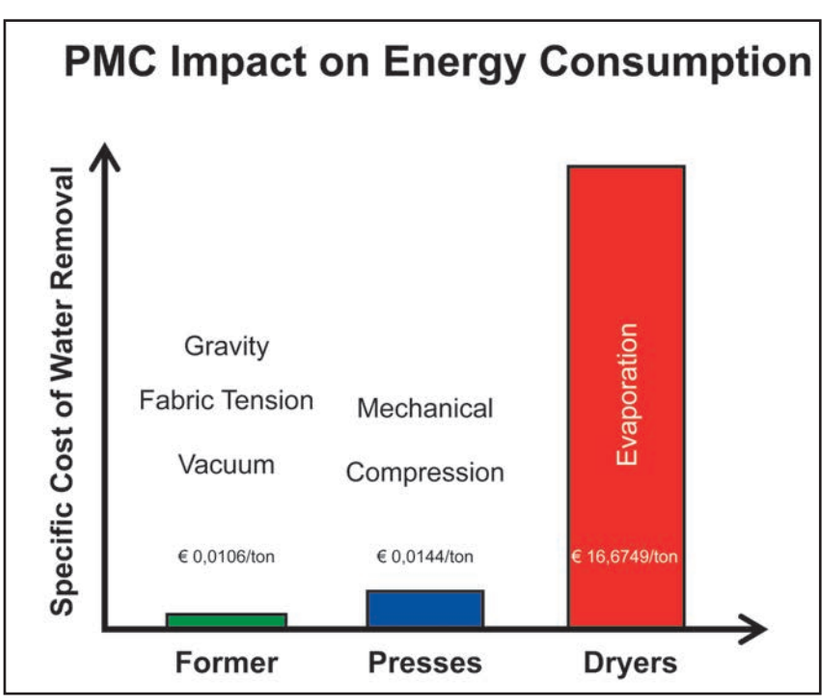


Figure 3 *Energy costs of the paper machine*

elevated due to poor ventilation then drying will be impeded, resulting in low productivity and higher energy costs. (See impact of high pocket humidity to drying rates in Figure 5.)

AEROPULSE is targeting to improve the drying environment and utilise the steam energy more efficiently. With this concept, possible dryer capacity bottlenecks can be targeted and you get potentially more output from your drying section.

FIELD RESULTS

Since the first launch as early as 2005, we have seen numerous successful installations globally. Normally we have seen positive impact in energy efficiency values, increased production and also paper quality improvements (moisture profile). On the right, two recent case studies.

CONCLUSIONS

AEROPULSE dryer fabrics are able to move more air into the dryer pockets by a combination of increased air drag and active ventilation through the fabric. This reduces the humidity levels in the dryer pockets, boosts the evaporation rate and improves the drying efficiency. The dynamic permeability of the fabric drives the behavior of the fabric and its ability to move air through the structure of a dryer fabric when moving. AEROPULSE dryer fabrics clearly have the advantage of higher dynamic permeability at a given speed than a conventional dryer fabric.

A number of AEROPULSE installations on different paper machines has proven the concept and shown significant reductions in humidity levels in dryer pockets, enabling higher production and reduced steam consumption resulting in significant savings for the mills.

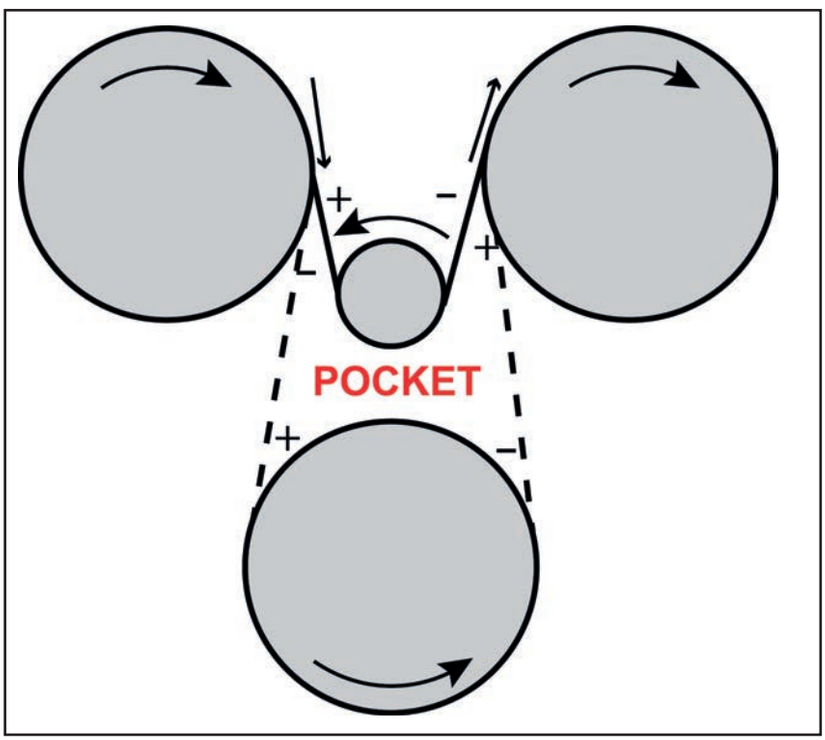


Figure 4. *Dryer pocket in a conventional group*

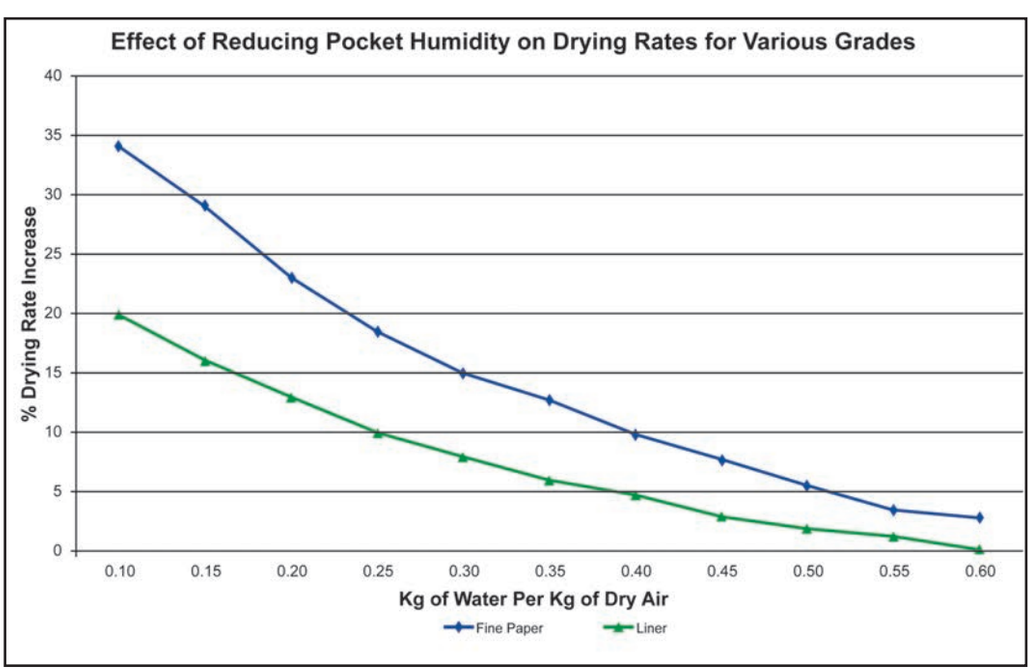
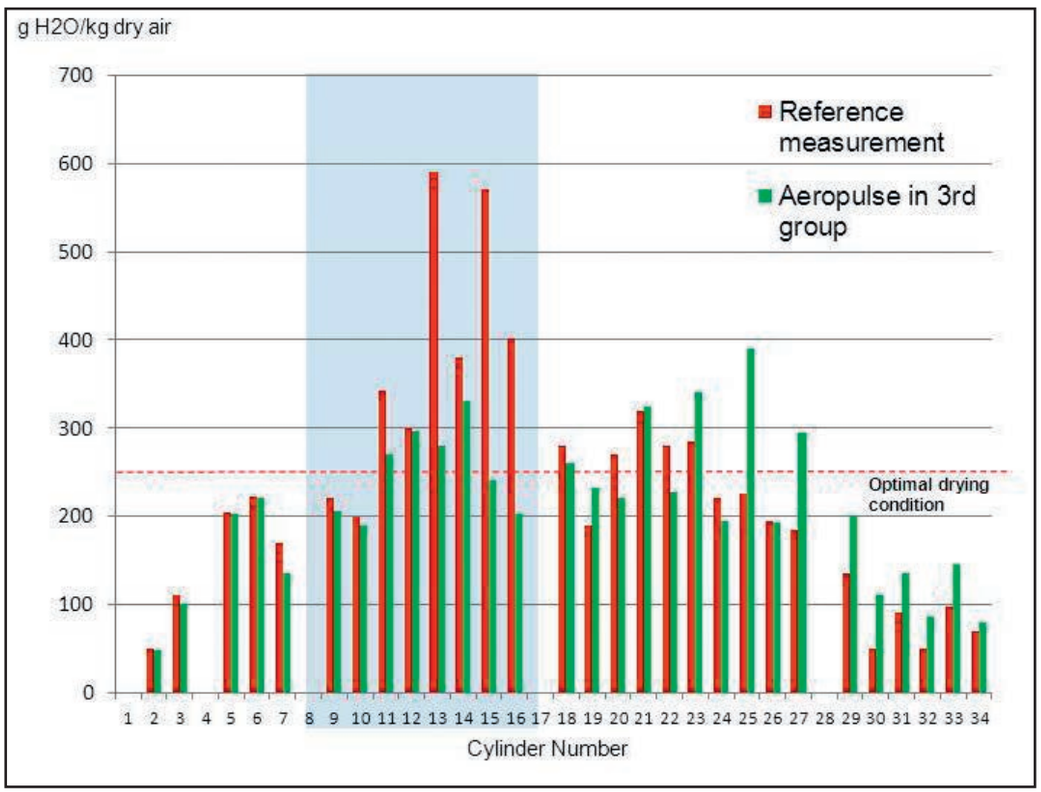


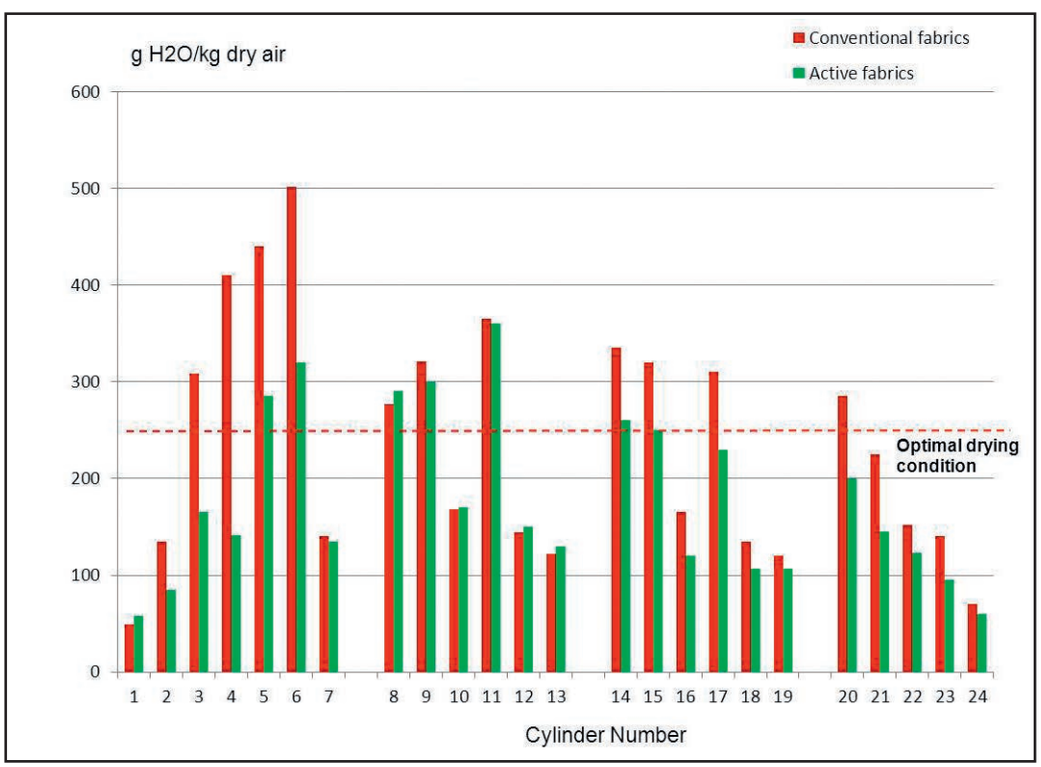
Figure 5 *Perrault drying systems study of the effect of pocket humidity on drying rates*



Case Study 1

CASE STUDY 1:
Fine paper machine, 800 m/min, 3.8m

An installation of AEROPULSE in the 3rd T/B group showed that the pocket ventilation significantly improved and the moisture levels came down by 25%. This radical drop improved the drying conditions and the customer reported savings up to 90,000 €/year.



Case Study 2

CASE STUDY 2:
Fine paper machine, 700 m/min, 4.5m

This machine wanted to fully see the impact of AEROPULSE by installing a whole set of Aeropulse in the pre-dryer (eight positions). The results were very positive, as an example, for the main grade 80gsm we could see an average of 22% reduction of absolute moisture in the pockets and this enabled the mill to lower the steam pressures and thus save steam in the end. Energy savings in range of 100,000 €/year. have been calculated and monitored by the customer.

Yankee safety: Steel doctors and process deviations are main chatter risks

By **Florent Bougerolle**, Product Manager Creping - Duroblade, BTG Eclépens S.A., Switzerland and **Mike Paczkowski**, Manager Marketing and Sales Support, BTG Americas Inc., USA

Over the last three years, we have gradually introduced BTG high-performance* blades to the market and today, many tissue makers have tested the different types of ceramics and cermets** proposed. Some of them now regularly use high-performance blades. Most tissue makers quickly appreciate the benefits of these blades and what they can bring in terms of quality and productivity.

It is a fact that – for a number of reasons – a recurring problem in tissue manufacturing is process instability. These process variations can compromise the results when running with high-performance blades. Many tissue makers are concerned about this and we would like to bring some hard facts to corroborate the reality of tissue making.

In this article, we will show why high-performance blades prevent damage to the Yankee surface.

The concept we propose is to analyse and control the tissue machine process from the wet-end to the converting plant in order to stabilise all machine parameters, control the quality, save costs and minimise the risk of chatter marks.

Bernard Rodriguez, Sales Manager Southern Europe - Duroblade, BTG Southern Europe S.A.S., France.

INTRODUCTION

The tissue market is constantly growing. Raising demand requires new tissue machines, higher speeds, improved quality and enhanced efficiency, pushing technology to its limits. Blade wear and risk of Yankee damage under certain circumstances become elevated as handling chemical products, mechanical equipment, steam and fibres becomes more complex.

** High-performance blades is a concept that encompasses a range of specially-designed creping doctors, all with a tailor-made working edge, viz. different, application-specific tip materials and geometries.*
*** Cermet = carbide/metal compound*

Raising demand requires new tissue machines, higher speeds, improved quality and enhanced efficiency, pushing technology to its limits

Even with today's sophisticated machine control systems, the phenomena involved remain obscure and demand a multi-competence approach and in-depth knowledge of the complete tissue process to be understood.

Since the 1980s, the range of high-performance blade products has rapidly conquered the traditional steel blade market worldwide.

But although we are bringing tremendous benefits to the world's widest and most productive machines and to more than 350 Yankees, some tissue makers are still reluctant. They question the harmlessness of ceramic and cermet** materials for their cast iron or metallised Yankee, are concerned about Yankee life and the cost of refurbishing the cylinder surface after chatter marks.

Thanks to our long experience, research capability and a holistic approach to tissue troubleshooting, we are currently running a number of projects to help understand the interactions between creping blade and Yankee surface, working specifically on the friction phenomenon and sources of chatter on the machines.

Below, we will briefly review the basics of friction and will then go on to a recent wear test carried out with several different material types (steel, ceramics and cermet) on the Yankee surface, as well as the key points regarding chatter-generating vibrations.

FRICTION AND BLADE-WEAR: THE HIGH-PERFORMANCE BLADE AS A RESPONSE TO STEEL DRAWBACKS

The definition of wear is a progressive loss or displacement of material from the operating surface of a body occurring as a result of relative motion at the surface. Wear induces damage with loss of material, which is usually considered as the typical wear effect, but can also induce damage with gain of material, e.g. with transfer of material. Wear can be divided into two types, adhesive wear and abrasive wear.

ADHESIVE WEAR WITH STEEL BLADE, OR THE ORIGIN OF MICROWELDING

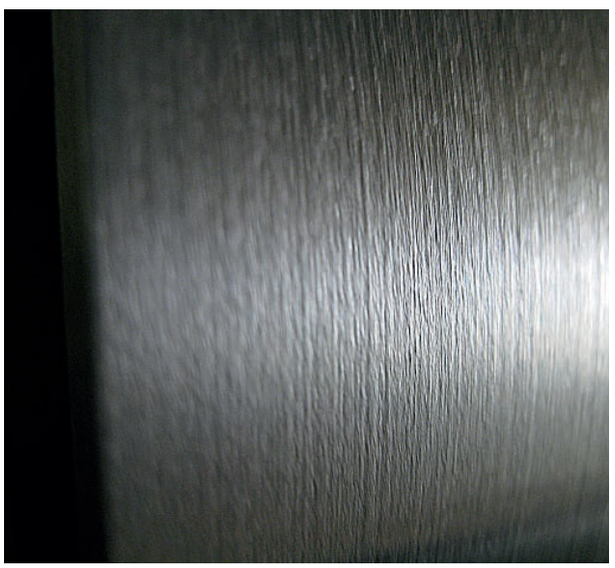
This occurs when two surfaces under high specific pressure tend to microweld the asperities of the surfaces to one another, and then break free. In the case of steel blades against a cast iron Yankee surface this tendency is high since both materials are chemically similar and ductile.

In the case of pure ceramics (an 'inert' material) against cast iron the dissimilarity of the two surfaces does not allow this phenomenon. In the case of cermets, the carbide structure prevents any microwelding between its metal phase and cast iron as well as metallised Yankee coatings as it is of a completely different nature.

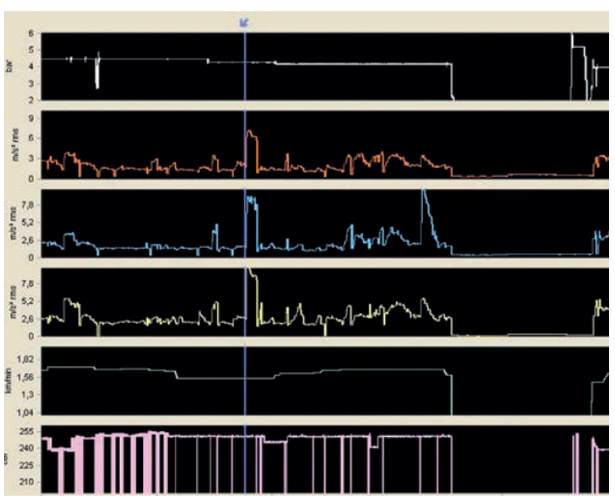
'SAFER' ABRASIVE WEAR WITH CERAMIC MATERIALS

Abrasion means 'microcutting' of one surface by the other. It is dependent on the roughness of the two surfaces as well as on the hardness and the 'fracture toughness' of the materials.

Blade chatter-the scourge of tissue makers



Microwelding on test Yankee



Vibration spectrum

Although we are bringing tremendous benefits to the world's widest and most productive machines and to more than 350 Yankees, some tissue makers are still reluctant

Microwelding on steel blade due to adhesive wear

Typical edge chatter

Ceramic materials are hard but not very tough. The smooth surface and brittle nature prevents these types of materials from abrading a much tougher cast iron surface.

For steel blades, worn particles generated through adhesive wear are hardened under the high specific pressure and the temperature, and become an additional factor accelerating both Yankee and blade wear by abrasion.

The higher the toughness difference, the more wear is generated.

EVIDENCE OF CERAMIC MATERIAL WEAR ADVANTAGES

A comprehensive series of friction tests performed on steel, cermet (chromium carbide) and ceramic creping blades confirm that ceramic and carbide blades significantly reduce wear on machine components and eliminate the potential for damage to the Yankee cylinder associated with steel blades. To analyse the performance of each blade type, roughness (Ra) value, Yankee wear-incurred weight loss along with temperature induced at the blade top were measured. Results from running the Yankee dry, without coating, showed that steel blades wore the Yankee considerably more than BTG's Duroblade®. The steel blade induced more than 15 times the weight loss caused by its ceramic counterparts!

The adhesive wear process seen in steel blades translates into a significant roughness increase, measured at Ra 0.28 microns before the test, increasing to Ra 2.19 microns after. The ceramic type blades, on the other hand, thanks to the low abrasion of the blade, registered Ra 0.31 microns before the test, and only Ra 0.41 microns after.

With cast iron as a counter-body the friction coefficient is about 0.6 with steel while it is lower, around 0.4, for ceramic materials. This is explained by

the higher plastic deformation at contact points and potential micro-adhesion between materials of similar nature (steel and cast iron), favoured by high temperature.

The new generation of metallised Yankee surfaces makes it possible to think of the Yankee service lifetime as potentially unlimited. The wear-resistance of the surface will eliminate virtually all of the significant re-grinding outages that are required with cast iron. In the test, calculating the amount of material worn away, the steel blade lost 250% more material during the test period compared to a ceramic blade when run against a cast iron surface, and 460% more on the metallised surface.

CHATTER MARK RISKS: MICROWELDING AND PROCESS ISSUES

The adhesive wear caused by metal-to-metal contact when using steel blades also provokes another serious problem for tissue manufacturers – friction disturbances and microvibrations that create 'chatter marks' on the surface of the Yankee.

In fact, when the blade is running on a cast iron Yankee, microwelding occurs between the two materials under pressure. Since the Yankee is in continuous movement, the microwelding is broken and the stress accumulated in the steel blade suddenly released, inducing a brutal movement of the blade tip towards the Yankee surface.

