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MESSUKESKUS

Dr.-Ing. Kerstin Graf
Chief Editor

Market for packaging 2019

For the first time in years, the German packaging market has shown a slight decline in earnings. According to the Joint Committee of German Packaging Manufacturers (GADV), around 19 million tons of packaging material were produced in 2019. This means that the production volume fell by 1.8 %.

The production value decreased by 1.0 % to around € 33 billion. As in previous years, plastic packaging generated the largest share of the production value with a share of around 45 %. In terms of volume, packaging made of paper, cardboard and paperboard was the largest packaging material fraction with around 47 %.

In terms of production, the packaging fractions show a mixed picture: glass packaging is recording growth of 1.2 %. In contrast, production of metal packaging made of aluminum (-4.6 %) and steel (-4.2 %), and packaging made of paper, cardboard and paperboard (-2.5 %), as well as plastic (-2.4 %) declined.

The picture is similar in terms of production value, with only glass packaging showing growth in 2019 (+7 %). By contrast, the production value declined of packaging made of aluminum (-3.3 %), plastic (-2.1 %), steel (-0.7 %) and paper, cardboard and board (-0.4 %).

"Packaging is an important part of the entire retail chain. Without it, a safe and reliable supply of everyday goods for people would be unthinkable. The corona pandemic also makes many consumers more aware again that packaging has an important protective function, as it reliably protects food and beverages from environmental influences," says Johann Overath, General Manager of the Federal Association of the German Glass Industry (Bundesverbands Glasindustrie e. V.) and GADV spokesman.

On a political level, everything in the packaging industry revolves around the topic of the circular economy: recyclability, increasing collection rates for packaging and the discussion about mandatory recycling quotas. "The packaging industry continues to work on optimizing its products, also with regard to the end of the life cycle and thus closing loops," explains Overath. This is an important topic, because increasing numbers of end consumers are also attaching importance to environmentally friendly and sustainable consumption and include the environmental friendliness of the packaging at the point of sale in their purchasing decisions.

The latest industry survey conducted by the Association of the Paper and Foil Wrapping Industry (IPV) shows that plastic packaging and the corresponding manufacturing companies face a difficult future. Fossil plastics have so far been indispensable for many applications due to their properties such as very good formability and elasticity. At the same time, consumers are calling for a sustainable replacement of petroleum-based plastics. A major challenge is the lack of alternatives for substitutes. At the same time, the trend towards paper packaging as a substitute for plastic continues and is also gaining momentum. Not only is the development of alternative composite products being driven forward by different players, research has also made progress in areas such as the barrier protection function of paper. 80 % of companies state that customer demand for fiber-based substitute products is strong or even very strong. Recyclability is in the foreground here, but the negative public image of plastics and the desire to avoid the introduction of plastics into the environment also play a major role in the high demand for paper substitutes. Products from renewable raw materials are preferred.

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The VR training programs offered by Voith Paper-School not only improve the quality and efficiency of basic and advanced training for paper producer LEIPA at its Schwedt location. The virtual reality application also creates new possibilities for the company and enhances the employer brand in the competition for skilled workers.

Picture: Voith

Picture: Holzforschung Austria

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Complexing agents such as EDTA and DTPA are still important for the production of speciality papers and pulp to obtain the required ISO brightness. However, environmental certificates and legislation demand the reduction of these complexing agents and regular monitoring of wastewater emissions is mandatory.

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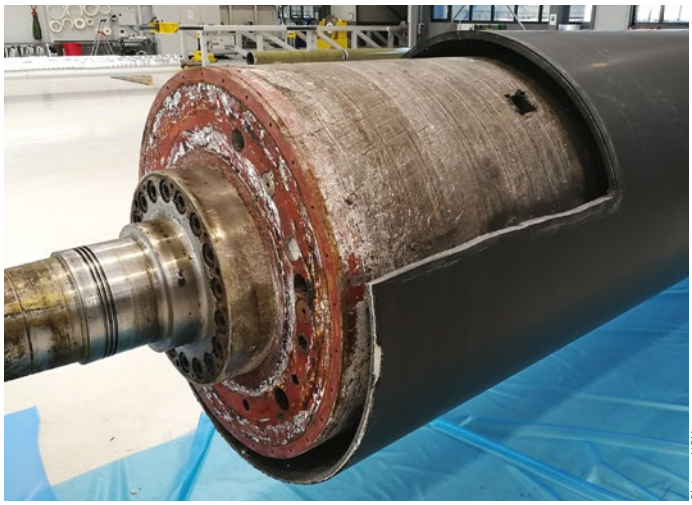
UPM is the world's leading manufacturer of graphic papers. The factory in Schongau near Munich, Germany, produces standard and special newspaper (MFS), as well as uncoated magazine papers (SC). On the PM 9 paper machine, the machine operator was faced with the problem of increasingly stronger vibrations developing with the CSR roll (Center Supported Roll) in the position of the breast roll and the wire drive roll.



Picture: UPM

Picture: Solenis

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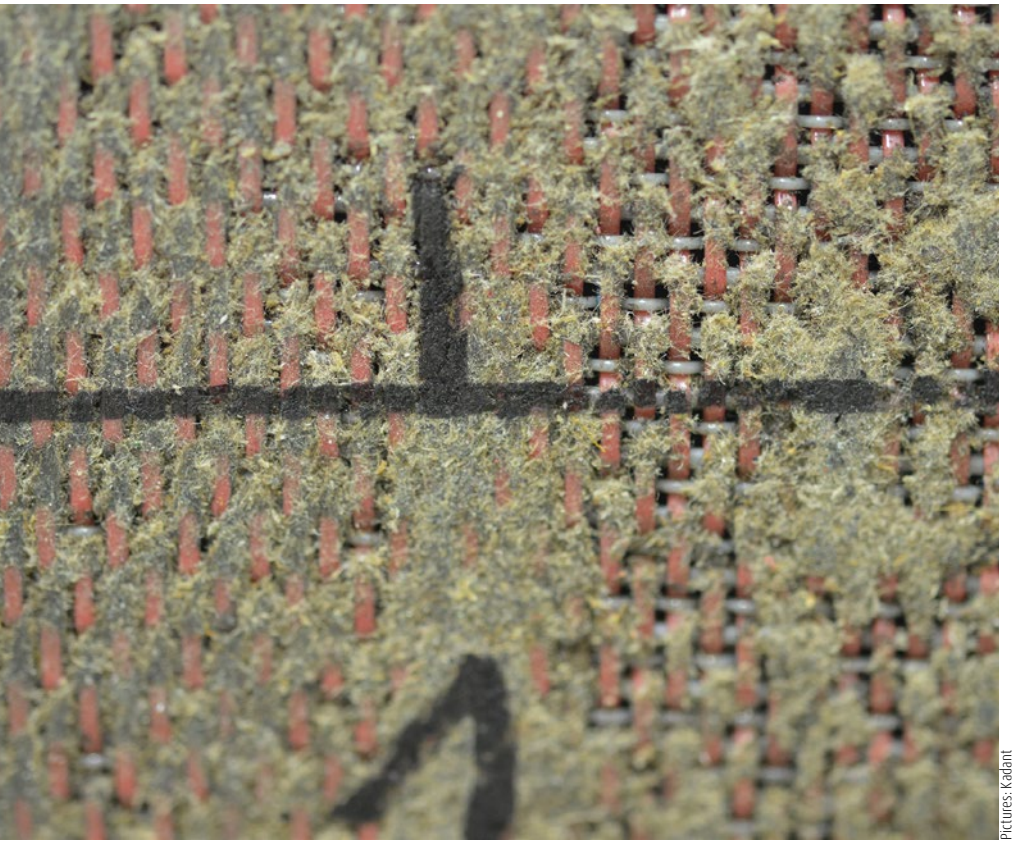
The unfolding of the past several months has led to more unpredictability than any of us could have imagined. Stay-at-home orders, social distancing guidelines and consumer panic buying have created major irregularities in tissue and towel market dynamics and consumption patterns. These challenges also present a great opportunity to help tissue and towel producers adapt and respond to these sudden changes.

Dryer fabric cleaning on a different level

... and without waterways



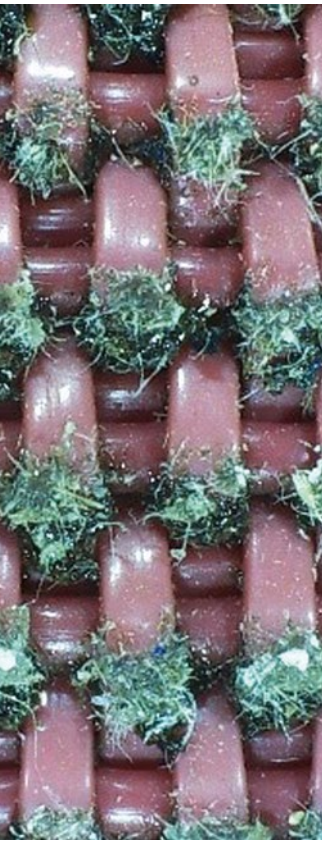
Pictures: Kadant

Fig. 1: "Shadow Dirt" on paper side

Already during his employment at the clothing manufacturer Heimbach in Düren, where Werner Raschka was the strategic product manager for dryer fabrics, the question of how to clean the dryer fabrics as efficiently as possible was raised again and again.

As a result, Heimbach began to develop dryer fabrics that got less dirty and could also be cleaned much more easily. In order to test the newly developed dryer fabrics, trials were done with manufacturers of traversing cleaners. During this time, contact was established with Kadant Nordic in Sweden, where Werner Raschka eventually began to work as Product Manager in 2015.

What was the focus of your research on cleaning dryer fabrics?
W. Raschka: Right from the start, the main focus of development was on significantly improving cleaning. Cleaning without any disturbing factors, such as damp streaks in the paper from the dryer fabric cleaning, or the coating of the fabrics on the roll side. During several dryer fabric tests on paper machines that were equipped with different cleaning units, we saw the "same pattern" on the paper side again and again. The contamination always stuck at the same place; always in the trailing part of the warp thread and in the space between the warp and weft thread. This so-called "shadow dirt" (as shown in Fig. 1) is due to cleaning against the running direction.
But even if the paper side was clean, there was often a reduction in air permeability. The screen was dirty from the roll side. This was very often a consequence of the cleaning concept. The dirt was "cleaned" to the roll side and remained there.



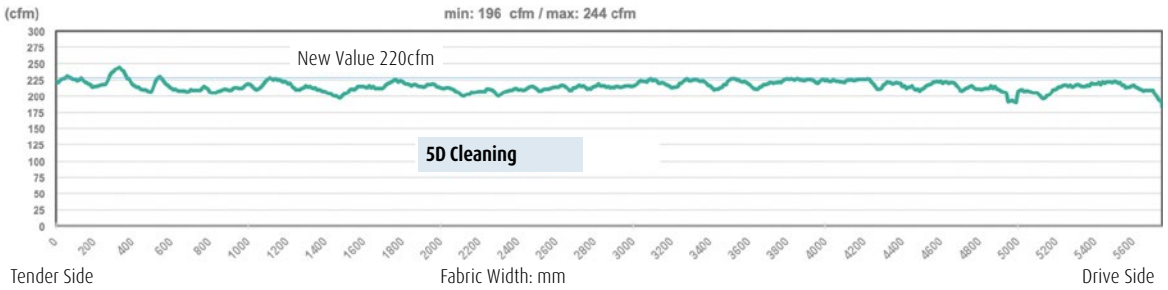


Fig. 2 Air permeability measurement after almost 70 days of operation with 5D

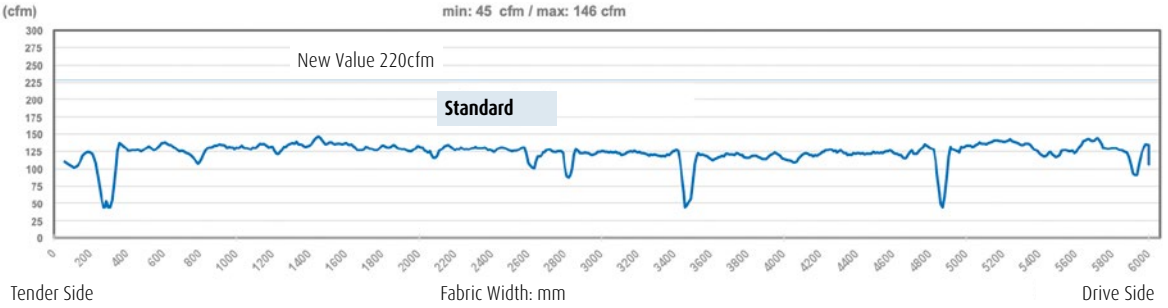


Fig. 3: Air permeability measurement with the conventional standard cleaning method

Fig. 4: New values in air permeability after several cleanings of heavily soiled dryer fabrics

...
Here, the weft and warp threads are, in the truest sense of the word, individually "ploughed" from 5 different directions, and thus almost perfectly cleaned.

Werner Raschka

Interview

Werner Raschka, born 1966
- University degree: Process engineering paper plastics with focus on paper production 1989–1993
- Production experience: 1994–2003
- Assistant in Cham Tenero, Cham, Switzerland, 1994–1998, Technocell Dekor, Neustadt, Germany, 1998–1999
- Operations Manager at Kappa Badenkarton Gernsbach, Germany, 1999–2003
- Change to the supply industry: 2003– today
- Heimbach GmbH & Co KG Strategic Product Manager Dryer fabric, 2003–2014
- Kadant Nordic AB in Sweden Product Manager m-clean 2015– today

How did you finally become master of the "shadow dirt"?

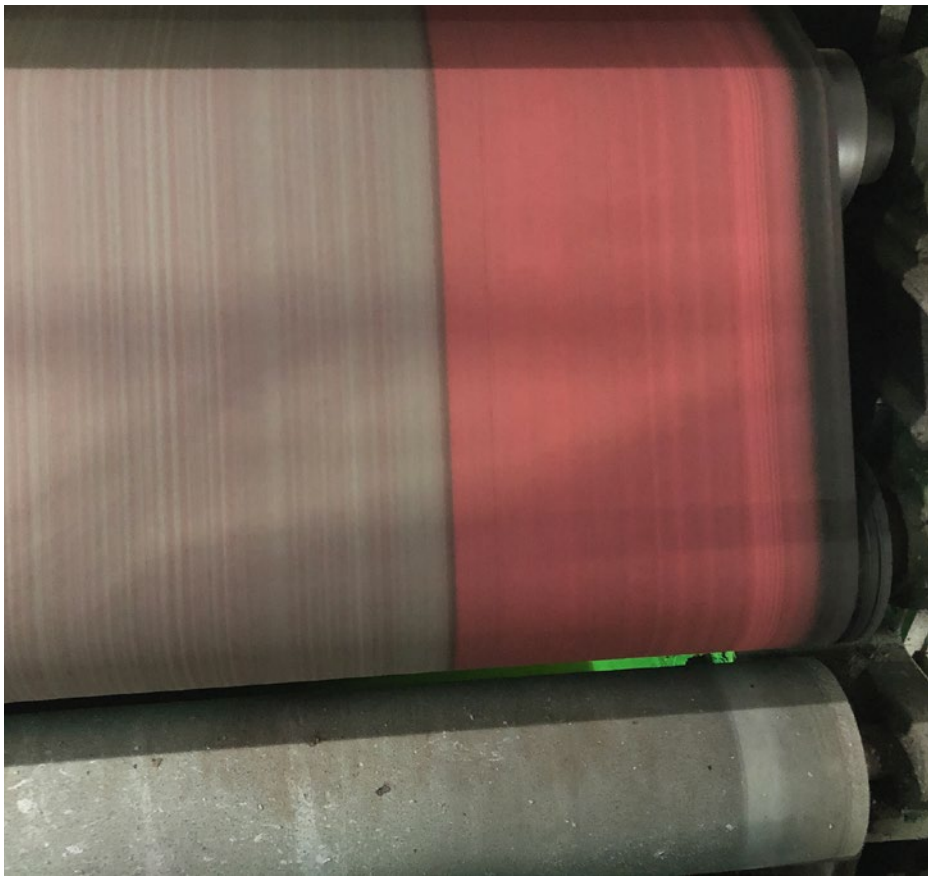
W. Raschka: During further tests on our trial machine in Sweden with various dryer screen designs, we tried out cleaning variants and learned a lot about how best to clean which dryer screen design. In the case of dryer fabrics, one should distinguish between the two main groups, woven fabrics and spiral fabrics, in terms of their behavior. Nevertheless, from the very beginning, our aim was to clean all dryer screen designs with the same cleaning strategy.

Kadant has had its own R&D center in Sweden for decades and first put the cleaning strategies developed on the trial machine there through their paces in several elaborate test series. They then additionally tested, monitored, and evaluated with trials on various paper machines at the customer on-site.

What results were seen?

W. Raschka: It was recognized early on that the cleaning of the remaining shadow dirt requires an adjustment of the cleaning angles and the direction – up to now, cleaning has mainly been done against the direction of the dryer fabric. The cleaning performance of the original one direction cleaning was compared with the development of 3D (3 directions) and 4D.

Here, a significant improvement was already noticeable, but in our opinion, the result was not yet completely sufficient. We had expected more.



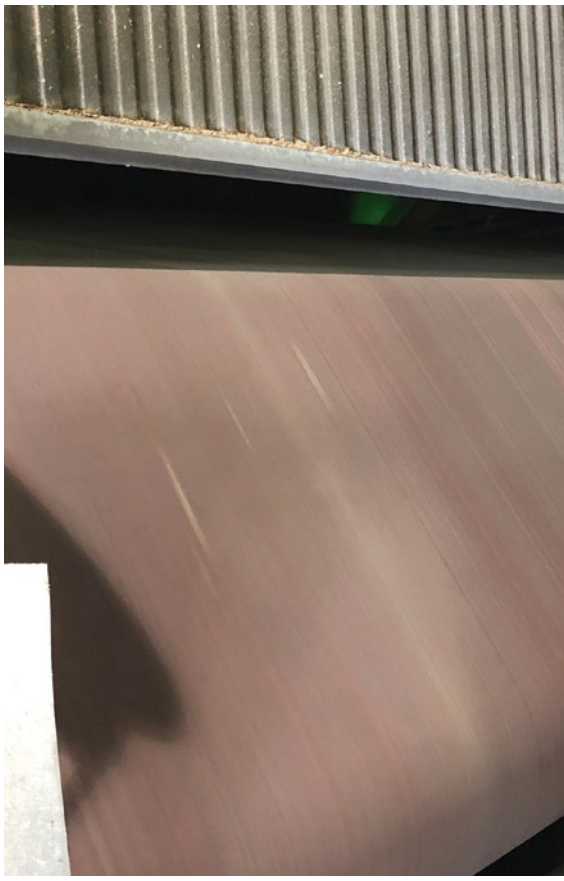


Fig. 5: First traversing after installation of the 5D cleaning concept

So you continued to tinker.

W. Raschka: Yes, and we achieved the absolute breakthrough with the development of our 5D concept. Here, the weft and warp threads are, in the truest sense of the word, individually "ploughed" from 5 different directions, and thus almost perfectly cleaned. Not only the paper side but also the roller side remained or became as good as new again. Already on the test machine we saw a difference like night and day to the previous cleaning results.

After the success of the 5D cleaning on our test machine, we looked for further customers with existing cleaning systems where we could show the performance of our new 5D development in practice. The more challenging the application was, the more we were attracted by the test.

Has the new system reached its limits?

W. Raschka: No. The new cleaning concept was an overwhelming success everywhere. The dryer fabrics maintained almost the same air permeability values as when they were delivered throughout their entire service life. On a brown paper machine (Fig. 2), the air permeability measurement remained at "new value" after just under 70 days of operation.

For comparison, Figure 3 shows the cleaning performance drop almost 50% at the same position with the same running time but with the conventional standard cleaning method.

> ... we also dared to use the successes with new dryer fabrics on already soiled dryer fabrics.

What results can be seen when cleaning dirty dryer fabrics?

W. Raschka: Since it is known that it is easier to keep dryer fabrics clean than to clean dirty dryer fabrics, we also dared to use the successes with new dryer fabrics on already soiled dryer fabrics. Even with very heavily soiled fabrics, we were able to regain the new values in air permeability after several cleaning cycles during production. A result that had never been seen before. Up to now, it was thought that cleaning units could only slow down the reduction in air permeability but could by no means restore the original condition. This theory has now been refuted (Fig. 4).

Figures 5 and 6 show the enormous cleaning effect of the new 5D nozzle concept during its first traversing.

Thus, the first part of the development – improvement of the cleaning performance – was more than fulfilled with the new 5D cleaning concept. A cleaning performance that enables the paper machine operator to carry put production with the new values of air permeability until the end of the dryer fabric's service life. Stable production conditions are a key factor in achieving high paper machine efficiency.

And what about the roller side?

W. Raschka: Thank you for the question. The roll side was also cleaned with the new 5D nozzle body and this was already done during the first traversing (Fig. 7).

One customer had indeed noticed that even the rolls are much cleaner than before the change to 5D.

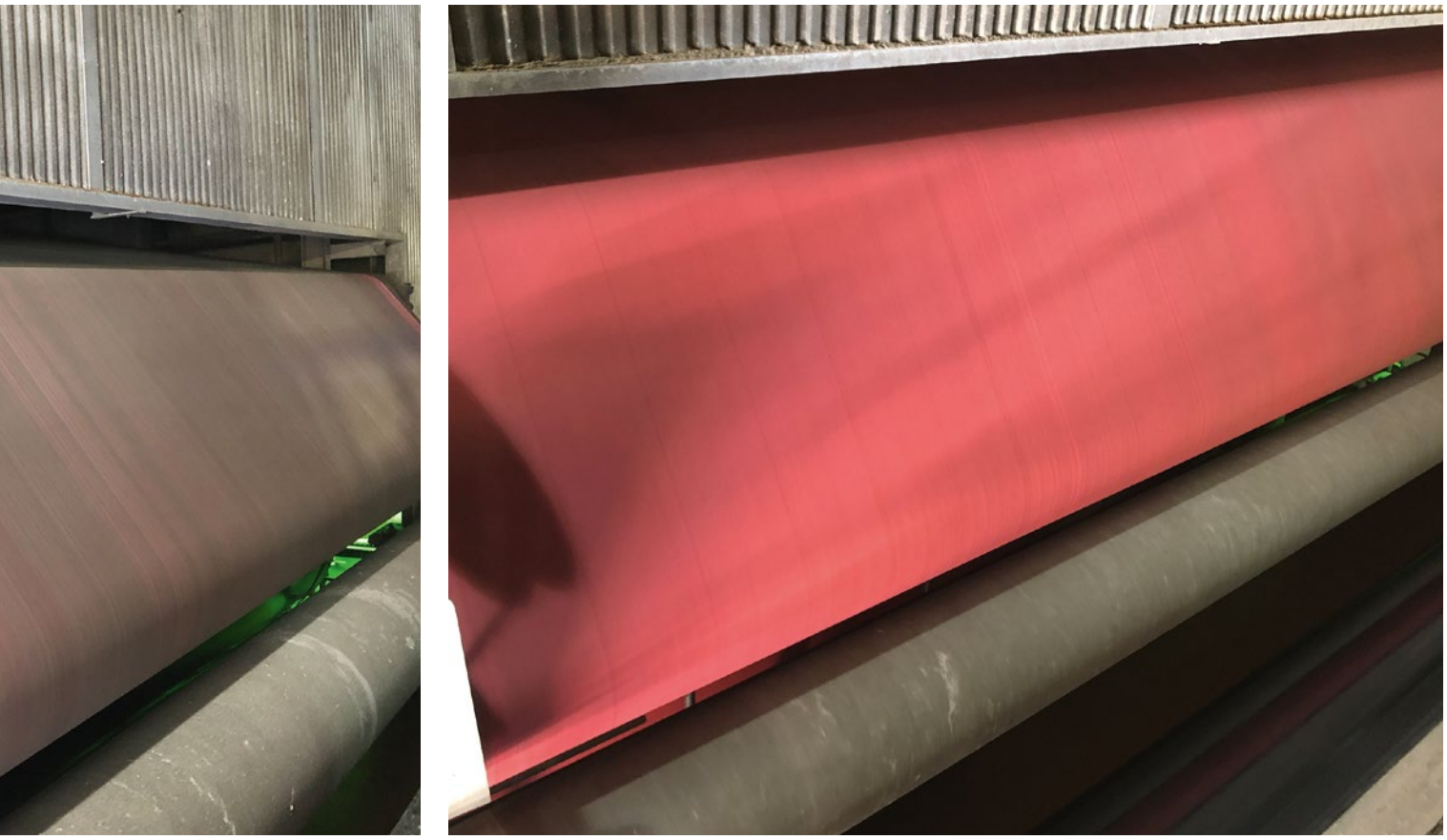


Fig. 6: Cleaning result after the first traverses after installation of the 5D cleaning concept – before – after

> ... and already soiled screens are cleaned again to LD new value.

What challenge have you set yourself for the next step?
W. Raschka: The second focus of development was to achieve this exceptional cleaning performance without negative side effects such as residual water in the dryer fabric. Residual water in dryer fabrics often leads to damp streaks, which cause production problems at the size press or winder, among other things.
Thanks to a new development of the air knife and optimization of the vacuum flows in the cleaning head, problems with damp streaks in the paper from the dryer fabric cleaning are now a thing of the past.

What other optimizations have you implemented?
W. Raschka: In the course of the development we optimized further points. For example, the cleaning head on the outside and the entire cleaning bar remain much cleaner than before. The new cleaning head also eliminates clogging of the head and the lines (Fig. 8).

But you have remained true to a few things...
W. Raschka: For good reason. We still clean on the roller as we did before. This has the great advantage that the conditions are or remain the same, even with the new machine concepts without an external guide roller. The two main problems with cleaning in free draw are the collection of the water/dirt mixture underneath the wire and the varying distance of the cleaning head from the clothing due to the non-horizontal tensioner path.
The cleaning and blowing out of the water/dirt mixture immediately takes place shortly after the screen has left the roller. In this case it is often not possible to pull the trough upwards far enough to collect the entire mixture directly. A main part of the mixture gets onto the roller and contaminates the dryer fabric from the roller side. The result is that the dryer fabric on the paper side is clean, but the gaps and the roll side are dirty. The air permeability is significantly reduced.
Furthermore, the use of a tub to collect the water/dirt mixture in the dryer section must always be viewed critically. Thus, the tub must be cleaned from time to time in order to prevent clogging, or it comes to drop formation at the tub, ... to name but a few points. With this I do not mean that it isn't possible.
Another point when cleaning in free draft?? is the adjustment and maintenance of the correct distance of the cleaning head to the covering over the running time of the fabric.
As a result of the stretching or shrinking of the dryer fabric, the distance between the cleaning head and the fabric varies. This is due to the trigonometry of the roller arrangement (see picture below). The various distances of the cleaning head can lead to a reduced cleaning performance, to an increase of the residual water content in the dryer fabric and also to increased abrasion (Fig. 9). In general, housekeeping is also more difficult if the distance between the cleaning head and the screen surface is too large.

Fig. 7: Cleaning result on roll side of the fabric during the first traversing

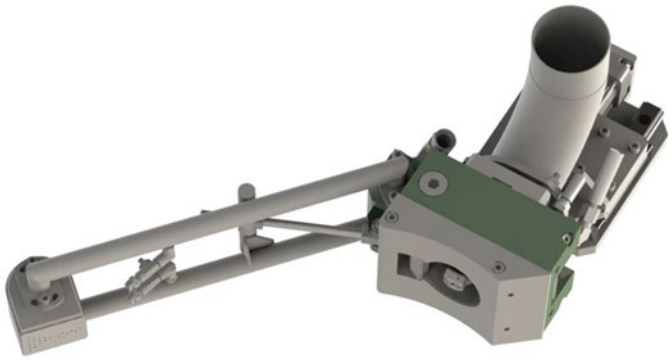


Fig. 8: New M10 cleaning head with 5D cleaning concept

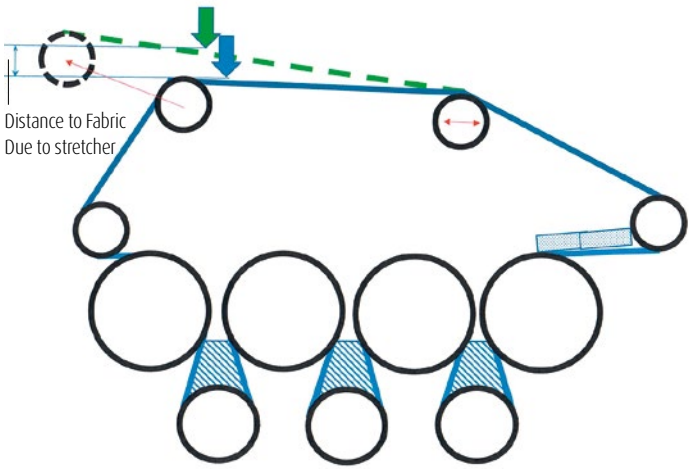


Fig. 9: Change of the distance of the cleaning head by non-horizontal stretcher

> This keeps the cleaning head on the outside and the entire cleaning bar much cleaner than before.

Are there any other advantages that speak for operating the cleaning head on the roller?

W. Raschka: I will only mention a few points here. Flabby edges or the edge formation of the dryer fabric are not a problem when cleaning on the roll. Even with a high vacuum, to suck off the water/dirt mixture, cleaning on the roller never causes suction and thus damage to the dryer fabric.

What are the economic advantages of the new cleaning concept?

W. Raschka: The nice thing about the new cleaning concept is that the ROI can also be calculated very easily. Increased screen service life due

M-clean™ System

The M-clean system is a modular cleaning system for fabrics, belts, and rolls in process industries.

The modular design provides flexibility allowing all new equipment or a combination of new and existing equipment. Key components, such as spray nozzles, are also interchangeable to fit the application. The three customizable M-clean systems available are the M-clean PRO, M-clean ULTRA, and M-clean BRUSH.

M-clean PRO

The M-clean PRO has the largest installation base and is the most powerful unit within the M-clean system product line.

It contains a complete set of high-pressure pumps, evacuations, and control systems where a desired number of cleaning units are connected. The system effectively cleans both the surface and deep inside the fabric structure or roll cover and ensures that all removed impurities are collected and discharged outside the machine.

M-clean ULTRA

The M-clean ULTRA builds upon the M-clean PRO, however it is constructed with a simpler, more streamlined design to suit narrow and tight installation positions. The M-clean ULTRA works with lower water pressure and a simplified pumping and control system but offers all necessary features suitable for a high-quality system. The M-clean ULTRA is designed for continuous operation; however, some applications require only intermittent use.

M-clean BRUSH

The M-clean BRUSH uses the same method of high-pressure water, evacuation, and air knife system as the M-clean PRO and works in combination to remove impurities, dried out coating color residues, and roll contaminants. Additionally, it has a rotating brush which is an integrated part of the cleaning head for removing contaminants from the roll surface. The cleaning head includes double nozzle bodies for shock cleaning during breaks and continuous cleaning.

to previous contamination-related changes and reduced use of chemicals for cleaning. These are only two of the factors that speak clearly in favor of the new 5D cleaning concept from Kadant, in addition to the greatest ROI factor, the increase in production volume or the reduction of downtime. The environment is also protected by this new cleaning concept. Due to the extremely effective cleaning, in the majority of cases we operate our systems discontinuously, i.e. energy and water are only used intermittently.
We will be pleased to present our new cleaning concept to interested parties.

