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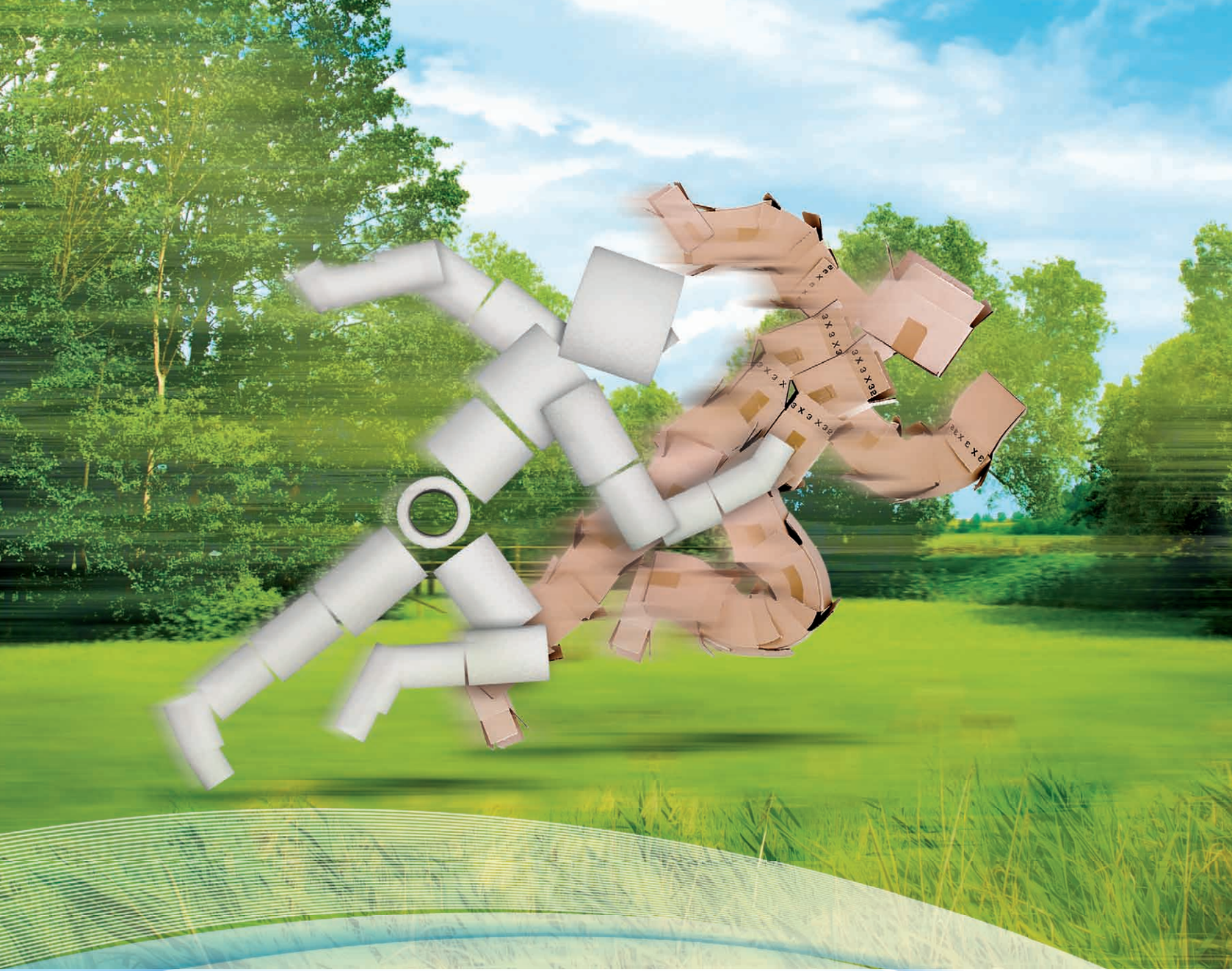

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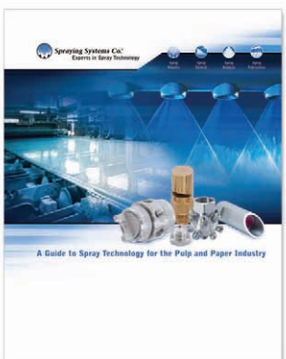

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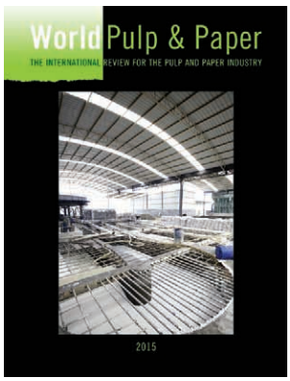

World Pulp & Paper 2015

I do hope you will find the excellent articles brought together here from all areas of the paper manufacturing process to be an interesting, useful and thought provoking read. I extend my grateful thanks to all those who have contributed this year; being able to draw upon the input and unique knowledge of so many technical experts allows us to once again present this unique platform of communication for this industry.

With efficiency and sustainability being the two words that continue to dominate current thinking, it is unsurprising to find so many of the editorials herein exploring these topics from different areas of the manufacturing and supply process.

It has been another hugely exciting year for us with this, the International Edition of World Pulp & Paper, as well as our stand-alone Chinese Edition (published in Mandarin) continuing to flourish – the latter having truly established itself as a 'must read' in the region. A number of readers have recently asked whether we could perhaps explore the possibilities of an additional publication to focus upon the growing Biomass and Bioenergy sectors. In response, the pilot issue of World Biomass was duly published in August last year to a very warm worldwide reception. World Biomass has therefore joined World Pulp & Paper as an annually-published title in our steadily growing portfolio.

Meanwhile, I wish you every success in the months ahead and hope that you will thoroughly enjoy this edition of World Pulp & Paper.

Colin Smith, Publisher

Efficiency and sustainability: the two words that continue to dominate current thinking

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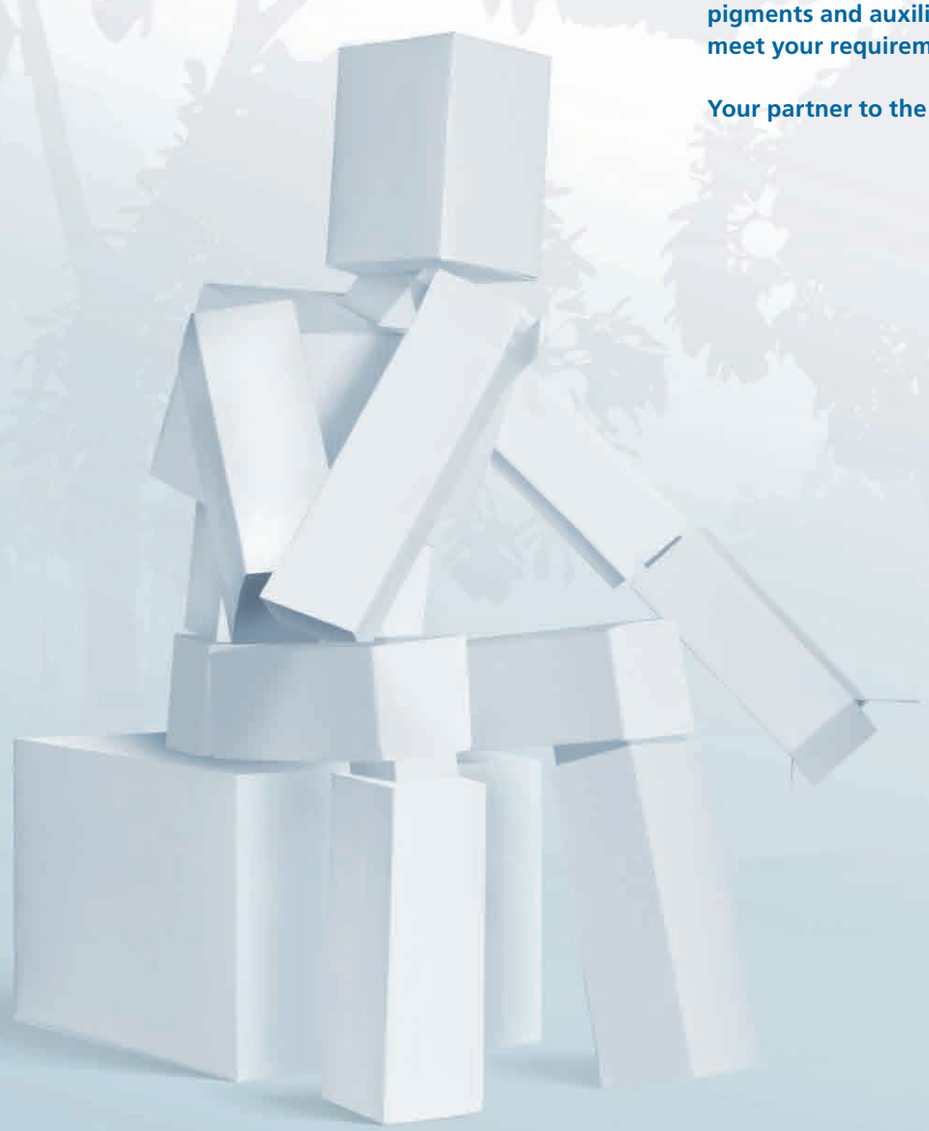

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Consolidation in the pulp and paper industry

By **Rod Fisher**, President, Fisher International

One of the most important trends in any industry is consolidation; all industries are experiencing it in one stage or another. Consolidation occurs when organic growth becomes too expensive and companies grow by merger and acquisition. It is a process that is observed as companies seek to sustain profitable growth while their markets mature and growth rates fall.

In December 2002, the Harvard Business Review presented an article by A.T. Kearney that described the consolidation curve, showing how industries mature over time (Figure 1). In this figure, the left vertical axis shows the degree of consolidation across a range of industries. The authors show here the percentage market share of the top three producers. On the right vertical axis the same data is shown on the HHI scale[1], a standard measure of consolidation.

Over time, industries evolve and the authors chose to divide this development curve into four stages: opening, scale, focus, and balance and alliance.

Consolidation occurs when organic growth becomes too expensive and companies grow by merger and acquisition

Applying this four-stage model to the paper industry, we can say that China in the late 1990s to early 2000s and the Western paper industry in the 1950s and 1960s are examples of Stage 1 consolidation. North America and Europe were in Stage 2 consolidation in the 1970s and 1980s. North America entered Stage 3 consolidation in the 1990s and early 2000s. And, from late 2000s on, North America and Europe have entered Stage 4 consolidation. However, market leaders do not comprise the 70-90% share that the model prescribes. Why not?

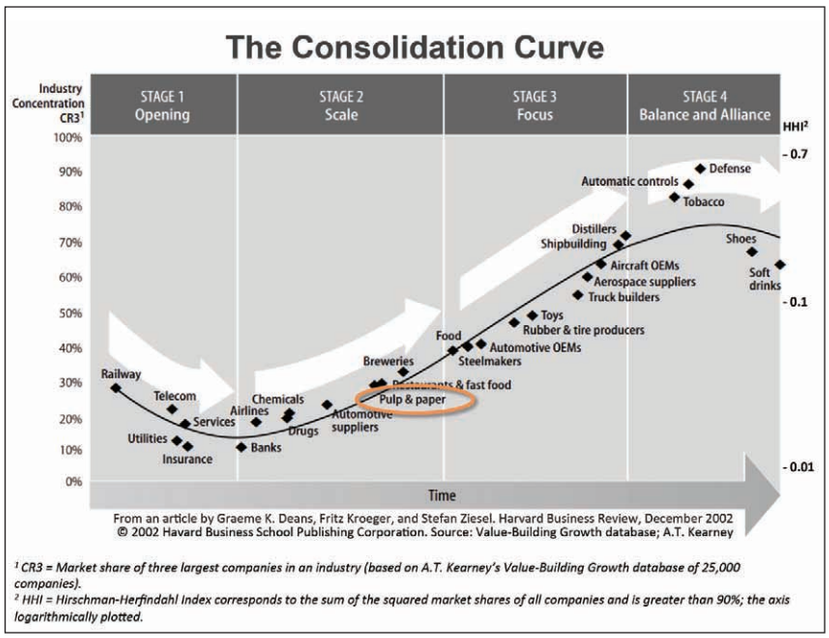

Figure 1. *The pulp and paper industry would be in Stage 2 consolidation, if seen as a global industry*

STAGE 1	STAGE 2	STAGE 3	STAGE 4
Opening	**Scale**	**Focus**	**Balance and Alliance**
The emerging market is characterised by small scale, rapid technology change, and increasing investment in technology by the emerging winners. At this stage, the top three companies typically control 10-30% of the market.	Winners investing in larger-scale operations to meet the needs of rapidly-growing markets. It is not possible to generalise about the precise rate of growth to be expected - it could be 3% or 10% - but it will be rapid relative to that experienced in other growth phases. Some M&A activity can be expected, leading to typical concentrations of 15-45% in the hands of the top three.	We see a slowing of growth and the pace of technology change. M&A becomes increasingly important for companies seeking to grow. Concen-tration accelerates, with the top three taking 35-70% of the market, as successful businesses buy smaller or less efficient competitors and merge with other market leaders.	There is little or no growth - and even decline - in market size and companies are obliged to consolidate to maintain sales and reduce costs. By this stage, mergers can be extremely large-scale and market concentration in the hands of the top three will normally be in the 70-90% range.

Stages of consolidation as defined by A.T. Kearney report

It is important to recognise that paper is not a global business. Markets tend to be regional. This fact is dramatically illustrated when we look at a chart of all the paper producers worldwide segmented by grade and capacity (Figure 2). No individual company or companies dominates. There are large players but the market share of even the largest is only a few percent.

Further analysis by segment and region reveals striking differences. Using Fisher*Solve*™ industry data and analytics, we'll examine the current

1. HHI - Hirschman-Herfindahl Index corresponds to the sum of the squared market shares of all companies and is greater than 90%.

state of consolidation in the global pulp and paper industry, assessing changes over time that can help predict what developments to expect in the years ahead. The discussion considers each of the following paper grades and regions:

Paper Grade	Global Region
Containerboard	Europe
Coated Papers	Asia Pacific
Uncoated Freesheet	Brazil
Tissue and Towel	(Representative of Latin America)

We also look at the market for bleached hardwood kraft pulp which, unlike any paper grade, is truly a global market.

NORTH AMERICA

In North America, growth is slow or flat for containerboard; coated paper and uncoated freesheet are both in decline; and tissue is growing at about the same rate as the population (Figure 3).

Within North America, the top three players account for 63% of the containerboard market which puts the sector in Stage 3 of consolidation (Figure 4). That seems reasonable; the growth curve is slow to flat, there is little breakthrough technology, so corporate growth requires M&A, which has been evident in recent years. Driven by cost reduction, the cost gap between the top and bottom quartiles is very narrow in this sector (Figure 5).

In recent years, large-scale mergers have sharply increased the market share of the leaders (Figure 6). In 2007 IP acquired Weyerhaeuser's brown paper facilities, following this in 2011 with Temple Inland, almost trebling its market share in the process. Likewise, the acquisition of Smurfit-Stone by RockTenn has created a second very large unit which was further enhanced with Simpson. More recently, in the solid fibre containerboard packaging sector, RockTenn announced that it is merging with MeadWestvaco.

In recent years, large-scale mergers have sharply increased the market share of the leaders

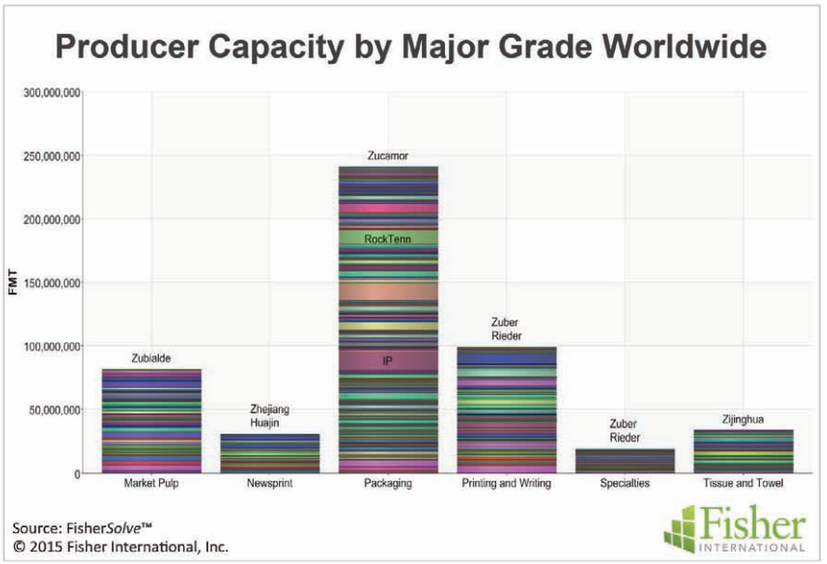

Figure 2. *The pulp and paper industry clearly is not consolidated globally*

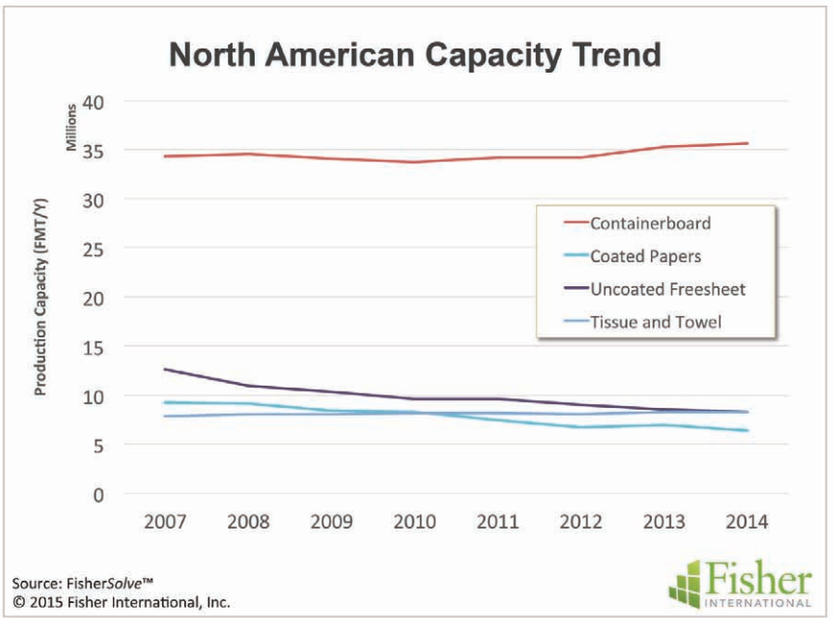

Figure 3. *Growth is relatively flat across paper grades in North America*

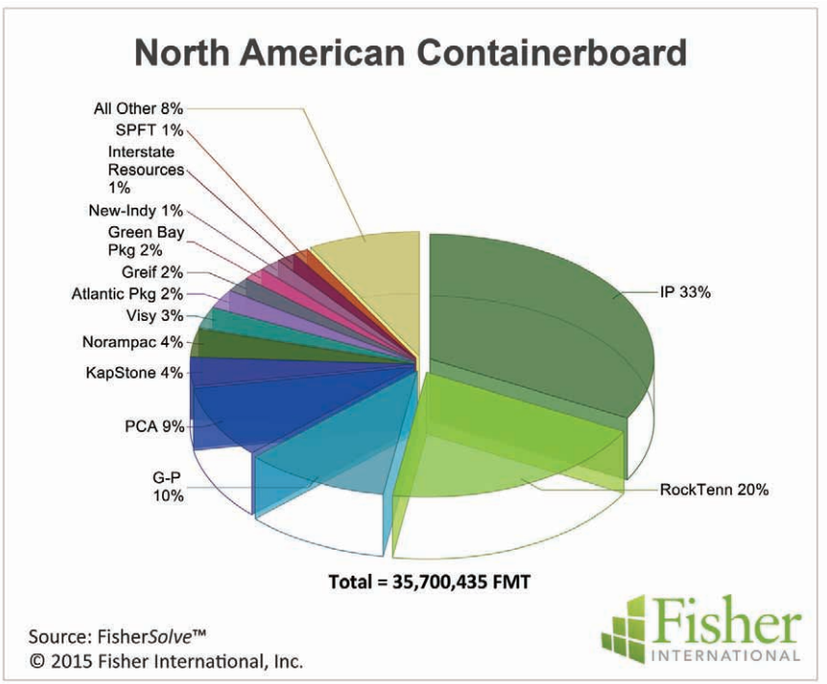

Figure 4. *North America containerboard: Stage 3 consolidation with top three producers accounting for 63% market share*

Fisher expects consolidation in the North American market to continue (so long as regulators allow), as flat market conditions force the remaining players to continue reducing costs in response to the demand of stakeholders for continued increases in profit.

In North American coated papers, the top three producers account for 73% of the market (Figure 7). This declining segment entered the last phase of consolidation with the Verso-NewPage mer-ger serving as the tipping point. Further consolidation is expected in the years ahead.

In North American uncoated freesheet papers, the picture is broadly similar (Figure 8), with the top three sharing 67% of the market. Again, further consolidation is to be expected in a market where demand is on the wane. It should be noted that consolidation can happen through closures as well as M&A.

Tissue and towel is growing at the rate of the region's population. The top three producers account for 60% of the market (Stage 3), so the potential exists for further consolidation (Figure 9). What we have seen recently in this market is the arrival of new single-mill operators financed by venture capital, which have been rapidly acquired by the big players. This "deconsolidation" phenomenon is likely to continue, as the entry capital costs are relatively modest in the tissue sector, unlike the other grades considered here.

Looking at the away-from-home sector of the tissue market, we see that concentration is in Stage 4, with 71% market share in the hands of the top three (GP, SCA and KC). The at-home market is a little more widely distributed, with the top three (GP, P&G and KC) accounting for 64%. This illustrates that the more we can segment our market, the easier it is to analyse and forecast development.

Further consolidation is to be expected in a market where demand is on the wane… consolidation can happen through closures as well as M&A

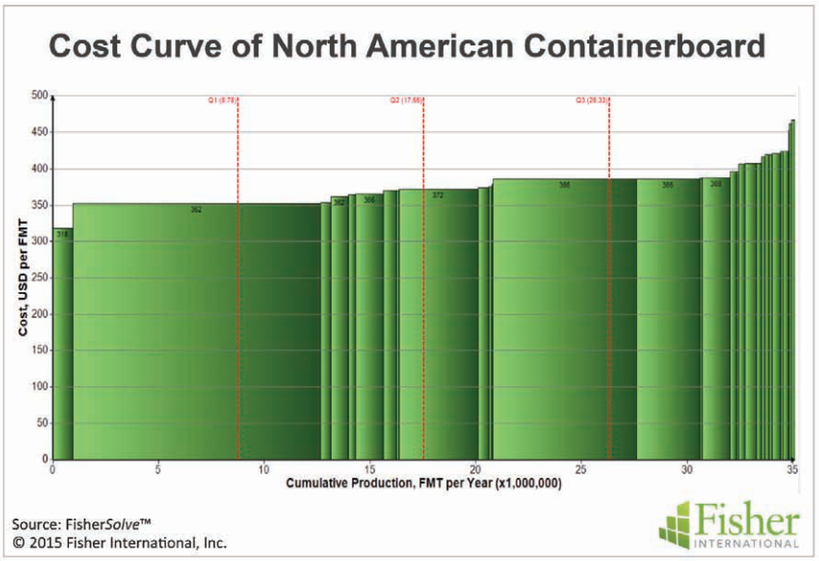

Figure 5. *Cost reductions have narrowed the gap between top and bottom quartiles in this sector*

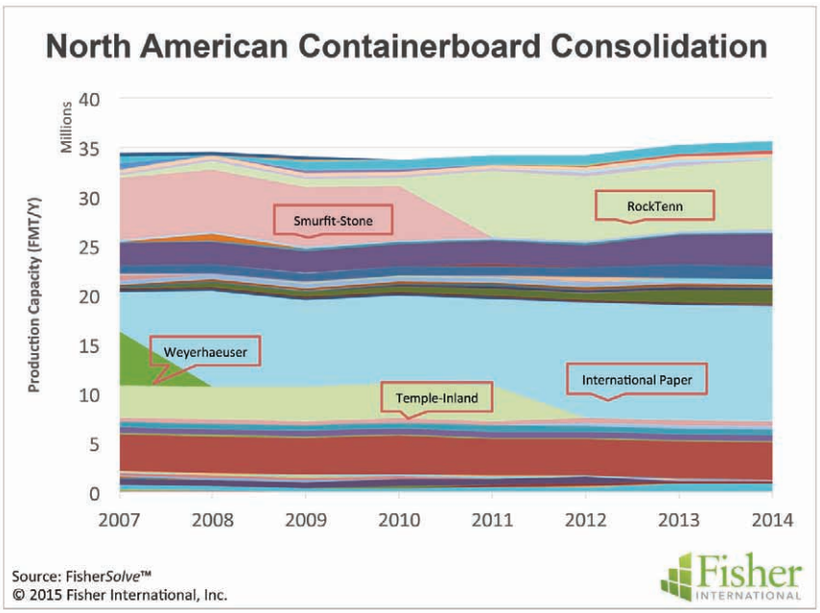

Figure 6. *Large-scale mergers sharply increased leaders' market shares*

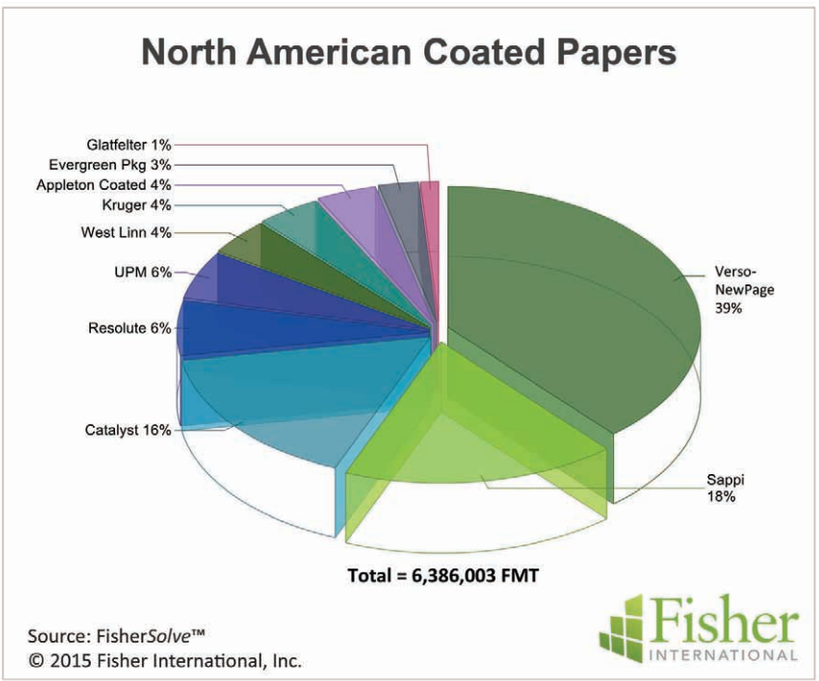

Figure 7. *North American coated papers: Stage 4 consolidation with top three producers accounting for 73% market share*

To summarise, North America is a typical low-growth region characterised by mainly Stage 3 concentration and further consolidation. It is also notable for the tendency of large organisations to spin off non-core business areas. A good example of this is IP's disposition of its distribution company, xpedx, which merged with Unisource to become Veritiv. The distribution sector is relatively unconsolidated, so there are opportunities here to boost profit through organic growth.

ASIA PACIFIC

The Asia Pacific region is key to understanding why paper is featured in Stage 2 of the Harvard Business Review article. Its growth over the past two decades has been rapid and continuous, with new companies, mills and capacity springing up regularly in all sectors (Figure 10). Growth in coated papers has been flat since 2007 but containerboard capacity has more than doubled since 2007, uncoated freesheet is up by around two-thirds, and tissue has tripled in seven years.

In Asia Pacific the top three producers have 23% of the containerboard market - Stage 1 (Figure 11). Here, though the technology is not new in absolute terms, it is new for the region. And Asia Pacific boasts by far the largest number of state-of-the-art new paper machines in the world.

Coated paper in Asia Pacific, by contrast, is in Stage 3, with the top three companies sharing 45% of the market (Figure 12). M&A activity has not yet had a significant impact on this market but we expect that this will start to create more concentration in the near future. Again, concentration is also likely to be achieved through closures.

In uncoated freesheet, concentration is at 18% - Stage 2 (Figure 13). The industry is continuing to add capacity but, with slowing growth, the focus will switch from investment in new machines to M&A and, most likely, closures and repurposing.

Growth over the past two decades [in the Asia Pacific region] has been rapid and continuous, with new companies, mills and capacity springing up regularly

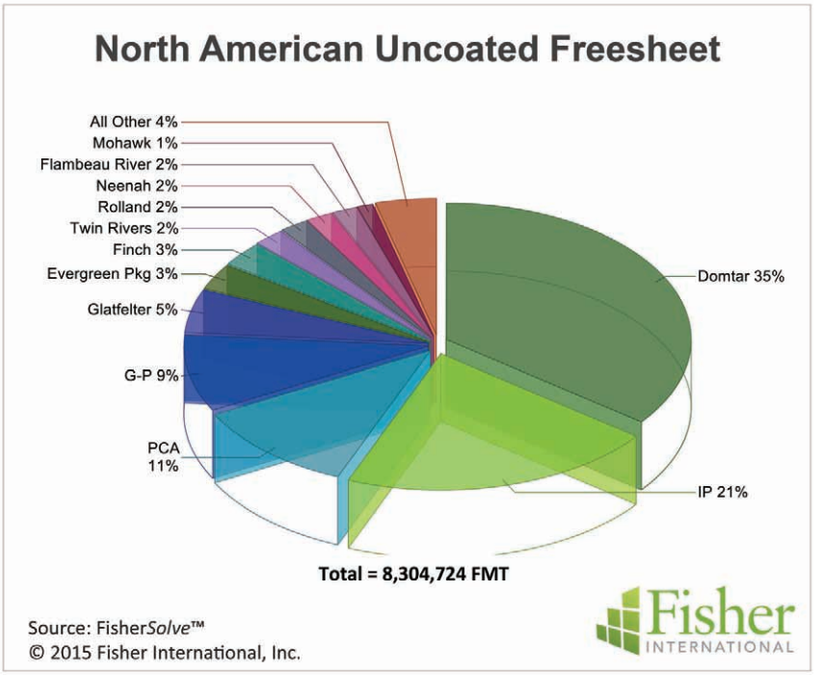

Figure 8. *North American uncoated freesheet: Stage 3 consolidation with top three producers accounting for 67% market share*

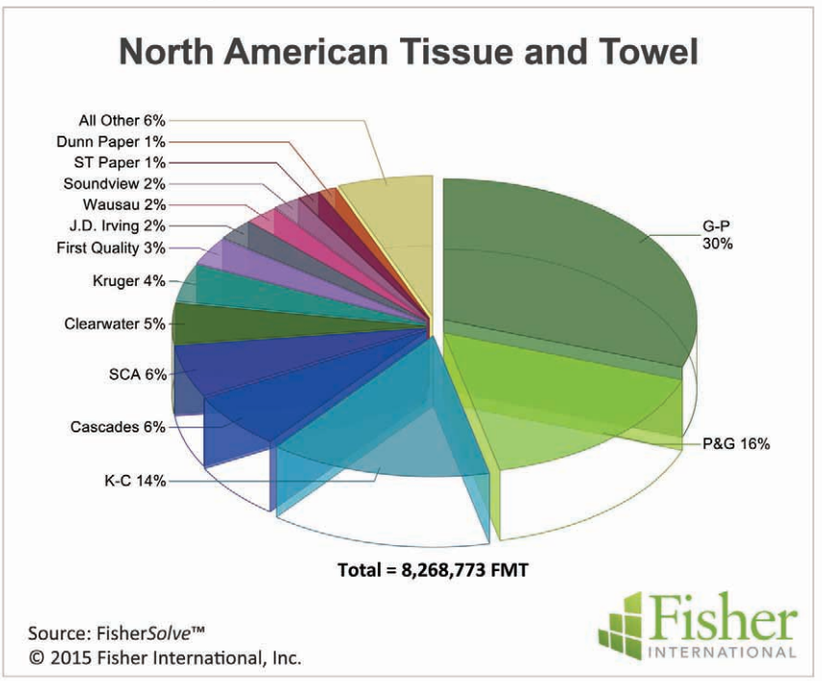

Figure 9. *North American tissue and towel: Stage 3 consolidation with top three producers accounting for 60% market share*

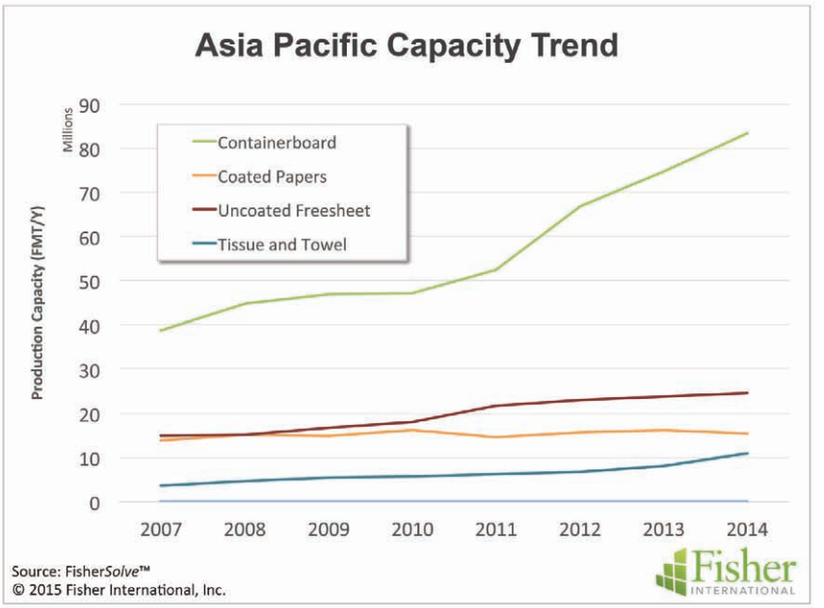

Figure 10. *Asia Pacific growth has been rapid and continuous over the past decade*

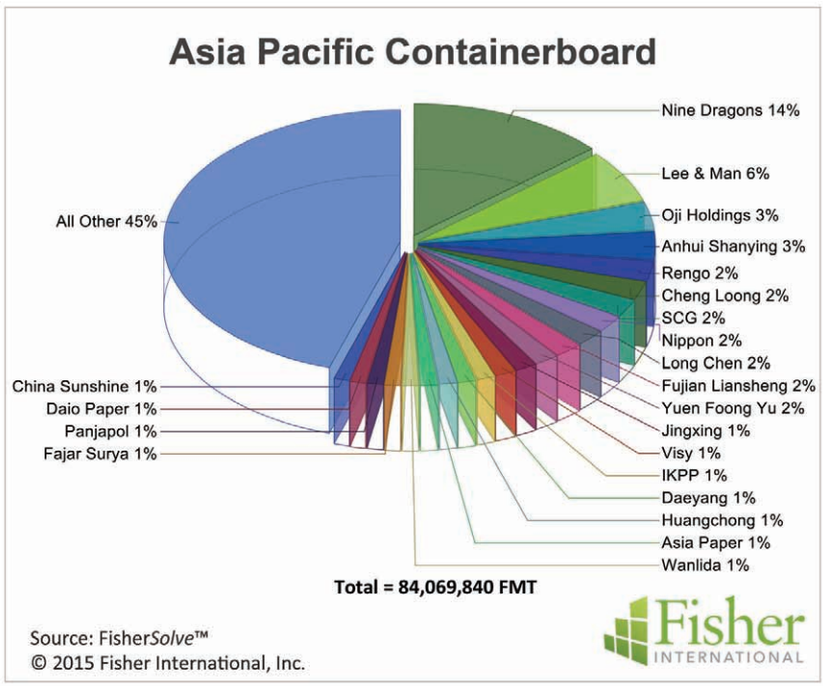

Figure 11. *Asia Pacific containerboard: Stage 1 consolidation with top three producers accounting for 23% market share*

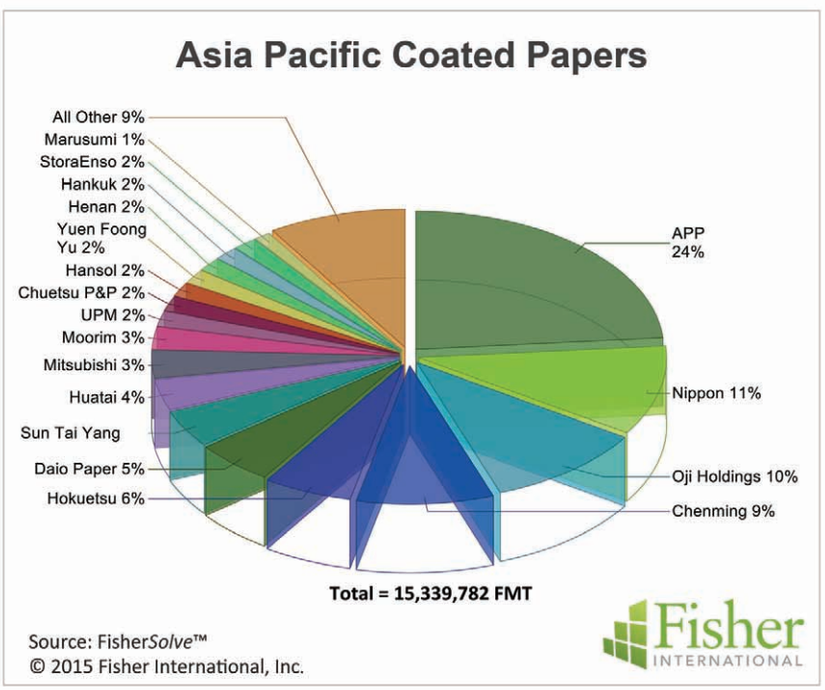

Figure 12. *Asia Pacific coated papers: Stage 3 consolidation with top three producers accounting for 45% market share*

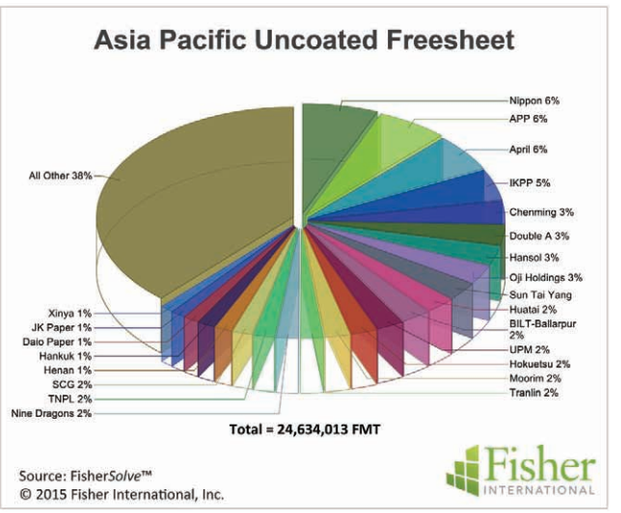

Figure 13. *Uncoated freesheet: Stage 2 consolidation with top three producers accounting for 18% market share*

In tissue, despite the extraordinary pace of investment in new capacity in recent years, consolidation is already at 31% - Stage 2 (Figure 14). The number of mills and machines is continuing to increase rapidly however, with the winners adding to their existing machine parks.