Such a sequence repeated hundreds of times per Yankee rotation, induces a self-excited vibration usually between 5 and 25 kHz. Such vibration and friction disturbances, associated with the use of steel blades, can cause chatter mark damage to the cylinder surface. But besides microwelding, which only occurs with steel blades, several other sources have now been identified as serious contributors to blade vibration and chatter.

EDGE CONTAMINATION

The dark brown, or white, band at the Yankee edges outside the paper trim is not only a blade life killer, but also a major initiator of vibrations. In this case, hard, cooked coating, full of fibres or fines brakes the blade in a movement which accumulates stress and is then suddenly released towards the Yankee. Suitable adjustments of the coating package, spray boom design, blade load, blade holder edge profile, hood edge damper, felt and wire, and of many other parameters help significantly reduce, or even remove, edge contamination, and hence lower vibrations considerably.

UNEVEN PROFILE OVER THE YANKEE WIDTH

Whenever we talk about coating distribution profile, moisture profile, blade holder profile or even paper grammage profile, it is clear that the unevenness on the Yankee surface supplies the ideal conditions for vibrations.

Each of these items locally changes the adhesion of the paper on the Yankee and thus, stress on the blade. As a result, the blade is excited and starts to vibrate. The origin of the unevenness comes from various parts of the machine, such as the condensate extraction pipe, the spray boom, dirty felts, hood problems etc.

WEAR DEVELOPMENT

Blade wear is also an important factor since it monitors vibration development speed and amplitude. We usually see that with steel blades vibrations increase very quickly.

Rapid reduction of specific pressure at the tip due to a higher contact surface, induced by wear, makes the blade less efficient in controlling the coating layer and it becomes more prone to vibrations. In the case of high-performance ceramic type blades, the coating penetration is more efficient and during a longer period, which reduces the development of vibrations. Moreover, these blades usually remove edge contamination more effectively and are less sensitive to Yankee surface unevenness, creating a much safer situation for the Yankee regarding vibrations and chatter marks.

The real challenge comes from controlling the process so that vibrations remain low, which requires a structured approach and proven experience in chatter problem diagnosis and problem-solving

CONCLUSION

The primary cause of Yankee wear and damage is direct metal-to-metal contact between the cylinder and the steel doctor blades. However, experience has showed that many other process situations also favour vibrations, thus chatter in the Yankee cylinder surface.

Chronic surface damage can necessitate regrinding of the Yankee surface – an unwelcome expense that also entails considerable machine downtime. While the use of cylinder coating solutions offers a degree of protection, ceramic type blades represent a more cost-effective long-term solution.

Combined with the suitable process conditions, these blades – unlike steel-based blades – ensure that there will be virtually no wear on the metallised Yankee surface from frictional interaction. The real challenge comes from controlling the process so that vibrations remain low, which requires a structured approach and proven experience in chatter problem diagnosis and problem-solving.

BTG's expertise and competence when it comes to high-performance blades and process understanding is obvious, and all our engineers are committed to providing the best choice of blade material. Our recommendations always result in less variability of tissue properties over time, higher blade lifetime with clear benefits cascading from the Yankee surface to the finishing room and, ultimately, to the consumer.

FennoBond™ 4000X – higher board strength, with lower fiber cost

Kemira FennoBond™ 4000X is a new hydrogel dry strength agent, especially suited for testliner, fluting and coreboard, that can give a 10-20% increase in strength properties such as CMT, SCT and burst at the same grammage. This can also allow a lower grammage while retaining strength specs or, alternatively, a higher percentage of lower-quality recycled paper for cost savings on fiber. As an added benefit, FennoBond™ 4000X tolerates high calcium in the wet-end, as well as high COD and conductivity.

www.kemira.com/fennobond

Advanced process control saves chemicals and waste paper in DIP plants

By **Dr. Albrecht Sieber**, Siemens AG, Product Manager Sipaper APC (Advanced Process Control)

A major challenge facing DIP (deinked pulp) plants is to ensure the necessary DIP quality and keep costs to a minimum, even as waste paper quality fluctuates. It requires a permanent adjustment of the most important control parameters – such as chemical dosages and reject rates – to accommodate the current state of the mill and of the waste paper. For this purpose, Siemens has developed a new control system based on fuzzy rules and has implemented it at UPM Hürth, Rhein Papier GmbH. The control system is a component of Sipaper APC (Advanced Process Control), a software solution for model-based process control.

Figure 1. *Flotation cells in the DIP plant of UPM Hürth, Rhein Papier GmbH*

OVERVIEW

Each year, UPM's paper mill in Hürth near Cologne, Germany produces roughly 300,000 tons of newsprint from 100% recycled paper on a paper machine that has been in operation since 2002. Using waste paper grades of 1.10 and 1.11, the DIP plant produces DIP with an ISO brightness of 59 to 62 without the use of a bleaching tower or post-bleaching. Peroxide, among other chemicals, is used only in the dissolver drum. Instead, the mill has a two-loop system with pre- and post-flotation. Through storing options and loop separation, as well as the assignment of sorting tasks to stock preparation, this system guarantees the high availability of the paper machine.

With Sipaper APC (Advanced Process Control), a higher-level process control system was already implemented at the Hürth mill for the purpose of optimising the plant's operating mode.

The Siemens software serves to improve plant operation in the drying section in order to reduce steam consumption and energy costs

Since September 2009, the Siemens software has been in continuous operation, calculating optimised set points based on current process values and transferring these set points to the DCS (Decentralised Control System). Among other things, it serves to improve plant operation in the drying section in order to reduce steam consumption and energy costs.

OPTIMISED OPERATING MODE: CHALLENGES AND OBJECTIVES

Process control for this type of DIP plant must face a wide variety of challenges. Its highest priority is to achieve the requisite DIP quality. Brightness, ash content, residual ink concentration, and dirt specks must be within a specified range or must not fall below or exceed specific limit values. Some of these quality parameters (for example, brightness) can be very precisely measured online. Other parameters, such as ash and residual ink, can be measured only very approximately, while dirt specks and stickies can hardly be measured at all. Consequently, the number-one quality objective is to achieve the specified brightness and keep the ash

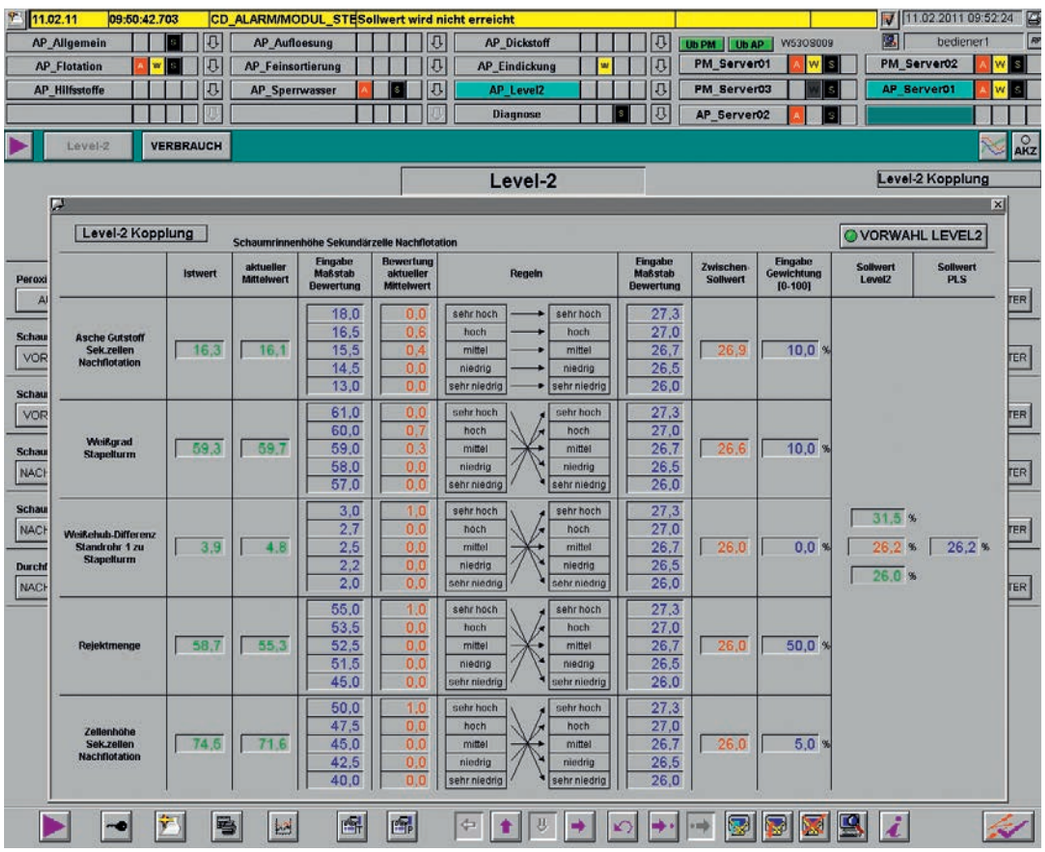


Figure 2. *Several criteria and process variables are used to evaluate the state of the fibre suspension and of the mill, and are adjusted to as to optimise the mill's operating mode*

content at a uniform level. The most important thing is to regulate the highs and lows measured by the existing sensors.

Control elements available for this purpose sometimes change target parameters in a contrary direction. If, for example, both brightness and ash content are extremely high, changing the foam channel height in the flotation cells – and thus changing the associated reject rate – cannot modify both the quality parameters simultaneously in the desired direction. Increasing the reject rate does reduce ash content, but brightness is also increased. Peroxide is already dosed in the dissolver drum. However, brightness and ash content have not yet been measured this early in the process and are therefore unknown,

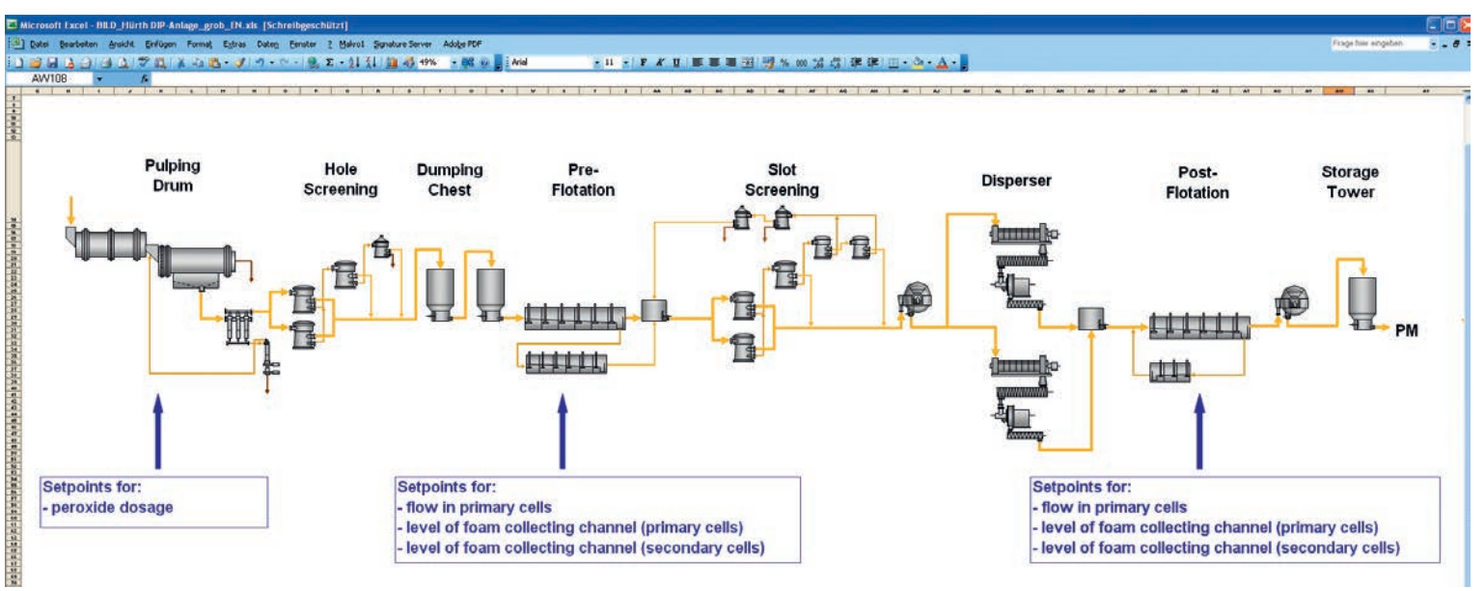


Figure 3. *The higher level control system calculates seven set points that help determine both the quality of the DIP and the specific costs*

meaning that the peroxide dose in the dissolver drum and the reject rate in the flotation cells cannot be optimally coordinated.

The goal is to fulfil the specified quality parameters as efficiently as possible, i.e. to minimise the specific waste paper, chemical, and energy consumption. When waste paper quality is high, the peroxide dose and reject rate must be reduced in order to lower costs. Conversely, when waste paper quality is low these parameters must be increased. This means that fluctuations in the quality of the waste paper used must be compensated and the 'safety margin' with regard to the specified quality parameters must be kept as small as possible in order to optimise costs. In addition, DIP plant operation must be as steady and smooth as possible. For example, the recirculation quantity and the levels in the flotation cells must be kept as constant as possible.

DECISION: MODEL-BASED OR FUZZY CONTROL?

Depending on mill throughput, it takes about one hour for stock to travel from the dissolver drum to the storage tower. During this time, the control parameters released for the higher-level control system must remain within the specified upper and lower limits. Model-based control systems have been proven effective for processes with long dead times and boundary conditions for control parameters that also need to be operated in a cost-minimised operating point. Especially closed-loop control systems with MPC (Model Predictive Control) have been used successfully.

MPC is based on dynamic process models that have been generated from recorded process values. It can use data acquired during 'normal operation', provided enough variance exists in the plant operating mode or in the relevant control elements, or it can use data acquired through targeted plant tests. Using model-based control systems becomes a problem when it is not possible to generate accurate process models. In DIP plants in particular, the quality of the waste paper used fluctuates significantly over time. The properties of the fibre suspension and the reaction to changes in nominal parameters differ accordingly – for example, the bleachability of the fibrous stock changes. As a result, the increase in brightness can differ despite an equivalent increase in the peroxide dose. Because of these drawbacks, it was decided to use a fuzzy-rule approach, which offers a number of advantages. Fuzzy controllers permit modelling that is problem-specific and more meaningful, including modelling of complex systems with nonlinear behaviour. Such controllers work with fuzzy state descriptions such as those also used by plant operators. Thus, for example, ash content can be 'high' or 'very high'. It is relatively simple to convert user knowledge to rules and to break down complex interactions into clear relationships. To evaluate the condition of the fibre suspension and of the mill, several criteria and process variables are used that the user can raise or lower by adapting the weighting accordingly. For example, five criteria are currently used for setting the secondary cells for post-flotation (Fig. 2). The plant operator can reproduce how the control parameters were calculated. This high degree of transparency means that the control system is well accepted by plant operators and is easy to maintain.

On average, it was possible to drastically reduce peroxide dosing and reject rates in pre- and post-flotation while keeping the quality of the DIP inside the specified quality parameters

HOW FUZZY CONTROL WORKS

The higher-level control system currently calculates seven set points that help determine both the quality of the DIP and the specific costs (Fig. 3). All the process values used in the fuzzy rules to assess the state are first pre-processed, meaning that they are basically flattened out. Based on these process values, a new set of set points is calculated every minute by means of the fuzzy rules and passed to the DCS, where they are set by means of the underlying PI (proportional-integral) controller implemented there. The higher-level control system is integrated into the PCS7 control system used by Rhein Papier.

CONSTANT QUALITY AND CONTINUOUS PLANT OPERATION

The control system based on fuzzy rules has now been in continuous operation for 18 months. During this period, the main objectives of constant DIP quality, continuous plant operation, and reduced specific costs have been successfully achieved. On average, it was possible to drastically reduce peroxide dosing and reject rates in pre- and post-flotation while keeping the quality of the DIP inside the specified quality parameters. Thus, peroxide dosing was reduced by approximately 8% and the waste paper utilisation factor by about 0.75%. It was also possible to further stabilise the operating mode of the flotation cells – and of the primary cells in particular – thanks to smoother operation and the more constant recirculation associated with it.

Size Wise.

How a packaging mill saved **$457,040** per year by switching to the Medallion® sizing program from Buckman.

The Challenge

The mill was a successful producer of sack paper and Kraft liner from both virgin unbleached Kraft pulp and mixed pulps. Unfortunately, high rosin and alum costs were eating away at the mill's profitability.

The Solution

Buckman introduced its Medallion ASA Sizing program, replacing rosin and significantly reducing the need for alum. Emulsion quality and particle uniformity were good. Retention and Cobb values remained within their target limits. Equipment functioned without any issues.

The Savings

Rosin cost elimination: from $9.35/ton to $0

Alum cost reduction: from $6.01/ton to $3.34/ton

Medallion program cost: $6.98/ton

Freight reduction for sizing chemicals: from 23 trucks/year to 4 trucks/year

Total ROI: $457,040 per year + reduced carbon footprint

Find out more.

To learn more about our Medallion sizing program or to discuss any other production issues you may have, contact your local Buckman representative. Let us give you a story worth telling.

For more information call +1 901 278-0330 or visit buckman.com

Buckman

Commitment makes the best chemistry.

Process control in pulp and paper – a look at the future

By **Jack Ross** and **Ben Blanchette**, Honeywell Process Solutions

Pulp and paper manufacturers face difficult challenges in order to remain competitive in the marketplace. Increased global competition and an uncertain economic outlook have forced many mills to seek new ways to optimise production, lower operating costs and improve quality. Rising energy and environmental compliance costs have put further pressure on profit margins.

Electronic media, and how people receive information, and share it, is changing dramatically. The impact on all forms of communication papers has been significant, and will continue to into the future. Look at what has happened to the newsprint business in recent years. Just look at how many books today are sold and delivered electronically, and not via a printed page? This change in demand is resulting in consolidation and the shut down of many machines in North America and Europe.

As pulp and paper mills continue to 'do more with less', their assets are stretched thinner than ever. The ability to control the process with accuracy, flexibility and high availability is important to increasing quality, productivity and providing a sustainable competitive advantage. Whether it's an existing application or new process addition, mills must find ways to improve efficiency, safety, energy savings, and productivity.

Figure 1 *For pulp and paper mills, business survival depends on adopting a long-term vision for automation technology investments and process optimisation.*

The ability to control the process with accuracy, flexibility, and high availability is important to increasing quality, productivity and providing a sustainable competitive advantage

BACKGROUND

The U.S. pulp and paper industry has contracted significantly in the past five to ten years. There has been a steady increase in the closure of mills, and paper demand has dropped by approximately 10-25% in some regions. Major problems for the industry include overcapacity as well as high labour, energy and raw material costs. North American paper companies also suffer from fibre supply disadvantages compared with South America and some parts of Asia; and environmental constraints relative to South America, Asia and Eastern Europe.

Papermakers in the U.S. and Europe now face strong competition from developing markets. New Chinese paper mills are employing world-class process technologies with the very latest control capabilities. U.S. operations with 30 to 40 year-old paper machines cannot provide the same level of efficiency and productivity.

In the current environment, where capital budgets are under increasing scrutiny and human resources have never been more limited, business survival depends on adopting a long-term vision for automation technology investments and process optimisation (See Figure 1).

TODAY'S INDUSTRY OUTLOOK

Process control is being affected by multiple factors, which will put at risk the ability to get the maximum value and benefit from automation systems. These include the reduction of employees, both management and hourly; an ageing of the workforce and reduction of advanced skill sets; and dramatic developments in technology.

The growth of open systems has

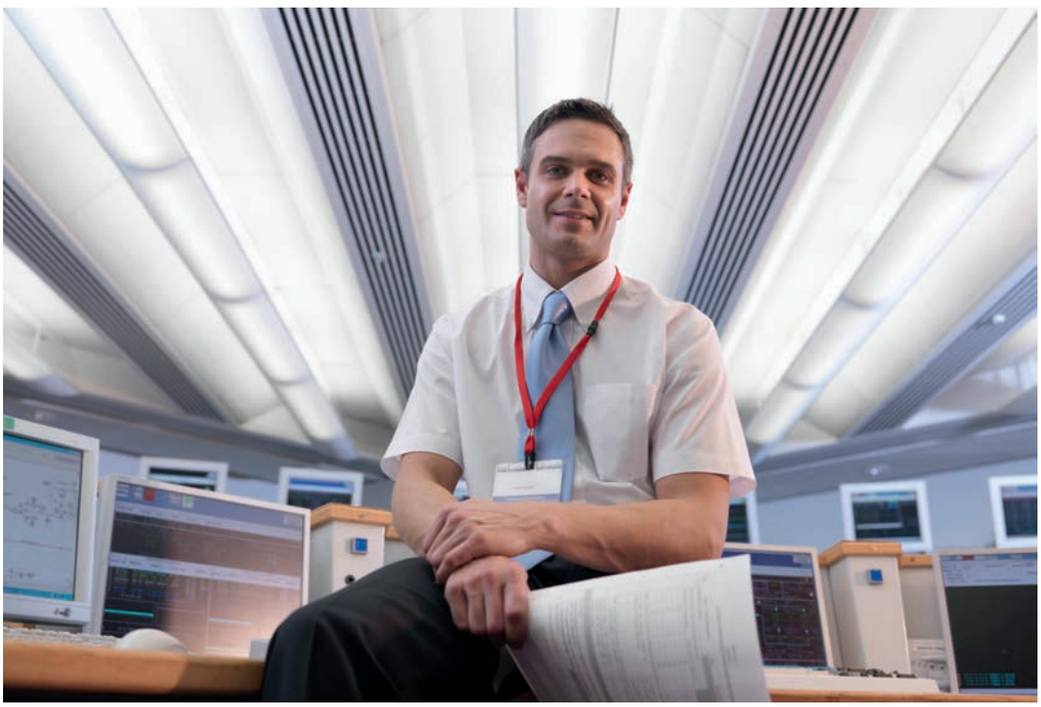


Figure 2
The current trend is towards fewer managers in the mill with expanded areas of responsibility

resulted in lower cost products and services, but now threatens traditional standards of security, serviceability and stability within the process control environment. Increasing energy and raw material costs also require new solutions to reduce capital and operating expenses, maximise profits, increase production and improve quality. Additionally, new environmental and safety regulations demand more sensors, computers and data mining to meet business demands.

