twogether

Paper Technology Journal

Special Issue

Systems for Finishing

Contents

Thomas Koller
Voith Paper
Krefeld

Dear reader,

this special "Finishing" edition of our Twogether Magazine is timed to coincide with the long-awaited merger of Jagenberg Paper Technology with Voith Paper.

Having finally taken this step, we shall spare no effort to meet your high expectations of our now even stronger organization.

The Voith Paper scope has now been ideally rounded off in the finishing sector. This particularly applies for example to winders, coating and drying equipment.

Accordingly, the first few articles in this issue deal with the current state of winding technology, optimally complemented with our Twister™ roll conveying and wrapping technology. You will certainly hear a lot more about these concepts in the future.

Also in calendering technology developments, Voith Paper has broken completely new ground over the last few years – starting with the Janus™ concept and continuing into online calendering, including some innovative roll cover and coating developments.

The limits of technological feasibility have been steadily widened and redefined, thereby, at the same time, continuously improving cost-effectiveness.

Through trial and error we have come a long way. The overall result is nevertheless an unprecedented advance in calendering technology, which has made Voith Paper the market leader in this field.

This issue, therefore, reviews in detail the state of the art in calendering technology at the beginning of a new millennium.

Apart from calendering, roll slitting, winding and wrapping, coating and drying also play a key role in the finishing process. Here again, the last decade has brought a transition from offline to online technology. Jagenberg technology ideally complements the Voith Paper and Voith IHI product portfolios in this segment.

As part of Voith Paper's comprehensive partnership with the paper industry, we now contribute even more decisively in the finishing sector to surface quality enhancement over the entire product spectrum.

We sincerely hope this special Finishing edition of our Twogether Magazine will provide you with and interesting as well as informative reading!

Thomas Koller
On behalf of the new Voith Paper Finishing Team

A dream comes true

Thomas Koller

Voith Paper
Krefeld, Germany

It was in 1999 that Michael Rogowski, then Chairman of the Board of J. M. Voith AG, dreamed aloud of Jagenberg and Voith joining forces – much to the displeasure of Rheinmetall Chairman of the Board Hans U. Brauner. But the story goes back even further.

This is the full history of how Voith and Jagenberg came together:

1993
Cooperation agreement with Sulzer Escher Wyss (Ravensburg).

1994
Termination of agreement due to the Voith Sulzer joint venture.

1995/96
Cooperation agreement with Beloit.

November 1999
Divestiture to Sachsenring (Zwickau), an automobile industry supplier; in parallel, negotiations with Voith.

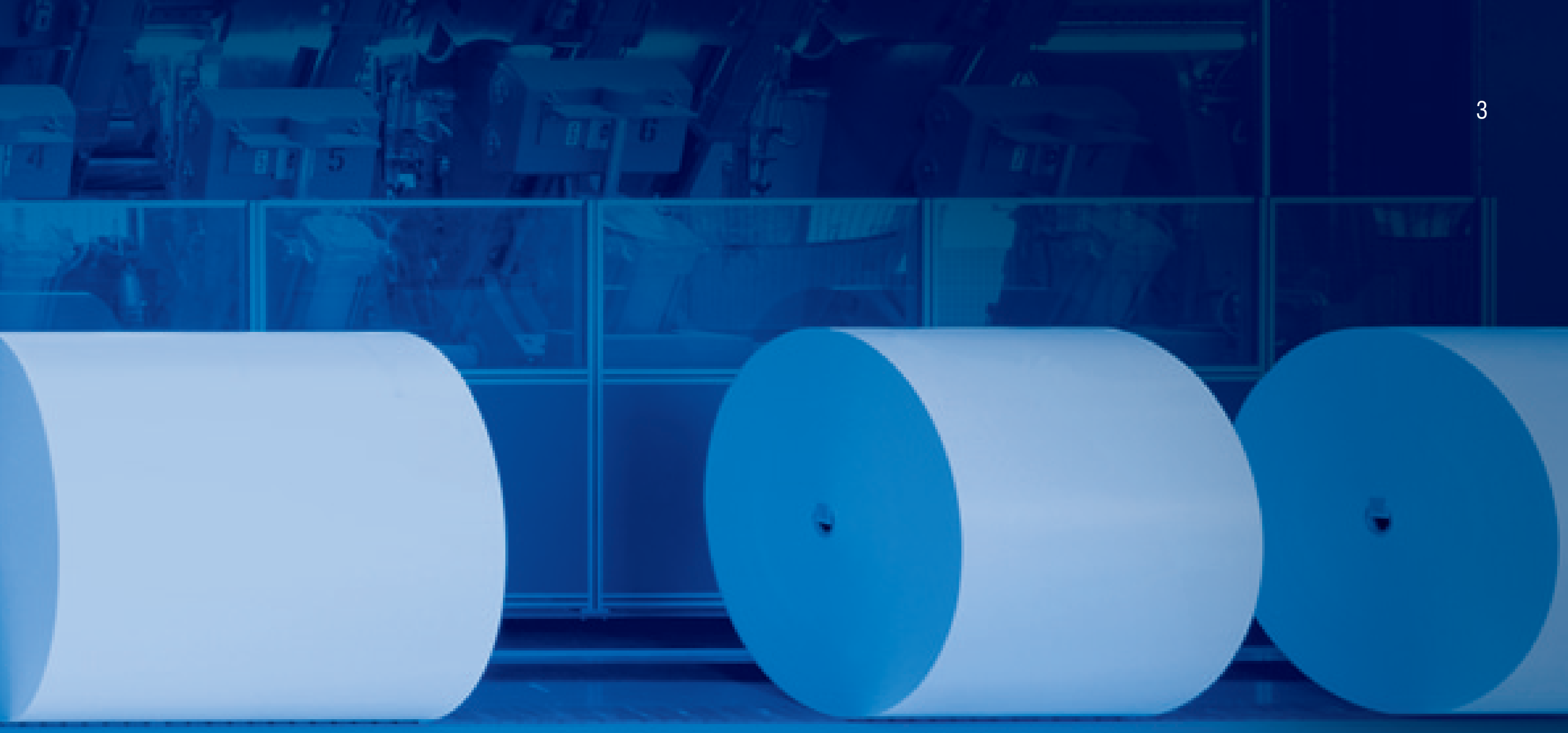
March 2000
Reversal of the Sachsenring transaction in favour of sale to the investor group Millennium Capital GmbH & Co. (Munich).

March 2000
Resignation of the Rheinmetall Chairman of the Board, and reversal of the Millennium Capital transaction.

2000
Sales negotiations with Voith initiated again by the new Chairman of the Board Klaus Eberhardt.

October 2001
Jagenberg AG Paper Technology Division sold to Voith.

June 2002
Folio sheeter business sold to Bielomatik.



To quote Voith Paper President and CEO Hans Müller at a Zellcheming press conference in 1999: *“The bride and bridegroom have finally found each other”.*

But today, in autumn 2002, the honeymoon is over and building a marriage is the order of the day. Among the far-reaching decisions made during the first half of this year were the following:

- Closure of Jagenberg Maschinenbau GmbH in order to trim production capacities
- Integration of Jagenberg Papiertechnik GmbH in to the Voith Paper Finishing Division
- Transfer of slitter-winder production from Neuss to the Krefeld calender and roll wrapping/transporting equipment.

The latter decision was taken in June this year. In December the Neuss team will already be moving to Krefeld, 39 km away. And in future the coating technology division, also acquired from Jagenberg, will be located in Heidenheim. About 35 former Jagenberg employees will remain in Krefeld to look after the Jagenberg coating lines and rebuilds there.

After integration, the management organization of our expanded Finishing Division will be as follows:

Thomas Koller

Executive management spokesman with responsibility for:
- Production
- Materials management, logistics, erection
- Calenders
- Nipco
- Human resources

Dr. Lothar Bopp

Member of the executive management board (CFO) with responsibility for:
- Law, patents, insurance
- Information technology
- Accounting, finance and controlling

Hans-Peter Marleaux

Member of the executive management board with responsibility for:
- Sales of new and used machinery
- Marketing
- Trials for customers

Dr. Ing. Michael Schopen

Member of the executive management board with responsibility for:
- Slitter-winders
- Paper roll wrapping and transport systems
- Service
- Quality management

Apart from integration as rapidly as possible in Krefeld, our joint efforts toward strengthening the Voith Paper Finishing Division’s market positioning are mainly focused on:

- Slitter-winder product development
- Further expansion of service activities
- Ongoing optimization of slitter-winders already delivered
- Cost optimization.

After completing the integration process in Krefeld, we shall be able to concentrate all the more again on our real mission – **to serve our valuable customers!**

The number of orders received over the last few weeks is extremely encouraging – we are clearly on the upswing!

1

Voith Paper winders – for a better product profile

Georg Müller

Voith Paper
Krefeld, Germany

Printing paper rolls have become wider and bigger over the last few years, and the trend shows every sign of continuing. It goes without saying, that this has development consequences for winders: new ways have to be found for the perfect winding of heavier rolls.

This article provides an overview of Voith's wide range of modern winders, and shows how tailored concepts ensuring optimal winding quality, are put together by selecting the most appropriate types according to application.

Four types of winders

Voith Paper has been supplying winders for more than one hundred and twenty years. Always on the forefront of technology, they handle roll widths today from 70 mm to 4,600 mm and diameters up to 2,500 mm, weighing as much as 10 tonnes each.

This entire range is covered by four different types **(Figs. 1, 2, 5 and 6)**:

VariSoft™, tissue winders
VariFlex™, the allrounder
VariPlus™, mainly for better and especially coated papers
VariTop™, for the largest, heaviest and most demanding rolls.

2

Two different winding concepts

- The two-drum winder concept **(Fig. 3)**
- the single drum concept **(Fig. 4)**.

On two-drum winders the entire roll set is wound supported on two drums, so that there are two nips. These machines are user-friendly, very efficient, and can handle the narrowest rolls.

The VariFlex™ and VariSoft™ winders are both of the two-drum type.

On the single drum-winder, each paper roll is wound in a separate station and supported on a single drum, so that there is only one nip per roll. Each station has its own axial drive to apply additional torque to the respective roll. Single drum winders are very convenient to use, since each winding station is practically a separate machine.

Voith Paper offers single drum winders under the VariPlus™ and VariTop™ brands.

With the two-drum winder concept, nip load between the drums and the paper rolls steadily increases with the winding diameter. With the single drum concept, nip load can be adjusted as required, because each roll is in a separate station.

That is why for example VariTop™ winders are technologically predestined for the widest range of paper grades and product needs. However, the single drum type of winder costs considerably more than the two-drum type. Therefore, there is always the question, based on production needs: until which point is the two-drum winder adequate, and when should the single drum concept be used? Important in this context is, that with the development of the MultiDrive™ and JagFlex™ drum covers (more details below), the application range of two-drum winders could decisively be extended.

The new winder generation

To meet the ever-rising demands of higher speeds, wider machines, and better

Fig. 1: *VariPlus.*

Fig. 2: *VariSoft.*

Fig. 3: *Two-drum winder.*

Fig. 4: *Single drum winder.*

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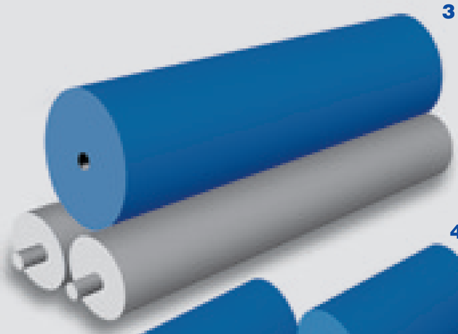

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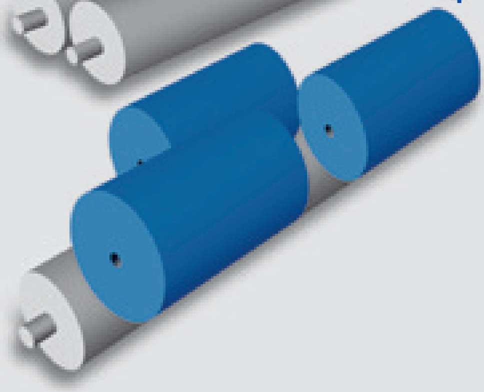

Fig. 5: *VariFlex.*

winding quality, Voith Paper has developed a new generation of winders.

Under the brand name VariFlex™, for example, a two-drum concept is now available for winding even the most sensitive, high-quality papers perfectly.

The well-proven VariTop™ and VariPlus™ single drum concepts have also been thoroughly modernized. At speeds up to 3,000 m/min, and with a much higher degree of automation, they produce perfect results with significantly wider and larger rolls – wound cleanly, with perfect edge profiles and without any bursts, cracks and/or wrinkles.

One of the reasons for the perfect paper roll quality attained by Voith Paper winders is the soft-covered drums used in these machines. Depending on specific product requirements, covers are either of the MultiDrive™ or JagFlex™ type. Both these materials consist of extremely tough and abrasion-resistant elastomers **(Fig. 6)**.

The MultiDrive™ solid elastomer characteristics are ideal for controlling winding structure over a wide range, thus complying perfectly with product requirements. For this reason the central drum in VariTop™ and VariPlus™ winders are covered, as a standard, with MultiDrive™ elastomer.

In VariFlex™ two-drum winders, the front drum is covered with MultiDrive™. As a result, this type of machine also produces a perfect winding structure thanks to wide-ranging control. The MultiDrive™ cover ensures a stable web run of the slit paper webs, thus resulting in perfectly straight roll faces (no telescoping).

Another important advantage is the excellent compensation of CD thickness profile variations, which verifiably prevents the numerous winding errors unavoidable with conventional steel drums.

JagFlex™ cellular elastomer is much softer than MultiDrive™ covers, and is also very compressible due to its cellular structure. It is used for quite different applications than MultiDrive™ covers. Rather than increasing the winding hardness in the nip, the JagFlex™ covered back drum in VariFlex™ winders only provides support. At the same time, the cellular surface structure of this cover material ensures non-slip torque transmission to the roll.

JagFlex™ cover on the rider roll ensures good contact with the paper over the entire width, resulting in an excellent winding process.

This makes the formerly “hard” drums and rider rolls “soft”, thus greatly reducing the stress on the paper in the contact area. **Fig. 7** shows the kind of winding errors which can be caused by hard drums. The corrugations shown in **Fig. 7** are attributable to excessive stretching of the paper during winding on hard drums, and are generally irreversible. The different winding dynamics of soft drums prevent this kind of fault, and a lot of others such as roll bursts, crepe wrinkles, cracks, dished rolls and telescoped rolls.

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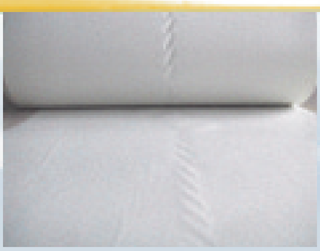

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These new soft drum/roll systems can easily be retrofitted to existing machines, and numerous customers have already taken advantage of this possibility.

Automation

Voith Paper offers the following automation options for winders:

- Butt splicer for automated parent roll changing
- Automatic removal of empty spools
- High-precision machine stopping on reaching the defined paper length or roll diameter
- Automated gluing of paper end to finished roll after winding
- Automated gluing of the web to the cores before winding
- Web separation between start and finish gluing
- Feed and insertion of new cores in the correct sequence
- Feed of the new web over the entire machine width.

R&D centre with pilot winder

Voith Paper has its own R&D center, with a winder unit for universal applications **(Fig. 9)**.

This pilot machine can operate both in two-drum winder mode and single drum mode. All components, drive and control units always comply with the latest state of development. The extensive winding tests conducted on this machine with customers' paper are preconditional for optimizing new installation layouts as well as rebuilds.

Prospects

In view of the time required for systematic new developments and improvements to existing concepts, it goes without saying that Voith Paper is already working on the next generation in this field.

The principle governing all our development work is to uphold customer product quality during the winding process. We aim thereby to enhance machine productivity such as by:

- increasing operating speed without risk, above all for currently critical grades
- optimizing automation for greatest reliability and time savings.

Fig. 6: *Elastomer-covered "soft" roll.*

Fig. 7: *Corrugations.*

Fig. 8: *VariTop.*

Fig. 9: *Pilot winder in R&D Center.*

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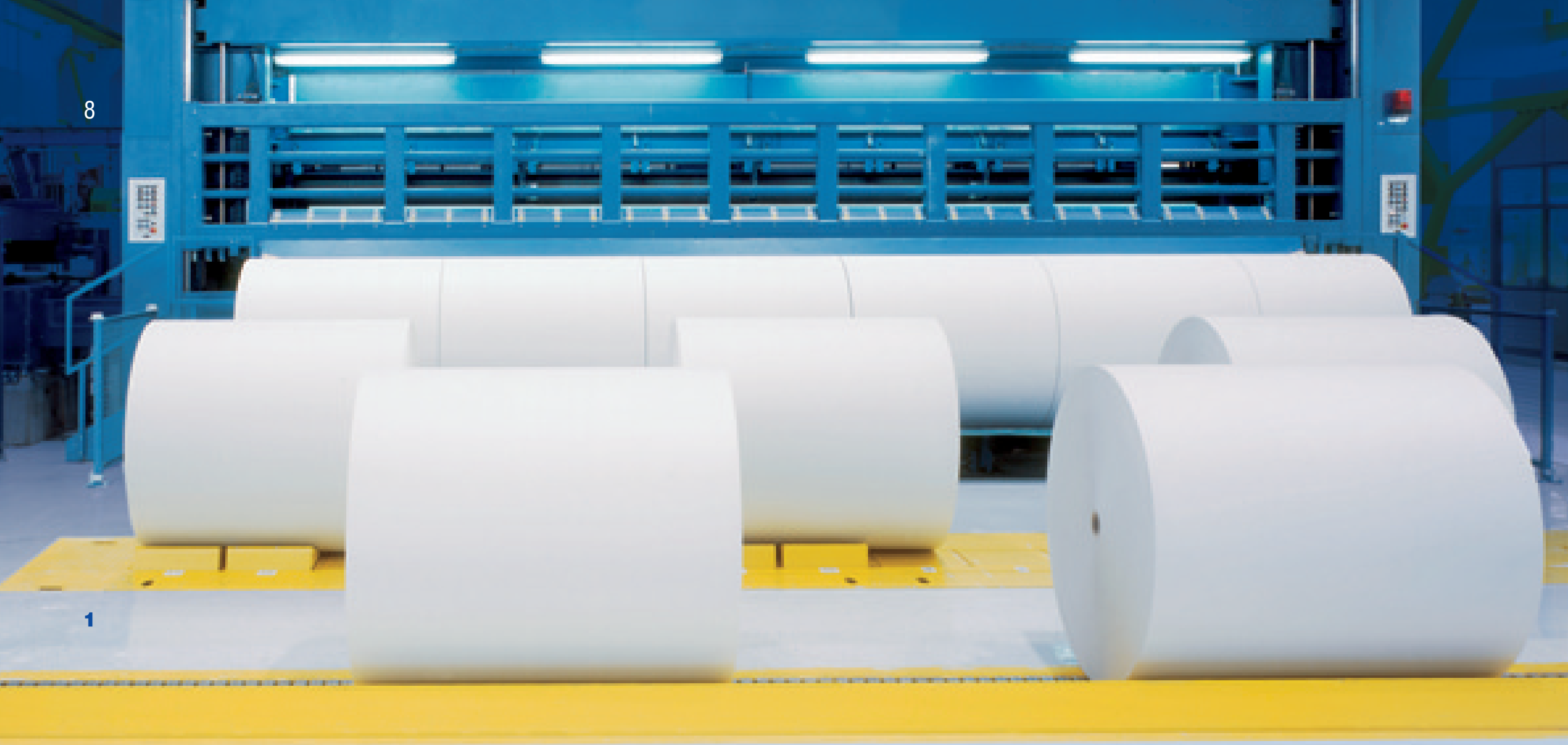

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VariFlex™ two-drum slitter-winders – for perfect newsprint rolls at Rhein Papier, Hürth, Germany

Stefan Maier
Voith Paper
Krefeld, Germany

In the year 2000, Myllykoski – a global player and specialist in coated and uncoated graphic grades – decided on a completely new central European newsprint production plant. After tender negotiations, the paper machine (PM 1) for this plant was ordered from Voith Paper in March 2001. One month later an order was placed for two VariFlex L™ 2-drum slitter-winders (working width 8,200 mm) and a VariFlex S™ rewinder (working width 2,800 mm).

The two slitter-winders are designed to easily handle the entire output of PM 1, i.e. 280,000 t.p.a. of newsprint with basis weights from 36 to 48 g/m². At operating speeds up to 2,500 m/min, finished paper rolls wound to a diameter of 1,350 mm are produced.

The results impressively proved again here, that VariFlex™ 2-drum slitter-winders are the ideal solution for newsprint production. This article explains the reasons.

Newsprint wound on conventional 2-drum slitter-winder with hard steel surfaces is very susceptible to folding. These hidden faults, which usually remain undetected in the paper mill, are bound to cause breaks in the printing press. As a result, the entire newsprint roll is wasted. The cause of folding is high radial nip loads between the steel drums and the paper roll.