EUROPE

Europe overall is flat to declining in printing and writing grades, tissue is growing with the population, but containerboard has been on the up for several years, notably through the conversion of printing paper machines to packaging production (Figure 15).

Consolidation in containerboard in Europe is still very low for a business in the mature phase. The top three companies control just 27% of the market - Stage 2 (Figure 16). Geo-political boundaries and preference for doing business within national or linguistic zones may account for this low level of consolidation. However that may be, M&A activity seems lower than normal in a market with this level of maturity.

Containerboard [in Europe] has been on the up for several years, notably through the conversion of printing paper machines to packaging production

European coated papers certainly demonstrate that consolidation is possible in Europe. Here the top three are in Stage 3, with 54% market share between them (Figure 17). In a declining market, further M&A is to be expected.

With flat to declining growth [in uncoated freesheet paper], further consolidation is expected

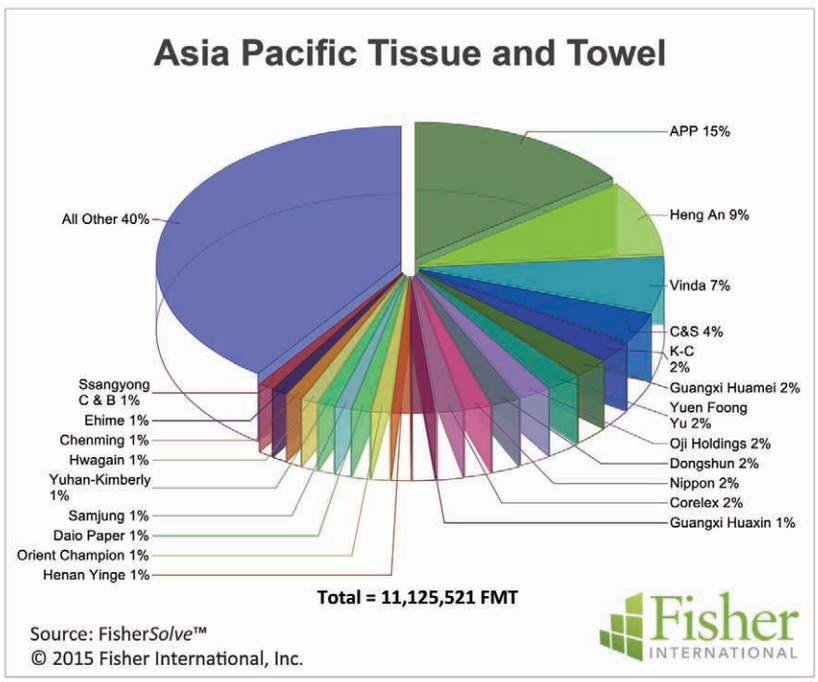

Figure 14. *Asia Pacific tissue and towel: Stage 2 consolidation with top three producers accounting for 31% market share*

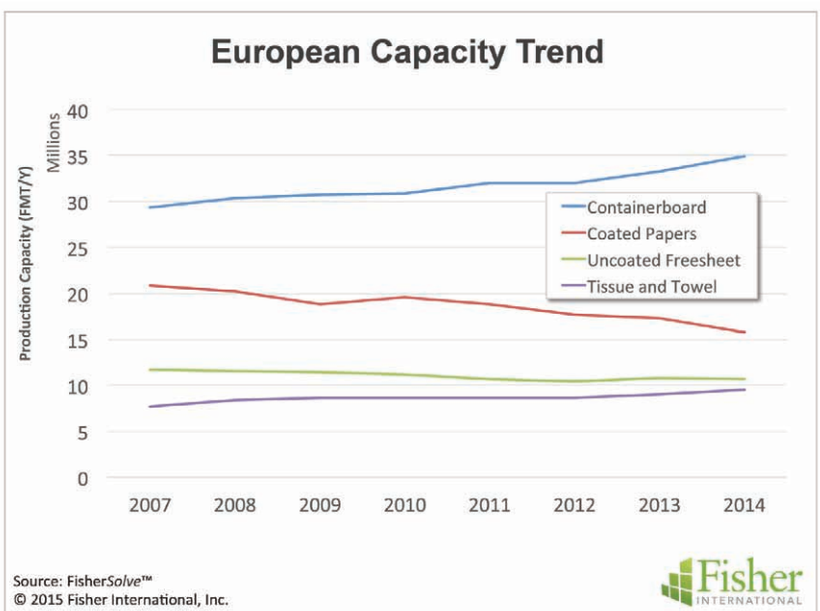

Figure 15. *European growth is flat to declining but containerboard has been on the up for several years*

In uncoated freesheet paper, Europe is also in Stage 3 with 39% consolidation for the top three producers (Figure 18). With flat to declining growth, further consolidation is expected.

Tissue is also in Stage 3, with 41% consolidation (Figure 19). Several large producers have expanded market share sharply through M&A - SCA by buying P&G's European operations; Sofidel by acquiring GP's former European business. At the same time, there is plentiful scope for further consolidation, as fully one third of the market is served by a multitude of small producers with less than 1% each of the overall market.

LATIN AMERICA

Taking Brazil as a proxy for the region and looking at containerboard, we can see that the top three, with 36% of the capacity, are in Stage 2 (Figure 20). Market growth is still strong, largely for domestic consumption, and

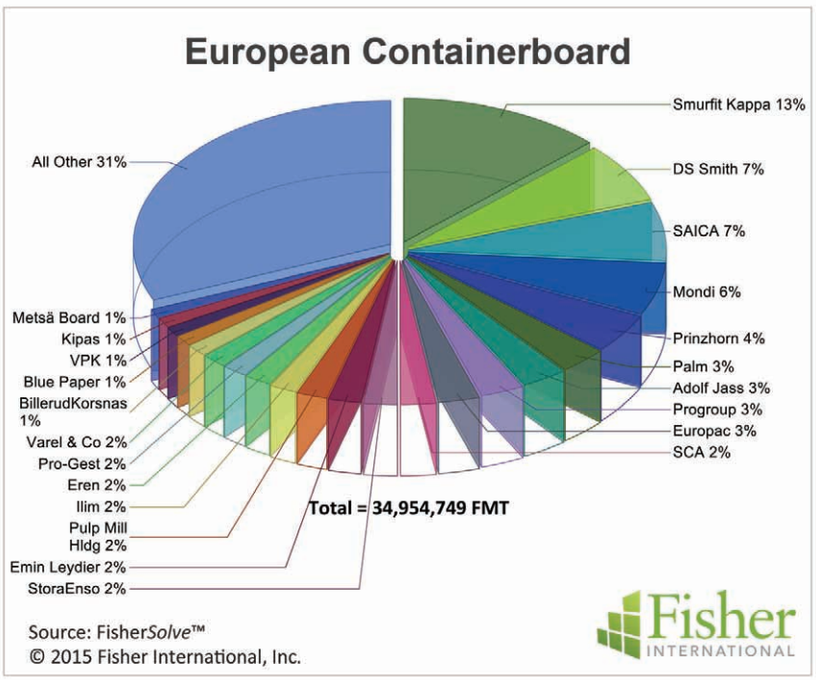

Figure 16. *European containerboard: Stage 2 consolidation with top three producers accounting for 27% market share*

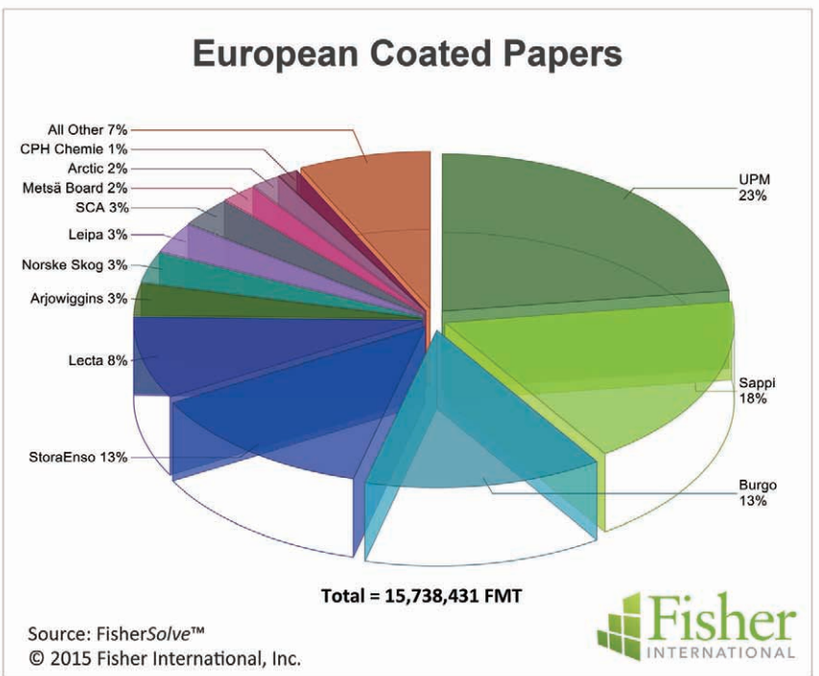

Figure 17. *European coated papers: Stage 3 consolidation with top three producers accounting for 54% market share*

Latin American capacity growth [in BHKP] has been very rapid over the past few years and it has solidified its role as the world's leading producer

the industry is expected to continue growing by adding new mills and machines. If, however, market growth slows, then further consolidation is the probable outcome.

GLOBAL BLEACHED HARDWOOD KRAFT PULP

As noted above, bleached hardwood kraft pulp (BHKP) is a truly global market, unlike the paper grades we have discussed. Here the role of Latin America is key, thanks largely to its fast-growing plantations. Latin American capacity growth has been very rapid over the past few years and it has solidified its role as the world's leading producer (Figures 21 and 22). Asia Pacific has also continued to grow, while Europe and North America have been in decline.

FUTURE CONSOLIDATION

The bubble chart (Figure 23) that plots growth against the degree of consolidation by grade and market offers insights into how we can use this analysis to forecast the consolidation ahead.

For example, Asia Pacific containerboard might be expected to migrate up the concentration curve. European uncoated freesheet is under pressure to consolidate further. In North American containerboard, uncoated freesheet and coated

In North American containerboard, uncoated freesheet and coated paper, the industry is already highly concentrated but, given slow growth in these markets, more consolidation is expected

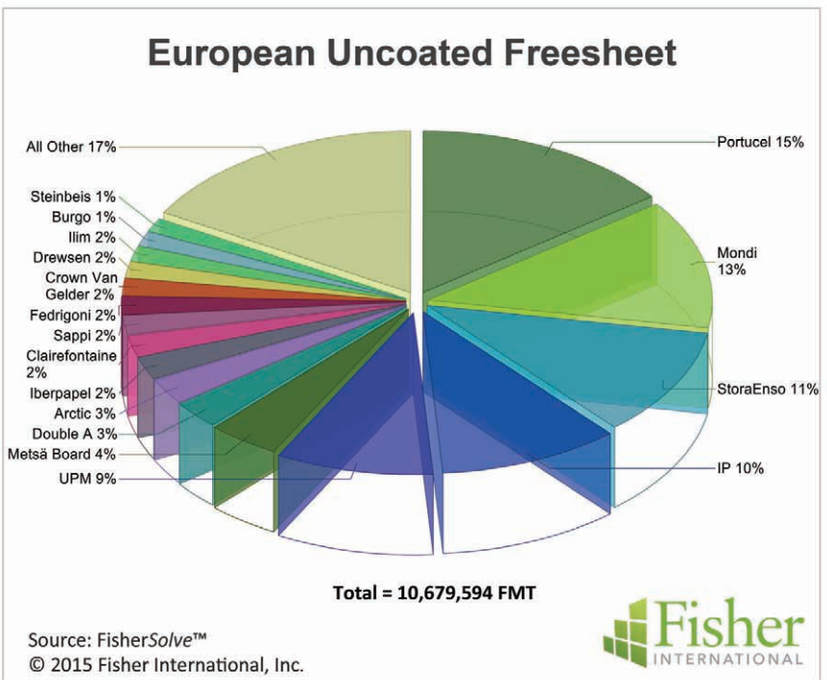

Figure 18. *European uncoated freesheet: Stage 3 consolidation with top three producers accounting for 39% market share*

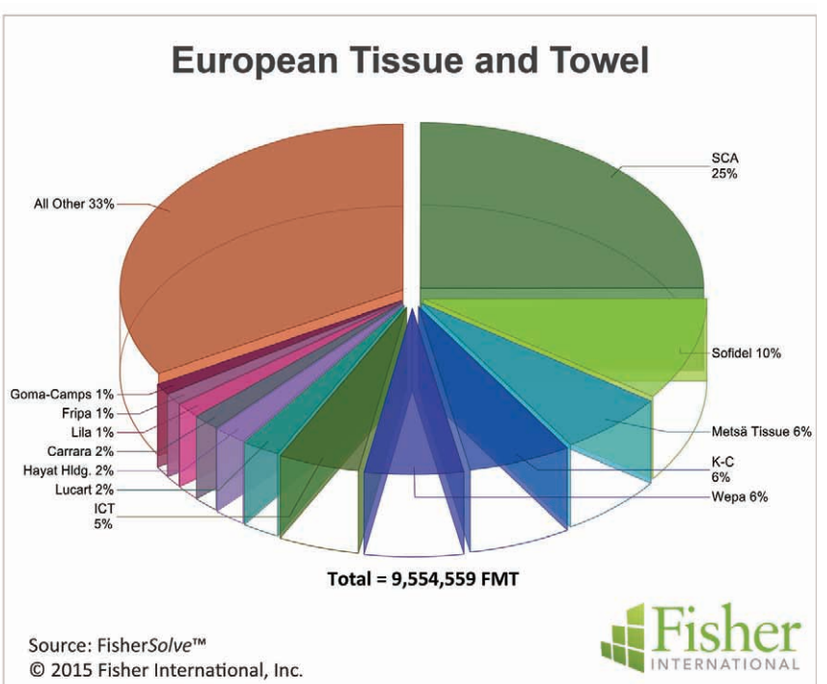

Figure 19. *European tissue and towel: Stage 3 consolidation with top three producers accounting for 41% market share*

paper, the industry is already highly concentrated but, given slow growth in these markets, more consolidation is expected. Eventually, growth will slow for all grades but, where it is still very high, such as in Asia Pacific tissue and towel, we do not expect that to occur for some time. Likewise in BHKP, further consolidation seems less likely in the near term than continued expansion through new plant construction.

So, we might ask ourselves in conclusion, have we reached the limits of consolidation in the pulp and paper industry?

In market pulp, the answer is a clear "no" for the global market.

In North American printing and writing paper and packaging, we are nearing the limits where the US Department of

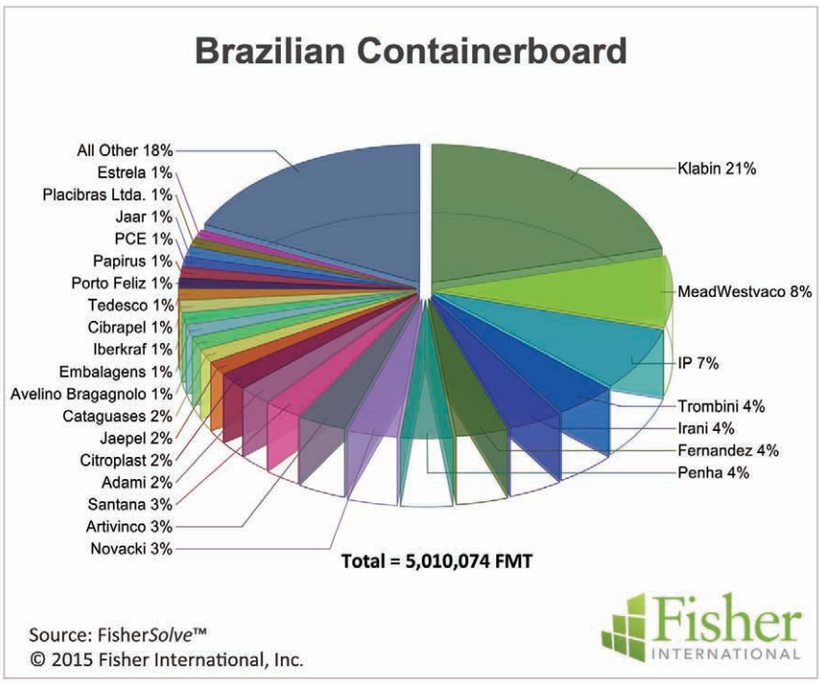

Figure 20. *Brazil Containerboard: Stage 2 consolidation with top three producers accounting for 36% market share*

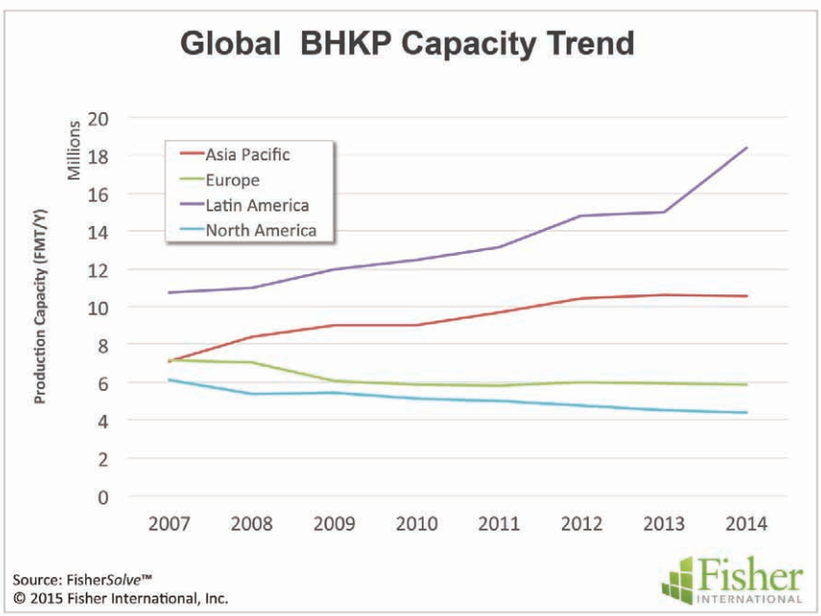

Figure 21. *Latin America has solidified it's position as the world's leading BHKP producer*

In Europe, there will be more M&A as markets mature further from current high levels

Justice will be imposing conditions on market leaders seeking to consolidate further, as it has already done, for example, in the case of Versa-NewPage or IP-Temple-Inland, where mills had to be sold. In Europe, there will be more M&A as markets mature further from current high levels. In printing and writing paper this process is already well advanced, and packaging is likely to follow.

In Asia Pacific, printing and writing paper will be first, and we are already seeing the first signs in packaging. In Latin America, many markets are already consolidated because they are rather small and isolated from one another.

In Latin America, many markets are already consolidated because they are rather small and isolated from one another

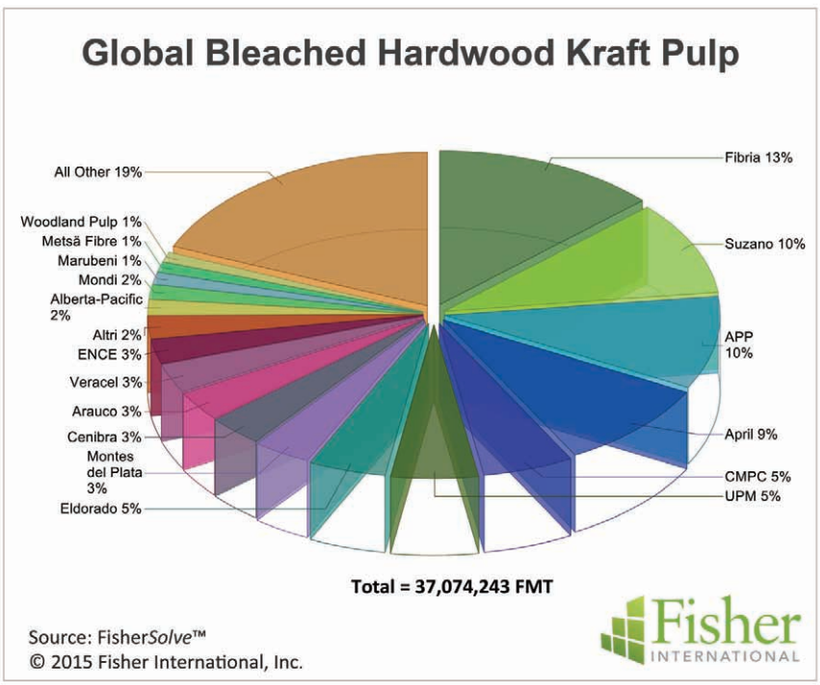

Figure 22. *Bleached hardwood kraft pulp (BHKP) is a truly global market*

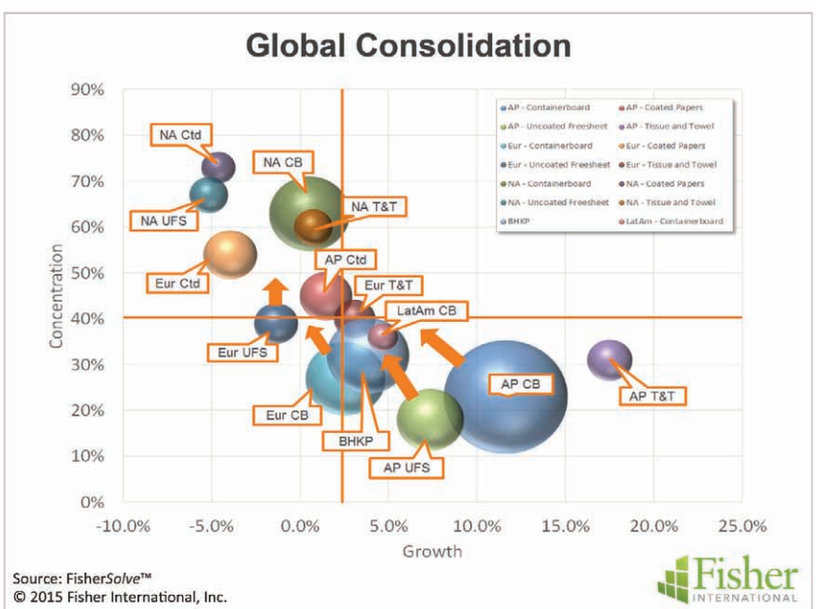

Figure 23. *The pressure to consolidate predicted by grade and market*

ABOUT THE AUTHOR:

Rod Fisher is President of Fisher International, a leading consulting firm supporting the pulp and paper industry with business intelligence and management consulting services since 1985. With research resources in nearly every pulp and paper producing country in the world, Fisher International's expert consultants, proprietary databases, analytical technologies, and business management tools are used by pulp and paper producers, suppliers, investors, and buyers around the world every day. To learn more, please visit www.fisheri.com.

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Creating flushable products – squaring the circle

By **Sebastian Basel and Dr. Roland Scholz**, Kelheim Fibres Gmbh

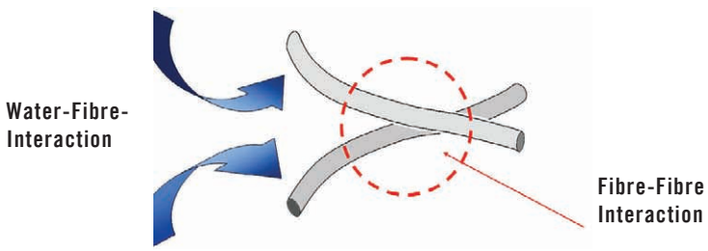
Currently, the product category of "flushable wipes" represents one of the most dominant topics in the world of paper and nonwoven-production: wipes that can be flushed down the wastewater system without adversely impacting plumbing or wastewater infrastructure and operations. Due to their convenience, the request for such products is constantly growing on the part of the consumer, thus increasing the production demand at the manufacturer's end. In the past, broader market coverage of flushable wipes was prevented only by a contradiction that was hard to resolve: during both the production process and during use, the web strength of the wipe has to be high enough to ensure the web stays intact. However, after use the wipe needs to disintegrate as quickly and as completely as possible, as shown in figure 1.

Figure 1. *Break-up of nonwoven and dispersion of fibres in water at different stages*

Only a few products could manage this balancing act successfully using the conventional spunlace-technology, based on carding and hydroentanglement. To clearly define the term of "flushability" for the end consumer, EDANA and INDA – the two leading trade associations for the nonwovens industry – published the 3rd edition of their "Guidelines for Assessing the Flushability of Disposable Nonwoven Products" (EDANA III). These guidelines clearly define the testing methods that have to be accomplished before a product can be labelled as flushable to avoid any problems with sewage clogging and further challenges during waste water treatment. With the introduction of the new combined process of wetlaid and hydroentanglement into the market, a breakthrough in the functionality of flushable products seems to have been reached. The following article explains methods for improving parameters such as flushability, web strength, or softness.

BASICS OF FLUSHABILITY

Starting at the fibre level, the following mechanisms play an important role in the break-up of the nonwoven and the in the dispersion of the fibres in water. Considered are fibre-fibre interactions as well as interaction between fibres (or the web that consists of the fibres) and turbulent water.

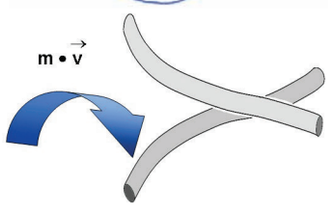


a) Friction between Fibre and Water

❑ Influence on water flow and friction between fibre and water by total fibre surface, diameter (exemplary here for Viloft®), cross-section and surface conditions

b) Momentum transfer (collision of water and fibre)

❑ Dependant on fibre diameter and cross section



With the introduction of the new combined process of wetlaid and hydro-entanglement into the market, a breakthrough in the functionality of flushable products seems to have been reached

It became increasingly clear that a fibre length of less than 20mm is necessary to produce flushable wipes according to EDANA III

c) Entanglement of fibres

- ❑ Degree of entanglement can be controlled by the intensity of hydroentanglement/ water jet pressure
- ❑ Influence of fibre length, bending resistance, surface conditions on degree of entanglement

d) Breaking fibres

- ❑ Dependent on tenacity, elongation and bending resistance of the fibres. Breaking fibres do not play a relevant role for dispersion and therefore for flushability of a wipe.

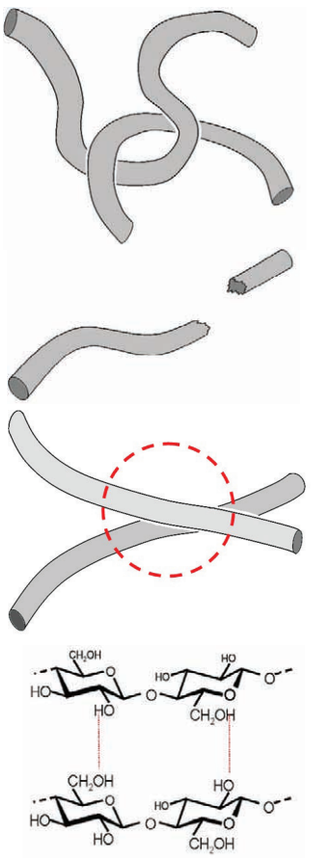
e) Fibre-Fibre-Bonding

- ❑ Surface conditions, bending resistance

f) Hydrogen bonds between fibres

- ❑ Surface conditions (smooth, crenellated), fibre cross-section

On the process side, the conventional spunlacing – carding process with subsequent hydroentanglement – can provide wipes with high tensile strength and softness. However, the necessary minimum fibre length of 20mm creates entanglements of the fibres (as shown in c) that are very difficult to open-up again. Even in case of an initial break-up of the wipe the single web pieces entangle again or build up fibre ropes which prevent a sufficient dispersion into single fibres. It became increasingly clear that a fibre length of less than 20mm is necessary to produce flushable wipes according to EDANA III. The challenge: the carding process does not work with such “short fibres”. This was the point where the combination of wetlaid and hydroentanglement jumped in. In a wetlaid process, a blend of pulp and cellulosic long fibres is dispersed in water and then drained on an inclined wire. The homogenously formed wet fibre web is then bonded in a next step of hydroentanglement. Within this process the key to success is the perfect combination of all relevant



parameters, namely the raw materials, the right fibre blend and specific process settings during wetlaid and hydroentanglement. The questions regarding process technology were addressed by machine suppliers such as Voith/ Trützschler or Andritz in recent years, both of which supply full turnkey lines to the market.

INFLUENCING FLUSHABILITY ALREADY ON THE FIBRE SCALE

In the past Kelheim Fibres GmbH investigated the influences of fibre properties such as length, dimensions, cross-section and surface on the flushability of nonwoven products to offer tailor made solutions for these applications already on the fibre scale. At the same time, Kelheim Fibres GmbH has been supplying Danufil® KS, a viscose short cut fibre in different lengths from 3 to 12mm for wetlaid processes for many years. Product such as tea bags, coffee pads, plug-wrap papers or other speciality papers are produced with Danufil KS, benefiting from high porosity, and either increased absorption or fine dispersion properties. For the new wetlaid-hydroentanglement process, the question arose how such a short-cut fibre could be modified to achieve both sufficient bonding to the pulp component of the fabric and the dispersion of the wipe in the wastewater system. Such a fibre would help to fulfil the requirements of initial web strength during production and use and break-up and dispersion after use. Multiple steps of development and trial runs with different fibre types as well as various blends showed that Viloft® short cut fibre is particularly suited for this application for various reasons:

- Cellulosic nature: Viscose fibres have the potential of building hydrogen bonds to each other as well as to pulp fibres (as shown in f); this would deliver tensile strength to the wipe. Moreover, viscose fibres are widely spread in hygiene products due to their softness and next-to-skin comfort.
- Fibre length: The short fibre length of Viloft® short cut prevents entanglements as shown in c.
- Fibre surface: The crenellated surface of the Viloft® fibre creates “predetermined breaking points” within the wipe and increases the fibre-water friction (as shown in a and e). In addition, the water can pass along the fibres into the wipe construction during flushing to open up the web. Especially in combination with pulp fibres free spaces are generated within the wipe. Here, the water can tackle it very effectively.
- Fibre cross-section: The flat cross-section stands out due to its specific stiffness properties. When water impacts vertically on the slim lateral face, the fibre opposes high stiffness. However, when water impacts vertically to the wide face, the fibre shows low stiffness. With this combination the Viloft® fibre shows

a high momentum transfer via the narrow sides (and transfers the force of the water into the wipe as shown in b) while the fibres can be separated easily via the wide sides which leads to a quick dispersion of the wipe.

- Biodegradability: As illustrated in figure 2, Viloft is biodegradable according to DIN EN 13432:2000-12. Biodegradability is a requirement of the EDANA III guideline to guarantee not only flushability through the waste water system, but also environmental sustainability in water. This avoids the contamination of the seas with synthetic particles and microparticles (known as "marine litter") introduced by fibres that are not biodegradable.

Both length and cross-section of the fibre have a crucial influence on the flushability of the fibre which is illustrated in figure 3. Here fibre dispersions were flushed through sieve as described in the EDANA III guidelines. The y-axis shows the remaining amount of fibres on the sieve. According to EDANA III, more than 25% of an article's initial dry must pass the sieve, so less than 75% can remain on the sieve.

The fibres are already completely dispersed, but the modifications of Viloft® show a clear improvement in terms of flushability compared to a standard viscose fibre with round cross-section. At the same time it becomes clear that a fibre length of 16mm is too long to fulfil the requirements of EDANA III. It can be safely assumed that a maximum fibre length of 12mm should not be exceeded.

For further analysis of qualitative differences in flushability, the "Slosh Box Disintegration Test" described in EDANA III has been implemented in Kelheim. First results confirm the improved flushability of wipes using Viloft® fibres.

"UNDER PRESSURE"

Another important factor to influence the flushability of a product is the choice

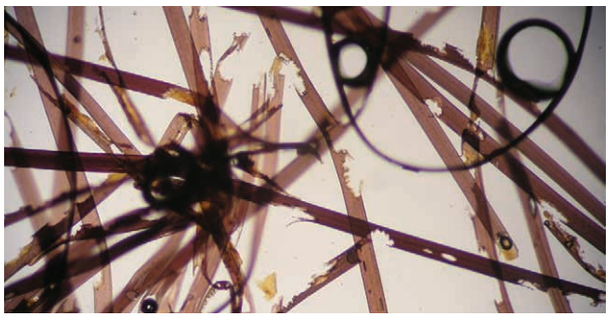


Figure 2. *Microscopic image of Viloft® during biodegradation. Picture provided by IPS labs, Appleton*

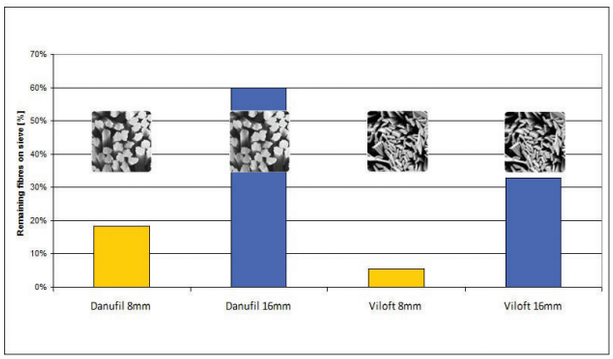


Figure 3. *Remaining fibres on a 12.5mm sieve*

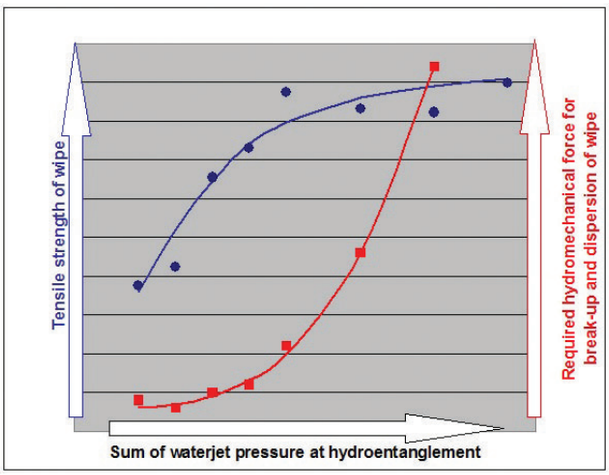


Figure 4. *Influence of water jet pressure on tensile strength and required hydromechanical force for break-up and dispersion of the wipe.*

of the right pressure levels during hydroentanglement. Figure 4 shows that after reaching a certain pressure level the tensile strength of the wipe does not increase (blue curve), whereas the flushability of the wipe is reduced significantly at the same time. The tensile strength only increases slightly once a level of about 80% is reached. Just at this point the required force for break-up and dispersion of the wipe increases steeply. In addition to that, significant savings in the application of energy during hydroentanglement can be made by

Another important factor to influence the flushability of a product is the choice of the right pressure levels during hydro-entanglement

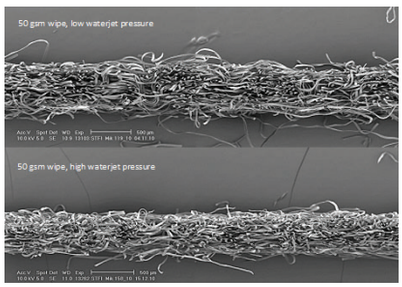


Figure 5. *Comparison of one wipe made of Viloft®, using two different waterjet pressures*

adjusting the water jet pressure to a minimum. For every producer the goal is to identify the optimum settings with respect to the chosen raw materials and the required product properties. The increasing compaction of the wipe – as shown in figure 5 – will also prevent the water opening up the web between pulp and fibres, bringing it to complete dispersion.

Moreover, a lower water jet pressure and a lower compaction will be beneficial in terms of softness and handling of the end products.

CONCLUSION:

The new wetlaid-hydroentanglement technology allows the production of flushable products certified according to EDANA III guidelines using one in-line process. There are various requirements for such products; it is therefore crucial to respect a manifold of parameters to implement all required product properties. Kelheim Fibres GmbH uses the versatility of the viscose manufacturing process for the production of specialty fibres like Viloft® dedicated for flushable products. By using these fibres in combination with the right process settings and other suitable raw materials, paper manufacturers and nonwoven producers already create innovative, sustainable products with added value due to their flushability.

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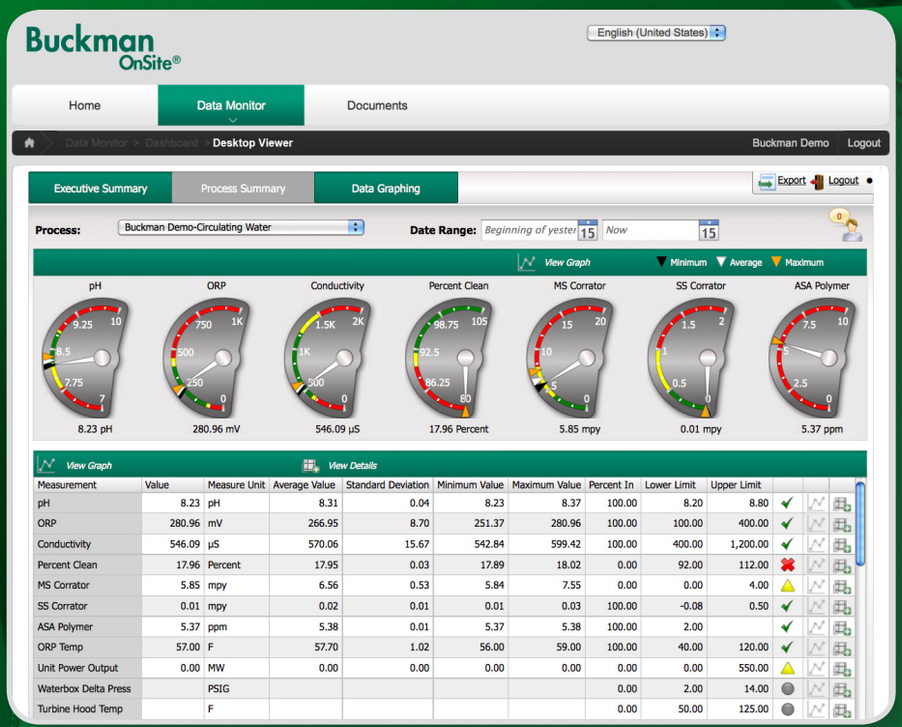

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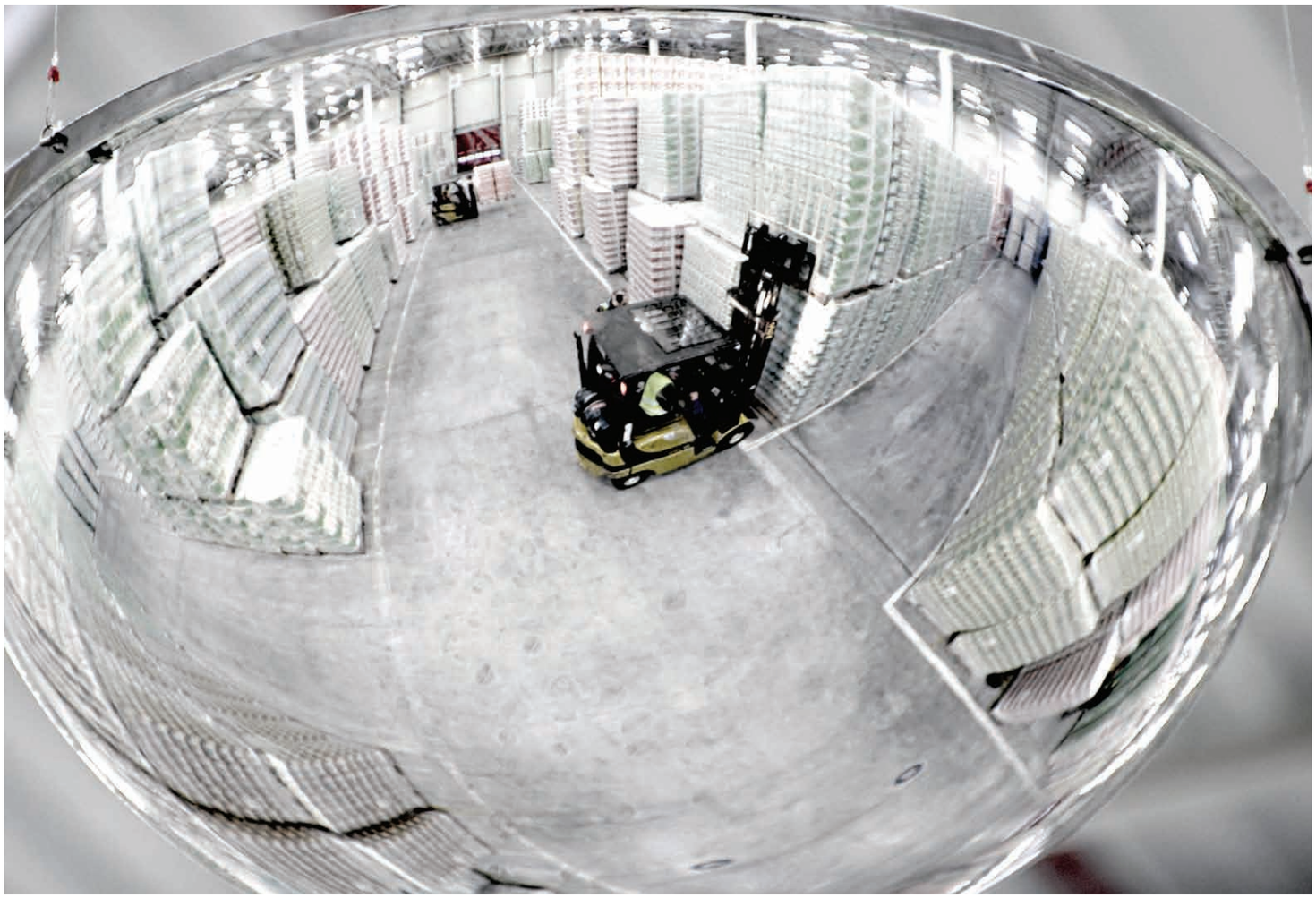
Uncharted territory

By **Ian Fenton**, Miltton Ltd, on behalf of Metsä Fibre



Deeply engaged, technical customer service is not a common concept in the pulp industry. But at Metsä Fibre, a multi-disciplinary team of experts is helping their customers to explore the true potential of both materials and processes.