Many thanks for the interview.

www.kadant.com

About Kadant

Kadant Inc. has provided intelligent and efficient solutions to the process industry for over a hundred years. As a global leader in the fields of fiber processing, fluid handling, water management and doctor systems, Kadant develops and manufactures products for a wide range of industries – from paper and plastics production to the textile industry and tire manufacture.
Kadant is a leading manufacturer of technology-based systems for the global pulp and paper industry and other processing industries. Kadant's systems play a critical role in almost every stage of paper production and recycling, as they improve process efficiency and product quality for customers. Kadant offers innovative products and technologies that help reduce energy consumption, improve water management and further develop sustainable systems.

The main product offerings interests:
- Stock preparation systems for the recovery of recyclers fibers and paper fiber preparation
- Fluid handling systems to monitor repairs, steam or air in rotating cylinders and fixed pipelines
- Roller doctor process and wiping products for cleaning the roller surfaces to ensure an eff. To secure machine operation
- Water management systems for the cleaning and conditioning of fibers and for the recycling of process water
- Fiber-based granulate, belongs to the secondary business of paper production for agriculture or use in private gardens

Although Kadant is a relatively new name and has only been a completely independent company since 2001, many of the divisions have been serving industrial customers for over 100 years. Through a combination of takeovers and internal development processes, the position as one of the leading suppliers for global processes could be expanded.
Kadant is based in Westford, Massachusetts. The company employs 2,800 people in 20 countries worldwide. The stock is listed on the New York Stock Exchange under the symbol KAI.
Kadant branded products and services are offered worldwide through offices in North America, South America, Europe and Asia.

Online air balance PM8 / SM8 at the Koehler Paper Group

airinotec optimizes the operation of air handling units and heat recovery systems for increased efficiency, sustainability and operational safety

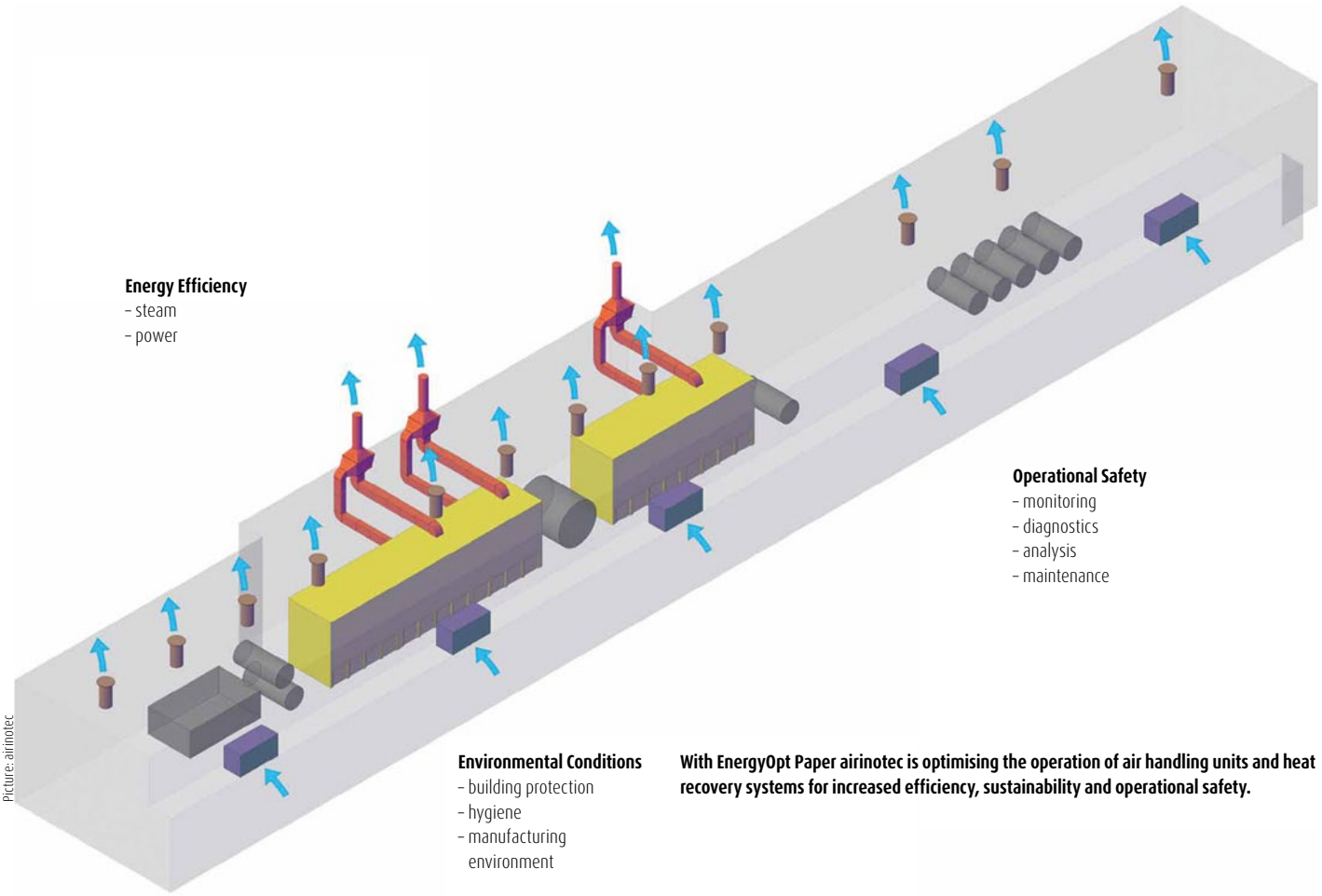
Picture: Koehler Paper Group

Since the beginning of 2020, EnergyOpt Paper has been in use on the paper machine PM8 and coating machine SM8 at Koehler Paper Group in Kehl.

The paper industry is one of the most energy-intensive industries. At the same time, there is a series of approaches being taken in factories which can support less expensive and more energy-efficient production. The operation of energy-intensive air handling units and heat recovery systems offers savings potentials. With EnergyOpt Paper, airinotec has developed a system that specifically addresses this issue. EnergyOpt Paper has been deployed at Koehler Paper Group for the paper machine PM8 and the coating machine SM8 since the beginning of 2020.

With the new paper machine PM8 and the coating machine SM8, the Koehler Paper Group has invested in a sustainable future. The plant produces flexible, sustainable packaging solutions which replace plastic packaging by innovative and recyclable barrier papers.

As in the entire paper industry, air handling with the heat recovery systems is of significant importance for the new Koehler plant. For this reason, the company consulted airinotec, experts in this field, at an early phase in the planning process. The objective was to ensure that not only the final product is sustainable, but that operation of the energy-intensive air handling units and heat recovery systems is also made energy-efficient.



Picture: airinotec

With EnergyOpt Paper airinotec is optimising the operation of air handling units and heat recovery systems for increased efficiency, sustainability and operational safety.

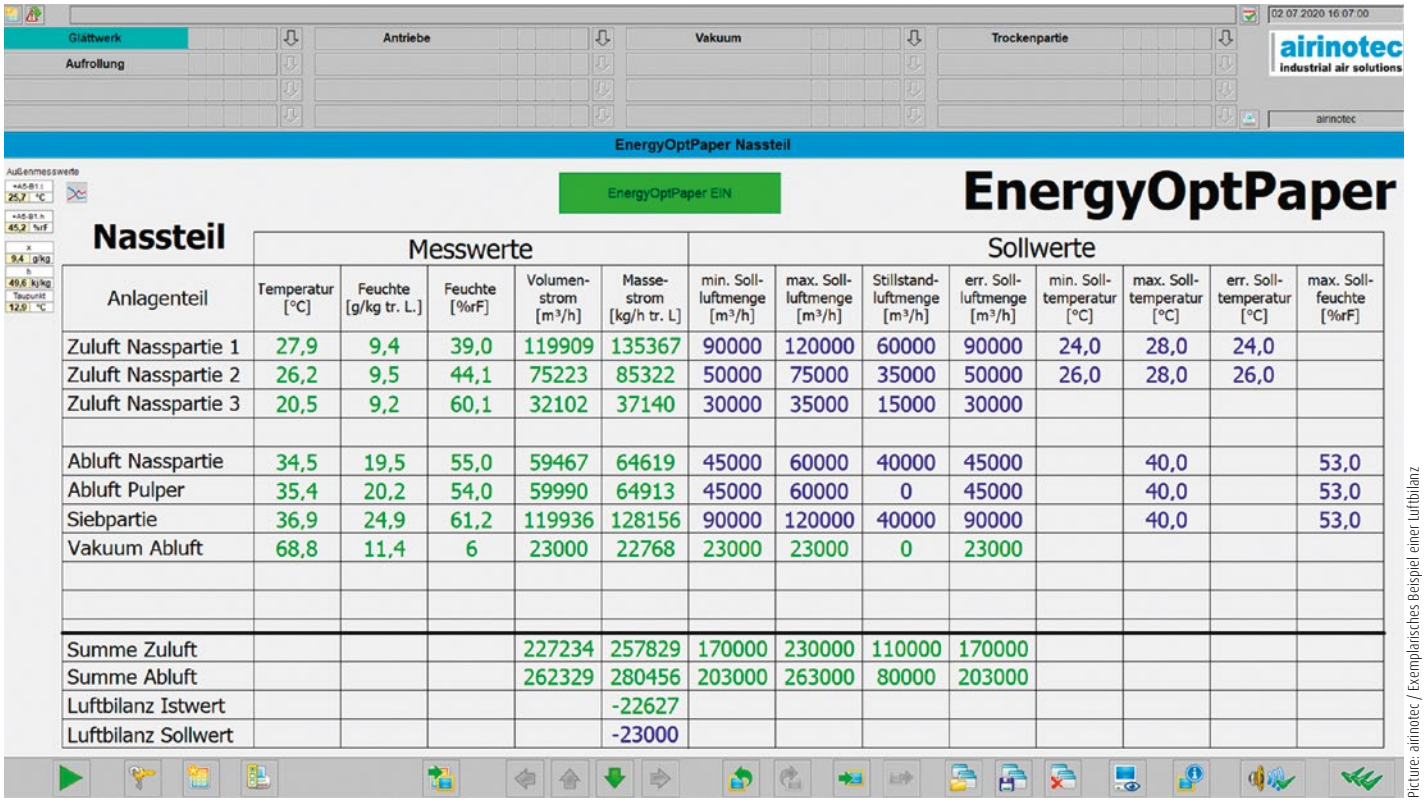
The best available technology is not the same as state of the art

It is no secret that the paper industry is extremely energy-intensive. Therefore it is all the more astonishing that energy-saving potentials are not exploited sufficiently. Steam and heat have to be dissipated during the drying process – this task is taken over by the air handling unit, which has been dimensioned to cope with the maximum case. Steam and heat are dissipated in such a way that the unit works under the most difficult conditions – in other words in summer and at maximum production capacity. The systems are statically adjusted once during commissioning and are either not controlled at all or are only set for summer/winter changeover.

This practice results in a whole range of disadvantages, which in turn lead to problems or at least to the inefficient handling of resources. The uncertainties begin with how any regulation is to be defined: it must be considered, for example, what is to be designated as summer and winter respectively, and whether temperature, humidity or external air are to be used as an indicator. Independently of these regulation uncertainties, the greatest difficulty is the non-consideration of changes in production or processes. The systems run at the same level – no matter how high or low the humidity input in the hall climate is or how the hall air balance is changed by the dew point control of the PM hood or the switching on and off of other units, for example. The operation of air handling units is often like flying blind: the operator does not receive any feedback about whether the units are achieving the target air quantities and often operate these at a poor operating point due to lack of knowledge. Another fact about current practice is the less than optimum use of heat recovery potentials.

Plant operation in blind flight

This means a whole range of problems – some of them extremely serious – can arise for the operator. The first worth mentioning is the uneven air balance in the production hall. A sub-balance often leads to infiltration of cold air, which in turn can lead to condensation and mould formation. If air flows and humidity loads occur uncontrolled in the production process, fluctuations in pressure, web flapping and drop formation can be the result. Alongside hygienic aspects, in other



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Zuluft Nasspartie 1	27,9	9,4	39,0	119909	135367	90000	120000	60000	90000	24,0	28,0	24,0	
Zuluft Nasspartie 2	26,2	9,5	44,1	75223	85322	50000	75000	35000	50000	26,0	28,0	26,0	
Zuluft Nasspartie 3	20,5	9,2	60,1	32102	37140	30000	35000	15000	30000				
Abluft Nasspartie	34,5	19,5	55,0	59467	64619	45000	60000	40000	45000		40,0		53,0
Abluft Pulper	35,4	20,2	54,0	59990	64913	45000	60000	0	45000		40,0		53,0
Siebpartie	36,9	24,9	61,2	119936	128156	90000	120000	40000	90000		40,0		53,0
Vakuum Abluft	68,8	11,4	6	23000	22768	23000	23000	0	23000				
Summe Zuluft				227234	257829	170000	230000	110000	170000				
Summe Abluft				262329	280456	203000	263000	80000	203000				
Luftbilanz Istwert					-22627								
Luftbilanz Sollwert					-23000								

Picture: airinotec / Exemplarisches Beispiel einer Luftbilanz

EnergyOpt Paper makes online-controlled air balance possible.

Features of EnergyOpt Paper

- Air and water balance determined online
- Requirement-guided optimisation of supply and waste air quantities in accordance with production conditions and climatic requirements
- Requirement-guided optimisation of the quantities of water circulating in the system
- Optimization of the degree of effectiveness of all heat recovery
- Self-adapting comparison of water hydraulics
- Heating through steam only when all resources have been exploited
- Online analysis for increased operational safety
- Integration in existing process control systems or as standalone solution

Information about airinotec

airinotec GmbH, with a registered office in Bayreuth, is an internationally active system provider which focuses on industrial climate technology and process air technology. The company always ensures the right climate in production and processes by utilising its innovative concepts, modern automation solutions and intelligent service products. Starting with consulting and system development and on to the complete construction of plants or systems and up to, and including, upgrading existing plants and systems – challenging task activities and areas require tailor-made solutions: airinotec has many years of experience in the foodstuff and paper industries and ensures optimum production conditions in many other branches of industry – effectively and energy-efficiently.

words poor working conditions for employees and critical ambient conditions for the products, these conditions will damage the building in the long term.

If the operator is not informed of the condition of the air handling units and heat recovery systems, this will also affect energy efficiency: consumption of steam and electrical energy will be higher than necessary. Lack of monitoring not only means energy inefficiency but also insufficient operational safety plus increased maintenance and operating costs.

Requirement-optimized operation with EnergyOpt Paper

This is where airinotec's system comes in: EnergyOpt Paper makes an online-controlled hall air balance possible, allowing the problems outlined above to be eliminated. Companies thus receive a diagnosis and control tool which makes it possible to implement a comprehensive system operating strategy.

EnergyOpt Paper determines the air volume flows and blow-in temperatures required taking the air balances determined online into account – adapted to influences on production and external air conditions. This way, the use of energy for hall supply and waste air is optimised, leading to a reduction in energy costs. The heat supply is also determined on the basis of real conditions and constantly adapted. This reduces the power consumption for fans and pumps, and only the air-heating water quantity actually required is transported.

EnergyOpt Paper at Koehler

Koehler Paper Group and airinotec have been business partners for many years. At the company's main plant in Oberkirch, the existing paper machine PM5 was equipped with the software at the beginning of 2019. When designing the new production line for flexible,

sustainable packaging solutions in Kehl, the Koehler production team once again decided in favour of the airinotec system. Here, EnergyOpt Paper has been in operation for the paper machine PM8 and coating machine SM8 since the beginning of 2020. In total, EnergyOpt Paper at Koehler controls and acquires data from 15 hall supply air systems and 21 hall waste air systems, 20 machine waste air systems and three heat recovery systems for PM8 process air as well as two heat recovery systems for SM8 process air. Sensors transmit the required data which EnergyOpt Paper uses to calculate the air and water balances of the different production areas online – and regulates these fully automatically in accordance with the specifications made by production. The result: air handling units and heat recovery systems exactly matched to the respective situation in production.

Sustainable production which meets high hygiene requirements

For Koehler, the sustainability aspect played a central role in system planning – product and production should serve the same purpose here. With the implementation of EnergyOpt Paper, Koehler is reducing both energy costs and CO_2 emissions at the new production line.

In addition, the use of EnergyOpt Paper offers further advantages in terms of hygiene: the formation of condensation and mould is to be avoided. Thus a hygienic production environment is created with improved working conditions for employees. Buildings are protected and undesirable interference with production is prevented.

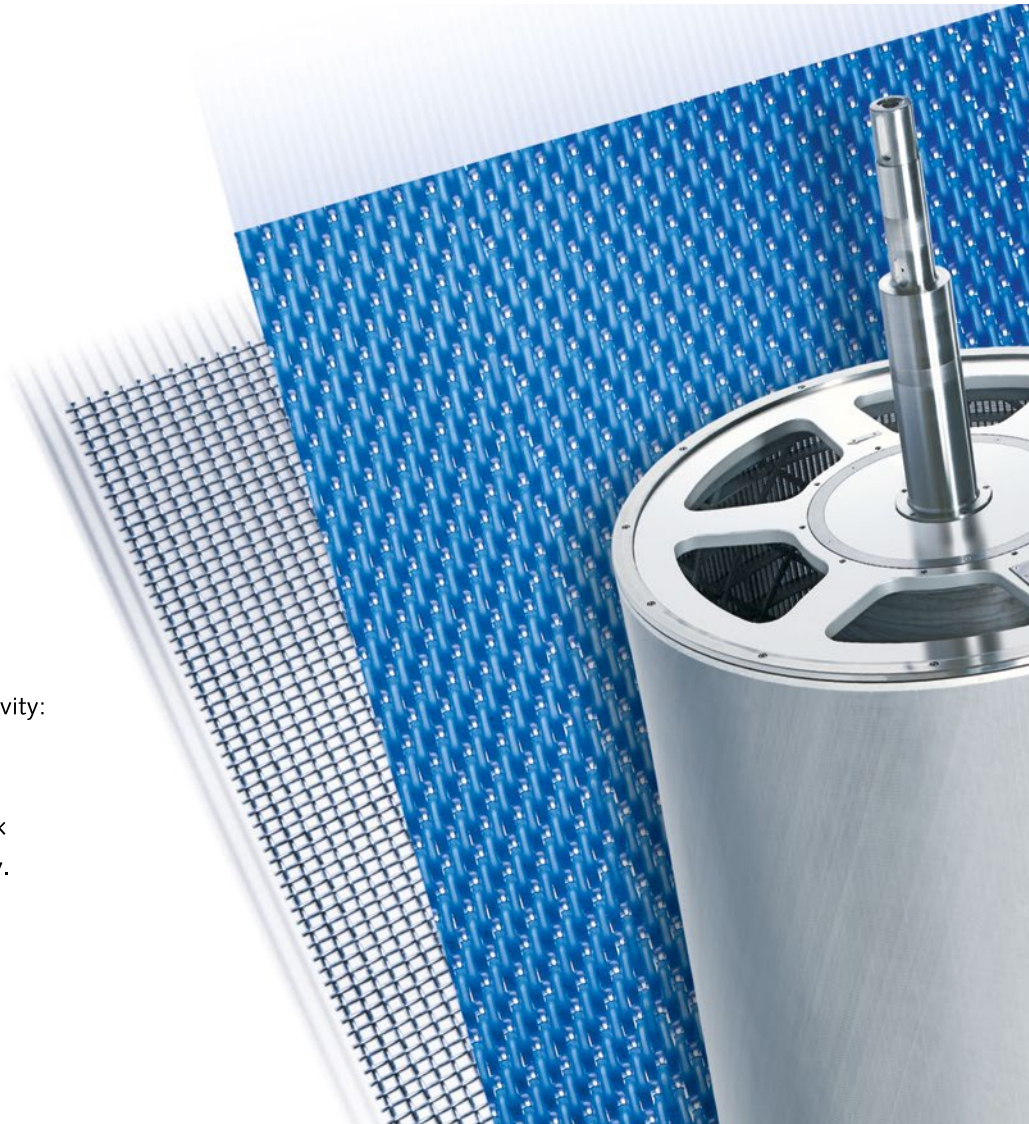
Analysis increases operational safety

As an add-on, the new process transparency ensures increased operational safety and support with the analysis of malfunctions or faults. The system provides information about the condition of the systems. Deviations from the target condition and faults can thus be detected early. The operator can establish problems quickly and eliminate them purposefully. Maintenance work can also be coordinated perfectly. EnergyOpt Paper is a system that offers many advantages at manageable investment costs.

Integration in process management systems

The system is flexible in terms of implementation, too: EnergyOpt Paper can be integrated in new or existing process control systems or realised as a stand-alone system. And it goes without saying that as a plant manufacturer, airinotec can also deliver the respective systems for machine and hall air, heat recovery and paper machine hoods. With these features, airinotec offers companies in the paper industry the possibility of advancing their sustainability policy, reducing expenditure and making their systems transparent with EnergyOpt Paper.

www.airinotec.com



Pictures: Bellmer GmbH

Start-up of the new Bellmer reeling, transporter and winding section.

Market pulp line conversion to fluff pulp line with Bellmer

Stora Enso Skutskär Mill, Sweden

Stora Enso converted one of its bale-based market pulp lines into a softwood fluff pulp line and increased its fluff pulp capacity at Skutskär Mill in Sweden. Bellmer was selected as their technology partner.

The 26 million euro investment enhanced Skutskär Mill's profitability and long-term competitiveness by increasing fluff production by 160 000 tonnes annually. The mill's total fluff pulp capacity after the investment is 415 000 tonnes.

"Both hygiene and non-woven products are a fast-growing market. This investment has enabled us to support the growth of our customers and further develop this business together with them," states Stora Enso's Biomaterials Division.

Stora Enso's Skutskär Mill in eastern Sweden is a modern pulp mill that primarily produces fluff pulp for diapers, other hygiene products and non-wovens, but also pulp for liquid packaging board and speciality papers. The mill's total annual capacity is 540 000 tonnes of NBSK pulp, softwood fluff pulp and bleached hardwood (birch) pulp.

Authors: Leif Lindberg, author for a Finish paper magazine
Ahti Peiponen, Winder specialist, Bellmer GmbH

At the middle Lasse Aspelin, StoraEnso Skutskär, right Frank Schorzmann and Ahti Peiponen from Bellmer.

Unique solution for finished rolls end taping with special tape.

Picture: Stora Enso

Storaenso Skutskär Mill in eastern Sweden is a modern pulp mill that primarily produces fluff pulp

Fluff Pulp – "NaturaFluff by Stora Enso"

According to the company, 'NaturaFluff by Stora Enso' is the widest range of fluff pulp grades on the market, including a completely chlorine-free bleached fluff pulp. After the investment, Skutskär Mill now produces 415 000 tons of fluff pulp per year.

"Skutskär Mill started manufacturing fluff pulp in 1969. We have long been the largest manufacturer of this pulp in Europe. In the last couple of years, we have only strengthened our position. Demand for fluff pulp is growing by 4 per cent a year globally," says Henrik Holm, Director of Stora Enso Skutskär Mill.

Stora Enso studied the transformation work for four years with various equipment suppliers before deciding to carry out the project with Bellmer. The modernization was large and included a new dilution controlled headbox, water removal improvements at the wire section, a new reel and a winder, including complete automation and controls. The reel delivery also included an automatic return system for bringing empty spools back to the reel spool storage. As this is a swing dryer machine that can produce both sheets and rolls from pulp, the project included a fly-over section to pass the web over the cutter lay-boy to the new reel at the dry end.

"The formation of the fluff pulp must be good and the quality must be just right, since the pulp is used directly in the converter's end products. That is why we needed to make significant improvements also to the production line's wet end. We replaced the wire section and installed a new headbox," says Henrik Holm. "A key part of the conversion was, however, the new winder, which Bellmer supplied seamlessly in co-operation with us. Bellmer was flexible, as when we had an idea, they were quick to develop it. Solutions emerged smoothly," says Holm.

Customer-focussed product development

"Effective threading through the winder is crucial for a fluff web due to its thickness (> 750 g/m^2). We improved the web threading to wind-up section by installing driven belts instead of air blows," says Bellmer's sales manager Ahti Peiponen.

"Fluff pulp, winded to the desired customer reel dimensions at the automatic winder, is delivered directly to the converting plants manufacturing hygienic products; therefore, Stora Enso only needs to apply medical tape used in hospitals to bind the tails of the customer reels, instead of the typically used hot-melt glue. R&D was required to invent this medical-tape solution, which was successful, and the outcome is that 28 tape dispenser units units do the job required during the automatic set change" says Peiponen.

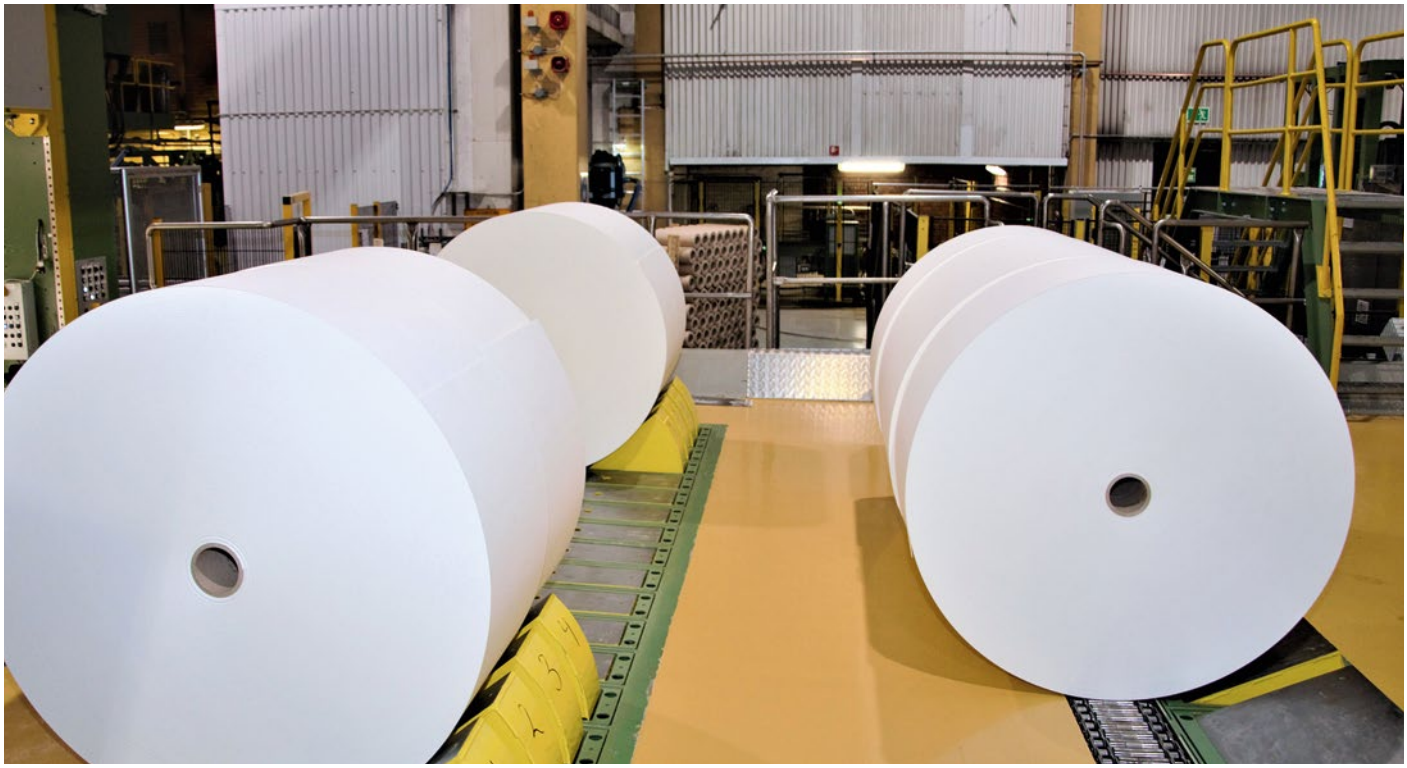
"Occupational Safety and Healthy requirements were fulfilled by taking the necessary measures to avoid excessive noise levels and improve ergonomics," he adds.

Picture: Leif Lindberg for Bellmer GmbH

Winder unwinder section with new parent reel feeding and empty spool lifting.

"A perfect match"

"Our main criteria were that Bellmer fulfilled our technical specifications and guarantees, had the right delivery time – and price, of course," says production manager Lasse Aspelin. "The targets were to reach several scheduled points, such as the start-up time, rolling test fluff pulp the first time and mixing between fluff and bale pulp. When the line was ready, we started regular fluff pulp production and periodically in bales in order to fine-tune the winder/packing line," says Aspelin. "As this was Bellmer's first modern, new-generation reel and winder delivery to a Scandinavian customer, the project was important to us. At the same time, we are pleased to be Stora Enso's partner in Skutskär as a leading headbox manufacturer," says Jyrki Strengell, CEO of Bellmer Finland Oy. www.bellmer.com



Superior finished fluff pulp roll quality with precise dimensions.

TURBOWinder™ by Bellmer

Bellmer's scope of the turnkey delivery was very detailed, including:

- Automatic set change with 28 tape applicators to fasten shipping roll tails to the roll body.
- A traversing cutting device.
- Web holders to maintain tension during set change.
- Effective and reliable web separation after the slitters, with two spreader rolls mounted in an adjustable frame.
- An automatic core feeding table and pivoting device to load new cores between the drums.
- Fast and accurate automatic slitter positioning for 15 pairs of bottom and top slitters.
- Separation *fingers* after the slitting to force the webs to separate.
- Web feeding with vacuum and driven belts.
- A parent roll transporting system, TURBOTransporter™ from reel to unwinder. An automatic empty reel spool return system was also included.

Stora Enso

Stora Enso says its strategy is to support customers to meet consumers' demand for sustainable products based on renewable materials. Part of the bioeconomy, Stora Enso is a leading global provider of renewable solutions in packaging, biomaterials, wooden constructions and paper. Stora Enso's business divisions are Consumer Board, Packaging Solutions, Wood Products and Biomaterials.
The Biomaterials Division offers a wide variety of pulp grades to meet the demands of paper, board, tissue, textile, and hygiene product producers.

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Innovative. Sustainable. Efficient.