To avoid such high loads, paper roll

Fig. 1: *VariFlex™ two-drum slitter-winder at Rhein Papier, Hürth, Germany.*

weights had to be significantly restricted so far. The production output of conventional 2-drum slitter-winders, i.e. winders equipped with steel drums, was therefore limited. With the VariFlex™ concept, this limitation is now a thing of the past because the first drum is covered with Multidrive™ elastomer. Winding dynamics on this special cover are quite different from those on hard steel drums. The following aspects are involved:

On the one hand, newsprint demands the greatest possible winding hardness in the ingoing nip in order to minimize folding problems due to layer displacement (J line). On the other hand, layer displacement is caused by radial forces in the ingoing nip, which must, therefore, be minimized.

On machines with conventional steel drums, winding hardness is increased by the fact that the steel drums are deeply pressed into the rolls – but this also increases the undesirable radial nip forces. With unequal cross-profiles, the result is excessive overloading in some zones across the roll width, which is bound to cause winding defects.

Attempts have been made to combat the limitation of winding diameter by using the largest possible drums and increasing the web tension – which however increases break frequency – but without much success.

With the VariFlex™ concept, the MultiDrive™ elastomer cover is compressed by the weight of the roll. The reduction in thickness of the cover leads to a dynamic deformation process within the cover. I.e. the cover is accelerated in the nip area and its higher velocity is transferred to the roll. Since the resulting speed is higher than the web intake speed, the differential velocity exerts a stretching force on the web which increases the winding hardness.

With the MultiDrive™ technology it is even possible to produce higher hardnesses – while simultaneously reducing the web draw – than obtainable with steel drums of large diameters in combination with high web draws.

Furthermore, flattening of the cover under compression also reduces the radial nip forces on the paper roll, thus eliminating layer displacement. As an additional advantage, the cover flexibility enables optimal adaptation to the roll profile.

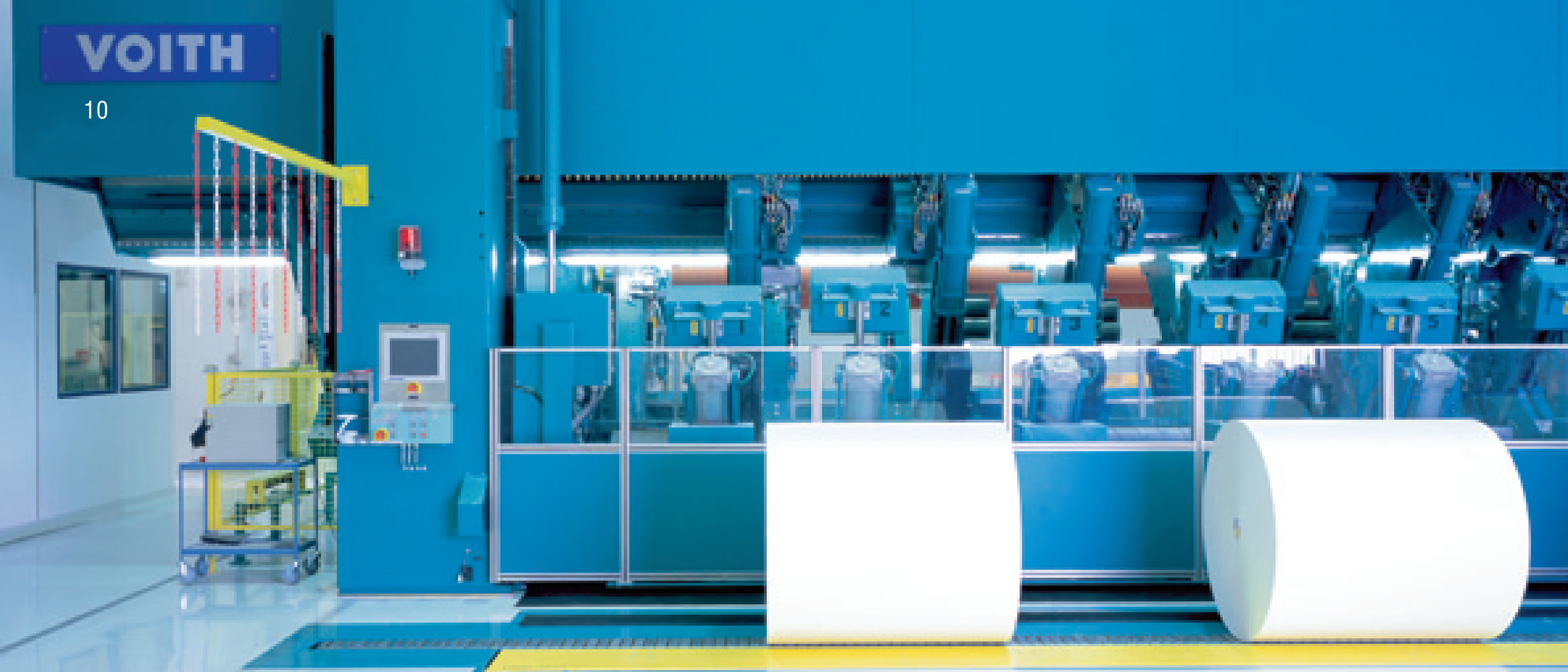
Thanks to all these benefits, Voith Paper's new slitter-winder generation is already known as "the soft revolution". This summarizes very aptly one of the main reasons why this concept has attained such success so rapidly. More than 150 new machines and rebuilds (also of other makes) have so far been fitted with Voith elastomer roll covers and operating results are excellent in all cases.

Of course, the VariFlex™ concept is highly automated. Apart from automatically splicing the old and new web ends during winding, this also includes automated set-change with roll start and finish gluing. As a result, production is practically continuous and uninterrupted.

Newsprint production today, generally from 100% recovered paper and at high processing speeds, demands state-of-the-art slitter-winders for optimal results. VariFlex™ two-drum slitter-winders ensure perfect winding quality at roll diameters up to 1,350 mm, thus proving that this is truly a future-oriented concept.

And true to the Voith philosophy, the customer shall have the last word:

"We at Rhein Papier", said project leader **Bernhard Schmidt**, *"are really proud of our new production line. PM 1 broke all records for start-up speeds so far, and our paper rolls were on the market considerably earlier than originally planned. The winding quality we now achieve certainly confirms that we made the right choice with VariFlex™ slitter-winders. Currently the Voith team is working hand in hand with us on fine-tuning for even better results, and with such excellent cooperation, we are making great progress. My complements and thanks to all concerned!"*



Voith VariTop™ on PM 11 at SCA Graphic Paper Laakirchen, Austria – Top-notch winding

Reinhard Hehner

Voith Paper
Krefeld, Germany

The SCA Group, a European leader in wood and pulp processing, has concentrated its production of natural chlorine-free graphic grades in Laakirchen, producing a total of about 485,000 t.p.a. of SC-rotogravure and offset papers on PM 10 and 11 respectively. These grades, such as Grapho Gravure, Grapho Set and Grapho Grande, are notable for their high-volume uniformity with outstanding opacity and print gloss, clean mottle-free surface, and excellent print density. Notable are also the strict ecological standards maintained in Laakirchen, for which this plant has won a coveted Austrian environment-protection award.

To meet all these demands, SCA Laakirchen decided on a state-of-the-art solution for their new PM 11. Based on the Voith Paper One Platform Concept, this production line incorporates all modules required for the highest quality SCA+ rotogravure and offset grades. It also includes a VariTop™ slitter-winder **(Fig. 1)**, known as RSM 3, since it is the third one to be installed here – a sure sign of customer satisfaction!

This RSM 3 belongs to the new generation of center drum winders, 150 of which have been supplied since the VariTop™ was first launched. Its technical data are as follows:

- Working width 8,800 mm
- Design width 12,000 mm
- Operating speed 2,800 m/min
- Design speed 3,200 m/min
- Winding diameter 1,500 mm
- Design winding diameter 1,650 mm
- Maximum paper roll weight 10 tons.

From this data, the enormous reserves incorporated in RSM 3 are clearly evident. While paper rolls today are up to 1,500 mm in diameter and 3,700 mm wide, a quantum leap is already apparent

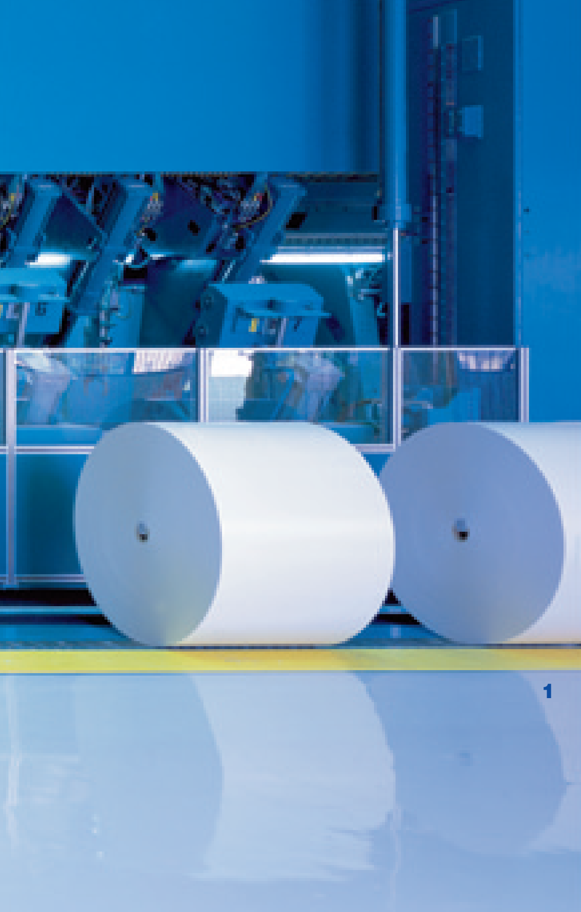


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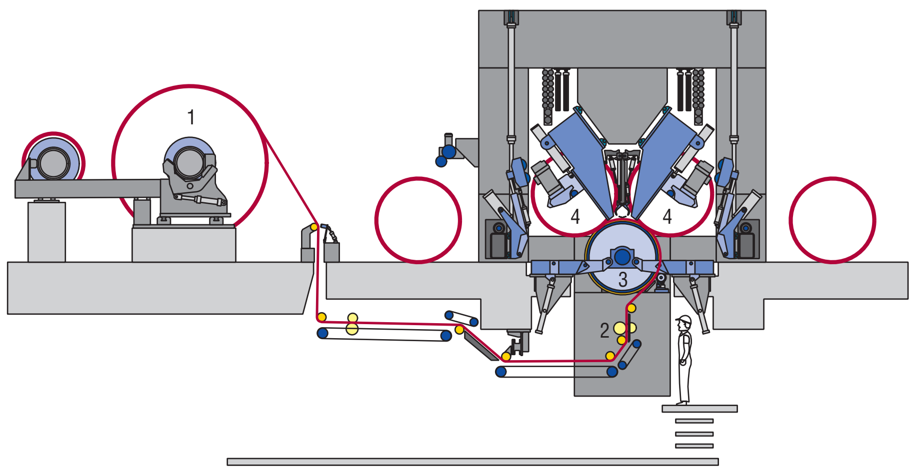
Fig. 1: *VariTop™ slitter-winder on PM 11 at SCA Graphic Paper, Laakirchen.*

Fig. 2: *VariTop™ layout.*



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with respect to printing presses, whose working width will rise sooner or later to 4,300 mm. It is therefore very reassuring to know that this – and more – has already been taken into account with the new RSM 3 slitter-winder.

Based on the VariTop™ layout shown in **Fig. 2**, here are some more details of this concept:
Paper from the unwind (1) first runs through the slitting station (2) and the glue application device, then enters the nip between the web draw isolator roll (web tension interruption roll) and the center drum (3), passes around the latter drum and is finally taken up in the winding stations (4). The slitter knives are automatically positioned by a servo-driven belt which moves the top and bottom knives. Since all elements are adjusted together, repositioning is also possible with the sheet in the machine. The slitter station is fitted with Blue Slit™ top knives, which last two to three times longer than conventional knives. And thanks to the patented design of the bottom knives, they do not have to be recalibrated after sharpening. The glue applicators are automatically swivelled into the operating position, and after applying glue to the paper they return to the parking position. Web tension is removed by the web draw isolator roll installed between the unwind stand and the rewind stations. The rewind stations incorporate additional center drives and rider rolls. The stations are positioned in coordination with the slitter knives. Thanks to the controlled co-operation of web draw isolator roll, center drives and rider rolls, the winding structure of the finished paper rolls is optimized for subsequent processing, with ideal geometric form (perfectly square ends; no telescoping). This is assisted by the MultiDrive™ cover of the center drum. The RSM 3 slitter-winder layout is largely decentralized, with a busbar control system instead of parallel wiring. In addition to the master computer with graphic user interfaces in the control room, local terminals with monitors are also provided. Troubleshooting is assisted by a defect diagnosis system which immediately indicates the incident type, location and time of occurrence, the probable cause and the recommended action.

Dr. J. Hafellner, SCA Graphic Paper Laakirchen, was very impressed by the successful RSM 3 startup: *"Installation proceeded without a hitch in only six weeks, largely thanks to complete workshop assembly beforehand. And I pay tribute to the ingenious commissioning engineers: by first winding paper from the narrower PM 10 on to a new PM 11 reel spool, they were able to test and optimize the RSM 3 VariTop™ prior to PM 11 startup. This enabled immediate product processing afterwards, at the same time stabilizing operating speeds at 2,400 m/min. Optimization is currently in progress for raising the production speed to 2,800 m/min. The machine clearly has substantial potential, which we and Voith shall soon be exploiting step by step."*

Voith is very delighted about this positive opinion, and pays tribute in turn to the successful teamwork, which will certainly benefit the fine-tuning phase.

1

Twister™ Automatic –
Fully automated roll wrapping with the Twister™

This is a rare case of unanimous global opinion: the best way of wrapping paper rolls is in packaging paper, with double headers at each roll face. The carton or corrugated board inner headers protect the vulnerable roll faces from damage during transport and storage. And together with the laminated wrapping made of PE-coated kraft paper, the outer headers of the same material form a very sturdy and climatic-proof packaging.

Volker Schölzke

Voith Paper
Krefeld, Germany

Despite the cost involved, this kind of wrapping is used in practically every paper mill worldwide. Hardly surprising, in view of the fact that packaging paper optimally meets all the legal and other requirements on paper roll wrappings. It is much stronger and more durable than plastic wrap, and it can be printed with all kinds of marketing information, warnings and classification codings. That is why nearly every paper mill has at least one roll wrapping system using packaging paper. Such systems are well proven since decades, and they can be automated to any degree according to requirements.

Due to the wide variety of paper rolls, however, conventional wrapping systems can involve substantial costs. Headers and packaging paper have to be stocked in sizes to suit different roll widths and diameters, and as far as possible, automatic handling must be adjusted accordingly.

Voith Paper has opened up new horizons here by developing the Twister™ **(Fig. 1)**.

It uses only one size of packaging paper, 500 mm wide, for the entire range of paper roll widths and diameters. And thanks to the flexibility of this concept, roll width changes in future are no problem. Another advantage of the Twister™ compared with conventional wrapping machines is that it eliminates multiple handling phases and complex feed and gluing systems. The lateral and angular displacement of the wrapping paper dispenser is automatically done by a patented servo-drive system, so that the roll is spirally wrapped in a single operation with the required number of layers. Adequate adhesive is applied in one or more tracks between the layers to fix them firmly together.

The 500 mm wide wrapping paper used is also ideal for additional (optional) protection of the roll edges, which are particularly vulnerable to transport damage.

The Twister™ greatly simplifies roll wrapping without compromising efficiency in any way – on the contrary, the packed rolls are sturdier and have a neater appearance than with conventional wrapping. Our customers report that since they installed a Twister™, less than half as many rolls are rejected by printers due to transport damage.

The Twister™ offers so many benefits, apart from its great flexibility and compactness, that far more packaging installations of this type than any other were realized over the last four years. Since 1996 Voith Paper has sold more than twenty Twister™ wrapping machines.

Encouraged by this success, Voith Paper saw no reason why the complex task of fitting the inner and outer headers could not be simplified as well.

The fewer the parts, the fewer the problems – so all previous components such as transfer stations, clamps, elevators and other devices have been replaced in this automatic header handling system by two 6-axis industrial robots.

In the Twister™ Automatic, a robot takes each inner header directly from the pallet stack by vacuum grippers, and holds it against the respective face of the roll until it is firmly fixed by the automatically folded wrap overlap. The reach of these robots can be extended by mounting them on an optional traverse, this additional axis being taken over by the robot control system. Even the widest variety of inner headers is easily handled by the Twister™ Automatic without any transfer stations **(Fig. 3)**.

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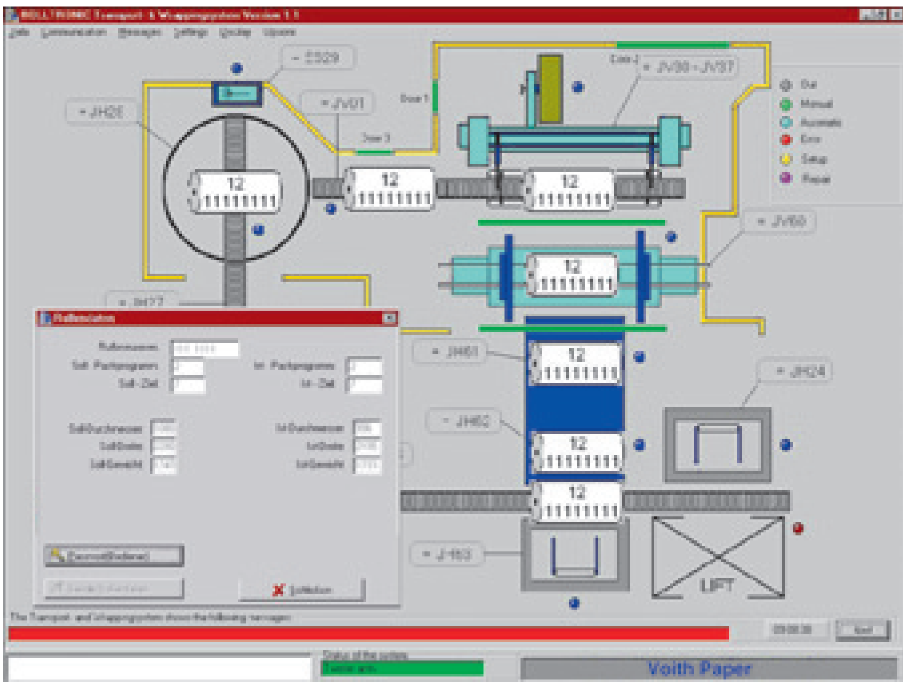
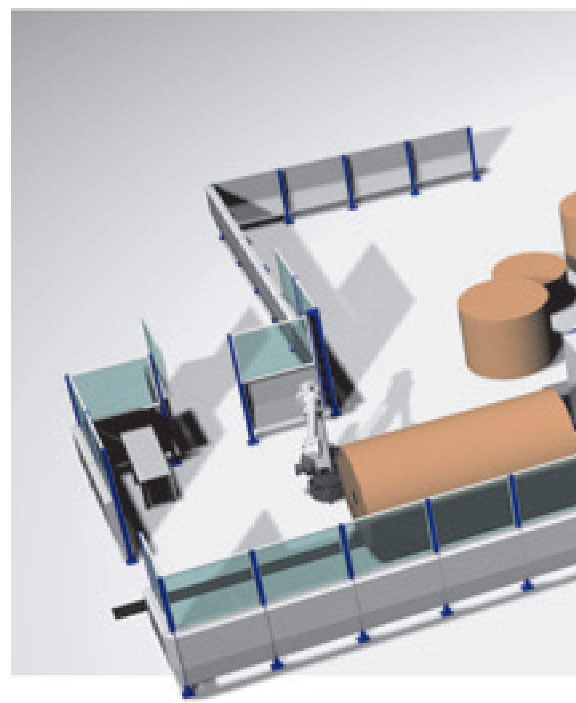
Fig. 1: *Twister™ wrapping and folding station.*

Fig. 2: *Paper dispenser.*

Fig. 3: *Inner header robot.*

Fig. 4: *Rolltronic™ user interface.*





The double claw of the outer header robot automatically adapts to various diameters. Here again, the headers are taken directly from the pallet stack, a special separating device ensuring that even if firmly linked together, they are removed individually. As soon as the header press tilts into position, the robot places the outer headers precisely on the pressure plates, which can be as hot as 180° C.

Roll labelling is taken over by a fourth robot. This picks up the two printed labels, normally DIN A3 size, with its double gripper and passes the back of them over a hot glue applicator. It then presses one label on the roll face and the other one on the roll body – neatly and without any creases. Self-adhesive labels can also be used, the backing paper first being automatically peeled off on the printer.

This roll wrapping system is rounded off by a conveying system to deliver unpackaged rolls to the Twister™ and transport wrapped rolls to the storage point.