Since the turn of the millennium, paper mill companies have been becoming more and more efficient, and their personnel base has decreased accordingly. This has led to a situation in which many paper makers now rely much more upon their suppliers for support in certain key areas. For example, it is not unheard of for chemical and felt suppliers to provide their service expertise for the benefit of their customers. Pulp suppliers, on the other hand, rarely play such an important role in a service capacity.

Many paper makers now rely much more upon their suppliers for support in certain key areas

Metsä Fibre is the noteworthy exception. Its Technical Customer Service team has carved out a niche by showing customers the undiscovered potential of both pulp as a material and the processes it is subjected to in their operations.

BETTER REFINING MEANS STRONGER TISSUE

A typical case for this team in an established paper facility will revolve around the pulp refining process. In fact, the team identify this as one of the most commonly neglected aspects of paper production, despite being an area where vast improvements to the end

product's characteristics – strength in particular – can be made.

Failure to prioritise the refining process, or adapt it to changes made elsewhere (the grade of pulp used, for example) may be the root cause of this neglect. Lack of resources may be another factor. But as the benefits of paying more attention to refining become evident, paper makers are generally quick to take notice.

In the production of tissue paper, where strength and softness are key properties governing the end consumer's perception of its final quality, the benefits of upgrading the refining process are twofold.

First, even the highest grades of pulp can't achieve their maximum potential in terms of strength without the proper treatment. In practice, this often means using more softwood than is actually necessary. By refining in the optimum manner, use of this resource – often the most expensive component for tissue paper producers – can potentially be reduced significantly, while increasing the hardwood content in the total furnish leads to a higher softness potential.

As the benefits of paying more attention to refining become evident, paper makers are generally quick to take notice

Secondly, another cost which can be abated by updating the refining process is that of electricity. Particularly in Europe, a mature market in which established paper makers need to preserve their competitive edge, paper mills typically run at a very high level of consumption, and energy costs are huge. Modifications to the refining system can reduce power needs, bringing the customer another drop in expenditure.

ENABLING STRATEGIC BENEFITS

When paper makers become aware of the dramatic improvements which can be made through a detailed look at their processes, the realisation inevitably leads to more than just a few technical changes in a long-forgotten room at the plant.

An understanding of the complex relationship between the pulp grades employed, the furnish, and the refining process – along with a number of other factors – can actually enable strategic-level decisions within a company. To facilitate actions like these, Metsä Fibre hosts "innovation days" with customers who have particular ambitions in mind: the need to dramatically reduce production costs across a number of facilities, for example.

By providing an interface between the customer's management team and Metsä Fibre's service experts and R&D

specialists, operative issues can be identified to help accomplish high-level goals. The Technical Customer Service team can then take a closer look at the facilities in question to actualise these improvements. As well as the refining upgrades mentioned above, this may involve changes to the furnish to allow for some replacement of soft wood for hardwood, leading to further cost savings.

In this way, the team are best able to help their clients communicate better internally, bringing together purchasers, operational personnel and management to ensure that paper-making operations generate larger quantities of the highest grade of product possible, for the lowest achievable cost.

DELIVERING ON EARLY POTENTIAL

To address established paper makers who may be overlooking their potential is one important part of the Technical Customer Service team's work, but there is another clear opportunity for them to add value: assisting new players in emerging markets.

Tissue paper has been one of the fastest growing areas in China in recent years, due to improving living standards, the emergence of the middle class, and the country's rapid urbanisation. However, this has been tempered by increased consciousness of cost and efficiency, and the growing need for more sustainable solutions. The ramp-up stage of a new plant is therefore the ideal point at which to apply Metsä Fibre's expertise over the entire paper production process, as customers have swiftly understood.

The team has been supplying a service it terms the "startup kit": a purpose-designed solution to meet the needs of a paper maker building a new plant. This means that when a customer plans a new machine, Metsä Fibre is present to assist the machinery supplier and help the customer make the most out of their investment.

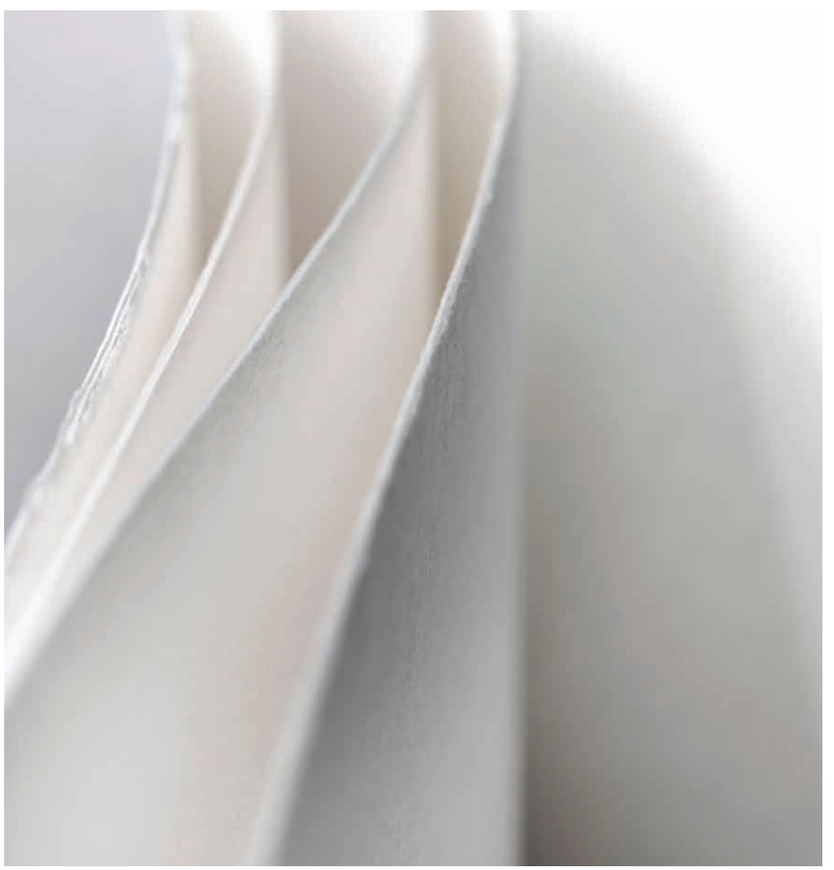
There is another clear opportunity to add value: assisting new players in emerging markets

This encompasses all aspects of the production process, as well as the pulp itself. The team does everything it can to ensure that start-up proceeds smoothly.

With knowledge of the pulp to be employed (be it one of Metsä Fibre's own products or that of a competitor) and the furnish combination, the team's experts are able to make detailed recommendations and begin checking the process even before production has begun. The team includes two native Chinese speakers, so communication is no issue whatsoever.

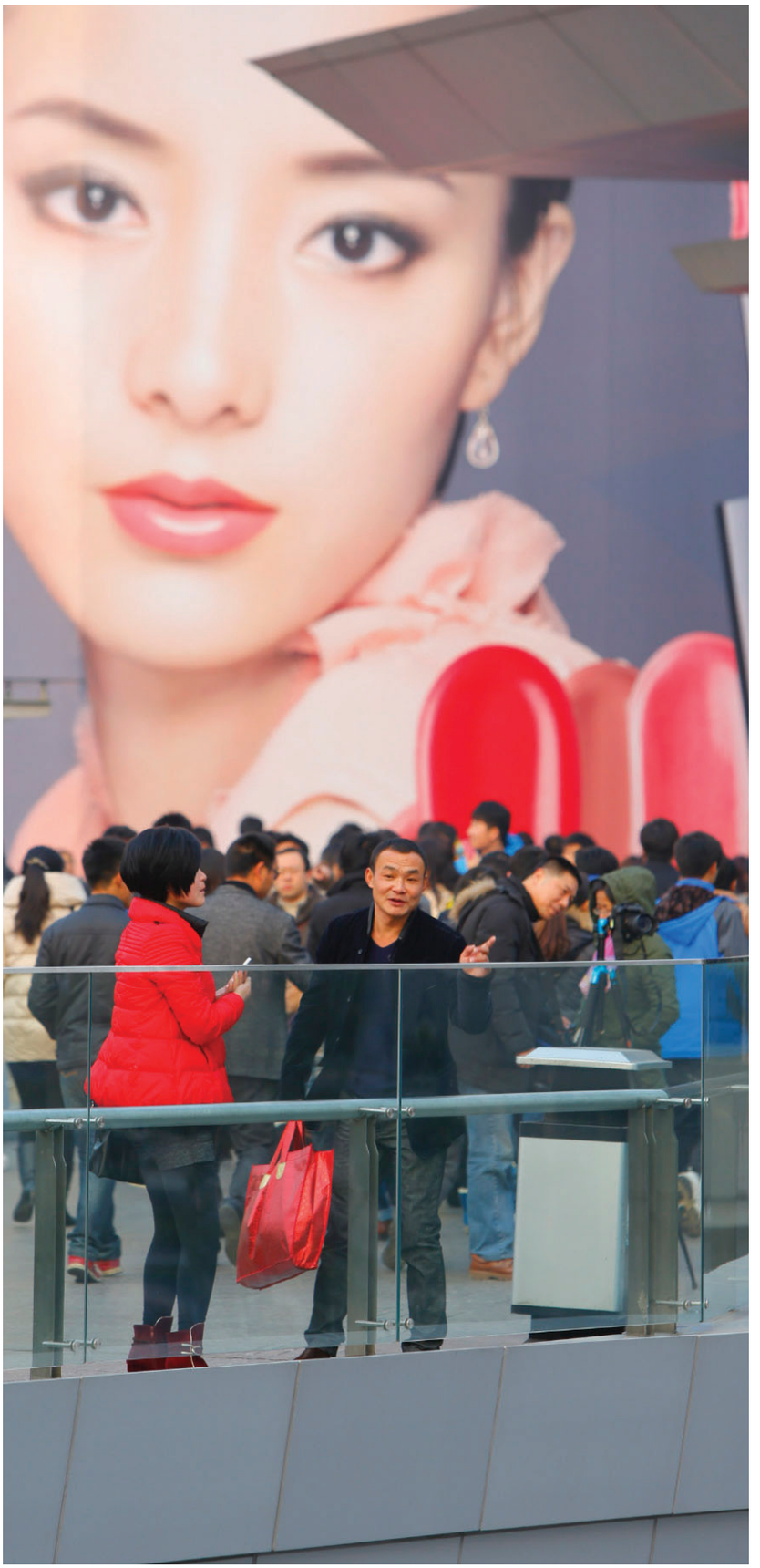
An experienced hand is of great value in this growing market, as many new entrants to the area find themselves equipped with the latest refining

A better grasp of the topic can enable strategic decisions and considerable savings



technology but a lack of understanding when it comes to the varied characteristics of different pulps. This may even necessitate a fundamental decision in the purchasing of refining machinery, hence the importance of having solid paper-making expertise on board as early in the planning stages as possible.

In China, as well as other markets in a similar phase such as Turkey, there is a clear hunger for knowledge like this. To meet this clear customer need, Metsä Fibre has been providing a service training kit comprising short lectures on a variety of topics. This isn't just a sales exercise either: educating the client on the team's approach to the key challenges of paper making can only be beneficial. As we noted in the case of refining upgrades, a better grasp of the topic can enable strategic decisions and considerable savings.



Traditionally something of a gap has existed between pulp and paper makers: somehow these two vital competences weren't communicating optimally

A UNIQUE STATE OF AFFAIRS

It would be fair to ask why Metsä Fibre alone is able to offer such a comprehensive package of support services to paper makers. There are two reasons: the company's background in paper production, and its sustained investment in a team of experts in a wide range of fields.

Metsä Group's heritage covers the entire paper production value chain, from forestry to the end product. This knowledge permeates even the other, distinct competences present in the organisation. Their production know-how addresses pulp production and refining, but as must surely be evident from the service examples described thus far, go far beyond these into production and beyond.

Pursuing a strategy of delivering value to the customer through in-house expertise, Metsä Fibre has systematically increased their team over the past 15 years, bringing in complementary competences to deepen the offering even further. Each member of the team has an average of 15 years work experience in the pulp and paper business, whether in various paper and chemical companies, or with machinery suppliers.

Traditionally a gap has existed between pulp and paper makers: somehow these two vital competences weren't communicating optimally. Metsä Fibre's Technical Customer Service team see themselves as something in between these two groups, and thereby capable of bridging the gap. They are working in uncharted territory, providing something genuinely unique to support and benefit their customers' future business.

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A low energy solution for cleaner and refiner protection

By **Daniel Brouillette**, Global Business Manager Screening, GL&V Canada Inc.

Unfortunately, most production lines have experience with baling wire, broken tile, lost fasteners, stones, staples and other tramp material accidently infiltrating their stock preparation systems. These contaminants can cause significant damage to equipment such as refiners and approach flow cleaners, ultimately leading to off-grade paper and unplanned downtime in addition to the inherent maintenance costs.

Cleaner cone tips are an obvious place for these types of contaminants to gather, plugging the rejects outlet and often causing spinning and premature wear. As cleaner banks generally consist of hundreds of cones, a widespread contamination event can plug multiple components, upsetting the system balance, throughput and efficiency. To clean the system, plugged cones must be manually removed, cleared and replaced if necessary which obviously costs hours of unplanned downtime.

Figure 1. *Plugged Cleaners*

Figure 2. *Refiner filling damaged by baling wires*

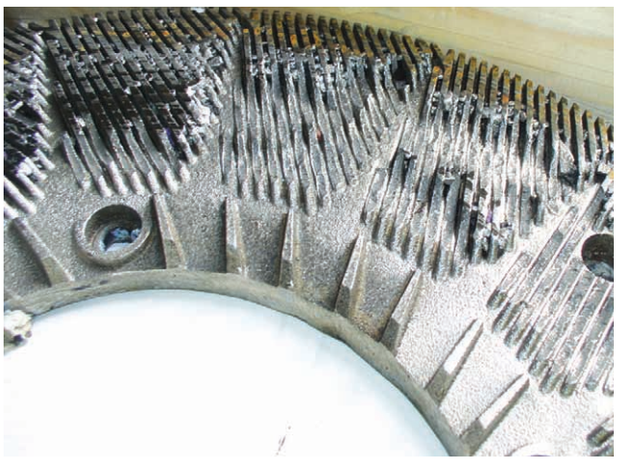

Figure 3. *Damage from a large contaminant entering the refiner*

A widespread contamination event can plug multiple components, upsetting the system balance, throughput and efficiency

Refiners are also susceptible to damage from these contaminants. Baling wires get caught up in the grooves between the bars in the refiner fillings, disrupting the intended flow pattern and refining efficiency. In the worst cases, larger and denser contaminants cause catastrophic failure of the refiner fillings, resulting in downtime for a plate change and unfortunately also sending additional contaminants downstream in the process.

Traditional solutions to protect against baling wire, broken tile, lost fasteners, stones, staples and other debris have been large, high density cleaners and/or trash screens. High density cleaners are simple and reasonably effective, but suffer from frequent reliability, maintenance, and housekeeping issues. Trash screens are perhaps a better solution, but carry a high initial

capital cost and an ongoing operating cost through relatively high connected power consumption.

As an expert and leading supplier of both cleaner and refiner systems, GL&V recognised the need and developed the DUALXCLUDER® technology to protect cleaners, refiners and other equipment from damage by tramp material. The DUALXCLUDER tramp material separator is a barrier screen efficiently removing contaminants larger than the screen cylinder aperture, down to 2mm for certain applications. The DUALXCLUDER separator can operate at up to 5% consistency and is currently available in three sizes to suit specific production requirements. Connected power varies from 5.5 kW (7.5 HP) to 15 kW (20 HP) depending on the model selected.

Stock flow enters the DUALXCLUDER unit tangentially, directing dense contaminants to the outside of the flow pattern and away from the screen cylinder by centrifugal force. Clean pulp passes through the screen aperture from the outside inwards. Rejects unable to physically pass through the screen, separate into a trap supplied with the unit and are emptied automatically on a timed cycle. Dilution is fed through the rejects trap to minimise good fibre loss. A set of doctor blades serve both to keep the screen apertures clear and also to push tramp materials away from the screening zone.

The DUALXCLUDER® provides
- Efficient protection
- Low energy consumption
- Negligible fibre loss
- Small footprint
- Ease of operation

The DUALXCLUDER technology can now be found protecting downstream equipment and removing contaminants in a wide variety of applications including tissue, CTMP, market pulp and specialty papers, including installation on more than 20 production lines around the world.

Plugged cones must be manually removed, cleared and replaced if necessary which obviously costs hours of unplanned downtime

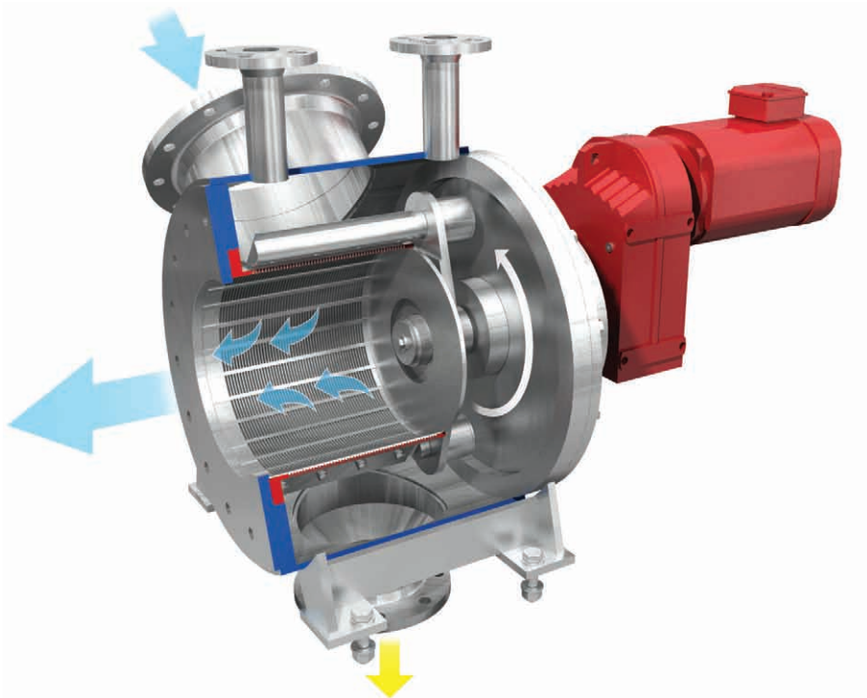

Figure 4. *Cross section of the DUALXCLUDER® separator*

Figure 5. *Typical contaminants removed*

DUALXCLUDER® installation

The machines continue to run trouble free with very little operator attention required

CONCLUSION

The DUALXCLUDER technology has proven to be a small footprint, low energy solution to problems faced by pulp and paper mills with tramp material contamination such as baling wire. The pressure drop across the unit is minimal, making it possible to install the screen into existing lines with very few changes required. In most cases a single unit can handle full production.

GL&V's innovation programs focus on energy and capital cost reduction in both equipment and process system designs. Their innovations, where possible, are designed to be retrofitted into older equipment as well, in order to reduce investment cost and for sustainability.

CASE STUDIES

Recently, a European tissue mill installed two DUALXCLUDER screens on separate lines to protect refiners. The tissue mill had previously experienced repeated damage to the refiner fillings from contaminants in the process, mainly pieces of tile and baling wires. Both DUALXCLUDER screens were commissioned in October 2014. The DX Model 20/25 processes slightly more than 1000 lpm of 3% consistency pulp with a 0.1 bar pressure drop and 50% motor load (5.5kW motor). The DX Model 30/35 processes nearly 2000 lpm of 4% consistency pulp with a 0.1 bar pressure drop and 50% motor load (7.5kW motor). Both DUALXCLUDER screens started up troublefree and the removal of tramp materials could be observed following the first flush sequences. The machines continue to run trouble free with very little operator attention required.

Södra Cell Värö in Sweden installed two DX Model 40/50 screens to protect the new approach flow cleaners installed as part of their 2011 bleached softwood pulp line upgrade. The machines are situated in parallel because of the high flow required, but discharge intermittantly into a common reject trap. Due to the long fibres for this particular application, GL&V supplied a patented diamond pattern screen cylinder. The machines continue to operate successfully. In 2013, two additional DX Model 40/50 screens were delivered for the upcoming capacity expansion of the mill.

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- **easy to clean**, increased retention, less sheet breaks,
- **less fibre and water carry**.

Inline measurements optimise recycling and deinking operations

By **Daniel Wätzig**, Application Manager Central Europe, BTG Instruments GmbH

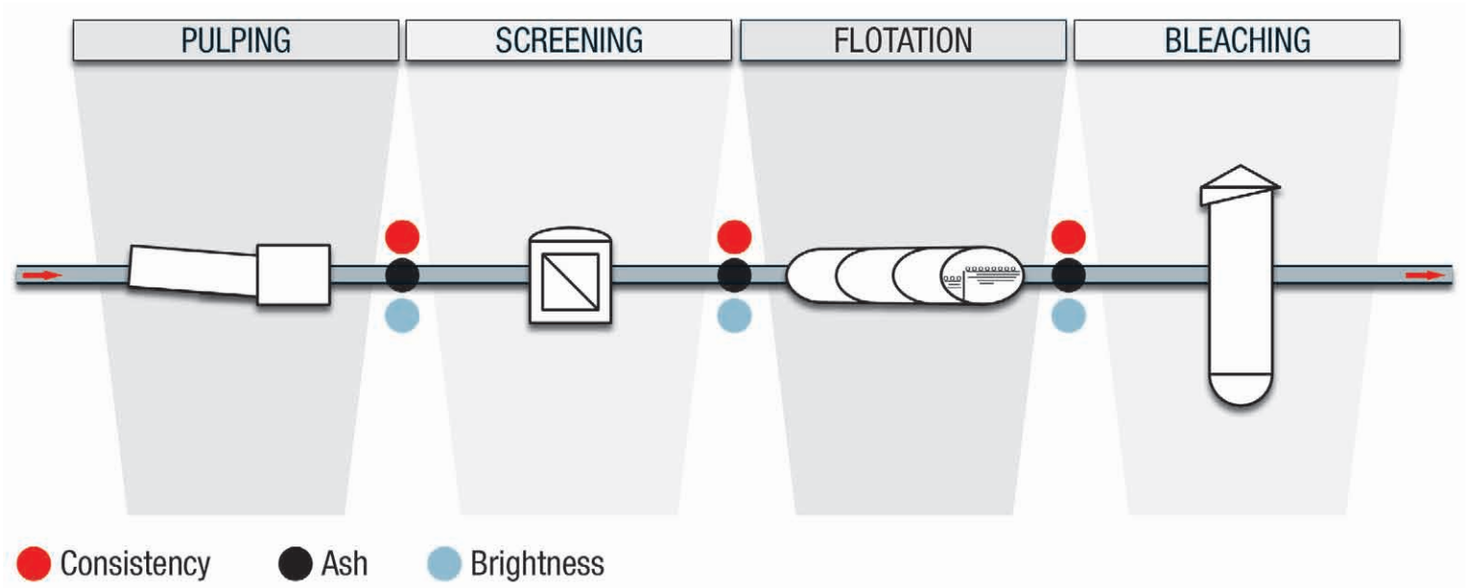

Figure 1. *Important measurement points in a recycled fibre plant*

Recycled fibre (RCF) plants are comprised of different sequential unit operations including pulping, deinking, deinked pulp (DIP) bleaching, fibre fractionation, screening, cleaning and refining before the fibre they process is finally made into paper. The productivity, efficiency and manufacturing costs of these units are interdependent; the output of a previous stage determines the operating characteristics of the next. If the fibre supply was uniform and predictable, these operations could be optimised with relative ease. But variable and generally poor quality fibre supply, plus higher costs for recycled fibre are industry wide problems. How can these variables be controlled so the process becomes more efficient and costs optimised?

All too often, processes are not well controlled; the installed equipment is either old or not used in the right way. Nevertheless, there are enough ways to improve the fibre recycling process to make up for this. The importance of controlling selected parameters as early as possible in the process is key to success. With the implementation of application-specific inline technology such as consistency and ash sensors, brightness, UV fluorescence and residual ink transmitters many of these unit operation issues can be solved and the downstream benefits can be realised. Control strategies can be established step by step with low investments. The key measurements in a typical RCF process are shown in figure 1. Several examples of how the measurements can be used to get better plant performance results are reviewed.

All too often, processes are not well controlled; the installed equipment is either old or not used in the right way

STABILISING INK REMOVAL EFFICIENCY

Stabilising ink removal efficiency will produce a consistently bright furnish for papermaking. In one case, a newsprint mill with a furnish of deinked pulp and TMP operated a 500 t/d capacity flotation deinking line with BT-55 series inline brightness and residual ink (ERIC) transmitters installed before and after the flotation line. Both transmitters were calibrated to measure brightness and ERIC. The inlet stock was measured at a consistency of 3.5% to 4.0% then diluted to normal operating consistency, whereas the diluted outlet stock is measured at 1.25 to 1.5%.

The two transmitters are primarily used to measure the ink removal efficiency so that process operators can make timely adjustments to the soap and other chemical feeds to

the flotation cells. The objective is to provide a fibre feedstock with low and constant residual ink levels to the following hydrosulphite bleaching stage, thus ensuring the paper machines receive a uniform brightness furnish. This residual ink regulation avoids any slowing of mill production if final brightness targets are not met.

SAVING BLEACHING CHEMICALS

Bleaching of DIP is costly so efforts should be made to measure and control the effectiveness of deinking operations before the bleach plant. A deinking plant providing furnish to a 110,000 t/y tissue and printing paper mill installed two BT-5400 brightness transmitters with UV fluorescence and ERIC measurements after the first flotation stage and then after the second flotation stage. Both stages operated at 3.5% consistency.

In the first stage, operators manage brightness levels by adjusting the mix of the recycled fibre quality to achieve stable target brightness. With this strategy, brightness variations were reduced. In the second stage, operators managed the residual ink (ERIC) levels by process adjustments. By reducing ERIC, the need for bleaching chemicals was reduced without sacrificing brightness. Access to accurate and real time data about brightness has enabled the mill to maintain its stringent quality control standards while simplifying its process and cutting unnecessary chemical costs. This chemical saving plus the more common use of lower cost recycled fibre has provided a payback of less than one year.

MANAGING PULPER BRIGHTNESS FOR LOWEST FIBRE COST

An inline brightness transmitter can be used at the beginning of a batch re-pulping operation to achieve the right brightness for subsequent stages of ink removal and bleach with minimum furnish cost. For example, a tissue mill that recycles waste paper installed a BT-5500 brightness transmitter on the wall of a batch pulper, about 1 metre from the maximum fill level. The brightness measurement was on a large display above the pulper to emphasise its importance to the operators.

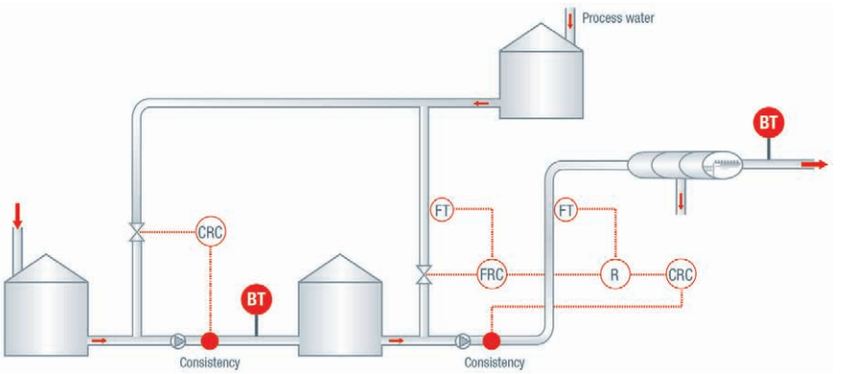

Figure 2. *Flotation cell monitoring with BT brightness transmitters*

To achieve their target brightness the mill used several qualities of baled waste paper with significantly different price levels. The highest priced bales contained no ink since it is paper mill trim waste. The mill reasoned that with the inline measurement the operators would get an indication about 8 minutes before the end of a 20-minute batch sequence if the brightness was on, above or below target. This would allow them to decide if more high priced, premium baled paper should be used to achieve their target, or, if lower cost bales could be substituted and still achieve the target brightness. This operator-managed strategy with the brightness measurement made at just the right time has saved this particular mill about $250,000 in fibre costs. The strategy used by the operators is shown in figure 3. The operators aimed for a range of 63% to 78% ISO brightness in the batch pulper.

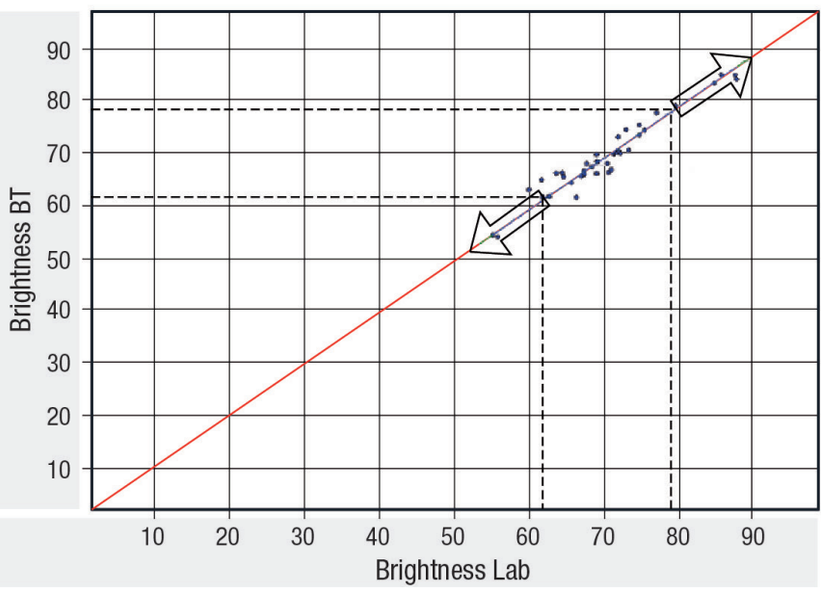

Figure 3. *ISO brightness measured in the batch pulper, BT results versus laboratory*

Bleaching of DIP is costly so efforts should be made to measure and control the effectiveness of deinking operations before the bleach plant

PULPER TOTAL CONSISTENCY STABILISES PROCESS

Being able to accurately and repeatedly measure consistency after a pulper in a recycled fibre process is very challenging. Firstly, trash and fibre clumps from the pulper are major problems for blade-type shear force transmitters. Secondly, mixed waste paper is comprised of many different fibres, and contains fine materials and fillers that are not measured by shear force. An absolute inline total consistency transmitter is needed after the pulper; that is the basis for total mass flow at the beginning of the process and the accurate calculation of overall process yield in the mill. This need can be filled by a TCR-2501 total consistency transmitter that uses an optical signal peak detection method. The transmitter measures the total mass of fibres of all types – small, fine particles and ash.

Figure 4. *TCR-2501 total consistency transmitter installed after a pulper*

Accurately measuring the consistency at each stage is extremely important since the right consistency entering a stage will determine its fibre fractionation effectiveness

A recycled fibre linerboard mill using this transmitter confirmed that the pulper exit consistency measured by the new transmitter is more varied than that indicated by the previous consistency transmitter. Having this knowledge, the mill implemented a consistency control loop using the conveyor speed and dilution water in order to control the consistency at this point. This had the additional benefit of stabilising the entire downstream process. Yield calculations became accurate and further improvement steps could be taken at the right point in the process. As the consistency in the pulper is stable at 5%, enough pulp is available to run the paper machine at full speed. The pulper sets the initial consistency level. From here on the consistency is reduced in all chests that are between the pulper and the linerboard machine. Furthermore, low consistency pulp that comes from a side stream does not disturb the process.

At another testliner mill, a TCR transmitter was installed after the RCF pulper (pictured in figure 4 above) and before high consistency cleaners operating at 3%. Before the control loop implemented with the new transmitter, the consistency varied between 2 and 4%. When the consistency was too high, the cleaners plugged. Also, at very high consistency the pulper motor load was high and some pulp did not pass through the screen plate. When the consistency was too low, the efficiency of the cleaners was poor. These problems have been solved now that the consistency is maintained at 3% to 3.5%. Managing to avoid the cleaners plugging once (and thus risking a shutdown of the machine) paid off immediately for the TCR measurement.

OPTIMUM FIBRE FRACTIONATION

The fibre fractionation processes required for a multi-ply forming process requires precise separation of long and short fibres so the right level of refining is applied. The sheet plies are then formed to give the optimum drainage on the formers, and to ensure the required fibre-to-fibre bonding and sheet strength properties can be achieved. Accurately measuring the consistency at each stage is extremely important since the right consistency entering a stage will determine its fibre fractionation effectiveness, and avoid plugging if the consistency is too high.

ACT-2500 transmitters measure the amplitude of oscillation of a specially designed active blade oscillating at its resonant frequency. The measurement is sensitive to both the shear forces and the viscoelastic properties of the fibre matrix in the pulp slurry. Its measurement range is extended down to 1.0%. The transmitter has a higher accuracy than a standard blade transmitter with a price point below an optical measurement. A typical fibre fractionation instrument layout is shown in figure 5.

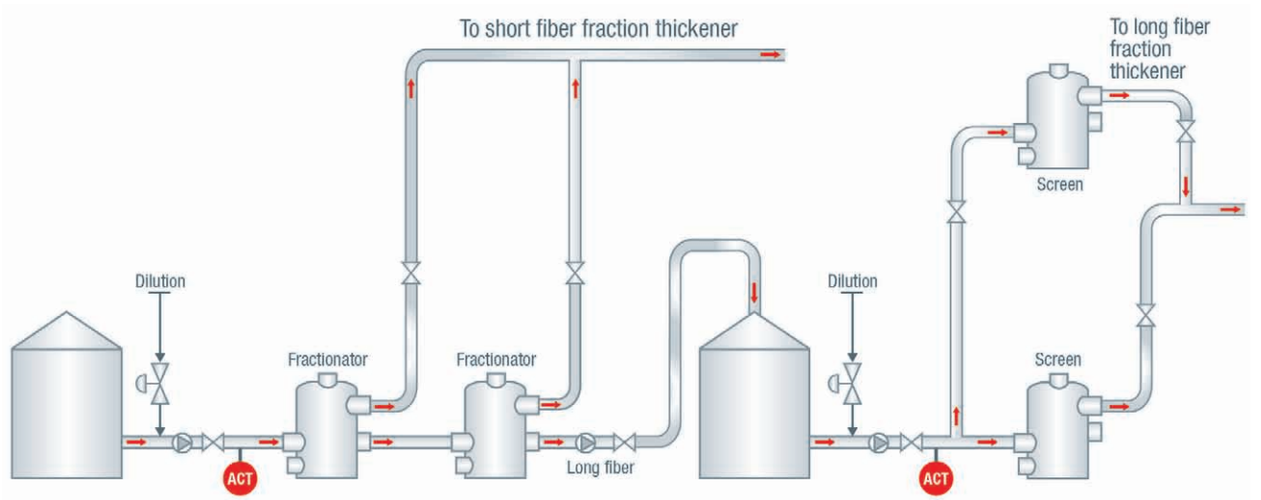

Figure 5. *A typical fibre fractionation instrument layout*

Fibre consistency and ash control audits can reveal where improvements in stability can be made in screening, cleaning, disc filter operation and dilution

More precise consistency control will improve the operation of many of the unit operations in a fibre fractionation plant. Fibre consistency and ash control audits can reveal where improvements in stability can be made in screening, cleaning, disc filter operation and dilution. These audits also measure long and short fibre separation, fines, and fibre morphology as well as process operating conditions.

For instance, screen feedstock consistency requires very tight control since it influences screen throughput and runnability (screen blinding) and can also determine the quality. An increase in consistency will increase throughput but can increase the risk of blinding. A large variability in consistency can upset the screen reject rate and cause disturbances to efficiency, fibre quality and freeness. In one case with variations in consistency of 0.9%, the screens act as fractionators and unexpectedly remove long fibre from the process, resulting in lower efficiency and lower strength.

CONCLUSIONS

Strategically applied inline measurements within a recycled fibre operation can yield many benefits including stable product quality, even throughput, increased yield, lower furnish costs and lower chemical and bleaching costs for DIP. These measurements can form the basis of operator managed controls or simple single loop controls that are inexpensive to implement. The return on investment is excellent. Multi-variable controls (APCs) have shown promise as a way to control RCF plants – however, they must be based upon reliable and accurate process measurements of controlled and manipulated variables. The message is clear: a stable and efficient RCF operation must be well measured.