Progroup's paper factory PM3 has started operating and is setting the industry benchmark

Pictures: Progroup

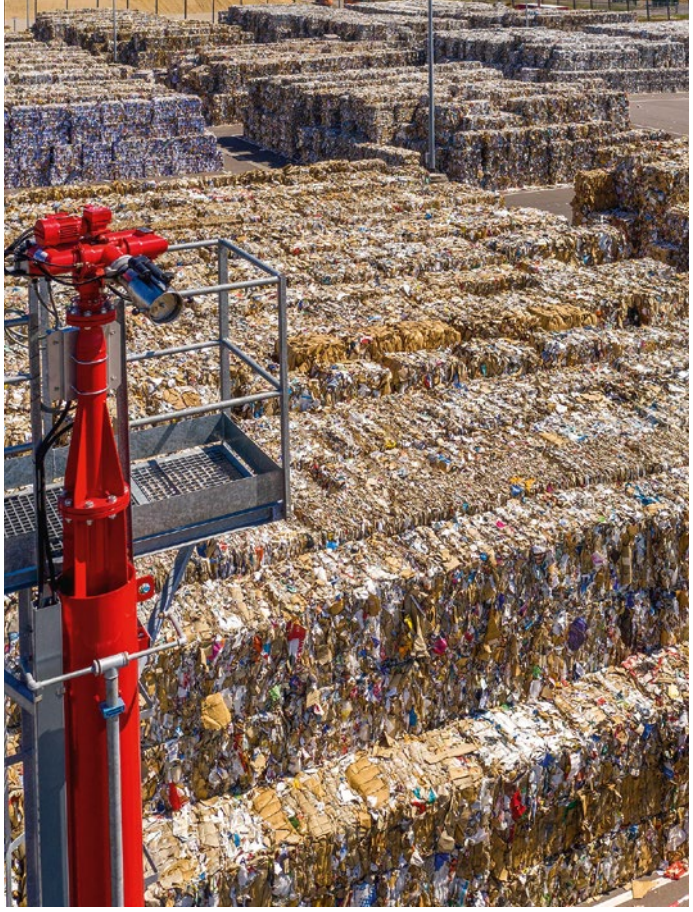
With PM3, Progroup started operation of one of the most modern paper factories in the world in August 2020. It stretches over an area of 453,000 square metres.

Following a record-breaking construction and assembly time of just 18 months, Progroup's paper factory PM3 in Sandersdorf-Brehna started operating at the end of August 2020. The plant stretches over an area of 453,000 square metres and has an annual capacity of 750,000 tonnes. Progroup is thus increasing its production of containerboard from 1.1 million tonnes to a total of around 1.85 million tonnes annually. The company focuses on sustainable production technologies in particular.

PM3 is an important part of Progroup's growth strategy

As one of three paper factories that the company now operates, the new plant forms an important part of Progroup's "Two Twentyfive" growth strategy: The aim is to double the size of the company by 2025 compared to 2015. In addition to the new paper factory PM3, there are another eight corrugated sheetfeeder plants and more than 500 new employees. The total level of investment for these growth projects is around 1.35 billion euros. "With our paper factories, we are expanding Progroup's value chain for corrugated board production to include an important early stage. They supply our corrugated board plants with containerboard and thus safeguard our independence," says Progroup founder and Chief Executive Officer Jürgen Heindl in explaining the benefit of backward integration.

He views the fact that, in spite of the restrictions brought about by the coronavirus pandemic, PM3 is starting to operate at the end of August as a clear team success: "The last few months have demonstrated in an impressive way how responsibly, flexibly and creatively all the parties involved know how to handle any challenge. Just like in



Circular economy: Around 860,000 tonnes of recovered paper are processed to make containerboard at PM3 each year.

the manufacturing plants, the workers on the construction site also observed the strictest hygiene measures. This allowed us to live up to our promise to our employees, customers, suppliers and service providers to be a reliable and strong partner for them in any situation."
At the peak, up to 1,300 people were involved in the construction of the plant. The heart of the new factory is one of the most modern and high-performance paper machines in the world for the manufacture of environmentally friendly and high-quality containerboard.

Green Hightech conserves resources and sets the benchmark for the future

The Green Hightech strategy that Progroup has consistently followed since its founding means less use of energy and raw materials as well as lower CO_2 emissions coupled with enhanced performance. As part of this, around 100 million euros were invested in resource-conserving technology at PM3. It means that, when it comes to environmental protection, energy efficiency and sustainability, the new factory sets the benchmark for the future in the paper industry.
"Sustainable planning is in our DNA. We only have one planet Earth, which we need and want to nurture for the benefit of generations to come. As a family company, we are aware of this responsibility and act accordingly," stresses Maximilian Heindl, Chief Development Officer and member of the Board of Progroup.

Circular economy: Containerboard made entirely from recycled material

This starts with the product itself: Progroup manufactures containerboard entirely from recovered paper. Ideally this can be recycled eight to 12 times and therefore offers significant ecological benefits. The corrugated board end product is also recyclable and can be returned to the loop – because consumers recycle their waste.
Around 860,000 tonnes of recovered paper will be processed to make containerboard at PM3 each year. The raw material is treated in a state-of-the-art drum pulper and drum screen. The 48-metre drum pulper and the 23-metre drum screen each have a diameter of 4.5 metres, a total weight of around 300 tonnes and installed drive power of 3,800 kW. They are designed to handle very high volumes of up to 3,000 tonnes of recovered paper each day. With an overall installed length of 78 metres, the recovered paper drums are the largest of their type in the world.
The special design of the drums means that they are better at conserving resources than comparable one-piece models. Thanks to the rotation of the drum pulper and the addition of very little water, the recovered paper is pulped gently, so without shear forces. This ensures that the impurities contained in the recovered paper remain preserved in their original form and can then be eliminated at an early stage in the drum screen. The presorted pulp passes on to further processing via the perforated drum screen.

> Sustainable planning is in our DNA. We only have one planet Earth, which we need and want to nurture for the benefit of generations to come.

The new type of circulating water treatment plant of PM3 treats the process water used and returns it to the closed water cycle of the paper production.

Closed water cycle minimises the amount of fresh water used

Climate change is threatening the water supply of millions of people. All relevant stakeholders must therefore take even more decisive action to combat the increasing shortage of water and decline in the quality of drinking water. This is why right from day one water as a resource played a key role in the planning of the new paper machine PM3. In order to consume as little fresh water as possible in the production of paper, Progroup purifies the process water in a specific facility: The circulating water treatment plant which recycles the water works like a biological kidney. It ensures that recovered paper impurities in the process water are biologically degraded. As a result, Progroup saves 80 per cent or 3,750,000 cubic metres of fresh water per year and makes a clear statement in an era of climate change.
Impurities in the water are recorded by the COD (Chemical Oxygen Demand), which is measured in milligrams of oxygen per litre. This

Chief Development Officer Maximilian Heindl is championing technological innovations for sustainable growth of the company.

index value indicates the amount of oxygen that is required purely arithmetically to break down a certain quantity of impurities. The plant in Sandersdorf-Brehna can handle a COD of up to 105 tonnes a day. This is equivalent to the average contamination in the domestic waste water from around 875,000 residents in Germany.

PM3 does not pollute any municipal or industrial wastewater treatment plants

The pretreated water flows into the stripping reactors and is intensively aerated there. This removes the calcium carbonate from the process water, increases the pH of the water and the dissolved lime is precipitated. The subsequent flotation system skims off the floating lime components. This water is then returned back to the overall process. All of the water used in production is processed roughly twice a day. This means that absolutely no process water ends up in municipal or industrial wastewater treatment plants.

The lime which is separated off can be added for example in a brickyard in cement production or in road-building as a filler. The organic contamination in the process water is largely converted into biogas (methane). This is used in the plant's own boiler house and can replace the appropriate quantity of natural gas. PM3 therefore saves up to 62,000 megawatt hours of natural gas and prevents the emission of more than 12,000 tonnes of carbon dioxide each year. The innovative production techniques at PM3 reduce CO_2 emissions by a total of 170,000 tonnes per year in comparison to similar plants. This corresponds to the annual CO_2 emissions caused by around 19,150 inhabitants of Germany.

Innovation leadership remains a crucial factor for success in the future too

"The economy and ecology are intertwined, I am convinced of this. "It is only by constantly investing in efficient production facilities that we can strengthen our leadership on cost, so that we can operate successfully in the market together with our customers. Sustainability plays an important here: Lack of sustainability will become a cost factor in the long run. This is why it makes sense to invest heavily in carbon neutrality and the principle of recycling," stresses Maximilian Heindl.

> The next step for us is to link and evaluate this data.

Innovation leadership is an important aspect of Progroup's corporate strategy. It is based on consistently developing existing processes, embracing technical innovations and cooperating in a spirit of trust with partners from industry. Plants such as the new paper factory PM3 therefore not only lead the way when it comes to sustainability, but also set the technological benchmark within the industry.

Maximilian Heindl is a key person in championing this trend in his role as Chief Development Officer. In 2023, as part of the change of the generations, he will take over as Chief Executive Officer of Progroup. He has a clear idea of the direction he wants to take the company in: "For me, the common values that I share with my father and the resulting attitude to many issues are the basis for continuing the successes that we have enjoyed over recent decades. It will be very important for Progroup not to just stand still in the future as well. We are always striving to take the necessary steps to champion innovations."

Establish digital networking of all processes and sites

Thanks to its state-of-the-art plants, the company is ready for Industry 4.0. Business intelligence is based on "big data", so huge amounts of data. Progroup has this database. It not only relates to the machines themselves, but to the complete value-added chain. There is great potential here which Maximilian Heindl wants to fully exploit: "The next step for us is to link and evaluate this data. On the basis of this,

we will develop intelligent, overarching networking of all processes and sites."

The close partnership with the machine manufacturers enables Progroup to exploit the opportunities of digitisation: Artificial Intelligence and the Internet of Things (IoT) will drive forward manufacturing in the future. When it comes to paper production, new IoT services are already going live with the launch of PM3, for example. Virtual sensors help here to reduce the consumption of resources with the same level of quality.

Next Generation Products: Light high-performance papers for environmentally friendly packaging

Trends such as digitisation, industrialisation and demographic change are transforming the whole packaging market: Combining smaller batch sizes and new functional or smart packaging with more sustainability are just some of the challenges for the industry. A study by the market research institute Ipsos from 2019 shows that more than three in four consumers in Germany want to buy products which involve the use of as little packaging material as possible.

Progroup responded to this trend for more sustainability many years ago. This is how the Next Generation Products came about. Following the paper factory PM2 in Eisenhüttenstadt, which has been producing lightweight and resource-conserving papers with grammages of from 60 to 80 g/m² since 2010, the state-of-the-art PM3 represents another important element in Progroup's strategy to manufacture paper in a way that conserves resources: "With our Next Generation Products, we are not only pursuing our strategy of 'minimal use of materials for maximum performance', but we are also able to meet our customers' requirements for recyclable packaging," says Heindl. "With them we shape the market by enabling customers to reduce their carbon footprint. The level of acceptance from consumers, who receive truly sustainable packaging, means that we set trends with our products: The debate about more eco-friendly packaging is well underway."

Outstanding environmental protection: PM3 was awarded the EMAS certificate from the European Union already before operation started.

Outstanding environmental protection

For consistently improving its environmental performance, Progroup was awarded the "Eco-Management and Audit Scheme" (EMAS) certificate from the European Union for PM3 during the construction phase in January 2020. As part of a public statement, each year the company will provide information about relevant environmental protection measures and also subject itself to a review by independent, government-accredited auditors. A recertification audit will be conducted by an expert auditor every three years.

"Sustainability is a core element of the philosophy that we have pursued for 27 years. It is therefore obvious for us to act in a way that is environmentally friendly and conserves resources right from day one," says Maximilian Heindl. In the construction phase, among other things, most of the soil that was excavated was temporarily stored and reused once the construction work had been completed. It was used, for example, to construct an earth wall that minimises noise emissions. Thanks to a dedicated concrete mixing plant, up to 2,000 m³ of concrete were produced on site every day. This is equivalent to a saving of around 200 truckloads. Progroup also cooperates primarily with regional companies. This enables journey distances and therefore CO_2 emissions to be minimised.

Biggest investment project in Saxony-Anhalt creates jobs and long-term prospects

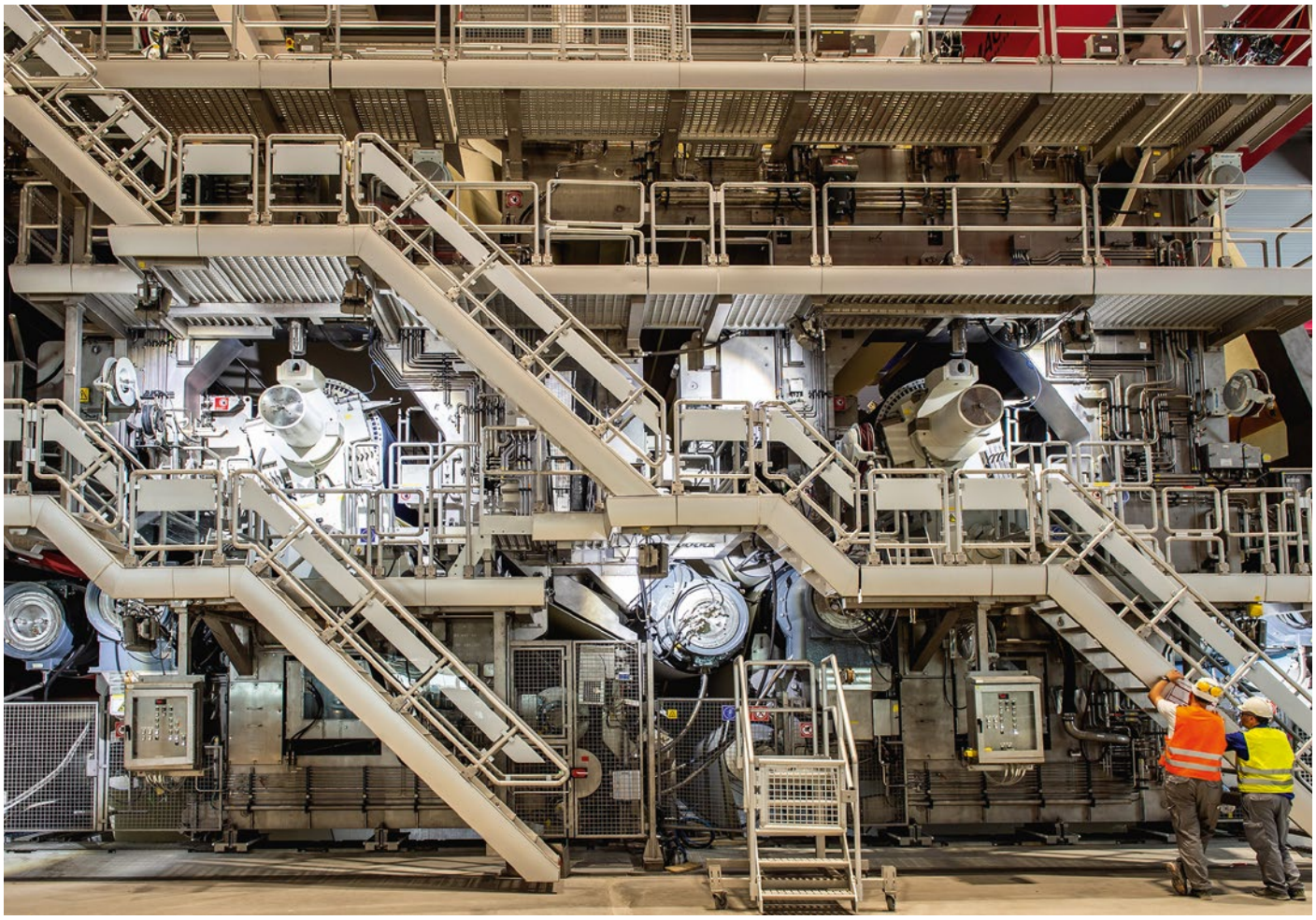
With a total level of investment of 465 million euros, PM3 is currently the biggest investment project in Saxony-Anhalt. The State Economics Minister, Prof. Dr. Armin Willingmann, emphasises the importance of Progroup setting up its business: "In the last four years in particular, Saxony-Anhalt has increasingly developed to become an attractive business location for national and international investors, which is also demonstrated by the major investment that Progroup has made in the new paper factory in Sandersdorf-Brehna. The paper factory – one of the most modern and powerful in the world – exemplifies a second pleasing development: Saxony-Anhalt is evolving to become a state for the technologies of the future in which as well as technical innovations high-quality jobs are also being created. I am therefore very optimistic that the economy in Saxony-Anhalt will cope well with the consequences of the corona pandemic and will grow dynamically again in the next few years. Progroup's new paper factory will also have a very positive effect on the economic strength of the state over the long term."

> With our Next Generation Products, ... we are ... able to meet our customers' requirements for recyclable packaging,

"The state-of-the-art and environmentally friendly plant really does showcase the region," adds Andy Grabner, Mayor of Sandersdorf-Brehna. "The working relationship with the town council was characterised by mutual respect and appreciation right from day one. Since construction work began, Progroup has considered many local companies in the supply chain. With the commissioning of PM3, further jobs and apprenticeships are now being added." Whereas in other regions in Germany employment is stagnant in places, thanks to Progroup the Sandersdorf-Brehna site will see the creation of around 140 direct jobs and up to 350 indirect jobs with great potential for the future.

Employer with a future and responsibility

As a fast-growing company, Progroup is used to having to compete for skilled workers and young talent in the labour market. Over the



The paper machine is about 250 meters long, has a working width of 9.20 meters and a production capacity of 11 t/h/m.

period from 2018 to 2022, the intention is to create a total of 400 new jobs across the company. Here too, the company is thinking and acting with a long-term view. "Good recruitment is a short-term measure," knows Maximilian Heindl. "We offer our employees high-tech jobs, state-of-the-art plants, a pleasant working environment and a unifying corporate culture in which cooperation, team spirit and trust are embraced."

In addition, Progroup has implemented a concept across its sites for boosting the company's brand so that it can present itself as an attractive employer. "In this context, I think it is essential to seek to speak to people directly on site. This is the only way for us to find out what matters to them and how we can make a lasting contribution to the regions in which our sites are located," says Heindl. The company regularly supports specific projects involving the environment as well as education for children and young people. "I see us as a regional company that has a duty to support the issues and projects that really matter to local people. For this is also what makes a good employer – being a good neighbour to the families and friends of our employees," says Maximilian Heindl. He has a clear view of the objective and how to get there. Not just for PM3 but for the company as a whole. Progroup wants to do its bit – for more sustainability, digitisation and modern working environments in order to create a future for the benefit of generations to come.

www.progroup.ag

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PM3 at a glance

Total investment	Around 465 million euros
Product	Containerboard from 80 to 150 g/m²
Annual production	750,000 tonnes of containerboard
Daily production	Up to 2,760 tonnes of containerboard
Operating speed	1,600 metres per minute
Working width	9.20 metres
Commissioning	End of August 2020
Building plot	~ 450,000 m²
Jobs	140 direct, 350 indirect jobs
Apprenticeships	Up to 10% of the number of jobs

Picture: Pixabay

Picture 1: Why building with paper and not with timber?

Why ... and not ... ?

Questions, thoughts and a discussion on building with paper

The topic "Building with paper" often causes astonishment and enthusiasm at first but it inevitably leads to a number of critical questions. The most obvious question is usually "Why building with paper and not timber?". This is followed by questions about fire and moisture protection, but also by questions about the sustainability of paper as a building material. The longer one thinks about the topic the more questions arise.

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Part 1 of this article collects these questions and shares some thoughts on them. The reader is invited to examine critically the topic and his own attitude towards it.
After an emotional consideration of the subject in Part 1, Part 2 begins with a more scientific discussion of the topic. Based on facts and data, paper as a building material is examined with respect to its sustainability. Subsequently, a paper beam is used in a feasibility study to compare the load-bearing capacity of paper components with other materials. This is followed by a life cycle analysis of the paper beam.

Introduction

The interdisciplinary project Building with Paper (BAMP!) started in 2017 at the Technical University Darmstadt with the aim of making paper accessible as a building material. After three years of the project, the team noticed that a number of questions are recurring in the public discussion.
A collection of these questions and additional information is given in Part 1 of this article. This is of importance as the acceptance of paper as a building material is not only a matter of appropriate material properties and functionalization but is highly related to our thinking of housing, safety and reliability. Part 2 includes sustainability considerations and a feasibility study where the possibility to build a load bearing beam from paper is investigated experimentally and analytically. By using a sandwich structure, the performance of the beam is optimized using theoretical considerations and

Picture 2: Flammability test with a demonstrator house.

Pictures: Oskar Gerspach

Picture 3: Concept study: wall elements. Department of Sculptural Design.

is compared to glulam and steal profiles. Finally, a Life Cycle Assessment (LCA) of these beams is conducted.

Part 1: Questions, emotions and thoughts concerning paper as a building material

Since paper consists of wood fibres the most obvious questions usually are "*Why make paper from wood first and not use wood directly?*" and "*Why building with paper and not with timber?*". On the other hand, since laminated wood is widely used in the building industry today, one can ask the question "*Why laminated wood and not naturally grown wood?*". Laminated wood has the advantage that it has less imperfections than naturally grown wood and thus it is more homogeneous. The lamination process leads to an increased load capacity. The beams can be adapted to the requirements and have almost no limits in all dimensions [1, 2]. So why not use laminated paper instead of laminated wood? Paper can easily be laminated. It can be made very thin what leads to many layers and this is advantageous for laminates [3]. Paper can be made of various fibre types which are free in position and orientation. In a beam of paper, specific fibres can be placed exactly where they are needed. Additionally, they can be functionalized. Paper is suitable for lightweight applications as it is easily possible to provide recesses. Another advantage of paper is that it can be made of wood that cannot become a beam.

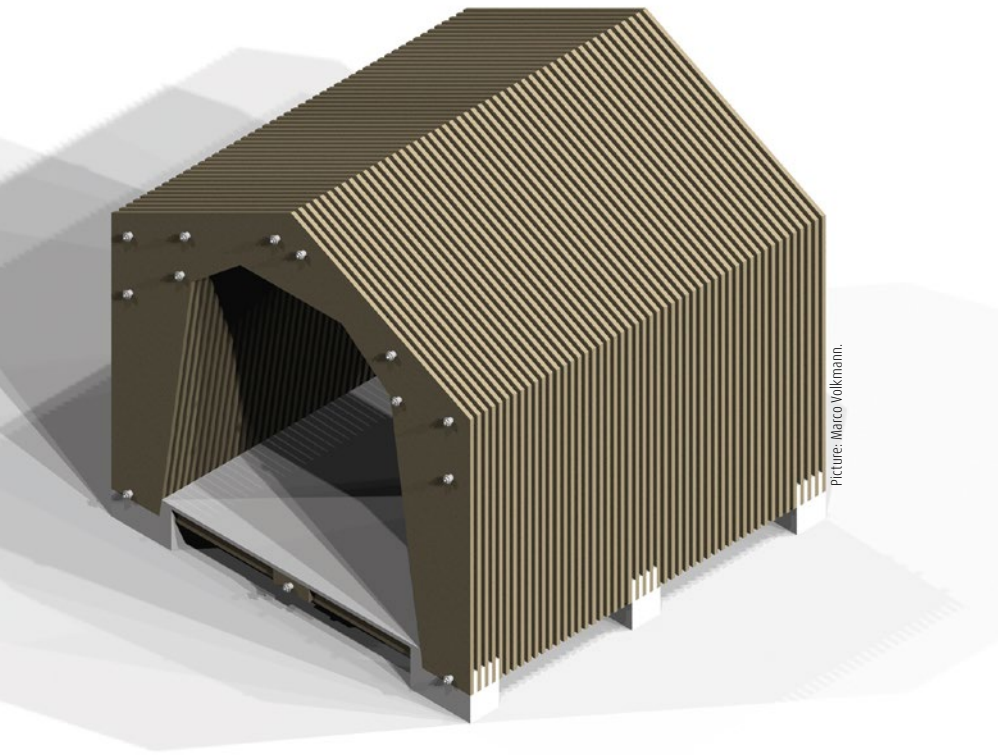
On the subject of load-bearing capacity, one can also ask the question "*Why paper as insulation material and not for example mineral wool?*". In fact, paper is a material that at the same time insulates heat and carries load.

Heat – One of the biggest concerns is the flammability of paper, but "*Why should paper burn worse than other materials?*". In the case of the fire in Grenfell Tower, it is assumed that the façade material in combination with the construction and design led to an accelerated fire. It is possible that people died due to toxic gases that were emitted during burning of the insulating material [4]. In general, polystyrene facades must be specially disposed of and may need to be replaced regularly [5]. These facts lead to the questions "*Is paper worse?*" and "*Isn't it a question of design?*". The correct design with the building material paper has not yet been researched. When designing houses made of paper, do we have to get away from familiar construction methods? By the way, it is quite possible to protect paper against fire.

Closely related is the concern about the softening of paper when it comes into contact with water: "*Why use a soaking and not water-repellent material?*". This is exactly one of the approaches pursued in the BAMP! project, namely to make paper water-repellent. Let us have a short look to Venice: Venice has been standing for centuries on tree trunks in the sea. If it is possible to build cities in the sea on wood, shouldn't it also be possible to build houses with paper?

This in turn leads to questions about the construction method: "*Why prefabricated construction and not brick buildings?*". Prefabrication saves time in the construction of the building and thus money [6]. This is one of the main arguments for the construction of wooden high-rise buildings and also applies to paper. This might also be an answer to the question *"Why high weight materials and not saving weight?"*. Light materials are easier to transport to and on the construction site. On one hand, this saves resources and money. On the other hand, light means fewer security risks. Furthermore, lightweight materials open up the possibility of easily adding another storey to existing buildings. Especially when thinking of applications in developing countries, paper has advantages, because even unskilled workers can handle the material fast and easily. Why make everything complicated and not simple?

"W*hy temporary and not permanent buildings?*" The declared aim of the BAMP project is the development of temporary buildings, e. g. for commercial purposes or schools, emergency shelters, so-called "microhomes" or in trade fair construction. Paper is not (yet)



Picture: Marco Volkmann.

Picture 4: First concepts for layered construction with corrugated board and honeycomb boards.

so durable and is therefore suitable for temporary construction applications and there is a need for them.

The paradox, however, is that the discussion keeps drifting towards solutions for 50 years and more, although we need temporary solutions. This raises another question: "*Why always new and not stay with the tried and tested?*". Perhaps it is due to the space, in the architectural sense, which each generation has at its disposal. Every generation uses this space differently. Needs change over time. Paper in interior design is individual, light and flexible. Thus, paper manages to follow these changes.

The material paper is undergoing change. Nevertheless, the image of paper poses a challenge for its acceptance as a building material. Very quickly we are talking about "Timber construction 2.0", "Fiber hybrid construction", "Innovative sustainable solutions", "Fiber and pulp based construction" or "Bio-composites". Why are we talking about timber construction 2.0 and not paper construction 1.0? Why do we need buzzwords and not just say „paper"? Why hide paper and not be honest? A possible answer to these questions was given by Marcel Bilow at the BAMP! Conference 2019 [7]: Living in cardboard boxes quickly creates the image of homeless people sleeping on the street. This could be the reason why living in paper houses has a poor image among the middle and upper classes.

Interestingly, paper is very often immediately stamped as having poor durability. A comment on the durability of paper: In contrast to modern media such as CDs, cassettes and floppy disks, paper is the only known storage medium that lasts several 100 years and remains readable.

Why does paper have an image of ugly and brown and not of noble or artfully structured? Décor paper is state of the art and is widely used. Paper has an aesthetic effect. Haptics and optics can be designed in many ways. This makes paper particularly interesting for architecture.

Although paper is a flagship product in terms of recycling, how sustainable is building with paper? Again and again, music festivals make headlines with the mountains of waste that are left at the end. Known pictures were taken after the festival Rock'n Heim. Whole tents just stay on the camping sites [8]. Similar pictures were seen in the media at the peak of the refugee wave, see for example [9]. The refugee camp Idomeni in particular made sad headlines. The current discussion about micro plastics makes it clear that the plastic waste that humans leave behind in the environment is not biologically degraded. Although it is getting smaller and smaller, it does not disappear [10]. Paper represents a biodegradable alternative, especially for short-term applications. There are already commercially available products for replacing festival tents with cardboard tents.

"W*hy recycle and not reuse?*" is a very important question, because reuse is by far the best ecological solution. From an ecological point of view, paper should not become a substitute for other disposable products. Unfortunately, this is exactly what happens when plastic straws are replaced by paper straws. Nevertheless, paper is superior to many other products because there is already a functioning recycling cycle. We have to deal with the critical question whether paper as a building material will really be recycled? Is paper still recyclable if it is modified for protection against fire and water? From an energetic point of view, the question arises as to why people still burn wood pellets today. This wood could first be processed into paper. The paper could be recycled and ultimately used thermallythermal. On the other hand, the link to the initial question can be made here: "*Why paper if paper consumes more energy than timber?*". This question is dealt with in detail in Part 2 of this article. Where does the future of the paper industry lie? The study "Fibres & Paper 2030" [11] dealt with this question. Top 3 (16 %) of all close to paper related ideas addressed living and work. Only a fraction of the ideas is evaluated as new business models with high attractiveness in the time horizon. Do we not dare to accept the challenge although we see our future in this field?

(part 2, PPM page 52 ff)

Pictures: Voith

The VR system from Voith provides an extraordinary training experience.

At the leading edge with digital tools

New virtual reality training solution and remote video system generate additional digital benefits for LEIPA

The VR training programs offered by Voith PaperSchool not only improve the quality and efficiency of basic and advanced training for paper producer LEIPA at its Schwedt location. The virtual reality application also creates new possibilities for the company and enhances the employer brand in the competition for skilled workers. Beyond that, the OnCall.Video remote video system gives LEIPA fast access to external know-how, allowing it to find solutions to production problems with virtually no delay.

While the young preventive maintenance technician is going upstairs in the mill to change the drive belt on an electric motor, he makes a mistake. In his haste, he overlooks a leak in the steam line running alongside him just above his head. The consequences are grave; he immediately sustains burns from the escaping hot steam – a serious occupational accident.

Actually, this is just a simulation; the employee is not really injured. Rather than a real incident in the mill, it is part of a training program in Voith PaperSchool's virtual reality application. With a virtual reality headset and hand controllers, the participants experience the simulated reality of a paper mill. In the VR environment, tasks such as preventive maintenance work on the paper machine can be practiced with maximum realism but with absolutely no danger and no downtime or resource consumption.

World premiere in the paper industry

Paper producer LEIPA recognized the benefits of this technology for basic and advanced operational training. At the Schwedt location in Brandenburg, Germany, it is the first company in the world to use Voith's VR system to train apprentices, papermakers and preventive maintenance technicians with especially high effectiveness. Compared

with classic face-to-face instruction or playing of educational videos, where participants only passively consume the content, virtual reality yields longer-lasting learning success. This is because with this training method, participants are confronted with a situation that demands concrete action from them.

When the participant puts the VR headset on, he or she is transported to a virtual world and can thus devote his or her full attention to the training. Because the relative sizes in virtual reality correspond exactly to the real ones, the same impression of space is created. "Within 15 seconds, the participant thinks he is standing in the machine room," explains Voith PaperSchool Manager Michael Neumann. "The controllers replace the hands. When a person works with his hands, he experiences a completely different interaction than he would if he were watching a video or a presentation. Hand-eye coordination generates muscle memory, through which a more effective form of knowledge transfer is achieved – a clear advantage over classroom training."

Voith is developing the VR training content specially for each application area. Thus, in the field of preventive maintenance, tasks such as the sleeve change on the shoe press, installation and dismantling of the screen basket during a change, or the blade change on the winder can be practiced. "It is a new, modern, fully digital way of conveying knowledge," summarizes Steffen Deszpot, Senior Manager Maintenance at LEIPA.

Remote installation with OnCall.Video

Specifically for the high-tech training program, LEIPA transformed a conference room into a futuristically designed virtual reality studio at the company's premises in Schwedt. It houses, for one, the hardware in the form of a powerful PC and the VR system complete with positional tracking sensors, wireless headset and hand controllers. Also, it has a large monitor. Because only one person can undertake virtual reality training at a time, the screen permits others to follow the training both visually and acoustically via the monitor.