Paper rolls are ejected from the winder on to a roller track with pneumatic stop. This is segmented so that every second roll passes through on to the plate conveyor, thus giving the winder operator time to inspect the roll faces and label each roll with a bar code. On their way to the wrapping machine, the rolls are then clearly identifiable by laser scanner.

With the Twister™, each roll can be wrapped differently according to individual production and transport requirements. For example, a roll wrapped in four layers for ocean shipping can follow immediately after a roll wrapped in only two layers with additional edge protection.

All this is possible thanks to the Rolltronic™ process control system specially developed for the Twister™ **(Fig. 4)**.

The Rolltronic™ process control system is linked online with the mill's production planning and inventory management computers. It also ensures that data such as weight, width and diameter are always

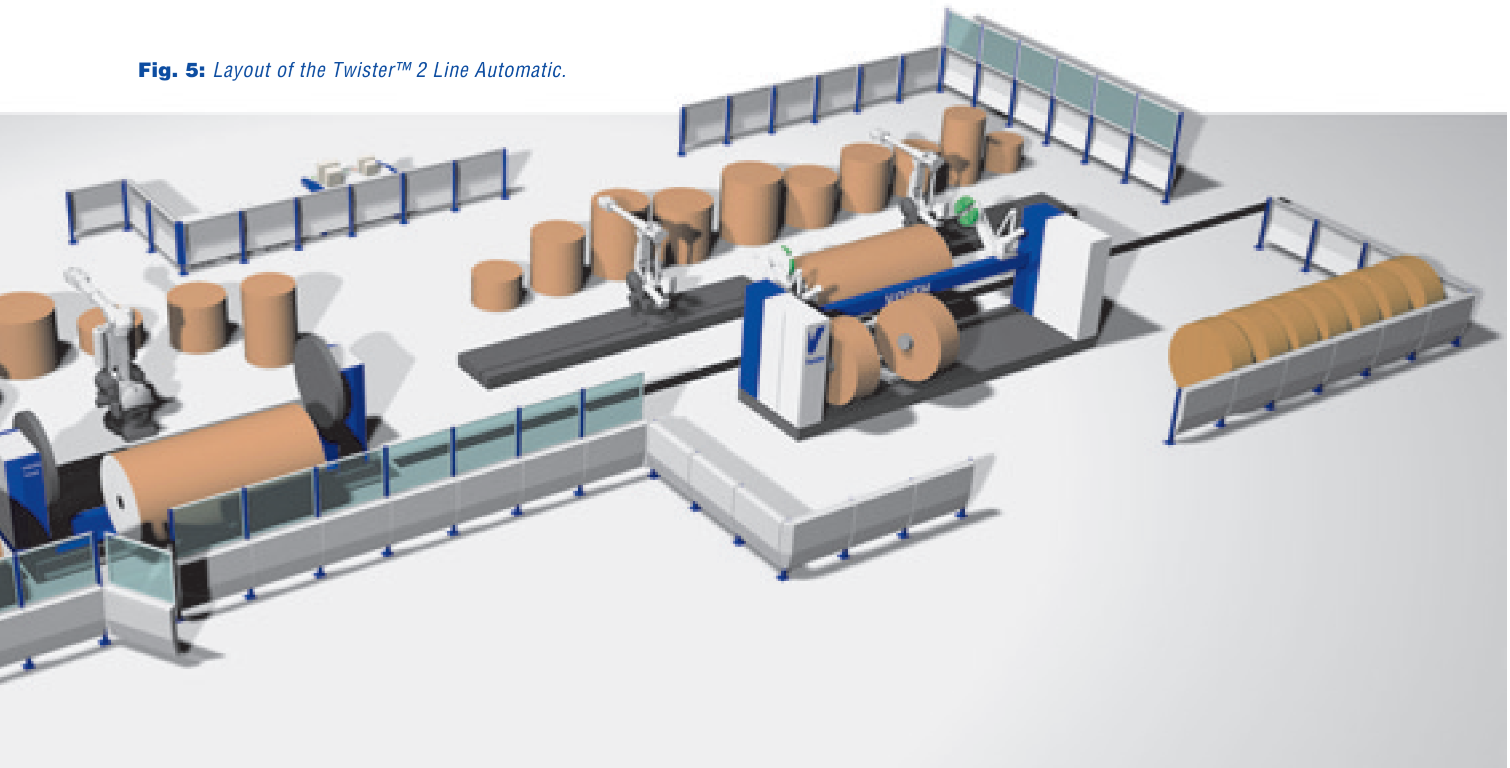


Fig. 5: *Layout of the Twister™ 2 Line Automatic.*

assigned to the correct roll, thus eliminating label printing errors.

Each element of the Voith Paper roll conveyor system is specially designed to avoid damage during handing. As always, these components have been continuously optimized over the years to ensure perfect functionality.

Since the plate conveyor runs on ball-bearings to minimize friction, low-powered frequency-controlled AC-motors can be used, despite today's conveyor speeds around 60 m/min and paper rolls weighing up to ten tonnes each. Thanks to the new plate conveyor generation, Twister™ Line speeds can now be up to 120 rolls per hour. Although the modular Twister™ concept enables numerous different layouts according to local conditions, the Twister™ Line is the most popular version on the market.

Such a smoothly continuous wrapping line, without any intermediate roll ejection or gripping, has long been the dream of every paper production manager. It represents the ultimate in gentle roll handling **(Fig. 5)**.

Summary

Twister™ wrapping systems and their conveying elements are uncomplicated, clearly arranged and functionally efficient. The Twister™ Automatic eliminates all peripheral elements and respective trouble sources, thus improving reliability and consequently long-term profitability.

The inherent risk with conventional wrapping systems – of ever-increasing production outages due to ongoing wear and tear – is substantially reduced with the Twister™ concept.

Together with roll transport elements optimized for the Twister™, Voith Paper offers a comprehensive and cost-effective paper roll logistics concept ranging from winder to roll storage.

Joachim Hinz

Voith Paper, Krefeld

Jost Hefter

Voith Paper, Krefeld

The Janus™ Concept and Janus™ MK 2 – Milestones in calendering excellence

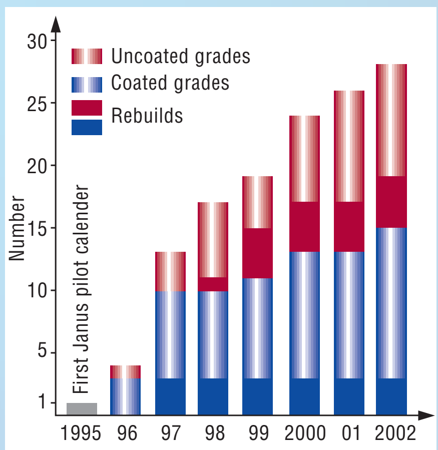
The history of papermaking is also the history of calendering. When paper was still fashioned by hand, the surface was made smooth enough to write on by rubbing with a stone, and later on by water-driven hammers. It was the printers that got things moving, and calendering really got underway with wooden rollers turned by handles. This was actually the birth of modern papermaking technology, for with the invention of the paper machine around the turn of the eighteenth century, rolls were used for continuous operation. Since then rolls have been the key component of every paper machine and in particular, of every calender.

Various problems arose in connection with rolls, however, and even machine calenders with chilled cast iron rolls were not able to meet the rising demands on paper quality. Although more advanced, the supercalender was too slow for online operation and thus involved the additional expense of a separate calendering line. To keep up with the production of a high-speed paper machine, up to three super-calenders were required.

Development of the soft calender around 1980 represented a considerable step forward, because heated rolls could now be used for the first time together with plastic-covered rolls. Despite its wide-spread success, however, the soft calender likewise failed to meet all the quality demands. In this respect the supercalender remained unchallenged, although there had hardly been made any improvement. The main reason for this long stagnation in supercalender development was its cotton rolls.

A quantum leap

This situation changed dramatically when plastic-covered rolls were first installed in supercalenders. Voith Paper pioneered the implementation of this new roll cover technology in 1995 with the innovative Janus™ calender, first presented in Krefeld, Germany.



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The market need for this new approach is reflected in the large number of Janus™ installations since then, particularly with regard to the growing production of uncoated SC grades. Milestones in modern calendering technology were set by the first online Janus™ calender in 1996, and above all by the revolutionary Janus™ MK 2 in 1999, which is now state of the art in the paper industry.

This article, focusing mainly on SC grades, shows the rapid progress made by Voith Paper since launching this new calendering technology.

Fig. 1: *Cumulative deliveries of Janus™ calenders.*

Fig. 2: *Development of calendering speed.*

Fig. 3: *Productivity development.*

Fig. 4: *Port Hawkesbury installation.*

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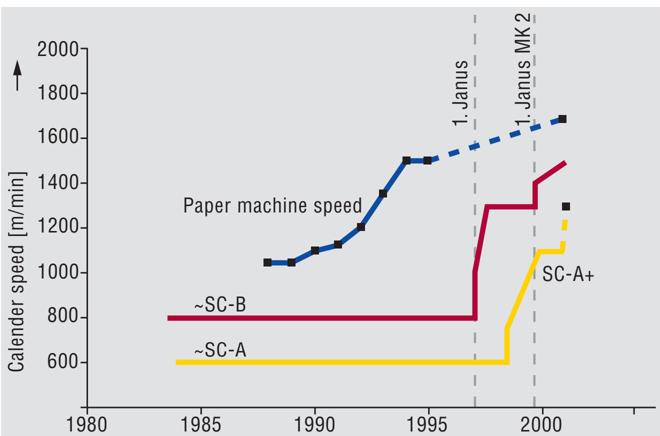

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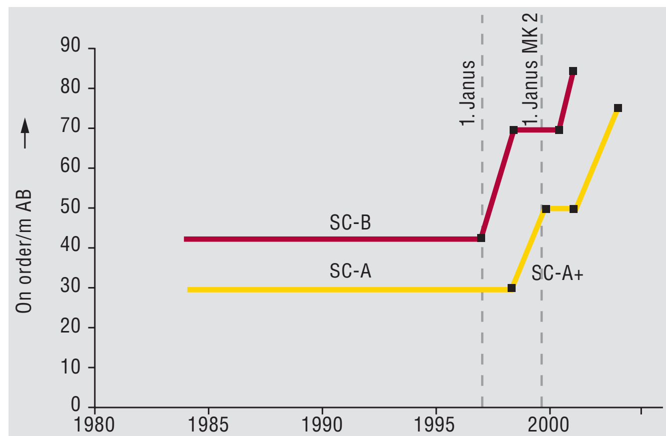

Development steps

As shown in **Fig. 2**, offline Janus™ calendering technology increased calendering speeds for SC-A grades in only three or four years to around 1,100 m/min, compared with about 600 m/min for supercalenders. Despite the accompanying speed increase of paper machines from around 1,200 to 1,600 m/min, only two offline Janus™ calenders operating at 1,100 to 1,200 m/min, can handle, for example, the correspondingly higher production of an SC-A+ line in North America.

In 1996 the teamwork between a progressive German papermaker and Voith Paper led to the world's first online Janus™ calender installation for newsprint and rotogravure printing grades.

This represented another milestone in the new calendering era: online calendering speeds reached well over 1,350 m/min for the first time, with significantly improved paper surface quality.

Voith Paper engineers in Krefeld were encouraged by this to develop a completely new concept: the Janus™ MK 2, which took online calendering technology one step further. The first online installation of this new Janus™ generation was in 1999 at the same German mill in a Voith paper machine, this time for SC-A grades. The result was a further production increase at speeds up to 1,550 m/min.

Since this new concept not only increases calendering speed significantly, but also improves efficiency, the productivity of high-speed paper machines with online Janus™ calenders rises dramatically. **Fig. 3** shows this in terms of tonnes per meter web width.

In only five years, the Janus™ concept has in fact brought about a quantum leap in calendering technology. Compared with the supercalender, it has multiplied productivity several times.

Interim review

Although this development took place in a relatively short period, it was technically very demanding and often plagued with enormous difficulties. As shown by the technical aspects explained below, some drastic changes were necessary to make up for the long stagnation in supercalender development with a successful new calendering technology in only four to five years.

Development findings

Plastic covers

In the initial development phase, damage frequently occurred to soft roll covers be-

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cause the plastic was not strong enough to stand up to long-term operation. The self-heating and damping characteristics of the roll cover material were therefore optimized for better heat dissipation and resistance to local pressure peaks.

This problem was also solved by continuous roll temperature control during operation, and by heating up the rolls to operating temperature before restarting. The precise geometrical and thermal stability thus attained not only helps to prevent roll cover damage, but also upholds uniform product quality.

The result is considerably stronger plastic roll covers, which now reach a service life of around 1,000 hours. Since they are currently limited to a maximum line load of 400 to 450 N/mm, however, further development work is still required to enable the higher line loads technologically possible.

Roll surfaces

The heated hard rolls with surface temperatures up to 170 °C play a decisive role in calendering quality. At high calendering temperatures, more stickies separate out of the paper and adhere to the rolls, and in some cases caused holes in the web and even breaks. This problem has now been solved by more efficient doctoring of all the calender rolls. One of the biggest challenges in this connection was plastic roll cover doctoring.

For that, special doctor bodies, blade holders and blade materials were developed for the new Janus™ MK 2 generation. As shown in practice, the service life of hard rolls is too short unless they are surface coated. They roughen too quickly, and become geometrically deformed particularly at the web edges. Various types of surface coating are used today, depending on the wear mechanisms affecting the rolls during operation. They are either applied thermally or galvanically, always taking account of optimal doctoring. Both thermal and galvanic surface coatings have been further optimized over the last few years to combat the faster abrasion and corrosion caused by much higher operating speeds, temperatures nearly twice as high, and above all, the significantly greater process moisture.

Barring

Roll humming and vibration due to barring is a well-known phenomenon, mainly in multi-roll calenders and in printing machines. In supercalenders, this hardly ever occurred because of the short service life of filled rolls. With the much longer lasting roll covers used in Janus™ calenders, combined with higher operating speeds and line loads, the barring problem arose again.

Due to the elastic reaction of every roll system with paper, barring cannot be eliminated even by the highest roll precision. However, soft roll covers have now been developed to the point where the negative effects of barring – including noisy running and paper surface defects – are largely avoided.

Some types of cover materials were found to be less vulnerable to barring, and their optimization brought further improvements. In general, the best results so far have been obtained with Voith Paper Safir™ covers.

Apart from other measures, online condition monitoring systems for the entire roll stack are very effective. The Voith VMM and VTM systems provide very reliable early warning of developing barring and roll surface wear.

Quick opening

Great attention was also paid to the quick-acting nip opening system necessary for roll protection. The innovative NipProtect™ system shuts off all nip line loads simultaneously in less than 0.5 seconds. Although the bottom roll opening distances are now more than three times larger than in supercalenders, this new hydraulic system – maintenance-free and self-adjusting – minimizes mechanical shocks by opening the roll stack smoothly under all circumstances.

Threading

Critically important for integrating the Janus™ calender in a paper machine is the threading procedure. Due to the high operating speed and the long zigzag web path through the calender, the paper tail is subject to particularly high strain.

After very intensive development work on this aspect, almost exclusively on the testbed, an optimal combination of Fibron vacuum threading belts and transfer ropes was found to minimize tail stress.

Numerous components of the Janus™ calender have been modified to free up the web run for the threading system. Furthermore, paper tail quality is now improved by a double tail cutter which cuts off the tail about 100 mm in from the web end. This eliminates the edge section with its extreme shrinkage stresses, edge damage and positional variations in this zone.

Structural rigidity

Based on operating experience with all the first-generation Janus™ calenders, this technology was systematically developed into the new Janus™ MK 2 concept. Its most outstanding feature is the 45° layout, which differentiates the Janus™ MK 2 from all supercalender types.

Apart from the above mentioned optimization measures, the biggest improvements are the much more rigid stack frame and the significantly better accessibility of nearly all components. The natural frequency, which largely depends on the frame stiffness, is now five times higher than with previous designs. In future this will enable operating speeds of well over 2,000 m/min without problem.

Modified process conditions

Web in-going moisture

Due to the higher operating speeds, loads and temperatures, this new calendering concept requires different process conditions. For example, ingoing web moisture to the Janus™ MK 2 is significantly higher than before at 11 to 12%, in order to attain the required paper gloss and final moisture content. Controlled moisturizing prior to calendering, and steam boxes in the calender in combination with thickness cross-profile control, are now state of the art.

Over-compensation

Paper quality not only depends on a perfectly uniform thickness cross-profile, but is also improved by a controlled increase in line load from nip to nip. Thanks to roll weight compensation, the Janus™ MK 2 incorporates an ideally increasing line load characteristic. Line

Fig. 5: *SC-grade calendering performance by supercalenders and Janus™ calenders as a function of operating speed.*

Fig. 6: *Supercalender/Janus™ calender operating data for SC-A grades.*

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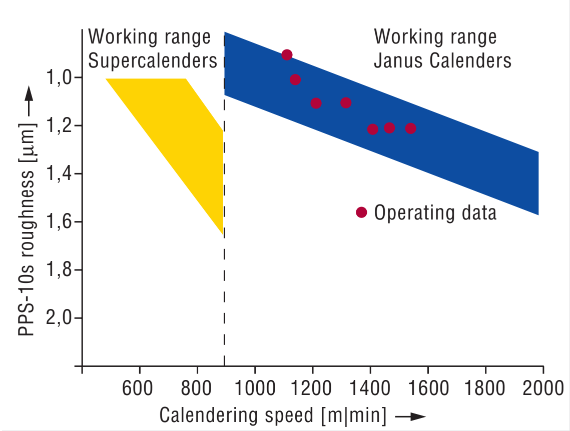

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	Supercalender 750 m/min 340 N/mm 120°C heating medium temperature	Janus Calender 1.100 m/min 370 N/mm 190°C heating medium temperature	Janus Calender 1.100 m/min 370 N/mm 220°C heating medium temperature	Janus Calender 1.100 m/min 370 N/mm 160°C heating medium temperature
Gloss	52.3	57.9	59.3	53.8
PPS-10S roughness	0.98	0.9	0.87	0.95
Porosity	17	16	15	167
Blackening	55	56.1	57.5	53.9
Opacity	91.95	91.71	91.49	92.05
Brightness	68.43	67.55	66.24	68.41

load in the first nips is overcompensated, i.e. it is higher than in the uncompensated calender, and reduces again in the lower nips. The Janus™ concept also ensures, however, that the paper is not overpressed by excessive line loads in the top nips. The Janus™ MK 2 takes account of this with the creative method of an exactly controlled increase in line load from nip to nip.

Web width

It goes without saying that calendering results depend very much on prior factors in the papermaking process, so that to optimize quality and output, the line conditions as a whole must be taken into account.

Apart from the kind of furnish and stock preparation, process conditions in the paper machine are also very important. The suppression of web shrinkage in modern paper machines, as far as the end of the dryer section, not only changes web shrinkage in the calender, but also web run characteristics.

Product quality

Smoothness/roughness

Fig. 5 shows PPS roughness for SC grades as a function of calendering speed and type, based on test results which correspond well with the operating data also shown for some modern installations. Notably, maximum smoothness values have hardly been affected by the substantial rise in operating speeds so far, and are rather increasing – as shown by the trend for SC-A+ grades.

For unrestricted online production of SC-A grades, however, further developments in calendering technology are required if the quality level is to be maintained or improved at still higher speeds.

Fig. 6 compares other characteristics before and after rebuilding supercalenders to the Janus™ concept for SC-A grades in a German paper mill. The steep rise in calendering speed, from 750 m/min to 1,100 m/min, hardly had any effect on product quality. Similar experiences are reported with other Voith Paper installations of this type.

Blackening

Blackening is clearly also a function of other process criteria, such as furnish. With regard to the Janus™ calender itself, it has been found that the right kind of soft roll covers influence blackening results much more favourably than the filled cotton rolls used in supercalenders.

Coated papers

There are some aspects which apply, in particular, to coated papers, where operating speeds and pressures are generally lower than for SC grades, although in some cases with relatively high temperatures.

Wood-free coated grades

Despite the higher operating speed of Janus™ calenders, outstanding gloss values can be attained with these grades even at moderate line loads of 200-250 N/mm. Flatness is significantly improved, in particular for roll offset grades, and results in general are more consistent than with supercalenders.

LWC grades

Initial results with online Janus™ calendering show hardly any dust formation with these grades, and excellent printing press runnability. Print gloss is very high compared with the paper surface gloss.

Summary and conclusions

This quantum leap in calendering technology not only demanded enormous personnel effort and financial expense, but is also the fruit of intensive teamwork with our customers, for whose patience and understanding we give our sincere thanks.

In less than five years, Voith Paper has upgraded calendering technology from the rather unsophisticated supercalender, restricted to intermittent offline operation, into the modern Janus™ concept and now the Janus™ MK 2 generation, which meets the highest demands for online operation. The optimal 45° layout of this calender – completely different from all its vertical predecessors – signals a new era in calendering technology. For the first time, online calendering is now possible without the restrictions previously applying. The trend has now been set for the future – and it will certainly be followed up without delay.