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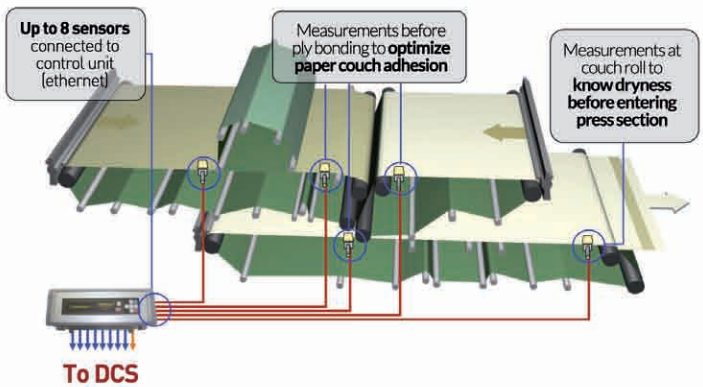

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Wet strength innovations for regulatory compliances

By **Alistair J. Diack**, Solenis

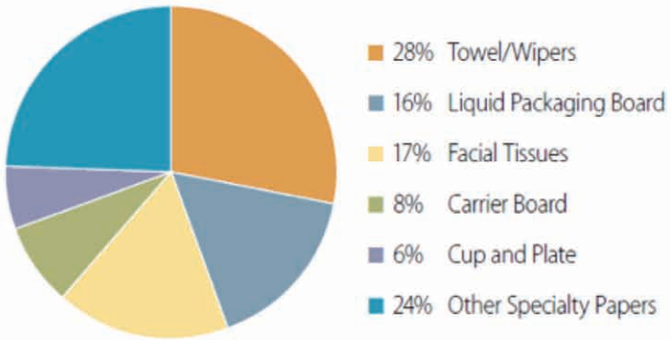
INTRODUCTION

Solenis invented the modern era of wet-strength paper manufacturing with the introduction of Kymene™ wet-strength resin, the first polyamido-amine- epichlorohydrin (PAE) resin ever brought to the market.

PAE technology was an instant commercial success, both for its ability to function in neutral/alkaline papermaking processes and for its novel wet-strength capabilities. Today more than 90% of wet strengthened paper and board utilize PAE resins.

In recent years, greater awareness of the hazards posed to human health and the environment by some of the processes and chemicals used when manufacturing paper products has resulted in various regulatory measures being imposed on the industry. To ensure business sustainability, papermakers must comply with these regulatory measures typically through operational changes. In addition, these same regulatory concerns have driven chemical suppliers to develop new products and technologies to help papermakers meet these ever changing demands.

As these regulatory measures have evolved, newer generations of PAE resins have been developed. Typically, these regulatory measures are specific by region so the development of a global solution will not meet the current manufacture and consumer needs in all regions. However, paper manufacturers that desire to produce for the global market must ensure that regulatory compliance for both grade and region are met.



Wet-strength papermaking is vitally important because of the prominence these grades have in day-to-day consumer activities and because governments carefully monitor any paper and board that comes into contact with food.

Paper manufacturers that desire to produce for the global market must ensure that regulatory compliance for both grade and region are met

Product development efforts focus on meeting these regulatory and sustainability goals while maximizing the cost performance of the PAE resin. Second generation (G2) products were developed to meet worker safety labeling requirements, and must have less than 1,000 parts per million of 1,3-dichloro-2-propanol (1,3-DCP) on an "as received" basis. With G2 resins, "polymer-bound AOX" is the primary contributor to AOX, while 1,3-DCP and 3-monochloropropane-1,2-diol (3-MCPD) are minor contributors. Subsequently, third generation (G3) products were developed to meet all European regulatory requirements (e.g., BfR XXXVI 1/2/3). Additionally, G3 and G2.5 resins were developed to allow papermakers to achieve very low AOX in effluent and very low AOX in paper to meet totally chlorine-free (TCF) requirements.

In addition to external regulatory measures imposed in the industry, major producers of wet-strengthened paper products have corporate sustainability programs to ensure the long term viability of their businesses. These programs often have a component for commitment to environmental sustainability by reducing the impact of their overall manufacturing footprint.

TECHNOLOGY OVERVIEW

The basic manufacturing process for a PAE resin begins with a low molecular weight polyaminopolyamide, known as a prepolymer, which his initially formed by polycondensation of adipic acid and diethylenetriamine (DETA), but alternative dibasic acids (and acid derivatives) and polyalkylenepolyamines have been used (Figure 1).

The ratio of the adipic acid and DETA can be varied to provide a prepolymer with higher amine functionality which provides lower levels of 1,3-dichloropropanol (1,3-DCP) and 3-monochloropropane-1,2-diol (3-MCPD) in the PAE resin.

An aqueous mixture of the prepolymer is alkylated with epichlorohydrin (epi) at 20-40oC to initially form tertiary aminochlorohydrin (ACH) functionality. Good temperature control is required

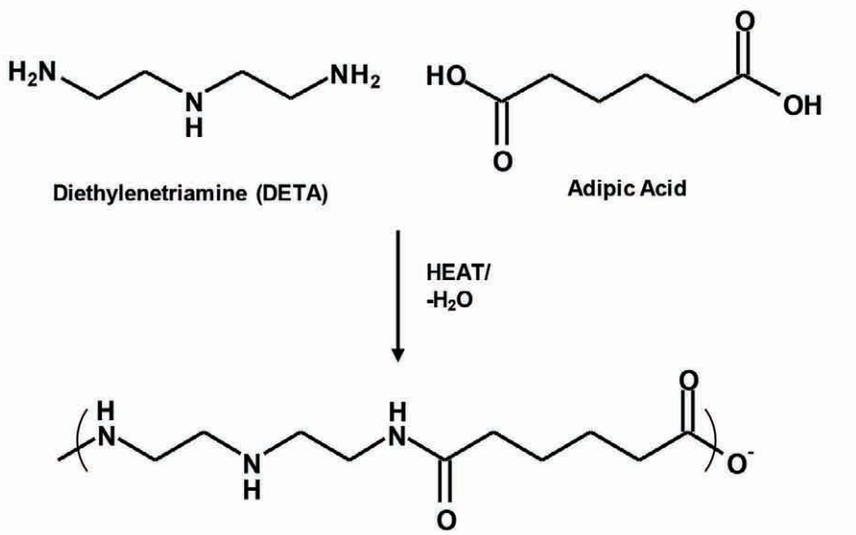


Figure 1. *Polycondensation of adipic acid and diethylenetriamine (DETA)*

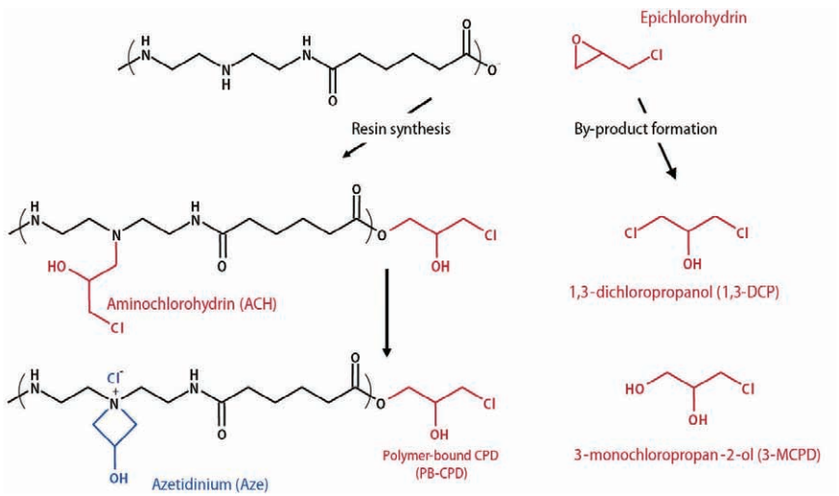


Figure 2. *Typical PAE Resin Manufacture and Formation of Epi By-products.*

to minimise epi hydrolysis and to minimise chloride ion formation. After the initial alkylation step, the reaction mixture is heated to 60-80^{oC}. This step results in further conversion of ACH functionality to azetidinium (AZE) functionality (Figure 2) and further crosslinking to build a PAE resin of the desired molecular weight. The reaction is quenched with acid (typically sulfuric acid) at the target viscosity and cooled to less than 25oC before pumping to storage.

PAE RESINS, EPI BY-PRODUCTS IN PAPER

Initial concerns about epi by-products in PAE technology were related to the potential hazard to human health when handling the product and the impact they had on the environment. The focus in recent years has been the potential for these epi by-products to enter the food chain by migration from various food contact grades. After much review and assessment of such risks, the German Federal Institute of Risk Assessment (Bundesinstitut für Risikobewertung, BfR) provides a series of recommendations (XXXVI) for the levels of 1,3-dichloro-2-propanol (1,3-DCP) and 3-monochloro-1,2-propandiol (3-MCPD) that may be extracted with water from a paper sample or product manufactured for different types of food contact grades of paper.

For all food contact paper grades, the recommendation states that the "1,3-dichloro-2-propanol must not be detectable in water extract of the finished product (detection limit 2µg/l). The transfer of 3-monochloro-1,2-propanediol into the water extract of the finished product must be as low as technically achievable, a limit of 12µg/l must not be exceeded in any case."

While the BfR recommendation for the water extract is the same for all the different types of paper grades, the sample size and the method of aqueous extraction must be considered to appreciate what this means in terms of levels of the allowable 1,3-DCP and 3-MCPD in paper.

Initial concerns about epi by-products in PAE technology were related to the potential hazard to human health when handling the product and the impact they had on the environment

Recommended Sample Size and Extraction Method for the Determination of 1,3-DCP and 3-MCPD in Paper Samples							
Sample Type	Sample Weight	Extraction Method	Hot/Cold Extraction	BfR Limit in Water Extract		BfR Limit in Calculated Back to Paper	
				1,3-DCP	3-MCPD	1,3-DCP	3-MCPD
Teabag/ coffee filter	40g/l (10g/250 mls)	EN647	HOT	2 µg/l	12 µg/l	50 ppb	300 ppb
Kitchen Towel	4g/l (1g/250 mls)	EN645	COLD	2 µg/l	12 µg/l	500 ppb	3000 ppb
Wipes	40g/l (10g/250 mls)	EN645	COLD	2 µg/l	12 µg/l	50 ppb	300 ppb
Other Grades	40g/l (10g/250 mls)	EN645	COLD	2 µg/l	12 µg/l	50 ppb	300 ppb

Taking into account the sample size and the test methodology, kitchen towel grades are permitted higher levels of 1,3-DCP and 3-MCPD in the final paper product. For all other food contact grades, the levels permitted in the paper are one order of magnitude lower.

While the recommendations originate from Germany, they have been adopted by the different European countries and European Union institutions (for example the 2004 Policy Statement from the Council of Europe concerning Tissue Paper, Kitchen Towels and Napkins). The recommendations apply to food contact grades used in Europe, regardless of whether the paper is manufactured in or imported to the region. Therefore, to be active in the European market, producers worldwide need to ensure that their products comply with these recommendations.

The amount of 1,3-DCP and 3-MCPD in paper manufactured from PAE resins is dependent on a number of papermaking factors including; the amount of 1,3-DCP, 3-MCPD and PB-CPD in the PAE resin, the PAE resin dosage, cycle-up of 1,3-DCP and free 3-MCPD (which is dependent on the water closure level), amount of broke or recycled paper used (especially if the recycled paper used a G1 resin), solids before the dryer section and drying conditions. In practice, 1,3-DCP and free 3-MCPD are poorly retained by pulp fibres. The amount of 1,3-DCP and free 3-MCPD in the PAE resin is an inaccurate predictor for the amount of 1,3-DCP and 3-MCPD that will be in the paper [e.g., 1 part per million (ppm) of 3-MCPD in the PAE resin is not likely to result in 1 part per billion (ppb) of 3-MCPD measured in the paper]. Paper testing is needed to ensure compliance.

With current PAE resins, an examination of paper test results reveals that the 3-MCPD levels are much higher than the 1,3-DCP levels even when there is much more 1,3-DCP present in the wet strength resin product. Usually, papermakers struggle to meet the limits for the level of 3-MCPD while the 1,3-DCP level is typically well below the BfR limits.

However, the principle cause of high levels of 3-MCPD found in (and extracted from) paper is the generation of 3-MCPD in the papermaking process. G1 and G2 wet strength resins contain a significant amount of Polymer Bound CPD (PB-CPD) species [produced from the reaction of epi and acid end groups in the prepolymer (Figure 2)]. The PB-CPD species (also known as "CPD-esters") are part of the polymer that is adsorbed and retained by pulp fibres and fines in the wet-end which are formed into the wet paper web in the wire and press sections of the paper machine (Figure 3). In the dryer section, the action of heat causes hydrolysis of the ester bond; thereby generating an acid end group on the polymer and freed 3-MCPD, both of which remain in the dried paper sheet (Figure 4). During paper testing, the total of the initial free 3-MCPD before the dryer section and the freed 3-MCPD is measured to determine compliance with the recommendations of the BfR.

The principle cause of high levels of 3-MCPD found in (and extracted from) paper is the generation of 3-MCPD in the papermaking process

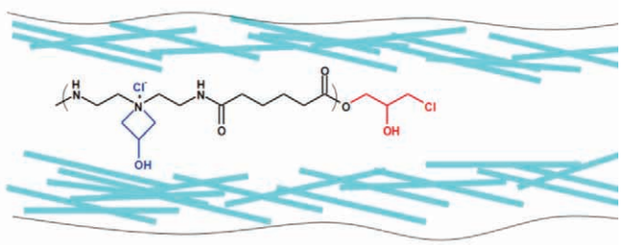


Figure 3. *PAE Resin Polymer Retained on Fibre and Fines in the Wet Web. 1,3-DCP and free 3-MCPD are poorly retained but will cycle-up in the water component of the wet web.*

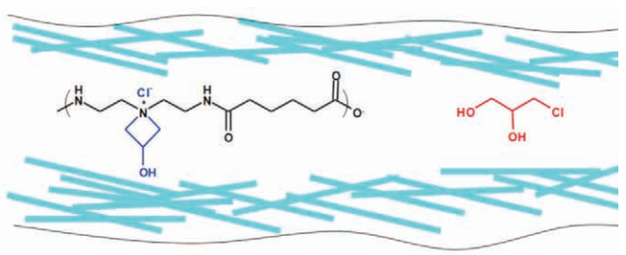


Figure 4. *Hydrolysis of the CPD-ester on PAE Resin Polymer in the Dryer Section. Both the PAE Resin and the freed 3-MCPD are retained in the Dry Web and in the Paper Sheet.*

In kitchen towel grades, resins that contain small amounts of PB-CPD (e.g., G2 resins) can in a lot of cases still allow papermakers to produce products that comply with the BfR XXXVI recommendations due to the lower paper sample size for the BfR test method permitting higher levels of 1,3-DCP and 3-MCPD to be present in the paper. Where very high levels of Wet strength are used, then it may be necessary to utilise a G2.5 or even G3 resin technology.

However, for other grades, (such as tea bag paper & coffee filters and liquid packaging board), the paper sample size used in the test method is higher, thereby resulting in lower limits for 1,3-DCP and 3-MCPD to be present in the paper. PAE resins that contain PB-CPD species may have levels of 3-MCPD that are not compliant with the BfR XXXVI/1, XXXVI/2 and XXXVI/3 recommendations. A PAE resin with very low or even non-detectable levels of free 3-MCPD could result in a paper with high levels of 3-MCPD if the PAE resin has a significant level of PB-CPD.

Formulation and process conditions for PAE resins can minimise the formation of PB-CPD. However, to achieve the very low levels of PB-CPD needed for G2.5 and G3 resins, post-manufacturing processes are needed. While initial products were based on acidic or enzymatic treatment to hydrolyze PB-CPD, basic treatment is currently the most cost effective process resulting in the highest efficiency PAE resins. The basic treatment destroys much of the 1,3-DCP. During the base treatment process, most of the initial 1,3-DCP, free 3-MCPD and PB-CPD are ultimately removed from the PAE resin due to further reaction with amine functionality on the polymer and due to further hydrolysis to glycerol. This destruction of 1,3-DCP, free 3-MCPD and PB-CPD reduces the environmental impact and potential hazard to human health when handling these products.

While hydrolysis processes can actually increase the overall free 3-MCPD in the resin, the low substantivity of 3-MCPD to paper fibres (relative to PB-CPD on the cationic polymer) results in an overall lower level of 3-MCPD in the paper product. Additionally, these hydrolysis processes allow post-treatment processes (e.g., microbial dehalogenation or membrane separation) to eliminate the PAE resin contribution to 3-MCPD to paper resulting in a G3 resin. G3 resins have less than 10 ppm of 1,3-DCP and free 3-MCPD but most importantly, exhibit no potential to generate 3-MCPD due to having very low levels of PB-CPD. Use of G3 resins allows papermakers to produce products that meet all the recommendations of the BfR.

PAE RESINS EFFECT ON AOX AND THE ENVIRONMENT

The epi by-products, 1,3-DCP and 3-MCPD are the focus of worker safety and food contact paper regulations. Due to their Absorbable Organo Halogen (AOX) contribution, 1,3-DCP, 3-MCPD, PB-CPD and polymeric aminochlorohydrin (ACH) in PAE resins also affect environmentally driven regulations and guidelines. Legislation, such as the German Waste Water Act, imposes financial penalties on papermakers based on the level of AOX in their effluent stream. AOX is a “blanket term” that quantifies the amount of organochlorine containing compounds that can be adsorbed onto activated charcoal from water. The term, and methodology used does not distinguish the chemical nature of different organochlorine containing species. It is a sum parameter for quantifying the total organic halogen load in water and is often used as a surrogate measure of Persistent Organic Pollutants (POP) in the environment. The methods for determining AOX have been standardised worldwide. A number of methods exist such as US EPA Method 1650C, DIN EN 1485 and ISO 9562. All of these methods follow the same basic principles: **(1)** a known quantity of aqueous sample is mixed with activated charcoal, **(2)** the charcoal is carefully washed with nitric acid to displace and remove any ionic halides (usually chloride ions) from the matrix, **(3)** the total halide (TOX) content is determined.

In the mid 1980’s, a large amount of paper was produced using pulps bleached with chlorine gas. It was found that organochlorine compounds present in these pulps were the major contributor to the AOX content of a papermaker’s effluent stream. The AOX contribution from the bleaching of pulp has been addressed by the use of alternative bleaching techniques; **(1)** chlorine dioxide for Elemental Chlorine Free (ECF) bleaching and **(2)** ozone/hydrogen peroxide for Total Chlorine Free (TCF) bleaching.

After bleaching of papermaking pulps, the next major contributor to the AOX content of a papermaker’s effluent stream was found to be PAE resins. The development of Generation 2 wet strength products to address worker safety regulations by reducing the levels of 1,3-DCP and free 3-MCPD also resulted in the AOX content being reduced. The high levels of 1,3-DCP found in Generation 1 products are a significant contributor to a papermaker’s effluent stream.

However, 1,3-DCP and free 3-MCPD are not the only source of organochlorine species that can be determined by the AOX methodology and contribute to a papermaker’s effluent stream. Low 1,3-DCP containing resins are sometimes referred to as low AOX. However, with

While initial products were based on acidic or enzymatic treatment to hydrolyze PB-CPD, basic treatment is currently the most cost effective process

G2, G2.5 and G3 resins, Polymer Bound Organochlorine (PBOX) is by far the primary contributor to AOX, not the free species, 1,3-DCP and free 3-MCPD. In the manufacture of a PAE resin, epi reacts with the secondary amine groups of the prepolymer to form aminochlorohydrin (ACH). This ACH species then converts to AZE functionality (Figure 2). Additionally, epi also reacts with the acidic end groups of the prepolymer to generate Polymer Bound CPD (PB-CPD). Both ACH and PB-CPD are examples of Polymer Bound Organochlorine (PBOX) species. In the AOX methodology, the polymeric component of the PAE resin is retained on the activated charcoal and contributes significantly to the measured AOX.

Theoretically, the AOX content is the sum of the chloride content from the 1,3-DCP, 3-MCPD, PB-CPD and polymeric ACH in the PAE resin. The chloride content of 1,3-DCP is 55 wt % and the chloride content of 3-MCPD is 32 wt %. The contribution of 3-MCPD to the AOX content of a resin is lower than theoretical because 3-MCPD is not completely adsorbed and retained by activated charcoal in the AOX methodology. Whereas 90-95% of 1,3-DCP can be retained by activated charcoal, typically only 25% of 3-MCPD is retained under the same conditions. This is due to the greater hydrophilic nature of the 3-MCPD molecule.

The polymeric component of the PAE resin is considered to be well retained by the activated charcoal in the AOX methodology, so an abridged version of the equation (AOX = PBOX + 0.55xDCP) has been found to provide a good description of the AOX content of the PAE. Prior to 1990, Generation 1 PAE resins had high levels of AOX mainly due to the high levels of 1,3-DCP present. The development of Generation 2 wet strength resins, resulted not only in a reduction of 1,3-DCP by about one order of magnitude, but also resulted in a reduction in the AOX content of the PAE resin.

An analysis of the relative contributions of the free species (1,3-DCP and 3-MCPD) compared to the PBOX in a G2 PAE resin shows a much higher contribution of PBOX species to the AOX value. This is further exemplified by the application of a post-reaction cleaning technique to a G2 resin to remove only the 1,3-DCP and 3-MCPD (Figure 5). To emphasize the points that; **(1)** AOX and 1,3-DCP and 3-MCPD are not necessarily directly correlated and **(2)** that PBOX is a primary contributor to AOX, it was discovered that a G1 resin can be designed to have an AOX level that is higher or lower than the 1,3-DCP level. While the PBOX content decreases from G1 to G2 to G2.5 to G3, the high PBOX content of G2 resins relative to 1,3-DCP and 3-MCPD content clearly shows that PBOX species are the major contributors to AOX in G2, G2.5 and G3 resins. In practise, most of the polymeric component of the PAE resin is retained in the paper product. This retained PBOX does not contribute to the AOX in a mill's effluent discharge. A high level of retained PAE resin (and therefore a lower AOX in effluent contribution) can be achieved by using best practice application techniques (e.g., optimum dosing points and use of anionic co-factors).

In the manufacture of a PAE resin, epi reacts with the secondary amine groups of the prepolymer to form aminochlorohydrin

High efficiency PAE resins with a

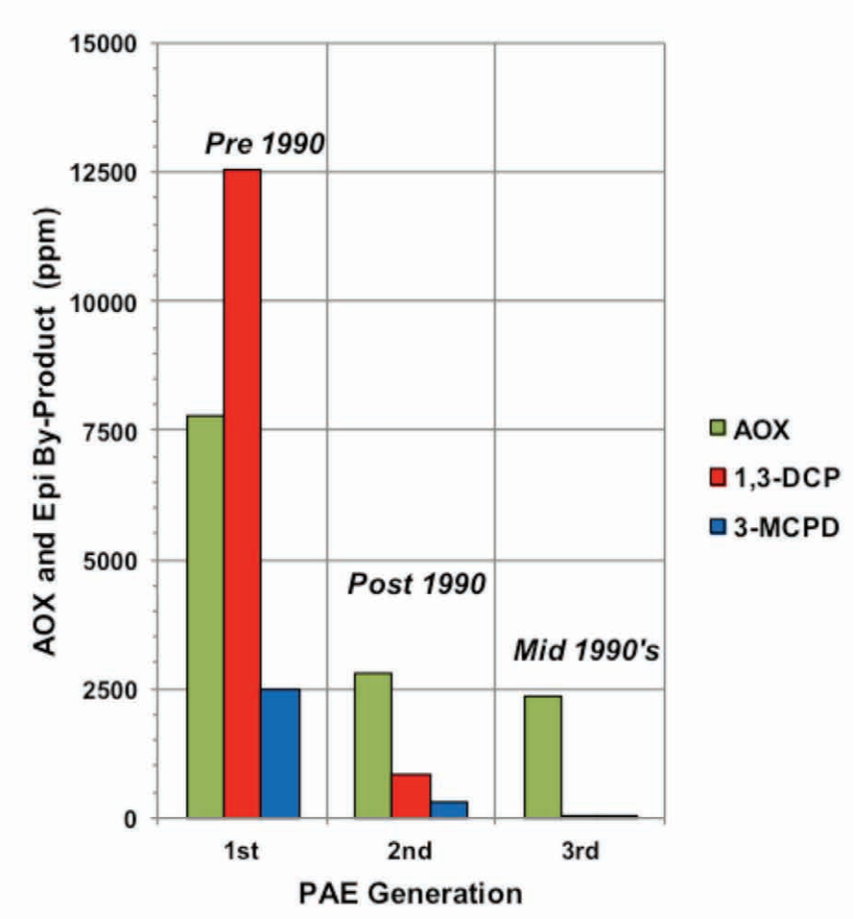


Figure 5. *AOX content relative to the 1,3-DCP and 3-MCPD Content (12.5% active basis), Demonstrating the Contribution from PBOX species (polymeric ACH and PB-CPD).*

high AZE level and therefore a high cationic charge are better retained than resins with a low AZE level when best application practises are employed. Additionally, resins with a high AZE level typically have a low level of ACH species, further minimising the PBOX contribution to AOX. With high efficiency PAE resins, the conversion of ACH to AZE during manufacture is maximized and the conversion of AZE to ACH during aging is minimized resulting in lower PBOX at the time of papermaker use and therefore lower AOX in effluent.

In G2 resins, PB-CPD and especially polymeric ACH remain the major source of AOX in PAE resins. With G2.5 and G3 resins, the PBOX content of PAE resins is further reduced by having greatly reduced the level of PB-CPD. With G3 resins, polymeric ACH is the only significant contributor to AOX. When considering how much a PAE resin contributes to the AOX content of an effluent stream, papermakers need to consider the actual/total AOX content of the resin and not just the level of epi by-products present in a product.

PAE RESIN EFFECT ON TOTAL ORGANIC CHLORINE CONTENT OF PAPER AND CONSUMER PREFERENCE

Some manufacturers produce grades of paper considered to be Total Chlorine Free (TCF). For such grades, the Total Organic Halogen (TOX) content is less than 30 mg per kg of dry paper. These grades use TCF pulps, which are produced using oxygen-based bleaching agents (such as ozone and/or hydrogen peroxide). Several methods can be used to determine the (total) organic chlorine of pulp and paper, such as ISO 11480 and PTS RH12/90. The principles of these methods are similar to those used for the determination of AOX content of aqueous samples, except that the paper sample is mixed with the activated charcoal. The measured value is typically called Organic Halogen (OX) in paper. As with AOX in aqueous samples, the OX in paper is a sum parameter, and does not differentiate between the different species present in the paper that contribute to the final value.

As with AOX in aqueous samples, all the organic chlorine species present in the PAE resin will contribute to the OX content of the final paper product. The OX content in paper is primarily driven by the PBOX content and not by free epi by-products (1,3-DCP and 3-MCPD) for G2, G2.5 and G3 resins. The following example illustrates this concept:

When considering the maximum limits for epi by-products in paper (kitchen towel);

500 ppb of 1,3-DCP equates to 0.28 mg/kg of OX in the paper.
3000 ppb of 3-MCPD equates to 0.98 mg/kg of OX in the paper.

Even at the limits recommended by the BfR, free epi by-products are not significant contributors to the OX content of paper. It is the Polymer Bound Organic Chlorine species (PBOX) of the resin that are the main contributors to the OX content of paper.

Of the two PBOX species present in the resin, polymeric ACH is the principle source of organic chlorine. The proprietary manufacturing processes for G2.5 and G3 wet-strength resins, which were developed to eliminate PB-CPD species from the final product, also reduce the level of ACH, thereby reducing the total AOX and PBOX content of the resin. Therefore, the same G2.5 and G3 resins that allow papermakers to minimise mill effluent AOX content will also allow manufacturers to produce TCF grades of paper.

The evolution of cleaner PAE resin technology to help papermakers meet regulatory measures to address environmental and health concerns related to organochloride species has resulted in a better understanding of the PAE resin technology. Improved process control in the basic resin manufacturing process, and the development of novel post-reaction techniques were needed to address these concerns. This improved knowledge of PAE resins has been used to generate products with better performance characteristics that can be shipped at higher solids, across all the different generations of PAE technology.

Improved knowledge of PAE resins has been used to generate products with better performance characteristics

SUMMARY

Regulatory drivers and sustainability efforts have resulted in step-change improvements in PAE resin technology which have dramatically lowered 1,3-DCP and 3-MCPD levels to reduce the potential hazard to worker and consumer health and lowered PBOX species to reduce the impact on the environment (AOX of mill effluent) and allow for the manufacture of TCF grades of paper. Additionally, in gaining an understanding of mechanisms that produce undesired organochloride species, formulations and process to reduce them were developed which resulted in improvements in the wet strengthening performance of PAE resins. High solids, high efficiency PAE resins contribute to a smaller environmental impact by allowing the use of less chemistry, less emissions from transportation and less PAE resin (and AOX) in effluent. These attributes fit well with the corporate environmental sustainability programs of major papermakers.

When selecting which generation of technology to use, consideration of external regulatory measures is required together with the papermakers' own needs to meet the guidelines of non-governmental organisations plus their own corporate sustainability programs.

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Strength and productivity achieved in high performance recycled linerboard

By **Brad Benz**, Senior Industry Technical Consultant and **Brian Duffy,** Director of Marketing, Nalco, An Ecolab Company

The recent worldwide economic recovery and globalisation of the market has brought about a rallying demand for containerboard. Faster machine speeds, increased operating rates, and the ongoing demand for fibre to fulfill production needs has been a challenge across the industry. This demand has caused fibre prices to fluctuate, especially recycled fibre such as OCC from recovery processes. Many producers target fibre reduction as it has a direct link with manufacturing cost and selling prices. This issue is discussed daily in plants across the globe. Having a well-managed chemical programme and well-run mechanical operation is an effective way to sustain the process of fibre reduction without compromising ECT or compression strength.

Lighter basis weights, strength, and energy costs are key drivers in the board and packaging market. However, achieving the desired end-product performance to satisfy demand, while maintaining and improving production efficiency can be a difficult task. Often, chemical dry strength additives are used as a tool to balance the negative impacts that can come from attempts to lower total operating cost.

THE "LIGHT-WEIGHTING" OF CONTAINERBOARD

The shift to lighter basis weights for containerboard has been a compelling industry trend for the last 25 years. Since the adoption of Alternate Rule 41 in 1990, many users have opted for box compression standards as the preferred method for specifying their boxes.

Many producers target fibre reduction as it has a direct link with manufacturing cost and selling prices

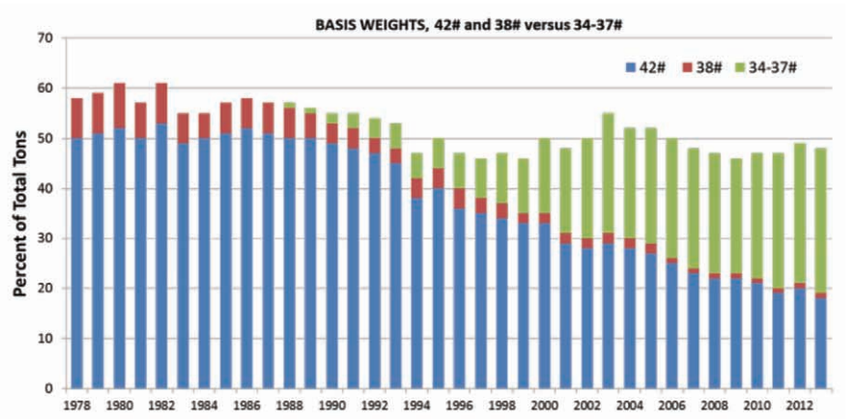

Table 1. *Basis weights for key linerboard grades have been steadily declining*

Several factors have influenced this shift including advances in manufacturing technology, shifts in fibre supply, supply chain considerations and sustainability awareness. Over time, basis weights have been steadily declining for key linerboard grades, as illustrated in Table 1.

Achieving strength and basis weight targets can be a challenge for any papermaker, especially when lower quality fibres are part of the furnish mix. Nalco's patented METRIX™ technology programme allows paperboard manufacturers to increase strength, lower basis weight, enhance production and improve sheet quality.

Variability in both quality and supply of raw materials presents additional challenges. Increasing refining to achieve strength often leads to reduced drainage, lower retention and higher energy costs. Increasing starch dosages may be ineffective as fibres become saturated and additional starch cannot be retained.

Overuse of other cationic additives such as alum and coagulants may also cause the furnish to become cationically dispersed, affecting retention, sizing, system foam, and finished product quality. Nalco developed the multi-functional METRIX technology to allow board manufacturers to simultaneously optimise basis weight, strength, caliper and sheet smoothness. Nalco METRIX technology gives papermakers the flexibility to increase strength while at the same time reducing basis weight, increasing machine speed, improving sheet properties and lowering fibre and energy costs.

NALCO INNOVATION DELIVERS VALUE

Nalco's commitment to developing new technologies, products and technical expertise underpins their continuing advancement as an innovation leader. This commitment is also key to expanding their customer relationships. For more than 90 successful years, Nalco has designed solutions to align

with their customers' key business drivers, resulting in significant economic and environmental benefit.

Over the past 15 years, Nalco has committed significant resources and research investment into the continued development of METRIX technology for strength and productivity. Their 9th and 10th generations of this technology are currently being marketed on a global scale.

In the board and packaging sector, an integrated team approach is used to align additive chemistry and best available mixing efficiency with the papermaker's key business drivers. These teams identify problems and opportunities around strength and grade development at the customer's plant. Nalco's research teams then work to develop effective solutions to these needs, often working jointly with their customer's research and development teams. The team participates in ongoing implementation and optimisation to ensure that their solutions deliver maximum value.

BACKGROUND

A linerboard manufacturer capable of producing 1,200 tons (1,091 metric tonnes) per day was experiencing serial reductions in production. Most days averaged 1,030 tons (938 metric tonnes) which was due to a need for higher basis weight to meet quality specifications. Low production was most prevalent on 35# (170 g/m^2) high performance linerboard and 42# (205 g/m^2) linerboard. This integrated board mill uses a higher percentage of recycled fibre in comparison with unbleached kraft pulp, 65% and 35% respectively. Recycled fibre quality has suffered over the years. The thick stock Canadian Standard Freeness (CSF) data showed recycled fibre had declined by 100mL or greater from the facility's recycling plant. Lower freeness was making it increasingly difficult to achieve sheet quality parameters at nominal basis weight and target speed/production. On occasion the paper machine was running at target speed, but rarely longer than one day. Several mechanical changes (refining, fourdrinier set-up, pressing, drying) contributed to minimal improvements in strength and speed. In addition, several wet-end chemical trials (coagulant, flocculant, starch, silica, strength resin) achieved minimal to moderate benefit in quality parameters. To meet quality goals, the mill was forced to run 2-3 lb (0.9-1.4 kg) over standard basis weight on select grades for this paper machine. This manufacturer sells finished board on a manufactured square foot/metre basis therefore, running over target creates several drawbacks including increased fibre cost, slower machine speed, decreased production rates, and higher energy unit cost per ton of linerboard produced.

Several mechanical changes (refining, fourdrinier set-up, pressing, drying) contributed to minimal improvements in strength and speed

The manufacturer wanted to run the machine at nominal basis weight or below while maintaining strength targets in ring crush and mullen. Additional key business drivers included production rates and reduced operating costs. Nalco understood that meeting these goals could prove difficult given the present and past operating conditions on the paper machine, given that minimal impacts had been realised with any previous changes.

Nalco's Industry Technical Consultants in cooperation with on-site Nalco personnel performed a thorough mechanical, operational and chemical (MOC) audit. The team provided several recommendations in each area with a major focus on chemistry. From a chemistry standpoint, there was a need to address drainage on the fourdrinier without disrupting sheet formation. This particular machine had a very long forming section. The wet-end chemistry and corresponding injection point was not overly complex with the use of alum, starch, rosin size, and cationic flocculant.

A review of audit findings was communicated to the manufacturer and a plan proposed to improve machine speed and increase strength. Chemical recommendations were made to limit early fourdrinier drainage, focusing on vacuum drainage and pressing, as well as strength development.

MILL OVERVIEW

Grade:	**Linerboard**
Basis Weight Produced:	**35 and 42#/1000 ft^2 (170 and 205 gsm)**
Machine Type:	**Single Ply Fourdrinier**
Press Type:	**1st Straight through, 2nd LNP**
Production Rate:	**45 TPH**
Machine Speed:	**1700-2250 fpm (518-686 mpm)**
Furnish:	**65% OCC and 35% Kraft**
Wet-end Chemistry	**CPAM Flocculant, Thin & Thick Stock Potato Starch, Rosin Size & Alum**
pH:	**5.2**

PROGRAMME DESIGN

As a first step, a high molecular weight cationic flocculant along with colloidal silica and a balance of thin versus thick stock starch provided necessary drainage on the fourdrinier. The ability to move the dry line on the fourdrinier was evident. However, this particular chemistry did not result in increased machine speed or strength. Several parameters were adjusted on the fourdrinier and press section, but no change provided sustained results. This was not a major setback as pre-trial audit findings suggested this was possibly due to limitations in the press section. The initial chemistry selection provided important technical information and demonstrated the Nalco team's ability to understand the papermaking process dynamics and provide a technical reason for the paper machine response observed.

Nalco's next step focused on a two-component polymer approach using high molecular cationic flocculant in combination with one of Nalco's METRIX technology products. METRIX technology was selected for this customer due to proven effectiveness with similar furnishes and also due to the inability of a traditional retention and drainage programme to meet the mill's key business drivers. METRIX also provides additional strength to allow for reduction in basis weight and refining. Vast experience with this technology, along with a thorough understanding of the papermaking process at this manufacturer's facility, allowed Nalco to design a programme that would provide maximum results at the lowest sustainable cost.

In designing the feed strategy of step two, existing wet-end additives were considered as well as their respective location to each unit operation. A feed location was selected that provided maximum METRIX technology retention with minimal interference from disruptive fines and colloidal material. The strategy incorporated a co-mix strategy of high molecular weight cationic flocculant and METRIX. At this facility overfeeding occurs at 3.0 lb/ton (1.36 kg/ton) of METRIX; therefore, the team selected 2.0 lb/ton (0.91 kg/ton) as the final dosage.

PROGRAMME RESULTS

After completing several trials with the METRIX technology programme, this customer incorporated the programme on a full time basis. They realised the following economic and environmental benefits to their operation:

Customer Impact	eROI	Economic Results
Increased production rate an average of 1.5-2.0% while realising a 7-10% increase in manufactured square footage	ASSETS	Operational return on investment $750/hour of production or $2,900,000/year
Savings of more than 29.4 billion BTU/year	ENERGY	More than $135,000/year savings
Lower basis weight resulted in fibre reduction of 4,847 tons/year. All wet-end chemical fed on a #/ton basis realised an annualised reduction equivalent to dosage rate multiplied by fibre savings of 4,847 tons	EARTH RESOURCES	More than $1,100,000/year savings
Reduced more than 1,074 lb/year of VOC's (volatile organic compounds)	AIR	Mill is operating within VOC regulatory limits
Saved 90,000 gallons/year in polymer make-down water	WATER	Reduced water use footprint

eROI is Nalco's exponential value: the combined outcomes of improved performance, operational efficiency and sustainable impact delivered through their services and programmes.