At most pulp and paper mills, data overload is becoming an increasing problem. Information gathered at each level of the control system architecture is often stored in massive databases requiring tools to manually mine and extract information for decision-making. At the same time, mills must establish key performance indicators (KPIs) for rapid decision-making in order to lower energy costs, reduce chemical demands and maximise quality — all while driving increased production. As mill operating expenses are on the rise, service and support programmes are becoming more scrutinised. Maintenance effectiveness is a key objective to reduce these costs without the eventual impact on production that occurs by simply slashing budgets.

Throughout the global paper industry, the current trend is towards fewer managers in the mill with expanded areas of responsibility. Supplying management with the right information, in a timely manner, is critical to sustain current operational standards and meet ever-increasing business demands (See Figure 2).

However, advanced process and quality control system software often is installed for a specific task that is not maintained over time, or changes to the manufacturing process take place, making the solution no longer applicable.

KEY TECHNOLOGY DEVELOPMENTS

In the pulp and paper industry, a difficult economy is spurring manufacturers looking for a competitive edge to consider adopting new technologies. Paper companies are challenged with differentiating their products versus the competition. They must produce a product inexpensively and at a highest possible volume, then sell it for market price. Today, however, the pressure is on to not only reduce the cost of commodity products, but to gain entry into new, expanding niche markets.

Key developments affecting pulp and paper operations include:

Innovations in sensor technology

Miniaturisation of sensors has revolutionised measurement and control applications in paper mills. New sensor designs are making measurements available in more locations and at lower cost than ever before. Sophisticated and robust on-line measurements can provide real improvements in process control, quality, efficiency and profitability (See Figure 3).

The development of scanning camera technologies is providing real-time views of the product that were never before available. These new measurements are now opening up new opportunities for real-time control.

There are sensors available today, based on high speed camera technology, that can measure formation, smoothness, and fibre orientation. Each of these sensors, on their own, can provide valuable information on the quality of the end product, and can be used as input to advanced control applications. They provide both numeric values as well as displays of the image of the product surface. As we look to the future, we can imagine where various on line measurements can be combined create new 'virtual' sensors. While the concept of virtual sensors is not new, with the availability of newer on line sensors, we now have the potential to create a whole new family of real time measurements. What if you could measure printability on line and actually control it, What if you could measure crepe-quality in real time, and control it?

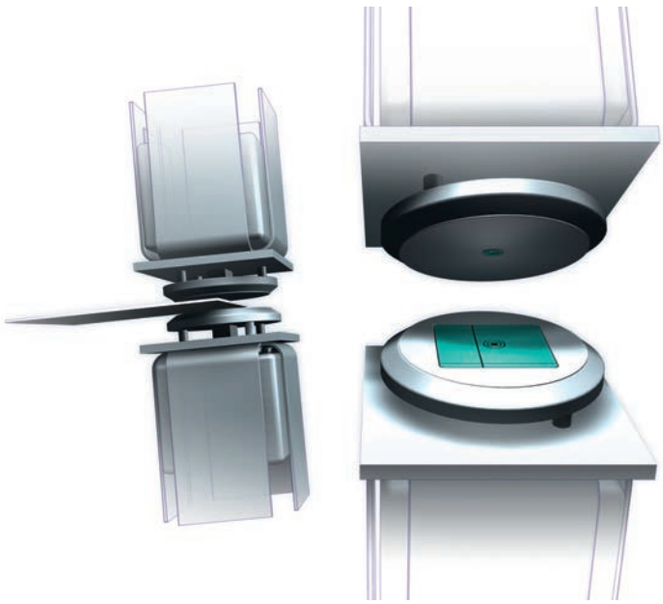


Figure 3. *Miniaturisation of sensors has revolutionised measurement and control applications in paper mills.*

Figure 4. *Across paper manufacturing sites, handheld wireless stations provide an increased awareness of critical process conditions.*

Acceptance of industrial wireless

Wireless mesh networks have become an established part of the mill process control environment. Modern wireless solutions are secure and viable at a lower cost and higher integrity. As such, the traditional view of an input, control and output hardwired to control a loop is being redefined. A greater quantity of information can now be acquired from process areas and delivered to any client without the limitations of wires. Across paper manufacturing sites, handheld wireless stations provide an increased awareness of critical process conditions. Maintenance technicians can carry wireless tools to troubleshoot and immediately initiate corrective actions. Control room operators can be paired with roving operators who have identical process visibility, enabling immediate verification of control actions in the field (See Figure 4).

Wireless is also finding its way into more and more safety functions. Wireless solutions can help personnel stay informed on a real-time basis, enabling them to make better decisions—ultimately minimising the occurrence of safety incidents and reducing unplanned downtime. The technology helps lessen the financial blow of lost production and cleanup, while ensuring workers' safety. Plus, many paper companies are finding that wireless is an effective method for staying environmentally friendly and compliant.

Low-cost RFID technology can now be combined with wireless to provide tracking of wood into the mill. An RFID tag is attached to the trees in the forest as they are cut, identifying the date and location. This information will stay with the log as it is stored in the wood yard. It can be retrieved as the log is being sent to the chipper, and then utilised in pulp tracking software such that the bale of pulp or roll of paper can be tied to the location and time the tree was cut down. This will be especially useful in sustainability certifications. The same RFID/wireless technology can be used on paper roll cores, allowing for tracking locations in the warehouse, and when loading on trucks or rail cars.

In addition, global positioning system (GPS) technology can identify the whereabouts of mill personnel for immediate responses to incidents or abnormal situations. This solution is particularly valuable in view of the increased use of contract employees, who may not be familiar with the mill facility. The location of people can be incorporated into the control strategies themselves, helping to ensure a safer production environment. Equipment interlocks, for example, can now include proximity of personnel. It is even possible to differentiate between individuals approved to be in proximity, and those who are not.

Advancement of digital video systems

Digital video sensor and surveillance systems can be integrated with the process control network (PCN) and used as an input in control strategies. Video software is able to monitor remote facilities, equipment or processes and trigger responses when conditions occur, and software tools are available to respond to acoustic transmitters and video streams of emissions.

Figure 5. *The latest technology developments are providing opportunities for closer relationships between mill operators and maintenance staff.*

HMIs will provide easy access to a wide range of key performance indicators (KPIs) to help managers prepare reports, make fast and informed decisions to optimise production and reduce costs

Thanks to digital video solutions, remote pumps, pop-off valves, sewers, stacks and mobile equipment can also be part of the control environment. The technology extends plant monitoring capabilities and integrates video stream and analytics with process control applications. This allows paper mills to observe hazardous or inaccessible areas from a distance and detect events beyond traditional sensor capabilities.

Use of interactive human-machine interfaces

In the near future, control room personnel will utilise highly interactive human-machine interfaces (HMIs) that show mill operating units, field equipment and other assets in an intuitive, 3D format. These HMIs will deliver operator instructions based on relevance and timeliness, and provide multiple cues to emphasise actions/state. Through the use of realistic images and appropriate colour schemes, the interface will clearly reflect if a process is proceeding normally, or if it is veering off course.

In addition, tomorrow's HMIs will utilise advanced simulation technology allowing operators to zoom in on various areas of the facility at a very granular level to check equipment status and other critical parameters. They will also provide easy access to a wide range of key performance indicators (KPIs) to help managers prepare reports, document performance history, make fast and informed decisions to optimise production and reduce costs.

Integration of process control and IT

Increasingly, the lines between traditional process control networks and IT technologies are becoming blurred. Open systems technology makes process control networks (PCNs) more vulnerable to cyber security problems, and as a result, IT tools to protect these critical networks are now being developed and 'baked in'. The merger of PCN and IT responsibilities also means sharing of information will continue to grow with the same toolsets often used at different levels of the mill, including IT, distributed control system (DCS), quality control system (QCS), manufacturing execution system (MES) and enterprise resource planning (ERP).

Collaboration between operations and maintenance

The latest technology developments are providing opportunities for closer relationships between mill operators and maintenance staff. For example, the application of handheld field operator stations allows operations to interface directly with process equipment. Wireless equipment health monitoring (EHM) solutions can be used to monitor essential assets to ensure healthy and trouble-free operation. And the use of data analytics enables both process performance monitoring and predictive asset monitoring, moving the roles of maintenance and operations even closer together (Figure 5).

Adoption of virtualisation and cloud computing

In a demanding economy, paper industry operations must find ways to reduce operating costs while maintaining or increasing production levels. They must also bring new projects online faster and at a lower cost than ever before. As such, there is an urgent need to identify inefficiencies and ensure operations are as productive and economical as possible. Whether used on new construction projects or at existing sites, virtualisation technology is forever changing how we think about

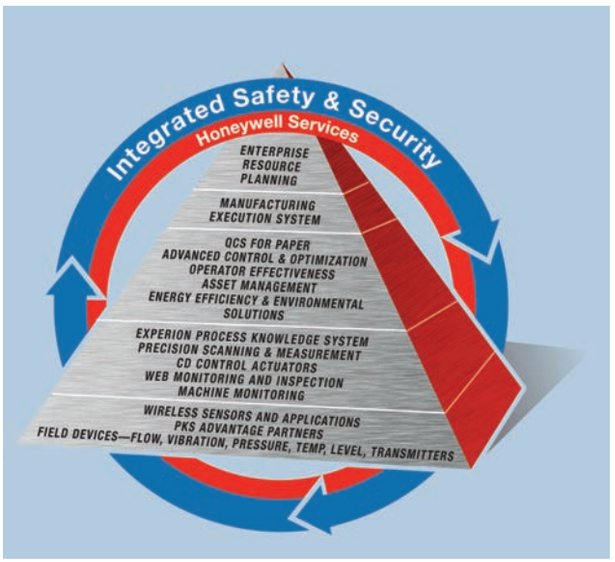
deploying the DCS IT infrastructure. Virtualisation is an innovative software solution that makes it possible to run multiple operating systems and applications on the same computer at the same time, increasing the utilisation and flexibility of hardware required to operate a production facility. Virtualisation impersonates or emulates the various layers of a typical computing environment. Through a process of abstraction, it removes many of the limitations experienced when dealing directly with these layers. It is intended to centralise IT administrative tasks while improving scalability and workloads. Across the enterprise, virtualisation allows users to pool and share IT resources.

The benefits of virtualisation technology can be summarised as doing more with less, whether that is less hardware or performing common system maintenance tasks with less labor resources. By applying virtualisation to open DCS and QCS systems, mill management can improve server utilisation rates, reduce disruptive operating system and hardware changes, simplify overall system management, and ensure the availability and reliability of critical assets. Fewer, more centralised, control rooms will also reduce expensive real estate and PC/software license costs.

Changing view of the control system environment

Advanced applications are beginning to address mill assets in a holistic manner, rather than as 'islands of automation'. This approach supports an integrated architecture with unified sensing, control, operations and information management. It enables the various elements of a mill automation system to be installed, started and operated together in a prepackaged manner without excessive tuning and adjustment by the implementation project engineer.

Figure 6. *Remote monitoring proactively monitors process control and QCS performance to enable early problem detection and notification.*
Figure 7. *In managing process control and IT systems, it will become increasingly important for mill supervisors to view these domains as an integral system.*
Figure 8. *Experion MX Scanner*



Hardware and software components continue to operate with high reliability because they were engineered to be compatible. And when it's time to expand or upgrade the system, that task is made easy as well.

Controlling the relationship between process areas enables dynamic improvements that yield lower chemical usage, as well as energy savings resulting in higher production. Mills can also manage capital equipment and resources to extend lifecycles and production while reducing downtime and maintenance.

Implementation of remote support services

A growing number of paper industry operations are taking advantage of improved remote presence technologies to centralise expertise and share best practices. This is due, in part, to automation vendors building self-diagnostics into products at an increasing rate. Remote support services allow the reduction of vendor contracts, reduce the time and cost for expert talent to travel to the mill, and minimise the need for onsite support staff. Remote monitoring proactively monitors control system performance to enable early problem detection and notification. Local or remote technicians can respond quickly, preventing productivity loss and saving time and money. Expert analysis of fault symptoms also assists in a more rapid problem resolution (See Figure 6). In addition, centralised tracking of process and quality upsets helps with long-term trend analysis, and

performance management reports provide valuable information to improve system reliability.

LOOKING TO THE FUTURE

In the coming years, pulp and paper mills around the world will be under increasing pressure to harness the power of technology and leverage advanced automation capabilities in order to optimise raw material and energy consumption, machine performance, sheet quality and profitability. They will also face greater demands in the areas of sustainability and environmental compliance.

In an increasingly competitive market, improvements in quality control for paper machines must deliver more than just small reductions in steady-state variability. Control engineers require advanced process control (APC) strategies that are easy to modify as production requirements change, and take advantage of sensors distributed along the length of the machine. Additional real-time inputs, such as stock flow pulsations and vibrations of rolls, can be used to identify the cause of high-frequency process variability and enable proactive maintenance.

Engineering departments also require simple tools allowing advanced control software to remain viable. They need to identify and standardise both control solutions and tools between facilities. This will enable management to analyse data from similar tools with confidence the variables are reasonably near base levels.

In addition, paper producers must choose a DCS and QCS platform that can continuously evolve, adding new measurements and controls without full replacement. This approach will protect legacy investments and minimise the risks of large-scale system upgrades.

Likewise, mills will seek to integrate digital video for paper machine quality control with overall process control capabilities to provide added value to production operations. In an environment where finding ways to optimise resources is vital, digital video is a powerful solution for enhancing productivity by providing vision of the process that could not be previously viewed.

Maintenance budgets are among the first to be slashed as paper mills try to control their costs. Remote and contract services address the issue by dramatically reducing maintenance expenses. These services are intended for functions not reasonable to support with existing talent. Proactive remote performance monitoring provides specialists who can access process and quality control systems as needed to resolve issues quickly.

Paper mills will also benefit from choosing highly collaborative MES packages that transform data into value quickly, and are easy to learn and use. In particular, they need MES solutions providing vendor and source-independent 'anywhere and everywhere' data. In managing process control and IT systems, it will become increasingly important for mill supervisors to view these domains as an integral system. This will allow them to manage all levels of measurement in a more vertical and seamless stream of data that can be mined to reduce total cost per ton (See Figure 7).

Rapid evolution is taking place in both hardware and software, as end users demand less costly systems with greater flexibility. Vertical data flow and data mining for control and business decision-making remains a key driving force. The same tool sets will eventually be used in both areas.

Finally, HMIs must continue to improve in ease of use, allowing more mill levels to participate in the information flow. Improved processing power will allow for real-time pattern recognition, eliminating the need for off-line analysis and reducing the time required to act on process data.

With process control and IT technologies continuing to merge, paper companies should partner with a supplier offering a holistic approach to meet all of their operational needs

Hamburger Pitten in Austria is a company that chose to leap into the future, utilising much of this new technology when they embarked on a massive modernisation project, including their PM#4.

Hamburger Pitten, a leading global producer of containerboard which operates eight production lines across Europe, were able to take advantage of many of the benefits mentioned above. They used advanced CD and MD control solutions to increase final paper quality and they reduced costs by choosing the Experion MX QCS system from Honeywell (See Figure 8). It included the world's fastest scanner, and newest sensors which have built-in diagnostics and remote monitoring capabilities making maintenance easy and cost-effective. This is particularly important as future trends are predicting on-site engineering expertise to be a luxury for many companies.

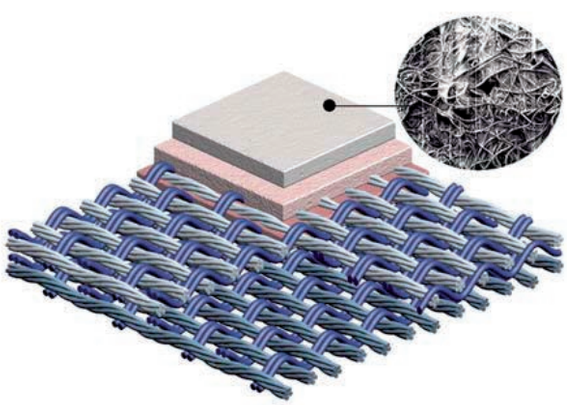
Modernising papermaking at Hamburger Pitten will allow them to be profitable, competitive and successful, well into the future.

CONCLUSION

Now, more than ever, it is more important for pulp and paper producers to establish a path forward to increase their safety, efficiency and productivity. Mill managers must make a concerted effort to glean the most pertinent operational and business data available. They must replace outdated legacy control systems and ensure they have the safest possible systems while providing the utmost confidence in their decision-making.

With process control and IT technologies continuing to merge, paper companies should partner with a supplier offering a holistic approach to meet all of their operational needs. Success in the future will depend on the ability to tightly integrate a wide range of process automation, quality control, production management, safety, security, and business systems.

Smoothness.
The secret is in the foam.



MicroPlast□, Polymeric Surface Press Fabrics□
For the first time, with MicroPlast□ the interaction between the paper sheet and the press fabric is by advanced polymer foam technologies, rather than with the traditional batt fibers. MicroPlast□'s engineered surface achieves levels of pressure uniformity and surface capillarity, impossible to reach with traditional textile technologies.
If you are aiming for outstanding paper smoothness, machine runability and press efficiency, choose the new era; choose MicroPlast□ Polymeric Surface Press Fabrics□.

Reliable Innovation□

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ABB PillowBlock tension measurement systems – quality tension measurement for quality tension control

Keeping the tension constant in web processes is essential for high product quality and productivity. By **Martin Ottosson**, Market Communication Manager, Force Measurement, ABB Sweden

In paper and board mills, in a wide range of converting operations and in plants processing textiles, plastics, rubber or almost any web material you can think of, you'll find ABB PillowBlock tension measurement systems. The performance of the PillowBlock load cells is unsurpassed for applications characterised by heavy rolls, high speeds and severe conditions – in some instances they're the only viable option. The key reason is the operating principle. ABB PillowBlock load cells produce signals as a result of magnetic change, which frees them from the inevitable limitations and design compromises of measurement technologies relying on some form of physical movement.

The result is a load cell that combines strong, low-impedance signal output with an exceedingly stiff and rugged construction. A reliable, high-performance load cell with exceptional resistance to vibration, overloads, extreme temperatures and otherwise harsh environments. A complete PillowBlock measuring system consists of appropriately sized load cells and tension electronics. A junction box is sometimes used to simplify the cabling and reduce cabling costs.

ABB offers two different types of PillowBlock load cells: one design intended for conventional vertical force measurement, and a second, unique design that measures only the horizontal force component resulting from web tension on a roll. Several models and nominal loads are available in standard stainless steel constructions as well as in acid-resistant and mill-duty versions. The user-friendly digital signal-processing electronics provides a high level of functionality to cover a wide range of applications.

ABB Force Measurement has supplied Holmen Paper AB Braviken, Norrköping, Sweden with, in total, 40 Pressductor PillowBlock Load Cells

A reliable, high-performance load cell with exceptional resistance to vibration, overloads, extreme temperatures and otherwise harsh environments

THE PRESSDUCTOR® DIFFERENCE

Like ABB's other load cells based on Pressductor® Technology, PillowBlock Load Cells rely on electro-magnetic changes in the transducer, not on physical movement, to sense fluctuations in web tension. The Pressductor® Technology operating principle provides exceptional improvements in load cell performance characteristics, including reliability (notably absence of drift), durability, repeatability, and wider measurement range. Machined from a solid block of steel, the load cells are rugged and stiff, affording high overload protection as well as an extended measurement range above the nominal capacity. And they won't contribute to machine vibration, even at high speeds. Since the transducer action – the magnetic flux – takes place inside a steel core, environmental factors like dirt or fluids can't degrade performance and reliability. Furthermore, low transducer impedance – less than a couple of ohms – helps eliminate susceptibility to radio-frequency and electromagnetic interference. For more info visit www.abb.com/pressductor.

CASE STUDY

Holmen Paper Braviken's paper machines, calenders and winders are running with Pressductor PillowBlock load cells providing accurate web tension measurement

Holmen Paper's operation in Braviken, Sweden has successfully installed Pressductor PillowBlock load cells in their paper machines, calenders and winders.

Since the very start of the Braviken paper operations in 1977, ABB's Pressductor load cells have been installed in the paper machines and calendars and are still running with accuracy and reliability.

In addition to the good load cell quality there have, over the years, been improvements of the tension electronics. Now, in order to learn more about the development in tension electronics the mill management gives a push for training of the products and systems.

As Mr. Mats Alfredsson, Manager Electric and Control Systems and Mr. Peter Othberg, Group Manager, put it: "The more knowledge we and the operators have about the PFEA Tension Electronics and the Pressductor load cells, the sooner Holmen Paper Braviken will exchange into new modern tension electronics as well as into further developed ABB load cells. We always want to keep our staff in the frontline and also updated on the latest developments; this will favour our maintenance organisation in the most efficient way."

Holmen Group produces almost 2.5 million tonnes of paper and paperboard. Holmen Group is Europe's fifth largest producer of printing paper with a total capacity of 1,900,000 tonnes per year. When it comes to virgin fibre board, Holmen is Europe's third biggest producer with an annular capacity of 530,000 tonnes. The annular production capacity for sawn timber is 860,000 cubic meters.

Holmen Paper is a business area within the Holmen Group. The head office is situated in Norrköping. They are one of the leading manufacturers of wood-containing printing paper in Europe with paper mills in Norrköping, Sweden, Hallstavik, Sweden and Madrid, Spain.

Total production capacity amounts to 1.9 million tonnes a year. Total turnover is approximately SEK 8.1 billion. Average number of employees is 2,000.

Holmen Paper produces wood-containing printing paper, mainly for magazines, catalogues, supplements, advertising matters, books, daily newspapers and telephone directories. Holmen Paper offers quality products, excellent service and qualified technical advise to daily newspapers, retailers, telephone directory companies, publishers and magazine publishers. They continuously strive to strengthen their position as a dedicated partner. Close communication with their customers' results in better products and new value added solutions.