Prospects

Printing paper – increasingly multicoloured these days – is gaining ground as an advertising medium, even in competition with modern electronic media. To uphold this trend, not only optimal productivity but also smoothness, gloss and uniformity are decisive. Since this applies equally to coated and uncoated grades, an increasingly important role will be played by the Janus™ concept in future. Destined for stardom is the Janus™ MK 2 calender. Integrated online in the paper machine, its possibilities are practically unlimited. Voith Paper's ongoing development effort will ensure that the Janus™ MK 2 stays abreast of all future demands.

LWC paper calendering technology

LWC grades are used above all for printing multicoloured magazines, brochures and catalogues. Surface quality demands on these papers range from mat to high gloss, thus requiring a correspondingly wide spectrum of calendering technology.

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Voith Paper
Krefeld, Germany

Until just a few years ago, LWC grades were calendered almost exclusively on supercalenders. This changed dramatically when the Janus™ concept was introduced. Actually, LWC papers today can, to a great extent, be produced on-line. The Voith Paper concepts are based on the well-proven Janus™ calender.

This review first examines the influence of the base paper characteristics, coating composition and pre-calendering on the calendering results. Afterwards the most suitable Janus™ MK 2 layouts for the various LWC grades are presented, showing how the best calendering concept for each particular application is arrived at by selecting the correct option. An actual installation – the PM 4 "Pioneer" at Perlen Paper, Switzerland – is then described, followed by a look at future development prospects.

Influence of raw paper characteristics, coating formulation and pre-calendering

The greater penetration of coating material into highly porous papers negatively affects gloss and smoothness due to poor surface coverage. To keep the coating on the surface, the structure of the base paper must be dense enough. This is illustrated in **Fig. 1**, which compares the gloss of LWC grades made from two different kinds of base paper. Furthermore, with the increasing use of DIP (deinked pulp) for LWC production these days, there is a greater tendency to grey mottling on the paper surface due to blackening.

The coating formulation also has a significant effect on gloss and smoothness. In this connection, **Fig. 2** shows the surface gloss and smoothness potential of various coating components.

Considerable use is made in North America of plastic pigment additives, which increase gloss and smoothness very effectively. Due to the high cost of these pigments, however, calcium carbonate and china clay are mainly used in Europe.

Irrespective of coating process (film, blade or curtain coating) and formulation, the base paper should be calibrated by precalendering prior to coating **(Fig. 3)**. The advantages are twofold. On the one

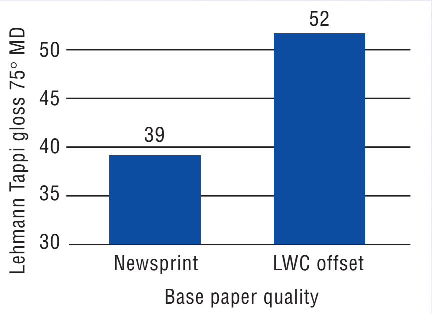

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Fig. 1: *Effects of coated base paper quality on gloss.*

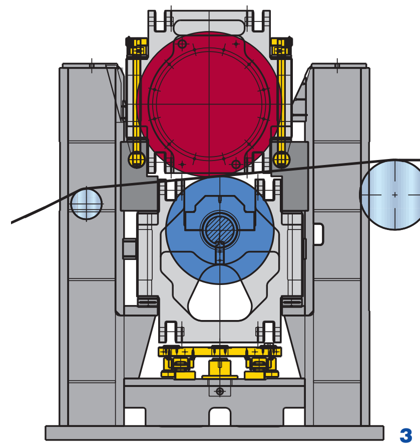
Fig. 2: *Gloss and smoothness potential of main coating components.*

Fig. 3: *Calender.*

Fig. 4: *Online Janus™ MK 2 calender, 1x10 rolls.*

2

Component	Gloss and smoothness	Comments
Plastic pigment	+++	High costs
China clay	++	Low brightness
Calcium carbonate	+	High brightness
Talcum		Slippage, reduces core bursting
Starch		Low cost, increases stiffness
Latex		Influences air permeability and printability
Fine ground	+	Better coverage, high costs
High coat weight	++	High costs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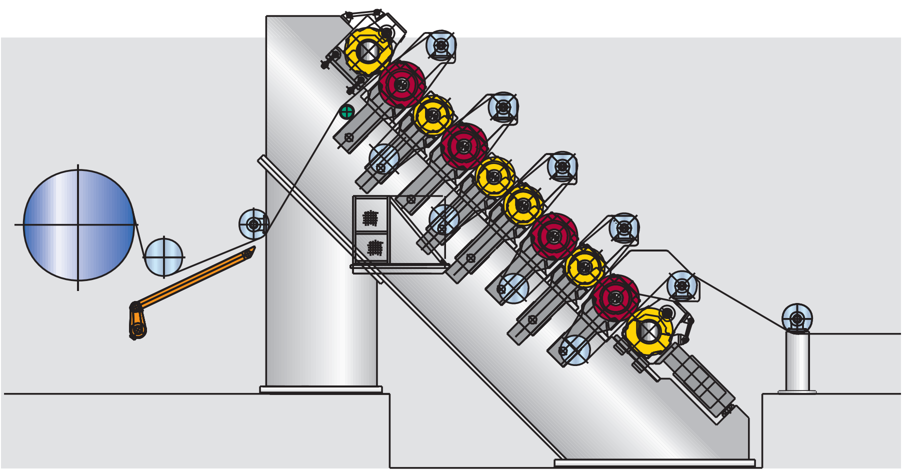

hand the CD thickness profile is optimized, which significantly improves runnability in the coating machine, and on the other hand moderate precalendering makes for more efficient calendering.

Janus™ MK 2 layouts

LWC offset grades can be calendered online in a 6-roll Janus™ MK 2, for example, or in a 10-roll Janus™ MK 2 **(Fig. 4)**. With these configurations, both sides of the paper are calendered in 2 and 4 hot nips respectively.

Plastic-covered Nipco™ or Nipcorect™ top and bottom rolls are used, whereby a Nipcorect™ roll is not normally required if the web has been precalendered before coating.

The hot rolls are covered with abrasion-resistant material and heated with oil. Their surface temperature can reach 170 °C.

In these one-stack layouts, the two soft-covered middle rolls form the reverse nip. To correct two-sidedness in such layouts, different temperature settings are required above and below the reverse nip.

In some cases, the base paper characteristics are particularly two-sided. Optimal layout conditions are then required for correcting this two-sidedness on a well-controlled basis.

For this purpose, Voith Paper offers for example a 1x8, 2x3 or 2x5 Janus™ MK 2 layout.

In the eight-roll version, the number of hot nips per paper side is asymmetrically arranged. The rougher paper side is calendered in four hot nips, and the smoother side in only two hot nips. Additionally, different temperatures can be set on each paper side to correct two-sidedness.

The 2x3 or 2x5-roll versions are particularly flexible, because they combine two independent calendering stacks in a single frame.

This means that apart from asymmetrical temperature settings, each stack can be operated at an individually variable line force independent of the other stack.

Selection of LWC calendering concepts

Selection of the optimal calendering concept depends on the one hand on surface quality requirements, and on the other hand on the required operating speed. For it is these criteria which dictate the operating conditions for Janus™ MK 2 technology to best meet customer needs. **Fig. 5** shows the typical surface quality requirements for LWC grades.

As another aid to select the optimal calendering concept, Voith Paper has compiled "product maps" for a wide range of paper grades. They are continuously extended and updated to take account not only of ongoing research results at our Krefeld test facility, but also of actual field results in practice. These product maps therefore give a detailed overview of all the latest technological possibilities.

Figs. 6 and 7 show product map extracts for film coated and blade coated LWC grades.

The main criterion here is attainable gloss level as a function of paper machine speed and calendering concept.

For example, to produce film coated LWC offset paper with ≤ 55% gloss at 1,400 m/min, Voith Paper would recommend an online Janus™ MK 2 layout with 1x6 or 2x3 rolls. For producing LWC rotogravure paper with gloss ≥ 65% Gardner on the same line, we recommend two offline Janus™ MK 2 calenders with 1x10 rolls each.

Optimal calendering concepts for blade coated LWC papers can similarly be determined as a function of PM speed and surface quality requirements.

Online calendering experience with LWC offset papers

The new online calendering generation for LWC offset printing papers was pioneered by PM 4 at Perlen Papier AG, Switzerland, commissioned in October 2000 **(Fig. 8)**.

Based on the Voith Paper "One Platform Paper Machine Concept™", this line includes the following components:

- Duoformer TQv™ with ModuleJet headbox;
- Tandem-NipcoFlex™ press section, with double-felted first press and top-felted second press;
- Well-proven TopDuoRun™ dryer section;
- Two-roll calender with 36-zone Nipcorect™ roll for optimal CD profile control;
- SpeedFlow™ for simultaneous film coating;
- Airturn, infra-red drying, also used for CD moisture profile control and hot air float dryer;
- 2x3-roll Janus™ MK 2 calender for exact compliance with surface quality requirements;
- Optimal wind-up of the extremely smooth-surfaced grades produced

Fig. 5: *Typical surface characteristics of LWC papers.*

Fig. 6: *Product map for film coated LWC.*

Fig. 7: *Product map for blade coated LWC.*

5

LWC grade	Gloss Gardner [%]	Roughness PPS S 10 [µm]
Offset satin	–	1.8 - 2.8
Offset glossy	50 - 60	1.1 - 1.7
Rotogravure	55 - 70	0.75 - 1.2

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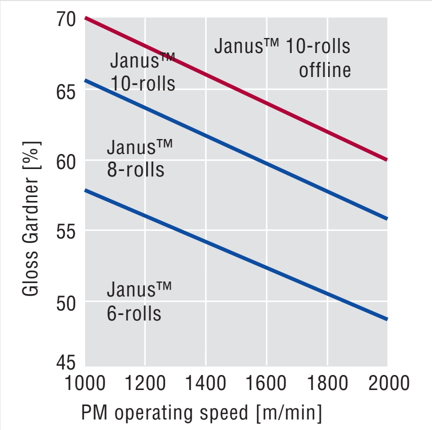

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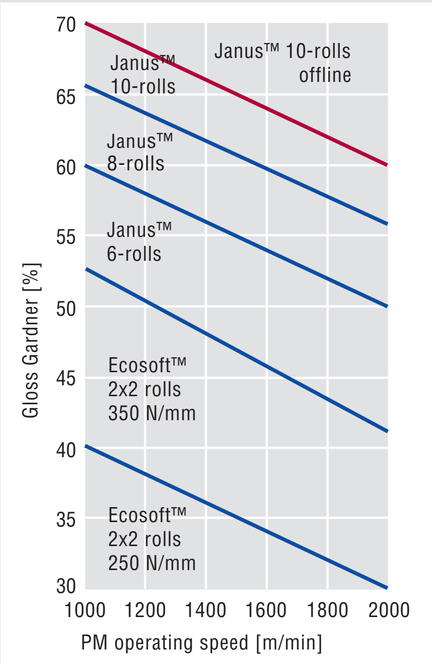

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here, up to paper roll diameters of 3,200 mm and with minimal waste, is ensured by a Sirius™ reel system at the end of the line.

Operating at a web width of 5,360 mm and a design speed of 1,500 m/min, Perlen Paper’s Pioneer PM 4 breaks no size or speed records (nor was it intended to), but it is certainly one of the most innovative lines to date.

Perlen PM 4 Janus™ MK 2

The 2x3-roll Janus™ MK 2 calender, installed in Perlen Paper's Pioneer PM 4 **(Fig. 8)**, offers further benefits on top of the already mentioned design advantages. Thanks to its outstanding flexibility, the Janus™ MK 2 calender can handle an exceptionally wide variety of grades including standard newsprint, high grade coldset and heatset printing papers, matt and high-gloss LWC offset printing papers. This gives Perlen Paper the decisive competitive advantage of being able to respond very rapidly to market changes.

To attain this flexibility, the heated hard rolls are fixed mounted while the soft rolls are self-loading Nipco™-F rolls. Not only can the Nipco™ rolls close the nips independently by controlling the shell movement, but the individual line loads can also be controlled precisely.

This also has the advantage that there is no need to change the web run from 2x1-nip to single nip operation, for example, because it simply passes through the open nips not required.

In the standard 2x2-nip operating mode, high-gloss LWC offset printing papers can be calendered at line loads from 300 N/mm to 400 N/mm and heating medium temperatures from 180 °C to 230 °C.

This standard mode is also well proven for calendering uncoated “Extra 70 Heatset” grades. In this case, the line loads vary between 120 N/mm and 200 N/mm in combination with heating medium temperatures around 80° C.

For producing matt LWC grades, the Janus™ MK 2 is currently operated in 2x1-nip mode, whereby each side of the paper passes once over the heated rolls, both of which with a heating medium temperature of 80 °C. Line loads in this mode vary from 110 to 140 N/mm.

“Extra 70 Coldset” and standard newsprint grades can be calendered in single-nip mode (first nip in stack 2). In each case the line load is 50 N/mm and the heating medium temperature is 70 °C.

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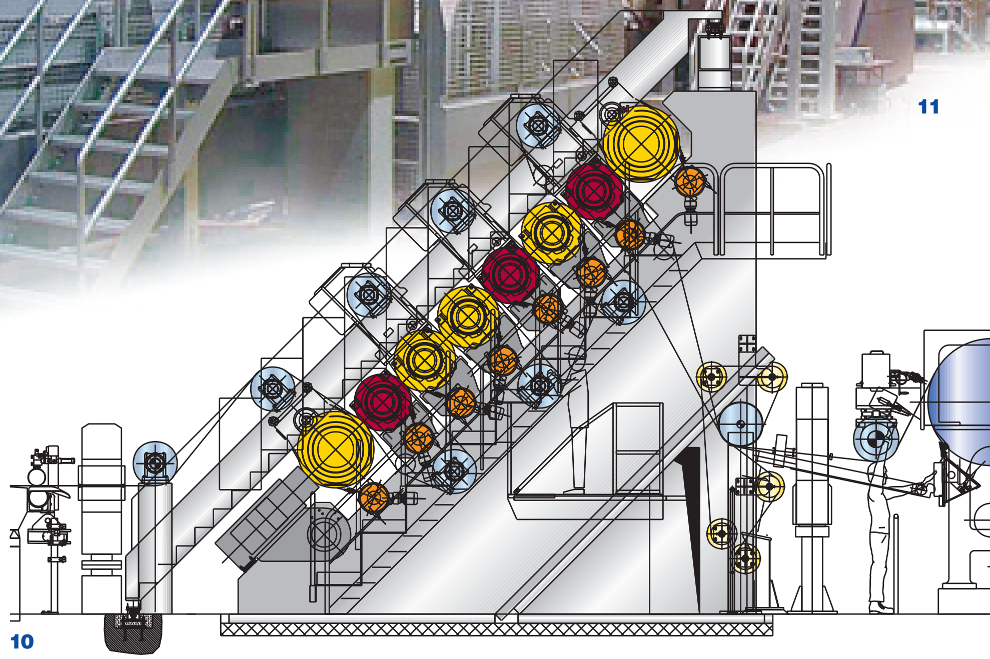

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Fig. 8: *Online Janus™ MK 2, Perlen PM 4.*

Fig. 9: *Quality characteristics of various products on Perlen Paper's pioneer PM 4.*

Fig. 10 and 11: *Online Janus™ MK 2, Madison Paper, Alsip, USA.*

9

	LWC offset 60 g/m²	LWC matt 60 g/m²	Heat Set
Gloss Lehmann T480 [%] measured in machine direction	50	–	–
Gloss Gardner [%] measured in machine direction	55 - 60	–	–
Roughness PPS S20 [µm]	–	2.7	2.4
Brightness T452 [%]	76	80	70
Opacity DIN 5316 [%]	92	93	93
Thickness to DIN EN 20534 [µm]	≈57	≈69	≈69
Bulk to DIN 53105 [cm³/g]	≈0.95	≈1.15	≈1.3

Perlen Paper's Pioneer PM 4 produces up to 550 tonnes per day of LWC grades with basis weights from 52 to 70 g/m², and about 420 t.p.d. of improved newsprint at 45 to 52 g/m².

The product quality characteristics so far attained on this machine are tabulated in Fig. 9.

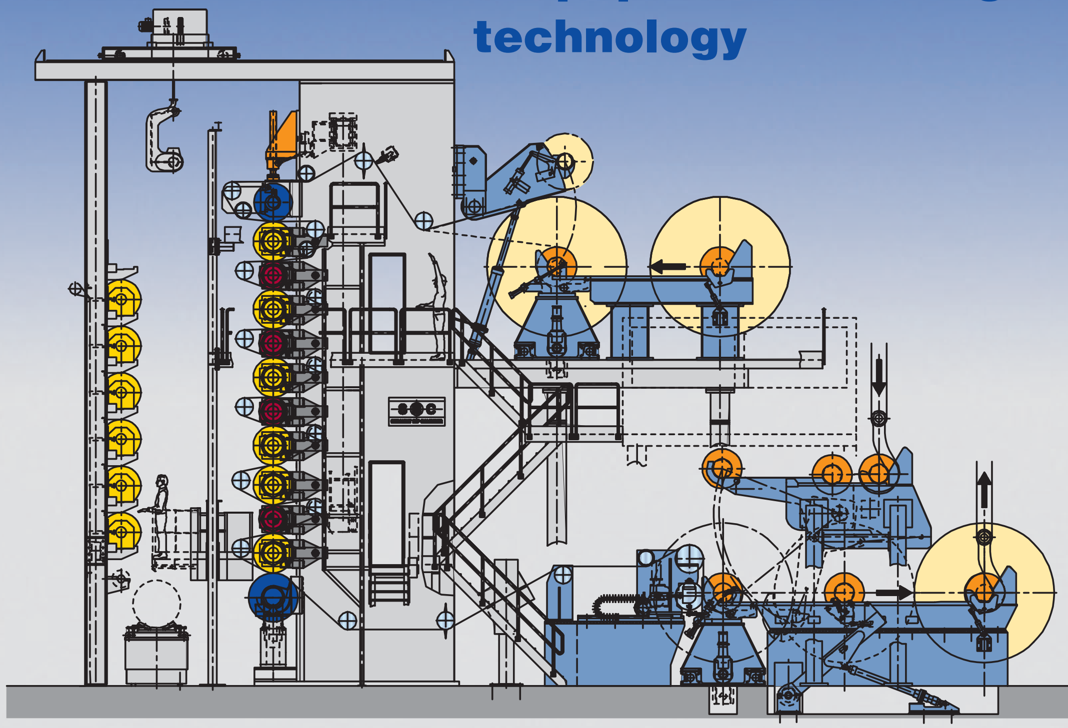
Prospects, and other current projects

Particularly for LWC offset and ULWC production, there is a growing demand for online machine concepts and online calendering accordingly. Moreover with the current trend toward lower basis weights and higher DIP content, the risk of sheet breaks is increasing. This risk can be counteracted very effectively by using indirect coating processes in combination with Janus™ online calendering technology.

Based on operating experience with PM 4 in Perlen, this trend will be followed up in 2002 and 2003 by commissioning two more LWC production lines in the USA. Each line will be equipped with an eight-roll Janus™ MK 2 for online calendering of high-quality LWC offset grades. Fig. 10 shows the Janus™ MK 2 layout in one of these two lines, at Madison Paper, Alsip.

As previously explained, offline calendering is still in demand for high-quality rotogravure printing papers. Instead of three supercalenders, for example, two offline Janus™ MK 2 calenders can, however, be used for this purpose. Here again, there is a growing interest in online calendering concepts.

SC paper calendering technology



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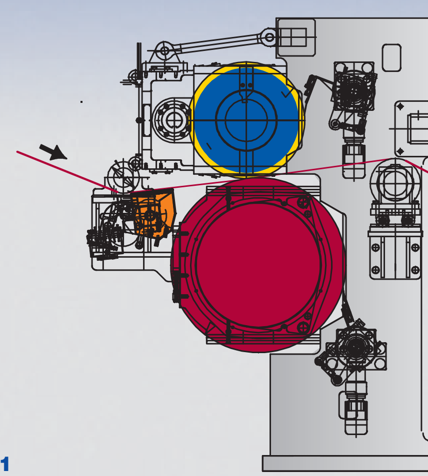

Ulrich Rothfuss

Voith Paper
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A good twenty years ago, all SC grades were calendered exclusively offline, usually with 12-roll supercalenders. The development of softcalender technology enabled some SC grades – improved rotogravure newsprint as well as SC-B grades – to be calendered online, normally with only two nips.

Due to its multiple nips with high coverage degree and rather low operating speed of 500-700 m/min, the supercalender **(Fig. 1)** delivered the best quality results. But as a typical offline system and also using filled cotton rolls prone to marking, it was not efficient enough. The availability of supercalenders was very low because of the frequent roll changes required. And due to their restricted operating speed, up to three of them were necessary to keep up with the output of a high-speed paper machine.

Unlike the supercalender, the Ecosoft™ calender **(Fig. 2)** can be integrated online in the paper machine. This brings enormous advantages, not only with regard to space and labour savings. Thanks to its individually controllable nips, the Ecosoft™ calender guarantees the least two-sidedness and a perfect cross-profile. As the Ecosoft™ uses polymer roll covers not prone to marking, its availability is much higher than the availability of the supercalender.