After completing several trials with the METRIX technology programme, this customer incorporated the programme on a full time basis

The following operational data was used to justify moving forward with the programme:

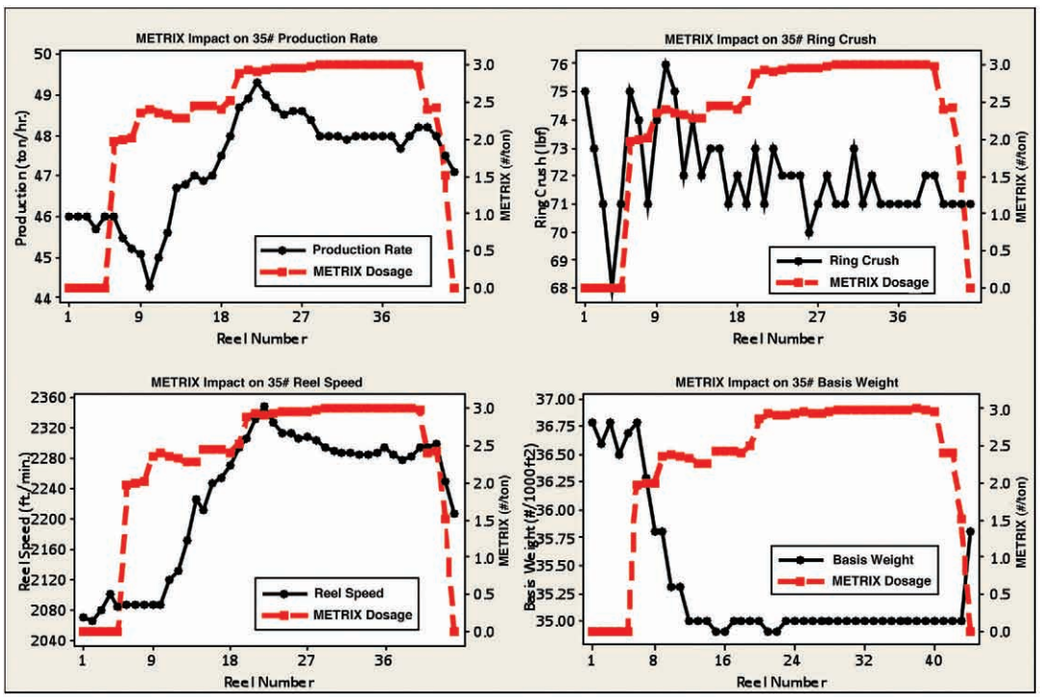

Figure 1. *METRIX technology results – 35# High performance linerboard*

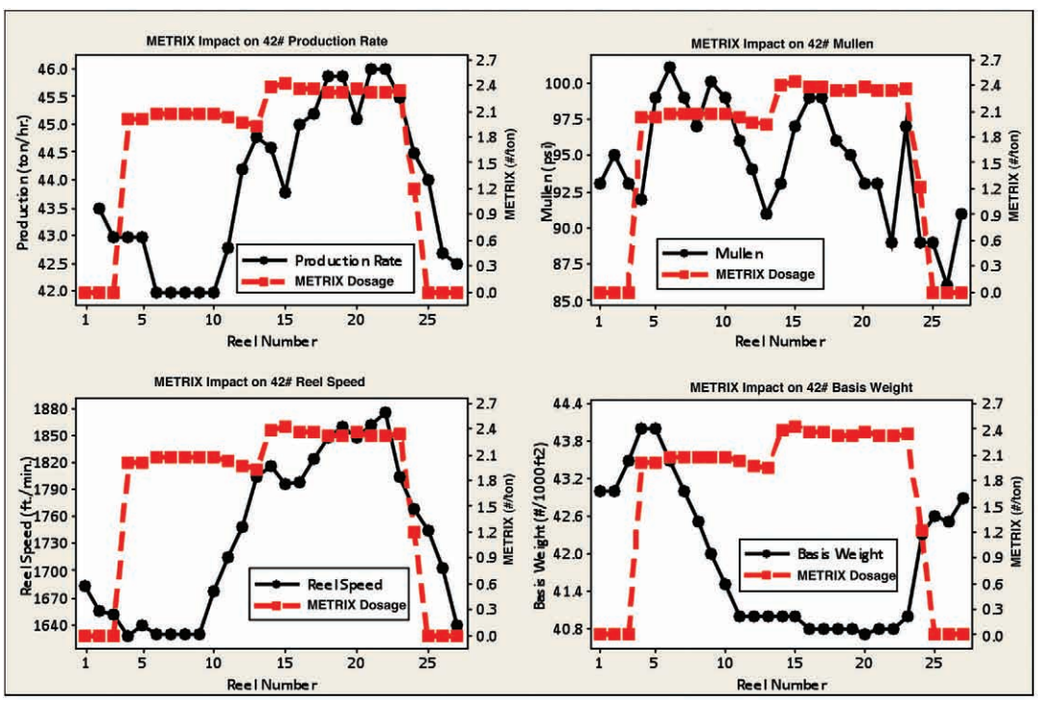

Figure 2. *METRIX technology results – 42# Linerboard*

Programme benefits include increased sheet strength and machine speed from enhanced dewatering during pressing and drying operations

CONCLUSION

METRIX technology is a synergistic, multicomponent programme developed to enhance productivity, press section dewatering and strength development for paperboard manufacturers. It encompasses the use of a reactive polymer and one of Nalco's advanced retention and drainage programmes. Programme benefits include increased sheet strength and machine speed from enhanced dewatering during pressing and drying operations.

The METRIX programme allows papermakers to substitute larger quantities of less expensive fibre, increase filler levels, and lower basis weights while maintaining target quality parameters. As a result, the manufacturer's profitability improves which makes them more competitive in an already very competitive paperboard and packaging market.

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2. Corrugated Today Magazine, July/ August 2011

Kelheim Fibres

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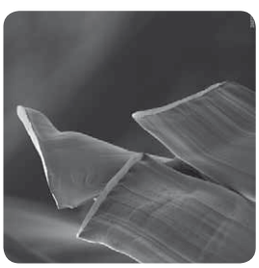
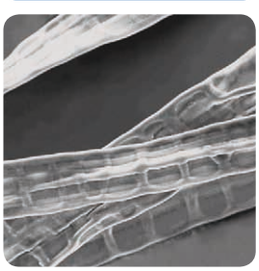


DISPERSION

FLUSHABILITY

BULK

SOFTNESS



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A new generation of cost-effective wet-end starches can achieve higher efficiency in your wet-end process

By **Dr. Andreas Becker,** Cargill Technology Manager Industrial
Andreas Voigt, Cargill Senior Specialist, Paper Applications & Solutions

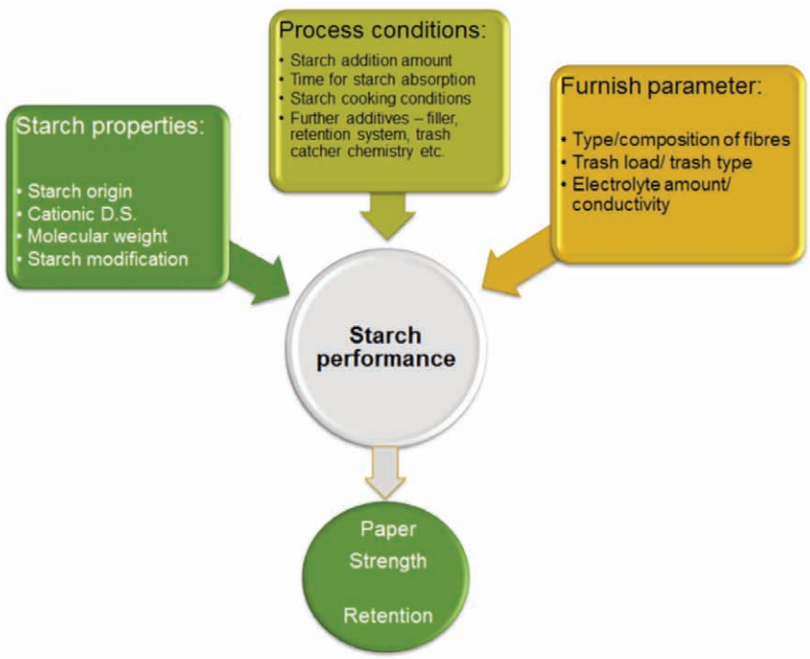
INTRODUCTION

In an increasingly competitive paper market, manufacturers are faced with challenging situations and need to constantly improve their products' performance in a cost effective way. With the foreseen reduction of the EU potato starch quota and its predictable effects on pricing, Cargill developed alternative solutions for the wet-end applications, with the objective to improve wet-end process while optimising costs, using an alternative raw material that would meet the characteristics of potato wet-end starch – and being readily available.

By combining solid technical knowledge and deep industry insights, Cargill has developed C★iBond®, a new wet-end solution which can improve wet-end performance while optimising costs. C★iBond® is a cereal-based product that offers long-term raw material availability, cost competitiveness and ensures sustainable business growth.

STARCH IN THE WET-END PROCESS

In the wet-end process, cationic wet-end starches are primarily added as a dry strength additive. They heavily influence dewatering as well as retention and formation in the wet section of the paper machine. That means that the type, amount and addition point of a wet-end starch is important to establish the best possible synergies with synthetic retention, dewatering and sizing chemicals. Of course other process conditions as well as furnish parameters are playing a major role in starch performance and its contribution to paper strength and/or retention development.



	Potato	Corn	Wheat
Amylose (%)	20	28	28
Amylopectin (%)	80	71	71
Diameter of the granules (mm)	5-100	3-25	2-35
Gelatinisation temperature (°C)	56-66	62-72	61-71

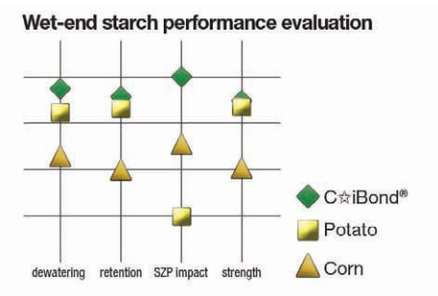
Table 1. *The effect of origin material on major starch properties*

When comparing potato and cereal starches, one obvious difference is the degree of pasting that is achieved upon cooking both starches at identical conditions

To achieve a desired wet-end performance with the given starch origin, it is necessary to adjust the starch modification, cationic degree of substitution and molecular weight in a very distinctive manner. Starch consists of two components: amylose and amylopectin. The latter of these is branched and the molecular weight is much higher than that of the amylose. When comparing potato and cereal starches, one obvious difference is the degree of pasting that is achieved upon cooking both starches at identical conditions. Different cooking requirements are needed for cereal based wet-end starches, which have to be considered when changing from potato based ones. Cargill's skilled specialists support customers at every step of the transition by starting with onsite cooking conditions evaluation, and then proposing and implementing technical solutions for adaptation.

To propose a cost-effective and readily available solution, Cargill's specialists have developed C★iBond® wet-end starch that achieves at least a similar performance than any other raw materials, if not better. Compared with a potato starch with the same cationic degree of substitution, C★iBond®'s

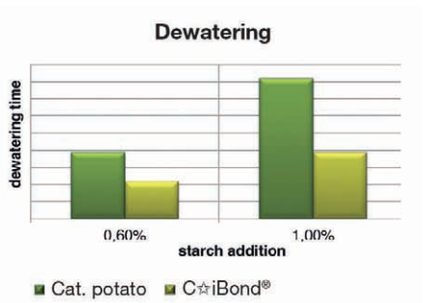
customers have identified a lower starch consumption, better ash retention as well as first pass retention combined with similar paper strength.



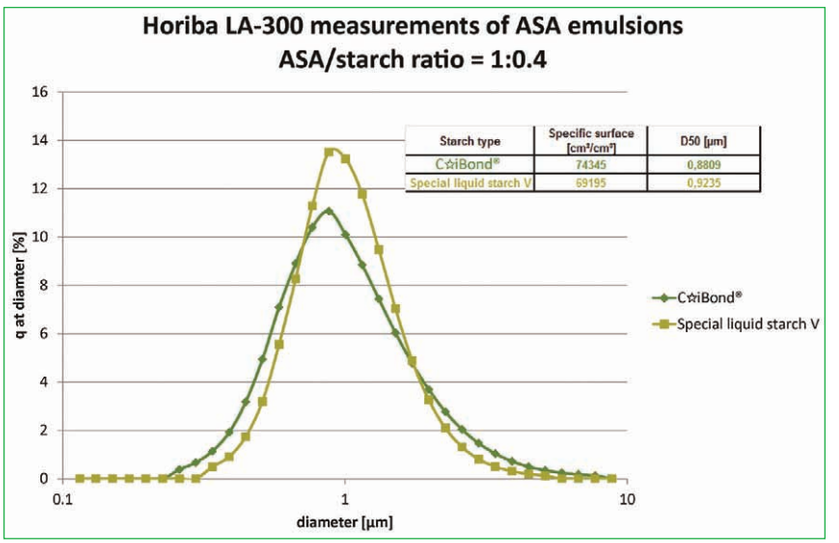
(the higher the better)

INCREASING THE DEWATERING TIME

Increasing the dewatering time at higher addition rates is a common effect of starches in the paper making process. But an increased starch dosage might be necessary to compensate strength while optimisation of furnish compositions or filler increase. C☆iBond® wet-end starch has significant benefits with regard to dewatering behaviour. The dewatering time of C☆iBond® wet-end starch at 1% addition is close to a cationic potato starch at 0.6% addition.



Since most of the paper mills which successfully utilise ASA are using cationic starch as emulsifying agent, the manufacturers of ASA are giving explicit advice on cationic starch suitability. Thus, C☆iBond® wet-end starch was tested and approved for ASA emulsification by the main suppliers in the market.



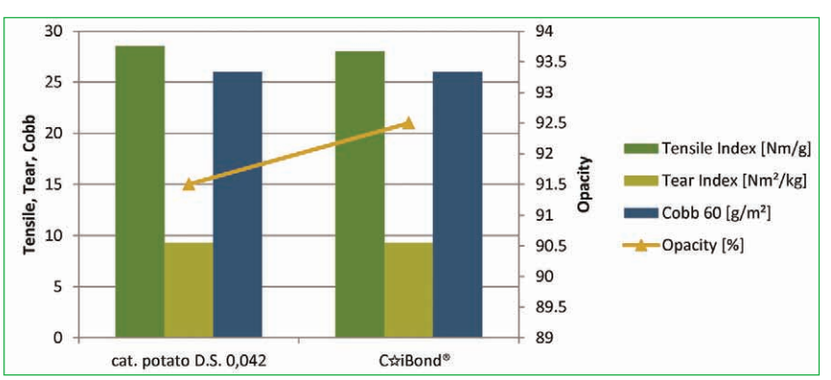
CASE STUDIES

Typically, potato based cationic wet-end starches are used in heavy duty applications, meaning highly filled or hard sized papers or papers being produced on high speed machines (e.g. LWC, SC, newsprint), because, in most cases so far, they outperform traditional cationic cereal starches of the same cationicity.

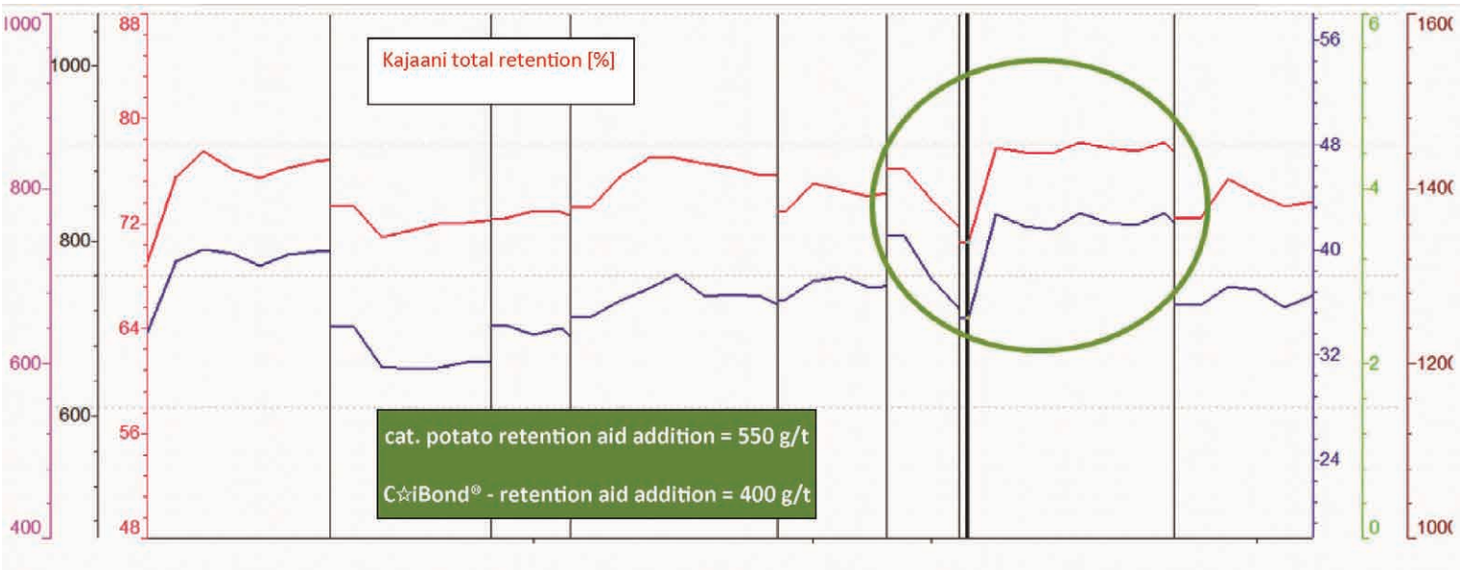
WOODFREE PAPER

In woodfree uncoated papers, machine trial results showed similar strength characteristics and constant sizing efficiency.

Wet-end starch addition was 5kg/t and the ASA amount maintained at a dosage level of 1.4-1.5kg/t. Additionally it was observed that both total and filler retention were improved and thus it was possible to decrease the amount of retention aid from 550 to 400g/t. After a trial period of 6 weeks the machine was switched from cationic potato (D.S. 0.042) to C☆iBond® wet-end starch.



In woodfree uncoated papers, machine trial results showed similar strength characteristics and constant sizing efficiency



WOOD CONTAINING PAPER

A LWC producer with an online metered size press coating unit compared the performance of a potato based cationic wet-end starch and challenged it against C★iBond® wet-end starch.

Lower starch consumption, better ash retention as well as first pass retention combined with similar paper strength were identified for C★iBond® wet-end starch compared to a potato starch with the same cationic degree of substitution.

Starch type	C☆iBond®	Potato competitor
Ash retention	50%	40%
First pass retention	66%	62%
Breaking length MD	4,65 km	4,75 km
Breaking length CD	2,1 km	2,15 km
Starch dosage	0,70%	0,83%

PACKAGING PAPER

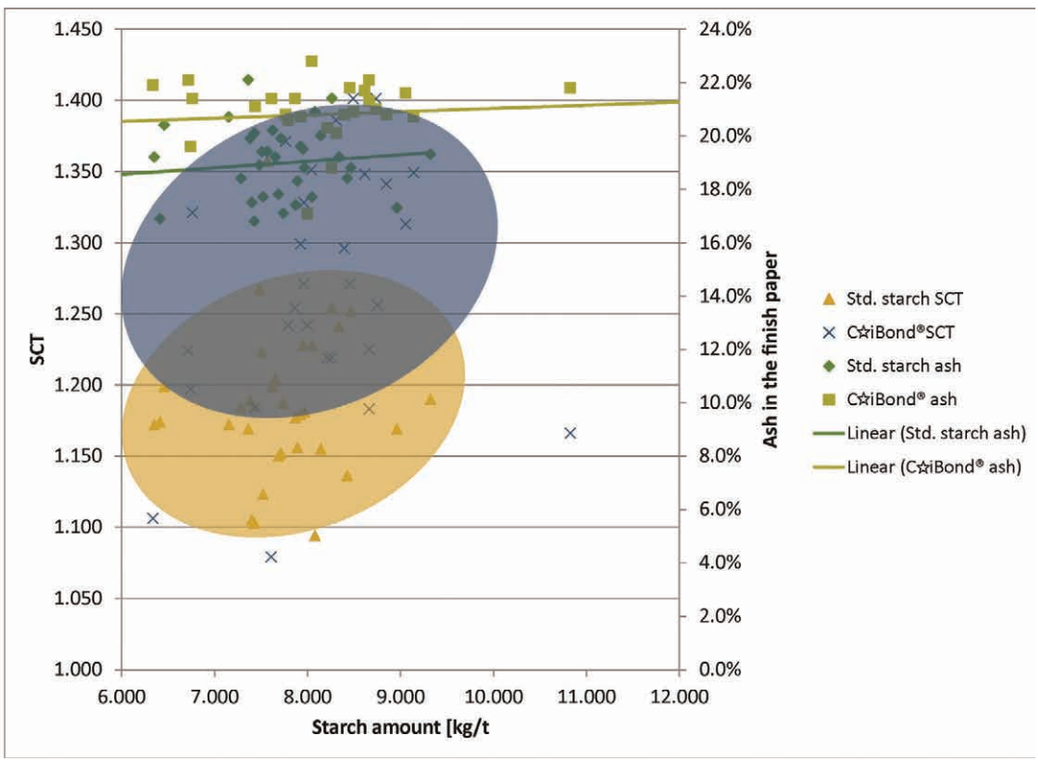
Not only printing and writing papers need the addition of a wet-end starch to fulfil strength requirements, but the packaging segment can also benefit when suffering from recycled fibre qualities that are becoming weaker. Thus the strength loss has to be compensated via higher surface sizing starch add-on. But starch coat weight is limited because of paper moisture and wet-strength limitations. For paper machines with no surface sizing treatment, quite often spray starch and/or a high cationic (D.S. ca. 0.06) wet-end starch potato or cereal based are utilised.

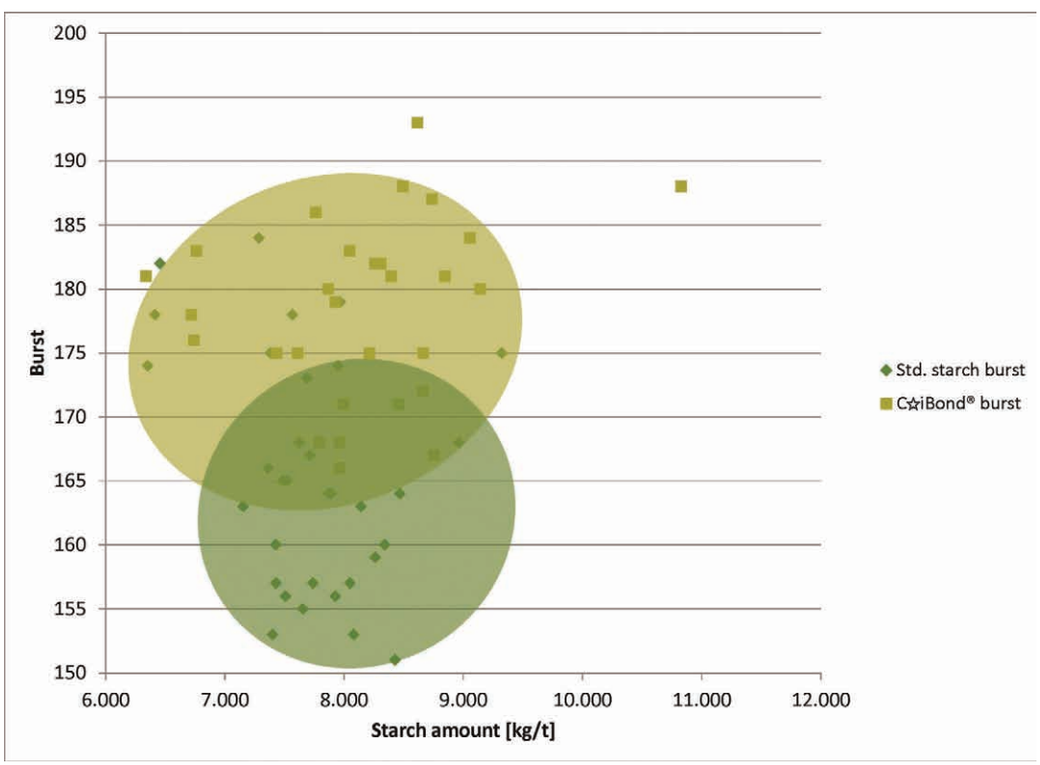
For paper machines with no surface sizing treatment, quite often spray starch and/or a high cationic wet-end starch potato or cereal based are utilised.

To overcome the problematic with high salt contents/high conductivities in the water circuit of recycled paper machines and achieve suitable retention and strength, wet-end starches with a higher cationic D. of S. of ca. 0.06 are found more often. Like in the next example in which C★iBond® wet-end starch was compared with a corn based starch with a cationic D.S. of 0.07. Conductivity was at ca. 4000µS/cm and starch addition at 6.5 – 9kg/t. Paper machine runnability was maintained and, at a similar retention of aid addition, starch as well as total retention was kept constant. Compared with the high cationic corn starch, 10-14% higher burst and SCT figures were generated by C★iBond® wet-end starch, despite a 2% higher ash level measurement in the finish paper.

SUSTAINABILITY

C★iBond® is a cereal-based product that can offer long-term raw material availability, cost competitiveness and help to ensure sustainable business growth.





The new cereal based wet-end starches performed at least as good as their potato counterparts in a variety of retention systems.

CONCLUSION

The new cereal based wet-end starches performed at least as good as their potato counterparts in a variety of retention systems. In most cases the formation is improved when using the cereal based products, resulting in improved strength. Furthermore, the zeta-potential of the pulp is much less affected, even if the nominal degree of substitution of the wheat based product is higher than that of the potato based product. This may be explained by less occupation of space on the fibres but by more stretch into the water phase. Logically, this allows more bridging between particles and also explains the improved retentions. As a consequence, more starch can be added before the pulp is charge neutralised, or, that there is more room for other cationic additives.

C☆iBond® wet-end starch, when compared to a potato starch with the same cationic degree of substitution, has been tested positively in various wet-end applications.

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Improving online monitoring and alert systems

By **Magesh Muthumani and Darren Robinson**, Buckman

INTRODUCTION

Modern pulp and paper manufacturers require online monitoring and alert systems to support their operations. Automation allows for the quick and reliable control of processes and chemical dosing. Having a web-based customer portal and data dashboard interface not only gives customers access to vital information regarding operations, it also enables chemical-supplier field-based personnel to identify operational gaps and provide potential solutions. Buckman has introduced its OnSite unit in more than one hundred customer sites. This interface along with EZe Monitor® was created to meet specific customer needs for up-to-date operational insight. The level of control and automation provided is site specific, dependent upon the process conditions of the customer, and system variability. The following article outlines the features and benefits of the OnSite technology and how it, when integrated with Buckman's EZe Monitor, can deliver value for the customer.

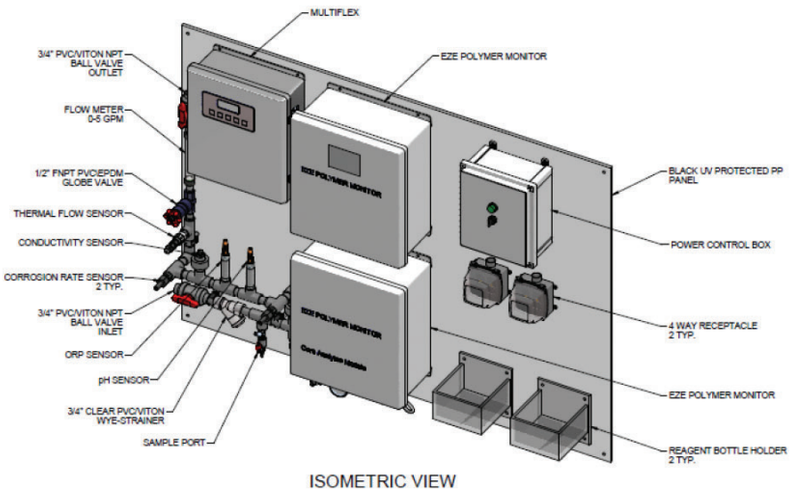


Figure 1. *Isometric view of EZe Monitor® and its components*

Compared to conventional corrosion monitoring techniques, EZe Monitor's advanced design uses electrochemical technique, such as linear polarisation resistance (or LPR).

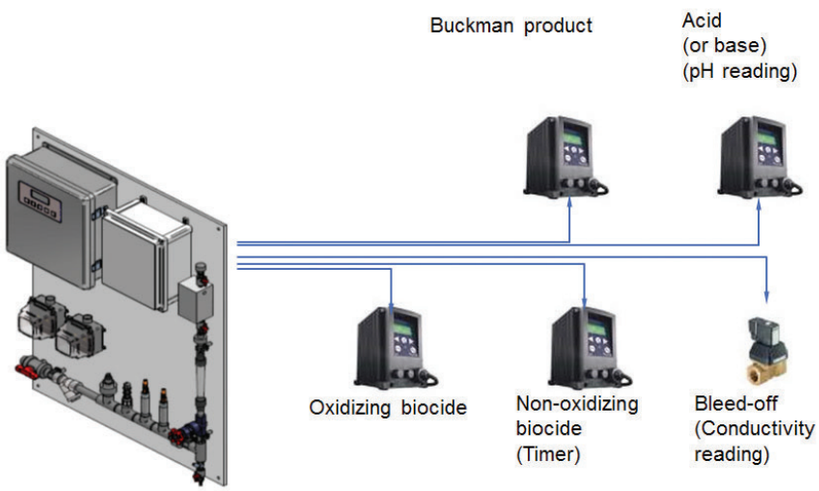


Figure 2. *Control relay outputs in EZe Monitor*

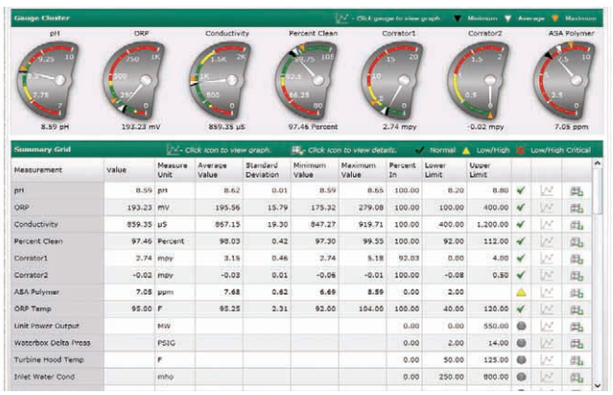
EZe Monitor – Overview:
Manual and frequent operator testing was the best way to monitor and maintain process water quality and control in the past. Buckman introduced EZe Monitor to automate process monitoring to keep it in optimal condition at all times. EZe Monitor is offered in a variety of configurations and customised to track multiple chemical treatment levels, to help maintain complete control over the process. Customers have been using EZe Monitor to control basic water quality parameters, such as pH, ORP and conductivity, in addition to adjusting levels of treatment chemicals remotely. Accessible via Web or LAN, EZe Monitor allows remote access to historic microbiological, scale and corrosion control data.

The level of control and automation provided is site specific, dependent upon the process conditions of the customer, and system variability

BUCKMAN ONSITE® – AN OVERVIEW

A breakthrough in customer reporting, Buckman OnSite's web-based customer portal and data dashboard interface give customers and their service reps access to vital information. It provides daily summary reports, exception reports, document management, data comparison and monitoring of key parameters.

Customers have been using EZe Monitor to control basic water quality parameters, such as pH, ORP and conductivity, in addition to adjusting levels of treatment chemicals remotely



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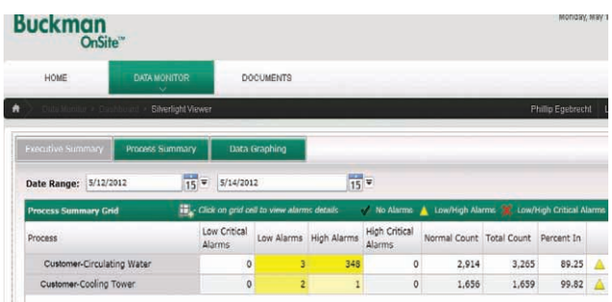

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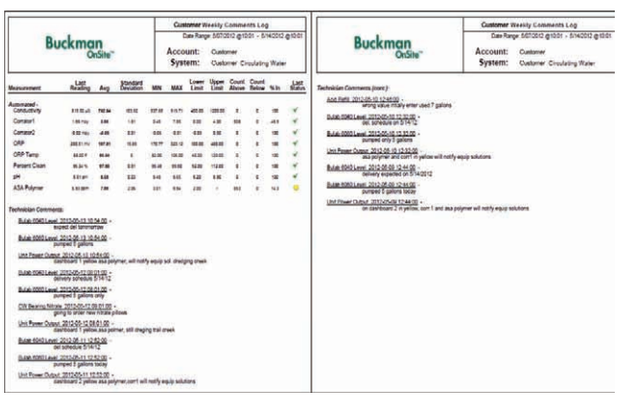

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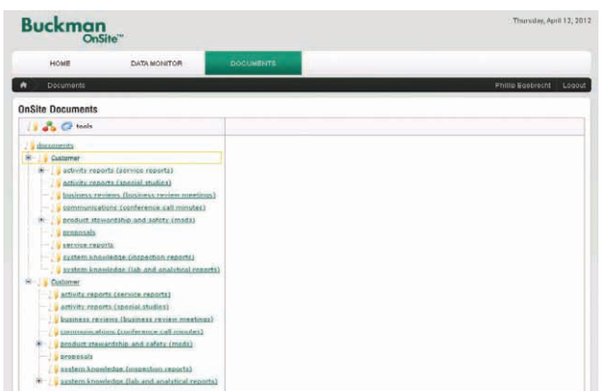

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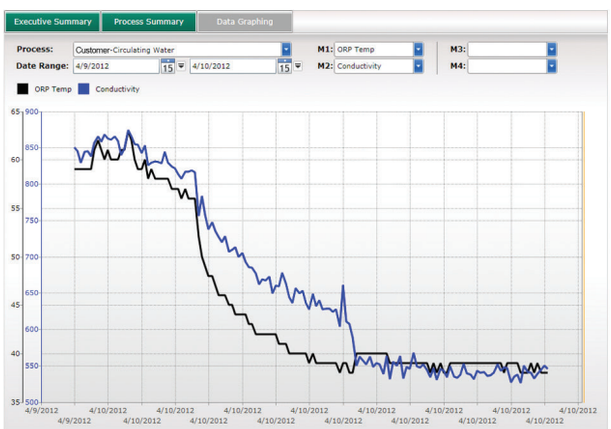

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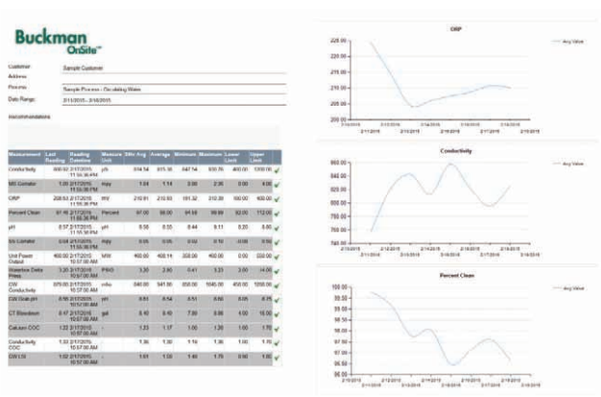

(3f).

Image 3a & 3b. *Dashboard and Executive Summary,* **3c:** *Reports,* **3d:** *Data management* **3e:** *Graphing and data comparison,* **3f:** *Service reports.*

INTEGRATING EZE MONITOR® AND BUCKMAN ONSITE®

EZe Monitor can be equipped with several different types of online process controllers (data collection devices). The devices are typically connected via cellular modem, or in some cases may be connected to the customer's network. It couples a powerful multi-I/O platform with analytical sensors and extensive communications technologies. These flexible configuration options make setup and configuration easy and fast.

Automation System Layout

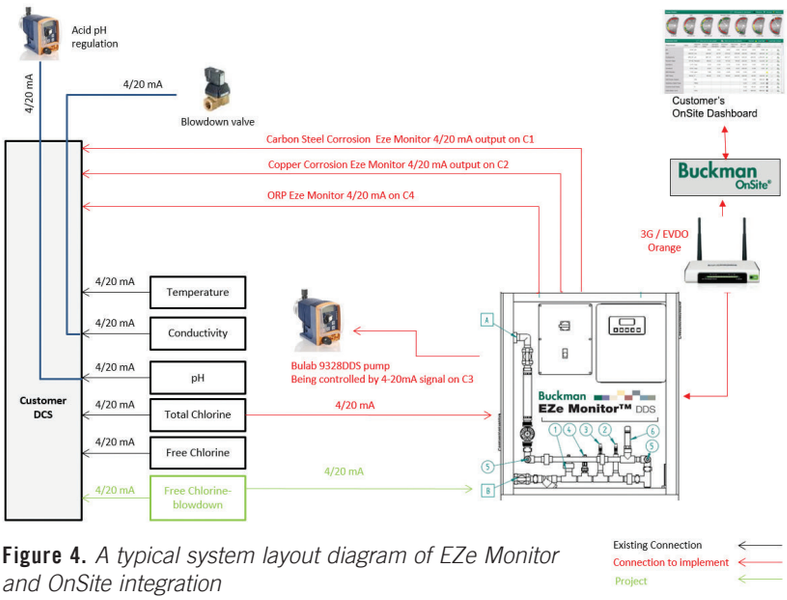

Figure 4. *A typical system layout diagram of EZe Monitor and OnSite integration*

Controllers and their configurations:

- The ModemMille will provide an Internet routable static IP Address.
- The Buckman OnSite utility server at Buckman headquarters in Memphis will use this IP address to interrogate the Aquatrac controller and retrieve the appropriate data using the telnet protocol on port 23.
- Once the data is retrieved, it is formatted and stored in the OnSite database for use by the dashboard interface.
- Each Aquatrac controller will need a ModemMille device to provide Internet connectivity.

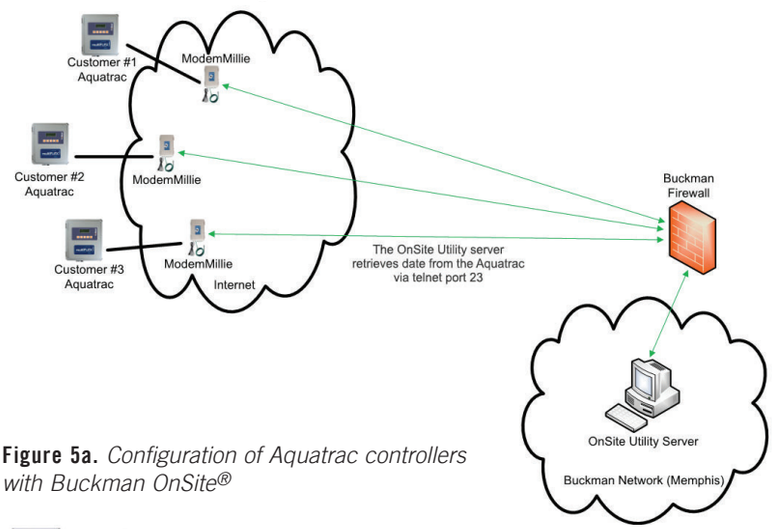

Figure 5a. *Configuration of Aquatrac controllers with Buckman OnSite®*

- The ModemMille or other cellular device will provide an Internet routable static IP Address.
- The Walchem controllers are configured to send an email with a .csv attachment every hour to the OnSite SMTP server.
- The OnSite utility server will retrieve the attachment, format it and store the data in the OnSite database for use by the dashboard interface.
- Because the Walchem initiates the data transfer, it can either use a cellular connection or be connected to the customer's network.