For more information, visit www.holmen.com.

"We feel secure of the stable measure-ments that we achieve from the load cells day after day, month after month, year after year"

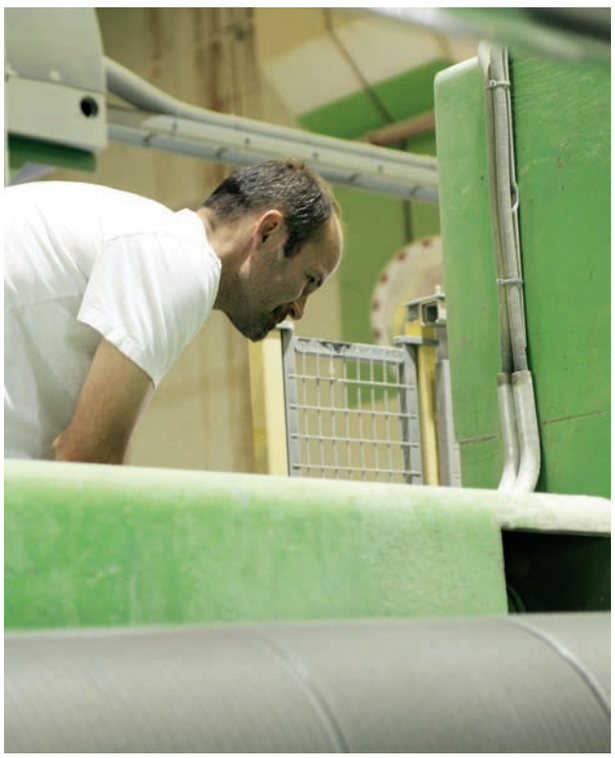
WHAT HAS BEEN ACHIEVED?

We ask Mr. Mats Alfredsson, Manager Electric and Control Systems and Mr. Peter Othberg, Group Manager, who concordantly express their opinion about the ABB Pressductor load cell installations:

"We are happy with the Pressductor installations. The ABB load cells have been installed since the start of the operations and we have positive things to say about them. ABB's Pressductor load cells are robust and durable with stable signals for stable measurement. Ever since the Pressductor PillowBlock load cells were installed and commissioned in 1977 they have been running well.

"The PFEA tension electronics is working well. The display is easy to operate and there are many functions to take advantage of. Our ambition is that the entire service and maintenance organisation should have more skills about the ABB load cells and tension electronics. In general, the ABB load cells have been running well and we feel secure of the stable measurements that we achieve from the load cells day after day, month after month, year after year."

The Pressductor® Technology operating principle provides exceptional improvements in load cell performance characteristics, including reliability (notably absence of drift), durability, repeatability, and wider measurement range.



FACTS ON HOLMEN PAPER BRAVIKEN SITE:
HOLMEN PAPER AB BRAVIKEN, NORRKÖPING, SWEDEN
Capacity: 750,000 t/year
Export: > 80 %
Workforce: 580
Products, brands: Wood-containing printing paper, mainly for magazines, catalogues, supplements, advertising matters, daily newspapers and telephone directories. Braviken's best known papers include white and coloured newsprint, among others the pink paper that is used by the financial press and sports press.
Applications: Paper machines, calenders and winders
ABB load cells installed: Pressductor PillowBlock Load cells, model PFTL 101A/101B, are the most common load cells installed

Wet-end technology and starch-based products

By **Régis Houzé**, Technologist Market Development Manager, Roquette

Serving a comprehensive range of industrial sectors, Roquette is one of the world's most advanced producers of starch and starch derivatives.

For many years now, Roquette has been working closely with the paper industry to improve production methodologies. By using creative starch technologies and developing new processes, Roquette aims to ensure effective innovation at each step of production.

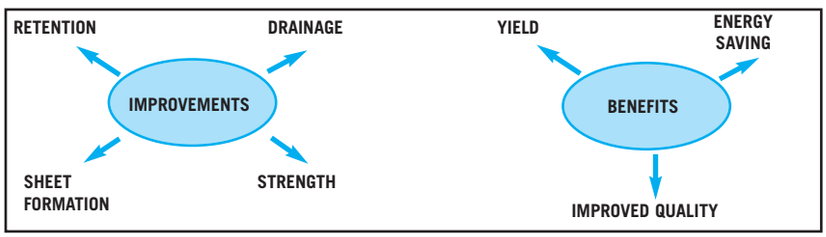
To achieve this result, Roquette has developed a range of Cationic starches - HI-CAT® - and functionalised bio-polymers - VECTOR® - that allow reduction of global costs while optimising the quality. HI-CAT® is a range of cook-up cationic wet end starches widely used today in the wet-end process. VECTOR® is a range of biopolymers, in liquid form, based on renewable sources. VECTOR® is a ready-to-use product, most of having the approval of FDA, BfR and China GPB9685.

The development of ROQUETTE's range is supported worldwide by a technical and commercial team that offers the best of nature. This means a good quality product and perfect delivery time but also advice on using our solutions in the best conditions on the paper process.

The cationic starch, thanks to its positive charge, acts as a neutralising agent of the forces of repulsion of fibres and fillers together. It attracts the electronegative elements of the molecule. The pulp flocculates, fines and charges may be fixed on the fibres via the cationic starch.

This one has a role of flocculant and retention agent. Fully retained in the paper, its effect on mechanical properties will be maximum.

The development of ROQUETTE's range is supported worldwide by a technical and commercial team that offers the best of all worlds



	Potato Starch	HI-CAT ® 5283 A
Nitrogen Content	**0.26%**	**0.60-0.65%**
Grammage	104.3	105.6
Scott-bond	107	120 **(+ 12%)**
Retention aid	315 g/T	255 g/T **(-20%)**
Headbox/White water conc. (g/l)	13.8/2.6	13.1/1.0

Figure 1: Fine paper – 100 gsm

To illustrate this, you can see above two examples of the use of cationic starch, one in fine paper and the other one in packaging paper.

In the first case, we illustrate that the use of a product with higher cationic degree of substitution not only increases the characteristic (Scott-bond + 12%) but also has a better retention system efficiency by the decrease in the wire water concentration at the same time decreasing the retention agent.

The second example also shows that increasing the degree of substitution, we can, while reducing the overall amount of cationic starch, optimise machine operation and contribute to the improvement of production, while optimising costs (lower steam consumption).

The evolution in the use of recycled fibres and water reuse cause a concentration of mineral and organic soluble materials, in the circuit. These solubles can interfere with starches having a too low degree of substitution and so decrease the efficiency. The nature and concentration of dissolved solids vary from one paper to another. We must examine each circuit in order to use the type of cationic starch most adapted and add it to the best introduction points, where the fibre is most receptive.

The anionic products can boost the cationic demand of circuits and

	HI-CAT ® serie	
Nitrogen Content	**0.24-0.28**	**0.60-0.65**
Grammage	175	175
CMT 30	372	372
Starch Dosage (kg/T)	15-30	10-15
Production (T/h)	4.4	5.2 **(+18%)**
Wire Speed	202	212
Steam Consumption (kg)	3	1.6

Figure 2 :packaging paper 150 gsm (100% OCC)

100% virgin fibres - Offset paper
· Reference: HI-CAT ®: 6 kg/t
- Receiving complaints on dusting

· Result:
Introduction of 1.2 kg/t of VECTOR [R] IC1412AS
- Increase of the cationic starch up to 10 kg.
BURST + 8% - SCOTT BOND + 15%
>> Retention aid: -50%
>> Reduction of dusting by 50%

Figure 3: Offset paper

ROQUETTE has also developed ready to use new biopolymers, in order to optimise the effectiveness of its current range of wet end cationic starches. Products can be anionic or cationic.

- **Renewable resources**
- **Tailored made product (solids, charge density)**
- **FDA, BfR and China GBP9685**

thereby contribute to the setting of a majority of cationic starch, to further improve the results on paper.

Figure 3 shows that the paper's characteristics can be improved through the combined action of VECTOR® IC 1412AS, which raises the possibility of fixing the amount of wet end cationic starch by increasing the final characteristics while having a positive effect on the retention.

The cationic products are used in many application fields as ASA sizing (see previous article in World Pulp & Paper 2011) and tissue paper. Here, as we are focused on wet-end efficiency, we would like to present a highly functionalised and highly cationic new biopolymer.

Decrease of water pollution will involve less deposits and a lowest level of broke and downgrade of paper

This product, called today by its development name (LAB 4202) is being tested and achieves a high level of cleaning circuits. The example in Figure 4 is the result of a paper machine producing packaging with a high level of anionicity (closed circuits, OCC pulp, etc.).

We can see here that we have for the sample of level box taken at 2 PM a clear neutralisation of anionic colloids with the introduction of LAB 4202. For the first dry kilos per ton of fibres, we have a reduction on SCD of 20%, 15% for the second and again 20% for the third one. In the same time, we are not impacting the pulp negatively as the Zeta Potential remains relatively stable from -7,1 for the reference to -6.2 with the addition of 3 kg/t.

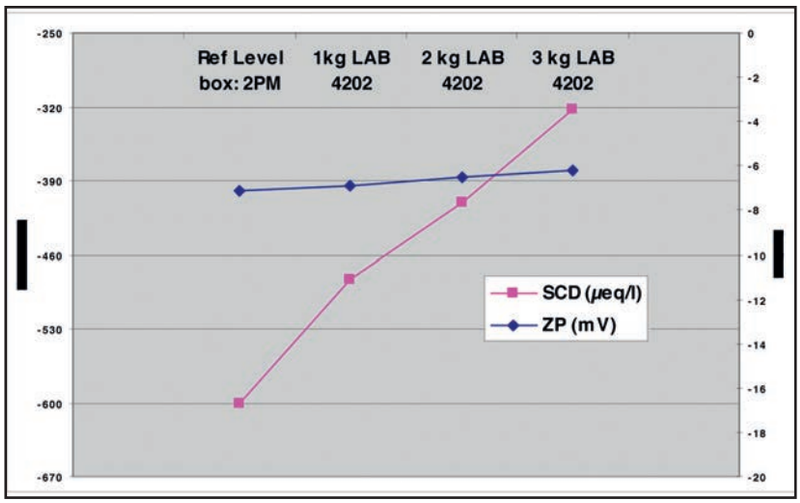
In parallel, we made turbidity measurements on the filtrate and we can see that the turbidity is divided by 2 with only 1 dry kg/t of LAB 4202 in the pulp after the level box.

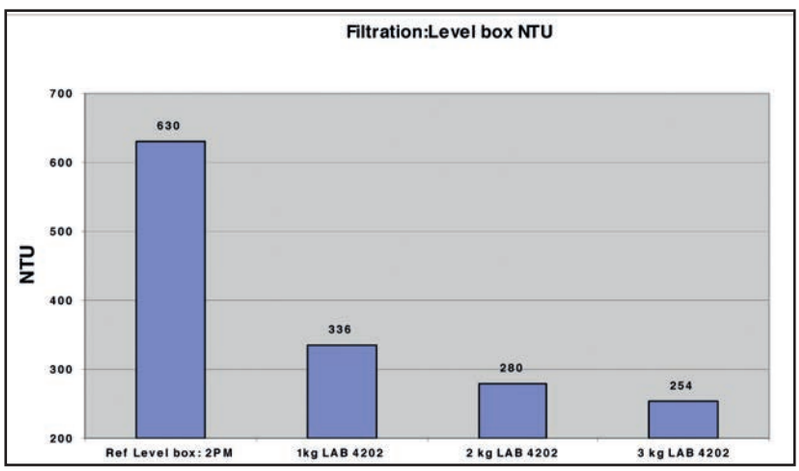
We can say that the level of anionic colloids (and fines) are at a high level in the pulp and can explain the non-effect of a basic cationic starch in the system. Introducing a high cationic bio-polymer can help to achieve a better wet-end chemistry and should also play on retention.

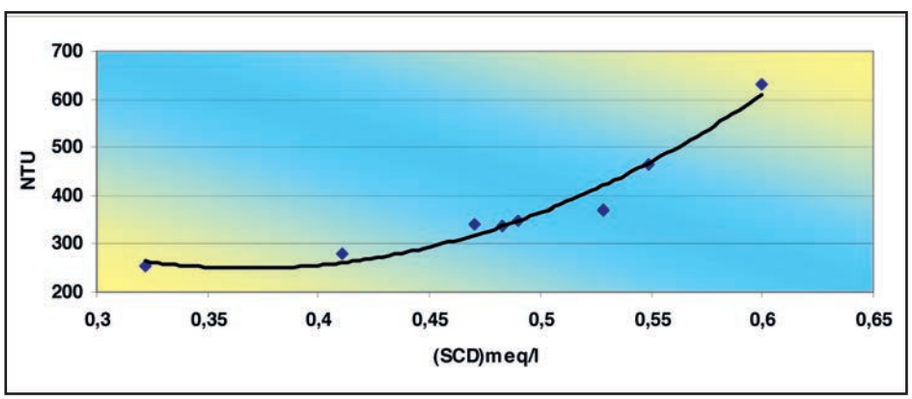
Decrease of water pollution will involve less deposits and a lowest level of broke and downgrade of paper.

According to this other representation, when polymer amount increases, the cationic demand of the system approaches zero. The smaller the cationic demand is, the less the system contains anionic trash.

Figure 4: Packaging paper







The bio-refinery concept is not new to starch manufacturers but will certainly be developed over the years to come and many of the synthetic chemicals being used today in papermaking may well be replaced in the future by products derived from starch

According to common knowledge, retention and drainage perform better in processes with low cationic demand as well as sizing chemicals.

The possible advantages can be achieved as:

- Reduction of steam consumption,
- Reduction of fresh water consumption,
- Reduction of broke,
- Etc.

We have illustrated by some examples the will of ROQUETTE to develop solutions to optimise production with, among others, the new biopolymers. These products are highly functionalised, which on the one hand can improve the efficiency of wet end cationic starches and also to answer specific requests based on the nature of the system.

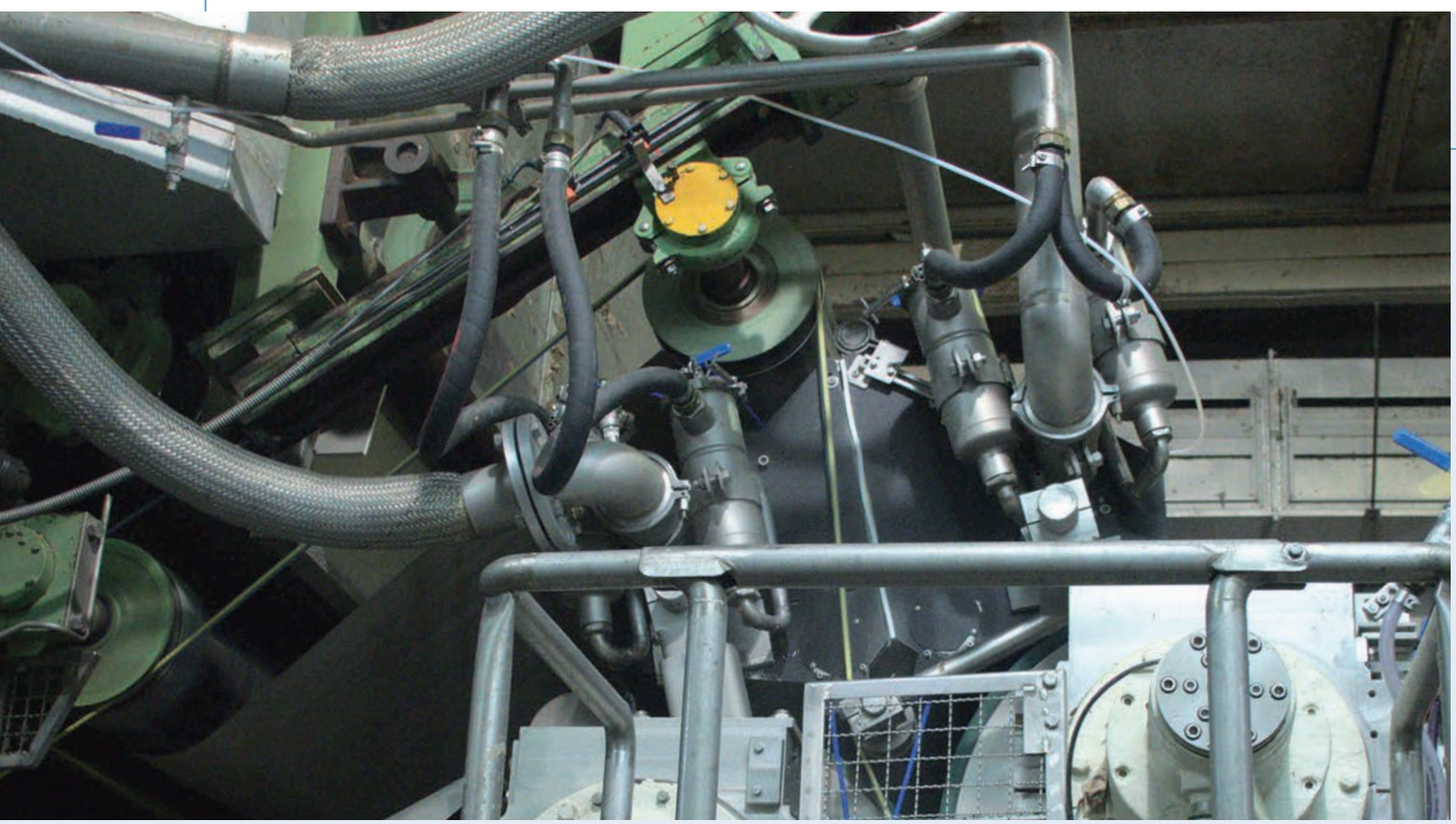
As mentioned, the use of these new VECTOR® biopolymers can be multiplied as in ASA sizing, Tissue, Decor paper, specialty papers and all classical paper ranges.

CONCLUSION

Starch is a natural biodegradable polymer made from a renewable resource. As such it can be used as the feedstock to produce many products to substitute and replace products derived from petroleum. It is already used to produce plasticisers, encapsulating products and films not to mention bio-fuels. The bio-refinery concept is not new to starch manufacturers but will certainly be developed over the years to come and many of the synthetic chemicals being used today in papermaking may well be replaced in the future by products derived from starch.

VIB FluidTech

Sizing with VIB FluidTech



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- VIB FluidTech is a highly efficient starch spraying unit which operates with solid content of up to 25 %.
- VIB FluidTech is completely Teflon impregnated for easy cleaning in the online process. The integrated mist protection assures an even cleaner size press area.
- VIB FluidTech increases the production or reduces the energy costs of your paper or board machine compared to normal size press operation.
- VIB FluidTech can work with corn starch or potato starch for further cost benefits.
- The calculated return of investment is approx. 12 months.

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VIB Systems. Advanced engineering for advantageous results.

EcoSphere® biolatex® binders: Next generation solutions for today's paper coating industry

By **Peter van Ballegooie**, VP Marketing & Business Development, **Phil Greenall**, VP Global Sales – Paper, **Steven Bloembergen**, Executive VP Technology, and **Ralph DeJong**, Director Product Development & Technical Support, ECOSYNTHETIX INC.

There is no doubt that the global paper industry faces a challenging future, as alternative technologies and ever growing environmental pressures require that the current manufacturers must significantly adapt to survive. In particular for coated grades, the current situation demands more sophisticated and cost-competitive alternatives to traditional petroleum-based chemistry. The industry is increasingly looking towards its supply partners for new solutions capable of offering them a superior balance of performance and economics. Welcoming this opportunity, ECOSYNTHETIX has the ambition of enabling constructive change within the industry towards more sustainable binder solutions that deliver high functional performance while simultaneously having superior economic benefits compared to traditional petroleum-based alternatives. ECOSYNTHETIX is a rapidly expanding, high-tech, green technology company that is committed to strengthening its position with customers around the world by working with them to optimise their coating formulations and introduce its innovative family of EcoSphere® bio-based emulsion binders.

As 2011 has come to a close, ECOSYNTHETIX is proud to announce that it is involved with the majority of the top 20 paper producers around the globe, either with ongoing commercial sales or with significant development projects underway. For 2012, our plan is to continue those efforts by delivering the most innovative, bio-based binder products that are commercially available. This edition of World Pulp and Paper provides an opportunity to highlight our company's latest technological capabilities, its new pilot extrusion line and its production facilities, all of which have been designed to provide exceptional benefits to our customers and new development partners in the industry.

For 2012, our plan is to continue those efforts by delivering the most innovative, bio-based binder products that are commercially available

STATE-OF-THE-ART PILOT EXTRUSION LINE CAPABILITY

ECOSYNTHETIX prides itself in establishing close working relationships with its customer partners. Understanding the customer's unique application needs is the first critical step in helping to tailor specific product offerings that exceed expectations. The second critical step is that of having a state-of-the-art pilot line, enabling rapid new product and process prototyping of sophisticated bio-based materials. The ECOSYNTHETIX pilot line was inaugurated in 2011 with the commissioning of its reactive extrusion line at the company's Center of Innovation in Burlington, Ontario, Canada (see Figure 1). The large pilot unit has been designed for extreme flexibility in operation and is capable of handling a variety of raw materials, using precision metering and flow control. This state-of-the-art process allows for rapid prototyping and yet still ensures excellent uniformity and product quality. Packaging options with this line, including either 25 kg bags, 1,000 kg or 1,250 kg super-sacks (see Figure 2), are very convenient for use with customers who are trialing the product on their pilot or full-scale paper coating lines.