Because Ecosoft™ calenders generally have only two nips, the calendering work is less than in supercalenders, the more so as they are run at paper machine speeds, i.e. two or three times faster than supercalenders.

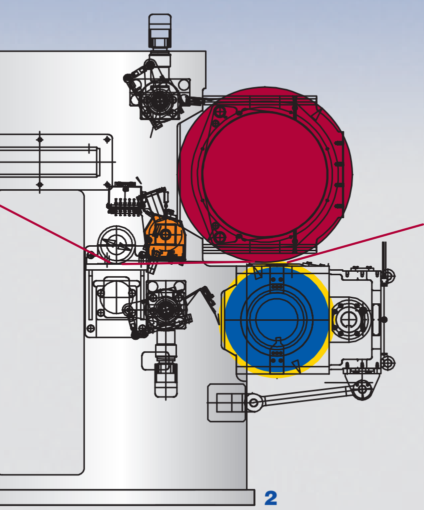
The advent of Janus™ calendering technology in the middle of the nineties made it possible, for the first time, to combine the technological advantages of the supercalender with the cost-effectiveness of the Ecosoft™ calender. High quality SC grades could now be calendered online at high speed with multiple nips.

Fig. 1: *Supercalender.*

Fig. 2: *Ecosoft™ calender.*

Fig. 3: *Janus™ MK 2 calender.*

Fig. 4: *SC paper grades.*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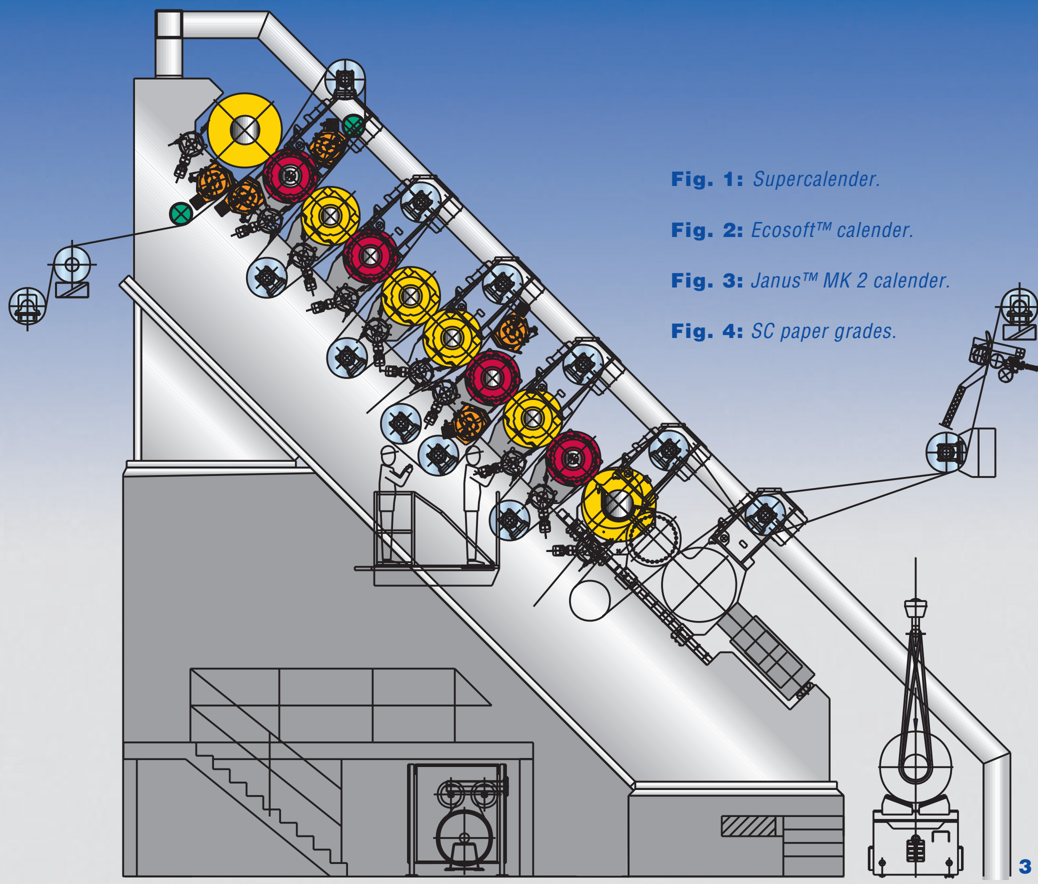
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With further development of this technology, the Janus™ MK 2 calender generation was launched only a few years later **(Fig. 3)**.

This concept with its 45° inclined layout was the first one to meet the special demands of online calendering in full. Particularly notable about the Janus™ MK 2 are its high availability, fast roll changing, easy accessibility to all relevant points of the calender, and anti-vibration frame design to prevent barring.

Ecosoft™ calenders are mainly used today for standard newsprint and improved SC-C grades.

For cold-set offset grades requiring Bendtsen roughnesses around 130-160 ml/min, a single soft-nip may suffice in some cases. Under certain conditions, these kinds of paper grades can also be calendered online with a single hard-nip. For heat-set offset grades with Bendtsen roughnesses around 80 ml/min, and for improved SC-C grades, 2-nip softcalenders are always used.

Higher quality SC grades require more calender nips. Depending on the furnish, product quality requirements and operating speed, Janus™ MK 2 calenders with 6, 8 or 10 rolls are used online for this purpose. Offline, 10 or 12-roll calenders are used.

Fig. 4 shows the respective calender configurations, expressed as number of hot nips, used for the various SC grades with their normal gloss and roughness values.

Also shown here are the respective operating speed limits, which particularly in the case of high quality SC-A grades, may currently preclude online calendering.

Calendering results naturally depend very much on the furnish. Apart from traditional quality criteria such as gloss and smoothness, optical characteristics are increasingly important in this connection, particularly with regard to blackening. Often an excessively high black calendering index limits calendering performance by

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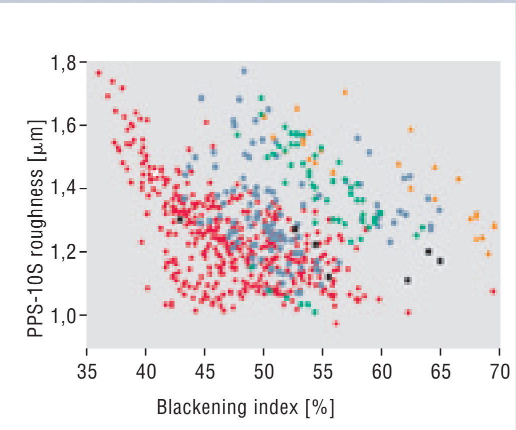
Grade	PPS roughness	Gardner gloss	Calender configuration	Operating speed
SC-C	2.5-3.5 µm	15-25 %	2 hot nips	Unlimited
SC-B	1.6-2.5 µm	25-35 %	2 hot nips	up to 1,500 m/min
			4 hot nips	Unlimited
SC-B+	1.4-1.8 µm	35-40 %	4 hot nips	up to 1,500 m/min
SC-B+	1.2-1.4 µm	40-45 %	6 or 8 hot nips	up to 1,800 m/min
SC-A	1.05-1.2 µm	40-50 %	8 hot nips	up to 1,500 m/min
SC-A+	0.95-1.15 µm	>50 %	8 hot nips	up to 1,300 m/min

Fig. 5: *Furnish influence on calendering results.*
GWD
TMP
DIP
Mix
SC production.

Fig. 6: *Product map for SC grades DIP content > 80 %.*

Fig. 7: *Product map for SC grades TMP content > 80 %.*



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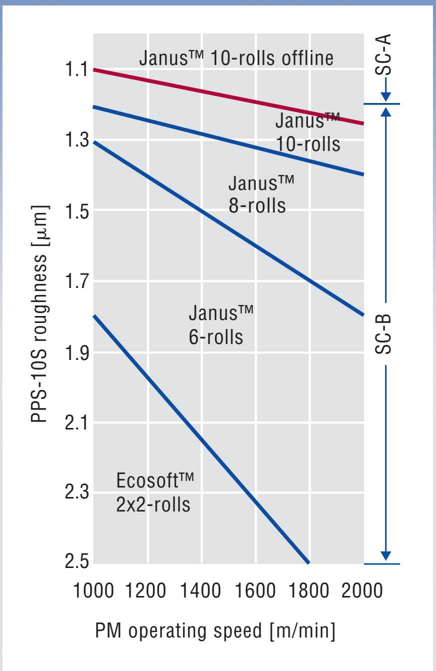

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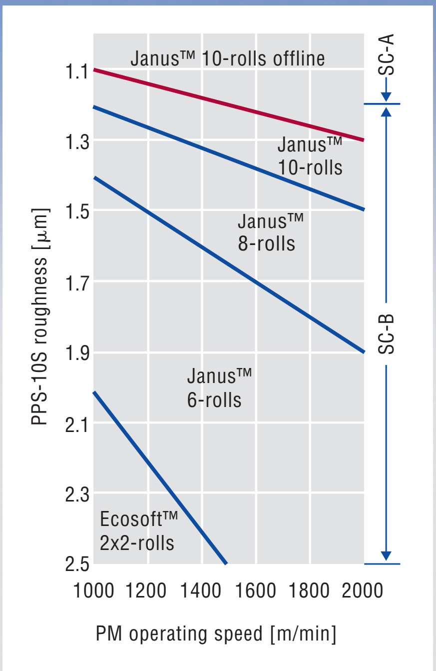

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preventing the use of higher line loads and/or temperatures, which would otherwise improve gloss and smoothness.

The goal of low roughness combined with lowest possible black calendering can only be reached, to a very limited extent, by adjusting calendering conditions. Furnish quality and stock preparation have a much greater effect here.

Numerous investigations have shown, for example, that a high groundwood content favourably affects the relation between roughness and black calendering, while a high DIP content is rather unfavourable in this respect.

Fig. 5 shows PPS-10 S roughness as a function of the black calendering index. This plot is based on the results of wide-ranging tests on SC papers from various manufacturers, and takes account only of furnish influence.

Clearly visible at bottom left – the most favourable zone with low roughness and low black calendering – is the predominance of grades with high groundwood content.

Grades with high TMP content are predominant in the zone of high roughness and high black calendering, while DIP-based grades mainly appear in the unfavourable zone at top right, with high black calendering and high roughness.

Calender design is fundamentally influenced by the paper machine concept, above all the press section configuration, since this is where the 2-sidedness and roughness of the paper are determined.

Highly refined stock is more favourable for calendering, in particular TMP stock. Also the fillers type and content significantly affect calendering results. As a basic rule, the higher the fillers content, the better the calendering results. Calcium carbonate and particularly PCC give significantly better optical qualities such as with regard to opacity, brightness and black calendering, however they result in lower gloss and greater porosity than for example flaky clay.

The question of optimal calender concept is, therefore, investigated here not only as a function of roughness and operating speed, but also with respect to furnish.

Since stock influences vary so widely, we only differentiate in the following between grades with a high DIP content and those with a high TMP content.

Fig. 6 shows the effects for SC-B and SC-A grades with a DIP content higher than 80%. The zones covered by specific calender concepts are defined as a function of operating speed and roughness. For example, the high roughness and low speed zone at bottom left is best suited to Ecosoft™ calenders with only two nips.

Operating at 1,500 m/min, this kind of calender can still attain a smoothness of 2.2 µm according to PPS-10 S. For a lower roughness such as 1.6 µm PPS-10 S, a 6-roll calender is required with two hot nips per sheet side instead of 1.

For attaining a roughness of 1.15 µm PPS-10 S at this speed of 1,500 m/min, a

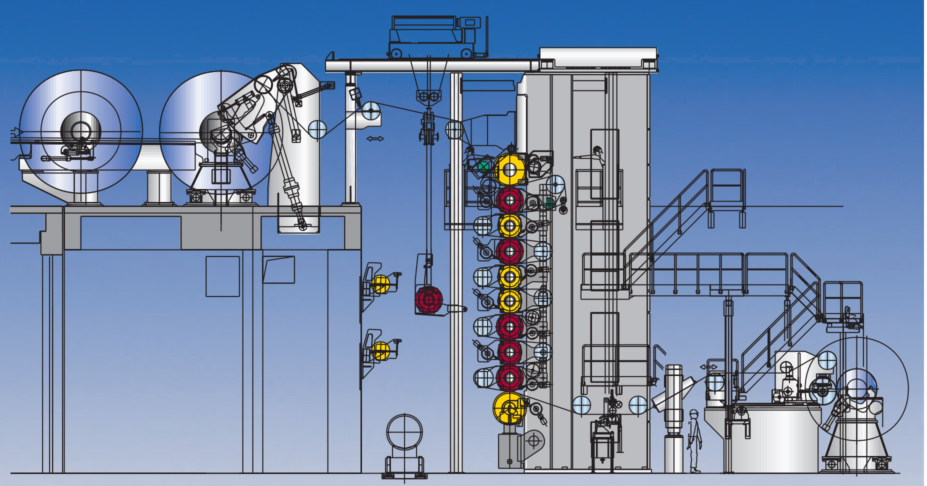

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Fig. 8: *Janus calender, Port Hawkesbury, Canada.*

10-roll or 2x5-roll calender with four hot nips per sheet side would be necessary.

The red line at the top delineates the maximum limit for online calendering. If for example a PPS roughness of 1.0 µm is required at 1,500 m/min, operating conditions are above this line and outside the online calendering range. In this case two offline calenders are required, operating at about 1,000 m/min as against the paper machine speed of 1,500 m/min.

Similarly, **Fig. 7** shows the situation for SC-B and SC-A grades with a TMP content higher than 80%. Clearly, grades with a high TMP content are more difficult to calender. The individual calender configuration zones now start at higher roughnesses and lower speeds.

Particularly, with regard to SC grades and online calendering, Voith Paper's integral know-how – covering all process stages from stock preparation and paper machinery to calendering and reeling – ensures optimal runnability and of course printability.

The world's biggest SC paper calenders are the two offline 10-roll Janus™ machines at Stora Enso in Port Hawkesbury, Canada **(Fig. 8)**.

For the SC-A Plus grades produced here, online calendering was precluded by the high paper machine speed of over 1,600 m/min. With a web width of 9,600 mm and speeds of 1,150 m/min, SC offset and SC rotogravure papers are calendered here at line forces around 400 N/mm and roll surface temperatures around 130°C.

Because these calenders operate at significantly higher temperatures than conventional supercalenders, on the one hand an excellent finish is obtained at nearly twice supercalender speeds with high gloss and low blackening, but on the other hand web moisture loss is significantly higher.

To ensure a final moisture content around 5%, for example, a web humidity around 11% is required at the calender intake for the aforesaid calendering conditions.

Together with the high steam quantities applied to the paper surface by several steam boxes to optimize calendering results, about 10 tonnes of water per hour have to be removed from both calenders by the building ventilation system. At the same time, stringent demands are placed on the moisture cross-profile quality.

This installation has clearly shown that offline calendering of these grades raises significantly more problems than online calendering.

The main reason for these problems is the intermittent offline calendering process, with acceleration and deceleration phases during parent roll changes, whereby the splice has to be made at speeds of 20-40 m/min with opened nips.

Opening and closing the calender without stopping the web always involves the risk of paper breaks. Furthermore, web shrinkage during the low-speed phases shortly before and after splicing is so excessive that the web width may be less than the length of the plastic roll covers. As a result, temperatures on the roll ends not in contact with the web may rise to the point of cover loss due to hot-spots.

At normal calendering speeds, web shrinkage is much less. The web thus remains wider than the length of the plastic roll covers, so that hot-spot problems do not arise.

The non-calendered web edges are cut off before winding.

Long-wave cross-profile variations are controlled in these calenders by the 10 to 12-zone Nipco™ rolls, and short-wave variations by the multi-zone steam boxes. This control strategy is now well proven.

The SC-A Plus grades produced in Port Hawkesbury are now long-established on the market, whereby the offset grades represent the absolute benchmark in North America. These grades are also well-accepted in some areas of the LWC market.

Further offline Janus™ calenders for SC-A Plus grades operate at Stora Enso, Maxau, Germany, and Myllykoski, Finland, comprising two supercalender rebuilds in each case. Due to the high quality requirements for SC-A grades, there are no online installations of this type as yet.

The new paper machine No. 11 at SCA Graphic Paper Laakirchen, Austria, is also fitted with a Janus™ MK 2 calender. Yet this calender is installed offline. Initially, this first offline calender will handle an annual output of 240,000 tonnes at reduced PM operating speed. When the

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Fig. 9: *Janus™ MK 2 calender, Ettringen, Germany.*

paper machine is run up to maximum speed in the second expansion phase, a second calender will have to be installed.

Since 1999 the first online calender of the new Janus™ MK 2 generation has been in service on PM 5 at Lang/Ettringen, Germany, paper mill **(Fig. 9)**. At speeds of more than 1,500 m/min this 8-roll calender, a good 8 m wide, now finishes SC-B Plus grades with a high recovered furnish content to a PPS roughness of 1.5 µm at line loads around 300 N/mm and roll surface temperatures of 130 °C.

Several test series on Ettringen PM 5 have shown that at high line forces and temperatures, PPS-10 S roughnesses can be reduced to 1.2 µm.

The extreme flexibility of this installation enables not only Janus™ operation utilizing all nips, but also single-nip operation for calendering standard newsprint. In the latter mode, speeds exceeding 1,700 m/min have been attained.

In this case all the nips not used remain open, so that roll changes can be prepared without interrupting production (e.g. cooling down the thermo-rolls). The Janus™ MK 2 concept realized here, for the first time, was an immediate success right from the beginning.

With good accessibility to all relevant points of the calender, fast and easy roll changing, extremely rigid anti-vibration stand design and good runnability, this is the optimal concept for trouble-free online calendering.

The multi-zone Nipcorect™ top and bottom rolls ensure an optimal thickness cross-profile even in single-nip mode for standard-newsprint calendering. The multi-zone steam boxes are not required for these grades, and are only used in Janus™ mode for correcting short-wave cross-profile variations with SC grades.

The problem of excessive web moisture loss is even more critical in online than in offline calendering, because for online calendering, high web moisture content with excellent humidity cross-profile at the calender intake is absolutely indispensable.

In conventional offline calendering, the web is dried in the paper machine to about 2.5% moisture content and then brought to the required moisture level with suitable moistening spray nozzles. Since calendering usually takes place several hours after moistening, the paper has time to soak up the water uniformly, and problems such as drop marking never occur.

With online calendering, the web is not dried in the paper machine. Due to the high initial web humidity of about 15%, spray nozzles are used only for adjusting the humidity cross-profile instead of for increasing the humidity level.

To give the water drops enough time to penetrate the web thoroughly, thus avoiding drop marking and similar defects, the spray nozzles are installed at a point corresponding to about 1 second before the web reaches the first calender nip. Normally there are 3 to 5 drying cylinders between this moistening point and the calender inlet.

By varying the number and positioning of the steam boxes, the steam quantity and the temperatures of the individual heating rolls, gloss and smoothness on each side of the web can be optimally adjusted even with this kind of asymmetrical calender arrangement.

The world's first multi-roll online Janus™ calender was commissioned in 1996 on PM 4 at Lang Papier, Ettringen, Germany. Further online Janus™ calenders are now in service at Haindl Paper, Schongau, Germany, and at Bowater in Donnacona, Canada. These special online-calendered SC-B Plus grades are now a well-established product in good demand on the market.

In some cases these grades are already a viable alternative to supercalendered SC-A products. For SC-B and SC-A grades, and many others as well, there will be an ongoing trend in future toward online calendering at ever increasing speeds.

With higher DIP content, lower basis weights and steadily increasing fillers content, the existing problems in this connection such as high blackening and higher opacity losses will certainly not diminish – notwithstanding the advantages of excellent printability and runnability.

As always, Voith Paper will meet these challenges in the interest of our customers with appropriate solutions and technologies. An important step in this direction is certainly the Janus™ MK 2 calender generation.

Janus™ MK 2 – Engineering aspects of a modern online calender

Josef Schneid
Voith Paper Krefeld, Germany

Josef Kohnen
Voith Paper Krefeld, Germany

Compared with conventional multi-roll calenders, the Janus™ MK 2 with its 45° inclined layout offers significant advantages for roll changing, accessibility, runnability, etc. Apart from these benefits, a good many details, decisively affecting reliability and efficiency, are not so obvious at first sight.

The NipProtect™ system

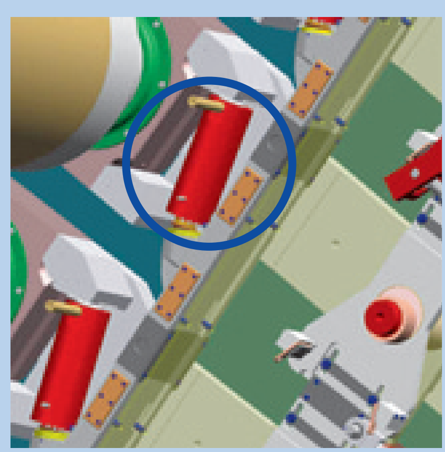
To start with, nip security has been greatly improved with the NipProtect™ system, which includes a number of cylinders centrally integrated in the levers of the intermediate rolls (Fig. 1).