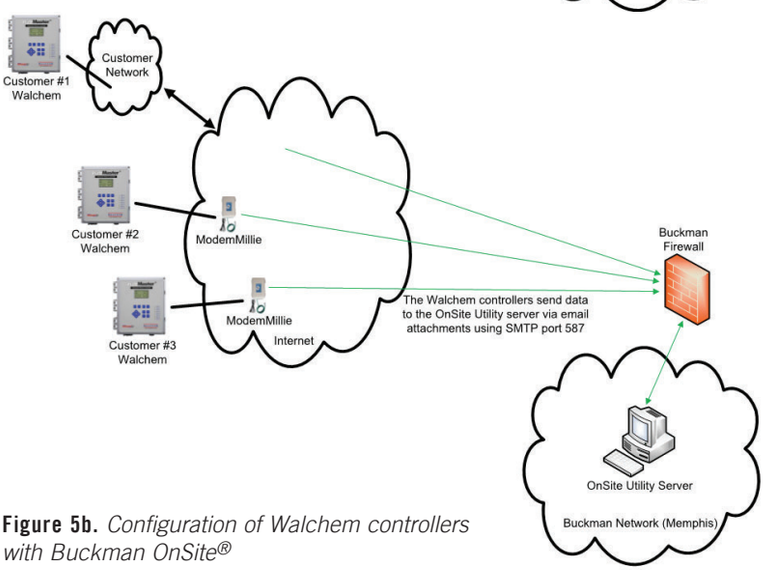

Figure 5b. *Configuration of Walchem controllers with Buckman OnSite®*

Flexible configuration options make setup and configuration easy and fast

CASE STUDY

Customer: An international tissue manufacturer

Application: DAF turbidity level monitor and control in the mill

Situation: Buckman was asked to design a chemical feed system to maintain the lower turbidity level in the mill DAF system, so that DAF process water can be reused in other parts of the mill.

Value Delivered: Buckman implemented a new DAF control and monitoring system by integrating Buckman EZe Monitor® DAF controller with Buckman OnSite®. This allows the Buckman account manager and customer to remotely monitor and control the process and provide access to real-time and historical process data, auto reporting, etc.

CONCLUSION

As industrial markets focus more on safety, automation, and/or improving operational efficiencies, the demand for more intensive monitoring, measurement and process control has naturally followed. Integrating EZe Monitor with Buckman OnSite meets specific customer needs for up-to-date operational insight by transforming data into useful information.

Incorporating these two monitoring systems can help mills reduce energy and water consumption, predict equipment failure, enhance plant reliability and achieve their sustainability goals.

Acknowledgements

Many thanks to the following Buckman associates: Andre Colangelo, Global Market Development Manager – DWT; Gary Jones, Lead Software Developer; Todd Teems, Computer Systems Engineer; and Bill Soutar, Technical Specialist – Automation, Water Technologies.

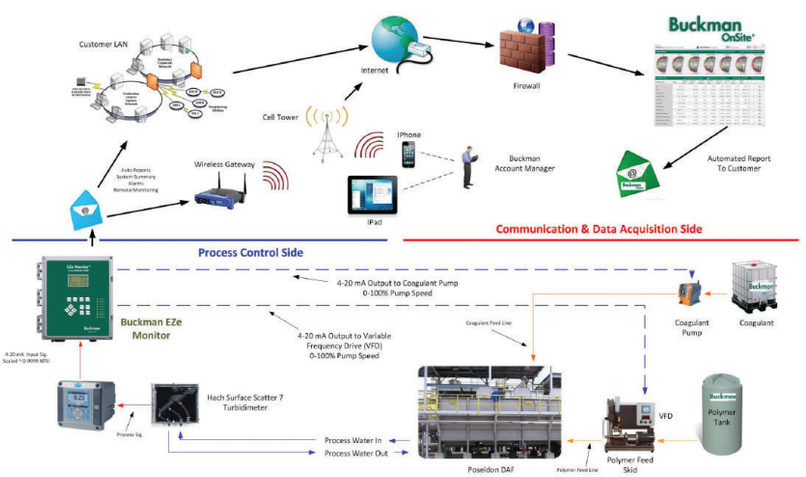

Figure 6. *Other references are available for installations of this system around the globe*

Incorporating these two monitoring systems can help mills reduce energy and water consumption, predict equipment failure, enhance plant reliability and achieve their sustainability goals

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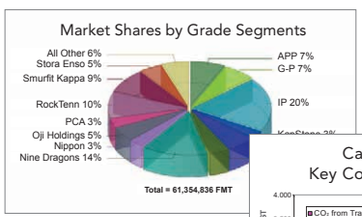
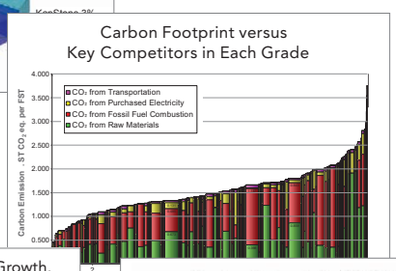
ANALYSIS AND PLANNING

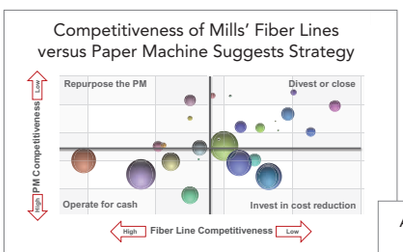
How big is the market and how is it growing?
How is capacity changing?
How competitive are we?
Is there profitability in exporting?
How do financial performances compare?
Which regions have the most potential?

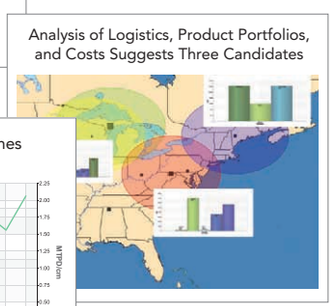
OPERATIONS AND PRODUCT DEVELOPMENT

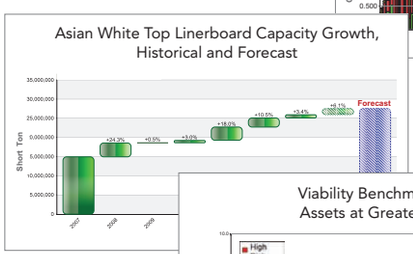
How does asset efficiency compare?
Where are cost improvement opportunities?
What else can the machine make?
How do environmental performances compare?
What new products does the market need most?
How competitive can we be in each new product?

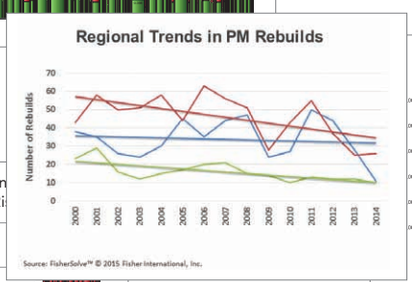


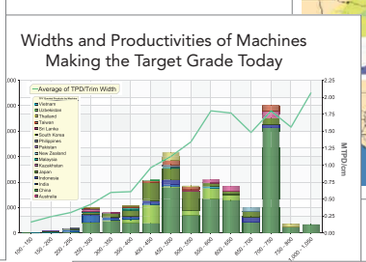


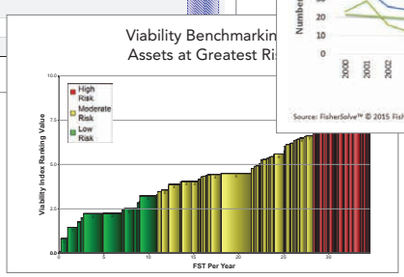


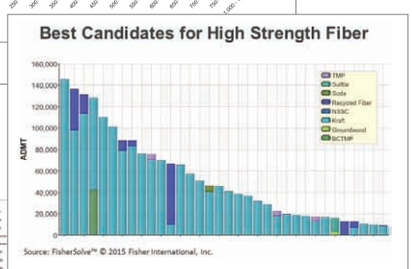


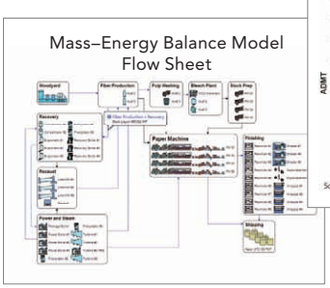












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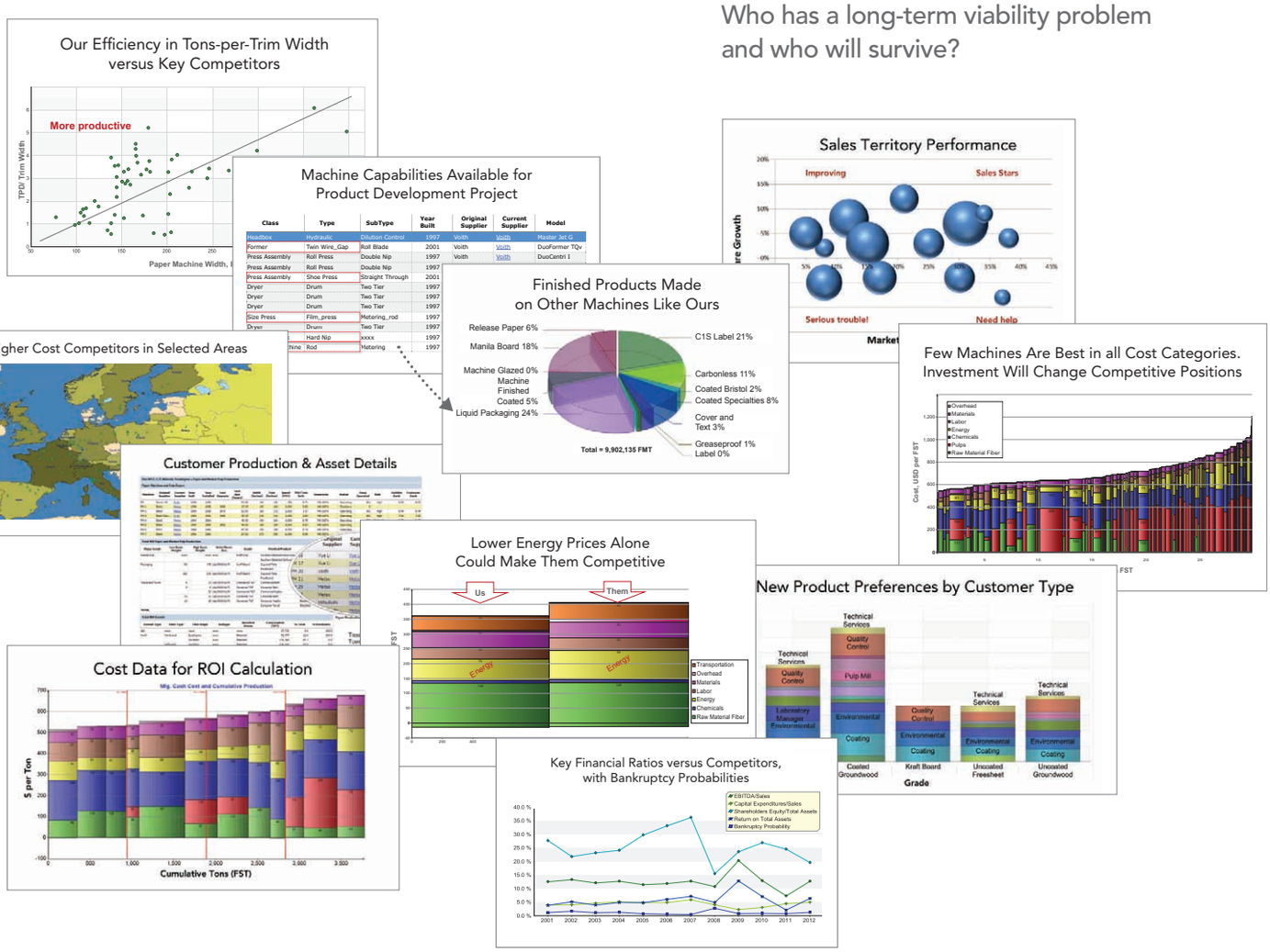
SALES AND MARKETING

Where are the best margins to be found?
How cost-competitive is each asset?
How attractive is the market for a new product?
What's in the pipeline and where's the best ROI?
Is sales well prepared?
Who's a star and who's not?

INVESTMENT, M&A, AND ASSET DISPOSAL

What should be sold, repurposed, or closed?
Which competitors should be targeted?
Whose products and locations fit best?
Where should capital be spent and why?
Who has a long-term viability problem and who will survive?



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Energy saving & sheet formation improvement using microwave meters

By **Luca Canali,** Development Leader, Cristini Diagnostic Systems, Italy
Giovanni Cristini, Vice President Technology, Cristini S.p.A. Italy

Today's paper machines require an impressive amount of data collecting and huge papermaking expertise to run at their peak efficiency. Recent instrumentation technology from Cristini Diagnostic Systems allows real time data output for consistency and drainage in the most critical parts of the forming section, even where access is limited for safety reasons. The direct measurement of water on the wire provides visibility into both drainage rates and the effects of stock preparation (raw material quality, chemicals/additives) as well as former set-up.

This information can help improve product quality, forming fabric performance and process efficiency while reducing the energy consumption of the forming, pressing and drying operations. Changes on the table are measured in real time and these measurements can then be used in a variety of methodologies.
The logic of the Cristini planar microwave sensor technology is typically oriented to provide an easy integration into other elaborate systems (DCS, MCS, QCS), found in the control loop of the papermaking process.

APPLICATION BASED ON THE MICROWAVE TECHNOLOGY

The story began over 25 years ago, and lead to the actual substitution of the radioactive sources (or radio frequency sensors). This new and innovative application based on microwave technology has changed the principles of the consistency measurements and is setting a new standard.

After the important success of the world's first portable microwave consistency metre, Cristini Diagnostic Systems has developed FiberscanFIX™ (Fig.1): fixed point and/or traversing measurement sensors that allow direct connections to the machine's own DCS/MCS systems for data analysis. Fast Fourier Transform (FFT) capabilities are included with this line of sensors, providing near instantaneous read-out of pulsation or vibration issues. The 24/7, unmanned data collection in the forming section has led to impressive results of process control and paper quality improvement.

Figure 1. *FiberScanFIX™ microwave sensor*

This new and innovative application based on microwave technology has changed the principles of the consistency measurements and is setting a new standard

Several studies… revealed the opportunity to reduce the electricity consumption, without compromising (and often actually improving) the machine efficiency

IMPROVING PRODUCT QUALITY

Advancements in instrumentation have opened new avenues for effective use of vacuum table elements to control sheet consistency; this has led to a variety of papermaking applications including dandy rolls for improved formation, multiple formers for optimum formation, coverage and ply bond as well as numerous chemical dosage applications.

Several studies, performed on different former configurations, including traditional Fourdriniers, revealed the opportunity to reduce the electricity consumption, without compromising (and often actually improving) the machine efficiency.

Fig.2 provides a good example of what can happen, when too high vacuum is applied to a gap former producing white top liner. The consistency levels in the two critical points (before the ply-bonding and the couch roll) remain almost unchanged, although there is a decrease of low vacuum zone about 50%.

In addition, a better distribution of the dewatering between the low and medium vacuum zones leads to a better paper quality with greater strength properties.

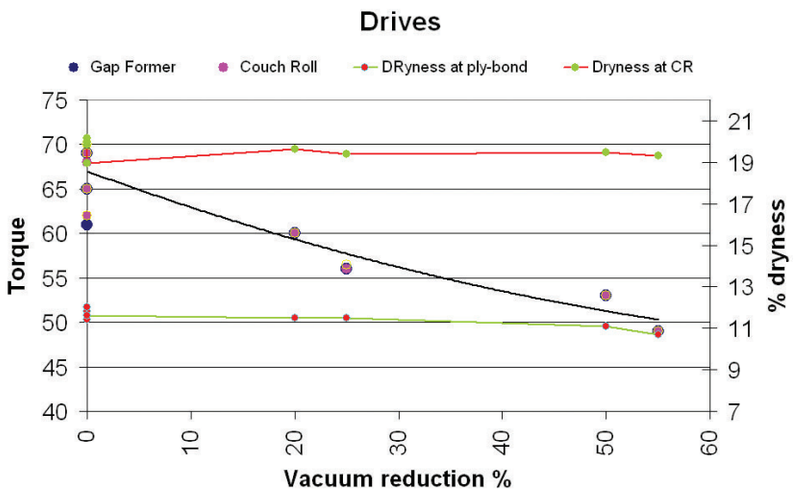

Figure 2. *Drive load saving*

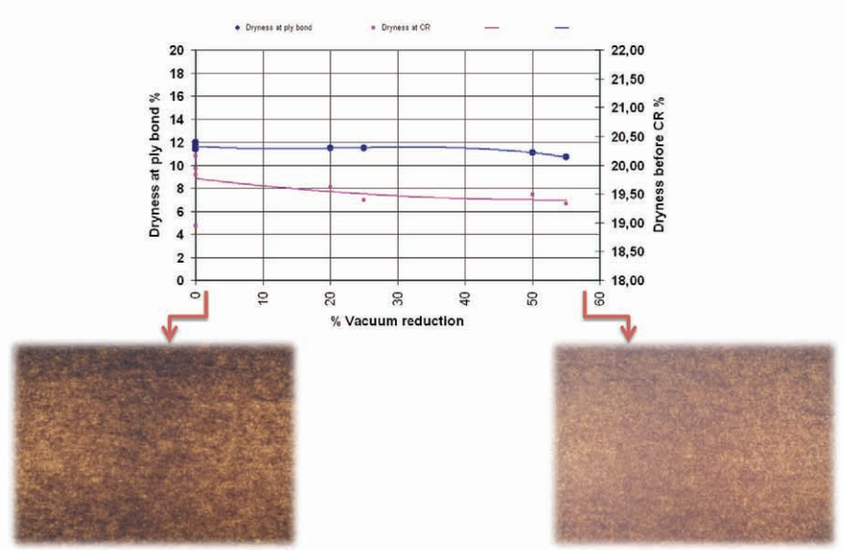

Figure 3. *Consistency measurement @ ply bond*

OPTIMISATION OF THE ENERGY CONSUMPTION

The optimisation of the energy consumption in the paper machine consists of expending the necessary energy only where it is required, and thus avoiding wasted energy that might lead to excessive wear of the machine elements (forming fabrics, ceramics, motors and pumps).

SHEET FORMATION VS. CONSISTENCY AT PLY BOND

The formation of each single ply has a direct impact on the formation of the entire board. Dewatering can be optimised in order to achieve the best sheet properties.

Water distribution is a key factor in water removal and energy consumption.

On-line monitoring of the ply consistency allows dewatering optimisation and to obtain specific settings by paper grade.

An example of this is the evident improvement of sheet formation with 50% vacuum reduction on the gap former (Fig.3).

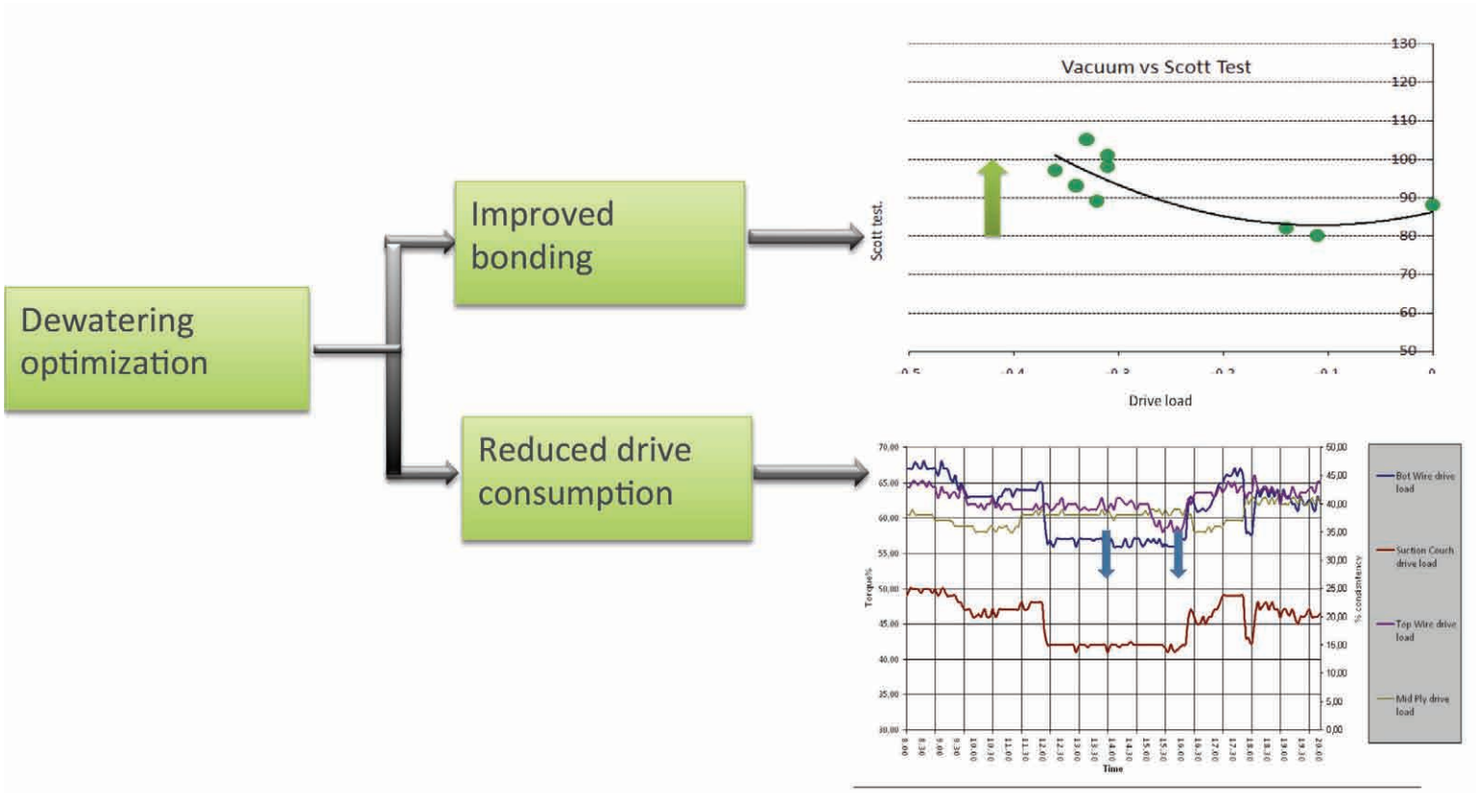

Figure 4. *Quality enhancement and energy saving*

Dewatering distribution on each single ply ensures better quality and more accurate (and therefore lower) energy consumption. Ideal conditions at the bonding stage leads to better fibre cohesion and distribution.

The use of excessive vacuum at low consistency range (from 1,5% to 5%) is very common; in many cases, this leads to "sheet sealing". A fast dewatering in the low vacuum area results in poor dewatering efficiency in many cases at the suction boxes.

PLY BONDING ENHANCEMENT ON A TEST LINER MACHINE

The test focused upon the dewatering of all ply. The reference sensor was located just before the bonding on each ply and before the suction roll.

The vacuum reduction was gradually reduced in all ply except at low vacuum of filler ply. One of the targets during the vacuum reductions was to keep the consistency before couch roll stable; in addition, stable steam consumption provided further evidence in support of this as a success.

REDUCED CONSISTENCY AT BONDING ON FILLER AND BOTTOM PLY

Thanks to the consistency sensor on the filler ply, operators can set the proper vacuum on the top former, in order to achieve the best board quality (Fig.4).

The sensor installed at couch roll controlled the global dewatering performance of the forming section.

CONCLUSION

When placed in strategic positions, the FiberScanFix™ sensors allow the dewatering to be distributed in a better way, and to define the best operative points for each vacuum element. In several case studies, the potential energy saving obtained through vacuum reduction has been around 500 KWh, which equates to approximately 4,000,000 KWh per year.

Given the average electricity price in Europe, this represents a saving of well over 380.000 €. The ROI for the complete sensor system payback was, in each case study, only few months.

The impressive results are even more important when considering the reduction of Green House Gases (GHG). 4,000,000 KWh/y equates to a reduction of 1.716 GHG t/year. Or, to put this another way, this is the equivalent GHG emission produced by 233 people in one year! Proven and repeated tests performed across Europe, Australia & North America have shown that very significant results in paper quality and energy consumption can be obtained in the vast majority of the cases.

In a paper world constantly evolving at a fast rate, this technology is a new starting point for better papermaking whilst enjoying lower production costs.

In several case studies, the potential energy saving obtained through vacuum reduction has been around 500 KWh, which equates to approximately 4,000,000 KWh per year

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A safe, lightning-fast, non-woven press fabric installation?

By **Kenneth Krook,** Vice President Global Product & Technology Pressing, Albany International GmbH

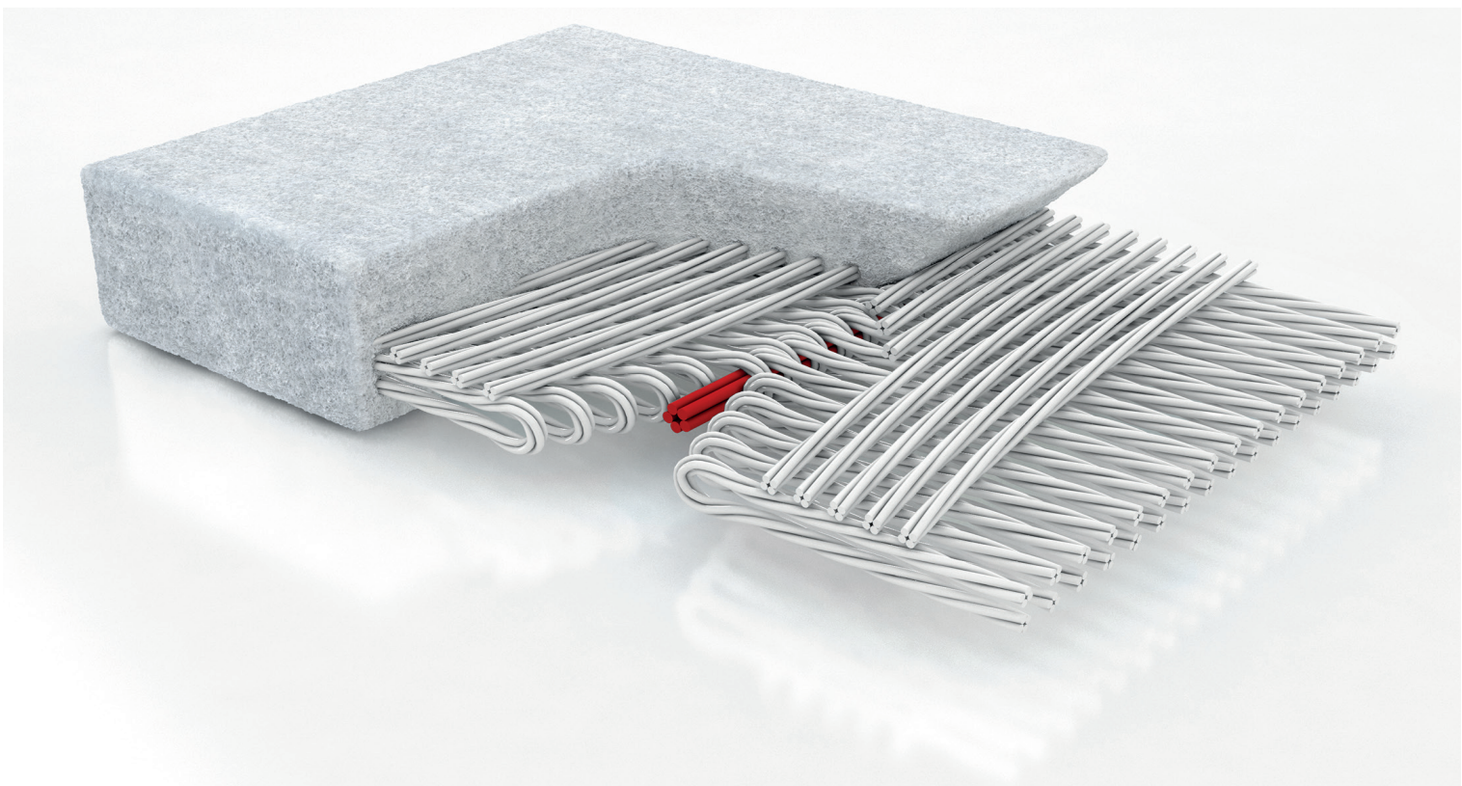

Figure 1. *SeamHydroCross: The first non-woven press fabric with a seam*

Albany International Corp., a pioneer in paper machine clothing (PMC), has developed a breakthrough line of seamed press fabrics. These fabrics combine the high dewatering, efficiency increasing characteristics of a non-woven with the safety and ease of installation provided by on-machine-seamability. The successful use of a seam on a non-woven fabric is an industry first.

CASE STUDY

In a joint project to improve paper machine efficiency, Albany International worked hand-in-hand with a leading newsprint and magazine paper manufacturer that had nine production facilities globally. Albany International had been partnering closely with this customer for over 20 years in forming, pressing, and drying fabrics, and has been one of the main paper machine clothing (PMC) suppliers for over five years. One of the primary project goals was to make the paper machines more productive through the use of next-generation PMC. The project led to the development of a specifically tailored press fabric: SeamHydroCross.

One of the primary project goals was to make the paper machines more productive through the use of next generation PMC

PROJECT GOALS

Primary goals targeted were: Improvements in productivity and efficiency through increased paper machine speeds with a simultaneous reduction in energy consumption Reducing the periodic downtime for fabric changes and maintenance as well as the time required to restart the paper machine (start-up- / “break in”-phase)

These goals were to be met without sacrificing either safety or quality. Focus was placed upon the press section as it was thought that the largest possibilities for improvement

Figure 2. *Albany International: Making Child's Play of Press Fabric Installation*

were to be found here. Despite promising early results, several key challenges had to be overcome before all goals were met and the project could be successfully completed.

COORDINATED REPLACEMENT OF THE BOTTOM- AND PICK-UP-FABRICS

The pickup fabric has a far shorter serviceable life than the bottom fabric. The paper machine operator was faced with the dilemma of either replacing the bottom fabric together with the pickup, despite the fact that it did not yet need to be replaced or risk having to shut down the machine for bottom fabric replacement before the new pickup needed replacement. For this reason, the initial focus was directed at achieving a bottom fabric life of 200% of that of the pickup fabric life. This would allow the replacement of the bottom fabric at every second replacement of the pickup fabric.

The challenge in this was maximising the life of both press fabrics without compromising paper quality or causing other issues. Initially a replacement interval of six weeks for the pickup and twelve weeks for the bottom was chosen. While both fabrics performed well throughout their life cycles, start-up with a new pickup fabric and used bottom fabric proved problematic. By incorporating a start-up aid in the pickup fabric, this issue was effectively eliminated.

This achievement was the first major project milestone. The bottom fabric could now be run for twelve weeks following the first replacement of the pickup felt after six weeks. Downtime for fabric replacement was minimised and safety was not compromised with either fabric, as both were on-machine-seamable SeamTech.

AN INDUSTRY-WIDE PREMIER: A SEAMABLE NON-WOVEN

Through its non-woven structure, Albany International's new HydroCross fabric provided improved sheet smoothness, while simultaneously using less vacuum energy, providing a fast start-up, and an excellent life. In addition, the improved dewatering provides improved sheet dryness.

Despite these advantages, there was one major drawback in the use of a non-woven in the press section: to date no PMC manufacturer had successfully incorporated a seam with a non-woven press fabric.

An on-machine-seamable fabric decreases down time and increases safety during fabric replacement. Developing a successful seam technology for non-woven press

The initial focus was… a bottom fabric life of 200% of that of the pickup fabric life. This would allow the replacement of the bottom fabric at every second replacement of the pickup fabric

GOALS	RESULTS
Shorter start-up phase (energy savings)	Reduced by 50% from 3-4 days to 12-32 hours ✓✓✓
Longer run-times pickup / bottom fabric = reduced time for maintenance	Replacement intervals pickup / 1st bottom-fabric (1. BF) increased from 6/6 weeks to 6/12 weeks
Safety	Reduced risks through seam technology
Quick seaming	~2,5 min/m
Perfect seam cover	✓
100% free of marking	100% free of marking for 90 days
High dimensionable stability	✓✓✓
Sustained seam strength	✓✓✓

fabrics became a top priority. During development, numerous issues had to be overcome: seamability (the time required to close the seam), seam cover durability, overall dimensional stability, seam strength, and minimising the potential for objectionable seam marking.

The product resulting from the intensive development efforts by Albany International is SeamHydroCross. All issues were overcome to allow the incorporation of non-woven fabric technology with a seam. This resulted in a substantial increase in dewatering, improved paper quality and machine efficiency.

SUCCESSFUL PROJECT COMPLETION

At the end of the project, the start-up phase was reduced by over 50% with target speeds being reached within twelve to thirty-two hours vs. to four days previously. The maintenance intervals were increased once again from six weeks pickup / twelve weeks bottom to seven weeks pickup / fourteen weeks bottom. All goals regarding machine efficiency, speed, and productivity were met. The customer's goals were all met and project targets had been achieved despite the considerable challenges presented. Albany International became the world's first PMC supplier to successfully implement a seamed, non-woven press fabric.

Despite the fact that the customer's paper machines are not of the latest generation, they operate at very high efficiency and remain profitable even in the economically challenging climate the paper industry faces today. The combined experience of Albany and its customer in the development, application, and fine-tuning of the PMC on the paper machines has led not only to a significant increase in productivity and efficiency, but also in the paper quality.

All issues were overcome to allow the incorporation of non-woven fabric technology with a seam. This resulted in a substantial increase in dewatering, improved paper quality and machine efficiency

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Savings potential in dryer section is more than just “hot air”

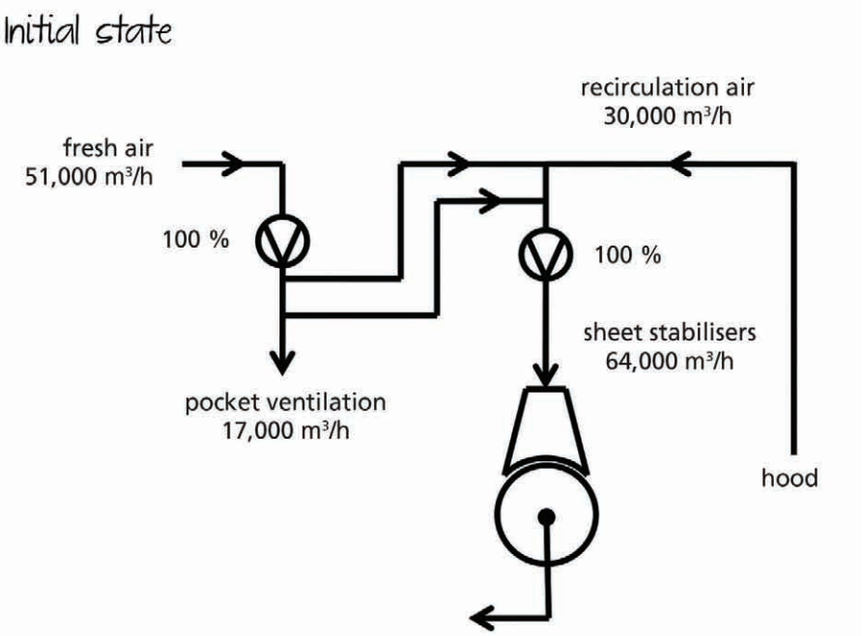
By **Thomas Fischer,** Heimbach GmbH & Co.KG

Even small improvements in the paper machine often bring significant savings A recent Heimbach TASK case demonstrated improvements in productivity, machine efficiency and resource conservation. In this particula case attention was paid to the hood ventilation in the dryer section – the section of the paper machine that is frequently but mistakenly neglected.

Approximately 65 % of the energy in the paper machine is consumed in the dryer Section – reason enough to take a closer look and uncover potential savings. In the case in question, the Heimbach TASK team was called by a customer who was experiencing problems with sheet edge lifting in the dryer section. “We conducted measurements throughout the entire dryer section and the hood ventilation and analysed the results, from which initial changes were derived and implemented. This brought the customer immediate energy savings” said Thomas Fischer, Head of TASK, describing the process.

JOINING FORCES TO REACH THE TARGET

The machine supplier was also brought on board to check the settings on the sheet stabilisers. “As usual, our experts worked in close cooperation with the supplier for the good of the customer by investigating possible causes” said Thomas Fischer. These investigations did not impair the normal operation of the paper machine producing newsprint at 1,600 m/min.



First measurement, initial state: Most of the incoming fresh air passes through sheet stabilisers and is not available for pocket ventilation.

Figure 1.

The following investigations were performed:

- Complete analysis of the drying section (Heimbach TASK)
- Measurement of the supply, circulation and exhaust air flows of the hood (Heimbach TASK)
- Creation of a hood balance (Heimbach TASK)
- Monitoring and reviewing of the sheet stabilisers (machine supplier)

The general situation in the dryer section, based on the water content of the pocket air, (see info box) was good, but the measurements showed the following shortcomings in detail:

- Suboptimal ventilation of the pockets, almost all of the fresh air supply is used to stabilise the sheet and is NOT available as pocket ventilation and the removal of air laden with water from the pockets was therefore too low. High humidity means low drying under these conditions.
- The channeling structure for different air flows is much too complicated with unnecessary branches and long air paths (resulting in loss of energy).
- The last door of the dryer section must be left open during production, otherwise droplets form in the hood. This generates an additional volume of exhaust air.

The temperature difference between the dry air and the dew point is a measure of the ability of the air in the pockets to absorb water

- The setting of many stabilisers in both slalom and conventional dryer groups was incorrect, which was the main cause of edge lifting.

SMALL MEASURES WITH A LARGE EFFECT

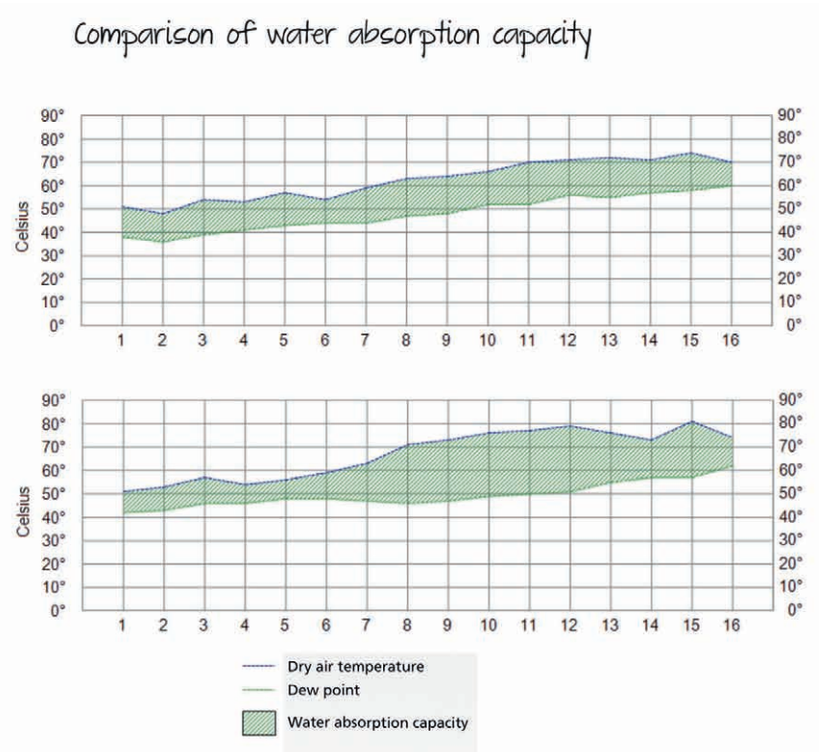
This initial state (Figure 1) led to the following preliminary steps:

- Optimisation of the sheet stabilisers for stabilisation rather than for ventilation eliminates sheet edge lifting.