ECOSYNTHETIX: SOLID FOUNDATION BUILT ON INNOVATIVE TECHNOLOGY

- **ECOSYNTHETIX becomes a public company on August 4, 2011 with the largest ever CleanTech IPO on the Canadian TSX exchange.**
- **The company's Center of Innovation and corporate headquarters is opened in 2011 in Burlington, Ontario, Canada.**
- **Our strong patent estate is the foundation of the company's two technology platforms: EcoSphere® biolatex® starch-based polymers and EcoMer® sugar based macromers.**
- **EcoSphere® biolatex® binders are being rapidly adopted and sold in paper coating applications in Asia, Europe and the Americas.**
- **Manufacturing facilities in North America and Europe have been significantly increased over the last year; the company's total annual production capacity now exceeds 100 thousand metric tons.**

WORLD CLASS PRODUCTION

Serving our customers with products delivering the highest overall level of quality also requires a commitment of capital investment for a world-class production facility. Following the successful addition of its second line in Europe in late 2011,

Figure 1 *ECOSYNTHETIX pilot reactive extrusion line in Burlington, Ontario supports the company's new product development efforts*

ECOSYNTHETIX is taking a leadership position within the industry with the installation and commissioning of a new flagship manufacturing line in Dyersburg, Tennessee (see Figure 3). This new custom-designed manufacturing line, which has similar design flexibility to the pilot extrusion line housed at the Center of Innovation in Burlington, Ontario, is slated to deliver an additional 35,000 metric tons (~80 million pounds) of finished product per annum.

The heart of this new manufacturing facility is its reactive extrusion line equipped with the capability of handling multiple types of raw material feedstocks. Quality assurance is taken to a new level as this heavily automated line can extract a product

Figure 2
Throughput of ECOSYNTHETIX pilot line, approximately one-eighth of its full production lines, supports large-scale customer trials and facilitates rapid scale-up to commercial manufacturing

sample every five seconds enabling product quality data to be recorded and accessed not only on a lot-to-lot basis but even on a bag-to-bag basis, if desired. The downstream portion of the extrusion facility is equally sophisticated with very stringent package weight control and ultrasonic bag sealing to eliminate any potential moisture ingress. The complete range of packaging options from 25 kg bags to super-sacks to bulk delivery via rail car or tank truck has been designed with consideration of our customer end-user needs.

PROVIDING VALUE-ADDING PRODUCTS MEETING CUSTOMER NEEDS

The technology and benefits of using biolatex® binders as substitutes for petroleum-based binders in paper and board coating applications has been broadly reported [1-4] within the industry (relevant white papers are also available at www.ecosynthetix.com). In general, these biolatex® binders provide comparable or superior technical performance to traditional carboxylated- or acrylonitrile-based styrene butadiene (XSB) and styrene acrylate (SA) latex binders in coated paper and board applications in terms of paper gloss, brightness, whiteness, fluorescence, ink gloss, and printability. Additionally, they deliver enhanced performance to XSB and SA binders when considering water retention, opacity, binding strength, porosity (higher blister resistance) and paper stiffness. Figure 4 provides a summary overview. ECOSYNTHETIX family of biolatex® binders for paper and board

Figure 3
Combining full automation with high quality standards, ECOSYNTHETIX flagship production line raises the bar for manufacturing excellence

Figure 4. *Relative performance comparison between various classes of binders based on collective feedback from customer paper coating trials*

Properties of Paper Coatings	ECOSPHERE® Biolatex® Polymers	Starches	Synthetic Petro-based Latexes
Ease of Formulation	+	-	++
Water Retention	++	+	-
High-Speed Runnability	++	-	+
Dry Strength	++	-	++
Wet Strength	+	-	++
Stiffness	++	+	-
Coating Gloss	+	-	+
Print Gloss	++	-	+
Brightness without OBA	+	-	++
Brightness with OBA	++	+	-
Whiteness	++	-	++
Resistance to Yellowing	++	+	-
Binder Migration & Mottle	++	-	+
Opacity	+	--	-
Printability	+	-	++
No VOCs	++	++	--

"+" = comparatively superior performance "-" = comparatively inferior performance

FORMULATION	Reference	T2	T3	T4	T5	T6	T7
PIGMENTS							
GCC	70	70	70	70	70	70	70
Clay	30	30	30	30	30	30	30
BINDERS							
XSB Binder	10.50	7.00	5.25	7.00	5.25	7.00	5.25
ECOSPHERE® 2202	0.00	4.00	5.75	4.00	5.75	5.00	7.75
ADDITIVES							
CMC	0.50	0.00	0.00	0.00	0.00	0.00	0.00
PVOH	1.00	1.00	1.00	1.00	1.00	0.50	0.00
Rheology Modifier	0.20	0.20	0.10	0.20	0.10	0.00	0.00
Calcium Stearate	0.25	0.25	0.25	0.25	0.25	0.25	0.25
OBA	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Insolubilizer	0.00	0.00	0.00	0.50	0.50	0.50	0.50
COATING PROPERTIES							
Solids Target (%)	65.0	68.0	68.0	68.0	68.0	68.0	68.0
Solids at the Coater (%)	**66.1**	**68.0**	**67.5**	**67.1**	**66.8**	**67.8**	**67.9**
Brookfield Viscosity (100 rpm)	1670	1360	1240	1200	1140	820	1760
pH	8.8	8.7	8.8	8.7	8.8	8.8	8.8
% XSB Replacement	0	33	50	33	50	33	50
% EcoSphere® in Total Binder	0	36	52	36	52	46	60

Figure 5. *Coating colour formulations used for customer pilot coater runs at PTS*

coating applications have been shown to impart unique rheological (shear-thinning), coating hold-out, coating structure and optical properties.

EcoSphere® is a proven technology that can clearly demonstrate the significant benefits of adopting biolatex® binders. Many years of validation trials in pilot coater and mill operations have been conducted with development partners from all corners of the globe. One such example is a series of customer pilot coater trials, run on a PTS Vestra pilot coater in Munich, Germany using typical coating colour formulations shown in Figure 5. This pilot coating line is unique in that it has five different coating applicators, including rod, blade, air knife, metered size press, and a three-layer slide curtain coater that operate at speeds ranging from 50 up to 2,500 m/min (164 to 8202 ft/min).

It should be noted that the positive pilot coater results were fully borne out by full-scale mill operations for the same customer. Interested parties may wish to peruse the trial analysis details contained in the original paper [4] as only an abbreviated summary is provided here. While all of the coating formulations produced very good quality coated paper product, some significant advantages were noted as follows:

- Incorporation of the EcoSphere® binder enabled a substantial solids increase of between 1-3% at a comparable bleeding level relative to the reference
- The successful elimination of CMC and reduction of the rheology modifier demonstrated the superior water retention characteristics of the EcoSphere® biolatex® binder
- Higher residual coated paper stiffness was achieved when EcoSphere® binders were utilised in comparison to the reference formulations containing only the XSB latex binder
- Overall, the excellent runnability, paper and print performance demonstrated that 30 - 50% of XSB latex plus additionally all or part of the co-binder, rheology modifier and OBA carrier could be replaced with EcoSphere® biolatex® binders to provide similar performance.

Many years of validation trials in pilot coater and mill operations have been conducted with development partners from all corners of the globe

BUILDING A BETTER WORLD WITH MORE SUSTAINABLE COATED PAPER

There is a continuous global requirement towards the usage of materials having lower overall carbon footprint. EcoSphere® biolatex® binders have been designed to have a neutral carbon footprint for the paper manufacturer. Using Life Cycle Analysis (LCA) tools and methodologies, the 'process carbon footprint' can be readily quantified [2,3]. In the case of traditional synthetic binders, the entrapped carbon is of fossil origin and, therefore, represents a source of Greenhouse Gas (GHG) emissions; the amount of fossil carbon in the structure of XSB latex has been estimated as being equivalent to approximately 3.0 kg of CO_2 per kg of XSB latex binder. On the other hand, biolatex® binders are made from renewable raw materials or crops that were grown in a single season by capturing and sequestering CO_2 in the plant via its photosynthesis reaction; consequently, their end-of-life GHG emissions can be regarded as part of the natural carbon cycle and

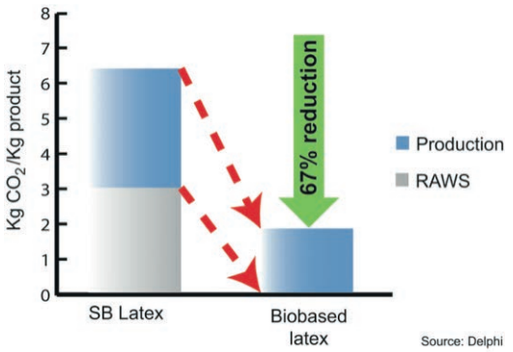

Figure 6. *Relative GHG Reduction between biolatex® binder and XSB latex binder materials*

they are carbon neutral from a raw material perspective.

Based on 'cradle-to-gate' life cycle analyses [5], total emissions associated with production of XSB latex binder are estimated at 6.45 kg of CO_2 per kg of the synthetic petroleum-based binder. This includes both embedded carbon of fossil-fuel origin (released to the atmosphere when the product decomposes) and emissions associated with manufacturing and transporting the product. This can be compared to total emissions of 2.1 kg of CO_2 per kg of the bio-based EcoSphere® binder. Figure 6 illustrates the significant carbon footprint reduction that can be realised when EcoSphere® biolatex binders® are used to displace traditional XSB latex.

A LOOK FORWARD INTO 2012

With the paper industry facing increasing global competitiveness pressures, it is paramount that manufacturers continue to address the evolving market needs and embrace new technologies that can combine both improved performance and economic benefits.

As a technology innovation leader in biomaterials, ECOSYNTHETIX is very well poised with its biolatex® polymer offerings that deliver solutions to these needs, while simultaneously providing opportunities for developing a more sustainable future for coated paper and board producers. None of these challenges, however, can be successfully resolved without having positive collaboration and teamwork between ECOSYNTHETIX and the most important part of the whole value chain - the customer. Visit us at **www.ecosynthetix.com** and we look forward to working with you.

It is paramount that manufacturers continue to address evolving market needs and embrace new technologies that can combine both improved performance and economic benefits

ACKNOWLEDGMENTS

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5. Based on project work that EcoSynthetix commissioned with the Delphi Group located in Ottawa, Ontario, Canada.

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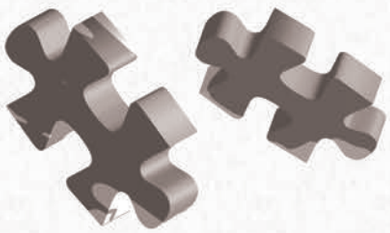

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Experiences with soluble bio-polymer for high solids coatings on various paper and board grades

By **Andreas Becker, Andreas Voigt** and **Richard Tippett,** Cargill Industrial Starches

Some time ago, we reported on the development of C*iCoat as a soluble Bio-Polymer, describing its unique properties and advantages for the papermaking industry. In this article we pick up the C*iCoat story once again, reflecting on the experience we have gained in the meantime. The focus is on the ease of use and simple handling, which – at first glance – may be unusual for papermakers.

It is well known that high coating colour solids have positive effects with respect to optical paper properties, printability and energy efficiency[1, 2]. Classical starches have to be cooked before use as co-binder in coating colours, resulting in dry solids restrictions due to the limited maximum solids of starch pastes. Typical examples are enzyme converted starches or oxidised (potato) starches with max. 32% paste solids. Replacing latex by these starches led to a reduction in coating colour solids, resulting in lower gloss, picking strength, and higher binder migration and thus mottling. During the 1990s the C*Film family was introduced to the market as a new generation of cook-up starches, and improved the situation by enabling cooking and handling of starch pastes of up to 45% solids.

Nevertheless, these products still require cooking, and the resulting starch pastes are still lower in dry solids than pure synthetic binder formulations. Therefore, we concentrated on the development of a new generation of starch-based biopolymers which are soluble, and

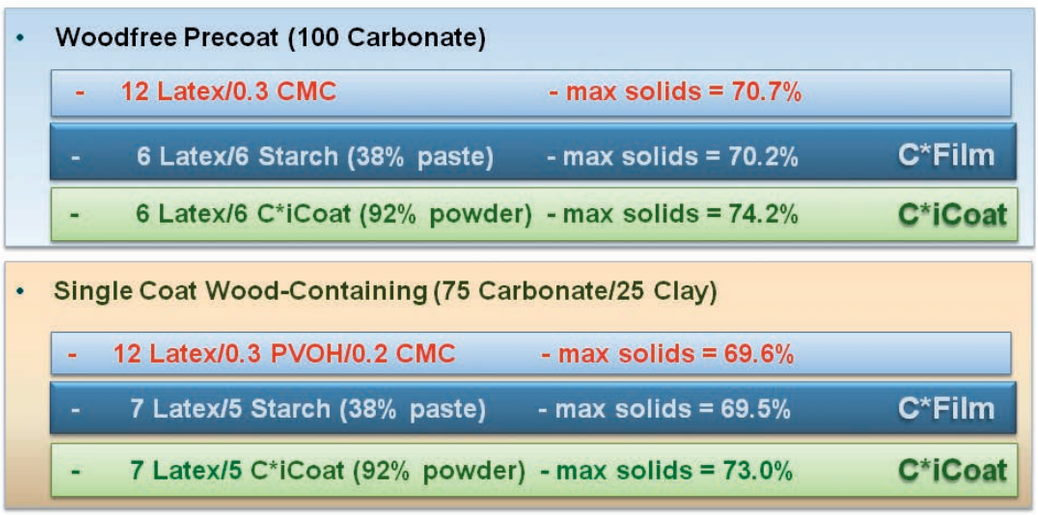


Figure 1 *Maximum Solids for Coating Formulations*

We concentrated on the development of a new generation of starch-based biopolymers which are soluble, providing a co-binder that adds negligible amounts of water to a coating colour

providing a co-binder that adds only negligible amounts of water to a coating colour.

The new product should be added as a dry powder into a coating mixer, easily dispersible and have advantageous binding power with good rheological properties. Certainly, this novel modified starch should allow attractive pricing compared to SBR latex. The result of these efforts was creation of the C*iCoat biopolymers. With these co-binders, we can achieve even higher coating solids than with latex, and, the more we replace, the higher the solids level (Fig.1).

DISCUSSION: HOW TO USE C*ICOAT AND IMPLEMENT IT IN A COATING PREPARATION PROCESS

In recent years, the paper industry has been faced with many changes, resulting in a severe focus on cost optimisation. As a result, personnel have been reduced, and thus any new product, system or solution that adds complexity or requires high investment should be avoided. Concerning complexity, the implementation of C*iCoat in coating colours was developed to be easy and trouble-free. The following case demonstrates these features.

At a coated board manufacturer seeking to reduce binder costs, C*iCoat was implemented in a series of steps, resulting in 50% latex replacement in the precoat formulation. In addition, the coating formulation underwent considerable simplification.

As the mill had previously never used starch in any of its coating formulations, no cooker was available,

and this made the choice to go for C*iCoat the most attractive option. Now, looking back, a starch requiring cooking would have added so much water to the coating colour that the solids level would have suffered unduly, increasing the need for drying energy on the one hand, and synthetic thickeners on the other.

The only necessary investments were the installation of a powder metering and dosing system, and a high-power stirrer to ensure good mixing within the prescribed time. These equipment costs have been paid back many times since commissioning, and the mill is proud to be using sustainable products and producing high-quality board with no compromises.

Depending on the existing equipment and of the amount of product to be added, our specialists are able to offer various alternatives.

Figure 2 simply shows just one of several alternatives of transferring the product – being delivered as a powder in bulk or big-bags – to the coating colour mixer. In a couple of cases we have seen that powder feeding systems - e.g. for CMC, are already installed and available. Such systems can be easily adapted for C*iCoat addition by slight system modifications.

C*iCoat possesses unique solubility properties, and was tailored to be easily dispersible even at high dosage rates such as 100kg per minute. It does not tend to form lumps, and thus does not lead to problems like filter residues, blade scratches or other coating defects. However, the homogeneous dispersion of C*iCoat still requires due consideration of certain critical steps.

When implementing C*iCoat in various mills and their coating machines, we experienced a plethora of different mixer set-ups and dosing sequences of the coating components. A couple of the mixers encountered are shown in Figure 3. In all of these cases, our experts were able to add C*iCoat in the coating formulations with minimal system modifications.

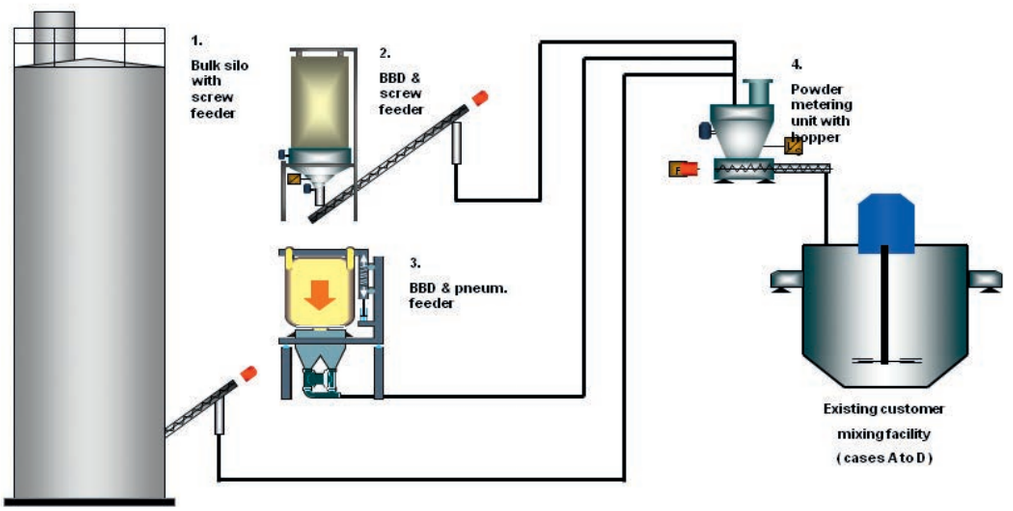


Figure 2 *Powder Dosage Systems*

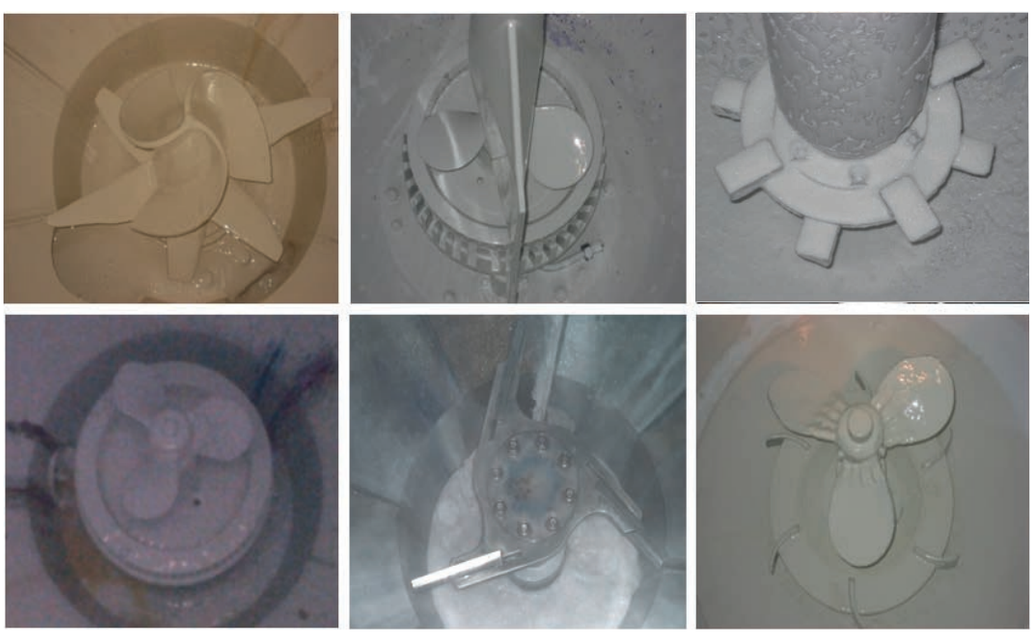


Figure 3 *Coating Colour Mixer Experiences*

C*iCoat is not only easy to implement via its easy handling – it also provides additional advantages regarding possible microbiological contamination.

MICROBIOLOGY

C*iCoat does not require cooking, and thus there is no starch handling system - e.g. slurry make-down, slurry storage tanks or starch cooker and paste storage and paste transfer lines which necessitate regular cleaning or boil-outs. Based on this, there are less potential problem spots – as displayed in Figure 4 - for microbiological growth compared to aqueous suspensions or solutions.

It follows that the absence of the starch handling system results in large biocide savings, and that only the coating colour preparation stage and perhaps the working circuit require

Figure 4 *: Examples of Possible Microbiological Contaminations in Standard Starch Systems*

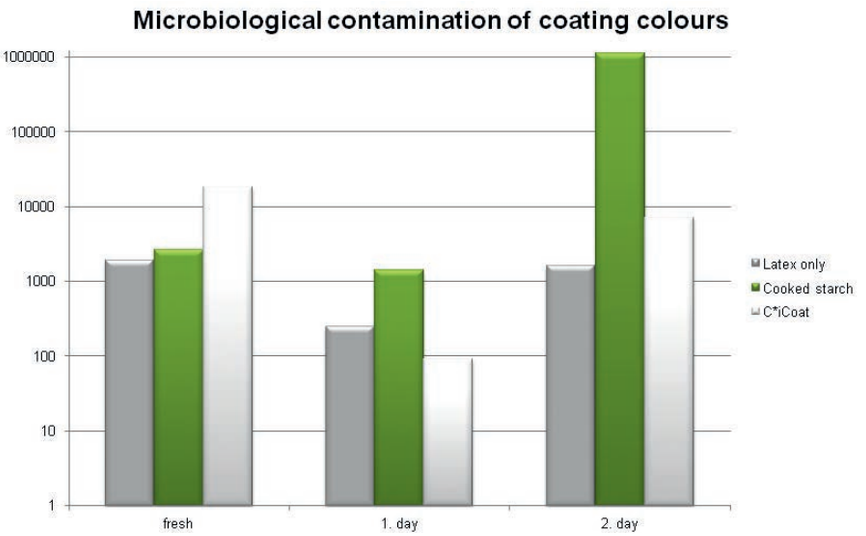


Figure 5 *Example of Coating Colour Stability Increase with C*iCoat*

microbial suppression. The result is more stable conditions as displayed in Figure 5. Here, a pure latex formulation is compared to a conventional coating starch system and one employing C*iCoat respectively.