The purpose of these cylinders is twofold. During operation they balance out the overhung masses and to some extent the mass of the intermediate roll. This results in higher line loads in the upper nips, thus increasing the calendering capacity for a given line load in the bottom nip. The degree of compensation depends on technological requirements, but is typically 85%.

Another patented function of these cylinders is fast roll nip-opening. When the bottom roll is lowered, all the intermediate rolls are lowered on the oil cushion of the compensation cylinders.

Each cylinder incorporates a throttle piston with a row of oil drain holes, so that the oil drainage cross-section is automatically adjusted according to cylinder stroke. During opening, when the lowest intermediate roll has to move the greatest distance, the compensation cylinder is almost fully extended and nearly all the oil drainage holes are open.

The cylinder stroke reduces from bottom to top intermediate roll, and the number of open drain holes is less accordingly. During fast opening, the top intermediate roll therefore lowers more slowly than the one below, etc. Due to the different lowering speeds of the intermediate rolls, all nips open simultaneously in less than 0.5 seconds (Fig. 2). The further the rolls lower, the more oil drainage holes



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are closed, so that the lowering speed reduces accordingly. Finally, all the rolls are gently laid down on a mechanical stop **(Fig. 2 and 3)**.

Fig. 4 shows conventional calender opening by comparison. During rapid opening, the intermediate rolls are laid down on mechanical stops one after the other from top to bottom. The bottom calender nip is the last one to open, thus leading to high structural loading.

Since June 2000 the first NipProtect™ system has been operating very successfully in a 9-m Janus™ calender. Meanwhile ten calenders have been equipped with NipProtect™, thus demonstrating the confidence of our customers in this system.

Further advantages

- Thanks to mechanical control of the oil drainage cross-section, the NipProtect™ system is extremely safe and reliable. Even in the event of control element failure, damping remains unaffected.
- At the end of the opening procedure, all rolls are supported on mechanical stops. This ensures complete safety for the operating and maintenance personnel.
- All pressures are controlled with mechanical valves. There are no proportional valves or electronic components.

Fig. 1: *Compensation cylinder.*

Fig. 2: *Compensation cylinder arrangement/ function principle NipProtect™ system.*

Fig. 3: *Fast opening – new system (NipProtect).*

Fig. 4: *Fast opening – old system.*
Roll 2
Roll 4
Roll 7
Roll 11

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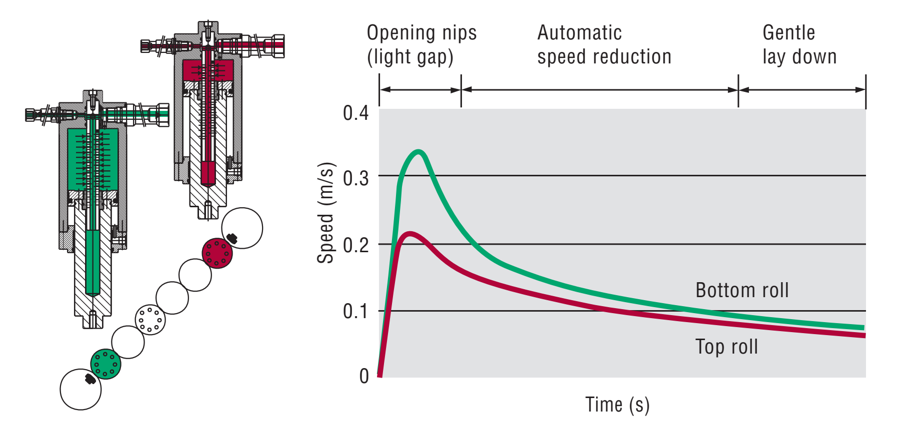

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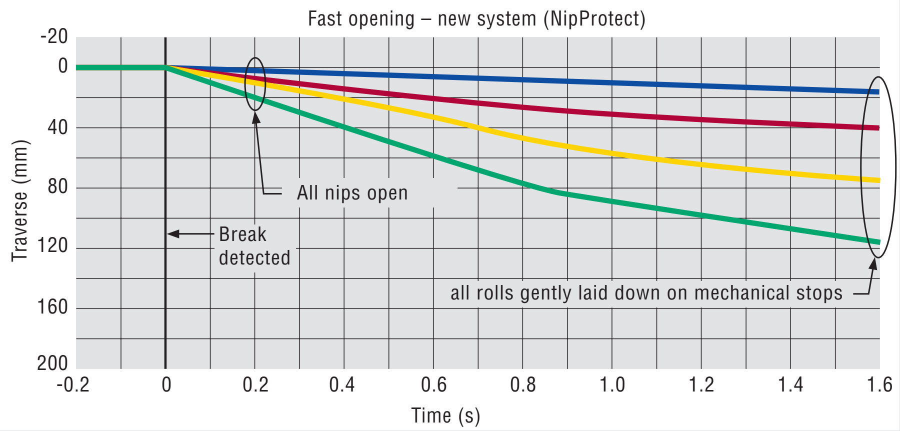

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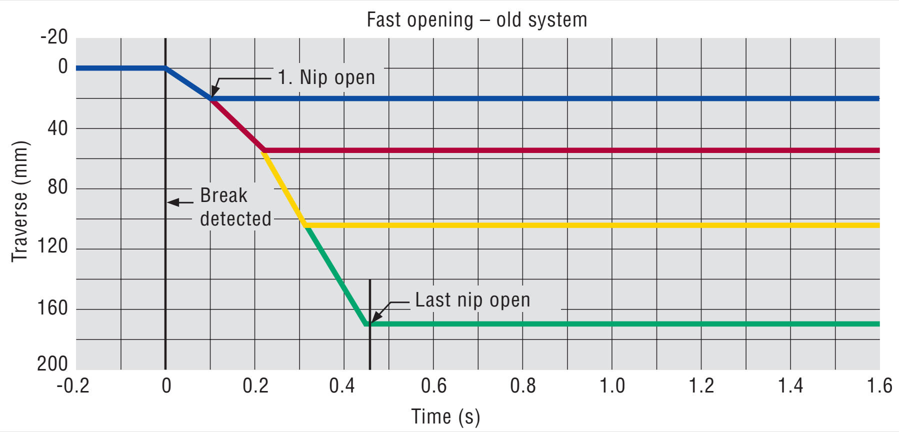
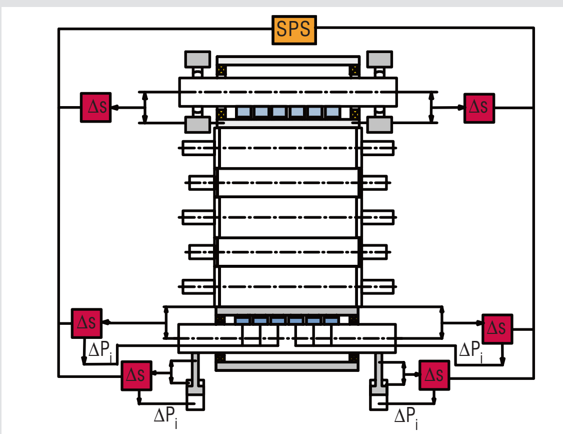
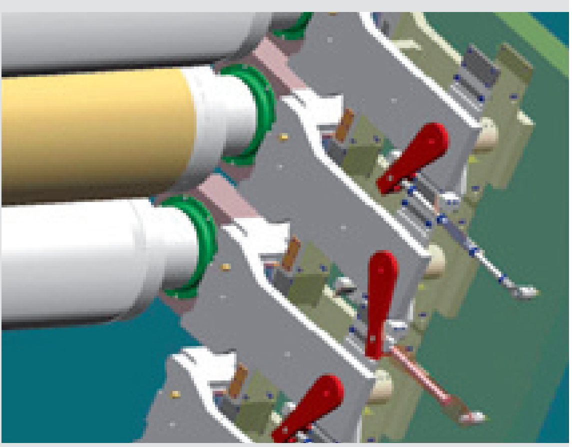


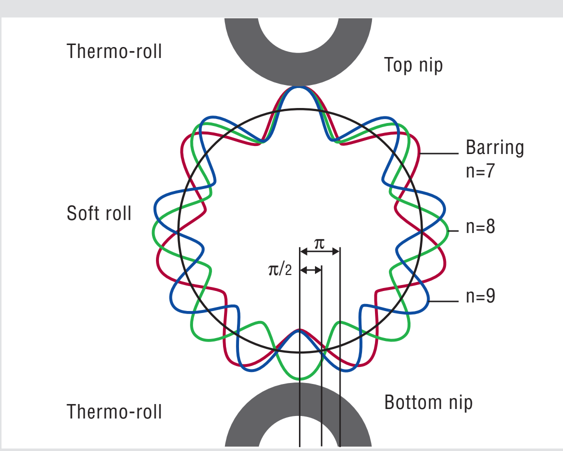
Fig. 5: *Roll stack.*

Fig. 6: *Eccentric offset adjustment.*

Fig. 7: *Roll offset arrangement.*







5 Floating Stack

The Floating Stack system has thoroughly optimized nip loading.
All the intermediate roll bearings are mounted in levers. The top and bottom rolls are self-loading Nipco™ rolls, each with a shell stroke of 30 mm. As a result, there is no fixed stop in the stack or for the top roll.

The roll stack positioning is monitored by sensors on the Nipco™ rolls. During
6 operation both the Nipco™ roll shells are in the central position **(Fig. 5)**.

During fast opening, pressure reduction in the top and bottom rolls has to be equivalent to pressure reduction in the bottom cylinders. If this is not precisely synchronized, conventional systems immediately react with excessive forces on the mechanical stops, possibly causing damage. The Floating Stack eliminates this problem, because any difference in
7 pressure reduction merely displaces the stack positioning slightly, without any negative effects.

Other advantages of the Floating Stack system

- The Floating Stack system is now well proven in about 100 online and offline installations, and is already operating successfully in three modern Janus™ calenders.
- The Floating Stack system prevents mechanical damage, because there are no fixed stops.
- All stack forces are automatically balanced.
- The system incorporates high overall damping and outstanding dynamic behaviour, because it is suspended between two oil-cushioned Nipco™ rolls.

Intermediate roll lever pivot offset – an effective measure against barring?

One of the most controversial aspects of multi-roll calenders is roll cover life, particularly in connection with roll barring.

Barring is a surface wear problem affecting both soft and hard rolls, caused by natural or externally excited vibrations of the roll stack. Since every calender roll stack has its own natural frequencies, barring is bound to occur sooner or later.

Barring can be prevented or delayed by offsetting some of the intermediate rolls perpendicular to the nip axis. This is done by mounting the intermediate roll lever pivot bolts eccentrically, thus enabling the pivot and roll position to be adjusted by up to 20 mm **(Fig. 6)**.

Barring frequencies can be detected by installing a monitoring system. In practice, barring patterns exhibit integer mul-

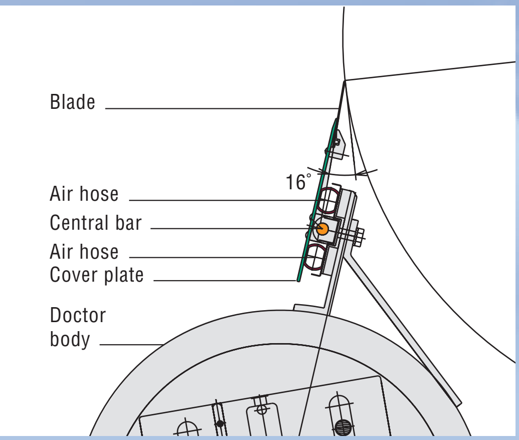


Fig. 8: *Doctor blade arrangement.*

tiples of n = 25-60 wave peaks and valleys. Fig. 7 shows for example a barring pattern with n = 8 wave peaks and valleys. Displacing the roll by e.g. $\pi/2$ changes the peripheral distance from nip to nip, thus interfering with the vibrational feedback mechanism. The roll is decoupled from the barring frequency, which helps to curtail barring from the outset.

State of technology

- Test measurements with a monitoring system have already confirmed longer service life due to roll offset.
- Longer-term trials will show how roll offset can be optimally applied in order to delay or prevent barring.

8 New doctor blade system – for optimal finish with the highest quality roll surfaces

Since paper surface quality reflects roll surface finish, we developed for the Janus™ MK 2 a doctor blade system doing full justice to the highest demands (Fig. 8).

The doctor blades have to keep the roll surfaces clean and prevent wrapping without causing any surface damage. The efficiency with which they do this directly affects paper surface quality.

Uniform doctor blade loading at the low level of 30-50 N/m is important for gentle but effective roll scraping. Materials and design were selected to avoid any thermal deformation due to roll surface temperatures, which can be very high. Only the continuous central bar is made of steel, all other components over the entire blade holder and doctor body width are made of carbon fibre laminate.

Due to the low specific heat capacity and low thermal conductivity of this material, the component surfaces get hot already during the warm-up phase, thus preventing condensation and drop formation during production.

The extremely good strength to weight ratio of this material enables a strong and rigid design with compact dimensions. This is a big advantage above all with respect to the blade holder cover plate and the doctor body.

The cross-machine stiffness of the cover plate has been reduced so that the blade can follow the roll surface perfectly. In web run direction, the cover plate is rigid enough to prevent even widely fluctuating loading forces from affecting the blade angle to any extent.

Thanks to this compact design, 75 mm wide blades can be used even for the largest roll diameters and at an angle of 16°, recommended for soft covers. Since they are much stiffer than 100 mm wide blades, the blade angle varies less, and the natural frequency of blade vibration is almost twice as high.

Prospects

Apart from these detailed examples of our further development work on Janus™ MK 2 technology, we are of course working on numerous other improvements. These are mainly concerned with the roll changing and drive systems.

In parallel, the principles of Janus™ MK 2 technology have naturally been applied to other calendering sectors as well – see our “Ecosoft™ calender” article in this issue.

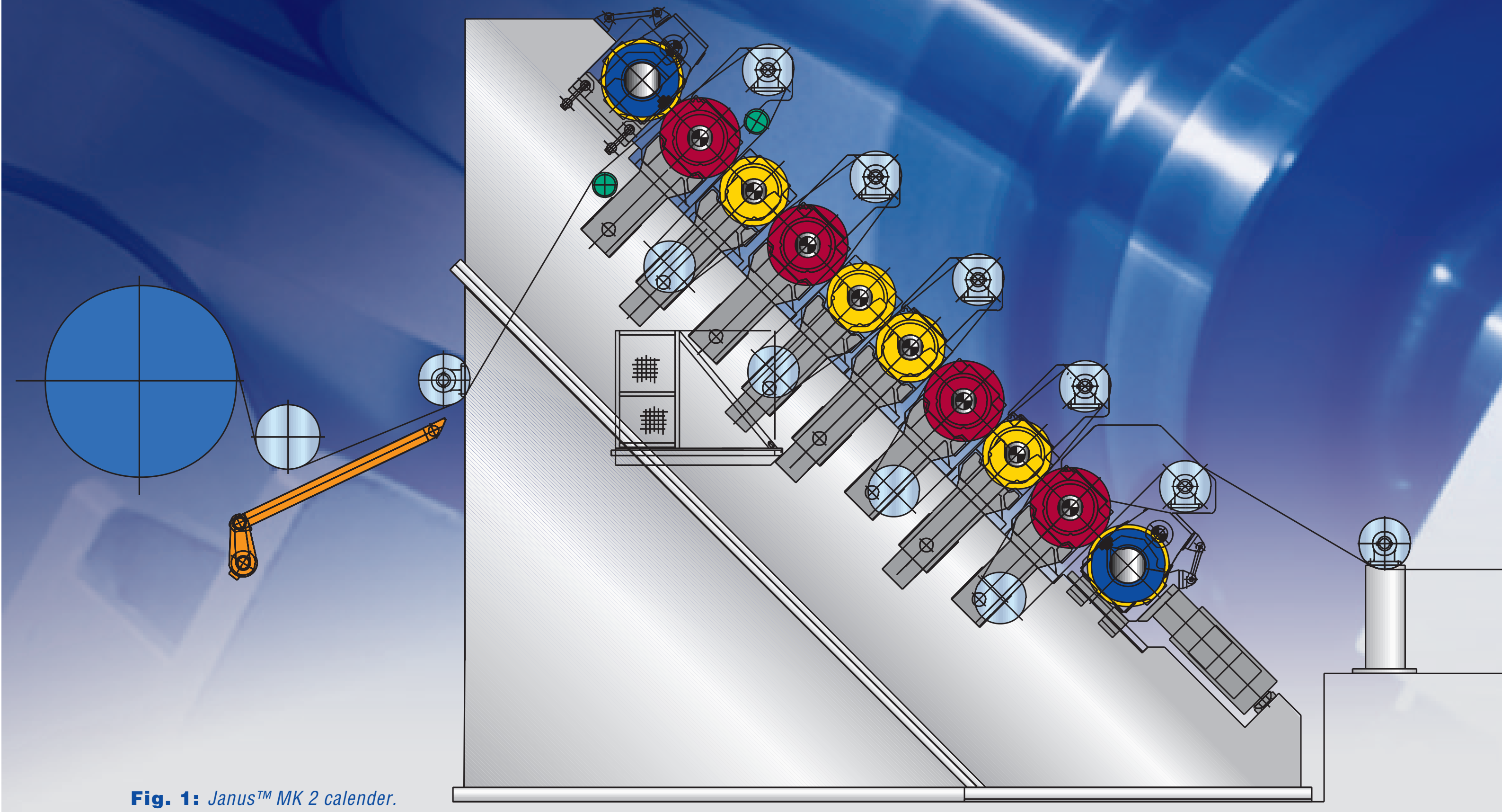


Fig. 1: *Janus™ MK 2 calender.*

Roll cover and coating effects on calendering quality

Dr. Lothar Zimmermann

Voith Paper
Krefeld, Germany

To optimize printability, paper has to be calendered, for example, on the Janus™ MK 2 (Fig. 1) after leaving the paper machine. Calenders are basically equipped with hard rolls and soft rolls. The paper is calendered on the side contacting the heated hard rolls, against which it is pressed with controlled force by the soft rolls. To calender the paper on both sides, a reversing nip is required with two soft rolls in contact. The smoothness of the roll surfaces is critical for upholding a high surface gloss on the paper. For this reason, development work has concentrated for years on maintaining, above all, the heated roll surfaces within a certain smoothness limit, even after long periods of operation.

Fig. 2: *Hard cast roll surface.*

Fig. 3: *Doctored chromium roll surface.*

Fig. 4: *Spray coating microstructure, scale 1,000 : 1.*

Fig. 5: *HVOF coating: particle boundary corrosion.*

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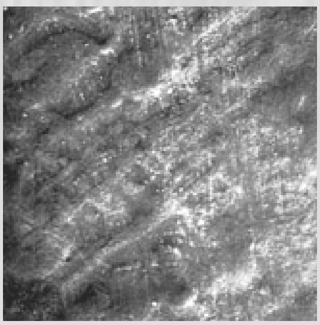

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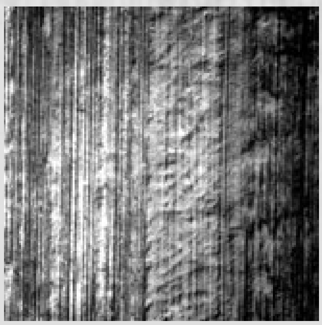

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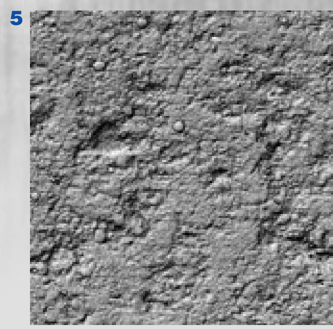

The steel or grey cast iron rolls used in the first supercalenders wore out so rapidly that they soon had to be replaced by chilled cast iron rolls. The impression of such a roll surface in **Fig. 2** clearly shows the roughness due to the relatively coarse iron carbide microstructure.

Surface quality was greatly improved with chromium plated rolls, but their extreme vulnerability to scratching precluded doctoring. Nevertheless, attempts were still made to doctor this type of roll.

Fig. 3 shows a chromium roll surface after about 38 days of operation. The grooves in peripheral direction can still be seen. The overall surface roughness is 0.15 Ra at that time and, therefore, still assures good operating conditions.

The development of HVOF (High Velocity Oxygen Fuel) technology enabled extremely hard surface coatings (>1,100 HV) which could be ground to a smoothness of Ra < 0.08 µm. They were then used instead of chromium surfacing wherever doctoring was important as well as resistance to abrasion. The more this coating was used, the more it became obvious that even this new coating technology was not suitable for every application.

For example, a customer producing wood-free coated paper, was not satisfied with the gloss attained using this kind of roll coating. And in another mill, producing SC grades, despite the long-term abrasion difference between HVOF coated rolls and chilled cast iron rolls **(Figs. 2 and 4)**, there was no difference in paper surface quality. In a third mill, also producing SC papers, HVOF coating resulted in a significantly longer service life, which, however, was still far too short. It turned out here that the surface had been damaged by particle boundary corrosion **(Fig. 5)**.