To perform the installation in spite of the contact restrictions imposed as a result of the coronavirus pandemic, Voith and LEIPA drew on a new tool for remote video support: OnCall.Video. With this video communications solution with wireless camera glasses, the concluding tasks can be guided from a distance.

"The room was already prepared and the sensors attached," recalls Patrick Dengel, Digital Tools Manager at Voith. "We handled the details via OnCall.Video. For this, the glasses were integrated into the LEIPA WLAN, via which a video and audio connection to the Voith experts in Heidenheim was established." Without the remote connection, the virtual reality system would not have been functional as quickly. The deployment also showed that several days of work could be saved, because there was no need to travel for on-site setup. "Within three hours, we got the system up and running and carried out two test training sessions," says Michael Neumann. The implementation phase, in which the LEIPA employees familiarize themselves further with the virtual reality system and OnCall.Video, is currently underway.

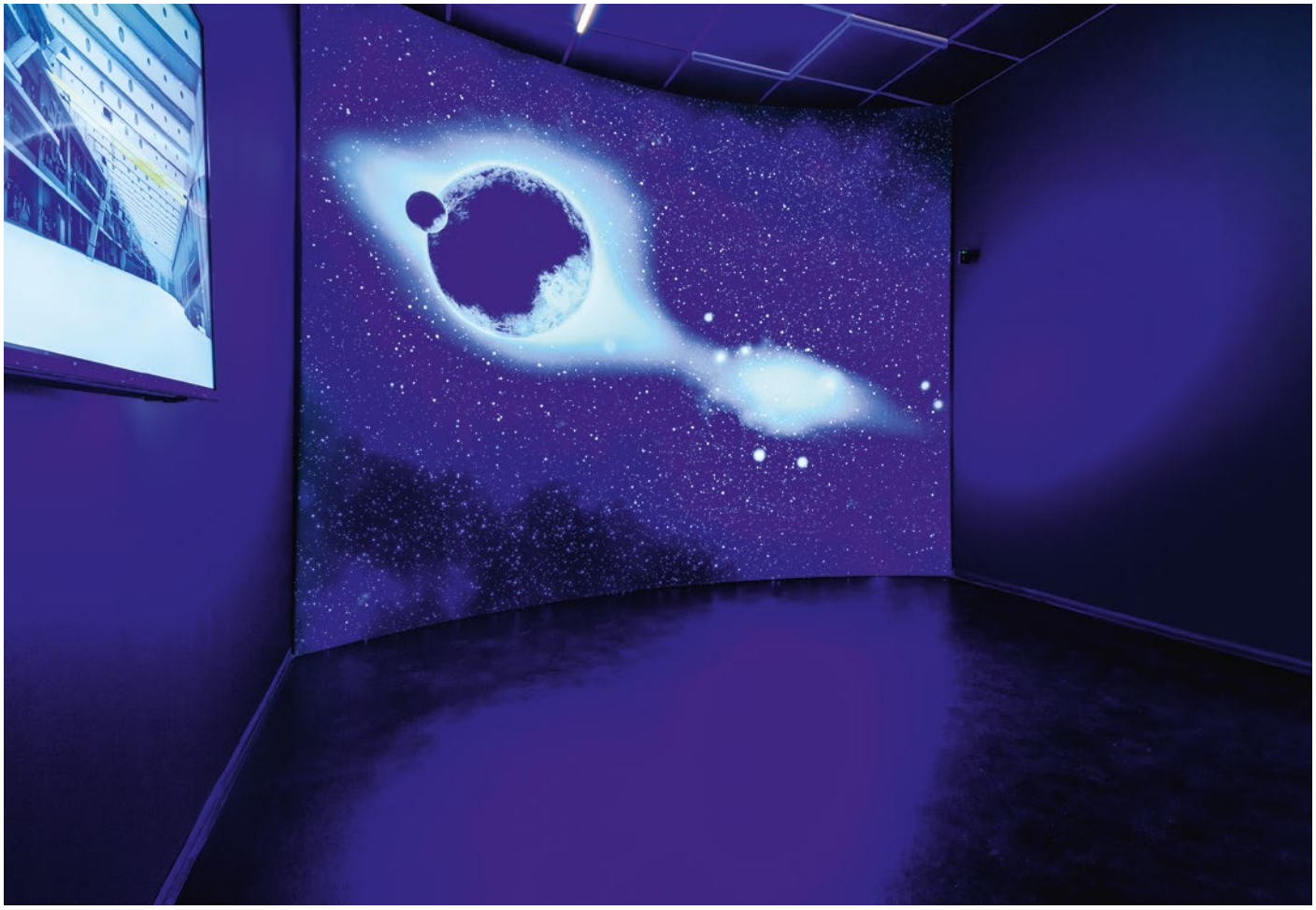
Digital solutions generate added value

Through the digitalization of its training measures and preventive maintenance tasks with the help of the Voith solutions, LEIPA has created numerous new options. For example, if there are problems in the production flow, the company can also draw on know-how outside the company through OnCall.Video to save time and money in finding solutions. "Required expert knowledge is not always available on site, so integration of external know-how is that much more important," stresses Patrick Dengel. "In principle, I can guide everything with the tool," adds his colleague Stefan Endras, Product Manager OnCall.Video. "Our main emphasis is on quickly connecting the customer with the experts. In this way, we can also partially compensate for the lack of skilled workers." Further added value is also offered to the customer through the fact that various locations can easily be connected to each other. This makes it possible to pass on in-house know-how from the various areas internally and promote exchange of specialized information.

In the LEIPA Virtual Reality Center, no cables interfere with the use of the VR system.

The benefits of the VR system offered by Voith PaperSchool also go far beyond the main application area, highly effective basic and advanced training that has a lasting impact. For example, in cooperation with students from Stralsund University of Applied Sciences, LEIPA is planning to visualize its digital data streams from the process control systems in multidimensional data spaces. From this, the manufacturer wants to gain findings that extend beyond the usual statistics and make a real contribution to a further increase in efficiency.

However, LEIPA also sees added value in terms of its external presentation and recruitment of employees. Through the virtual reality solution and OnCall.Video, the company can underscore its digital competence and simultaneously strengthen its employer brand – important advantages not just in competition but also so that when recruiting, it can present itself as a "digital champion" offering workplaces with pioneering technology. "Which papermaker can claim to have the most modern media in use before anyone else?" argues Senior Manager Steffen Deszpot. "Industry 4.0 has already arrived here – and we are happy to show it." www.voith.com



An illuminated, futuristically designed LED wall emphasizes the innovative character of the new training method.

"That's E-Learning 2.0"

Steffen Deszpot, Senior Maintenance Manager at LEIPA, describes in an interview the economic and didactics-related advantages associated with the virtual reality training from Voith PaperSchool.

What do you see as the most important advantages of training courses using the VR solution from Voith PaperSchool over knowledge transfer via book, presentation or video?

"Students" can achieve their learning outcomes independently at their own pace using all their senses in a previously unknown, but very exciting, way – a hands-on solution, so to speak. Through the active integration into the virtual world, students "create" their own learning world in which they are completely immersed. Feedback has shown that the simulated reality achieves a higher level of acceptance than, for example, an instructional video or a written manual does.

In your opinion, are the advantages of the VR training generally of a more qualitative or quantitative nature?

Both. Because training is always completed by just one "student" at a time, it is more intensive than group training, which speaks in favor of longer-lasting learning success. Because experience has shown that it is also fairly difficult to release larger groups of people simultaneously for a group training measure, the VR solution is just what we need.

Through it, employees can independently complete training courses assigned to them virtually 24/7 at freely selectable times tailored to their shifts or working hours. We see the more flexible use of working hours as a huge win.

Do you also want to use the VR installation for other purposes besides training?

The VR system installed here is so openly designed that any type of VR application can be integrated, beyond the innovative Voith PaperSchool that is aimed more at the papermakers and technicians and is constantly being extended to supplement the previously available modules. Open source projects that, for example, consider the current topic of "Big Data & Industry 4.0," i.e., typical topics for developers and technologists, are also being contemplated. For that reason, we are, among other things, working with students from Stralsund University of Applied Sciences to visualize our enormous digital data streams from the process control systems in virtual, multidimensional, multivariable data spaces and thus gain graphical and visual knowledge that goes far beyond today's standard statistics and known soft sensor/predictive control/APC/level 2 control systems.

We are entering a completely new world of data processing here. A use for our customers, apprentices, students and external parties is likewise conceivable. I can easily imagine ambitious apprentices across all trades virtualizing an interactive mill tour or specific process or maintenance flows. In my view, that's E-Learning 2.0.

How did the hardware and software installation and the collaboration with the Voith team go?

The hardware for the virtual reality world was completely preinstalled and tested at Voith. The Voith VR software solution and the integration of the VIVE Pro glasses were also preconfigured. This

greatly reduced the installation work on site. The room including the technical background installation was prepared by LEIPA. The actual startup was then performed by an automation employee from LEIPA in a single morning – using OnCall.Video, the remote video solution from Voith, with expert support from Heidenheim. The result is impressive and attests to the excellent and professional cooperation between the two companies. Doers were at work on both sides.

How have your initial experiences in using the system been and how is the resonance among participants?

Up to now, only a few people have gotten to know the complete extent of the system as testers. But everyone who has entered the virtual world for the first time has let out an "Ahh" or an "Ohh." Some have to orient themselves first and nearly lose their balance when they suddenly find themselves on the catwalk on the digitalized PM 4 at a height of seven meters above the floor. Because we also mounted a screen on the wall to project a 2D map of the VR scene, the impression is also conveyed audiovisually to other people and trainers in the room. These observers also dove into the VR world in our tests – the spacey overall design of the room definitely contributes to that.

Steffen Deszpot from LEIPA is excited about the possibilities offered by the digital tools from Voith.

Do you also expect advantages in the external presentation of the company through the use of VR?

By all means. It affects not just the new VR learning world but also the AR technology already in use by technicians and production workers. Besides the usual digital aids such as real-time databases for PLS data, SAP, condition monitoring and thermal cameras for condition-based maintenance, APC control systems, material/energy/cost monitoring, etc., the tradition-rich family-run company LEIPA is once again showing the way to the digital future of the industry.

A technician from LEIPA inspects a pick-up roll in cooperation with a remote Voith expert.

Virtual reality training

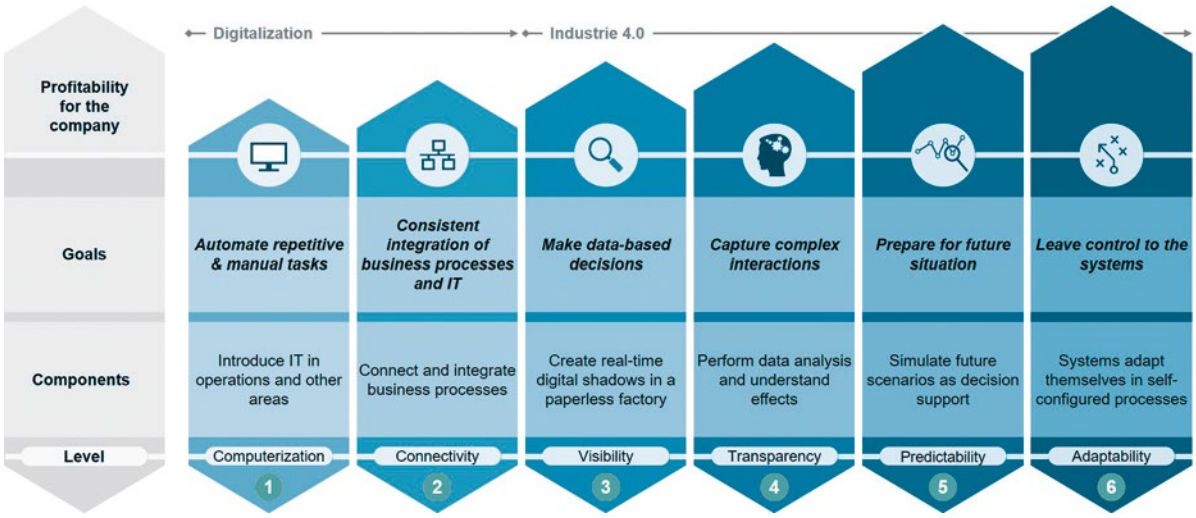
The VR-supported training is part of Voith PaperSchool. With it, knowledge can be conveyed with no downtime, material consumption or occupational safety risks. The solution installed at LEIPA comprises, on the hardware side, a powerful PC with high-end graphics card and the VR system, which enables maximum freedom of movement through its wireless headset and thus makes it easier for participants to become immersed in the artificially generated virtual reality world. Hand controllers and positional tracking sensors round out the package. The training modules developed by Voith are specially designed to meet the needs of the paper industry. To support industrial training and guide the attention of the participants, the VR solution deliberately works with a slightly reduced level of realism.

OnCall.Video

Conceived as a digital tool for remote video support, OnCall.Video makes time- and location-independent access to expert knowledge possible. The audiovisual communication system is made up of data glasses designed to meet industrial requirements and an internet-based video cooperation platform. It connects customers with Voith experts, who see in real time exactly what the customer's employee sees through the data glasses and can then mark the critical region in the video image and discuss it with the employee. In this way, for example, problem analyses, inspections, factory acceptance tests and commissioning can be conducted quickly and efficiently. OnCall.Video can also be used as a tool for promoting internal exchange of specialized information and passing on know-how.

Digital transformation in the paper industry

Growing challenges and increasing customer pressure



Pictures: Schmitz / Kaufmann

Figure 1: Description of the maturity levels according to the acatech Industrie 4.0 Maturity Index

Manufacturing companies are facing greater and new challenges. Crises lead to fluctuations in orders and influence industries with both decreasing and increasing production input, making short-term process adjustments necessary. Traditional technologies and working methods alone can no longer meet flexible customer requirements and complex value chains. In addition, climate change and resource scarcity are forcing companies to act sustainably. In order to ensure long-term competitiveness, new skills such as resilience, responsiveness and adaptability are now in greater demand than ever.

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Paper industry under pressure

The paper industry is affected by changing conditions and consumer behavior as well. Today, newspapers, books and magazines are being read online instead of printed. Other industries are converting their entire accounting and information exchange to digital resources, which also reduces the paper consumption (see Tagesspiegel 2018). Here, innovative and customer-oriented products as well as new business models are essential to remain competitive in the market.

Digitalization as a driver for a necessary change

The fourth industrial revolution, Industrie 4.0, introduced the vision of a connected, data-driven and smart factory of the future. The use of new, digital technologies and the interconnection of objects, devices and machines will enable more flexible and efficient production conditions, adaptability as well as the creation of new business fields. The willingness to understand the digital transformation as an opportunity is growing in the German economy. For example, 90 % of the board members interviewed by BITKOM Research 2020 stated that they see digitalization as a chance. Especially in the context of the Corona crisis, the need to drive digitization further became clear. Nevertheless, a large proportion of the board members surveyed stated that their company was lagging behind in digitalization, which leads to the rating of only satisfying (3.2) in their digital progress on a scale from 1 (very good) to 6 (insufficient).

The paper industry is also aware of the added value of a digitalized production environment and new, innovative products. Nevertheless, in a survey only 24 % of European paper, pulp and packaging companies stated that they had a digitalization strategy. This reflects the comparison with other industries showing that the paper industry is still far behind in the usage of digital technologies (see Wirth and Klein 2018, p. 721).

A structured and standardized approach to determining the own digitalization strategy

The beneficial use of digital technologies and an Industrie 4.0-oriented corporate strategy poses great challenges for companies. In many cases, a structured framework is missing to achieve the defined goals and push the digital transformation forward. The acatech Industrie 4.0 Maturity Index offers a worldwide proven, structured and standardized approach. This allows a holistic, comparable evaluation of the status quo of a company, which describes the current stage of digital transformation. It distinguishes six maturity levels of digitalization, which companies can use to coordinate their individual approaches (see Figure 1). The first two stages, *computerization* (stage 1) and *connectivity* (stage 2) do not represent Industrie 4.0 but provide the basis for an Industrie 4.0 implementation with their initiatives The focus here lies on the introduction of information technologies and their interconnection. Based on the connectivity, in a first transformation step of Industrie 4.0, *visibility* (stage 3), first decisions are made based on the data generated. The increasing availability of information helps to make well-founded decisions as well as simplifies and improves the documentation. The fourth stage, defined as *transparency*, is about understanding complex correlations. By making an appropriate use of the information generated, analyses can be carried out for a better understanding of the process. This accelerates the decision-making and adaptation processes in the companies. The last two stages, *predictability* (stage 5) and *adaptability* (stage 6), focus on proactive actions for future situations and for self-optimization of the systems. Based on simulation tools, future events can be predicted and adequate reactions to change these conditions can already be anticipated. In some cases, these changes can be performed autonomously by the machines.

The six maturity levels evaluate four structuring forces, consisting of *resources, information systems, organizational structure,* and *culture* create a holistic view of the entire company, as shown in figure 2. The structuring force *resources* includes both physical and intangible resources. For example, technical equipment must be able to capture and process data, while employees should develop an understanding of the information provided and communicate efficiently via interfaces. The *information systems* refer to the integration of IT systems and information processing. This requires the development of a digital information architecture to enable the collection, processing and distribution of data in real time. For this purpose, all systems must be integrated in a common IT architecture along the value chain. The *organizational structure* covers the internal organization and the collaboration in the value-added network. The former includes the creation of flexible work groups and task- or goal-oriented teams. The second focuses on the promotion of communication and connectivity to simplify the exchange of information internally and externally. Regarding the *culture* of a company, the readiness for change and social collaboration is focused. The goal is to promote an open exchange of experiences in dealing with data-based work. In addition, employees should be encouraged to proactively pursue new ideas for future changes and provide ongoing support for their implementation.

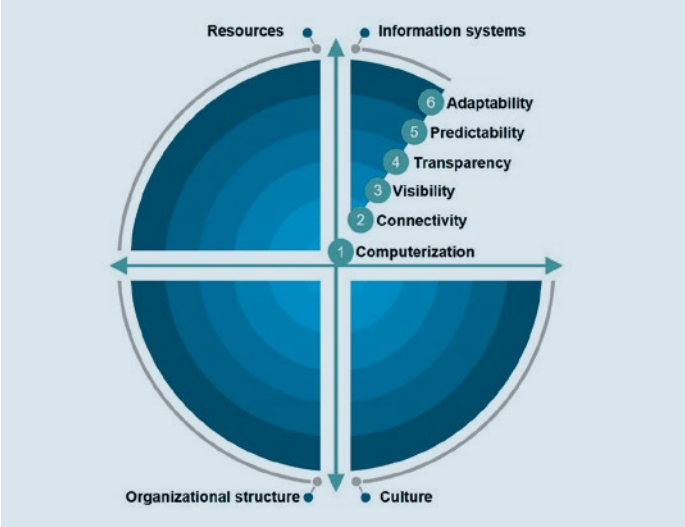

Figure 2: The four structuring forces with the six levels of maturity according to the acatech Industrie 4.0 Maturity Index

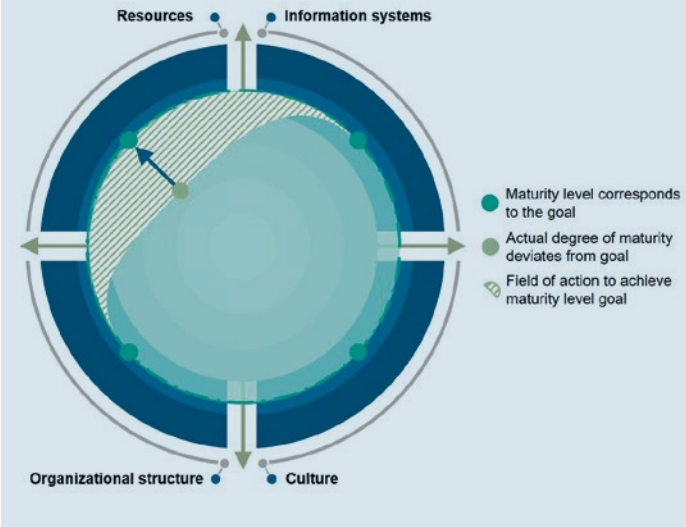

Figure 3: Pursuing digitalization goals by eliminating weaknesses

According to the acatech Industrie 4.0 Maturity Index, the goal for manufacturing companies is not necessarily to achieve the final maturity level of adaptability, as individual company goals are focused. Companies must clarify at this point which target level is most suitable in their competitive environment. The preliminary goal is to balance out differently developed structuring forces regarding digitalization. For a first step, this implies that all maturity levels should be brought to the same level, as shown in figure 3. In a further step, topics that will drive the company forward in all four structuring forces regarding Industrie 4.0 can then be focused on.

Using the Industrie 4.0 Maturity Index in the paper industry

The approach of the Industrie 4.0 Maturity Index has already been applied in various companies in the paper and packaging industry. One of the largest companies is the Mondi Group. But also packaging specialists, such as the company Akarton from Venlo or the German manufacturer of wallpaper, were able to use the Maturity Index to help determine their digital stage of maturity. For reasons of data protection, a fictitious example was chosen to describe the application, which is based on projects carried out in the paper industry.

Determination of the digitalization targets

The fictitious example company, paper factory Mustermann, produces paper at various locations worldwide. Regarding the market position as well as the various locations of the paper company, it became clear that a structured approach and a methodologically framework were required to achieve defined goals to drive the digital transformation. In the run-up to the digitalization project, several goals were defined, which all aimed to strengthen the company's market position. On the one hand, technological factors and on the other hand, organizational factors had to be addressed to ensure a holistic approach. Thus, the digitalization measures for the technological factors were to serve as a lever for increased productivity and flexibility as well as improved quality, i.e., to generate an improved OEE (Overall Equipment Effectiveness). In addition, the goals were defined to make the value-added network and material flow more transparent and to reduce the waste of "living" raw materials. Lastly, work safety needed to be improved in terms of organizational factors. Here, active change management and learning from events and mistakes were focused for a successful transformation process. The goals were defined with the assumption that the implementations would be standardized and thus applied across departments.

These objectives were developed in a kick-off event due to the lack of a clear vision for the digital transformation. It was therefore necessary to harmonize the collected goals with the corporate strategy and to link the internal processes with a detailed target picture.

Status quo evaluation

After the kickoff, the first step was to take a status quo analysis on site. Here, all relevant key figures, processes and information flows were recorded in a structured manner based on the four structuring forces of the Industrie 4.0 Maturity Index. The existing situation showed that the structuring force of information systems was in some part very advanced. The existing large machines were characterized by a high degree of connectivity. In addition, they could act partially autonomously. However, the input of process parameters and environmental conditions as well as the output of machine data showed a considerable backlog demand. In addition, there was no integrated quality control, which resulted in cracks during the production process and thus sabotaging the entire production plan. In the structuring force of resources, a significant demand of improvement could be identified. Especially the tracking of material flows and process information appeared to be a great challenge. The structuring forces of organizational structure and culture were also progressive. Here it became apparent that the will to become a digitally operating company was given and the first milestones had already been set. Lean management methods were established in individual areas and a continuous improvement process was used to optimize workflows.

Derivation of measures and creation of a digitalization roadmap

In the context of the detailed status quo analysis, existing strengths and needs for action were identified. As a result, a total of 30 individual measures for improvement were derived and incorporated into a digitalization roadmap. Considering the company's goals, "transparency" was defined as the target for the coming years. Robust production was identified as the overarching goal. For this purpose, the parameters of the input material had to be recorded and related to the

inline quality data. The resulting data analysis has the advantage that optimal process parameters are determined autonomously, which leads to higher process stability and fewer cracks during the production. In addition, the aim was to integrate the IT systems in order to establish a single source of truth. This would have the advantage that

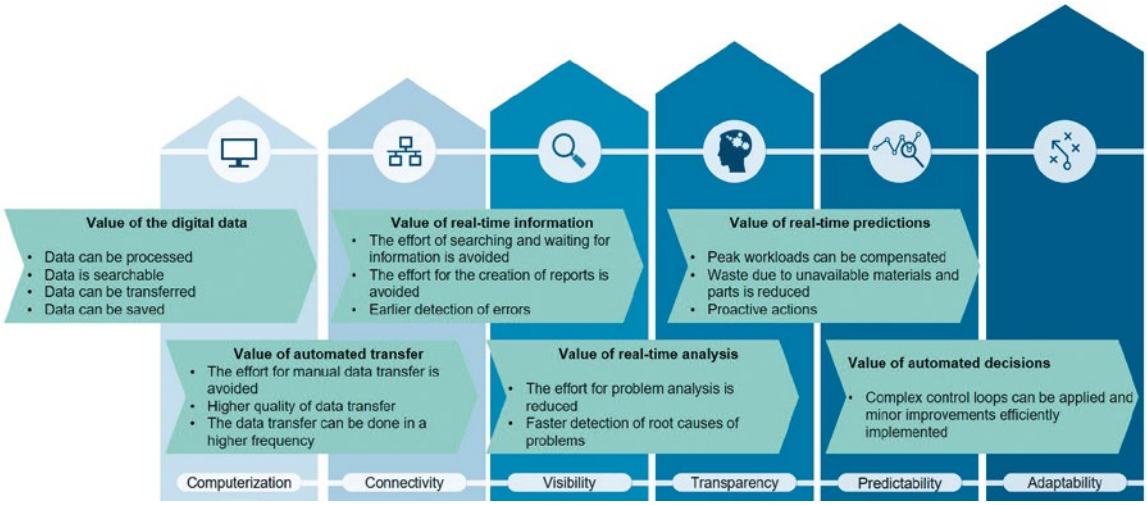

Figure 4: Exemplary representation of a digitalization roadmap

all systems could be used without workarounds and in additionally increase data security.

The measures were then assigned to the digitalization roadmap according to the gaps identified (see exemplary figure 4). Based on the company-specific targeted stage, an individual development path for the implementation of Industrie 4.0 is created. This path is based on the business strategy and an estimation of the cost-benefit ratio. In a first step, the differences in the progress of digitalization are balanced out. In the second step, the focus is placed on more in-depth Industrie 4.0 topics. The prioritization of the measures is thus carried out along the stages of maturity and is aligned both in terms of time and strategy. In order to make the roadmap as detailed and substantial as possible, operational strands are designed to bundle certain measures with reference to a common goal.

VDI 4000 – Systematic transformation and evaluation of production systems

In a standardization process, the Association of German Engineers (VDI) has developed the VDI 4000, whose publication is planned for the end of this year. This guideline is intended to serve as an orientation guide for manufacturing companies when selecting an adequate Industrie 4.0 maturity model. The standardization process is based on the six maturity levels and the four structuring forces of the Industrie 4.0 Maturity Index. The selection is based on the identification of a suitable model type in alignment with the own goals. For this purpose, the scope of the maturity analysis and the level of detail in recommended actions are used as primary decision criteria. Three model types are provided: A quick test, an extended quick test with recommendations for action as well as a comprehensive maturity analysis with individual measures. The quick test provides a simple list of questions to determine the level of maturity. However, the results of the test do not provide any recommendations for digitalization measures. The extended quick test provides a more comprehensive questionnaire. Additionally, general recommendations for taking action based on the degree of maturity are suggested. The comprehensive analysis involves internal and external experts in the status quo assessment. This procedure allows detailed results and individual digitalization measures. The secondary decision criteria can be determined based on the individual goals for the maturity level examination.

There are six criteria to be considered in this context. Existing knowledge, actual state analysis, support, business areas, content aspects and presentation of the results. Each of these criteria can be answered on a scale of 1 (not applicable) to 4 (fully applicable) according to one' s own priorities and ideas. Afterwards, the VDI standards committee makes qualified and classified suggestions for a matching maturity model.

Maturity Index

This project was conducted by the Industrie 4.0 Maturity Center (i40MC). The i40MC was founded by the Industrie 4.0 Maturity Index Consortium. The methodology was applied and tested in various industries worldwide. With over 70 digitization projects at customer sites, the i40MC is responsible for the implementation of the digitization goals and the advancement of the digital transformation.

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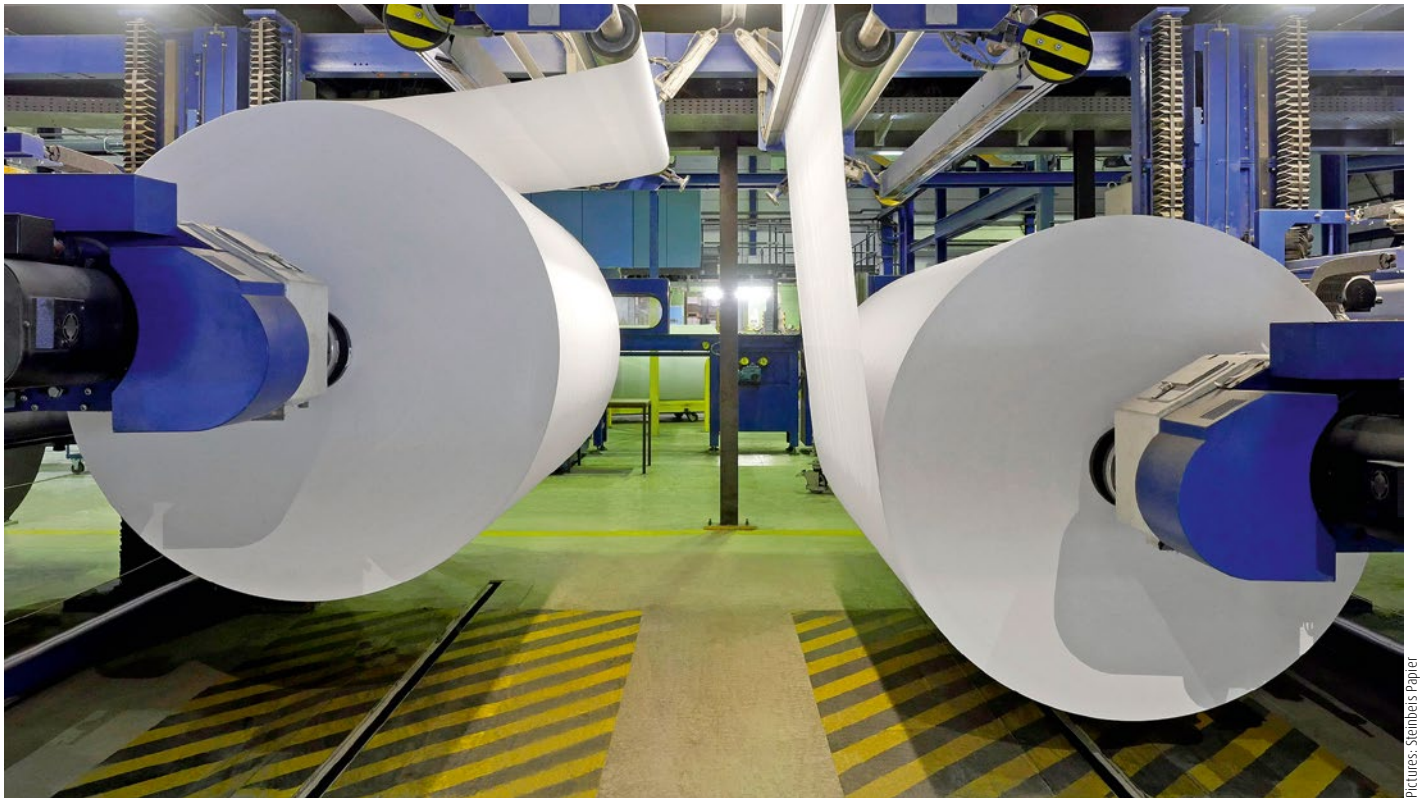

Pictures: Steinbeis Papier

Reel production in paper mill Glückstadt

An adaptable business tool

5 years of TRIM SUITE at Steinbeis Papier

For the last five years, Steinbeis Papier GmbH has been using TRIM SUITE. Now the company is able to minimize waste, to work more efficiently and cost-effectively.