- Upgrade of the sheet stabilisers leads to same vacuum with less air and consequently to reduced fan speed and direct energy saving!

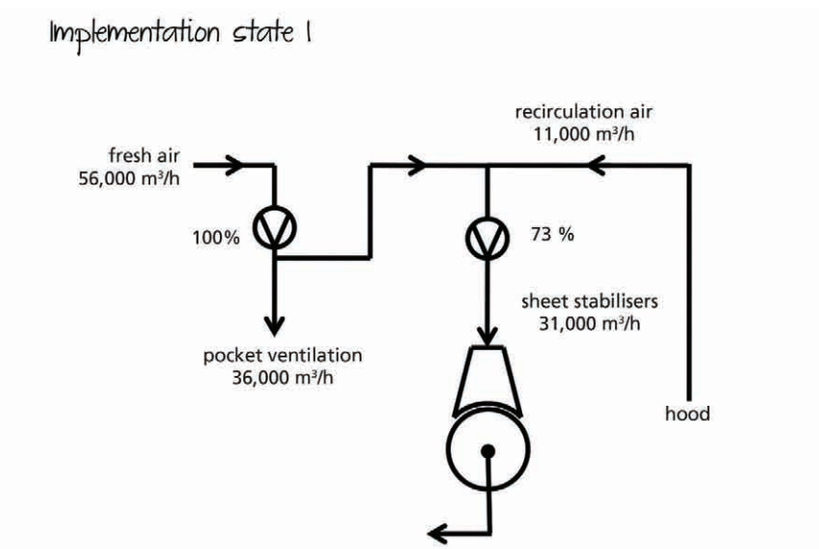
- Modification to the channel system by closing off two fresh air channels: In this way, stabilisers work with 100% recirculated air instead of a mixture of fresh and recirculated air (see implementation state 2). The fresh air saved is used for pocket ventilation which significantly increases the water absorption capacity (Figure 3 and 4).

These three measures, implemented during planned downtime, succeeded in reducing the air consumption of the stabilisers and increasing the air available for pocket ventilation. "The customer is saving around €50 000 per year by the reduction in the speed of the fan alone" said Thomas Fischer. "Greater sales profits through increased production speed are not included in this figure. The early involvement of TASK not only serves to prevent many disturbances in advance, rather the ideas that our experts bring can often lead to real cost savings".



The measurement comparison shows: in particular between the positions of the drying cylinders 7-14 the water absorption capacity is significantly increased by the improvements made by the TASK team and has almost doubled!

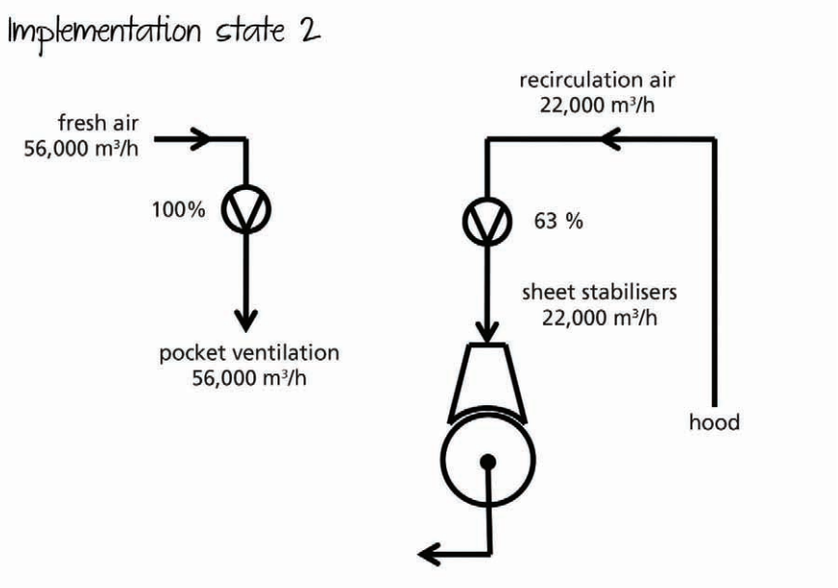
Figure 2.



Second measurement: After implementation of initial measures – stabiliser upgrade and removal of one channel – the volume of fresh air available for pocket ventilation has already doubled with the same total volume of fresh air.

Figure 3.

These three measures… succeeded in reducing the air consumption of the stabilisers and increasing the air available for pocket ventilation



Third measurement: There are now no open channels, the volume of fresh air fed to the pocket ventilation is optimally increased and water absorption capacity is doubled automatically bringing increased efficiency in the drying process.

Figure 4.

INFOBOX

POCKET VENTILATION CONDITIONS

The temperature difference between the dry air and the dew point is a measure of the ability of the air in the pockets to absorb water. The measurement of the pocket air condition is taken with the hood closed in order to exclude any influence from the indoor climatic conditions. The dew point is determined from the dry and moist air temperature.

The resulting measurements diagram (see Figure 2) shows the dry air temperature and the dew point; the difference between the dry air temperature and the dew point temperature is shown hatched within the diagrams. The greater this difference is, the higher the water absorption capacity of the air and, accordingly, the more favourable the conditions in the pocket.

Heimbach employees performing measurements on the dryer section

The temperature difference between the dry air and the dew point is a measure of the ability of the air in the pockets to absorb water

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Novel natural binder to improve quality and maximise latex replacement

By **Olli Siiskonen**, Market Unit Plant-Based Binding Solutions, Global Market Manager, Graphic Paper and Board, Roquette

The paper industry is changing: an era of fresh solutions from a new way of thinking is upon us! Binder development for paper & board coating is very good example of this change. Several producers are using over 50% natural binder in their formulations and environmental aims have led to targeting the 100% replacement of latex in the coating process. Natural binders can offer a lower carbon footprint, a greener image and better recyclability compared to latex. They can help to improve quality parameters as well as lower overall total costs. These incentives are enough to ensure that change does indeed occur. ROQUETTE has offered latex replacement over 10 years with STABILYS® binders. They are widely available for even the most demanding of sizing applications and latex replacement in coatings. The new generation has been developed together with substantial customer input – the end result of which is now available in the market: STABILYS® EVO New STABILYS® EVO can offer improved results for sizing, runnability in the coating process whilst maximising latex replacement in paper & board coating.

Natural binders can offer a lower carbon footprint, a greener image and better recyclability compared to latex

HOW TO IMPROVE FILM FORMING IN SURFACE SIZING

Film forming is an important characteristic in surface sizing. Film forming correlates with the dimensional stability, printability and process ability of paper and board. Improved film forming can enable the use of less starch in order to achieve at least similar quality parameters, or in some cases, actual improvements in quality with same amount. It can also decrease the need for silicon or other functional chemicals further on in the process. Surface tension is one good method of analysing film formation. The lower the surface tension, the better the spreading of starch film and thus, ultimately, film formation. Table 1 illustrates surface tension of different starches and their film forming ability. All starches are cooked and diluted to 20% solids content.

STABILYS® EVO can offer the lowest surface tension of modified starches to be found in the market and the best film forming properties. Results also show that molecular weight of the starch plays a role in film forming. The higher the molecular weight, the higher the surface tension is. In addition, high molecular weight is also needed to help achieve good surface strength properties. STABILYS EVO can offer both characteristics at the same time: excellent film forming without compromising the surface strength.

HOW TO DECREASE MISTING IN ROD COATING

Misting is known to be one of the greatest runnability challenges for film press/size press coating. Misting causes the accumulation of coating colour to machine parts which eventually results in quality defects in the final paper, or a production stop due to a web break.

A pilot coating study was conducted at KCL in Espoo, Finland to decrease misting in the coating process. Earlier studies have confirmed that latex replacement with STABILYS® has a positive effect on decreased misting. Internal laboratory studies have also shown improvements to water retention and viscoelasticity of coating colour with STABILYS® EVO. This pilot study was therefore needed to confirm the hypothesis.

The coating formulations of this pilot coating study can be seen in table 2. All formulations were prepared with

Product	Molecular weight	Treatment	Surface tension (mN/m)
STABILYS® EVO250	high	thermally modified	53,9
STABILYS® EVO850	high	thermally modified	56
Competitor potato	high	acetylated	62,7
Competitor potato	high	oxidized	63,3
STABILYS® A030	medium	thermally modified	64,1
STABILYS® A023	high	thermally modified	67,3

Table 1. *Surface tension of different modified starches*

Coating composition	REF	TP1	TP2	TP3
Carbonate	60	60	60	60
Clay	40	40	40	40
STABILYS A030	x			
STABILYS EVO		x+1	x+1,5	x+2
SB-latex	y	y-1	y-1,5	y-2
pH	9	9	9	9
Solids	65	65	65	65

Table 2. *Coating formulations of pilot coating study*

Rheology measurements	REF	TP1	TP2	TP3
Solids (%)	65,1	65	65,1	65,2
Br-100 viscostiy (mPas)	432	398	420	446
AA-GWR water retention (g/m^2)	108	94	82	73
ACAV (mPas) 10e6 1/s	44	43	45	47
Rod pressure (bar)	1,64	1,62	1,68	1,71
Misting (visual) 1= best, 4 = worst	4	3	2	1

Table 3. *Rheology measurements and misting*

On top of the rheological improvements and decreased misting, an improvement in the overall paper quality (gloss, smoothness, surface strength & printability) can also be offered

the same solids content and pH. A constant amount of synthetic thickener was used. STABILYS® & STABILYS® EVO were cooked with a jet cooker to 36% solids content. The base paper was LWC type. The speed of the coating machine was 1500 m/min and coat weight was 11 g/m^2 for both sides of paper.

Table 3 illustrates the rheology measurements and misting of the trial points. Misting was analysed with black velvet. A velvet sample was kept at a set time and distance from the size press and the amount of misting was analysed visually from the velvet.
The results confirmed the hypothesis: STABILYS® EVO can decrease misting and improve water retention. Higher latex replacement whilst decreasing misting: STABILYS EVO can offer higher latex replacement without significant difference in either viscosity or rod pressure. On top of the rheological improvements and decreased misting, an improvement in the overall paper quality (gloss, smoothness, surface strength & printability) can also be offered.

HOW TO MAXIMISE LATEX REPLACEMENT

Pre-coating can be achieved without latex. An experiment was set up some years ago with a coated wood-free paper mill. The mill was producing double coated papers with blade coating. The machine speed was 800-1200 m/min and pre-coat weights were varying from 12-16 g/m^2.

In the first phase, their previously-used coating starch was replaced with STABILYS® A025 and a 50% latex replacement level in pre-coating was achieved. The second step was to increase the latex replacement with STABILYS® EVO. The mill trials were conducted during 2014 and coating formulations are shown in table 4.

Changing the previously-used formulation over to STABILYS A025 showed benefits both in dynamic water retention and in achieving a more stable coating process. There was no need to change either the blade setting

Coating composition	OLD REF	NEW REF	TP1	TP2
Coarse GCC	100	100	100	100
Starch binder	4			
STABILYS A025		5,5		
STABILYS EVO			7	12
SB-latex	7	5,5	4	
HASE thickener	x	x	x	x
pH	9	9	9	9
Solids	67	67	67	67

Table 4. *Coating formulations to maximize latex replacement*

After adjustments, runnability was reference level and a slight improvement in both gloss & smoothness could be detected

or other runnability parameters in this trial. The customer was using HASE-type synthetic thickener for controlling the right Brookfield level for coating colour application. The thickener amount was slightly increased, when STABILYS A025 was introduced to the process. STABILYS A025 is cooked with jet cooking and solids content is 35%.

The first trial with STABILYS® EVO was conducted with unchanged machine parameters and using the same amount of thickner. STABILYS® EVO was cooked to 40% solids content. Similar paper quality was achieved with positive feedback received concerning the printability. The second trial showed a slight increase in both the viscosity of the coating colour and the blade pressure. Blade thickness and angle were optimised and the amount of thickener was reduced slightly. After adjustments, runnability was reference level and a slight improvement in both gloss & smoothness could be detected. Longer trials with 100% latex replacement are taking place during 2015.

In summary, the effect of natural binders can be optimised
Improve film forming; decrease misting; 100% latex replacement. All are possible with the right selection of natural binder. Perhaps now might be the time to act?

New spray systems can reduce both operating costs and paper breaks

By **Dave Kouwe,** Spraying Systems Co.

CASE STUDY 1: TISSUE MANUFACTURER SAVES US$40,000 AND IMPROVES SUSTAINABILITY

Problem:

A leading tissue manufacturer was winding rolls of commercial toilet tissue around cardboard core tubes. Plastic end caps were inserted into individual rolls after they were cut from long tissue logs into individual rolls. The core tubes and caps were costly and were ultimately discarded after the tissue roll was used, creating unnecessary waste. The manufacturer wanted to increase the number of sheets on the roll while reducing operating expenses and improving the sustainability of the product.

Solution:

An AutoJet® Model 1550+ Modular Spray System applies a light mist on the tissue as it is wound directly on a thin metal rod. Eight PulsaJet® nozzles with low flow air atomizing setups are triggered by the winding machine and spray just long enough to ensure the tissue adheres to the metal rod. The electrically-actuated PulsaJet nozzles are cycled quickly to maintain a very low application rate and avoid over-wetting. After the tissue roll is fully formed, the metal rod is pushed out of the roll, leaving only tissue product. Cardboard core tubes and plastic end caps are no longer needed.

Results:

The new AutoJet® spray system has helped the manufacturer achieve all of its goals for the coreless tissue line. The elimination of the cardboard core tubes allows more sheets of tissue to be wound on each roll. Annual savings gained by eliminating the cardboard tubes and plastic end caps are over US$40,000. The payback period for the new spray equipment was about seven months. In addition, the manufacturer has improved sustainability by eliminating components that were previously discarded.

The manufacturer wanted to increase the number of sheets on the roll while reducing operating expenses and improving the sustainability of the product

CASE STUDY 2: PAPER MANUFACTURER REDUCES PAPER BREAKS BY 75% WITH NEW SPRAY SYSTEM

Problem:

A manufacturer of linerboard needs to spray water on the queen roll in the calendar stack. The consistent low-flow application of water on the roll at the edge of the sheet wets the roll to prevent the mill's coated paper from sticking to the roll. Air atomizing nozzles were previously used but because of the high mineral content in the make-up water, the nozzles plugged frequently. When the nozzles failed to apply the water, sheet breaks occurred and resulted in expensive downtime.

Solution:

Spraying Systems Co. used four PulsaJet® automatic spray nozzles controlled by an AutoJet® Modular Spray System to solve the mill's problem.Two PulsaJet nozzles are mounted on each end of the queen roll to spray the 20" (508 mm) gap between the edge of the paper sheet and the end of the roll. The AutoJet Model 2250 Spray Controller triggers the nozzles to spray whenever the paper machine is in operation and uses Precision Spray Control (PSC) to achieve the desired flow rate based on the machine speed. By precisely adjusting the electrically-actuated PulsaJet nozzles, an extremely low flow of water is applied to the queen roll using hydraulic flat spray nozzles. The flat spray nozzles have larger nozzle orifices and are much more resistant to plugging than those of the previously used air atomizing nozzles. The system includes an electromagnetic liquid flow meter. Alarms are generated by the spray controller if reduced flow is detected indicating one or more plugged nozzles. Operators can then immediately inspect and clean spray tips without stopping the paper machine and return the system to full flow.

Figure 1. *The AutoJet Model 1550+ Modular Spray System triggers the nozzles to spray when a sensor is received from the winding machine*

The payback period for the new spray equipment was about seven months. In addition, the manufacturer has improved sustainability by eliminating components that were previously discarded

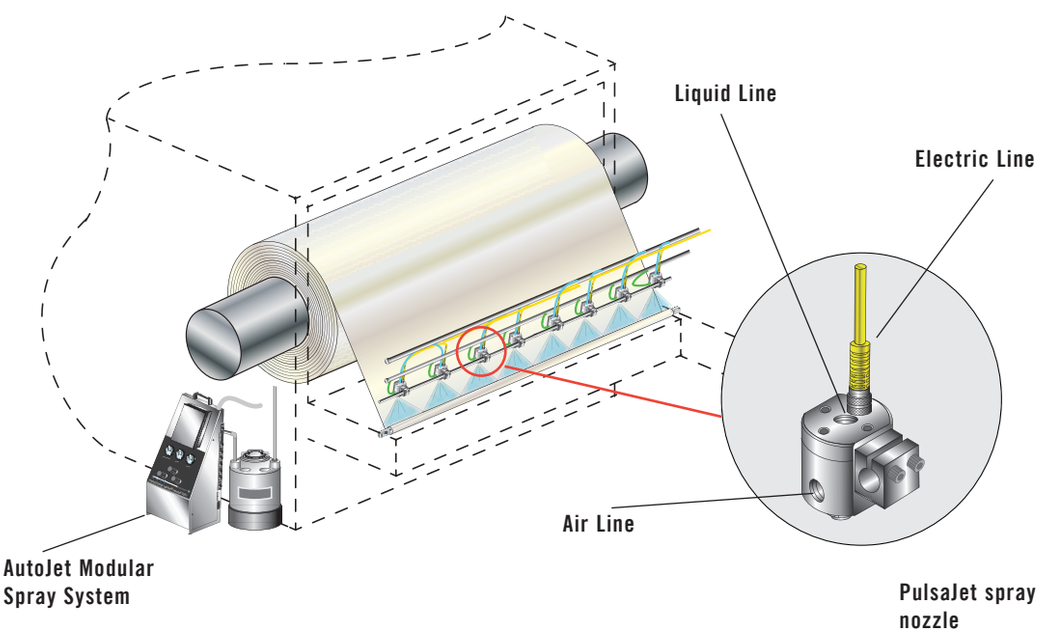

Figure 2. *Eight PulsaJet® Automatic Spray Nozzles apply a light mist of water on the tissue to ensure it adheres to the metal rod*

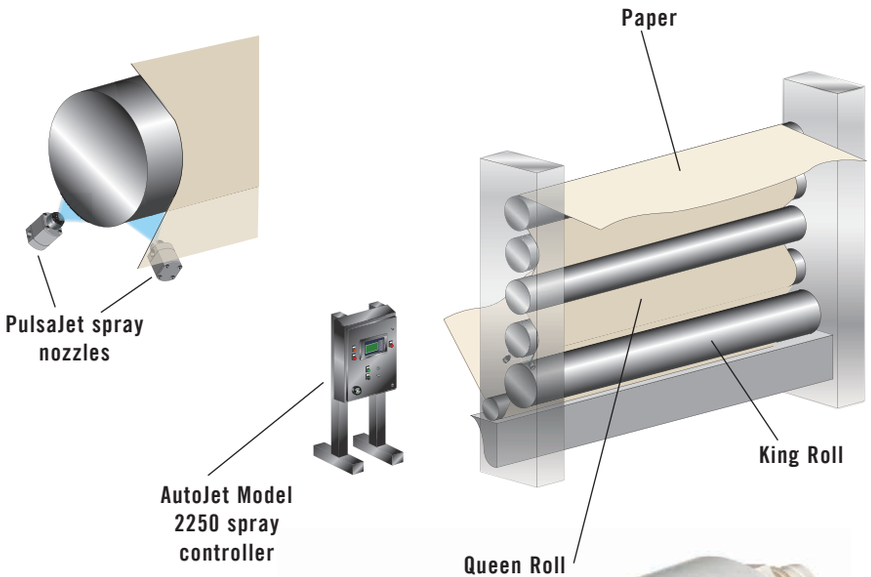

Figure 3. *Two PulsaJet Automatic Spray Nozzles mounted 12" (305 mm) from the roll are used at each end of the queen roll*

Results:

The AutoJet® Modular Spray System provides a consistent coating of water on the queen roll. Mill operators have determined that the PulsaJet® nozzle's hydraulic flat spray pattern does a better job of wetting and cleaning the roll than the previously used air atomizing nozzles. In addition, the system's alarm signal notifies operators of possible plugged nozzles, enabling proactive maintenance to prevent sheet breaks. Prior to installing the system, the mill experienced up to eight sheet breaks per month. After installing the AutoJet Modular Spray System, the number of sheet breaks averaged just two per month. Using the mill's estimated downtime expense of US$10,000 per sheet break, the investment in the new spray system was recouped in less than two months.

Precision Spray Control (PSC) involves turning nozzles on and off very quickly to control flow rate. This cycling is so fast that the flow often appears to be constant. With traditional nozzles, flow rate adjustments require a change in liquid pressure, which also changes the nozzle's spray angle/coverage and drop size. With PSC, pressure remains constant enabling flow rate changes without changes in spray performance. PSC requires the use of electrically-actuated spray nozzles and an AutoJet spray controller.

Precision Spray Control (PSC) involves turning nozzles on and off very quickly to control flow rate. This cycling is so fast that the flow often appears to be constant

Figure 4. *AutoJet Spray Controllers provide easy control of nozzles and cycle times up to 16,000 cycles per minute*

Tougher effluent regulation calls for cost effective chemical treatment

By **Ulla Gytel**, Application Specialist EMEA, **Chen Hongwei,** Application Specialist APAC, **Edouard Papin,** Application Specialist NAFTA and **Göran Bäckman,** Business Development Kemira

Many modern pulp and paper mills are using cost effective chemical treatment methods from Kemira to meet tougher regulatory standards for discharge of wastewater

INTRODUCTION

Water is an essential raw material for manufacturing pulp and paper, and effluent treatment is a critical part of this process. To meet tough regulatory standards for discharge of wastewater, many modern mills rely on Kemira for cost effective chemical treatment methods and support. Because effluent characteristics can differ greatly from one mill to another, so do the treatment procedures.

It is clear that advanced treatment is becoming a prerequisite to cost-effectively meet tougher regulatory standards for wastewater and, as the interest in specialised effluent treatment methods is growing, mills will likely have to monitor their emissions in much more detail in the future.

This article describes the major wastewater treatment sub-processes and some measures that can be taken to improve them.

- Primary treatment can be optimised with chemical coagulation or flocculation, for removal of particulate organic matter including surface active toxic compounds.
- Biological treatment, so called secondary treatment, is improved with micronutrients and flocculants to secure stable and optimal biomass activity. The treatment is further supported with ATP (adenosine triphosphate) and biological activity test methods.
- Tertiary treatment is enhanced with chemical/physical methods to meet the final regulatory standard for discharge of wastewater.
- Sludge treatment is assisted by new types of cost efficient dewatering chemicals capable of handling various types of sludge in demanding conditions.

BACKGROUND

Environmental protection and water management have been in focus for many years, especially in areas where clean water is scarce. Numerous guidelines are in force worldwide: China has a discharge standard of water pollutants in the pulp and paper industry[1], in Europe, the IPPC (Integrated Pollution Prevention and Control) and BAT (Best Available Technique)[2] is guiding mills on effluent limits, and in North America federal regulations for the environment are published by the EPA (Environmental Protection Agency)[3].

However, a comparison between effluent standard limits (Table 1) reveals that legislation focuses on different types of emissions in different parts of the world. In China organic pollutants are in focus, whereas nutrients and suspended solids are more strictly regulated in the EU. A comparison of regional discharge limits is shown in the table below.

Type of mill	Regulation	Parameter kg/Adt				
		SS	BOD_5	COD	N_{tot}	P_{tot}
Pulp mill	China	0.6-1.5	0.3-0.6	2.4-3	0.3-0.45	0.015-0.024
	BAT	0.3-1.5		2.5-20	0.05-0.25	0.01-0.03
	EPA	3-9.5	1.8-5.5			
Integrated mill	China	0.25-0.75	0.25-0.5	1.5-2.25	0.25-0.3	0.0125-0.02
	BAT	0.06-0.45		0.9-4.5	0.03-0.1	0.001-0.01
	EPA	3.8	2.5			
Paper mill	China	0.1-0.3	0.1-0.3	0.1-0.2	0.1-0.12	0.005-0.008
	BAT	0.02-0.35		0.15-1.5	0.01-0.1	0.003-0.012
	EPA	2.3	1.9			

Table 1. *A comparison between effluent standard limits reveals that legislation focuses on different types of emissions in different parts of the world*

This article describes several typical challenges that mills face with wastewater treatment procedures and treatment results that can be achieved using cost effective chemical treatment methods. The most important unit processes discussed are shown in the brief flow sheet overleaf (Figure 1).

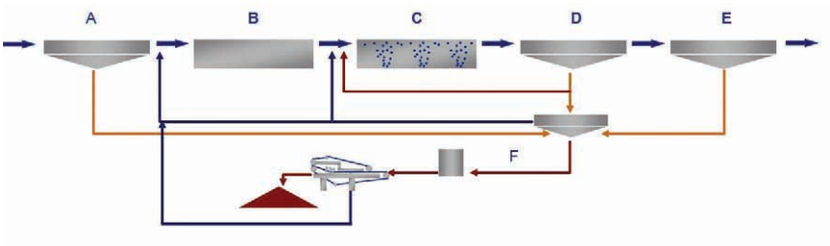

Figure 1. *Typical flow sheet with A: Primary sedimentation B: Equalisation/ Anaerobic step C: Active sludge D: Secondary sedimentation E: Tertiary treatment F: Sludge treatment*

PRIMARY SEDIMENTATION

Separation of suspended solids by primary sedimentation is often not effective at many pulp and paper mills. This leads to increased discharges of COD, phosphorous and nitrogen into the recipient. Even with efficient separation, some substances still have an adverse effect on the biological process which has to be taken care of.

Bacteria are only capable of degrading small, dissolved organic substances and have considerable difficulties with larger material and toxic substances from the wood or paper process. Therefore, effluent fed from primary sedimentation to the biological treatment process often has an unsuitable composition. The larger fraction, measured as suspended solids (SS), often simply passes directly through the primary sedimentation increasing the need for aeration and excess bio sludge-handling (Figure 2). Treating the incoming primary effluent before the biological process highly reduces the high-molecular COD fraction, leaving the low-molecular COD to be efficiently degraded in the subsequent biological treatment.

Targeted types of additives such as those in the Kemira NetFloc Lite program will boost primary sedimentation performance, thus retaining valuable prime-quality fibres and leaving only the low molecular COD for the biological treatment to degrade. Kemira NetFloc Lite is a cost efficient treatment that enables considerable improvements such as lower discharge of P, N and COD and a decreased need for aeration. The application is simple and fast to install on the in-flow pipe, with the treatment easily adjusted to give optimal results.

CASE STUDY:

NetFloc Lite: Enhanced primary treatment which improves conditions for the biological degradation process

Grade: Bleached Mechanical Pulp

Challenge: Mill wanted to lower WWTP operation cost and increase biodegradability. Especially production of bleached pulp grades was detrimental to the WWTP process stability

Solution: Dosage of a special additive to boost primary sedimentation performance

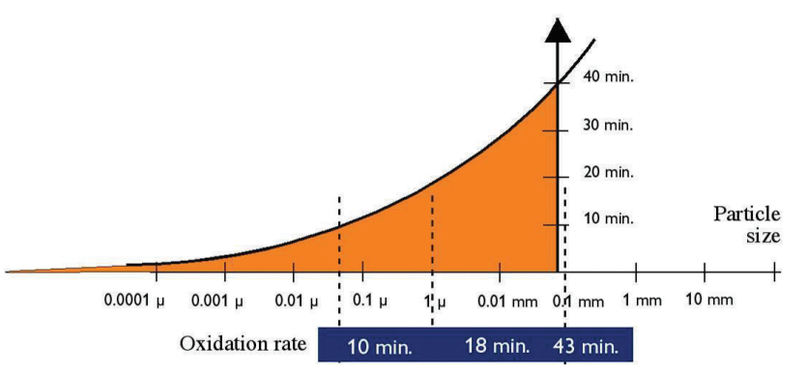

Figure 2. *Particle size vs.degradation rate*

Results: More stable biological processes with lower P, N and COD discharges to recipient
Lower aeration cost
Decreased amount of excess biological sludge to handle
Reduced sludge dewatering costs and increased sludge energy value

Savings: 20% total WWTP process costs saved, including lower usage of energy and chemicals as well as improved sludge dryness

BIOLOGICAL ADVANCES

Biological effluent treatment has for a long time been the state-of-the-art both in the pulp and paper industry, and other sectors. The activated sludge process is the most widely used method worldwide. If operated under stable and favourable conditions treatment results are excellent with low concentrations of organic matter, suspended solids and nutrients leaving the plant. The process is, however, sensitive to variations and disturbances[4] and upsets are costly and difficult to predict and control.

The effect of micronutrients on biological treatment has been studied by Kemira since the mid-1990's, resulting in the development of the FennoNutri range of products. Ferric ions especially have a very positive effect on the microbial oxygen uptake and excess growth of detrimental filaments commonly found in the pulp and paper effluent plants. FennoNutri products enhance sludge separation and help bacteria to form more compact flocs (Figure 3). Nowadays these products are used by many mills, in some cases supported by small amounts of polymer in the secondary settling tank, to prevent escaping biomass and decrease discharge values. Also in anaerobic treatment plants, the usage of FennoNutri

A better adapted 'diet' for the bacteria improves conditions for the biological degradation process. NetFloc Lite treatment offers numerous benefits to biological treatment, such as reduced P, N, and COD discharge.

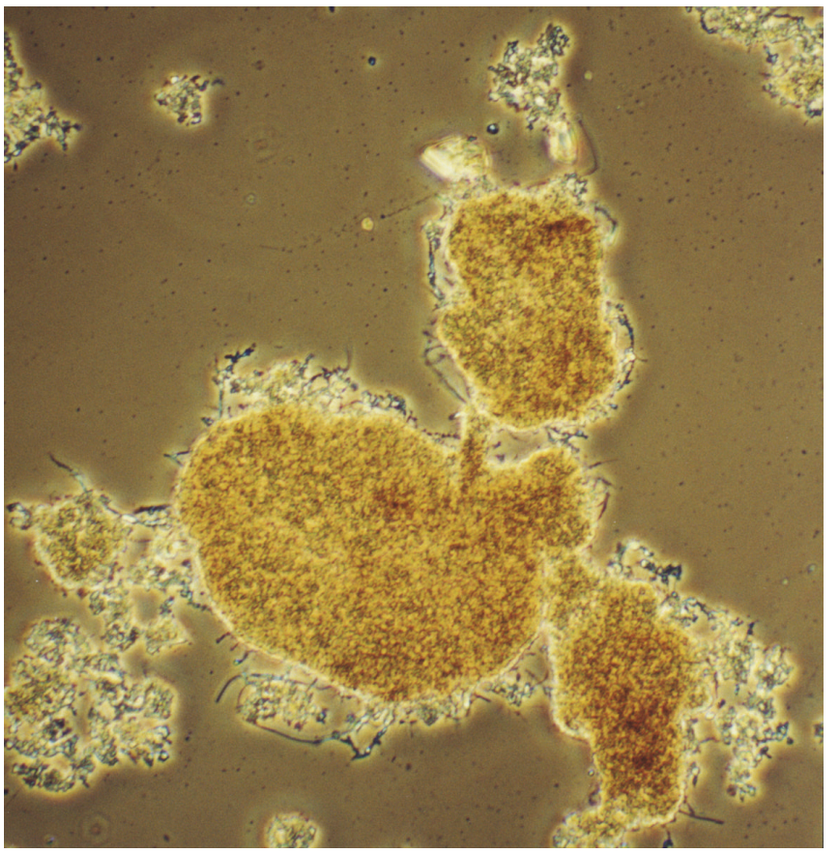

Figure 3. *Compact flocs after a Ferric based chemical has been added in activated sludge*[5]

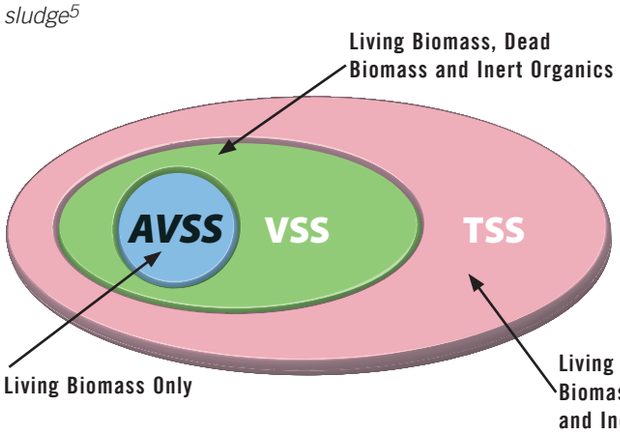

Figure 4. *Schematic describing the key components of sludge in biological processes*[6]

The stress level experienced by microbiological populations is measured as BSI (Bio Stress Index) – a very useful parameter when monitoring toxicity in and around bioreactors

products is a very cost effective way to increase the capacity and boost biogas production.

CASE STUDY:

FennoNutri: Addition of micronutrient stabilizes the biological treatment plant
Grade: RCF and Bleached Mechanical Pulp
Challenge: The biological treatment was not functioning very well. Unidentified filaments caused bad settling, high discharge of suspended solids and nutrients, and loss of biomass
Environmental discharge limits had been exceeded for several months in a row
Solution: The filaments were identified by gene probe technique as Alphaproteobacteria and addition of FennoNutri to the biological treatment in order to stabilise the process was proposed
Results: Effluent treatment is working according to permit
No need for filament killing in the WWTP
Savings: Not analysed in this case

MONITORING BIOLOGICAL ACTIVITY AND SLUDGE INVENTORIES

Activated sludge processes often carry large solids inventory and managing this is a key component of the optimisation process. Kemira has, together with the Canadian company LuminUltra, developed the LumiKem test kit to measure biological activity based on ATP. This measurement of the active volatile suspended solids (AVSS) helps quantify the living biomass in the activated sludge process (Figure 4). This information assists in optimising sludge inventories and ensuring that sufficient biomass is present for degradation of the wastewater constituents.

ATP measurements can also be used to alert operators if any components toxic to bacteria are present in wastewater. The stress level experienced by microbiological populations is measured as BSI (Bio Stress Index) – a very useful parameter when monitoring toxicity in and around bioreactors. Proper feeding of nutrients allows the living biomass to re-populate.

TERTIARY TREATMENT

In Asia Pacific and Central Europe, many mills are using coagulation and flocculation with inorganic chemicals and polymers as a final tertiary treatment to decrease COD to acceptable levels. The method is very effective and capable of removing 60-80 % of the organic matter. In China a special process utilising hydroxyl radicals, called the Fenton or FennoTriox process, is commonly used to remove more than 80% of residual COD.

CASE STUDY:

FennoFloc: Efficient tertiary treatment
Grade: Kraft pulp
Challenge: A mill wanted to significantly decrease discharge values. The mill was obliged by the government to rebuild the aeration process with new activated sludge treatment capacity to meet up with common standards for wastewater regulations and permits

Solution: The mill instead decided to invest in low energy, tertiary treatment with the latest DAF (Dissolved Air Flotation) technology. Kemira proposed using cost efficient inorganic precipitation products FennoFloc A and FennoPol K polymer.
Results: New treatment capacity reduced the discharge values to recipient: Total COD reduced by 70%, colour by 95%, suspended solids by > 95%, nitrogen by 60% and phosphorous by > 90%. Additionally, residual bacteria, heavy metals and chelating agents were reduced.
Savings: Mill could continue running the existing aeration plant, thus avoiding heavy investments to rebuild the aeration step into active sludge technology.

OPTIMISATION AND CONTROL

Overdosing of coagulation or flocculation chemicals, due to process variations in effluent treatment, is very common (Figure 5). This normally results in higher operating cost or calls for tighter manual control. Over the past 10 years, in collaboration with pulp and paper industry partners, Kemira has developed FennoDose controllers to give greater cost efficiencies in different applications where coagulants and flocculants are used. These include raw water, process water, sludge dewatering and effluent treatment.

SLUDGE DEWATERING

Sludge dewatering where the incoming sludge is varying in both composition and solids content is a good example of where the FennoDose controller is a very cost effective solution. Sludge can include various types, i.e. debarking sludge, RCF and DIP sludge, coating colour sludge and sludge from the effluent treatment plants (primary sludge, biological sludge, chemical sludge and sludge mixtures).

CASE STUDY:

FennoDose: Cost effective handling of sludge residuals
Grade: RCF/DIP packaging board
Challenge: Mill group in a corporation needed to upgrade their off machine process efficiency for sludge handling

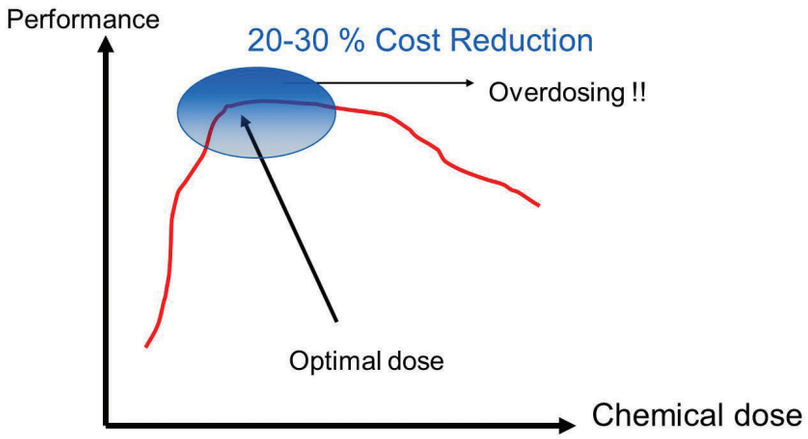

Figure 5. *FennoDose controller is designed to give optimal dosing of process chemicals and ensuring optimal process efficiency*

to be more cost efficient. Polymer products used in these applications must be both cost efficient and show good, robust performance in high solids, high alkalinity and high conductivity environments.
Solution: New FennoPol polymer grades were developed in order to secure optimal performance under demanding conditions. FennoDose controllers and online sensors were installed on the most critical sludge dewatering applications.
Results: Process runnability has been excellent from the start
Sludge handling capacity and solids removal increased in most applications
Improved or sustained runnability
Improved sludge dewatering capacity
Reliable planning of chemical costs/ consumption
Increased operator understanding
Savings: Implementation of FennoDose controllers has reduced the consumption of sludge dewatering chemicals by 20-30 %.

SUMMARY

Across a world where clean, fresh water is becoming increasingly scarce, the pulp and paper industry is facing tighter regulations for wastewater discharge and harsher penalties for violations. To continue operating cost effectively both with respect to plant operations and possible financial penalties, combined chemicals and biological methods are simultaneously being used. These should be complemented with modern tools for optimised chemical usage and efficient WWTP operation efficiency. Kemira's deep experience and know-how in wastewater treatment makes it well positioned to support pulp and paper mills with chemicals, methods and tools to meet these challenges in the most cost-effective and efficient manner.