The problem is that the spray coating particles impinging on the roll are mechanically flattened on to the previous spray material without forming an integral bond. Under certain conditions this can lead to boundary corrosion.

Further attempts were then made to develop an optimal kind of roll coating. In the meantime, technical advances in galvanic chromium plating had increased the attainable surface hardness from 850 HV to 950 HV. This new kind of chromium surfacing is currently in service, with doctoring, at a mill producing SC-A+ grades. The customer is very satisfied so far with product quality, but his heated rolls already show abrasion grooves due to doctoring. Although no roll coating with an optimally homogeneous surface, also compatible with doctoring, exists as yet, some very promising developments in spray coating technology are underway at Voith Paper.

Soft roll cover and surface characteristics

Due to the heavy loading on the intermediate rolls of high-speed, high performance Janus™ calenders, subsequent development work concentrated on increasing the service life and reliability of their soft covers.

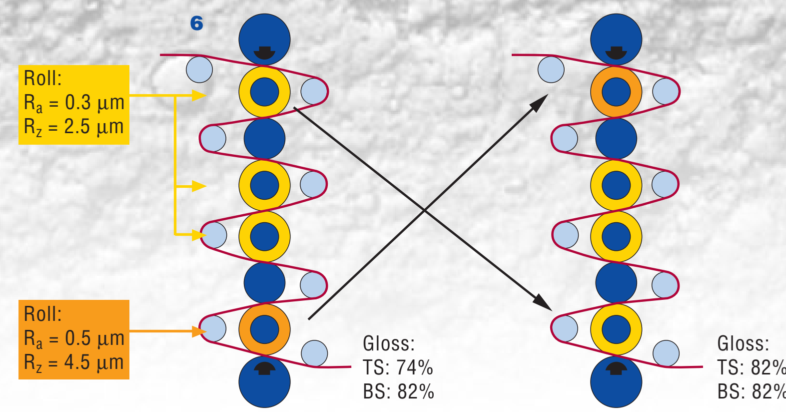

Fig. 6: *Effect of soft roll surface roughness on calendering results. v= 1,000 m/min, Q = 450 N/mm, T = 130°C coated wood-free paper, calendered on both sides, 100 g/m²*

With the new cover materials now developed, damage caused by internal flexural overheating can be practically excluded. As the next stage of development, attention is now being focused on the cover properties required for optimal calendering results.

With soft rolls in particular, it is very important to differentiate between the various paper grades. Some calendered papers may require a high volume, for example, while in other cases gloss, smoothness and production speed take priority.

The main calendering requirements for uncoated rotogravure printing papers are high gloss and above all smoothness, with minimal blackening effects.

This demands high stress, high temperatures, and possibly a good deal of steam-moisturizing. Therefore the soft covers must not only stand up to high stress levels, but also have the smoothest possible surface and greatest possible abrasion resistance.

For coated papers, the most critical aspect is the surface smoothness of the soft rolls. Any hard filler particles projecting from the roll covers easily penetrate the extremely fine-grained coating surface, with negative effects on gloss. To prevent this, very smooth-surfaced cover materials are used – at the expense of abrasion resistance.
Special requirements apply to roll covers for technical grades such as silicon base paper. To make this kind of paper transparent, the fibres have to be collapsed by extreme compression. Furthermore, the surface has to be extremely dense in order to prevent penetration of e.g. silicon oil during subsequent processing. The primary demand on roll cover materials is, therefore, high compressive strength, together with surface smoothness and extreme microhardness to compress the fibres and make the paper transparent.

Liner and board must retain a high volume after calendering. This requires very soft and smooth covers for only low compression stress. Such covers tend to heat up due to considerable internal flexing, because they form a wide nip with relatively low compression.

Interaction between covers and coatings in the nip

As explained above, one side of the paper is calendered in the upper section of a Janus™ calender, and the other side after the reversing nip.

Since the paper is calendered on the side contacting the heated roll, the soft roll surfaces after the reversing nip have to meet demanding requirements. This is impressively illustrated by a typical application for wood-free coated high-gloss grades **(Fig. 6)**.

Increasing roughness through wear of the heated roll surfaces has to be counteracted by increasing the line load. For a specified paper surface quality, the line load of e.g. 320 N/mm, required with freshly ground rolls, has to be increased during the service life to around 370 N/mm.

In this way, the required gloss and smoothness values can still be attained despite increased roughness of the heated roll surfaces (Ra >0.8). This is attributable to the more intensive contact between web and heated rolls under higher pressure, with better heat transfer as a result.

Nevertheless, by maintaining heated roll surface roughness below approx. Ra 0.8, paper quality requirements can be met with lower line forces and less flexible deformation of the soft covers.

This not only increases roll cover service life, but also reduces drive power requirements and saves energy accordingly. The overall benefit is even greater if soft roll surface quality can be improved to match that of the heated rolls as far as possible.

Furthermore, with particularly smooth rolls the production parameters can be adjusted accordingly, for example by reducing steam moistening and thus reducing heated roll temperatures.

With these findings, the development goals for roll covers and coatings are clear. Abrasion-resistant heated roll coatings with a typical surface roughness of Ra < 0.1 µm are required, in combination with soft roll surface roughness below Ra = 0.15 µm.

Roll cover and coating recommendations

What are the best surfacing materials today for optimal calendering of each paper grade?

Hard roll coatings:

- For wood-free coated grades demanding high gloss and smoothness, chromium plating plays an important role. Also recommended is CeraCal™ spray coating. Initial trials with CeraCal™ show excellent results without any particle boundary corrosion, also with steam moistening. Over an operating period of 70 days so far, CeraCal™ coating surface roughness has remained within Ra = 0.1 µm.
- CeraCal™ spray coating is also recommended for calendering SC-A, SC-B and LWC grades.
- For SC-C and newsprint, uncoated rolls are adequate unless profile wear is a problem.

Soft roll covers:

- For coated papers with high gloss requirements, Rubin™ S covers are recommended.
- Recommended for less demanding coated papers and LWC grades are Rubin™ covers. Due to the type and quantity of fillers used, these are classified as medium quality covers.
- Wherever high line loads and high production outputs are required, for example with SC-A and SC-B grades, only Safir™ S covers can be recommended. These are particularly tough and abrasion-resistant.

After addressing in this article roll cover and coating effects on calendering quality, the following articles in this issue report on the respective technical advances and design developments.

Paper grade	Special characteristics	Roll cover	Roll coating
Wood-free coated	Very high gloss	Rubin™ S	CeraCal (chromium)
Wood-free coated		Rubin™	CeraCal (chromium)
LWC		Safir™ S (Rubin)	CeraCal
SC-A+		Safir™ S (Rubin)	CeraCal
SC-A		Safir™ S	CeraCal
SC-B		Safir™ S	CeraCal (uncoated)
SC-C		Safir™ S (TopTec HC)	Uncoated
Decor (resin-impregnated) papers		Safir™ S	CeraCal
Technical papers	Very high transparency	Safir™ S	CeraCal (uncoated)
Newsprint		TopTec HC	Uncoated

Soft roll covers for Janus™ calenders

Voith Paper Service (formerly Scapa Kern) has been producing soft calender roll covers for more than a decade. A new cover generation has now been developed to take account of the special demands on soft roll covers in multi-nip calenders.

Dr. Benno Bader
Voith Paper Service,
Wimpassing, Austria

Development history of soft roll covers

The first two Janus™ calenders with soft roll covers went into service in 1996, including the first Janus™ online calender.

Modern calender roll covers are made of composite fibre materials, either with cast or fibre-reinforced surface layers.

The advantage of cast surface layers is the high isotropy and the very smooth and homogeneous surface. At the cost, however, of brittleness and a tendency to form cracks propagating in all directions **(Fig. 1)**.

That is why Voith Paper only uses cover materials with fibre-reinforced base and surface layers **(Fig. 2)**. The fracture characteristics of the fibre-reinforced surface layer are shown in **Fig. 3**.

Cover design principles

The TopTec™, Rubin™ and Safir™ calender roll covers manufactured by Voith Paper Service mainly comprise a fibreglass-reinforced base layer and a surface layer strengthened with aramide fibres.

The multi layered base construction is built up by winding fibreglass textile with fillers and resin around a metal core. It forms a dynamically strong composite, bonded both with the metal core and with the surface layer. To this purpose, the physical characteristics of the base layer such as mechanical strength, Young's modulus, deformation characteristics and bonding must comply on the inner side with the metal core material, and on the outside with the surface layer used for calendering.

In the first multi-nip calenders, hot-spot problems increasingly arose due to the high nip frequencies. They were caused by the thermal energy released during repeated local overloading of the cover material.

Due to the intrinsically low thermal conductivity of polymer material, this heat cannot be dissipated quickly enough, and

Fig. 1: *Cracks extending over the entire roll cover, mainly in the axial direction.*

Fig. 2: *Crack growth limitation by fiber reinforcement.*

Fig. 3: *Crack growth mechanism*
a Fiber fracture
b Fiber pull-out
c Crack bridging
d Matrix deformation.

Fig. 4: *Roll damage due to deposits.*

Fig. 5: *Mechanical overload due to deposits. Thickness of deposit*
- *200 µm*
- *100 µm*
- *70 µm*

Fig. 6: *Loss factor tan delta for various calender roll covers.*


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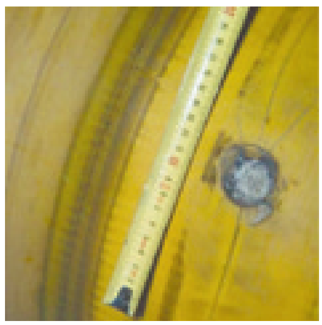
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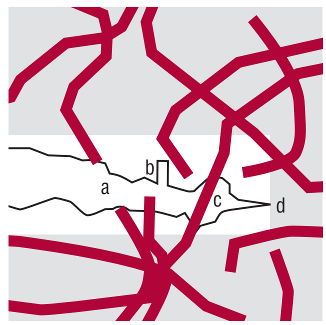

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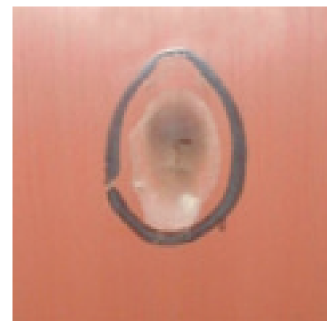
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the temperature rise causes cover expansion mainly in the radial direction. This process is repeated with every nip pass. The sum effect of periodic overloading and thermal expansion is a self-energizing cycle, which even might continue after the initial pulse due to roll deposits ceases.

On high-speed calenders, this effect can lead within minutes to hot-spot burning of polymer covers **(Fig. 4)**.

With heavy deposits or edge overloading, even the latest cover materials cannot stand up to this self-energizing effect **(Fig. 5)**. However, they are considerably more resistant to smaller nip fluctuations such as in pressure or temperature. The amount of deformation energy converted into heat during each nip pass depends on the material properties **(Fig. 6)**.

Critical for this is the none-dimensional "tan δ" parameter, which can be influenced by an appropriate molecular structure, as well as by interaction between the polymer matrix and fillers or fibres.

By optimizing the material composition, heat generation in the Rubin™ and Safir™ covers was nearly halved. As a result, the damage caused by these effects has been greatly reduced.

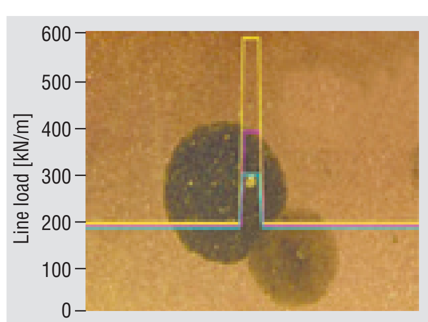
Surface quality of polymer covers

The outstanding feature of cast covers is their extremely homogeneous and smooth surface. To attain such quality with fibre-reinforced covers, enormous technological and development effort is required. It was found that roll cover service life could only be optimized by compromising with surface quality. For this reason, Voith Paper roll covers have been optimized in two directions.

Rubin™ covers were optimized for use with coated papers **(Fig. 7)**, where the smoothest possible surface is required. This was attained by particularly fine fillers distribution but with a reduced fillers quantity.

The resultant hardness is somewhat lower, i.e. 90 Shore D, thus compromising abrasion resistance and therefore service life to a certain extent **(Fig. 8)**.

Rubin™ covers are ideal for calendering grades where the most important requirement is high gloss.



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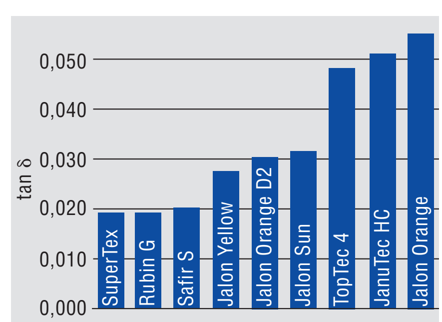

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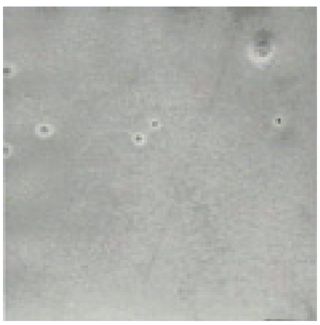
Fig. 7: *Coated paper surface.*

Fig. 8: *Fillers distribution in Rubin™ G cover.*

Fig. 9: *SC paper surface.*

Fig. 10: *Fillers distribution in Safir S cover.*



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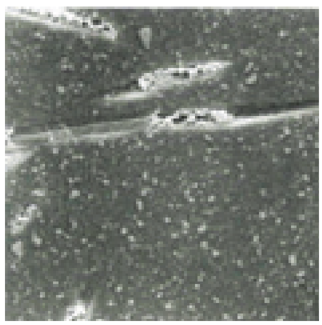

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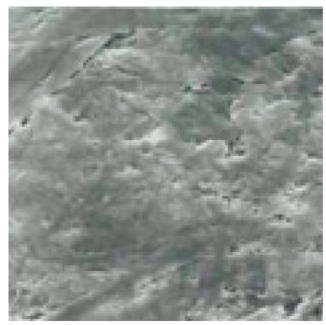

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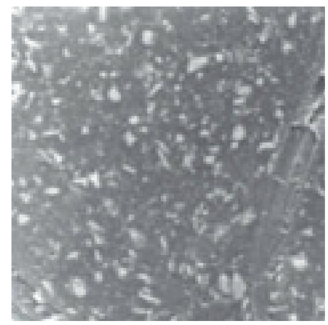

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On the other hand, for magazine papers in particular **(Fig. 9)**, roll covers with high availability and service life are indispensable for cost-effective paper machine operation.

Safir™ covers are therefore optimized for best possible resistance to abrasion, which makes them particularly proof against barring. The very hard fillers used to this purpose result in a cover surface hardness of 92 Shore D **(Fig. 10)**.

Due to these outstanding qualities, Safir™ roll covers are the most frequently used in multi-nip calenders.

Isolated cases of mechanical overloading often occur in practice. In contrast to the continuous dynamic overloading described above, which causes hot-spot damage due to heat development, sporadic mechanical overloading can cause damage which may take weeks to develop due to high cover elasticity.

Until recently, this kind of damage mechanism was not known in detail. To analyze the material stresses caused by such overloading, a finite-element simulation model was developed which reproduces the nip mechanisms very realistically within certain limits.

On the hard steel roll of a nip with polymer-covered counter-roll, a surface deposit was modelled **(Fig. 11)**. In the dynamic simulation model, this represents a foreign material accidentally passing through the nip.

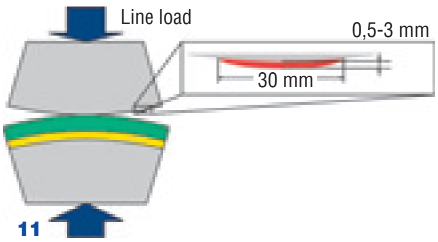
Simulation results revealed mechanical stresses and strains due to deformation caused by the surface deposit. To get results quickly, simulation was subject to the following limitations as against reality:

- Linear stress-strain characteristic assumed for the polymer cover material
- Surface deposit material characteristics assumed the same as steel
- Deformation of the steel roll not taken into account
- Prestressing of the reference model not taken into account

Despite these limitations, the simulation reproduces relatively well the physical processes taking place when a foreign material passes through the nip.

Results

● In the first simulation a line load of 550 kN/m was assumed as roll loading. As the surface deposit passed through the nip, simulation showed that beyond a certain pressure due to the roll mass and inertia, the nip opened, and the resultant stresses in the cover corresponded approximately to those which would occur at ten times the line load. This is roughly the same as the conditions occurring in single-nip calenders or with the top and bottom rolls in multi-nip calenders. The same behaviour has been observed on test calenders, where the intermediate rolls can evade due to their relatively low mass.



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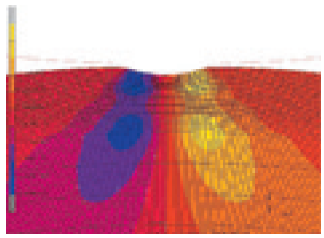

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Fig. 11: *Finite element method (FEM) simulation model design Line load.*

Fig. 12: *Compressive stress as a function of deformation.*

Fig. 13: *Shear stress in the tangential direction with 3 mm deformation.*

Fig. 14: *Operating experience with calender roll covers in a number of Janus™ calenders.*
- *Normal [%]*
- *Damage [%]*
- *Barring [%]*

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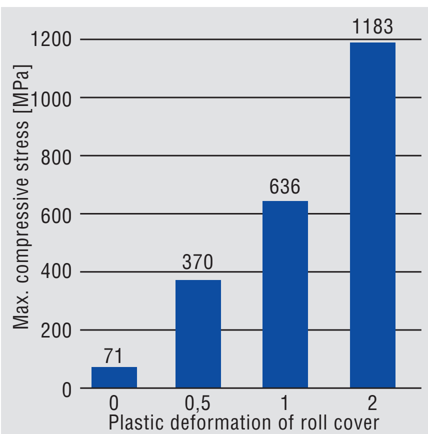

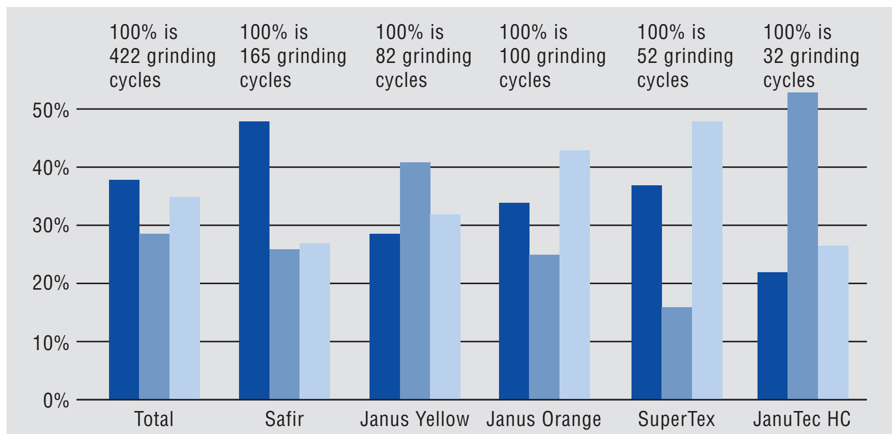

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In practice, however, the very heavy intermediate rolls of multi-nip calenders cannot deflect so easily. The simulation model was, therefore, adjusted by locking-in the roll centres accordingly. Due to the resultant deformation, this revised model revealed significantly higher stresses than the previous one.

● Surprisingly, the comparatively high deformation rates when a foreign material passes through the nip at 1,500 m/min, seemed to have relatively little effect. The reason is that despite the high peripheral speed, the deformation rate is still well below the sonic velocity in the polymer cover material, so that the shock waves, which can cause serious damage at unexpected points, do not occur in the simulation model.

The only identifiable effect in the dynamic simulation model is slightly asymmetric stresses in the nip as the surface deposit passes through.

● Since linear material parameters are assumed in the model, the resultant stresses are, of course, a linear function of the surface deposit thickness. They reach the equivalent of the stresses occurring at about 50 times the line load **(Fig. 12)**.
Already at relatively small deformations of only 0.5 mm, peak shear stresses exceeding the material strength occur in the cover cross-section **(Fig. 13)**.

● Secondary peak shear stresses occur tangentially in the transition zone between the cover and the metal core. These secondary peak stresses are due to the different Young's moduli of the cover and metal core materials, and can critically affect bonding of the cover to the core. In practice, this is often where damage due to mechanical overload first occurs. Such damage to the bonding layer is not immediately critical, but due to dynamic loading during ongoing roll operation it can spread until the cover is destroyed in the end. Since final destruction may not occur until some weeks afterwards, troubleshooting can be a very difficult task.

Ultrasonic inspection is a well-proven way of detecting damage due to mechanical deformation. It shows up any damage at a relatively early stage, thus avoiding further damage due to cover bursting and flying particles.