Steinbeis Papier GmbH, located in Glückstadt on the River Elbe, turns recovered paper into attractive magazine paper, office paper and inkjet paper. Environmental issues are naturally of primary importance to Steinbeis, but its business is also affected by the purchase price and availability of recovered paper – while at the same time, competition is fierce, and the margins are often narrow.

It's therefore very important for the company – and its operating result – to avoid waste in production.

"We produce different reel sizes and quantities for every printed item that the printing houses buy from us", explains Sönke König, Team Leader for Production Planning at Steinbeis Papier. "But the jumbo reel that we cut our reels from is always the same size. That means we need to get as many products out of the jumbo reel as we can, throwing away as little as possible."

A desire to optimize energy and raw materials efficiency throughout planning, production and feedback processes motivated a major digitalization project in 2015. The trim optimization that was in use at the time was due to be retired, since it was no longer guaranteed to be maintained. It was replaced by a software suite developed by Plattling-based SAP Gold Partner T.CON GmbH & Co. KG.

Sönke König was involved in the implementation project. The experienced papermaker/ industrial businessman and his two colleagues have now been using TRIM SUITE for planning for five years. "This isn't just about celebrating an anniversary. TRIM SUITE has been a real success story for us", says König.

Steinbeis Papier is one of the market leaders in Europe, producing recycled graphic paper from 100% recovered paper. The company had already been using SAP ERP and SAP APO to model its logistics process chain for some years. Unlike the tool it was replacing, TRIM SUITE is fully based on SAP technology. It is integrated into APO fine planning as a heuristic. The planning blocks modeled in SAP APO are planned in detail within the trim; they are then automatically supplied with any and all available feedback and process data through the T.CON manufacturing execution system, MES CAT.
Cutting plans are seamlessly passed to MES CAT for execution in production. This means that the complete order-to-cash process is then modeled using standard SAP and T.CON applications – 100% based on SAP technology and no external interfaces.

Varied optimization goals

Over the years, Sönke König has found that T.CON's global solution, thanks to its full integration, delivers the optimum planning results. At the same time, it is quick and easy to adapt it to new requirements.
One of the tasks of the Steinbeis planning team is block planning. Depending on the order situation, König and his team might plan months in advance exactly which paper will be produced on which day. König then plans how orders can be combined in production, to make sure the machines are utilized as fully as possible and as little as possible raw material is wasted.
Using TRIM SUITE doesn't just keep the trim quantities to a minimum. After all, that's not always the best planning objective: there are always several different factors that need to be taken into consideration, such as delivery dates or resource availability.

We are constantly changing our product range as we respond to the market

Sönke König

An example: Steinbeis has various machines that are used differently. On one machine, changing the knife settings is easy. The only objective for the trim on this machine is to minimize waste. However, on another machine, changing knives is a laborious process. In this case, the trim optimization needs to assign this work a much higher cost.

All dependencies considered

Using TRIM SUITE, Sönke König is able to select a variety of optimization objectives: he can minimize waste or keep set-up times low, as we've just seen, and there are many more parameters he can adjust. Through seamless SAP integration, TRIM SUITE can exchange information with other SAP components at each step of the optimization process. The overall result: when calculating the optimum trim, all dependencies and factors are automatically taken into account – and can be adjusted at the touch of a button.
Information from the warehouse, administration department and all other areas of the company are directly incorporated into the planning. König can start work on orders that perhaps only need to be completed in a month's time – by giving priority to producing certain types during the current machine run, he can reduce the overall waste.
He can also see straight away whether doing so is likely to be worthwhile, based on the storage costs for the outgoing goods.

Copy paper quality of Steinbeis Papier

The strategy determines the direction

Waste, set-up time, inventory, and many more – König can decide exactly which optimization
objectives he wants to pursue, considering overarching strategic or economic conditions. He can also create detailed definitions for how to prioritize each objective: which factors are most important?
At the same time, the app's SAP integration makes the process much smoother for the planners. Sönke König explains: "I don't need to switch back and forth between applications to calculate the trim. | just click on a block in SAP APO and launch the optimization."

Large spectrum of products and reels

Steinbeis has a large production range, which means high demand for versatile trim optimization scenarios. The smallest reel that is produced for printing house paper is 39
centimeters and weighs 400 kilograms. The largest measures 2.81 meters and weighs four tons. There are also other conditions that need to be taken into account during the calculations.

> We produce different reel sizes and quantities for every printed item that the printing houses buy from us

For example, not every combination of slits that is theoretically possible can be used in practice. Among other things, it's not possible to produce more than four of the smallest rolls next to each other.

Depending on the paper type to be produced, König may also account for issues such as paper shrinkage. That means his tool must work with the actual width of 4.48 meters, not the theoretical 4.50 meters. "The machines have to execute what we plan", explains Sönke König. "If | don't make the correct plans, if I've failed to take into account the technical conditions, we end up in trouble."

TRIM SUITE can take this kind of specification into account. "The T.CON consultants understand the exact requirements for the paper industry", says König. "Their familiarity with the industry is part of the reason a tool like TRIM SUITE models our needs so well."

A flexible tool reacts to changes

At the same time, the tool is flexible enough to react as the recovered paper specialists adapt their business. This has been proved over and over during the last five years, most recently when Steinbeis extended its portfolio with large-format papers and sheets. "We are constantly changing our product range as we respond to the market", says König. "Every new type of paper is accompanied by new restrictions. This affects how the reels must be trimmed."

König also must ensure the quality is always up to standard, which means taking into account type-specific dependencies during production and planning. TRIM SUITE is updated or given new functionality several times a year, as new requirements arise in production.

Sönke König sums up the five-year partnership with T.CON: "We have found that TRIM SUITE can be adapted to new requirements very quickly and easily. That helps us, as we often have lots of new ideas about ways we can improve."

Customer representatives and controllers also use the data

König also uses the tool to support the Steinbeis customer representatives, who prepare the sales quotes. König can use TRIM SUITE to help them, without needing to produce anything – indeed, ideally within just a few minutes. Based on his production run simulations, the customer

representatives can assess how a new order would fit into production: would this be an opportunity to maximize use of residual quantities or production capacity and thus avoid waste – or would the order result in a large increase in waste? This kind of information can now be incorporated when drawing up a quote. "Customers love that we respond rapidly and give reliable quotes", König says. "This reliability gives our corporate image a major boost. For that reason alone, TRIM SUITE and SAP APO pay for themselves many times over."

Head quarter of Steinbeis Papier in Glückstadt

TRIM SUTIE records the results of the optimizations in a database. All KPIs are automatically

measured based on the trim history. The company also uses the data for BI evaluations. Controlling use this information to see which products and paper types are most profitable. "These figures make a significant contribution to our profitability", says König. "We are using TRIM SUITE in numerous different places to help us get the best for both our customers and our company."

www.tcon-international.com

Recyclable Flow Wrap

BillerudKorsnäs launches recyclable paper-based flow wrap

Challenging the standard in confectionery packaging

Picture: BillerudKorsnäs

BillerudKorsnäs joins forces with Syntegon Technology to launch Recyclable Flow Wrap, a paper based packaging solution that enables a shift from conventional plastic to renewable and recyclable materials.

Flow wrap is a type of flexible packaging used for many products in the fast moving consumer goods (FMCG) sector and today plastic film flow wrap is standard for FMCG. BillerudKorsnäs Recyclable Flow Wrap is an innovative paper packaging solution, based on primary fibres from well-managed forests and with high barrier performance that can be recycled as paper.

> We are happy to launch a paper based flow wrap solution. The product is recyclable as paper and brand owners don't have to compromise neither product shelf life nor converting productivity in comparison to plastic packaging options" says Peter Åström, Project Manager Recyclable Flow Wrap

The product enables the shift from conventional plastic to paper and is suitable for medium to high barrier requirements such as those posed by chocolate bars and other confectionery as well as bakery product. A patent application for BillerudKorsnäs Recyclable Flow Wrap is pending.

Recyclable flow wrap is verified by Syntegon Technology and tested with their retrofit upgrade kit "paper-ON-form".

With the Syntegon upgrade kit paper-ON-form it can be installed on existing horizontal flow wrapping machines and new flow wrappers from Syntegon Packaging Systems AG. The solution was engineered in Syntegon´s own development center in Beringen, Switzerland, and consists of a flow-wrap forming unit and sealing tools or paper cold-sealing applications. The kit is already being used on existing lines from international manufacturers for packaging chocolate bars in paper.

"To make flow wraps future-proof we have to take a holistic approach. In our test lab, we are concentrating on three elements. Avoidance. Recycling. Recovery. Our retrofit kit allows customers the transition to paper packaging on their existing Syntegon Packaging Systems horizontal flow wrapping machine – without any restrictions regarding speed compared to the existing for cold-sealable paper," says Christoph Langohr, Project Manager of Sustainability Horizontal Packaging.

By introducing Recyclable Flow Wrap, BillerudKorsnäs brings forward innovation based on renewable and biodegradable materials meeting brand owners and legislators´ need to reduce littering and increase recycling without compromising on the barrier characteristics.

www.billerudkorsnas.com/recyclableflowwrap

Complexing agents in the paper industry – part 1

Green alternatives

Picture: HFA/schewig-fotodesign.at

Complexing agents based on polyaminocarboxylic acids are still in use for the production of speciality papers and pulp to obtain the required ISO brightness. However, environmental certificates and legislation demand the reduction of these complexing agents and regular monitoring of wastewater emissions is required. In a recent research project at Holzforschung Austria (HFA), new biodegradable complexing agents on the market were investigated for their applicability in paper production. Additionally, possibilities for reducing the amount of complexing agents by using simulation software were examined.

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Since the end of chlorine bleaching, the paper industry has switched to hydrogen peroxide as alternative bleaching agent to achieve the required paper brightness. However, this type of bleaching requires the use of complexing agents to keep the use of the bleaching chemicals to a minimum. Heavy metal ions such as manganese, iron and copper, mainly from fresh wood, catalyse the decomposition of hydrogen peroxide and therefore strongly reduce the efficiency of the bleaching process. Complexing agents such as EDTA and DTPA are the optimal scavengers of these heavy metals due to their stereochemistry but fail the environmental requirements as they cannot be removed from the wastewater and are considered non-biodegradable. Between 2005 and 2007, Holzforschung Austria and Austrian paper manufacturers, worked together on a project on this topic. Novel biodegradable products that were on the market at the time were investigated. Although some alternative complexing agents combined with further additives (e.g. stabilizers...) showed very good results in the bleaching process in the laboratory experiment and changes in the bleaching process (e.g. two-stage washing / bleaching processes), these promising results in practice could not be reproduced. For this reason, there are still no biodegradable complexing agents available that fulfil both the technical requirements and the requirements for the wastewater emission regulation.

The European commission decided on the implementation of regulations for the production of pulp, paper and board industry based on the BAT conclusions (BAT PP – Pulp, Paper and Board) on September 26th 2014. The Austrian national regulations of the previous "AEV bleached pulp" and "AEV paper and cardboard" have been adapted to the BAT conclusions and combined in one ordinance through the "AEV Zellstoff und Papier" published in BGBl II Nr. 62/2018. In the current text of the regulation, a total degradability of complexing agents by aerobic microorganisms in an aqueous environment of at least 70% after a test duration of 28 days is required.

New approaches in a research project

The paper and pulp industry is still looking for alternative biodegradable complexing agents. In the research project "EcoAgents", funded by the Austrian Research Promotion Agency (FFG), HFA is working on this topic in cooperation with partner of the Austrian paper and pulp industry.

The project focuses at five major aims:

– Investigations of biodegradable complexing agents in the bleaching process of the pulp and paper industry that are currently available on the market
– Investigations of technically suitable alternative complexing agents for their biodegradability (at least 70% after 28 days is required)
– Optimization of the amount of chelates that are required for optimal results (ISO brightness, peroxide stabilization)
– Development of analysis methods for complexing agents in pulp and paper production.
– Investigation of techniques for the efficient biological and photochemical degradation of complexing agents.

Novel biodegradable complexing agents

In recent years, producers of complexing agents have made efforts to develop new alternative complexing agents to fulfil the increased environmental and health requirements. However, it is known from practical experience that only a small amount of complexing agents are suitable for use in the paper industry. To find the best performing complexing agents, laboratory bleaching tests were conducted with selected novel biodegradable complexing agents in close cooperation with the paper industry. The performance requirements involved maximization of brightness (corresponds to a good bleaching effect), maximization of the residual peroxide content (corresponds to good peroxide stabilization) and an equal or even higher brightness than reference complexing agents, that is currently used in the different paper plants.

Figure 1 shows the bleaching results of the different starting materials to be bleached (wood pulp – PGW, kraft pulp, pulp, deinked pulp – DIP) with the alternative products examined. The graphic shows that only a few alternative complexing agents showed an increase in brightness.

After the laboratory tests, the project partners carried out operational tests with some complexing agents that exhibited an increase in brightness. In these operational tests, the concentration of the alternative complexing agents was gradually increased while the dosage of the conventional complexing agents currently used in the plant was reduced at the same time. Although there was initially no change in brightness, the tests had to be ended after adding approx. 2/3 of the alternative complexing agents, as there was a decrease in brightness points and the test was no longer justifiable during the ongoing paper production process.

Biodegradability tests were then carried out by some alternative complexing agents. The results are shown in Figure 2.

The alternative complexing agents were then further examined for their environmental degradation properties. The biodegradability of the investigated novel complexing agents was between 33 and 39% and thus did not meet the legally required biodegradation of 70%. In the course of the project complexing agents based on phosphonic acids achieved good results in terms of brightness, relatively. Thus, further action was focused on the degradability of phosphonates.

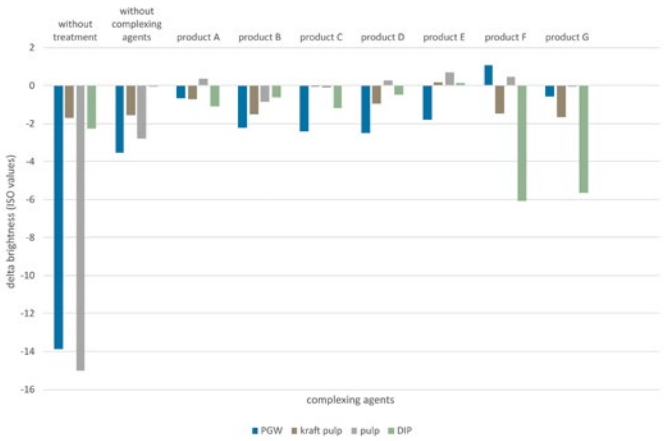

Figure 1: Changes of brightness (delta brightness) compared to the reference bleaching of anonymized complexing agents

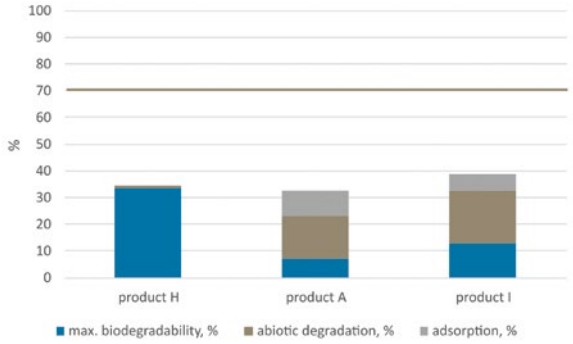

Figure 2: Biodegradability of the complexing agents investigated

Complexation Efficiency – Simulation Software

In addition to substituting conventional complexing agents by novel biodegradable complexing agents, it was tried to minimize the amount of complexing agents. This was done by simulating the complexing process of various mixtures of complexing agents, using numerical techniques. The complexation efficiency is influenced by the selected complexing agent and the composition of the metal ions present in the system. Other influencing factors are pH value, temperature and water hardness. Figure 3 shows the peroxide stability (or complexation efficiency) at pH 9.5 of EDTA as a complexing agent in a combination of different water hardness and metal ions.

It can be seen that the Ca component of the water hardness has a stronger negative effect on the peroxide stability or on the complexation than Mg (II). This indicates that the water hardness as a cumulative indicator (the Ca and Mg ions present in the system) alone is not suitable for estimating the complexation efficiency. It is important to take the interactions between the individual components (species) present in the process water into account. This allows to decide, how suitable a complexing agent is for bleaching under the specific practical conditions.

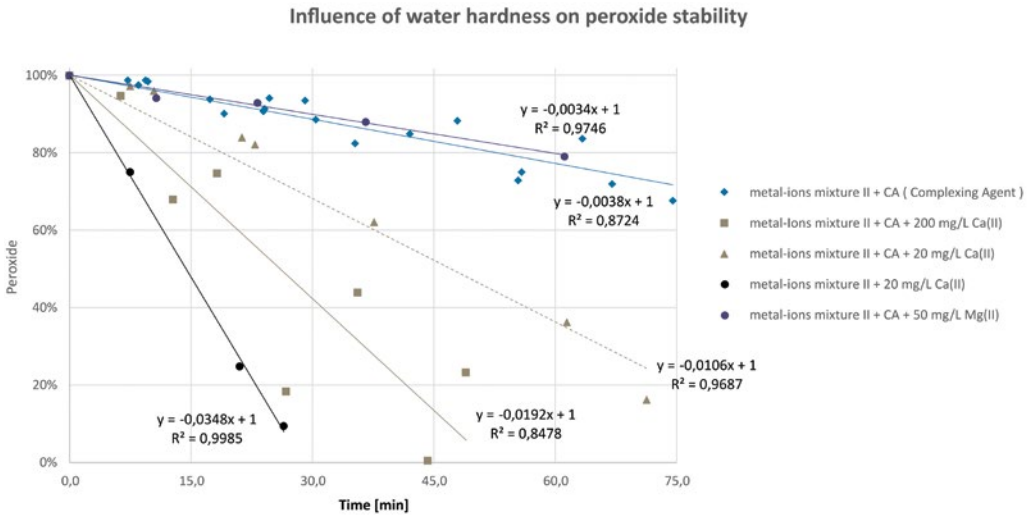

Figure 3: Complexing efficiency at pH 9.5 and different water hardness of EDTA with a metal ion mixture typical for the pulp industry

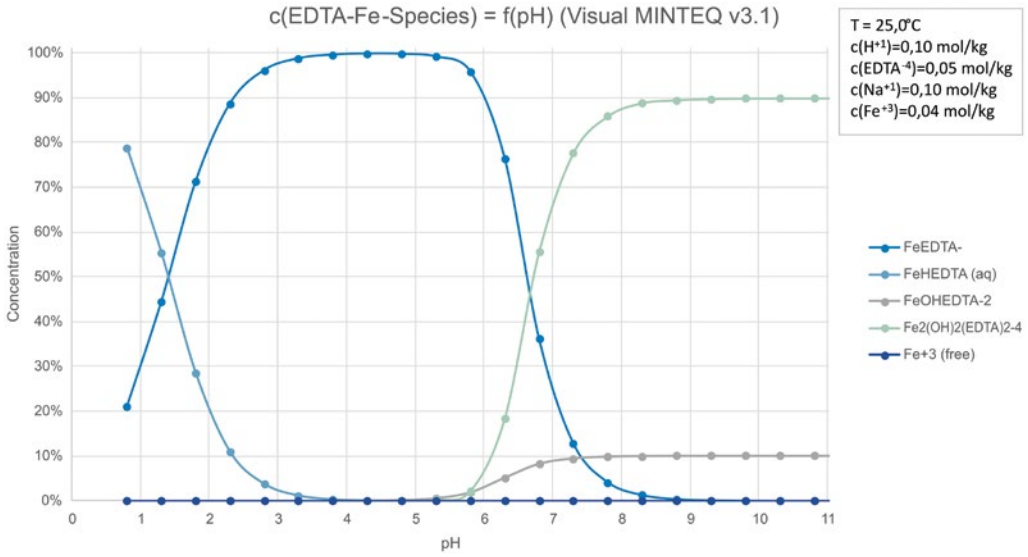

Figure 4: Simulation of the speciation of chelate-Fe (III) complexes at different pH values.

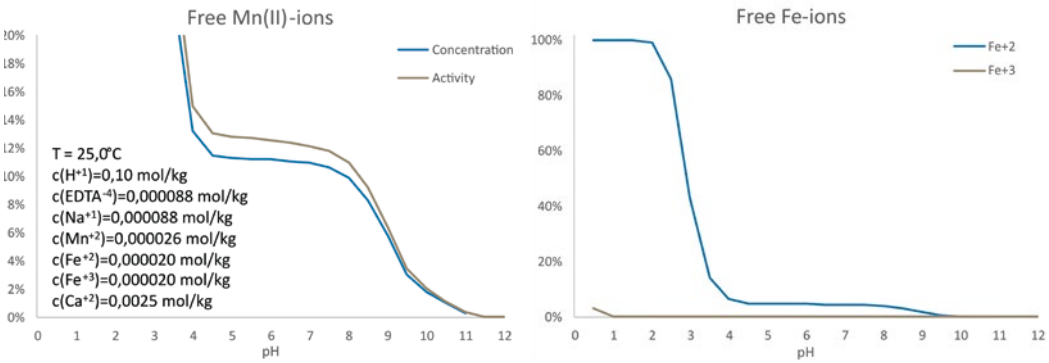

Figure 5: Calculation of the concentration of free metal ions by simulating the speciation of chelate-Mn (II) -Fe (III) -Fe (II) -Ca (II) complexes at different pH values.

The interactions between the individual species, even under different conditions (pH value, temperature), can be determined with the use of simulation software, e.g. Visual MINTEQ (freeware), (Figure 4). Provided that the chelates are well characterized in the software database, it is possible to carry out simulations with several metal species (Figure 5) or even with a mixture of several chelates (not shown). This enables to calculate the optimal dosage of complexing agents and establish in practice. In this way, an excess in the addition of complexing agents can be minimized.

Conclusions

In the EcoAgents project, novel biodegradable complexing agents could be found that showed good technical properties in laboratory experiments. However, these could not be confirmed in operational tests. The officially required biodegradability of 70 % within 28 days could not be achieved by any of the novel products examined. The use of simulation based modelling can help to improve the complexing agent optimization.

Acknowledgements: The project EcoAgents received funding from the Austrian Research Promotion Agency (FFG). Contributions to the project from the members of the paper and pulp industry are gratefully acknowledged.

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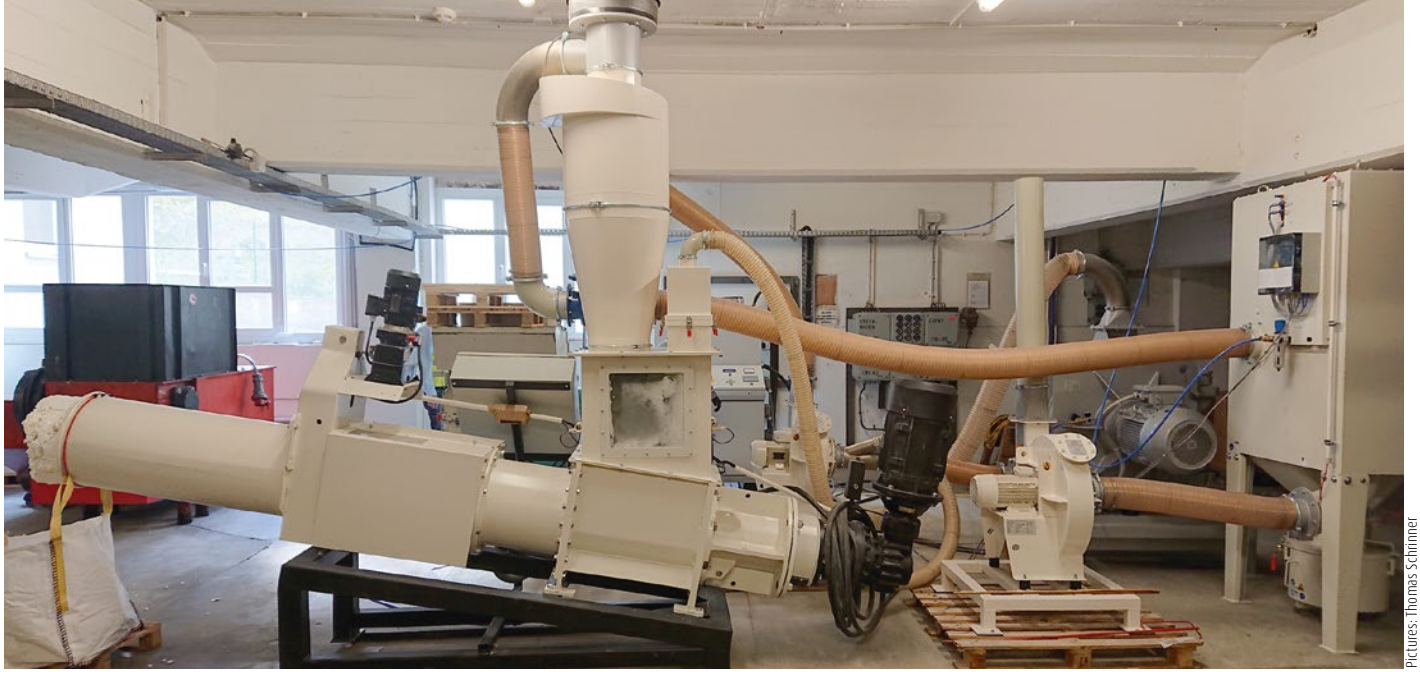

Pictures: Thomas Schrinner

The mobile dry defibration plant in use in a paper mill

How to reduce raw material costs and improve product properties

A new mobile plant allows interested paper manufacturers to test the diverse possibilities of dry defibration on site, i. e. in their own mills and to check the potential economic, qualitative and sustainability-related advantages of this process for their own products.

Since a couple of decades the paper industry has belonged to the most energy-intensive branches worldwide. This and the effects of the no longer deniable climate change have led to a situation in which this industry finds itself increasingly exposed to criticism from politics and society.

The still very high specific energy demand of the modern paper industry results in the first place from the fact that all efforts to reduce the enormous amount of water necessary for running the state-of-the-art process lines were not efficient enough. In fact, most of this water has still to be removed mechanically or thermically.

Against this background, the development of low-water technologies was pushed forward at the beginning of the 2010s at the Chair for Paper Technology at TU Dresden. In this context, the basic principles of dry defibration on laboratory and pilot plant scale have been developed, among other things, in order to enable the processing of raw materials that have so far been of limited or no use at all. In the course of the further development of this technology, a consortium was formed which carried out the first real production trials with dry-processed fibres on a larger scale in state-of-the-art paper mills. It quickly became apparent that application rates of up to 100 % were possible and that furthermore the addition of dry fibres to the fibre suspensions, as they have usually been used exclusively in the past can have a considerable positive influence on product properties.

In order to be able to transfer these successful possibilities to other paper manufacturers, a mobile dry defibration plant for industrial applications was developed and built. With this mobile test plant, which is currently already in operation, interested paper mills can test the potential of dry defibration under their own specific environmental conditions and in their own plants and evaluate the technological and economic added value in a practice-oriented manner.

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Development and application possibilities of dry defibration

About 8 years ago, the Chair for Paper Technology at the TU Dresden, under the direction of the now emeritus Professor Dr.-Ing. Harald Grossmann, focused its research on the development of innovative technologies for energy and resource saving for the paper industry and especially on efficient fibre preparation. Background were political objectives for a significant reduction of the CO_2-footprint until 2050, which were summarized for the paper industry in the so-called CEPI Roadmap. After the integration of these activities into the Chair of Wood Technology and Fibre Materials Technology, these research goals were pursued together with the now

established TU spin-off RPM (Rethink Paper Making). In this context, the idea of dry defibration of raw materials, especially of recovered paper, was born, not least in order to develop a low-water papermaking process based on this process, which would require far less water input than the classical techniques. In the meantime, not only the theoretical and scientific-technical foundations of dry defibration have been laid, but also numerous practical applications have been tested.

In particular, dry defibration allows the preparation of difficult to defibrillate products like e. g. highly wet-strength papers, which usually cannot be sufficiently defibrated by conventional technoloies techniques and can therefore be recycled in state-of-the-art recycling lines only to a limited extent or not at all. This makes dry pulping technology ideally suited as an energy-saving instrument for the recovery of valuable fibres, as has been successfully demonstrated in numerous pilot plant trials with a wide range of hard-to-pulp products from paper mills. This high level of industrial interest in a suitable processing technology is no coincidence. After all, the limited recyclability of, for example, difficult-to-defibre production waste has a twice as heavy economic effect for the paper mill concerned. On the one hand, because such products mostly consist of high-quality virgin fibres used for the first time and, on the other hand, because in addition to the loss of raw material, which has to be compensated for by purchasing additional material, disposal costs are often incurred. In addition, the sheer volume of products that are difficult to defibre is a problem for the entire industry which, once such products become recyclable would turn into a valuable tool for securing the supply of raw materials in the coming years.

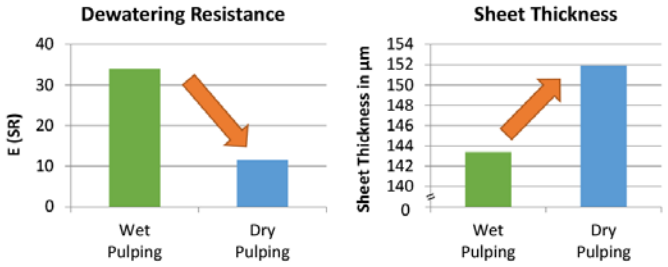


Fig. 1: Significantly accelerated dewatering and volume increase through the use of dry fibres

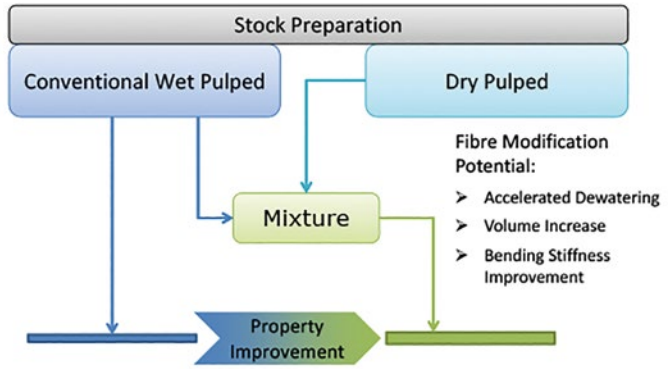


Fig. 2: Targeted influencing of properties through dry fibers.