The pulp and paper industry is facing tighter regulations for wastewater discharge and harsher penalties for violations

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Production changes demanded new prediction and simulation solutions

By **Soren Back,** SB Kommunikation AB

Hallsta 1. *Hallsta paper mill produces 550 000 tonnes of lightweight uncoated magazine papers and book papers on two paper machines*

Hallsta, one of Holmen Paper's Swedish paper mills, has closed one paper machine a groundwood mill and two old solid fuel boilers, and therefore needed an improved control of the energy balance. One of the restructuring projects involved development of a predicting and simulating system, MOPS PSA, enabling operators to balance changes in pulp, steam and water supply between the TMP plants and the paper machines.

The mill has two separate production lines, each consisting of a TMP plant with four refiner lines and a paper machine, with a common steam system for both production lines. The TMP plants produce pulp for their respective paper machine and steam to the common system, supplying the paper machines with their need of steam. This means that production changes, maintenance stops and production problems on the paper machines have direct effects on the pulp and steam production.

"The restructuring project work started in spring 2013 with the aim of being completed one year later," says Maria McGuinness, Production Engineer at TMP and project leader for the PSA project. With almost no other steam sources than the TMP refiners, apart from two electrical boilers, the new situation demanded a new way of running the mill. Therefore, a new tool providing a concept for process control to support this situation, using input from existing control systems, was needed."

With almost no other steam sources than the TMP refiners, apart from two electrical boilers, the new situation demamded a new way of running the mill

"We already had systems from MOPSsys in the mill so our first choice was to get in touch with them to discuss the situation and see if they could come up with a solution to our needs," says Maria McGuinness. "The idea was that Hallsta would supply all relevant data and connections between different production parameters and that MOPSsys would develop the system."

Hallsta 2. *"The PSA system was launched last May and has after some modifications proven to be a valuable tool," says Maria McGuinness who was project leader at Hallsta for the PSA project*

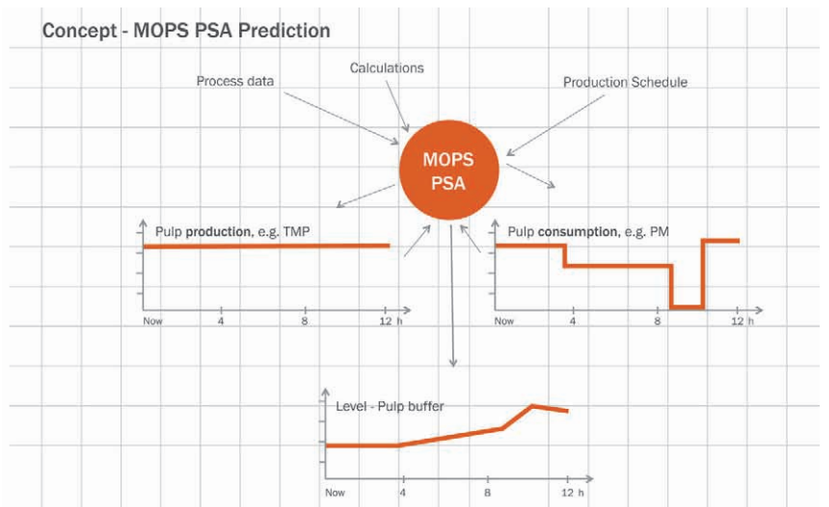

Figure 1. *A simplified example of how the prediction concept works. Pulp consumption changes increase the level in the pulp tank if TMP production continues on the same level*

"Hallsta approached us to see if we together could develop a system which would present an overall view of the mill status," says Kenneth Lundström, Senior Systems Engineer at MOPSsys. "In order to support decision making, the mill needed a system with capability to simulate different production situations. The result was a MOPS PSA (Predict and Simulate Analysis) system, which collects production data from different mill production and quality systems and every minute presents a prediction for the coming twelve hours regarding pulp and steam need and consequences – for example, storage tank levels."

Depending on different mills' needs, the PSA displays can be modified to show different process parameters. Process operators can examine latest history together with process values for the next twelve hours. Simulations can easily be performed by starting from an existing prediction or simulation, changing some input data and performing a new simulation. Performed predictions and simulations can be selected, analysed and compared to the real outcome of the process. The PSA can therefore be a tool to fine tune data models.

Performed predictions and simulations can be selected, analysed and compared to the real outcome of the process. The PSA can therefore be a tool to fine tune data models.

"The way the prediction concept works is illustrated in figure 1. Data is fed from different mill sources into the MOPS PSA unit. In this example, data consists of information about expected pulp consumption during the next twelve hours and a planned maintenance stop of two hours. If pulp production continues without changes, the result will be an increased pulp level in the storage tank. On screen, the operators can see the graphic presentation of when and how much the pulp level will increase and hence decide if and when pulp production will have to be changed. This figure shows a simplified situation. In reality the operators get much more detailed information, such as the present (and predicted) pulp and steam production of each refiner. This makes it possible to adapt the way the TMP plant should be run in the most efficient and economical way."

"Figure 2 shows simulations made on request from a user. Initial values are fetched from an earlier prediction or simulation. Input data can be changed by the user before the simulation starts. In this example the paper machine's maintenance stop is prolonged and a production stop in the TMP plant is planned. Based on these assumptions, the operator will see the resulting pulp level changes in the storage tank."

Depending on the needs of the mill in question, the displays show many more parameters as well as their dependence on each other. A complex production system can be simplified on the display without losing the important parameters and their connections with each other. In the Hallsta case, the process operators can see pulp and steam production, storage tank levels and paper machine consumption of pulp and steam. The consequences of one parameter change somewhere in the production line are immediately shown on the display, making it possible to decide on any action.

"Other mills might want to display other important connections between different process parts to facilitate decision making," Kenneth Lundström points out. "Some examples could be:

- Predicting buffers of chemicals and raw materials based on current situation and planned production.
- Minimising unnecessary changes in digesters' production speed, if the current situation and predicted future situation is known. Comparisons can be done with the drying machine's need.
- Optimising energy consumption by running only the most efficient refiners when predictions show that the pulp needed at the moment is enough."

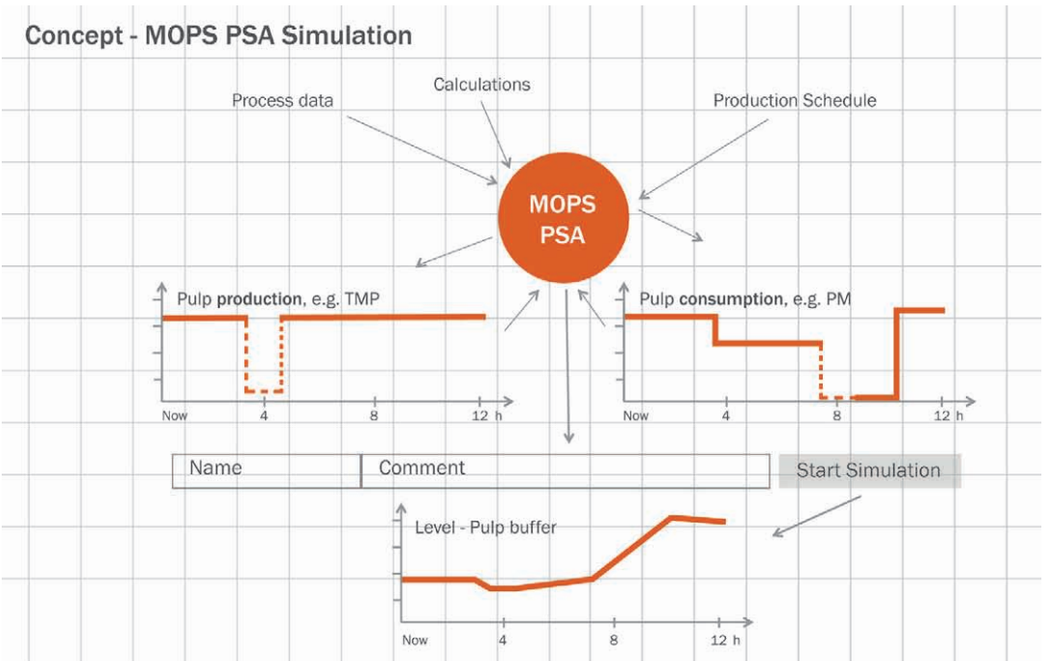

Figure 2. *In this case a simulation is done assuming a prolonged production stop on the paper machine and a production stop of the TMP line*

A complex production system can be simplified on the display without losing the important parameters and their connections with each other.

"In the future we might add an "Optimisation" functionality into PSA, allowing it to give advice on the most beneficial process situation for a certain point in time. During periods of high electricity cost, or perhaps a planned maintenance shutdown of the pulp mill, the system could give advice on pulp buffer levels at a certain time in order to be able to have enough pulp for the paper machines according to the production plan.

"In order to get the most out of the PSA system, training of all process operators took place during autumn and winter," Maria McGuinness continues. "It was important that they learned how to use it, not least the possibility to simulate ways of coping with changes – planned or unplanned – in paper production. It is of course easier when production runs normally and planned changes are known well in advance. But this system is also useful when unexpected problems on the paper machines occur, as the results of different actions can be simulated, giving a good basis for the right decision. It is also true to say that almost every process operator has been in the TMP plant for many years, so they can draw upon their experience when analysing simulation results."

Hallsta 3. *Kenneth Lundström was in charge of the development of the PSA system which provides predictions as well as possibilities to simulate consequences of different production situations.*

Kenneth Lundström points out. "The simulation tool is also useful when educating new people about how the production lines work. By letting them simulate different changes, many production situations can be easily and realistically performed without disturbing the ongoing production."

"The PSA system was launched in May 2014 and, after some modifications, has proven to be a valuable tool. Every minute we get a prediction of the consequences of the paper machines' pulp and steam consumption for the TMP plant and for the whole energy system. As not all of the refiners are the same size, their production capacity and energy consumption varies. This means that we can optimise our energy consumption to cater for the paper machines' varying needs of pulp and steam. Depending on production situations, we are able to run the most cost efficient refiner combination."

"One major benefit with the PSA system is that the process operators at a glance get an overview of the present and the expected situation. Another advantage is the simulation possibility, particularly when paper machines or TMP plants have runnability problems, as it gives a good basis for decision making in advance on how to run the refiners when sudden changes in pulp and steam consumption occur,"

"The energy and pulp balances are shown in graphical form, thus helping decision making to optimise the way to run pulp and steam production at all times. We are happy to see that this project with Hallsta has helped improve efficiency," says Kenneth Lundström.

"We see great opportunities for the PSA system in many mills," says Hans Hallin, CEO Eurocon MOPSsys. "Each mill has a different situation which means that the system has to adapt to the needs of the mill in question. It does not have be a situation with to drastic changes in production. The PSA system can also be a good support for decision making in mills where the consequences of a process change, planned or unplanned, need to be displayed in a clear way. Here, the prediction and simulation possibilities can be very valuable."

MOPSsys endeavours to apply the best technology available so that pulp and papermakers can achieve the greatest benefits from their mills and enterprise. Their mission is to help pulp and paper mills achieve substantial gains in product quality, efficiency and throughput, environmental stewardship and customer service, through skilful application of real-time information throughout their organisations.

Eurocon MOPSsys has more than a hundred installations in 18 countries and is a strategic part of the pulp and paper mills' production and quality management. MOPS Prediction and Simulation Analysis (PSA) is a part of Eurocon MOPSsys' product suite MOPS™. MOPS™ is a Process Information Management and Quality Management System enabling the integration of all mill information systems.

"we can optimise our energy consumption to cater for the paper machines' varying needs of pulp and steam"

How machine vision improves papermaking efficiency and paper quality

By **Kari K. Hilden,** Papertech Inc.

INTRODUCTION

Break or event recording cameras have now been used on all types of paper, board and tissue machines for over twenty years. During this time camera, lighting and computer technology, to capture and analyse all types of defects and break events has evolved at a rapid pace fuelled by the need for papermakers to reduce costly downtime associated with sheet breaks and compete in a market increasingly focused on high quality product.

Break or event recording camera systems, which are now commonly called Web Monitoring Systems or WMS, have become a standard means of solving and eliminating even the most difficult paper machine runnability issues. It is estimated that there are now over 1400 WMS systems around the world with Europe and North America representing around 80% of the installed base.

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Over the last five years, some 100 to 125 WMS systems have been sold each year, and are now being used in over 30 countries. The highest concentration of WMS systems is in Northern Europe for two reasons: first, the initial development of this technology occurred there in the mid-nineties; secondly, the demand to operate machines at highest possible efficiency and production levels can often be found in Europe.

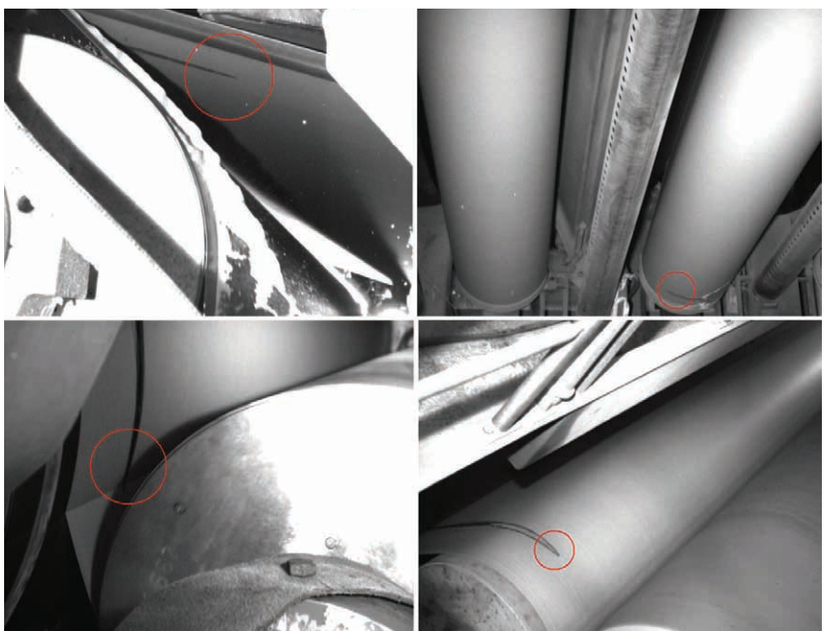
Over the last decade, WMS systems have become more intuitive, allowing operators to quickly and efficiently find the root cause – or origin – of their break causing defect or other quality issue. The cameras have become "smart" with full image recognition capabilities allowing them to see and alarm for any change in the sheet. In other words WMS cameras are now functioning in the same way as web inspection systems (WIS) located at the reel. This, together with better image quality and more images per second, has allowed all types of machines (including small ones) to justify the investment of automated camera-based web monitoring technology. Figure 1 shows some examples of WMS captured events.

WEB MONITORING TECHNOLOGY (WMS) PAST AND PRESENT

In the early nineties, major advances were made in CCD (charge coupled device) camera technology, which resulted in faster shutter speeds, improved image quality and higher resolution "Super" VHS format analog VCR's. The outcome of such an improved break recording system was reported by a Mid-Western paper mill , and demonstrated the potential that these systems offered in solving the root cause for unknown breaks.

Such an automated analog (VCR based) event capturing system was also installed on the UPM-Kymmene,

Figure 1. *Some example events captured by high speed cameras that are going to cause, or have caused, a break. Most commonly problems occur in the forming and press section and in many cases are originating from poor trimming on the wire.*



Kaukas mill's off-machine coater in 1993. In 1994 at the Tappi Coating Conference , the mill reported a major speed increase.

Over the next five years many automated basic software based WMS systems were installed, allowing for easier, faster and more reliable means of storing and reviewing breaks. Many of these developments were reported at the Tappsa African Pulp and Paper Week Conference in 2002 .

The next evolution took place with the advancements in digital image technology that allowed higher resolution and higher speed images to be generated, exceeding the old television broadcast standard (NTSC in North America, PAL in Europe and elsewhere).

In 1996, the U.S. Congress authorized the distribution of an additional broadcast channel to every full-power TV station so that each station could launch a digital broadcast channel while simultaneously continuing analog broadcasting. This freed up valuable broadcast spectrum for other communications services and allowed broadcasters to respond to increasing demand from consumers for digital programming.

Later, Congress set June 12, 2009 as the deadline for full power television stations to stop broadcasting analog signals. All stations are now required to broadcast digital television signals with many opting for additional high definition (HDTV) channels.

Just as broadcasters are providing consumers with digital television, the machine vision industry has also kept

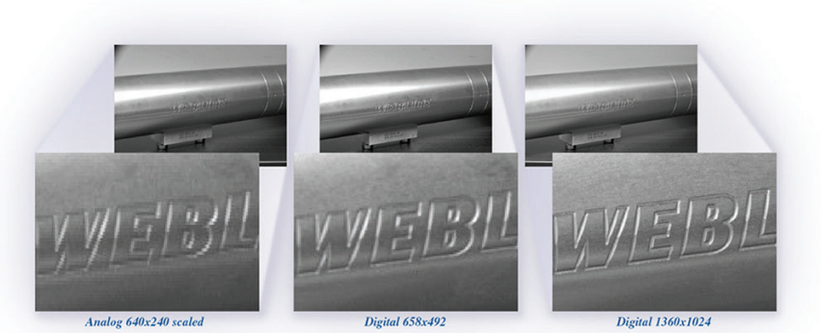


Figure 2. *Shows the image difference between analog (TV broadcast standard) on the left compared to higher resolution, and higher speed, digital GigE cameras*

pace and now offers papermakers a wide selection of industrial high-speed digital cameras providing much higher image quality (see figure 2) and imaging speed going from 50 or 60 images/second to as high as 1000. Along with the new cameras, various digital formats had also been evolving. The three primary ones for industrial applications are FireWire, CameraLink, and GigE-Vision. Of these, the GigE-Vision® standard has become the preferred choice for several reasons:

- GigE-Vision standard, from the Automated Imaging Association (AIA), is an interface for high-performance machine vision cameras that is widely supported in the industrial imaging industry.
- GigE is based on the well-known standard Ethernet. GigE has a high data rate of 1000Mbps.
- Offers the largest selection of industrial cameras.
- Most economical due to lower cable costs, lower camera costs, lower interface costs, lowest development costs.
- Longest direct transmission distance of 100 meters (330 ft) using standard CAT UTP cable

Although developers are constantly looking for ways to increase performance, GigE has become the widely supported choice of camera manufacturers and machine vision manufacturers.

MUST HAVE FEATURES

Today's WMS systems are able to provide a paper machine, or converting line, with a host of powerful features to allow the root cause of the efficiency robbing issue to be solved. When considering a camera system today, the following should be the "must have" list of capabilities:

1. **Digital cameras:** high sensitivity, uncompressed high resolution, high image speed, noise free, and ability to "plug and play" accept different cameras including colour.
2. **No weak links:** cameras that stay clean even in the dirtiest locations, effective and efficient lighting, robust mounting, cabling that minimises noise, industrial class computers and reliable software.
3. **Operator friendly:** intuitive, complete and easy to operate software allowing operators to rapidly find the root cause of the break or defect problem.
4. **Instant download:** all event data can be immediately analysed before re-threading, and breaks can be stored seconds apart without any loss of video information.
5. **Long video history:** sheet wet-end to dry-end transport time plus 2 minutes typical with the ability to extend to several hours for solving defect related problems.

The next evolution took place with the advancements in digital image technology that allowed higher resolution and higher speed images to be generated, exceeding the old television broadcast standard

6. **Non proprietary:** all system components including computers should be off-the-shelf, mill maintainable, allowing for easy upgrading and low cost ongoing maintenance.
7. **Full web inspection integration:** using the same WMS cameras the system has to have the capability also performing detailed web inspection (WIS) defect detection complete with reel map display and classification of defects into various papermaking categories. This reel to wet-end single platform integration provides a powerful platform to allow rapid dry-end defect to its root cause detection right to the wet-end, complete with defect image transfer capabilities and accurate same piece of paper synchronisation.
8. **Mill-wide information system (MIS) integration:** provides event summary statistics, highlights problem areas, automatic tracking of downtime, etc. and is typically performed most effectively using OPC data linking.

All of the above is now possible with the latest WMS systems and offers such an improvement in performance that it can be justified to either partially or fully upgrade previous generation WMS and WIS systems that might only be two years old. Figure 3 shows a typical synchronised break event and how the cameras and lights look when placed in the press section.

CAMERA APPLICATIONS FOR WEB MONITORING (WMS AND WEB INSPECTION (WIS)

Cameras and light housing technology are available today that can stay clean for extended periods, and can withstand very high temperatures. Due to their small size and mounting flexibility, cameras and lighting can be installed in nearly any position on a paper machine, pulp machine, coater, supercalender, winder, and many tissue converting lines. Figure 5 shows where cameras are typically located on a conventional paper machine. Figure 6 shows how both WMS and WIS cameras provide a means of fully monitoring the papermaking process through the winders to various converting operations.

The trim squirt application is very useful in ensuring that trim nozzle build-up, wear, and plugging is not affecting their operation and causing breaks. In many cases poor trimming can account for as much as half of all the breaks, so eliminating this problem becomes very important.

In the press section the most common locations are the pick-up, centre roll and last press. All open draws should be monitored. Viewing the sheet in the first dryer section is also important and particularly useful with unfelted uno-runs as this allows full cross direction viewing of the sheet. Coaters and size presses are always camera equipped due to their typically high break frequency. Calenders and the reel, for turn-ups, can also be problem areas. Winders can be equipped as well as other off-machine operations, the most important one being off-machine coaters.

RESULTS

Breaks are typically classified as coming from either known or unknown sources. Breaks coming from known sources can usually be eliminated, but it is for the unknown breaks that a WMS system is needed. Also it should be noted

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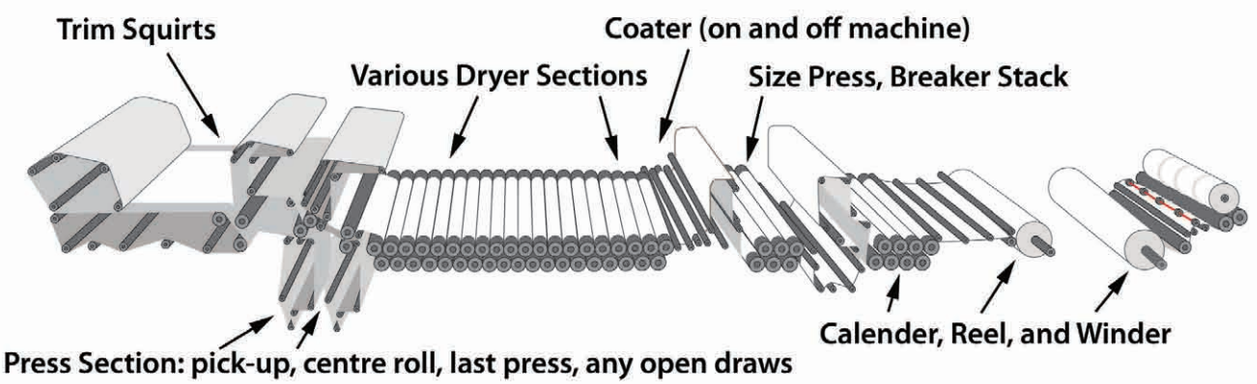

Figure 3. *Self-cleaning cameras (with waterproofing and high temperature ratings) can be located in all break sensitive locations with minimal concern over image quality and maintenance issues. The most common locations on conventional paper machines producing newsprint and fine papers are: trim squirts, pick-up, press section open draws, first dryer section, coater exit, size press exit, calender exit, reel for turnups and winder for edge issues and inspection*

Figure 4. *Shows how a fully integrated, single platform, web monitoring (WMS) and web inspection (WIS) operator station that allows a defect to be automatically transferred from the WIS to the WMS system synchronised to the same piece of paper. This allows for a rapid and accurate means for the user to find the source of the defect and to eliminate it. A single keyboard and mouse is able to operate both systems.*

With hundreds of WMS systems operating… it has become clear that this technology provides an effective means of solving breaks and provides a rapid return on investment

that experience has proven that many believed to be known sources of breaks have actually been found with cameras to be originating from another source – in other words, they actually were unknown.

A further WMS result is that preventive measures can be taken prior to a break occurring. This can be achieved today with automatic triggering of cameras as soon as they see a change in the sheet from a normal condition. Essentially, all WMS cameras today perform in the same way as web inspection cameras, and can be set up to trigger at all types of changes in the sheet and surrounding conditions. Examples of such changes could be problems occurring on trim squirts and felts, sheet flutter, sheet tension, vibration and various condensation and operator errors.

With hundreds of WMS systems operating on all types of paper, board, pulp and tissue machines, it has become clear that this technology provides an effective means of solving breaks and provides a rapid return on investment (often less than 6 months). With a sufficient number of cameras correctly placed, a complete picture of the event can be achieved from any part of the papermaking process.
The elimination of all unknown breaks is a function of several variables such as: type of camera system, type of break, similarity of breaks, number of cameras, camera locations and user capabilities and commitment. It should be noted that with the advancements that have now been made in WMS technology, it has become much easier for operators to find the root causes of breaks and defects.

Figure 5. *Example of a combined WIS (left) and WMS (right) operator control station display set-up providing total visibility to all of the machine cameras synchronised to the same piece of paper. Full two-way software integration provides automatic image transfer via pop-ups, as well as defect classification information, and other important variables to help speed up solving the root cause.*

Web monitoring systems have been found to be effective in eliminating breaks and defects on all types of paper machines and converting operations from tissue to pulp

A further noteworthy WMS development is the opportunity to fully integrate web inspection (WIS) with it. For many years, many WMS systems were set up to receive a trigger signal from the WIS allowing same piece of paper synchronisation of the hole or defect right to the wet-end cameras. Now these two systems are fully integrated, allowing two-way communication between the two systems into what can be called a single platform camera solution. Now, when a certain size of hole, edge crack, or surface defect is detected by the WIS, this image, with its exact time stamp, is sent to the WMS allowing operators to see the defect on the WMS screen together with the same piece of paper images all the way up to the wet-end. Similarly the WMS can send to the WIS images from certain defects further helping operators get to the root cause of quality disturbances.

CONCLUSIONS

Web monitoring systems have been found to be effective in eliminating breaks and defects on all types of paper machines and converting operations from tissue to pulp. WMS technology has now developed to a point where effective and reliable event capturing is possible, cameras are smart and perform continuous web inspection, and are fully integrated with all types of web inspection systems (WIS). The ideal WMS + WIS system is one that uses the same cameras, same processors and a single operating platform which simplifies the installation, makes maintenance easier, and offers the users the fastest and easiest way to achieve results.

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Improving roll receiving processes through absorption of kinetic energy

By **Mikko Rantanen,** CEO, MoveRoll Oy

Irrespective of the type of paper they contain, all paper rolls are both valuable and sensitive to damage. Damaged paper rolls cause unnecessary and avoidable expense. Slower handling processes of damaged paper rolls can cause production loss. Furthermore, damaged paper rolls often have to be rejected. Thus, the paper industry's need for undamaged paper rolls is significant.

INCREASED ROLL WEIGHTS

The two most common causes of damage to paper rolls are moisture and mechanical impact. Paper rolls may become distorted by falling, heavy impact, or perhaps by pressure from paper clamps. During the roll transportation process, steel stops and mechanical stoppers are further sources of damage. Increased paper roll sizes and roll weights are important additional factors that impact the paper roll handling quality. Today, for example, newsprint rolls may weigh up to 10 tons, while 20 years ago their weight was typically less than 3 tons. In most cases, old paper roll handling equipment had been designed for these smaller rolls and consequently does not have the capacity to handle the modern-day heavier rolls appropriately. Old, outdated paper roll handling equipment needs replacing with equipment that has been especially designed to cope with heavier rolls.

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TRADITIONAL ROLL RECEIVING PROCESS

Generally, paper roll receiving processes pose a major challenge to the ideal of damage-free paper roll handling. When MoveRoll started to analyse the roll receiving process in 2012, the following conclusion was reached: paper mills typically use either fixed steel plates or mechanically powered units to receive paper rolls. Over the course of the last 60 years, these two types of receivers have only seen minor improvements and adaptations to meet the requirements of higher roll weight and higher roll speed. When paper rolls, for example, leave the winder, they move down a ramp, taking on more speed through the rolling movement before they hit against a bare fixed steel plate. The energy is is not absorbed, the roll will bounce back and forth, and it is friction that eventually stops the rolls from moving. The hard impact can lead to distortions of the roll shape or possibly a damaged core; meanwhile, the friction may lead to tears and cuts. In addition, the bouncing of the rolls can cause severe health and safety risks. Mechanical receivers, on the other hand, encounter problems with adjusting to different roll weights and speeds. Different energy is needed to receive rolls well that have different weights, sizes, and move at different speed. Typically, the receiving capacity of mechanical receivers has been oversized: The units cannot recognise the roll weight and, as a compromise, operate at the same speed regardless of the actual

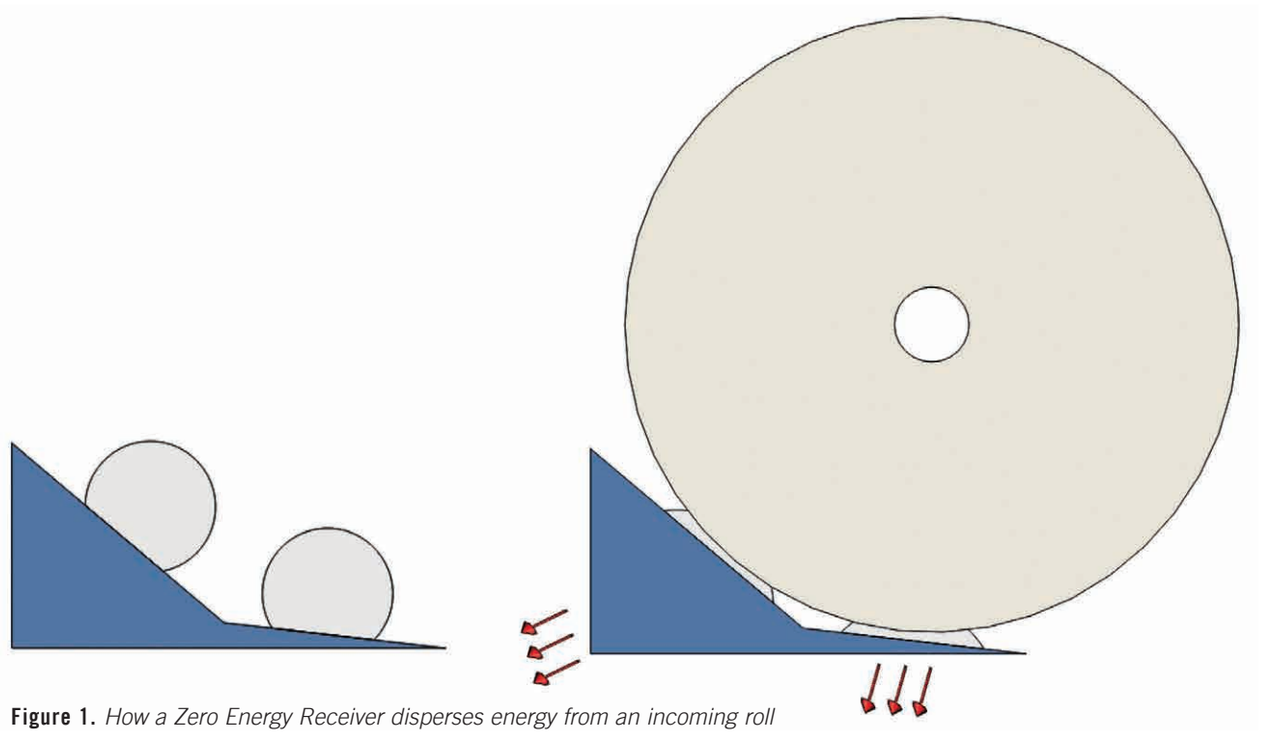

Figure 1. *How a Zero Energy Receiver disperses energy from an incoming roll*

Less roll bouncing also means less friction and roll spinning, and, accordingly, a reduction of paper cuts and tears

weight. This leads to two problems: First, the energy consumption is very high. Second, due to the increased roll weight, units that at one time were oversized are now undersized – and this causes high maintenance requirements.

NEW IDEAS SUPPORTED BY TEKES

In 2012, MoveRoll started to consider new alternatives to the traditional methods, in the hope of developing better ways to cushion rolls whilst saving as much energy as possible. During the R & D process, funded by TEKES (The Finnish Funding Agency for Innovation), we tested several methods – some of which had commercial potential – to learn how receiving processes could be improved. Based on the test results, we found that the best solution comprised two-level absorbing sections. We have introduced the MoveRoll Zero Energy Receiver (ZER) as a replacement to fixed steel stops, and developed a new philosophy to mechanical receiving that emphasises safety, simplicity, cost efficiency, and low energy consumption.

"Even if ZER-receivers look simple, it has been a challenging and difficult process to find the correct solution and technology which can be adapted to different paper roll sizes, different roll weights, and different paper qualities", comments MoveRoll's CEO, Mikko Rantanen.

ABSORBING KINETIC ENERGY

ZER-Receivers have been developed for low-frequency roll handling applications. They are very simple constructions and low-cost solutions that do not need to be connected to any energy sources. The unique receiving method uses self-inflating energy absorbers with adjustable energy absorbing capacity. This way most of the roll dimensions and widths can be handled with care. Compared to steel stops, the most significant benefit of the new receiving solution is that the energy actually is absorbed, while steel stops cause rolls to bounce back to the deck and eventually slow down through friction. This absorption of energy means two major improvements for the roll receiving process: first, and most importantly, increased workplace safety. Secondly, a reduction in paper roll damage. The improvement in safety is due to the energy absorbing function of ZER-Receivers which prevents paper rolls from bouncing back and forth heavily. This is especially relevant for applications where operators are working on decks. Winder decks are typical examples of this. Less roll bouncing also means less friction and roll spinning, and, accordingly, a reduction of paper cuts and tears. Furthermore, with ZER-Receivers paper rolls only ever touch the self-inflating energy absorbers; by having no contact with the steel plates, damages to paper rolls are further reduced.

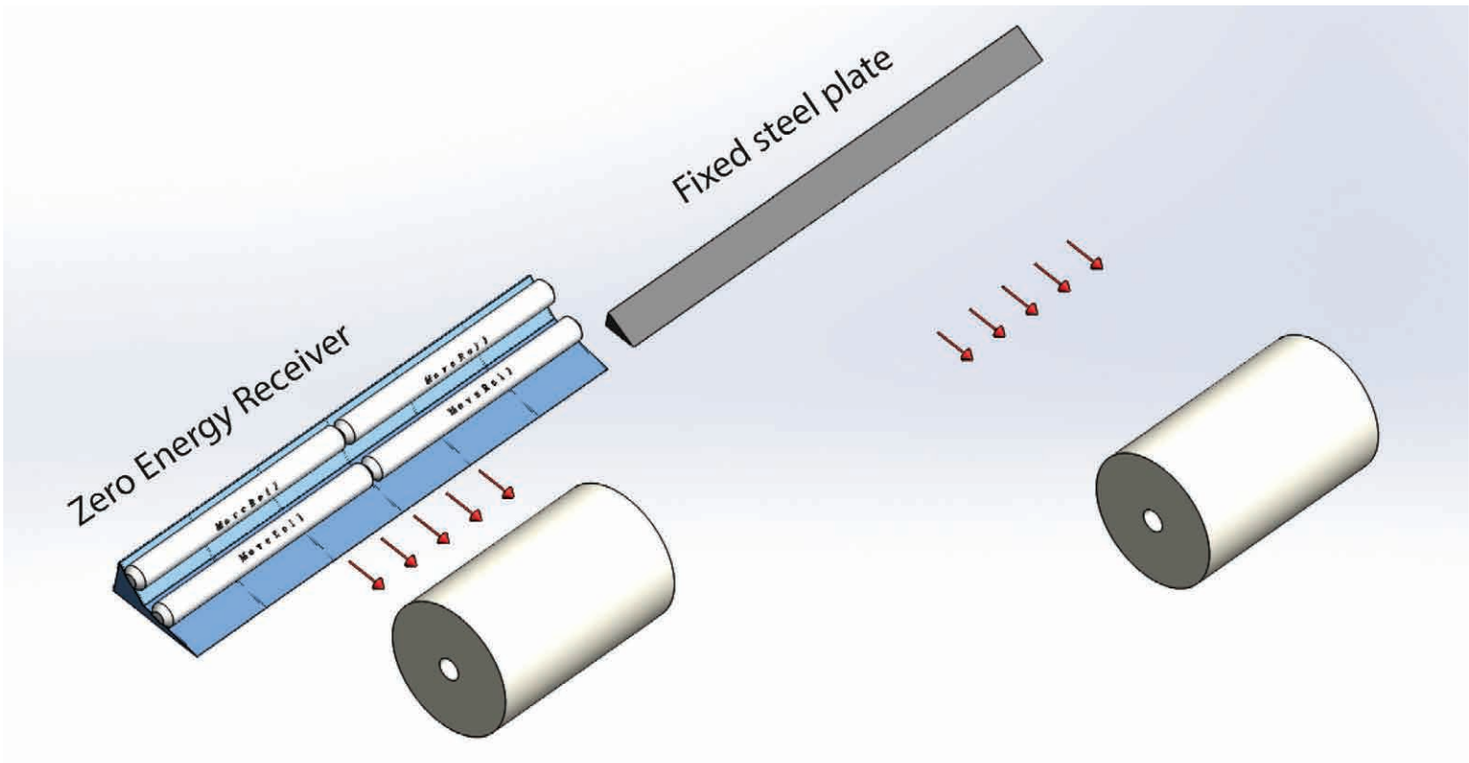

Figure 2. *Zero Energy Receiver vs. Fixed steel plate*

CASE STUDY: LIVE TESTING AT STORA ENSO

One of the first ZER-Receiver installations MoveRoll was made at the Stora Enso Anjala Mill. The changeover was straightforward, and was possible without interrupting production. Two major problems in the winder deck existed: because of elavation and too high a rolling speed, the rolls were hitting the fixed steel stop far too fast. This created safety risks for the winder deck as well as paper web cuts to the paper roll, which slowed the roll handling process down. "Safety has always been a key concern in places where operators are working with moving paper rolls. The movement of any heavy object can cause big safety hazards", explains Mikko Rantanen. The installation of the ZER-Receiver successfully addressed these problems. Compared to the old installation, more than 75% of the kinetic energy in a moving paper roll was absorbed; work safety was improved and paper cuts were reduced. Furthermore the process capacity increased and the process became faster.

"Today, occupational safety issues are highly relevant when planning investments, in addition to normal financial and productivity calculations. With the latest version of the cushioner, we had this on top of the agenda and we have reached our targets also in this respect," says Pekka Hujanen from Stora Enso. Due to the close relationship with this paper mill, MoveRoll has had the opportunity to improve the installed system and the whole ZER-receiving technology further after the installation.

"We often try to get partners involved in our development projects, but exactly this kind of arrangement we have not had before. This has been more or less pioneering in this field. Proximity and open communication with each other has helped us, and everything went smoothly," concluded Pekka Hujanen.

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