IS IT POSSIBLE TO RUN COATING COLOURS AT VERY HIGH SOLIDS AND SPEEDS?

The question which may arise is: "How can an increase of dry solids help when starch increases the high shear viscosity and impairs blade runnability?" Indeed, when considering only the laboratory high shear viscosity measurements, C*iCoat leads to an increase of high shear viscosity.

In a series comparing a coating colour with 10 parts latex as binder with formulations where 3, 5 and 7 parts were successively replaced by C*iCoat, the capillary high shear viscosities at identical coating colour solids increase as expected (Fig. 6). In spite of this, we are very confident about good blade runnability because of the very good water retention properties C*iCoat develops in coating colours. It is a fact that the coating colour is dewatered between the point of impingement and under the blade which results in much higher coating colour solids under the blade compared to the fresh coating colour.

Nobody can deny the fact that only the actual high shear viscosity under the blade is decisive for the runnability. The extent of dewatering depends upon the type of coater, the porosity/absorptivity of the paper and the coating speed. With a roll applicator where the applicator roll exerts a pressure pulse, combined with the long dwell time, the extent of dewatering will be higher than that in a jet applicator or a short dwell coater. The higher the coating speed the less the absorptivity of the paper in terms of hydrophobicity plays a role but the size and distribution of pores becomes more important. The water holding capacity of the soluble binder in the continuous phase of the coating colour determines speed and extent of dewatering and also the particle size distribution and shape of the pigments used plays a role in the speed and extent of the build-up of the filter cake and its porosity.

According to Toivakka and Bousfield[2, 3] higher solids accelerate the formation of such a filter cake at the paper <-> coating colour interface, resulting in a sufficiently thick mobile layer of coating colour under the blade. Fig. 7 illustrates the conditions

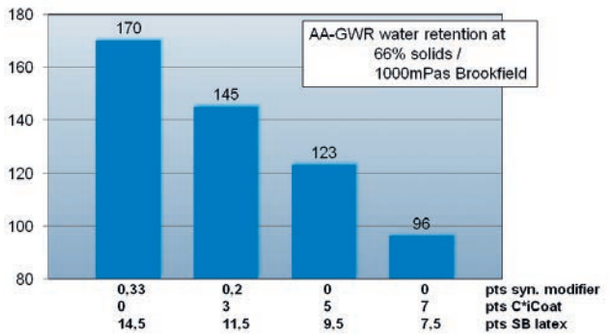
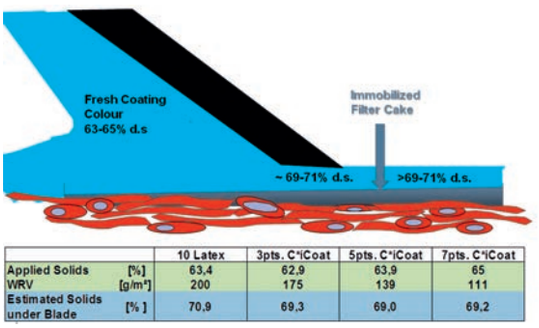


Figure 6 *Water Retention with C*iCoat*



		10 Latex	3pts. C*iCoat	5pts. C*iCoat	7pts. C*iCoat
Applied Solids	[%]	63,4	62,9	63,9	65
WRV	[g/m²]	200	175	139	111
Estimated Solids under Blade	[%]	70,9	69,3	69,0	69,2

Figure 7 *Dewatering under the Blade*

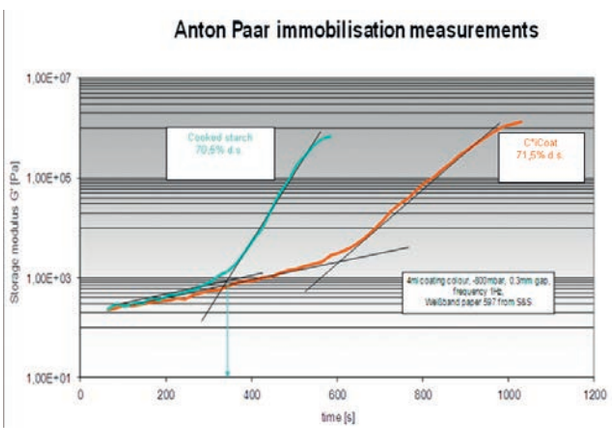


Figure 8 *Immobilisation Measurements*

under the blade for the coating colours discussed at the beginning of this chapter.

Based on the water retention values obtained according to the Abo Akademi method, we calculated the solids that are to be expected at the tip of the blade, taking into consideration the machine speed and absorbency of the paper. According to these calculations, the solids increase under the blade is much more limited for the colours with C*iCoat compared to the pure latex colour.

Using the Anton Paar Immobilisation cell we were able to confirm these calculations comparing a cooked starch coating colour system at 70.5% solids to a C*iCoat containing system at 71.5% solids as shown In Figure 8. It can clearly be seen that by employing the C*iCoat the immobilisation time is almost doubled.

That this is not just theory was also proven during several industrial applications where we applied C*iCoat. Examples are (Figure 9):

1. A top-coating with C*iCoat to a wood-free paper at 74.8% solids with a free jet applicator coater in bent blade mode. Blade angle could be increased without increase in blade bleeding

2. Less whiskering with C*iCoat

3. Less coating colour build up on the backing roll

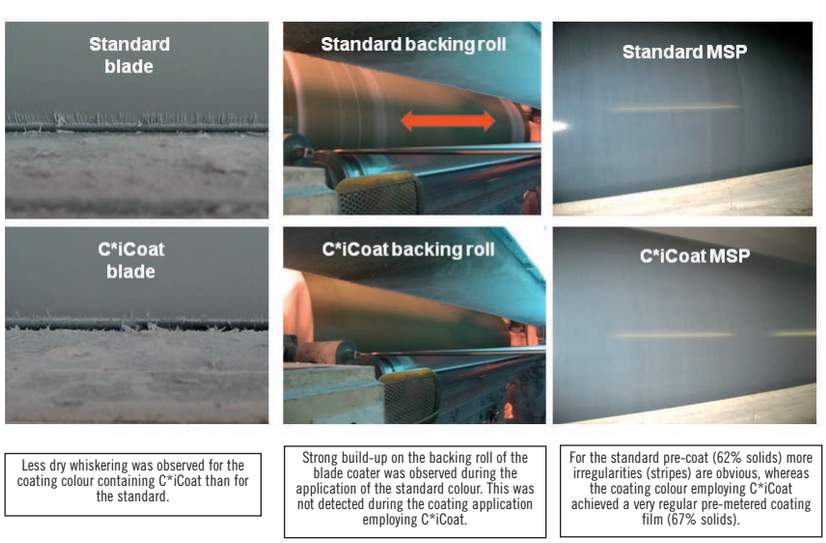


Figure 9 *Examples of C*iCoat's superior rheology*

CASE STUDIES

We have meanwhile run numerous trials for customers both on pilot and industrial scale on different paper grades. In the following, examples will be given for woodfree papers and coated board.

Top-coating of Woodfree Paper

Due to the higher solids, we haven't seen any negative effect by replacing four parts of SBR latex on a 1:1 basis by the bio-based binder during top coating of a double coated woodfree paper. While the solids of the reference formulation was 70% we could raise that to 72% with the cold soluble product. Application was done with a jet-coater at 1300 m/min.

All paper properties measured were on the same level as the reference except for the print gloss that was relatively 5% higher. The results show that under those conditions the binding power of the soluble binder is absolutely adequate (Fig. 10).

Mottling was not an issue and also cracking in the fold was not worsened. It can thus be said that replacing a part of the latex used in glossy top-coating formulations by a starch based bio-polymer has no negative influence on finished paper properties.

Pre-Coating of Board

The use of cook-up starch has become common practice in pre-coating of paper and board. Recent development of latex prices and the wish to use more binder based on renewable resources has been an incentive to investigate how far latex replacement can be pushed in this area when using an innovative bio-binder that increases coating colour solids with increased addition rate.

In this exercise we compared a reference with 13 parts latex as binder

	Ref. 9 pts latex	5 pts latex / 4 pts C*iCoat
Brightness	Par	
Opacity	Par	
IGT	Par	
PPS	Par	
Printed Gloss	→	+ 5%

Figure 10 *Results of replacing 4 parts of latex in top-coating*

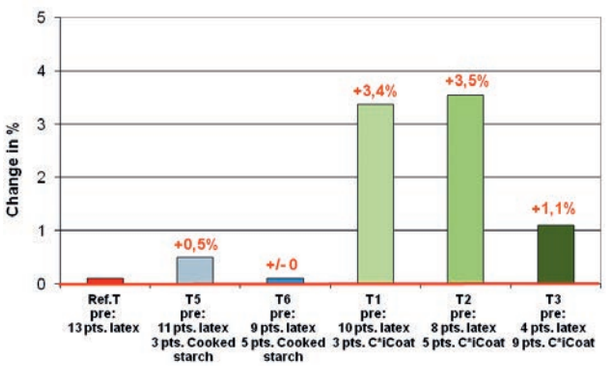


Figure 11 *Coated Board: Latex replacement in pre-coating (Gloss "Gardner" 75°)*

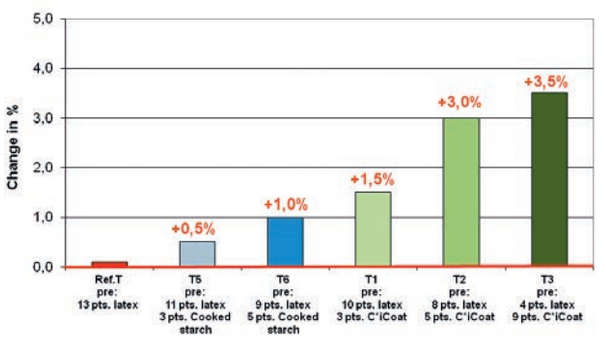


Figure 12 *Coated Board: Latex replacement in pre-coating (Printed Gloss "Prüfbau", 1.2 g/m²/ Lorilleux 3810)*

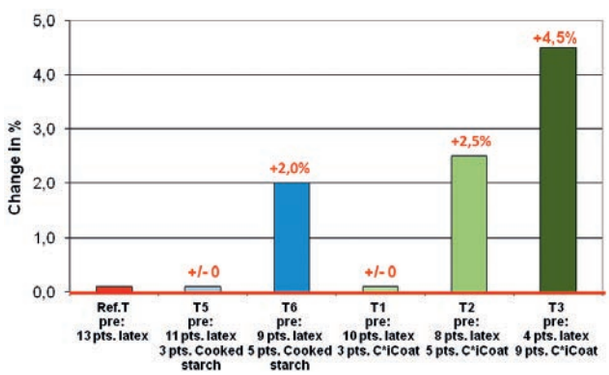


Figure 13 *Coated Board: Latex replacement in pre-coating (Delta Gloss)*

to formulations in which 2 and 4 parts of latex were replaced by 3 and 5 parts of cook-up starch respectively, and also comparing replacement of 3, 5 and 9 parts of latex by 3, 5 and 9 parts of C*iCoat. While the solids of the reference formulation was 68% we could raise that to 68.5 and 68.3% with 3 and 5 parts of cook-up starch respectively, and even to 70% with all levels of the cold soluble product. Application was done with a roll-applicator coater at 500 m/min. All trials were subsequently top-coated with an identical formulation under the same conditions. Fig. 11 shows that, with respect to the gloss of the finished board, the replacement of up to 4 parts of latex by 5 parts of cook-up starch is feasible without quality loss. However, using the cold soluble binder allows replacement of 5 parts of latex with a 3.5% relative increase in gloss, and even 9 parts of latex with a slight gain in gloss of 1.1% relative.

A similar trend can be recorded for Print Gloss (Fig. 12) where C*iCoat again showed better results than the cooked starch. In contrast to the gloss results, in this case the highest values were obtained with the highest proportion of bio-binder. Consequently Delta Gloss is also highest when the combination of 9 parts C*iCoat were combined with only 4 parts of latex in the pre-coating (Fig. 13).

ECONOMICAL CONSIDERATIONS

Binder Composition optimisation

We consider the cold soluble bio-polmer C*iCoat not to be a replacement but instead complementary to our existing C*Film range of cook-up starches. One obvious reason for this is the cost of the new product, the other is the fact that, depending on the formulation used, the maximum achievable solids when using C*iCoat can be higher than the optimum for smooth operation. Whichever co-binder or combination gives the best results is thus a question of what is desired from the formulation and paper quality point of view and what is available in the plant with respect to starch cooking equipment. Fig. 14 gives an overview of what has been tested and what we believe to be a favourable binder combination with respect to quality and cost. In cases where in a big mill (i.e. with existing cooking equipment) a 50 latex/50 C*Film combination is used for pre-coating, it can be envisaged to further reduce the latex to 25% and replace the balance with 25% of C*iCoat. If in pre-coating 100% latex is currently used because it is a small mill without starch cooking equipment, up to 70% of the synthetic binder can be replaced by C*iCoat. Analogously, for middle- or single coating, up to 60% of the latex can be replaced by our bio-polymer. For any mill in top-coating, 30-40% of the cold soluble co-binder can be utilised.

Fig 15 shows the economics of different variations of the pre- and top-coating binder/thickener compositions based on (December 2011) prices of the three binders/co-binders and CMC or PVOH calculated as cost reduction based on dry coating colour.

For pre-coating, a formulation with 7 parts latex + 7 parts C*Film + 0.2 parts CMC – which is common practice for woodfree double coated papers – was taken as the baseline. Increasing the C*Film proportion to 10 parts saves about 12.8% of the coating colour cost of paper with a slight decline in coating solids. An attractive option is to reduce the latex to 4 parts but do this adding 3 parts C*iCoat to the 7 parts of C*Film. This solution still saves a total of 8.8% of the coating colour costs and has the advantage of allowing to run at 2% higher solids. The highest solids of course can be achieved if 10 parts of C*iCoat are used as natural binder. The slightly higher cost of 0.6% compared to the

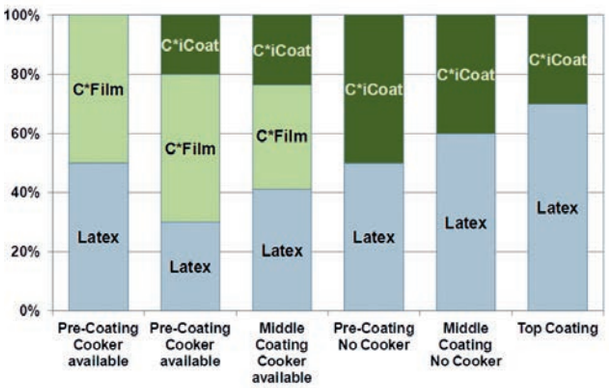


Figure 14 *Options for Binder Composition Optimisation*

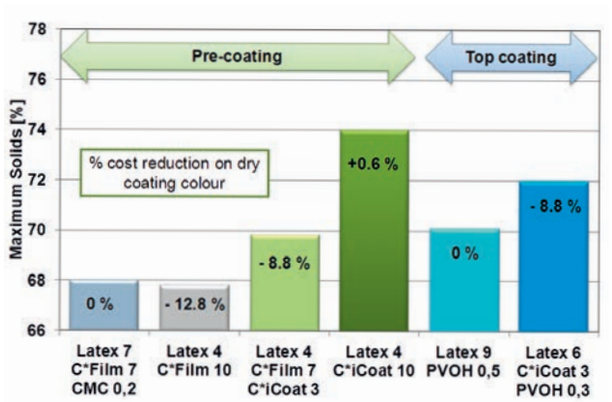


Figure 15 *Binder- and Additive-Cost Comparison (24 g/m² coating @145 g/m² final weight)*

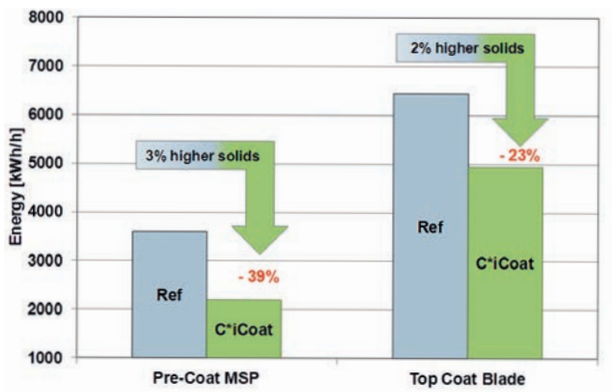


Figure 16 *Energy Consumption During Industrial Trial*

50/50 latex/C*Film combination are easily compensated by the fact that the solids can be raised significantly (see next chapter).

For Top-coating, a formulation with 9 parts latex + 0.5 parts of PVOH was taken as baseline. Replacing 3 parts of the synthetic binder + 0.2parts of PVOH by 3 parts of C*iCoat saves 8.8% binder costs and allows a solids increase of almost 2% with additional drying energy savings potential.

Drying Energy Savings

The effects of increased solids on the energy consumption are much higher than you would think. Theoretically, on the basis of a coating colour with 70% solids (i.e. 30% water), a solids increase of 3% to 73% means only a 10% relative reduction of the amount of water from 30 to 27%. The reality, however, looks more favourable: During industrial trials we were able to increase the solids in the pre-coating by 3% and saved 39% of drying energy, while in top coating a 2% higher solids level resulted in an energy reduction of 23%. In other words each percent of coating solids increase lead to a reduction in drying energy costs of around 12% (Fig. 16). An explanation for that result could be that at increase coating solids less water is absorbed by the fibres in the base sheet having a higher water holding capacity than the coating formulation.

CONCLUSIONS

The new co-binder C*iCoat can be easily handled and added dry to coating colours. In most cases, simple modification of the existing coating colour preparation equipment is all that is required, thus avoiding major investments and any increase in plant complexity The addition of C*iCoat - in contrast to the use of cook-up starches – gives better stability and less risk for microbiological contamination. C*iCoat doesn't lead to a decrease in coating solids but to an increase compared to using latex as sole binder. Due to the excellent water retention achieved and the unique visco-elastic properties of this bio-polymer, the beneficial high coating solids are still runnable on high speed blade coaters.

Industrial trials in many different coating applications have proven the benefits with respect to paper properties when replacing latex and thickener by this bio-polymer. C*iCoat can be used in a variety of coating colours alone or in combination with cook-up starches like C*Film. The optimal binder composition depends on the individual requirements of a mill.

In any case the use of the new cold soluble co-binder brings a whole bundle of economic benefits: see table below. Often a couple of these benefits can be achieved in combination, making the use of the new bio-polymer highly attractive.

ECONOMIC BENEFITS	
o Latex Replacement:	**500 – 700 €/ton C*iCoat**
o CMC/PVOH/Thickener savings:	**90 – 240 €/ton C*iCoat**
o Drying Energy (per percent solids increase):	**~12% (~1 €/t production)**
o CO_2 Emission Reduction	**0.02-0.24 €/t production**
o Productivity Increase:	**Higher revenues ~795 €/t prod'n.**
o Better Paper Quality:	**Improved market position**
o New Paper Grades:	**Develop new markets**
o More Efficient Use of Recycled Coating Colour:	**Cost reduction**

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RAISING YOUR PRODUCTIVITY

Styron collaborates with the academic world to move the paper coating industry forward

By **Prof. Pekka Salminen,** Styron R&D Fellow and **Prof. Martti Toivakka,** Head of Laboratory for Paper Coating and Converting, Åbo Akademi

Isaac Newton, the father of modern science, once said: "If I have seen further than others, it is by standing upon the shoulders of giants." Clearly in science, as in business, collaboration and the sharing of experience and expertise are critical to creating breakthrough discoveries. That very mindset is now pushing leaders in the paper and supplier industry to collaborate with the academic world and together address the challenges faced by the paper industry.

The paper coating supplier Styron has developed and maintained a network of academic research programmes with leading universities around the world. Through the joint efforts of industry specialists and academic research teams, Styron is moving the paper coating industry forward within a highly competitive and global market. This paper focuses on the results of the cooperation between Styron and Åbo Akademi University in Turku, Finland, which is considered one of the leading universities in the area of paper coating research and technology.

BENEFITS FOR THE ENTIRE PAPER INDUSTRY

A structural academic network with leading research institutes helps innovation-driven companies such as Styron attract the best talent in the industry and gain access to academic research, equipment and knowledge. By drawing in the best and brightest people in the industry, paper coating companies can guarantee a steady flow of innovative products that help customers stand their ground in today's competitive paper and board industry.

By drawing in the best and brightest people in the industry, paper coating companies can guarantee a steady flow of innovative products that help customers stand their ground in today's competitive paper and board industry

The resulting technological innovations benefit the entire paper value chain starting with paper mills, the direct customers of paper coating producers. At the same time, universities can benefit from additional funding, facility support and hands-on expertise to develop enhanced research programs that continue to drive innovation.

These benefits make it ever more evident that structural partnerships between industry leaders and the academic world can lead to win-win results for all and benefit the entire paper coating community.

COMPUTATIONAL AND EXPERIMENTAL STUDIES OF FOLD CRACK RESISTANCE[1]

A first example of the successful collaboration between Styron and Åbo Akademi University relates to fold crack resistance. It is generally understood that there is a trade-off between stiffness and fold crack resistance in coated paper.

Fold crack resistance is a critical internal quality parameter for a range of paper and board applications whereas stiffness is a common performance specification required to meet end consumers' needs. The stiffer a paper substrate, the more likely a coating is to crack when folded.

The increased coat weight of coating layers, as well as increased starch content over latex as an adhesive or binder agent, will also contribute to fold cracking. Finally, as a result of the economic pressure for cost-effective solutions, the use of lower quality fibres in the base paper layer means the average strength and crack-resistance of coated paper solutions have deteriorated.

To tackle this dilemma, Styron and the Laboratory of Paper Coating and Converting at Åbo Akademi University examined ways to decouple stiffness and fold crack resistance of coated paper and board grades.

Based on theoretical research about the relationship between the number of coating layers used, the individual layer thickness and the mechanical properties of the coating layers during tension and compression, the team conducted computational research to assess the relationship between fold crack resistance and bending stiffness in coated papers.