Tapping previously untapped raw material potential

The German paper industry currently produces about 22.1 Mt/a of paper. The quantity of recovered paper used for this production is 17.2 Mt/a, i.e. the recovered paper usage rate is approx. 78 %. The trade balance for recovered paper shows an import surplus of approx. 2.4 Mt/a. The quantity of recovered paper collected in Germany and used in the paper industry is thus calculated at approx. 14.8 million t/a, which corresponds to a return rate of 78 % with a calculated consumption of paper, cardboard and board of currently approx. 18.9 Mt/a. Approx. 22 % of the paper put into circulation in Germany is therefore not recorded. Even if the total quantity of hygienic paper consumed in Germany, most of which is not recyclable (share of domestic consumption 1.5 Mt/a or 6.8 %), is deducted from this figure, there would still remain more than 14.9 % of the total consumption (approx. 2.88 million t/a), which would with high certainty be fully recyclable at least to $^{2}/_{3}$. If only approx. 50 % of this potential could be tapped, an additional approx. 1.4 Mt/a of recovered paper would be available for material recycling. This would be a significant contribution to resource conservation and to reducing the import dependency of the German paper industry and possibly other customers. This calculation thus impressively underlines the environmentally relevant magnitude of the currently unused paper quantities. In addition, there is the economic aspect, because one of the few common features of the large number of products that are difficult to defibre is that most of them contain high-quality biogenic fibres and possibly also other valuable, in principle recyclable components whose material value adds up to a considerable volume of more than 100 M€/a (at an average waste paper price of 100 €/t). In Europe as a whole, this

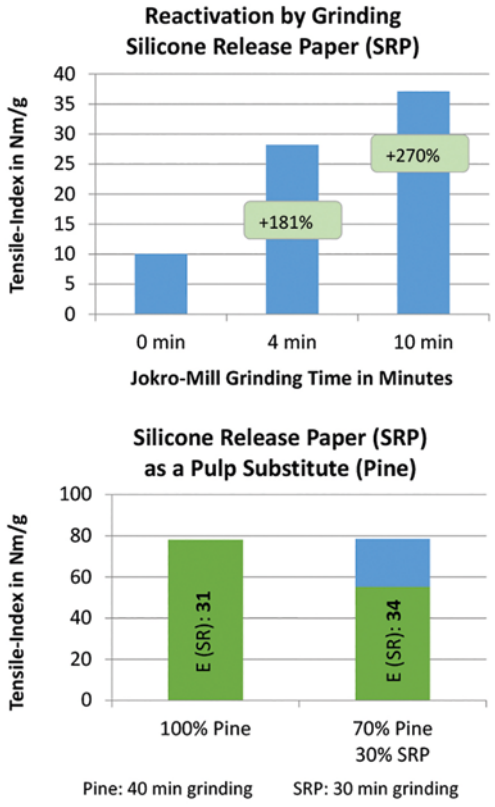


Fig. 3: Dry fibers as a pulp substitute

potential is likely to be even greater due to the lower recovered paper collection rate.

More volume through dry fibres

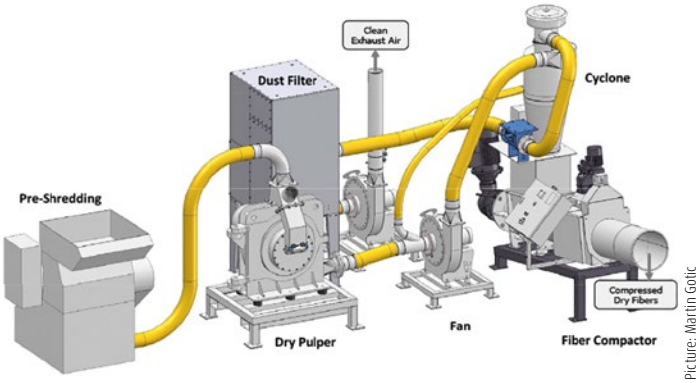
In addition to the economically and ecologically extremely important aspect of fibre recovery, dry defibration also offers the possibility of targeted improvements concerning process efficiency and product quality. These improvement potentials are mainly based on changes in fibre morphology, because dry-processed fibres are less stretched and more bent and curved as wet pulped fibres. The resulting increase in fibre stiffness results in faster dewatering of the fibre suspension and a significant increase in sheet thickness (Fig. 1). Dry defibration is therefore also a possibility for targeted fibre modification, which can improve the specific volume and bending stiffness of specialty and especially packaging papers (Fig. 2). The improvement potential is a function of the raw material, the dry pulping operation conditions and the mixing ratio with conventionally prepared pulp. However, a dry fibre content of 5–20 % is in many cases already sufficient to achieve very good results. Recent investigations of the TU Dresden have shown that dry fibres have a similar "volume effect" as TMP or mechanical pulp and can achieve an even higher increase in bending stiffness due to their higher binding potential at the same dosage quantity.

The fibre forming process taking place during dry defibration and the associated changes in properties are largely reversible in nature. The extent to which the resulting effects of fibre modification ultimately influence the manufacturing process and product properties depends on the intensity and the operating conditions of the dry preparation process and, in particular, on how the dry fibres are transferred to the subsequent wet process and further treating. The longer the dry fibres are exposed to the wet treatment process and the more energy is supplied to them in the process, the more the "volume effect" is reversed through fibre reactivation and flexibilization. In particular, additional disintegration or grinding can be used as a reactivation measure if necessary. By selecting the dosing point of the dry fibres, the dwell time and above all the treatment intensity during the transfer to the wet process, it is therefore decided whether the special characteristics of dry-processed fibres should be brought out more or whether the properties should essentially correspond to those of conventionally processed fibres. The first option offers paper mills, for example, the possibility to increase the volume of their products without changing the raw material base or to replace more expensive specialty fibres such as TMP. In the latter case, many products that are difficult to defibrate can be used as a full-value but inexpensive pulp substitute because of their high-quality components. The energy input required during refining to achieve a specific strength value is typically much lower for dry pulped fibres than for normal virgin pulps (Fig. 3).

Successful paper machine trials

In view of the manifold application possibilities and the high practical relevance, the technological further development of the dry defibration technology was advanced to an industrial scale in cooperation with industrial partners under the direction of TBP Future GmbH in cooperation with Gotic GmbH. This further development process was carried out under consideration of all practice-relevant aspects while ensuring the economic efficiency of the treatment process. This required, among other things, an upscaling of the dry defibration unit to an industrially required throughput and the development of a suitable separation and compression technology for the otherwise very voluminous fibre material in dry condition. In addition, larger quantities of dry fibres were produced in the pilot plant and for the first time used and tested in paper machine trials under real production conditions. It was possible to prove that the "volume effect" can also be used to increase the specific volume under real production conditions and that production with up to 100 % dry fibre use is possible and reasonable while adhering to the target parameters.

Fig. 4: Compressed dry fibres are successively discharged from the fibre compressor of the mobile dry defibration plant



Picture: Martin Gotic

Fig. 5: Schematic representation and structure of the mobile dry defibration plant

Mobile test facility

Due to the broad variety of products as well as the sometimes largely differing boundary conditions in the respective paper mills, pilot plant tests alone cannot achieve sufficiently resilient results or be transferred without restrictions. Furthermore, the use of dry fibres, which have to be produced in the pilot plant and transported to the paper mill, is by no means a permanently practicable solution for more extensive machine tests. Therefore, a mobile dry defibration plant was also developed, which allows interested paper mills to defibre their own raw materials dry on site on a large scale and to use the dry fibres produced in this way directly in the running operation. The mobile dry defibration plant can be operated semi-automatically by only one operator, completely detached from the normal production process. The installed capacity of the plant is approx. 100 kW and in addition to the power supply only a compressed air connection is required. This, the small space requirement (overall height: 3.5 m; footprint: approx. 15 m²) and the flexible installation

of the individual components should make it possible to install the complete plant in most paper mills without any problems (Fig. 5), especially since the screw compactor allows the compressed pulp to be easily transported to an intermediate storage facility or directly to the place of use. The capacity of 100–200 kg/h is sufficient, especially for small and medium-sized paper mills, to carry out a wide range of trials with up to 100 % dry fibre use. However, larger paper mills should also be able to produce enough dry fibre with the mobile plant in order to achieve dosages of 5–10 %, at least on a trial basis.

The mobile dry defibration device starts with pre-crushing of the product to be defibrated to a size of approx. 2×2 cm. Due to the rotor-stator shredding principle, pre-shredding is necessary for both the targeted single fibre shredding and for a constant feed, regardless of the size. A granulator was selected as the universal solution for the test operation, but for the design of an industrial plant the pre-shredding unit would be specially adapted to the customer's requirements. The pre-shredded product is conveyed through the dry pulper with the aid of an air flow generated by a fan and, supported by highly turbulent air eddies generated by special grinding elements due to the high speed, is shredded within a very short time. The forces acting in this process are essentially pressure-shear stresses in the grinding gap, particle-particle collisions and impact stresses on rotating and stationary body surfaces. Following the single fibre separation, the dry and very voluminous fibre material is separated from the air stream by means of a cyclone and compressed by a screw compactor to a desired density of 100–500 kg/m³ and successively discharged (Fig. 4). The fine and short fibre components still in the air stream are retained by a dust filter at the end of the process chain. The separation efficiency of the cyclone is more than 99 %. Operation and control of the mobile plant, which is of course explosion-proof, is carried out via a control cabinet.

The mobile plant allows interested parties to extensively test the various possibilities of dry defibration in their own production plant and to evaluate the results to be expected with regard to their own economic, technical and quality-specific objectives. We support all interested parties directly and are happy to supervise the mobile plant and production trials on site during the rental phase. If required, we can also carry out preliminary tests in the pilot plant on the basis of which the interested party can decide to use the mobile test plant.

Timetable and schedule:

- Book a test appointment.
- The mobile dry pulping system is delivered to the installation site and put into operation by experienced technicians.
- Instruction and training will take place.
- If necessary, the production trials are supervised scientifically and technically.
- There is also the possibility that we support the trials with laboratory analysis.
- After the rental period, the mobile dry pulping system will be picked up again.
- Finally, joint evaluation of the test phase and upscaling to an industrial process.

Figure 1: Paper beam from student work at the Institute of Paper Technology and Mechanical Process Engineering, TU-Darmstadt – side view

Why ... and not ... ?

Questions, thoughts and a discussion on building with paper

Part 2: Scientific discourse

In contrast to Part 1, which was a rather emotional discussion, Part 2 examines paper as a building material on the basis of facts and data. It starts with some sustainability considerations, followed by a feasibility study. Here, a paper beam is used to compare the load-bearing capacity of paper components with other materials. This is followed by a life cycle analysis of the paper beam presented in this feasibility study.

Using wood for paper – Facts about sustainability

The following considerations are limited to Germany and the German forest.

According to the "Factsheet Forest, Wood and Climate", around 122 million m³ of wood are growing in Germany every year. The average use of wood in Germany is 76 million m³. Forests that are regularly managed protect the climate demonstrably better than set-aside, use-free forest areas. If wood utilization were to be renounced, the climate protection effect would be significantly lower only by stock accumulation in unused forests [12].

From this it can be concluded that the German forest is growing and neither timber nor paper is destroying the German forest. Climate protection is not worsened by the use of wood itself.

In Germany, around 35 million m³ of wood are used in the sawmill industry and construction timber. Another 9 million m³ are used in the wood-based materials industry. Only 6 million m³ are used in the pulp and paper industry. 26 million m³ are firewood for private households and commercial energy wood [12].

These numbers show that the pulp and paper industry could be expanded if wood was not burned directly but was first used for another purpose. This could be the production of paper for building with paper, for example. In [13] it is even openly stated that the increase in state-subsidized energy use of wood is a danger for the paper industry.

All sectors mentioned in [12] use more softwood. Only for the energetic use the proportions are the same. However, the forest of the future will consist of much less pure softwood (10 % instead of 27 %) and also less mixed forest (37 % instead of 51 %). This means that the entire timber industry will have to adapt to changing types of wood. In this respect, paper has advantages because fibre mixtures are possible as well as the use of recycled paper.

Expressed in tonnes instead of cubic metres: Germany produced 2398 t of pulp and mechanical pulp in 2018. In addition, however, 3423 t of pulp and mechanical pulp were imported [14]. This means that if Germany produced all the pulp itself, more than twice as much wood would be needed. Nevertheless, the amount of wood consumed is smaller than that which is simply burned and is also much smaller than the amount of saw and construction timber.

Germany has recycling rates of 76 %[15]. A fibre can be recycled more than 20 times [16]. This shows that technology and know-how are available to reuse the fibres several times. Not only fresh fibres have to be used for construction applications. The right mixture is crucial. Each fibre has a function and must be brought to the right place in the paper or building. A good example is corrugated board: A mixture of fresh and recycled long fibres is used in the liners. The recycled short fibres are used in the flute. All in all, corrugated board still has excellent strength properties.

The paper industry uses residual sawmill wood and thinning wood. The diameter of the logs is 20–30 cm maximum. Trees for trunk or saw timber for the construction industry grow for about 80 to 120 years, but only 10 % of the original plants are used [13]. Accordingly, wood for paper is available more quickly. The total number of plants that can be used for paper is therefore higher than those that can be used for construction timber.

Overall, the following conclusions can be drawn from these sustainability considerations:

1. **Paper neither destroys the forest nor does climate protection suffer because German trees are felled.**
2. **Building with paper makes sense above all when we use wood for "building paper" and do not burn it. An energetic use should always be the second step.**
3. **Paper has overall advantages in terms of sustainability, especially if not only fresh fibres are considered, but also recycled fibres.**

Feasibility Study – A Paper Beam

The following sections present theoretical and experimental comparisons of beams made of conventional materials with existing regulations of geometry and material quality to paper beams in terms of their mechanical properties. The focus lies on the question given in Part 1 of this article whether it is possible to save weight and energy when building with paper. Thereby the influence of heat and moisture is neglected. At first an experimental feasibility study is presented where a paper beam was built by students to get an impression of the performance (Figure 1). Since the cross section of this paper beam is not constant it is necessary to define a representative bending stiffness for comparison purposes. In addition, a theoretical approach is used to further increase the performance of paper beams by making use of a sandwich structure. The optimized system is compared to standard IPE and glulam profiles in terms of weight-to-stiffness ratios. The theoretical approach is applied to commercial honeycomb board and the results are compared to those obtained from bending tests.

Determining a representative bending stiffness of the beam

The beam shown in Figure 1 was tested under 4-point-bending. The structural system of the beam under 4-point-bending is given by Figure 2. The deflection is measured at the centre of the beam, where symmetry line is drawn. The test results as acting force to occurring mid-span deflection are shown in Figure 3.

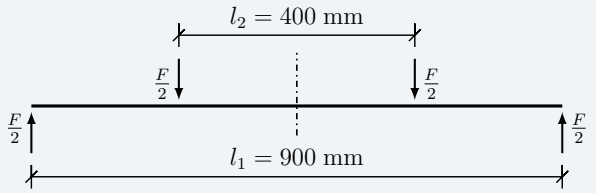


Figure 2: Structural system of the 4-point-bending test setup

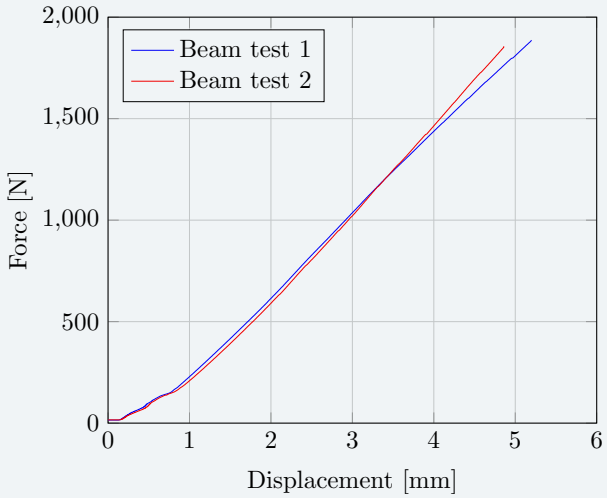


Figure 3: Results of the 4-point-bending-test of the beam

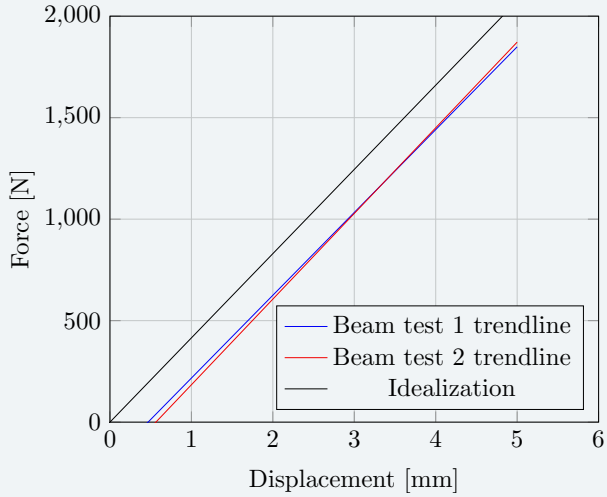


Figure 4: Idealization of the force-displacement-behaviour

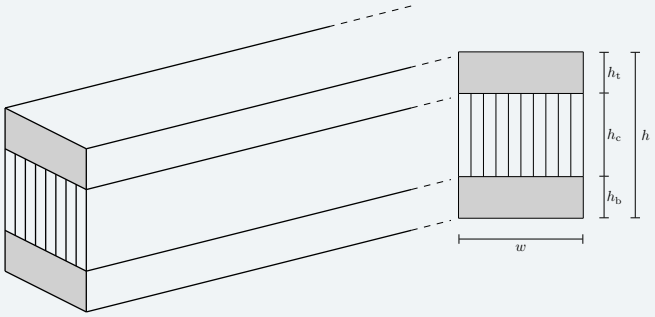


Figure 5: Paper beam with honeycomb plate core

Figure 6: Cross section dimensions

The linear parts of the force-displacement-curves are approximated by trend lines (cf. Figure 4). The idealized behaviour is given by the mean of both trend lines and elimination of the nonlinear behaviour at the beginning of the test.

A representative bending stiffness of the tested beam can be estimated:

$$EI_R = 4.711{,}98 \text{ Nm}^2 \qquad \text{Eq. (1)}$$

I_R is the moment of inertia of a representative cross section. Table 1 shows the required edge length for an equivalent bending stiffness of beams out of steel, concrete and timber (each with a square shaped cross section) to the paper beam. Also, the resulting weight per unit length is shown.

Table 1: Different materials and cross section dimensions leading to equal bending stiffness

Material	Young's modulus *E* MPa	density *p* kg/m³	edge length *a* mm	weight per length m_L kg/m
Paper beam	–	–	–	2.4
Steel	210,000	7,850	22.8	4.1
Concrete C20/25	30,000	2,400	37.1	3.3
Timber C24	11,000	350	47.6	0.8

It can be concluded that the corresponding is lower for paper when compared to steel and concrete but further optimization of the paper beam will improve its performance.

Optimized beam: theoretical concept

In the following a beam with a constant cross section along its length is regarded. It consists of a top and bottom layer made of the same material and a low-density core, see Figure 5. It is further assumed that top and bottom layer have the same height ($h_b = h_t$), see Figure 6.

For further investigations on the bending stiffness of this cross section, the stiffness of the core is neglected. Figure 7 shows a specific measure for the bending stiffness vs. the relative height of the top and bottom layer. Reducing the core's weight leads to an increase of the stiffness-weight-ratio. E. g. the reduction of the top and bottom layer thickness to 1/10 in comparison to the full rectangle cross section leads to a stiffness-weight-ratio increase of 2.44. The efficient use of material and higher utilization can be achieved. Since timber beams are mainly built with a full cross section, paper materials allow building more lightweight structures.

Another approach is used by Murthy et al., 2006 [17], in which the stiffness is related to the core-skin-weight-ratio for thin skin layers where $h_t << h_c$. By using this approach, the maximum bending stiffness is obtained by computing the optimal ratio h_t / h_c which depends on the material parameters.

Based on the above considerations a comparison of paper beams to glulam and IPE profiles is performed in terms of the resulting weight per unit length (m_L) to obtain the same bending stiffness. Typical paper material parameters are used, and the core is assumed to be made of paper honeycomb whereas for the top and bottom layer a paper material with high elastic stiffness is assumed. Only the machine direction (MD) elastic modulus is regarded for the top and bottom layer and an

ideal transfer of shear stresses is assumed. The cross direction (CD) is not regarded. Table 2 shows the used material parameters.

Table 2: Paper material parameters used for comparison

Layer	Parameter	Value
Top / Bottom	Young's modulus (E_{paper})	5,000 MPa
	Density (ρ_t)	780 kg/m³
Core	Density (ρ_c)	116 kg/m³

Comparison with glulam

The material parameters used for glulam are shown in Table 3. A constant width (w) of 60 mm is assumed for a variety of height-to-width ratios (h/w) between 2 to 4.

Table 3: Glulam parameters

Parameter	Value
Young's modulus (E_{timber})	11,600 MPa
Density (ρ_{timber})	380 kg/m³

Figure 8 shows of paper and timber beams vs. the used height-to-width ratios for the timber beams. The mass per unit length of the paper beams is almost identical to the corresponding values of the glulam beams. If the Young's modulus of the top and bottom layers would by increased by e.g. using another paper material, the mass per unit length could be decreased further. Due to the low core density of the paper beam, the resulting beam height is about two times the height of the corresponding timber beam which is illustrated in Figure 8.

Comparison with IPE-profiles

To perform a comparison with IPE-profiles, tabulated moments of inertia are used together with the material parameters in Table 4. As IPE-profiles do not have a constant width that may be used for the paper beams as it was done for glulam, a constant height-to-width ratio of 3 is used for the paper beam.

Table 4: Steel material parameters

Parameter	Value
Young's modulus (E_{steel})	210.000 MPa
Density (ρ_{steel})	7.850 kg/m³

The resulting length-weighted mass of the paper beams are shown in Figure 9 together with the values for the corresponding IPE class by assuming equal bending stiffness for the corresponding beams.
The relative height of the paper beams with respect to the corresponding IPE profiles decreases with increasing IPE class from a factor of 3.4 for IPE 80 to a factor of 3 for IPE 240.

Experimental investigation: Bending of honeycomb board

To examine the theoretical approach outlined above, three-point bending tests on honeycomb boards were performed (see Figure 10) and the resulting bending stiffness is compared to the analytical value. A sample size of 150 mm width, 500 mm length and a thickness of

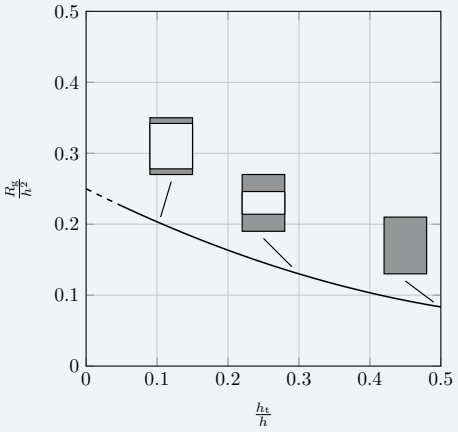


Figure 7: Representation of the normalized radius of gyration via the height of top and bottom layer of the sandwich beam

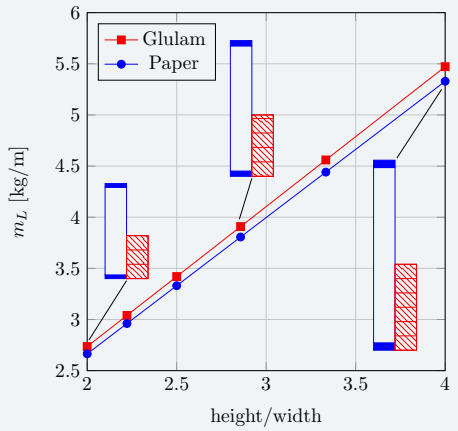


Figure 8: Comparison of resulting mass per unit length of timber and paper beam vs. height-to-width ratio of the timber beam

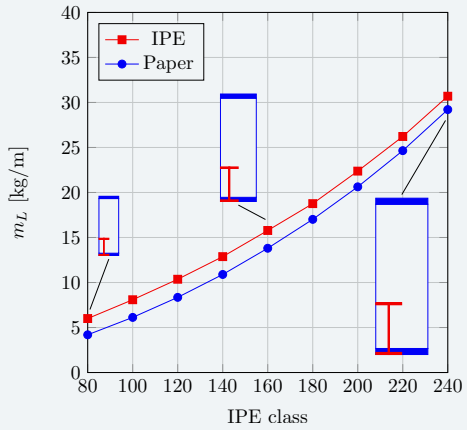


Figure 9: Comparison of resulting mass per unit length of IPE profile and paper beam vs. corresponding IPE class

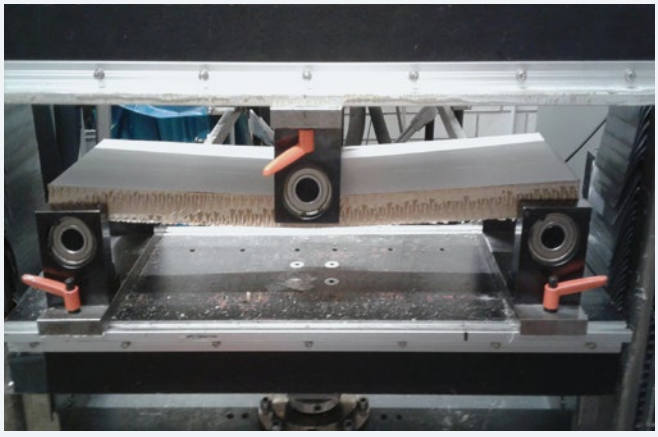


Figure 10: Three-point-bending test setup

30 mm was used. Two directions have been regarded during the tests: fluting parallel and perpendicular to the span direction. The top and bottom layer material was characterized separately, and the core density was calculated. The material parameters obtained from the characterization are shown in Table 5.

Table 5: Honeycomb plate components characterization

Parameter	Value
Young's modulus MD (E_{MD})	4,609.7 MPa
Young's modulus CD (E_{CD})	2,448.4 MPa
Core density	115.57 kg/m^3

A comparison of the resulting bending stiffness from 3-point-bending tests to the analytical values is given in Table 6. It has to be pointed out, that the tested directions not necessarily coincide with MD- and CD-direction of the liner. However, the higher stiffness obtained from the bending test is compared to the MD-direction used in the analytical approach. The results are of the same order of magnitude, but analytical calculations result in lower bending stiffness in MD and CD compared to the experiments. One reason may be the assumption of negligible core bending stiffness which results in a conservative estimation. Also as mentioned before, the influence of temperature and moisture is not considered. Though, the conditioning and climate differed for the determination of the honeycomb plate's bending stiffness and the liner's Young's modulus. This may have affected the results in Table 6.

Table 6: Honeycomb plates: comparison of analytical and experimental investigation of the flexural stiffness

	Bending stiffness	
Loading direction	Experimental	Analytical
MD	196.94 Nm^2	139.23 Nm^2
CD	149.95 Nm^2	73.95 Nm^2

The following conclusions can be drawn from this feasibility study:

1. **It seems to be possible to build beam structures of paper materials.**
2. **Using theoretical considerations, these structures may have mass per length values comparable to beams made of conventional building materials.**
3. **The analytical approach delivers bending stiffness values in the range of the experimental analysis, while underestimating the test values, which is beneficial for more security in calculations of structure serviceability. The present approach has to be validated in further investigations.**

Life cycle assessment

General principles for conducting comparative life cycle assessment

The aim of this comparative life cycle assessment is to classify beam constructions made of paper materials in the structural context of conventional beam constructions. The LCA is based on the general methodology according to [18] and [19].

The indicators non-renewable primary energy in [MJ], global warming potential in [kg CO_2-equivalent] and raw material input in [kg] are calculated using the CML characterization method. The system boundaries are limited to the production phases A1 – raw material extraction, A2 – transport to the manufacturer, A3 – manufacturing according to [20], since the construction phase, the use phase and the disposal phase depend on the installation situation in the building and are therefore construction-specific. The recyclability is not calculated but discussed in summary. In the following, the main source materials for different beam constructions are first examined and compared in order to enable a general classification of paper materials. Then the beam variants of the specific comparisons to glulam and IPE profiles are analysed and evaluated in terms of life cycle assessment.

LCA comparison of source materials for beam production per [kg] material

To compare the LCA data of different building materials, the data are taken from "ökobaudat", an LCA database of the Federal Ministry of the Interior, Building and Community (see [21]). The data sets for paper materials are based on [22] and on further calculations from [23].

Calculating the amount of non-renewable primary energy per [kg] results in the values given in Table 7.

Table 7: Amount of non-renewable primary energy.

Primary energy non-renewable	Value [MJ/kg]
Concrete C20/25	0.38
Paper (fresh fibre)	1.77
Timber C24	2.46
Paper (recycled)	4.39
Glued-laminated timber	4.39
Steel	10.99

Concrete has the lowest demand for non-renewable primary energy during the production phase. This is followed by paper- and wood-based materials. Fresh fibre papers achieve the lowest values. Recycled paper and glued-laminated timber have the highest values in the category of renewable resources. Steel has by far the highest demand for non-renewable primary energy. The values in Table 8 show the global warming potential of the different materials in comparison.

Table 8: Global warming potential.

Global warming potential	Value [kg CO_2-Equivalent/kg]
Paper (recycled)	-1.51
Timber C24	-1.44
Glued-laminated timber	-1.26
Paper (fresh fibre)	-0.96
Concrete C20/25	0.07
Steel	0.99

Paper and wood-based materials can be regarded as an effective natural storage medium for CO_2. CO_2 is bound during the growth phase of the wood, i.e. the source raw material. This is only re-emitted when the material is thermally processed, i.e. burned, at the end of its life cycle. The largest proportion of material-bound CO_2 equivalent is found in recycled papers. This is followed by solid wood, glued-laminated timber and fresh fibre paper. Concrete and steel have significantly lower values, as they do not bind CO_2.

Table 9 lists the raw materials required to produce the various materials. They are divided into non-renewable primary materials, renewable primary materials and secondary materials.

Table 9: Non-renewable primary materials, renewable primary materials and secondary materials.

Raw materials	non-renewable [kg/kg]	Renewable [kg/kg]	Secondary [kg/kg]
Paper (recycled)	0.00	0.00	1.00
Paper (fresh fibre)	0.00	0.75	0.25
Timber C24	0.00	1.00	0.00
Glued-laminated timber	0.01	0.99	0.00
Steel	0.20	0.00	0.80
Concrete C20/25	0.98	0.00	0.02

Recycled paper has the best raw material-related values, as it is obtained 100 % from the secondary raw material recovered paper. Fresh fibre papers can contain up to 25 % recycled fibres. The primary raw materials for virgin fibre papers are obtained from the renewable raw material wood, which is why they are ranked second. Solid wood consists of 100 % renewable primary raw material and glued-laminated timber has only a very small proportion of non-renewable raw material, depending on the glue. Steel, like paper, has a very high proportion of secondary raw material because the recycling processes are very advanced and there is a high rate of use of secondary raw materials. Concrete, on the other hand, has the highest proportion of non-renewable primary raw material and is therefore to be classified as the worst. If all three aspects, i.e. non-renewable primary energy, global warming potential and raw material consumption are considered together, the following hierarchy emerges:

1. Paper (recycled)
2. Timber C24
3. Paper (fresh fibre)
4. Glued-laminated timber
5. Concrete C20/25
6. Steel

In summary, recovered paper materials have by far the best ecological values. This is followed by solid wood materials, fresh fibre papers and glued-laminated timber. Concrete materials achieve significantly worse values. The worst results are achieved by steel.

LCA comparison of specific beam constructions

LCA comparison glulam

In order to enable a comparison between the paper and glulam beam constructions, described within the feasibility study before, the indicators non-renewable primary energy and global warming potential are calculated for the respective beams. Figure 11 and Figure 12 clearly show that the paper beam has lower, i.e. better, values than the wooden beam in both considerations. At a low height/width ratio the values are still close together, but the higher this value becomes, the greater the difference between paper beam and glulam.

LCA comparison IPE profiles

The ecological comparison of a paper beam with a steel beam illustrates the ecological advantages of paper construction even more clearly than the previous example. Even though the paper profiles have significantly larger cross-sections, they have much better ecological balances for the same stiffness, as shown in Figure 13 and Figure 14.

The following conclusions can therefore be drawn from these life cycle analyses:

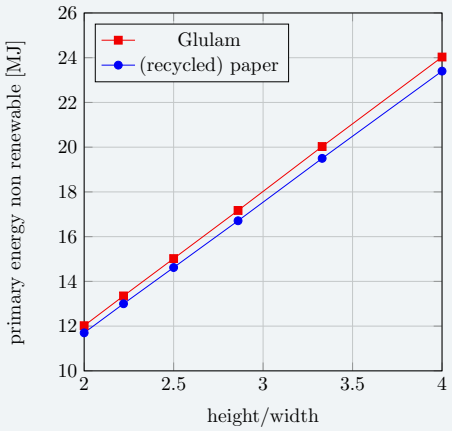


Figure 11: Primary energy over beam height/width ratio for beams made of glulam and paper

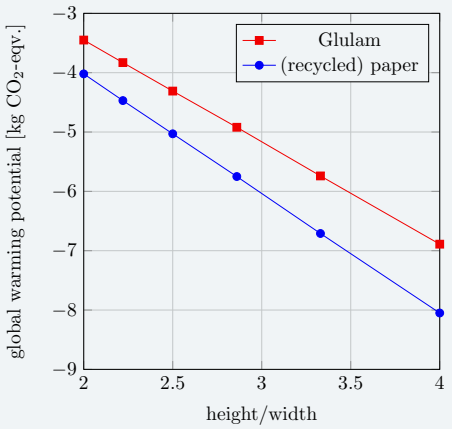


Figure 12: Global warming potential over beam height/width ratio for beams made of glulam and paper

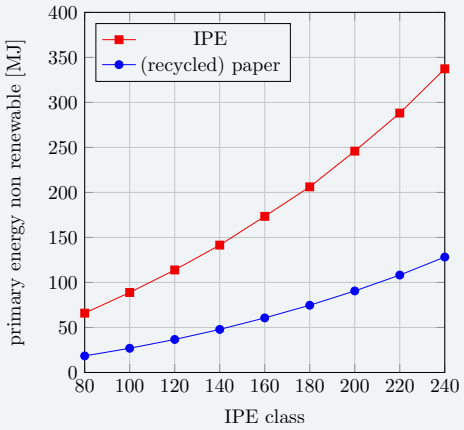


Figure 13: Primary energy over beam height/width ratio for beams made of steel and paper

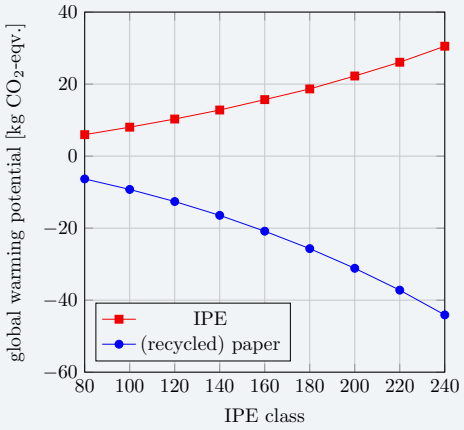


Figure 14: Global warming potential over beam height/width ratio for beams made of steel and paper

1. **The comparison of specific beam constructions shows that paper beams have better values in terms of both primary energy and global warming potential.**
2. **Due to the CO_2 binding of the raw material, paper constructions can function as a CO_2 storage when used over long periods of time or in several cycles.**
3. **The general advantages of paper as a building material, which are already described in the sustainability facts in the beginning of Part 2, are verified by calculations of the life cycle analysis.**

Summary and Outlook

In the context of circular and sustainable economies, building with paper is an innovative and fascinating topic. In the public discussions on this topic, fundamental questions about material properties like strength and durability or about the effects of water frequently arise. In addition, concrete indicator values for characterizing the sustainability of such solutions, like e. g. the potential for saving CO_2 emission, are requested and a popular questions is why should building with paper be better than building with wood. In this article, such facts have been collected with a paper beam as the reference object, which has the same strength properties as a wooden beam. Therefore, a beam made of paper was designed and tested. The mechanical properties have been modelled in order to do systematic comparisons with beams from wood, concrete, and steel. A life cycle analysis is conducted and a feasibility study shows the application potential of optimized paper-based solutions. It can be shown that paper has a great potential in the building sector and its use is only just beginning. The areas in which paper can be used reasonably in the building sector are not well defined, today. However, projects like "building with paper (BAMP!)" at TU Darmstadt pave the way for adequate fields of application. Paper has many advantages regarding the sustainability of materials, in particular when recovered fibres are used. According to results shown in this article, paper-based beam structures can be manufactured which have strength values comparable to conventional building materials and similar or better weight per length characteristics. The analytical model developed for the stiffness of the paper beam provides results in the same order of magnitude as experimental tests, although the experimental results are underestimated. Therefore, these results include an additional safety factor and can be used for first design calculations. They have to be validated by more experiments in the future. The comparison of sustainability indicators shows better values for a paper beam from virgin fibres regarding the consumption of non-renewable primary energy (1.77 MJ/kg) compared to a wooden beam with similar strength (2.46 MJ/kg). The global warming potential of a beam from recovered paper (-1.51 kg CO_2 equiv./kg) is far better than for wood (1.44 kg CO_2 equiv./kg). Since paper is storing CO_2, paper-based solutions in the building area can contribute to CO_2-storage – the longer they are used or the more often they are recycled, the better. The low CO_2 footprint of paper is one reason for the excellent performance of paper in the combined consideration of non-renewable primary energy, global warming potential and raw material consumption.

This paper gives a first overview and benchmark but there are still many open questions to be solved, like long lasting fire and water resistance which are topics of further investigation at the TU Darmstadt. New concepts and solutions will be presented at the International Architecture Exhibition "Biennale" in Venice 2021 and the book "Building with Paper" which is a guide to engineering practice will also be published in 2021.

Acknowledgements: The authors would like to thank the whole BAMP!-Team for the input and the lively discussion on the topic. We gratefully acknowledge the financial support by the German Federal State of Hesse for the LOEWE priority program „ BAMP! Building with Paper".

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Uncertainties in the quantification of complexing agents – part 2

Analytics – methods

Picture: Holzforschung Austria

Complexing agents such as EDTA and DTPA are still important for the production of speciality papers and pulp to obtain the required ISO brightness. However, environmental certificates and legislation demand the reduction of these complexing agents and regular monitoring of wastewater emissions is mandatory. However, findings gained from practical experience often show considerable fluctuations in the comparative analysis of different laboratories. For this reason, Holzforschung Austria carried out a comparative test within the framework of the research project "EcoAgents".

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Complexing agents are still important additives which are particularly important in paper bleaching process. They bind heavy metal ions such as manganese, iron and copper, which otherwise catalyse the breakdown of the peroxide required for bleaching. However, since complexing agents such as EDTA (ethylenediaminetetraacetic acid) and DTPA (diethylenetriaminepentaacetic acid) do not meet the requirements of the Austrian Waste Water Emissions Ordinance Pulp and Paper (Federal Law Gazette II No. 62/2018), a monitoring of the concentrations of these substances in industrial waste water is required by the authorities in Austria.

Comparative test on samples derived from the paper industry

In order to compare the results of the analyses, sampling took place during several time points in the production process of four different paper mills. Afterwards, the samples were sent to four Austrian accredited laboratories. In the different labs, the samples were analysed for their EDTA, DTPA and NTA (nitriloacetic acid) concentration using the following methods: GC / MS according to ISO 16588, HPLC / UV according to DIN 384138 and IC / UV according to Dionex Report 04-2011 -574 A. Relatively large deviations of the values between the laboratories were observed for all complexing agents.

Results in detail

The results of the comparative experiment are shown in Figure 1. It is obvious that for EDTA in the concentration range between approx. 400 µg / l and 1000 µg / l analysed by the GC / MS method as well as by the HPLC method, comparable results were achieved. The scattering of the values was approx. ± 200 µg / l for the same sample. It can also be seen that the scattering of the values between the laboratories is constant and therefore systematic. As expected, the absolute scattering of the values also increases at a higher concentration value. The applied IC / UV method with pre-column iron derivatization, however, led to large concentration overestimations (Figure 1, blue triangles). It is assumed that the deviations observed are based on matrix effects (ghost peaks). These values were therefore not considered for the further calculation of the measurement uncertainty (Table 1).

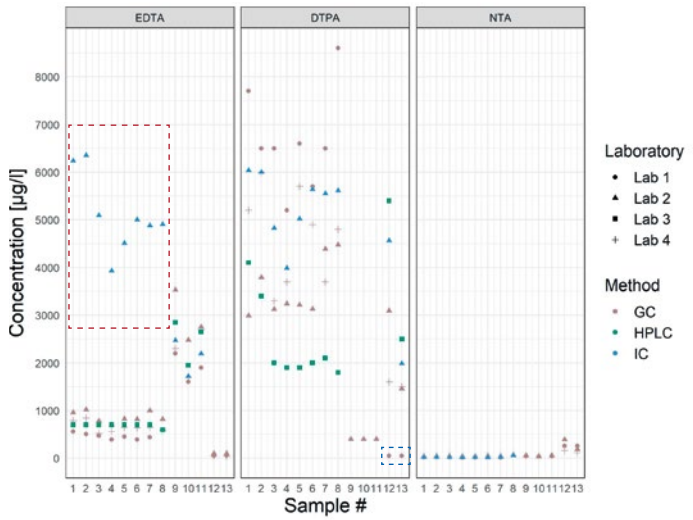

Figure 1: Results of the comparative experiment for the analysis of complexing agents

The scattering of the results for DTPA is also very high. Values between approx. 1800 µg / l and 8600 µg / l were obtained between different laboratories for the same sample. In addition, the differences were not systematic but random. For samples 12 and 13, one laboratory reported values below the limit of quantification in both cases (Figure 1, marked in blue), while values of up to 5500 µg / l were obtained in other laboratories for the same samples. It was also shown that the HPLC method revealed systematically lower values. The relative measurement uncertainty between the results of the individual methods was 39 % for DTPA. During the IC analysis of the samples from a paper manufacturer, peak overlaps were observed, which made DTPA quantification difficult. It is known that due to the high molar mass of the DTPA derivatives in the GC / MS determination, combined with a weak ionization of the fragments in the MS ion source, leads to a lower sensitivity to DTPA. This could be the reason for the relatively high deviation between the laboratories.

The quantitative detection of NTA was carried out by three laboratories. The HPLC method was not used for the NTA analysis. The results showed good agreement. During the IC analysis of the samples especially from one paper manufacturer, peak overlaps were observed, which made NTA quantification difficult.

Table 1 shows a summary of the results obtained as well as the calculated expanded measurement uncertainties of the present comparative test. These examined concentration ranges can be seen as a representative estimate of the usual amount of complexing agents in process waters of the paper industry.

The determination uncertainties (expansion factor k = 1, i.e. the value of the measured variable is usually within the assigned coverage interval with a probability of 68%) for each substance and for the analytical method are also given.

Table 1: Summary of the results obtained including expanded measurement uncertainty

Complexing agent	Concentrations [µg/m³]										
	absolute measured values		Average values								
		of all analyses (n=5)						GC/MS-analyses (n=3)			
		Without outlier correction				With outlier correction					
	c_{min} [µg/m³]	c_{max} [µg/m³]	MIN	MAX	u (k=1)	MIN	MAX	u (k=1)	MIN	MAX	u (k=1)
EDTA	45	3531	49	2671	±119%	49	2671	±34%	49	2677	±39%
DTPA	<50	8600	<50	5207	±39%	<50	5207	±39%	<50	5957	±34%
NTA	14	592	24	351	±41%	24	351	±41%	28	271	±46%
u (k=1)	-		±80%			±38%			±40%		

GC / MS shows the highest sensitivity

A summary of the advantages and disadvantages of the various analytical methods for determining the complexing agent concentration is given in Table 2. It can be stated that GC / MS analysis according to ISO 16588 has the highest sensitivity of all the methods investigated. At the same time, however, this method is laborious and time requirement is high (analysis time of more than 36 hours and more than 12 individual steps in sample preparation). The long analysis time makes this method unsuitable for internal production controls. The recommended use of deuterated standards for GC / MS quantification increases the accuracy of the method, but at the same time also increases the complexity and costs of this analysis method.

The tested IC / UV method is significantly faster compared to GC / MS analysis (analysis time <2h) and very robust for NTA and DTPA but was found to be unreliable for the quantification of EDTA from certain process wastewater. The reason for this high deviation has not yet been clarified finally. The HPLC method was also characterized by a short analysis time (~ 3h) but led to a systematically lower recovery of the DTPA concentration compared to the GC / MS method. Interestingly, however, no systematic deviations were found in the EDTA quantification, although the method corresponds in principle to the IC / UV method (derivatisation and UV detection at 260 nm).

Based on the calculated determination uncertainties, one can conclude that the outliers of the EDTA concentration values of the IC method (Figure 1 red marking), which are regarded as systematic, can be viewed as problematic. If one were able to identify the cause of the outliers and consequently avoid them, the uncertainty of the determination by all analyses (GC / MS + IC + HPLC) would be similar to that of the GC / MS analyses alone.

Table 2: Comparison of the advantages and disadvantages of the analytical methods used for the determination of complexing agents

Method	Advantages/Disadvantages	LOQ [µg/m³]	Time [h]	MU k=2
GC/MS (ISO 16588)	+ high sensitivity + good selectivity - very complex, large measurement uncertainty (>50%)	<1* until <50*	>36	>50%
IC-UV (Dionex)	+ easy implementation - Matrix effects (EDTA, NTA)	20 until 50	~2	<50% (until >100%)
HPLC-UV	+ high sensitivity + no matrix effects reported (method was not tested for NTA) - Sensitivity	300** until 600**	>3	<50%

* depending on the GC/MS system and complexing agent

** estimated values

Conclusions

It was found that the determination of the concentration of complexing agents in process waters in the paper industry is fraught with great uncertainty. Spreads of the DTPA measured values between the laboratories of over 300 % allow only a very rough estimate of the actual DTPA content. The exact measurement and compliance with a limit value, as it could be required by the authority, cannot be implemented due to the comparison test.

It was also found that the GC / MS method according to ISO 16588 is more reliable for the quantification of complexing agents than the methods based on liquid chromatography (IC / UV or HPLC / UV). Due to the high complexity and long process duration, the GC / MS method is rather unsuitable for internal quality control.

However, after appropriate adjustments and further development, the liquid chromatographic methods can be considered more suitable for internal production control due to the short time required. With the methods of liquid chromatography, matrix effects and peak overlaps are expected in certain situations. However, these could be circumvented after a corresponding method characterization through specially developed pretreatment steps.

Acknowledgements We gratefully acknowledge the financial support of the Austrian Research Promotion Agency (FFG) and the participating companies of the Austrian paper and pulp industry. Furthermore, we would like to thank the Federal Ministry of Agriculture, Regions and Tourism and the Environment Agency Austria in Vienna for the expert discussion on the analysis methods and for carrying out measurements.

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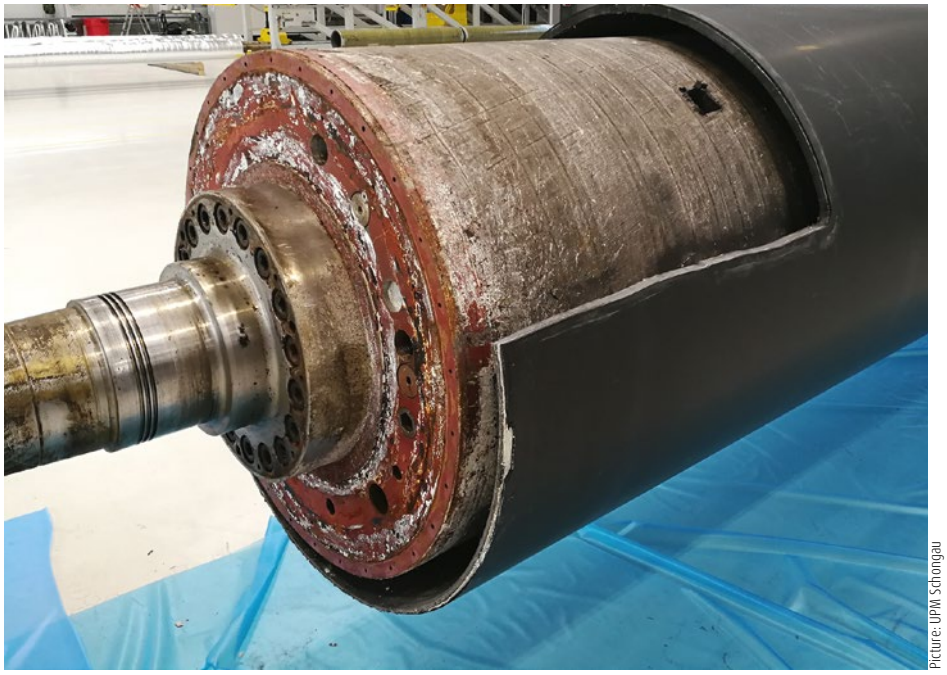
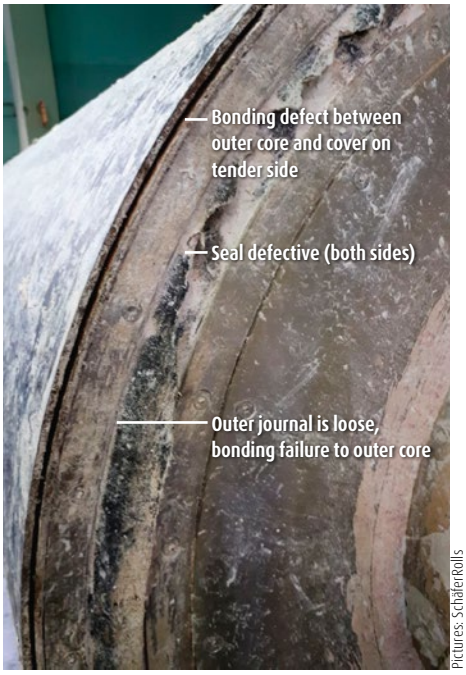
Bundled competence for customised roll solutions



Picture: UPM Schongau



Pictures: SchäferRolls

Fig. 1: Previous design shows distinct weak points

SchäferRolls, MWN and :CCOR provide efficient and successful support as system providers, example from UPM Schongau

UPM is the world's leading manufacturer of graphic papers. The factory in Schongau near Munich, Germany, produces standard and special newspaper (MFS), as well as uncoated magazine papers (SC). On the PM 9 paper machine, the machine operator was faced with the problem of increasingly stronger vibrations developing with the CSR roll (Center Supported Roll) in the position of the breast roll and the wire drive roll. The special double-walled rolls were delivered when the machine was built in the year 2000 (Fig. 1).

"As the seals between outer and inner core needed to be replaced every 3 month, UPM asked us for a solution", says Daniel Reich, who is responsible for the customer on behalf of SchäferRolls. "I was convinced that we could solve the problem that the competition had previously regarded as being impossible by combining the forces of SchäferRolls, MWN and :CCOR."

During the comprehensive inspection of one of the defective rolls, it became obvious that the biggest problem was the defective seals on both sides between the inner and outer core. Penetrating water was causing accelerated aging and degradation of the polymer matrix used (Fig. 2).

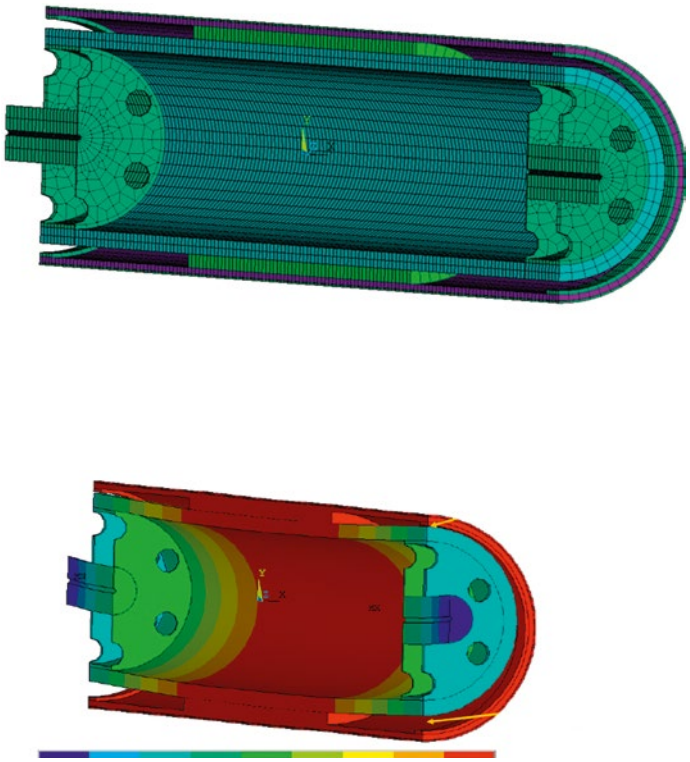


Fig. 2: Previous design with the seal being a clear weak point. Due to limited space between inner and outer core

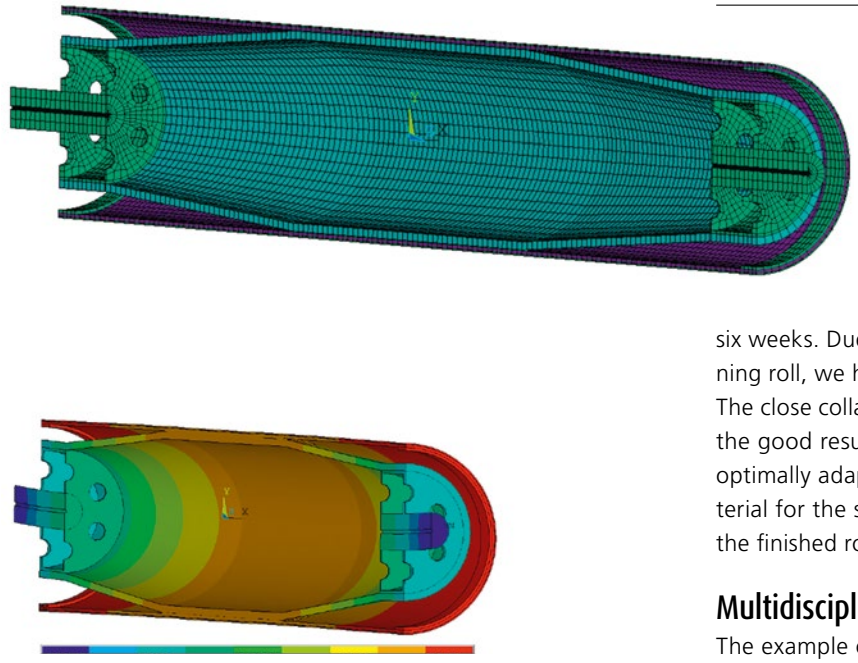


Fig. 3: New design with significant advantages and with less demanding loads on the seals

> This prime example shows the efficiency of interdisciplinary co-working. A wonderful, exciting project for us ...

A durable sealing of the space between inner and outer core called for a significant design change. "This prime example shows the efficiency of interdisciplinary co-working. A wonderful, exciting project for us", adds Reich.

Based on an idea, initially developed for an ADR contact roll (active deflection contact roll) in the film industry, the development engineers of :CCOR drafted a double-conical roll design with a stiffer inner core and more space between the cores in the critical area at both ends of the roll. The design of the coupling point was completely revised to ensure the optimum bending characteristic (Fig. 3). This meant that the requirement regarding stiffness was achieved. Positive side effects were the increase in natural frequency by 7% and the material savings of approx. 130 kg in the inner core. These points make it possible to operate the roll safely at even higher speed.

> We are very satisfied with the operation of the roll, which has now been used for approx. 1.5 years. Due to the modified design of the CSR roll, we have not needed to replace a single seal so far.

Roman Niessner, Engineer PM6 / PM9 at UPM Schongau, confirms the success: "We are very satisfied with the operation of the roll, which has now been used for approx. 1.5 years. Due to the modified design of the CSR roll, we have not needed to replace a single seal so far. These needed to be replaced at regular intervals with the previously installed rolls, lately, after four to six weeks. Due to the good results and the constantly smooth-running roll, we have already ordered another two rolls."

The close collaboration with the partners was the crucial factor for the good results: MWN coordinated the shaft and journal design optimally adapted to the core. SchäferRolls supplied a special material for the seals, as well as a hard rubber cover. Figure 4 shows the finished roll ready for delivery.

Multidisciplinary engineering know-how

The example of UPM Schongau clearly shows what a difference a good partnership makes for the optimal design of a roll and its performance. As the functional requirements for the roll are very diverse, different operating speeds and installation situations re-

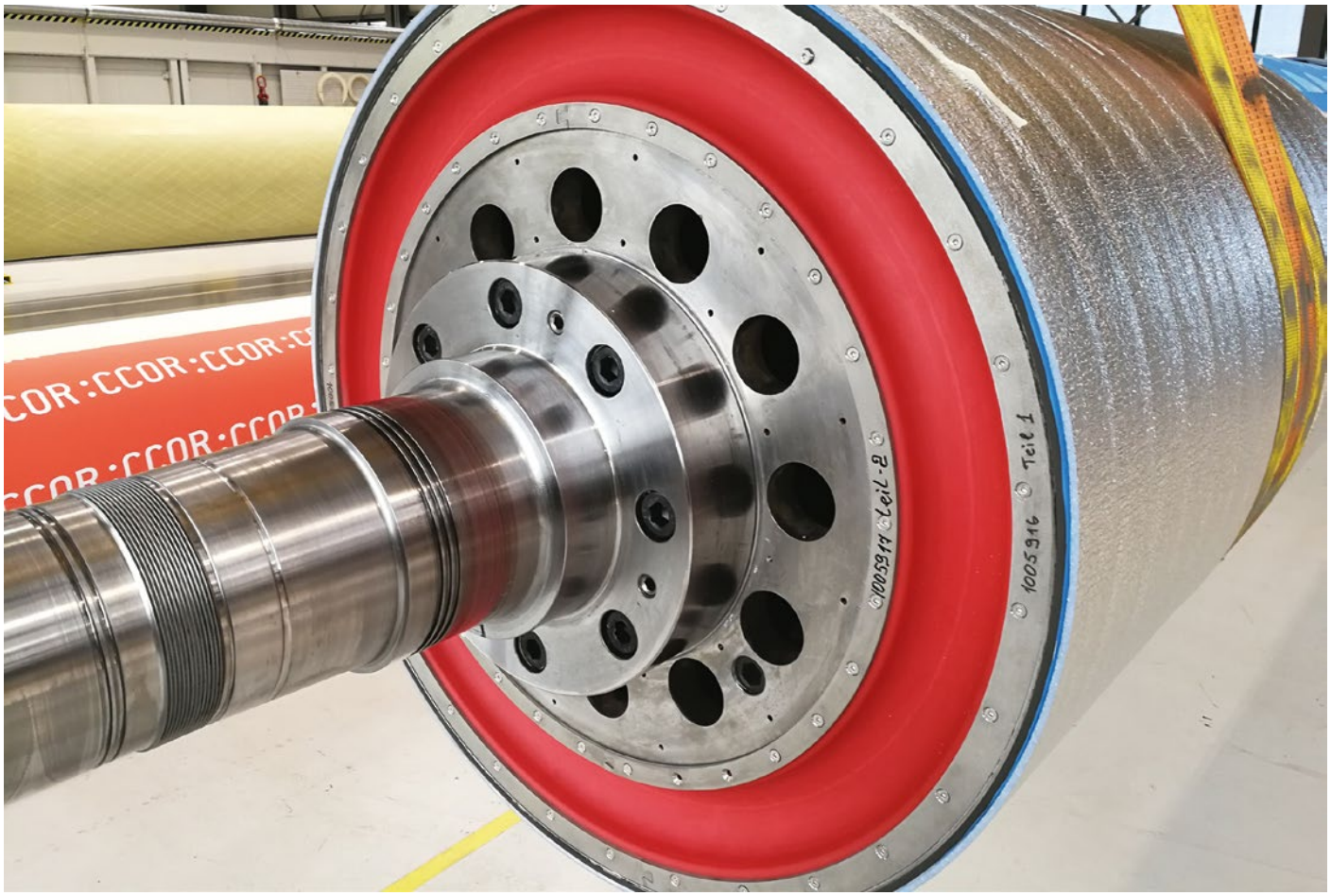


Fig. 4: Double-conical CSR roll with special seal ready for delivery

quire roll cores, load transfer concepts, journal and shaft designs that are specifically adapted to the application. The cover materials need to be tailored to the respective application with a perfect bond to the roll core and an optimised surface design. Irrespective of which product is being produced on a system, it shows: In the manufacturing and finishing of sheet materials, the functionality of the roll systems used in the machine are essential factors for the quality of the end product and the stability of the production processes.

In order to face this challenge, the three German companies, MWN Niefern Maschinenfabrik GmbH, specialized in roll design and manufacturing, :CCOR (trade name of Schäfer MWN GmbH), expert in design and manufacturing of components and rolls made of advanced composites materials, and SchäferRolls GmbH & Co. KG, manufacturer of high-performance roll covers made of elastomer and composite materials, bundled their competences in a network based on partnership, which develops innovative roll solutions for all industrial sectors as a system supplier. Through the different technical emphases and experiences, tasks are examined from different perspectives. The respective capabilities offers extensive technical possibilities, and the geographical proximity and associated short decision-making paths involve a high level of process orientation. This way, all required individual components can be efficiently brought together with one another in an optimally coordinated system, which, as a whole, fulfils its function reliably over the long term.

www.schaeferrolls.com

About SchäferRolls

SchäferRolls has been producing polymer based roll covers since 1946.

With over 300 employees worldwide, the company manufactures technologically sophisticated and high-performance roll systems and roll covers for all industries, particularly for the paper, foil, textile, printing, furniture, packaging and metal industry, as well as machinery and plant engineering. Production facilities are located at Renningen (Germany), Kranj (Slovenia) as well as at Farmington, NH and Covington, VA (USA) with a total production area of more than 25,000 m².

Introducing eggshell waste for paper industry: part I

Suitability for bagasse pulp

The present work aims at introducing eggshell waste for the major types of pulp used in paper industry. It creates new use for eggshell (an important food industry byproduct). This promotes the sustainability of both food and paper industries. A major industrial crop waste was chosen as a model to uncover the potential of eggshell waste for paper production; namely bagasse. It is well established in paper industry to add inorganic fillers such as calcium carbonate to improve paper properties. Eggshell is mainly composed of calcium carbonate. Moreover, eggshell contains small amounts of proteins and carbohydrates. Proteins and carbohydrates have recently been proven to improve mechanical strength properties of paper while increasing retention of inorganic fillers.

These facts motivated the authors of the present work to introduce eggshell for paper industry. Paper composites produced, in the present work, involving eggshell, show that eggshell succeeds to improve optical properties of paper while minimizing the deterioration of mechanical properties of paper, which normally occurs due to adding inorganic fillers. This is interpreted by the synergic effect produced from presence of calcium carbonate, proteins, and carbohydrates in eggshells. Calcium carbonate improved optical properties while proteins and carbohydrates counteracted the deterioration in mechanical properties. Thus, eggshell shows potential promise for application in paper industry.