To predict the onset of failure, models were developed to calculate the bending stiffness and, based on this prediction, calculate the residual load-carrying capacity of coated paper composites. In conjunction with the modelling, an experimental programme at the Styron Pilot Coater Facility in Samstagern, Switzerland was undertaken.

Interestingly, the computational modelling resulted in a hypothesis that differed from conventional industrial solutions based solely on experimental research. The optimal coating lay-up — as per the hypothesis — was a triple-coating comprising a thin, stiff inner coating layer; a thick, low-stiffness middle coating; and a thin, low-stiffness outer coating.

Experimental studies were conducted at the Styron pilot coating facility for single-, double-, and triple-

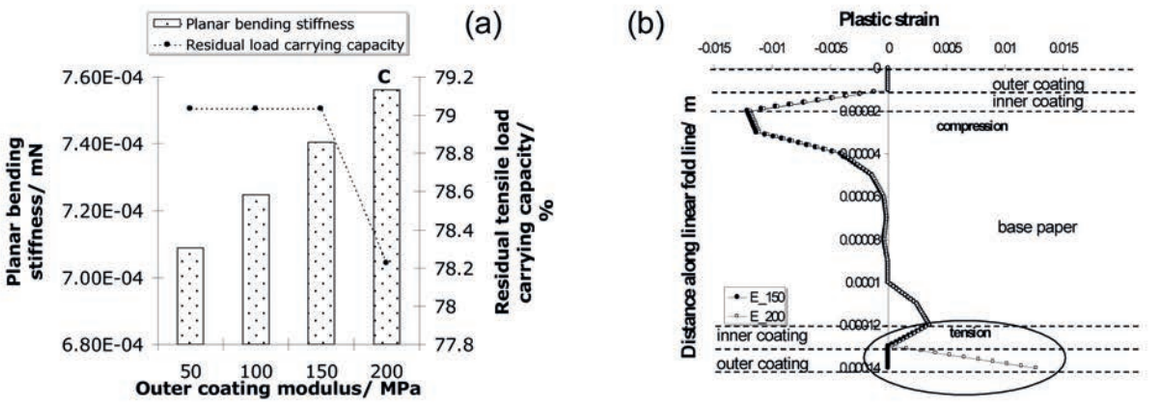

Figure 1. *(a) Demonstrates the folding properties plotted against outer coating modulus for double coated papers and (b) illustrates the failure profile through the fold line for E = 150 and 200MPa. The letter 'C' indicates outermost failure of the tensile coating*

coated papers, keeping the properties and dimensions of the base paper substrate constant throughout. All the while, the elastic moduli of the coatings were varied independently whereas failure stress values were kept constant in order to test failure stress and stiffness simultaneously. The pilot coating trials confirmed the hypothesis, resulting in a unique combination of high bending stiffness and high fold crack resistance.

PRINTED ELECTRONICS ON PAPER SURFACES?[2]

Imagine a paper application acting like an electronic screen that allows consumers to interact with product packaging, for example, a milk carton that indicates to the consumer when the milk turns sour by reflecting the change in pH value, ultimately presenting the altered quality of the product inside.

Or consider potential applications where ink printed on paper could act as an electronic screen, including intelligence built into the printed image. Why shouldn't it be possible to add simple sensory devices to paper applications? Again imagine a thermometer integrated into a paper application where a consumer simply places a finger on the paper surface for an instant temperature reading. Or why not go so far as to print television-like applications on paper surfaces?

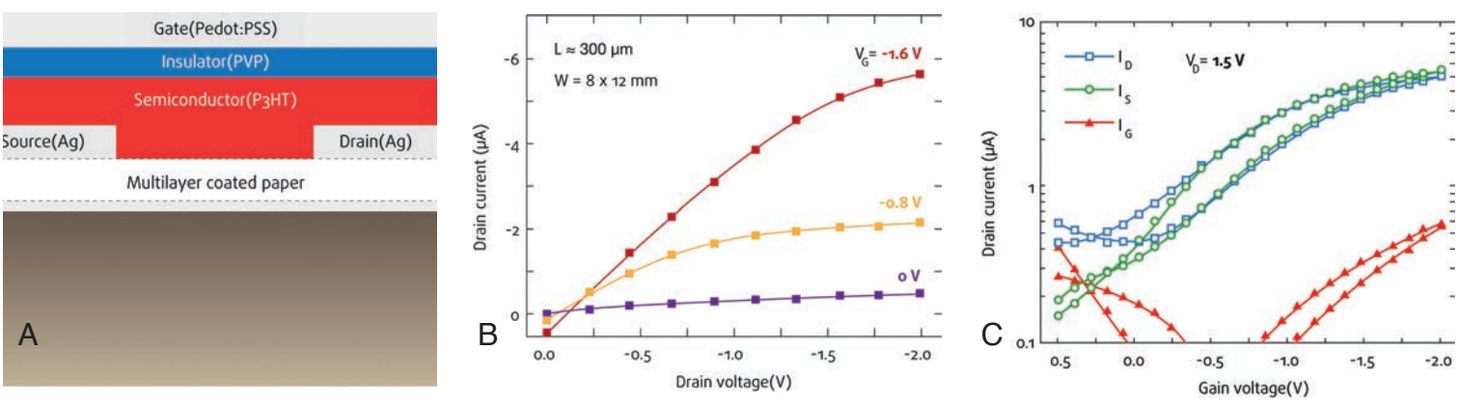

Figure 2. *(A) Schematic and optical image of reel-to-reel printed transistor on multilayer coated paper. Output (B) and transfer (C) characteristics of a HIFET on paper. The flexographic printed source and drain contacts (silver) had a relatively long channel length of around 300 µm. The semiconductor (P3HT) was spraycoated and insulator (PVP) was coated using reverse gravure technique. The gate (PEDOT:PSS) was printed using flexography.*

Linking such hi-tech applications to a cost-efficient, sustainable and readily available material like paper would certainly open up numerous market opportunities.

Although this might sound like science fiction today, a team of Styron experts recently teamed up with academics at Åbo Akademi University to research the potential of these novel printing techniques for functional materials and devices.

Keeping in mind that electronic ink is already available in printing on polyethylene films, the team turned to Styron's Multi-Layer Curtain Coating (MLCC) technology as a promising solution to identify a substrate onto which electronic ink could be printed.

MLCC takes technology traditionally used in the photographic industry a step further by enabling composite coating at high speeds beyond 2,000 m/min and by allowing two or more individual coating layers to be deposited on a substrate in just one pass. This makes a more cost-effective use of functional chemistry possible in thin, confined layers, enabling different functionalities to be shared in just one process. Researchers at Åbo Akademi and Styron managed to produce a substrate onto which electronic ink can be printed, thereby using the MLCC technology to obtain the necessary physical properties that allow printing on electronic inks.

FUNDAMENTAL RESEARCH INTO BINDING MECHANISMS[3]

Not all the research that universities and paper coating companies conduct together is directly related to current market trends or technologies on the verge of commercialisation. Additional research investigates more fundamental challenges, addressing questions such as how binding failure between particles in paper coating occurs, and how such failure can be prevented.

At the most basic level, paper coatings consist of pigments such as calcium carbonate or clay and an adhesive such as starch or latex. The adhesive binds the pigments to each other and also to the base paper being coated. Inside the coating two different types of binding mechanisms account for the strength of the coating. For

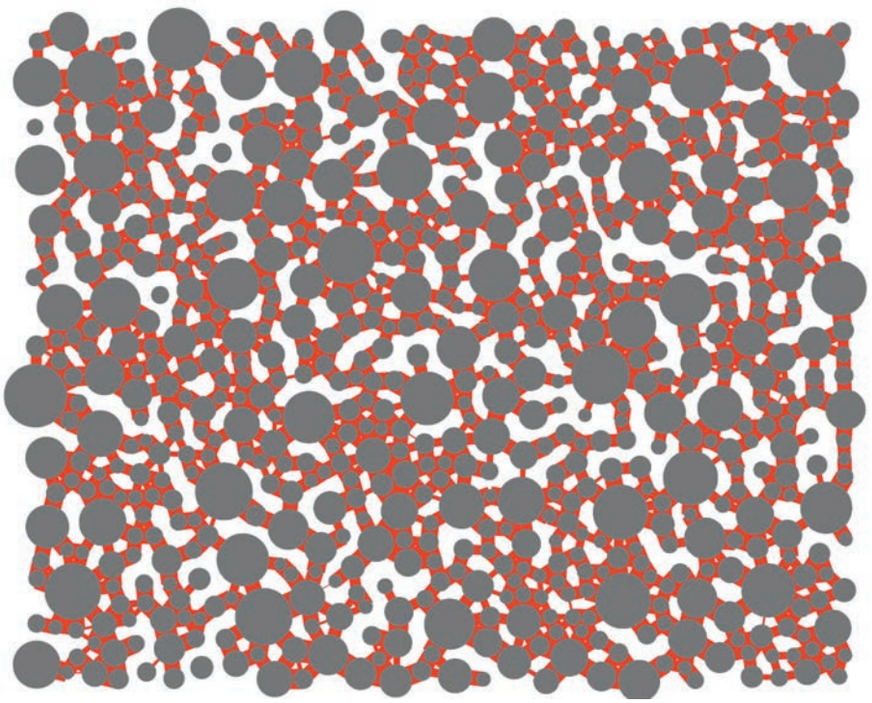

Figure 3. *Computer simulation of latex film formation in coating layer*

STYRON EMULSION POLYMERS' ACADEMIC NETWORK INCLUDES:

- **Åbo Akademi University, Turku, Finland (www.abo.fi)**
- **Karlstad University, Karlstad, Sweden (www.kau.se)**
- **University of Maine, Orono, ME, USA (www.umaine.edu)**
- **Western Michigan University, Kalamazoo, MI, USA (www.wmich.edu)**
- **University of New Hampshire, Durham, NH, USA (www.unh.edu)**
- **South China University of Technology (SCUT), Guangzhou, P. R. China (http://en.scut.edu.cn)**

both types of binding mechanisms, there are associated failures that can influence the performance of the coating. On one hand, failure can occur at the interface between pigment and binder, a so-called adhesive failure. In other cases, a break can occur within the binder, causing what is known as cohesive failure.

The question of which failure mechanism dominates under different conditions is especially relevant to develop better and more efficient binder technologies. Styron and the Laboratory of Paper Coating and Converting at Åbo Akademi University used computational modelling to discover whether adhesive or cohesive failure dominates in dry and wet conditions.

Unlike standard industry R&D processes, where experimental research is implemented early-on in the process, the team started by using computer models to predict the types of failures that could occur given a variety of different functions and variables.

Both the computational simulations and experimental laboratory research confirmed the same conclusions, i.e., that under dry conditions cohesive failures are more likely to occur and under wet conditions – when water weakens the adhesion between the particles – more adhesive failure is expected.

Fundamental insights like these do not immediately lead to new commercial products, but instead generate platforms that allow break-through developments to be achieved in due time.

SHARING KNOWLEDGE, TECHNOLOGY AND SKILLS

The examples listed above illustrate how a longstanding industry-academic collaboration can result both in fundamental findings and practical applications that benefit the entire paper and board value chain. Linking the hands-on expertise and facilities from paper coating and supplier companies with the deep-rooted fundamental knowledge of academic researchers has proved to be a winning recipe to address the hardest technical challenges in the paper industry.

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LEADING PAPER COATING EXPERTISE IN FINLAND

Åbo Akademi University is Finland's Swedish language university with some 7,000 students on three campuses. The main campus is located in Åbo (Turku in Finnish) on the southwest coast of Finland. The Laboratory of Paper Coating and Converting has an acknowledged position at the forefront of research in areas such as paper coating, novel surface treatment methods for natural fibre-based products, printing as a fabrication method and use of paper as a substrate for printed electronics.

KNOWLEDGE EXCHANGE IN A RAPIDLY DEVELOPING ASIAN MARKET

The knowledge sharing from industry-academic collaborations is especially relevant for emerging markets, notably in China, where the paper and board industry is booming. Despite a lack of formal paper coating research and education, an injection of fundamental research and knowledge should be high on the industry's agenda.

In November 2011, Styron, the State Key Laboratory of Pulp & Paper Engineering of South China University of Technology (SCUT) and Professional Committee for Paper Coating and Converting of CTAPI jointly organised the first Paper Coating Symposium in Guangzhou, China. The Symposium confirmed that the dramatic growth of packaging in the Chinese market and the burgeoning expertise will likely propel the Chinese paper and board industry to surpass the currently dominating Western paper industry in the near future.

Functionalised soy polymers offer improved performance, reduced cost and increased sustainability

By **Richard Gagnon**, Senior Research Scientist, DuPont Soy Polymers

Improving cost while meeting quality standards is a continuous challenge for the paper and board industry. Simultaneously, there is increasing pressure from both regulatory and sustainability perspectives. DuPont Soy Polymers offers a range of highly functional soy polymers, and the opportunity to address these requirements in cost-saving strategies for paper and board coatings.

Sustainability is really about reducing the impact of consumption on the environment. Materials derived from renewable resources that can displace petro-chemicals or products associated with a large 'carbon footprint' are desirable. Materials that can help us minimise the total amount of coating used or binders required for acceptable performance are desirable.

DuPont Soy Polymers are produced from renewable, agriculture soy feed-stocks. Plant-based proteins do not add to atmospheric CO_2 and can be grown around the world. Our products are bio-degradable (see ASTM E1720, Standard for ready, ultimate biodegradability) and compostable (see ASTM D6400).

Cradle-to-gate lifecycle analysis (LCA) of our products by an outside panel of experts has determined that these materials represent approximately one third of the carbon equivalents of latexes (emulsion polymers) and 52% as much fossil fuel depletion (per ISO 14040, value in mega joules).

The chemistry and conformation (structure) of soy storage proteins can be modified with the resulting 'functionalised' soy polymer capable of delivering the performance required in paper coatings. Functionalised soy polymers are colloids with an amphoteric, non-thermoplastic nature. They form intimate associations with mineral pigments, resist depletion in paper coating processes and can be combined with other coating binders to deliver superior results.

In this article, we will describe three routes to reduced cost and increased sustainability.

Pigment			
FGCC 60% < 1µm	100	100	100
Binder/Thickener			
SB Latex average diameter ca. 140 nm	7.50	3.75	0.00
Functionalised soy polymer	0.00	3.75	7.50
Synthetic thickener ASE	0.60	0.3	0.00
Total Binder (parts per hundred parts pigment)	**8.1**	**7.8**	**7.5**
Total Binder Volume (cm^3 / 100g pigment)	**7.8**	**6.8**	**5.9**

Figure 1 *Coating formulas evaluated in pilot coater study*

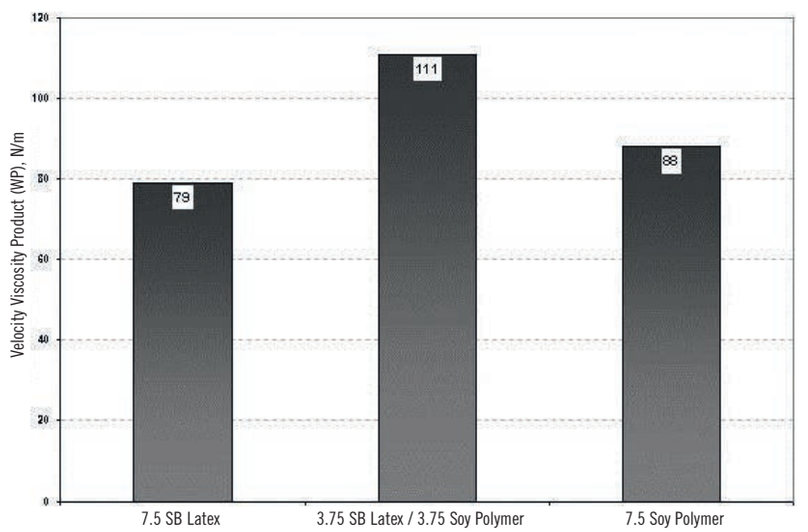

Figure 2 *IGT (oil) Pick Strength*

Materials that can help us minimise the total amount of coating used or binders required for acceptable performance are desirable

OPPORTUNITY FOR REDUCED COST THROUGH BINDER REDUCTION – BINDING STRENGTH OF FUNCTIONALISED SOY POLYMERS

The inclusion of functionalised soy polymers to coating systems results in modification of the overall pore diameter and volume distributions. Attendant increases in coating cohesive strength have been observed as these distributions are altered. While a complete discussion of the mechanism(s) by which pore structure

alterations influence cohesion is beyond the scope of this article, it seems reasonable to assume that latexes (being discrete particle of definite average diameter and volume) cannot occupy pores that are smaller than they are. Clustering of latexes can occur and is described in the literature[1]. Further, functionalised soy polymers are known to resist depletion over time in coating processes. This phenomenon is also described in the literature[2]. Changes in pore volume and diameter distributions have been observed when soy polymers are included in the coating matrix[3]. We have postulated that the intimate physical and chemical associations formed between soy polymers products and mineral pigments results in a significant reduction in the number of pores present in a coating structure and that this is a primary driver for increased coating cohesion.

Figures 1 and 2 (left) provide detail from a pilot coater study in which a functionalised soy polymers was compared to SB latex in a simplified pre-coat formula. In this experiment, the substrate was a 55 g/m^2 wood-free paper.

Note here that the total binder content of the formulas (discounting thickener) is equal on a weight added basis. Considering the differences in specific gravity that exist between SB latex (ca. 1.04 g/ml) and soy polymer (ca. 1.28 g/ml), the total volumes of binder added to these coatings exhibit some small differences which deserve note here.

The data from this pilot experiment suggest that functionalised Soy Polymer can replace SB Latex, either partially or totally in pre-coat formulas while maintaining coating cohesive strength and significant reductions in total binder may be achievable with functionalised Soy Polymer either alone or in combination with latexes. Such reductions will optimise costs.

Changes in pore volume and diameter distributions have been observed when soy polymers are included in the coating matrix

Kaolin Blend (80:20, Hydrous:Calcined)	**86**	**86**
TiO2 (Rutile)	**14**	**14**
SB Latex	**18**	**15**
Soy Polymer	**---**	**3**
ASE Thickener	**0.15**	**---**

Figure 3 *Mid-coat formulas*

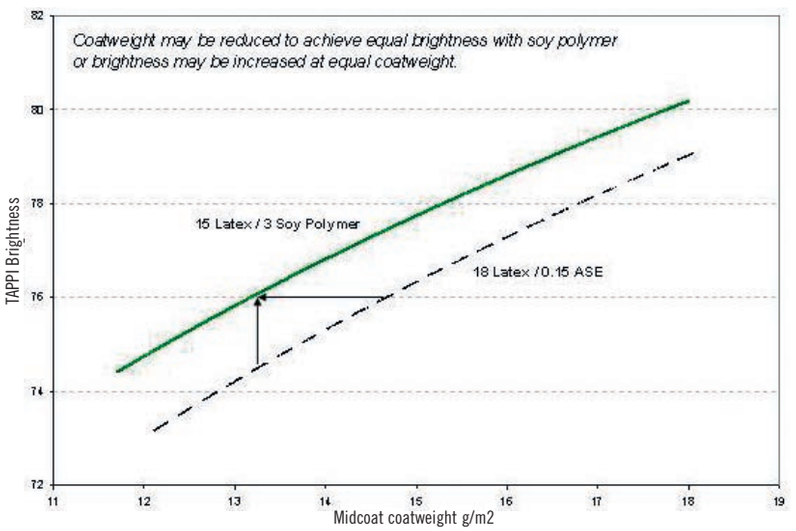

Figure 4 *Mid-coat brightness versus coat-weight*

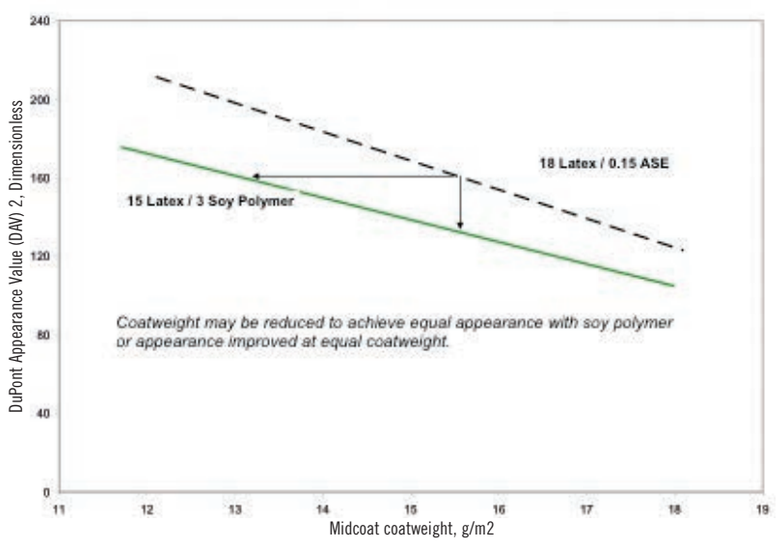

Figure 5 *Mid-coat appearance versus coat-weight*

OPPORTUNITY FOR REDUCED COST THROUGH FORMULA MODIFICATION OR COAT WEIGHT OPTIMISATION – INCREASED OPTICAL EFFICIENCY OF COATINGS CONTAINING FUNCTIONALISED SOY POLYMERS

The optical efficiency of pigments is determined not only by their respective refractive indices, but by their relative state of dispersion. The colloidal nature of functionalised soy polymers, combined with their amphoteric chemistry results in improved stabilisation of pigment dispersion in their presence. This is especially true of coating systems applied at relatively low weight solids (as seen in air knife / rod coating systems) and has particular value for manufacturers utilising expensive mineral pigments (TiO_2, calcined kaolin) to develop brightness, fibre coverage and appearance.

Figures 3 through 7 demonstrate the use of functionalised soy polymer to alter the relationships between brightness and coat-weight and appearance and coat-weight. In this experiment, the middle coat of a triple coated system was modified and the influence on final coated brightness and appearance evaluated. The substrate used was a low brightness packaging grade paperboard for which appearance and brightness are critical measures.

Figure 4 (previous page) demonstrates the value of functionalised soy polymer with respect to the relationship between brightness and coat-weight.

The data clearly show that the inclusion of soy polymer is expected to reduce the amount of coating required to reach a target brightness or, conversely, to allow the manufacturer to increase sheet brightness without an increase in total coat-weight.

The relationship between appearance and coat-weight clearly showed the advantage of functionalised soy polymer in developing uniform appearance.

There is increased/ renewed interest in all bio-based materials as alternatives to synthetic binders

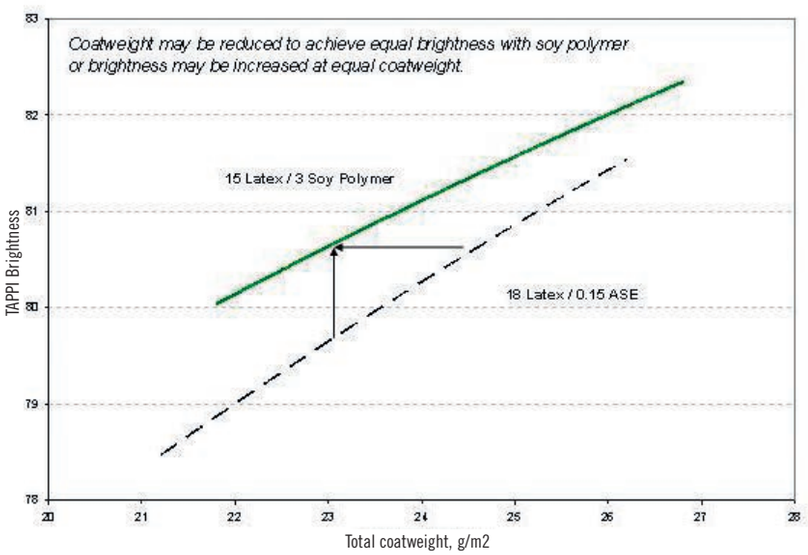

Figure 6 *Final coated brightness versus coat-weight*

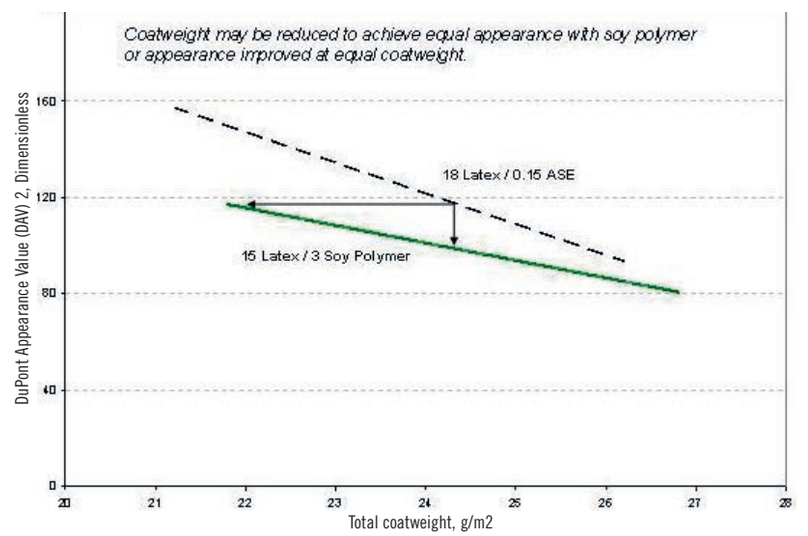

Figure 7 *Final coated appearance versus coat-weight*

The trends in appearance and brightness for the final, triple coated paperboard are shown in Figures 6 and 7 above.

Trends developed in the mid-coat translated directly to the final coated paperboard. Manufacturers may reduce coat-weight to achieve equivalent appearance, improve appearance at equal coat-weight, or consider formula modifications to reduce cost without penalty in appearance or brightness.

Fine Ground Calcium Carbonate (60% < 1 micron)	90	100
Kaolin Clay	100	0
SB Latex	10	0
Ethylated Corn Starch	7	20
Functionalised soy protein polymer	0	5
Precoat solids	66%	40%
Precoat weight applied, g/m2	8	5
Parker Print Surface Smoothness, PPS 10, microns	5.3	5.8
DuPont Appearance Value 2, lower values = more uniform	87	86

Figure 8 *Pre-coat formulas*

	Latex / Starch	Soy Polymer / Starch
Midcoat coatweight, g/m2	8	8
Midcoat smoothness, PPS 10, microns	5.6	5.5
Midcoat appearance, DAV2, lower values = more uniform	56	53
Topcoat coatweight, g/m2	9	9
Topcoat smoothness, PPS 10, microns	4.4	4.4
Topcoat appearance, DAV2, lower values = more uniform	41	40
Total coat weight applied to system, g/m2	25	22

Figure 9 *Mid and topcoat data*

OPPORTUNITY FOR COST REDUCTION THROUGH TOTAL COAT-WEIGHT REDUCTION – COMBINATIONS OF DUPONT SOY POLYMER AND STARCH

There is increased / renewed interest in all bio-based materials as alternatives to synthetic binders. Starches are being examined based on their (comparatively) low price and for the most part local sources. Starches, whether they be conventional (prepared at low solids / high temperatures), modified (i.e. pre-gelatinised / chemically modified), or dry-dispersible, present certain problems to coating formulators seeking to maximise their use for cost and sustainability.

Combinations of Functionalised Soy Polymers and starches exhibit rheological behavior which is synergistic, the combination being more elastic than either material alone. This behavior has been discussed in the literature[4].

It is possible to produce a highly localised deposition of pigmented surface size using a combination of functionalised soy polymer and starch and for this combination to be used in pre-coat of a triple coating system to reduce total coat-weight required to reach target smoothness and appearance in coated paperboard. Figures 8 through 10 provide detail of laboratory experiments demonstrating this concept.

Outside North America, the cost of kaolin clay can be significantly higher than that of ground calcium carbonate. As this is the case, the choice was made to remove the kaolin (included in most pre-coat formulas to provide smoothness and fibre coverage) for cost reasons and to rely on the film forming of the soy polymer / starch binding system to provide adequate holdout. As can be seen in Figure 8, the lower coat-weight of the trial system resulted in a slightly rougher sheet (PPS 10). The uniformity of brightness (appearance) of the two systems however was identical. In Figure 9, below, we present coat-weight, smoothness and appearance data for these two systems as the mid- and topcoats were applied.

The combination of functionalised soy polymer and starch in the pre-coat station produced smoothness and appearance properties equal to the reference as a more than 10% reduction in total coat-weight

The combination of functionalised soy polymer and starch in the pre-coat station produced smoothness and appearance properties equal to the reference as a more than 10% reduction in total coat-weight.

CONCLUSION

The three examples provided here give an overview of three key strategies to reduce cost in paper and paper-board coatings while retaining quality in a sustainable way.

The unique functional properties of DuPont Soy Polymers products offer these opportunities.

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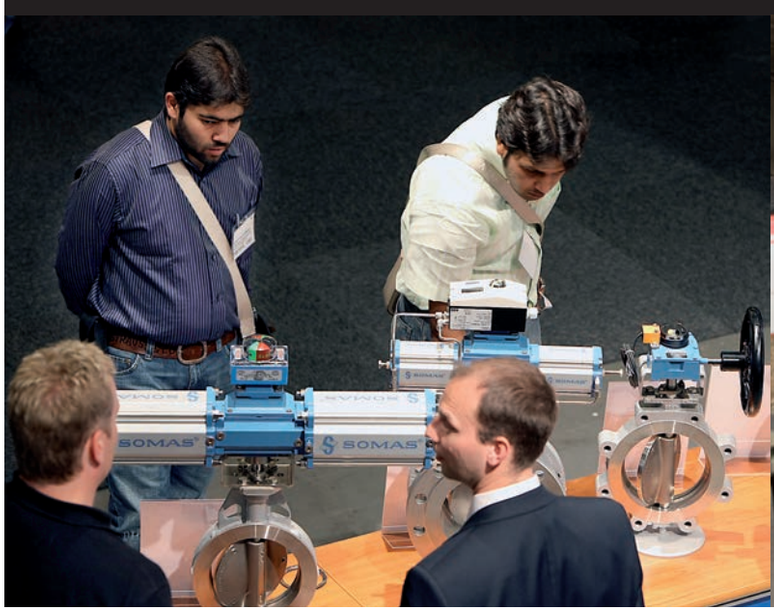

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Operational efficiency and cost savings with Pesmel TransRoll storing

By **Kaj Fahllund**, General Manager, Paper Industry, Pesmel Oy

Automated high-bay storages (ASRS) have been used long time in the converting industry with great success as an intermediate production buffers and finished products shipping storages. There, they offer great cost savings with simplified and automated material handling around and between the main processes. Properly integrated storages enable the main processes optimisation and broke minimisation in a way that is hard to believe to be true. That's why these automated high-bay storages, both for rolls and pallets, have became the best-kept secret in business what the companies with repeat orders guard jealously. Now these rack storages have slowly but surely started to spread into the paper mills too, and with good reasons as explained in this article.

FRESH THOUGHTS NEEDED FOR COST CUTTING

In paper mills, the challenge has been how to connect the paper machines, converting and shipping in a way that each of these main processes can be freely and individually optimised and maintained so that rolls sorting and moving can be done in a most simple and cost effective way with minimal or zero broke from reeler to shipping dock. With broke, we mean both production trimming and damages caused by rough roll handling. Traditionally the answer has been roll handling system to move and up-end rolls for needed number of clamp trucks with enough floor space to pile up rolls to designated areas. With bigger producers and those with need for more streamlined and automated operations, the storing efficiency has

Figure 1 *TransRoll stacker cranes between the rack structure, and the channel vehicle at the first level ready to deliver roll set on the out take conveyor*

been increased with automated overhead crane storages.

These traditional concepts have served well enough so far, but with multi-grade swing machines and high production multi-machine mills, these traditional conveyor and storing systems have swollen to big, complicated and space-requiring system behemoths. Here, the limited handling and sorting capacity especially is causing problems, which have been solved by adding more conveyors, overhead cranes, clamp trucks and quality floor space to tackle the increased sorting and volume needs. Also, fire safety has always been the limiting factor with piled rolls, which form chimney like conditions for air streams. The help of standard water sprinklers in storage hall ceilings is limited to certain roll pile heights, which can be improved with new, much higher cost nitrogen solutions and airtight storage spaces to make the oxygen reduction possible. But nevertheless the fire code has became one extra limiting factor for storages with piled rolls, which also can be helped with enlarged and advanced building technology. With rack storages, where rolls are laying on their bellies, fire extinction can be arranged with precision accuracy, where the standard sprinkler system can be integrated in to the rack.

But there is a limit with the spending in these times, when all the old 'cost cutting' ways have already been fully utilised. The fact is that as a producer, your success formula has six ingredients - cost of raw materials, energy, transportation, labour force, internal operations and of course, the selling price. Five of these, you can affect very little. The only thing you can do is to be smarter with the internal tasks. And therefore, the question is: How to arrange the entire production layout by minimising equipment and at the same time avoiding the production line bottlenecks?

Figure 2 *To save with building costs, the wall and roof elements can be attached and supported directly by the rack structure*

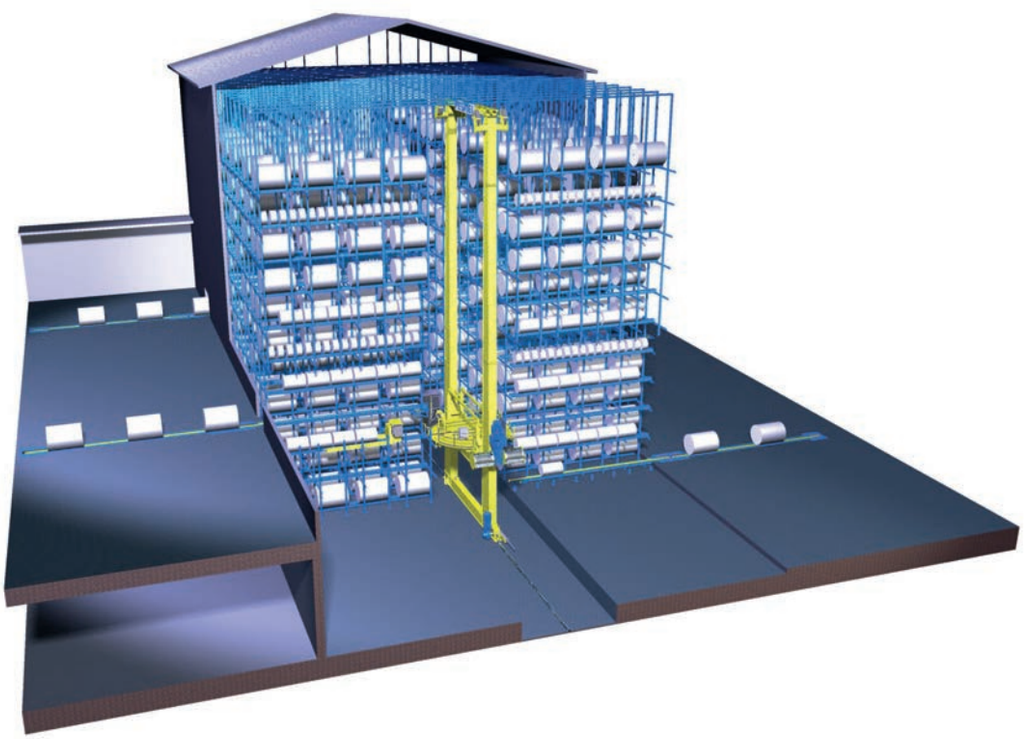


Figure 3 *TransRoll storage works like a big sieve. Mills roll stream in and out can be done freely from multiple points and levels along the rack structure sides. Rolls are moved in and out on horizontal position directly from standard conveyors*

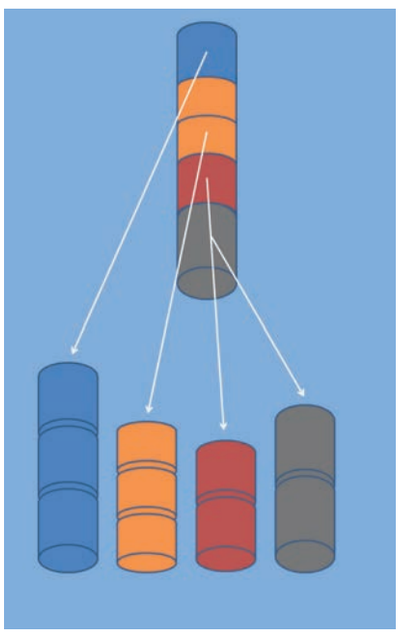


Figure 4 *Multi-roll handling is the key for high handling capacity. This combined to the hig-bay storage's sorting capacities means practically limitless automatically controlled material stream.*

Figure 5 *The incoming roll stream is sorted by the channel vehicle in the storage.*

Fire safety has always been the limiting factor with piled rolls, which form chimney-like comditions

PESMEL TRANSROLL HIGH-BAY STORAGE'S BASE ELEMENTS

To start with, it needs to be noticed, that there have been several different types of high-bay storing, some with a not particularly successful base idea. In this article, we present the unique Pesmel TransRoll high-bay storing concept, the success of which is based on its horizontal deep lane roll storing. It is easy to integrate this type of storage both to new and existing mills, as well as to big or small storage volume needs, because the rack structure itself can be stretched according the needs with all three axes (width, length and height).

Also, the rack can be located in the building, or the rack can support by itself the attached wall and roof elements (Figure 2).

And if in the future storage volume needs are increased, expanding the system is easy by expanding the rack and guiding rails for the stacker.

The base elements with high-bay, deep lane, TransRoll technology (Figure 3) are:

- Rack storage with channel profiles, which stores the rolls on laying horizontal position.
- Stacker crane, normally one or two units.
- Channel vehicles to move rolls or roll sets.
- Computer controlled Warehouse Management System (WMS) to manage the inventory.

There are motors only in the channel vehicle and stacker crane, the technology of which resembles a roughly vertically turned overhead crane.

The rest can be calculated in like structural building elements. Stacker cranes' horizontal speeds are twice that of overhead cranes with gripper (240 m/min vs 120 m/min), and with equal lifting and lowering speeds.

UNMATCHED CAPACITY WITH SMALLEST FOOTPRINT

With storage building volume comparison between different storage types, the rack storage's space utilisation efficiency and footprint need is clearly the best compared to other storing modes based on studies done. The rack structure enables two to three times higher storages, and therefore the floor space need is 50-70% smaller. The flexibility to fit the rack in almost anywhere, its almost limitless handling and sorting capacity separates TransRoll storages from the other alternatives. With a stacker crane's normal 40-50 cycles per hour handling capacity and six to eight rolls per set handled by the channel vehicle, the roll stream in and out together can be up to 400 rolls per hour per stacker crane. This equals also plenty of sorting capacity within the storage as well during off-peak hours. (Figs 4, 5).

The TransRoll storage works like a giant sieve, by being able to take rolls in and move them out from multiple points at the same time. The AGV (Automatic Guided Vehicle) robot truck type channel vehicle lifts rolls or roll sets straight from plain standard conveyors. It can handle roll sets without limitations related to roll dimensions or packing variants. Rolls can be unwrapped, partially wrapped or fully wrapped. Also, it is possible to store both rolls and pallets in the same shared rack structure. There is no need to up-end or pre-pile rolls with precision positioning or palletising as is needed with other systems. According the well-known rule of thumb, the horizontal handling is not only 25% more efficient than handling rolls vertically up-ended, but it is clearly gentler for the roll ends and corners. (Figures 6, 7)

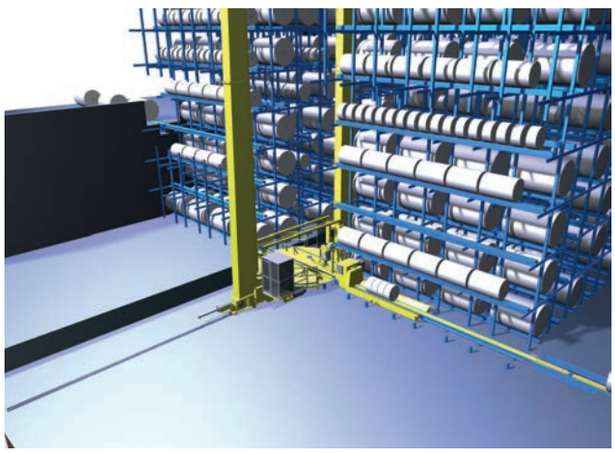
TRANSROLL DEEP LINE TECHNOLOGY - WHAT IS IT ALL ABOUT?

In the rack, the incoming roll stream is sorted by the channel vehicle on profile channels, which are formed optimally to support horizontally lying rolls from their belly. The needed storing volume is arranged by sizing enough channel meters to accumulate the needed number of rolls lying with 100mm spacing on the channel profiles.

The channel vehicle's home base is on the stacker crane's lifting platform, from where it makes the fetching or delivering strokes. The incoming roll stream is sorted according the given parameters (e.g. customer orders, paper grades, etc.) set in the WMS (Warehouse Management System). WMS combined with the channel vehicle's handling capabilities enables full freedom to store rolls according the needs either with FIFO (First In First Out) or LIFO (Last In First Out) or any possible mode combination needed, without any effects to set handling capacity needs (Fig. 8)

Figure 6 *(below) The TransRoll channel vehicle lifts rolls or roll sets straight from plain standard conveyors.*

Figure 7 *(bottom) TransRoll channel vehicle delivering roll from the rack storage to the out take slat conveyor.*



PROPER INTEGRATION NEEDED TO REAP THE BENEFITS

The old thinking goes that storing or buffering means something that is

Figure 8 *Secret for the high sorting and handling capacities is multi-roll handling without limitations related to roll dimensions or packing variants.*

sidelined or located off the main production process; something that needs to be moved away to minimise disturbance to the main processes. And that is exactly what clamp truck operated and overhead crane storages are, because of their limited capacity and requirements for floor space. But with automatic high-bay storages, the idea is the opposite - to move the storage in the centre between the main processes to enable the production lines' optimisation and to minimise the handling equipment needed. Smartly integrated storages breaks a rigid production line down into smaller, individually more manageable processes with minimal amount of connecting conveyors.

Let's take one concrete example with paper machine line, which produces few different grades with few different sorts of paper. With proper storage buffering, the paper machine's production cycle (the grade or sort change cycle) can be extended from a few days to a few weeks.

This means more optimisation possibilities for the paper production itself, at the same time, when the same is done for the sheeting and shipping operations. Similarly in converting big and fast enough Transroll or TransPallet storage means broke optimisation with a production window of several weeks instead of several days, which enables better trimming optimisation.

So, we should not push storage back to the sidelines. Instead integrate it between the main processes, and simplify the process by driving the whole production through the storage. This way, we are able to reap the full benefits from your systems. At the end, even the finest machines fail to deliver at their fullest performance, if they are not connected properly.

We should not push storage back to the sidelines but instead integrate it into the main processes

WAREHOUSE MANAGEMENT SYSTEM

TransRoll and TransPallet systems are controlled automatically and unmanned by Pesmel's own server PC-based WMS system with the necessary number of client PCs for operator terminals.

The base module controls the storage inventory according the production and customer order information downloaded from the Mill Information System (MIS), and includes all modern real-time process view, management, diagnostic and reporting features.

In cases where the MIS capabilities are limited, this system can be enlarged by production planning system. Also, add-on modules can be offered to mills' rolls or pallets tracking and shipping control needs.

OUTSMART YOUR COMPETITORS

Paper mills and converters success requires elimination of large scale manual and semi-manual work. With storing and material handling systems this is not purely related to bloated operational costs with old and outdated systems, but also a logistical issue that unnecessarily chokes production plants' main operations. As we know, the investment costs to mills' material handling are marginal compared to total investments in the mill.

So why bottleneck your production and shipping operations, when there are alternatives with proven payback?

SUMMARY OF THE BENEFITS

- Simplified layout with minimal number of integrated conveyors.
- Smallest storage footprint compared to other alternatives.
- Minimised storage building costs by rack supported walls and roof elements.
- Fire safety with zone divided standard sprinkler system.

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