Keywords: Eggshell waste; food industries byproducts; bagasse; sustainability of food and paper industries

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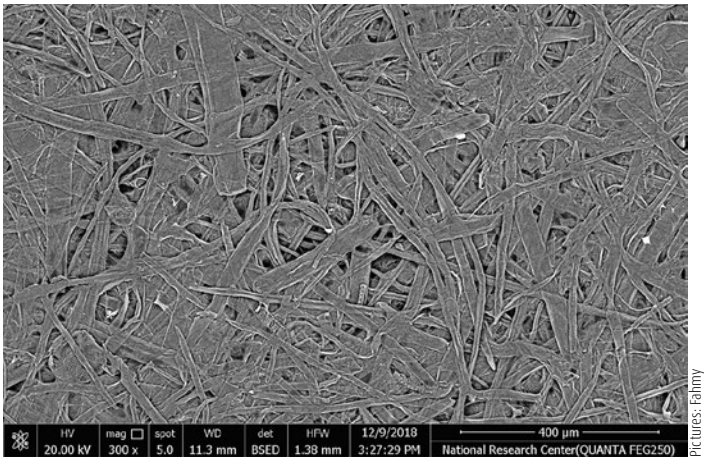
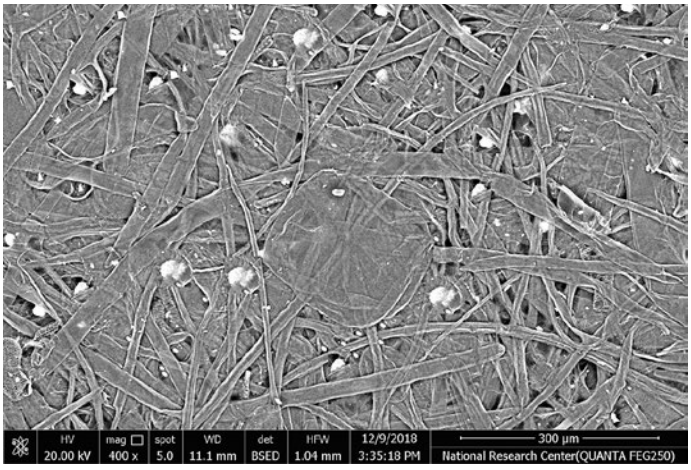


Pictures: Fahmy

Figure 1: SEM images of blank paper-sheets (A and C) and filled with eggshell paper (B and D).



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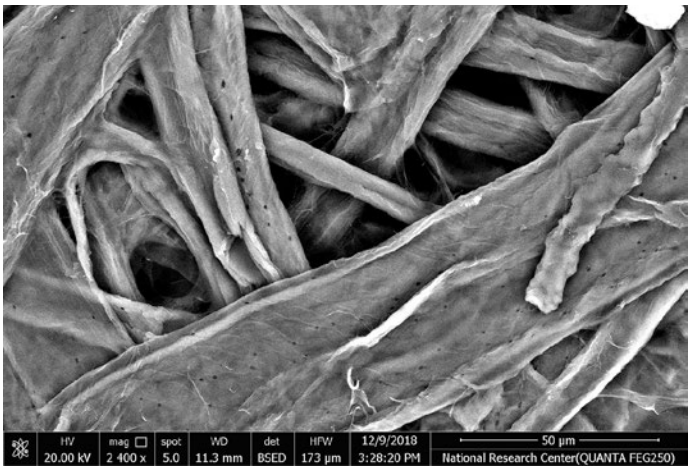

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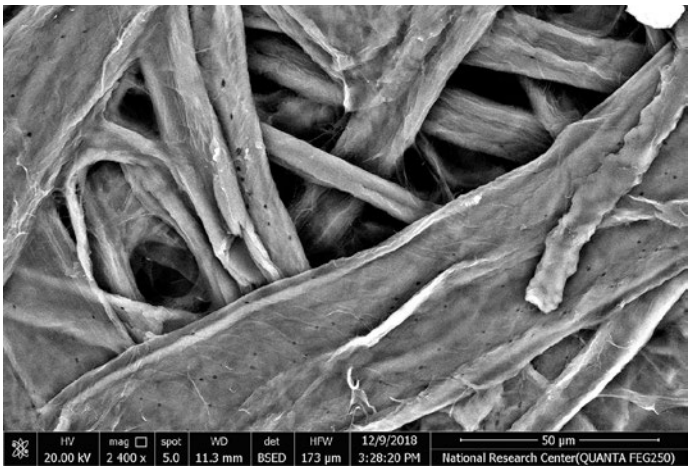


D

1. Introduction

Paper is mainly composed of cellulose fibers; obtained from wood or agricultural residues [1]. In ancient days of paper industry, mineral matter was added to paper furnish prior to sheet formation in order to increase the weight of paper. This process has been considered as adulteration. Later on, it was realized that the addition of certain minerals to paper is highly beneficial to improve the opacity of paper and increase the smoothness of paper surface. Thus, it improves the suitability of paper for printing. These added minerals are termed fillers. *Calcium carbonate* and clays are the Major types of fillers used in paper industry. Nowadays, it is well established practice in both literature and paper industry to add such fillers [1-3].

Recently, food industry byproducts, namely molasses, attracted attention as additives for paper industry. This trend promotes sustainability of both food and paper industries [4-9].

Waste Egg shell is an important byproduct of several food industries. Egg shell is mainly composed of *Calcium carbonate (the well-established paper filler as above mentioned).* Calcium carbonate in egg shell amounts to about 96 %. Moreover, egg shell contains about 2 % of proteins and carbohydrates [10-11]. Proteins and carbohydrates have recently shown success as additives in paper industry to improve paper strength and retention of fillers by paper [1, 4-9, 12-14]. All these facts motivated the authors of the present work to introduce egg shells as a new filler for paper industry. During our experiments, another research was published confirming our concept of introducing eggshell for papermaking. However, the other research did not investigate any of the major pulps used in paper industry [15].

2. Materials and Methods

A major industrial crop waste was chosen as a model to uncover the potential of eggshell waste for paper production; namely bagasse [1]. The bagasse pulp used was supplied from Quena Company for paper production, Egypt. The chemical characterization of pulp was found to be alpha cellulose (68.5 %), hemicellulose (29.5), lignin (0.8 %) and ash content (1.2 %). The fiber length of bagasse pulp was measured using Morfi device developed by Grenoble INP-Pagora and Paper Technical Center (PTC). It uses a technique of image analysis to determine the main morphological parameters of fibers suspended in water. This technique allows obtaining the following: the average fiber length (mm), the average fiber width (µm), the coarseness, and the percent of fine elements and the results are presented in Table 1.

Table 1: characteristics of bagasse pulp after refining

Fiber Length (mm)	Fiber width (µm)	Coarseness (mg/m)	Fine elements (%)
0.670	28.5	0.06	20.5

2.1. Preparation of Eggshell Waste

The eggshell waste was collected at Grenoble campus food in France, washed with hot water to eliminate the dirt, and separated from its membrane. The eggshell was dried in the oven at 105°C for 24 hrs to be fully dried. After that the dried eggshell was grindined using a mechanical grinder and the powder was sieved at 40 micrometer sieve.

2.2. Refining of the pulp

The samples of 30 gm was disintegrated in 2L of water according to the standard method ISO 5263-1. The suspension was filtered until the consistency of 10 % was reached. Different amount of eggshell powder was added to the pulp to produce paper sheets with a basis weight of 70 g/m^2 together by decreasing the amount of added pulp. Finally, the pulp with eggshell was refining in PFI mill refiner (ISO 5246-2) at 1500 revolutions.

2.3. Preparation and characterization of paper handsheets

Ten handsheets of each sample with basis weight of about 70 g/m^2 were prepared on Rapid Khoten sheet former, following ISO 5269-2 standard method. Scanning electron microscopy (SEM) was done on Model Quanta 250 FEG (Field Emission Gun). X-ray diffraction pattern (XRD) were recorded using X-ray diffractometer (PANa-lytical, Netherlands) at room temperature with amonochromatic Cu Kα radiation source (ʎ = 1.5418 A) with a 2∂ angle ranging from 4° to 60°. Thermogravimetric analyses (TGA) were performed using a Perkin-Elmer Thermogravimetric Analyzer. Regarding physical properties, the handsheets were conditioned at 23 oC and 50 % of relative humidity before testing (ISO 187). Then the basis weight (ISO 536), thickness (ISO 534) were measured. The mechanical properties of paper handsheets were assessed according to iso standard methods. Tensile strength were performed using TAPPIT 494-06 standard method using a universal testing machine (LR10K; Lloyd Instruments, Fareham, UK) with a 100-N load cell at a constant crosshead speed of 2.5 cm/min. Tear strength was carried out using Adamel Lhomargy tearing strength tester according to ISO 1974-1990. Burst strength was carried out using Adamel Lhomargy burst tester, according to ISO 2758-1983.

3. Results and discussion

The morphology of the hand sheets paper with and without the eggshell as filler was performed by SEM analysis to confirm the presence the filler particles.

3.1. Mechanical properties of paper sheets

The effect of eggshell filler on the mechanical properties of handsheets are summarized in Table 2. The breaking length decreased with increasing the amount of eggshell filler. This is normal due to the addition of inorganic fillers to paper; which decrease inter-fiber bonding between adjacent cellulose fibers. However, the paper composites produced, in the present work, involving eggshell, show that eggshell succeeded to minimize the deterioration of mechanical properties of paper, which normally occurs due to adding inorganic fillers. This is attributed to the presence of proteins and carbohydrates in eggshells. Proteins and carbohydrates counteracted the deterioration in mechanical properties [1, 4-9, 12-14].

Table 2: Mechanical properties of paper sheets

Eggshell content %	Breaking length (Km)	Tear index (mN m^2 g-1)	Burst index (Kpa m^2 g-1)
0	3.5	6.28	2.6
5	3.3	5.39	2.58
10	3.1	5.32	2.52
15	2.9	4.75	2.41
20	2.7	4.72	2.34
25	2.6	4.71	2.16

3.2. Effect of eggshell additives on the optical properties, thickness, and weight of paper sheets

It is obvious from Table 3 that the role of eggshell filler in the paper sheets tend to enhance the grammage and thickness of paper. The opacity and brightness of the bagasse paper handsheets increased by increasing the eggshell filler. It can be seen that the opacity significantly increased from 73.3 to 89.1 % and the brightness increased from 59.34 to 65 %. This is attributed to the Calcium carbonate present in eggshell.

Table 3: Optical properties, thickness, and weight of paper sheets

Filler content %	Thickness (µm)	Gramage (g/m²)	Opacity %	Brightness %
%0	113.6	60.2	73.3	59.3
5	149.6	62.3	77.2	65.7
10	184.3	69.8	79.9	63.1
15	187.4	76.4	82.1	63.8
20	191.7	78.2	85.5	64.8
25	203.5	82.5	89.1	65.1

3.3. XRD

Figure 2 is the X-ray diffraction pattern of the paper sheets in presence and absence of eggshell filler. The sample without eggshell, shows the characteristic peaks of cellulose at 2∂=15 and 23° which are indexed as (110) and (200). After addition of eggshell, the XRD clearly demonstrate strong reflection peak at 2∂=29.5° corresponding to the (104) plane which demonstrates the presence of calcium carbonate in the paper sheets.

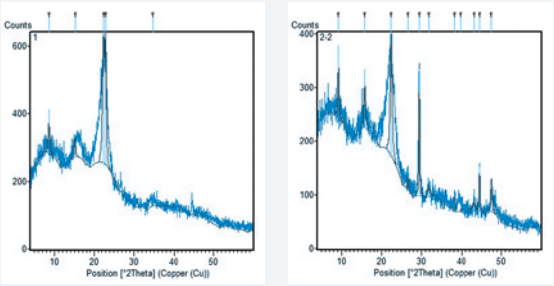


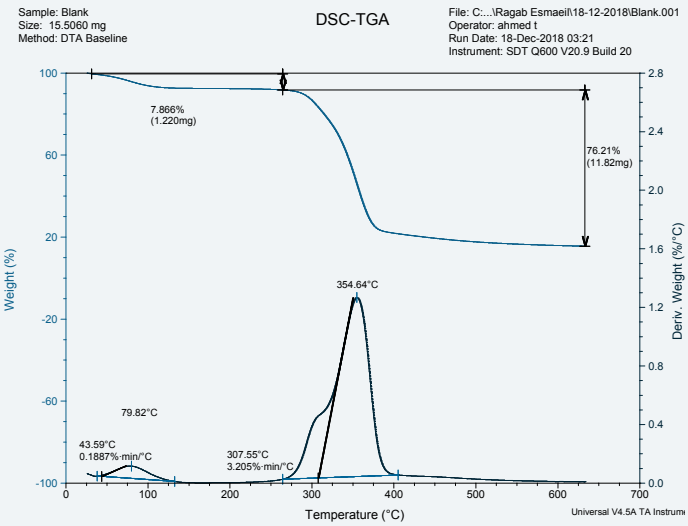
Figure 2: XRD paper sample with and without eggshell additive

3.4. TGA

Figure 3 and Table 4 show TGA results of blank paper and eggshell filled paper sheets. It is clear from the figure, that the blank paper sample TGA curve shows that its moisture is about 7 % and the sample starts to degrade at about 290°C and reaches a peak point at 380°C, and residue at 600°C about 13 %. However, the TGA curve of eggshell filled paper shows the sample starts to degrade at 300°C and the residue of about 25 % at 600°C due to the presence of inorganic filler.

Table 4: TGA results of blank paper and eggshell filled paper sheets

Temp in Celsius	Weight Loss % for Blank (In absence of eggshell)	Weight Loss % (In presence of eggshell)
0	0	0
50	5	5
100	8	7
150	8.2	7.3
200	8.5	7.4
250	8.6	7.6
300	23	23
350	65	60
400	80	75
450	81	76
500	82	78
550	84	78.2
600	84.2	78.2



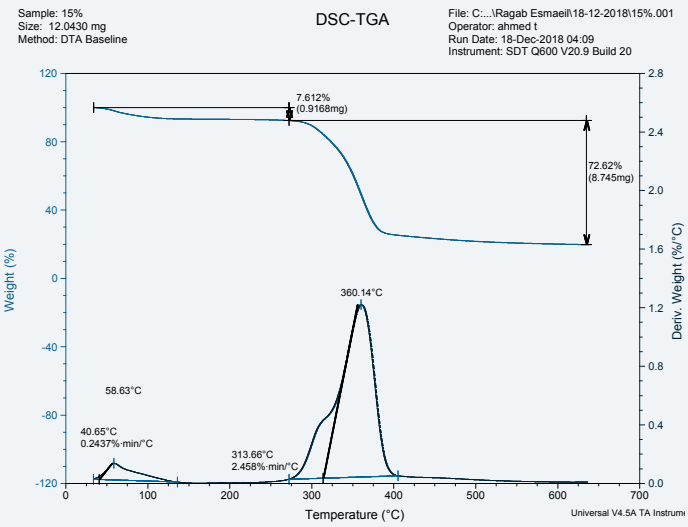


Figure 3: TGA of blank paper and eggshell filled paper sheets

4. Conclusions

The paper composites produced, in the present work, involving eggshell, show that eggshell succeed to improve optical properties of paper while minimizing the deterioration of mechanical properties of paper, which normally occurs due to adding inorganic fillers. This is interpreted by the synergic effect produced from presence of calcium carbonate, proteins, and carbohydrates in eggshells. Calcium carbonate improved optical properties while proteins and carbohydrates counteracted the deterioration in mechanical properties. Thus eggshell shows potential promise for application in paper industry.

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Stay-at-home orders, social distancing guidelines and consumer panic buying have created major irregularities in tissue and towel market dynamics and consumption patterns. These challenges present opportunities for companies like Solenis to help customers adapt and respond.

Pictures: Solenis

Handling tumultuous times in the tissue and towel market

Optimizing of wet-end process and coating stability

The unfolding of the past several months has led to more unpredictability than any of us could have imagined. Stay-at-home orders, social distancing guidelines and consumer panic buying have created major irregularities in tissue and towel market dynamics and consumption patterns. These challenges also present a great opportunity to help tissue and towel producers adapt and respond to these sudden changes.

The Author

Richard Cho has held the position of global marketing director for Solenis Tissue & Towel since 2016. In this role, he is responsible for developing the global strategy, driving the innovation pipeline and leading digital communication for this vertical market. Prior to Solenis, Richard was the director of global marketing for Industrial Specialties at Ashland. Earlier in his career, Richard held brand management positions at Diageo and Campbell Soup Company. He holds a Master of Science from the University of Massachusetts at Amherst.

Author: Richard Cho, Global Marketing Director, Tissue and Towel, Solenis

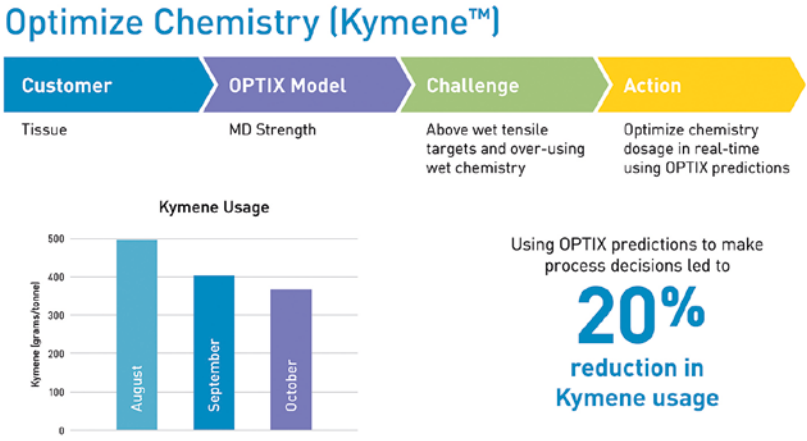
Pushing for productivity

As consumers around the world actively stockpiled supplies and household staple items, tissue makers were pushed to maximize production. In some countries, bath tissue sales increased by more than 50% during the early months of the pandemic. Though machine utilization rates spiked to nearly 100 %, there were still difficulties meeting demand. For Solenis, being part of a larger effort to help customers increase output through higher production efficiency was an opportunity to transform our expertise and capabilities into tangible benefits for our customers and, ultimately, for consumers who rely on their products every day. Our teams partnered with tissue makers across the globe to help optimize wet-end process and coating stability to improve productivity and paper quality. These efforts have helped multiple customers achieve record machine speeds to meet the unexpected surge in demand.

Beyond great chemistry and applications, many of our customers have also leveraged the Solenis OPTIX™ Applied Intelligence adaptive analytics platform to optimize their papermaking processes and meet quality targets. We have documented successes in reducing off-spec tissue production by helping customers significantly improve wet tensile target adherence and reduce variability.

Managing fiber supply challenges

Tissue made from recovered fiber accounts for approximately 30 % of global production. Over the past few months, the recovered paper market has experienced extreme volatility. An unprecedented surge in tissue and packaging board demand, combined with reductions in office wastepaper and old corrugated cardboard availability, has



Solenis has helped tissue makers optimize wet-end process and coating stability to improve productivity and paper quality. These efforts have led to record machine speeds to meet the unexpected surge in demand. In addition, many customers have leveraged the Solenis OPTIX™ Applied Intelligence adaptive analytics platform to optimize papermaking processes and meet quality targets, with documented success in lowering off-spec tissue production by significantly improving wet tensile target adherence and reducing variability.

	BEK	Acacia	NBSK	Bamboo
Width (µm)	15.2	16.2	28.4	15.4
% Fines	4.1	4.8	3.5	13.7
Length (mm)	0.80	0.79	2.39	1.75
Coarseness (mg/km)	70	63	140	90
Ash (%)	0.08	0.07	0.11	2.15
Silica (%)	<0.05	<0.05	<0.05	0.75
Extractives (%)	<0.1	0.4	0.5	0.9

Note:
BEK – Bleached Eucalyptus Kraft
NBSK – Norther Bleached Softwood Kraft
Testing carried out on dried pulp samples

Alternative-fiber tissue is seen as more environmentally friendly and sustainable. However, non-wood pulps typically contain higher levels of contaminants, such as silica and fines, which create Yankee coating challenges related to hardness, dusting and abrasiveness.

tightened supply. This has forced some tissue makers to switch from higher quality office waste to lower quality alternatives, which can result in lower strength and increased wet-end contamination. We have collaborated with a number of these tissue manufacturers, helping them evaluate and modify their dry-strength and contaminant control solutions to overcome these challenges.

An increasing number of tissue makers are also producing tissue made from non-wood alternative fiber, such as bamboo, which is not related to the pandemic per se, but it is exacerbating some of the other challenges affecting the industry. Non-wood tissue accounts for approximately 10 % of global tissue production. Though more common right now in the Asia Pacific market, non-wood tissue will continue to expand across the other regions. In fact, several recently launched direct-to-consumer tissue brands are selling 100 % bamboo tissue outside of Asia.

This type of tissue is seen as a more environmentally friendly and sustainable alternative. However, non-wood pulps typically contain higher levels of contaminants, such as silica and fines, which create Yankee coating challenges related to hardness, dusting and abrasiveness. Solenis has partnered with tissue makers to address challenges related to improving softness/hand feel, machine runnability and extending doctor blade life.

Preparing for new paper towel opportunities

In the wake of the global pandemic, there is a renewed emphasis on hand hygiene that has resulted in more hand washing and hand drying occasions. Many establishments are also replacing hot and jet air dryers with paper towel dispensers in public restrooms. In addition, experts recommend cleaning and disinfecting high-touch surfaces at least once a day to minimize the risk of COVID-19 transmission via surface contact. All of these trends are driving an increase in paper towel usage and pushing manufacturers to enhance their product requirements. Solenis is well-positioned to help tissue makers produce more – and higher quality – paper towels. Our extended network of field professionals and application experts collaborate directly with paper producers to customize solutions to their unique needs. At the same time, our global manufacturing footprint allows us to deliver a variety of wet- and dry-strength products efficiently and cost-effectively to any mill, anywhere in the world. Our additives have enabled towel producers in all regions to enhance product quality in the areas of wet strength (for improved durability when used with disinfectants/cleaners), absorbency and scrubbability (to ensure the towel can clean a wider surface area).

The new "Normal"

Post-COVID-19, the world will likely operate very differently. Suppliers must evolve as much as the customers they serve, which is why Solenis is actively working to enhance, extend and redefine our capabilities to align with the changing world. We have an exciting pipeline of new activities planned for the next 12 months and look forward to helping producers navigate through these tumultuous times.

www.solenis.com

About Solenis

Solenis is a leading global producer of specialty chemicals for water-intensive industries, including the pulp, paper, oil and gas, petroleum refining, chemical processing, mining, biorefining, power and municipal markets. The company's product portfolio includes a broad array of process, functional and water treatment chemistries as well as state-of-the-art monitoring and control systems. These technologies are used by customers to improve operational efficiencies, enhance product quality, protect plant assets and minimize environmental impact. Headquartered in Wilmington, Delaware, the company has 39 manufacturing facilities strategically located around the globe and employs a team of approximately 5,200 professionals in 120 countries across five continents. For additional information about Solenis, please visit www.solenis.com.

The ProVantage Komiwhite reels

Mondi delivers innovative logistics solution to reduce waste and provide more efficient customer service

Pictures: Mondi

Mondi ProVantage komiwhite reels

Mondi, a global leader in packaging and paper, is the first global paper manufacturer to introduce an innovative logistics solution for its large reels, which provides benefits throughout the supply chain. First global paper manufacturer to offer innovative logistics solution – a "roll-on/roll-off" service for its kraftliner products, transported from Russia to its Italian customers

The ProVantage Komiwhite reels with a width of 280cm, a diameter of 139cm and a weight of nearly four tonnes, presents a logistical challenge when it comes to transporting krafltiner products. To address this issue, Mondi is now transporting large reels on more efficient "roll-on/roll-off" (RoRo) vessels from its mill in Syktyvkar (Russia), via Bronka (Russia) and Luebeck (Germany), to the Innocenti terminal in Milan (Italy) without the need for them to be placed in shipping containers.

This innovative transportation mitigates damage significantly, shortens lead order times and reduces packaging waste by one truck load per month

"With this new way of transporting large reels, we are able to reduce our carbon footprint even further when moving goods. There is no longer a need for additional packaging materials to wrap around the

reels to protect the cargo during transport. This innovation has led to us decreasing the amount of protective material waste by one truck load per month. Additionally, we now dispose of far fewer damaged reels," says Giovanni Mondini, Sales Director at Mondi Italy.

> This innovation has led to us decreasing the amount of protective material waste by one truck load per month.

The RoRo service for large reels provides several benefits including:
– Using a new route which reduces transit times, by as much as a week
– The product is less exposed to adverse environmental factors, which significantly lowers the risk of damage to the consignment
– It rolls-on and off the ships and trains seamlessly

Innovation has led to using a new and quicker transport route

This efficient and innovative logistics solution is now being considered for further destinations including Antwerp and Hamburg, to serve customers in the Benelux states and Germany in a safe, sustainable and reliable way.

www.mondigroup.com

About Mondi

Mondi is a global leader in packaging and paper, contributing to a better world by making innovative packaging and paper solutions that are sustainable by design. Our business is fully integrated across the value chain – from managing forests and producing pulp, paper and plastic films to developing and manufacturing effective industrial and consumer packaging solutions. Sustainability is at the centre of our strategy and intrinsic in the way we do business. We lead the industry with our customer- centric approach, EcoSolutions, where we ask the right questions to find the most sustainable solution. In 2019, Mondi had revenues of €7.27 billion and underlying EBITDA of €1.66 billion.
Mondi has a premium listing on the London Stock Exchange (MNDI), and a secondary listing on the JSE Limited (MNP). Mondi is a FTSE 100 constituent, and has been included in the FTSE4Good Index Series since 2008 and the FTSE/JSE Responsible Investment Index Series since 2007.

IMPS 2021 "Progress in Board and Paper Technology"

30th International Munich Paper Symposium

4-6 May 2021

IMPS

For the 30th time, one of the major annual European conferences in paper technology, the International Munich Paper Symposium – IMPS – is going to take place in the modern Sheraton Munich Arabellapark Conference Center from May 4–6, 2021.

The theme of the meeting is "Progress in Board and Paper Technology", and while many of the papers are going to be presented by board mills and paper mills, it will be clear that papermaking equipment and innovations designed to improve the performance of paper, board and printing machines play a very important role. Quite unusual, almost all presentations are given by paper and board mills and most presentations will deal with first time reports and take an analytical, rather than a commercial approach. The speakers will share their experiences with relatively new systems, and will also take a look at some future developments.

The IMPS has been held annually for 30 years. It is always focused on specific topics related to the paper manufacturing and paper supply industry. In contrast to many very large conferences, the IMPS will host no more than 400–450 participants, in a first class atmosphere. Since 2013 the conference was fully booked each year and many companies have again already registered. It is intended to provide an international platform for people working in the field of board, paper and printing technology. The conference will be bilingual (English + German) with superb simultaneous translation.

The unchanged fee of 1540 EUR (plus 50 EUR for registrations after 10.3.2021) + 19% VAT includes a number of options: simultaneous translation German/English, internet access to abstracts, presentations as files, superb lunches as well as a gala dinner on Wednesday evening. As far as possible and places are available, a fascinating cultural event on Thursday evening and interesting mill tour to a paper mill or a visit to the well-known paper institute of the Munich University of Applied Sciences on Friday, are also included. The number of attendees may vary due to governmental regulations. If that happens parts or the complete conference will shift to an online conference.

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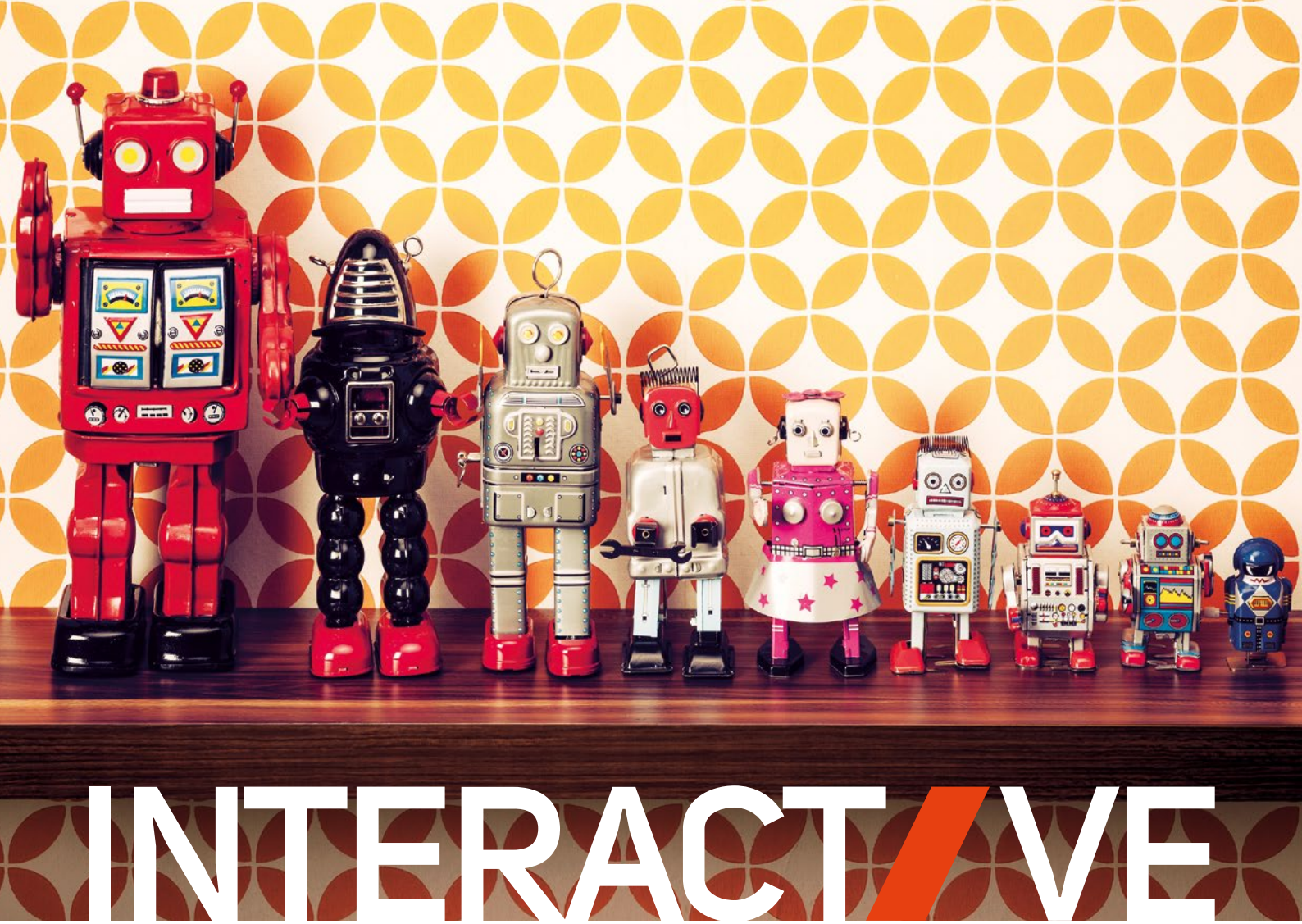

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