Summary and conclusions

All in all, there has been a significant reduction of damage to soft roll covers **(Fig. 14)**.

The type of damage has also changed. Barring is the most frequent reason for roll replacement, with mechanical damage in second place. Safir™ covers offer better running behaviour and longer grinding intervals than any other synthetic cover currently on the market.

CeraCal™ – Optimized high-performance coating for hard calender rolls

1

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The ongoing trend toward faster calenders, increasingly online, is bringing extreme demands on hot calender rolls. For high quality paper production, they have to ensure for months at time a high degree of smoothness without any appreciable contour deviations. As mentioned in an other article there are efforts under way to meet these requirements by perfecting electrolytic chromium plating methods. Due to the vulnerability of chromium to scratching, however, this approach is not very promising. That is why Voith Paper Service is focusing instead on the development of suitable spray coating.

Tailored thermal spray coatings for hot rolls

Thermal surface coating by plasma spray has been coming into greater use for some time now. Powdered composite materials are sprayed thereby onto the component with high kinetic and thermal energy, as shown in **Fig. 1**.

The hard carbide and boride materials used are embedded in various kinds of metallic matrix.

Depending on the materials used and the respective spray process, surface hardnesses of 1,500 HV or more can be attained. However, hardness is not necessarily a measure of wear resistance.

Fig. 1: *CeraCal™ spray-coating application.*

Fig. 2: *Microsection through a CeraCal™ coating layer, scale 1,000 : 1.*

Fig. 3: *CeraCal™ carbide particles in the µm range.*

Fig. 4: *Another type of coating, showing white oxidation seams around the carbide grains due to overheating.*

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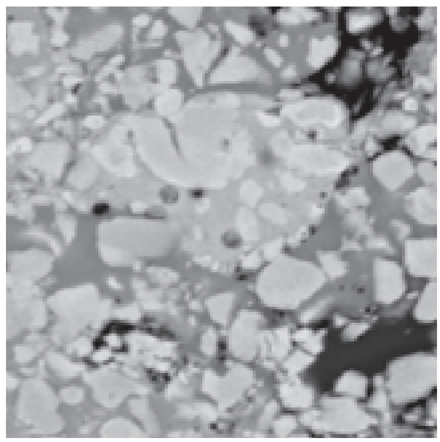

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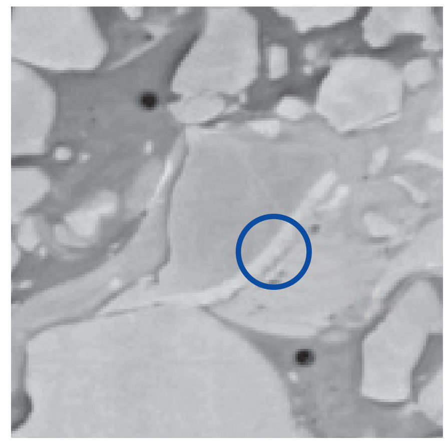

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More important for long service life is a coherent and well-bonded surface layer which is not too brittle.

The question has arisen as to whether multiphase surface coatings automatically roughen faster than chromium plated surfaces due to lack of homogeneity, thus causing a faster decline in paper quality. As proved by the latest developments in this field – for example the CeraCal™ system – the opposite is true. The main goal in developing this optimized coating system for hard calender rolls was to identify a materials and process combination perfectly matching requirements.

CeraCal™ – for the toughest demands

CeraCal™ hard-metal thermal spray coatings are applied by the High Velocity Oxygen Fuel (HVOF) method, using an encapsulated combustion chamber. This enables pressures of 12 bar or more for adding the necessary kinetic energy component to the thermal input. Moreover, by selecting an appropriate combustion medium, overheating of the carbide surfacing material is prevented by keeping the temperature below 500°C. Another advantage by comparison with the detonation method is that the HVOF process works continuously rather than intermittently, thus building up an extremely homogeneous surface layer **(Fig. 2)**.

The spray coating powder comprises spheroidal carbide pressed into a metallic carrier matrix. These spherical carbide particles ideally bond into the metal, while at the same time the matrix metal component is reduced. Surface roughening due to breakaway or erosion of the hard coating material during operation is thus prevented. The low metallic content reduces the risk of chemical corrosion separating out the carbide, which would also lead to premature roughening. This well-flowing powder material is sprayed by the HVOF nozzle on to the roll surface in layers. The particles reach velocities of 700 m/s or more and form a coating with a bond strength of more than 100 MPa and a hardness around 1,250 HV.

The roll surface can then be superfinished to Ra-roughness values of less than 0.03 µm, with negligible contour deviations (<8 µm over a working width of 9 m).

The effectiveness of this method is shown by electron scan microscope view comparisons of a CeraCal™ coating **(Fig. 3)** with another type of coating on the market **(Fig. 4)**. The carbide particles in the CeraCal™ coating are firmly embedded in the matrix, while the much larger carbide particles of the other coating show white seams. These white eta-phase seams are caused by peripheral carbon deficiency due to overheating. They weaken bonding and resistance to chemical corrosion. The CeraCal™ coating system avoids this problem by limiting the heat input.

Performance in practice

The CeraCal™ hard roll coating system is suitable for all types of calender, both with hard-soft and hard-hard nips. Good results have been obtained in hard-soft nips at line loads up to 550 kN/m and oil feed temperatures up to 270 °C, with roll heating by steamboxes or external Cal-Coils. Doctor blades can be used without problem, but metal blades must be avoided. We recommend doctor blades made of carbon fibre composite with heat resistant bonding resin.

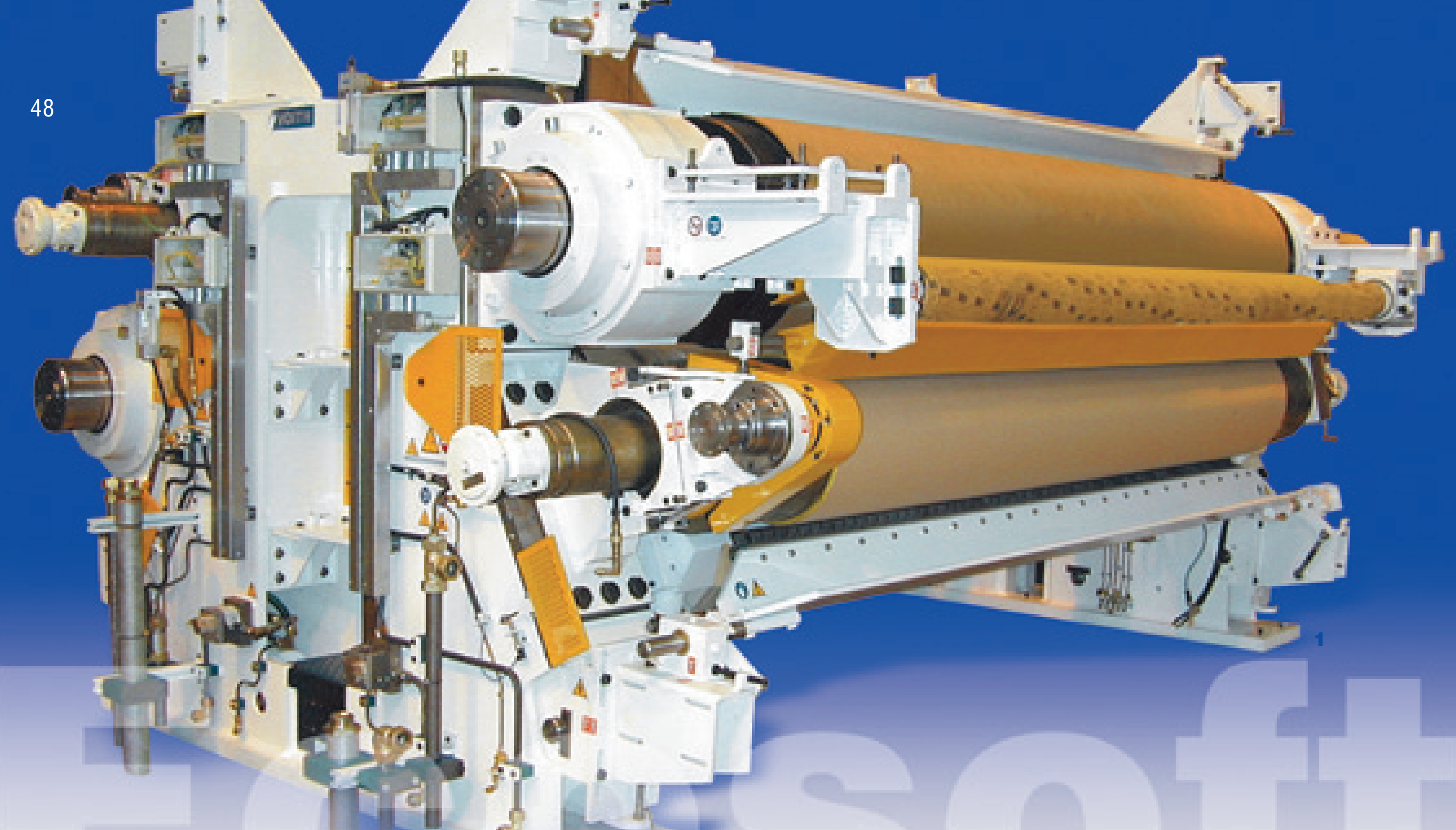
Users report very positive results with CeraCal™ coatings, as shown by the following examples:

- A producer of coated grades with high basis weights uses this type of coating in both calender stacks at 360 kN/m and 240 °C roll surface temperature. After operating for 2.5 years, the first CeraCal™ coating still shows the original surface roughness of Ra 0.04 µm.
- After more than 4,500 operating hours at 390 kN/m and about 1,160 m/min web speed, the producer of online-calendered SC-B grades measured an Ra-roughness of 0.12 µm on the CeraCal™ coating. Rolls in similar usage, but surfaced with another type of coating, had to be replaced after reaching the maximum roughness limit of Ra > 0.3 µm in less than 2,000 hours.
- LWC paper causes step-wise wear on hard supercalender rolls due to high pressure at the web edges. Based on good experience with HVOF coatings, this customer wanted to reduce surface wear to less than 40 µm in diameter per year. After two years of operation with CeraCal™ coating, annual wear is less than 30 µm.
- After installing a CeraCal™-surfaced thermo roll, a manufacturer of 50-70 g/m^2 coated paper for food packaging has been able to reduce line load by 7% and roll temperature by 10%. Product smoothness is, nevertheless, 1.5 times higher, with a gloss increase of 2 points.
- An SC-A producer coated his No. 3 water-heated supercalender roll with CeraCal™ process, and after six months of undoctored operation found, that with unchanged surface roughness of Ra 0.12 µm, product quality was identical to that with a chromium coating. He therefore decided to equip his new Janus MK 2 calender entirely with CeraCal™-coated thermo rolls.

As shown by these five examples, considerable progress has now been made in optimizing the surface coating of heated rolls. Results are no longer limited by the multiphase characteristics of thermal spray coatings. If the respective parameters are correctly adjusted, thermal spray coatings not only meet all specific requirements for hard calender rolls, but deteriorate far less than chromium plated rolls while producing quality results as least as good. Furthermore, the vulnerability of chromium surfaces to doctoring does not apply at all to CeraCal™ coatings.

Prospects

Further development work to optimize the various parameters influencing this process will also take into account the cost-benefit aspect. Field trials are currently underway with CeraCal™ coatings incorporating even finer carbide particles. If these trials with extremely demanding applications confirm the significantly longer service life expected, a favourable cost/benefit ratio will result despite the additional costs involved.



The Ecosoft™ calender family and its newest member, the Ecosoft™ Delta

Nick Dodd

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Guido Royla

Voith Paper
Krefeld, Germany

Online soft or hard calendering is a long-established procedure in papermaking. This article reports on the state of technology for both types of machine, as well as the new Ecosoft™ Delta calender developed from the successful Janus™ MK 2 concept.

Ecosoft™ calenders cover almost all requirements for online calendering, including the following grades:

- SC-B
- Newsprint
- Copying papers
- Coated papers
- Board
- Speciality grades.

The nip in a soft (compact) calender is formed between a soft-covered deflection compensation roll (Econip™, Nipco™ or Nipcorect™) and a Flexitherm™ roll. Depending on requirements, soft calenders primarily have two different layouts: 1x2 or 2x2. The 1x3 and 2x3 versions are also available but are not covered in detail in this article.

Voith Paper supplies custom built Ecosoft™ calenders for the entire range of applications – from lab calenders with 0.5 m web width to production calenders of 10.8 m width and with speeds of up to 2,200 m/min. Since such a wide range clearly cannot be covered by a single machine concept, there are three types of Ecosoft™ calenders:

- Ecosoft™ Modular
- Ecosoft™ Delta
- Ecosoft™ U.

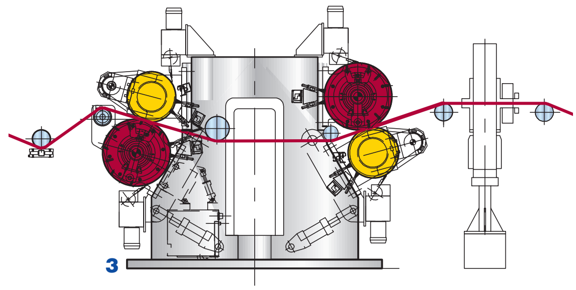

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Fig. 1: *Shop assembly of an Ecosoft™ Modular calender.*

Fig. 2: *Ecosoft™ calender applications.*

Fig. 3: *Ecosoft™ Modular layout.*

Fig. 4: *Ecosoft™ Modular design data.*

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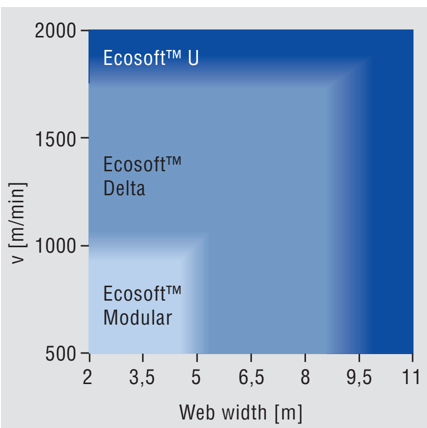

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Calender size	Web width range (mm)	Maximum operating speed	Maximum nip load	Maximum operating temperature
ECO 1.1	1,350-2,150	800 m/min	200 N/mm	200 °C
ECO 1.2	1,600-2,400	800 m/min	235 N/mm	200 °C
ECO 2.1	1,750-2,750	800 m/min	260 N/mm	200 °C
ECO 2.2	2,000-3,000	800 m/min	260 N/mm	200 °C
ECO 3.1	2,250-3,250	800 m/min	290 N/mm	200 °C
ECO 3.2	2,500-3,500	800 m/min	300 N/mm	200 °C
ECO 4.1	2,750-3,750	800 m/min	310 N/mm	200 °C
ECO 4.2	3,000-4,000	800 m/min	325 N/mm	200 °C
ECO 5.1	3,250-4,250	800 m/min	330 N/mm	200 °C
ECO 5.2	3,500-4,500	800 m/min	350 N/mm	200 °C
ECO 6.1	3,800-4,800	1,000 m/min	315 N/mm	200 °C
ECO 6.2	4,100-5,100	1,000 m/min	335 N/mm	200 °C

Each calender type has a defined application range; however, there is a certain amount of overlapping **(Fig. 2)**.

Each Ecosoft™ calender version has its own special features:

Ecosoft™ Modular

Based on the ongoing success of Ecosoft™ calenders, with more than 200 in service worldwide, the Ecosoft™ modular concept was developed. Since this concept was launched in the late nineties, over 20 of these machines have been sold **(Figs. 1 and 3)**. Most paper grades benefit from this calender concept, covering the more economical line in Voith Paper Finishing's calendering technology.

Recent Ecosoft™ Modular calender installations are as follows:

Milliani/Italy
2x2 3,100 mm 100 m/min
Security papers

Century Papers/Pakistan
1x2 2,000 mm 400 m/min
Coated board

Linan Jianjang/China
2x2 4,320 mm 800 m/min
Newsprint

Papier De Vizille/France
2x2 2,850 mm 600 m/min
Writing and printing papers

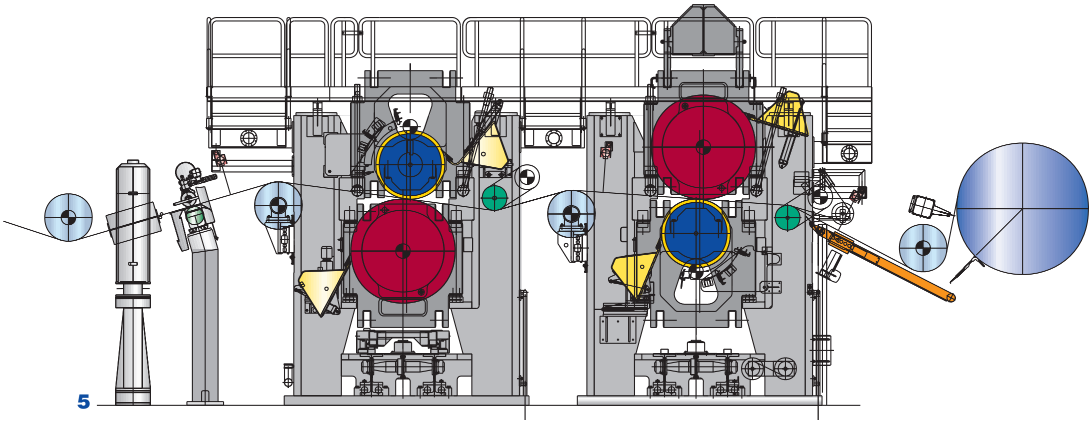
Gloria/Peru
1x2 3,300 mm 300 m/min
Linerboard

The Ecosoft™ Modular concept uses standard elements for all machine sizes. Not only does this shorten delivery times, but it also ensures optimal cost-effectiveness with well-proven technology. This modular system covers six calender sizes for web widths from 1.35 to 5.1 m. It was developed for maximum operating speeds up to 1,000 m/min, and particularly for integration in paper machine rebuilds **(Fig. 4)**.

Ecosoft™ Modular calenders generally use, as a standard, the proven Econip™-X roll, which, in combination with the heated roll, forms an excellent nip with minimal deviations in line force over the entire web width.

Both the 2-roll and 2x2-roll versions can be used throughout this modular system, thus enabling calendering on both sheet sides.

Pressure is applied by hydraulic cylinders underneath the bottom roll. All soft-calender functions are integrated in this modular system, such as temperature mon-



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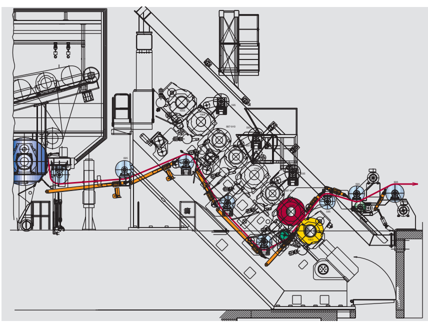

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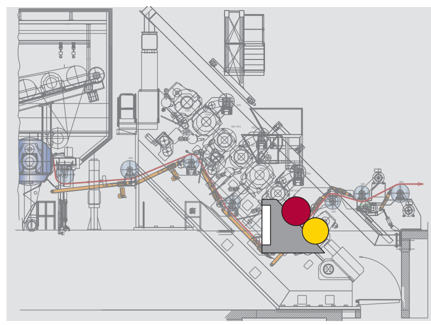

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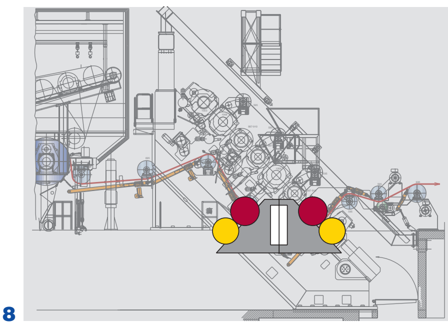

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itoring and roll edge cooling by the Softrol™ system, threading with open nip, etc.

Additional components can also be incorporated in the machine concept, such as steam moisturizers, external profiling equipment, or sheet threading systems. Despite the underlying idea of developing a standardized calender, this concept is also flexible enough to meet customized requirements.

In the future, Nipcorect™ rolls will also be used in Ecosoft™ Modular calenders, thus providing the option of optimal cross profile correction.

Ecosoft™ U

Particularly for today's wide, high-speed installations, this type of machine is the ideal solution. Our references speak for themselves (the following are only a few highlights):

Braviken PM 53/Sweden
2 x 2 8,950 mm 1,800 m/min
Newsprint

Dagang PM1+2/China
2 x 2 9,800 mm 1,700 m/min
Copy paper

Soporcel PM 2/Portugal
2 x 2 8,700 mm 1,500 m/min
Copy paper

Rheinpapier Hürth PM1/ Germany
1 x 2 8,200 mm 2,200 m/min
Newsprint

All these calenders are equipped with at least one Nipcorect™ roll for calliper-profiling. Their primary feature is a U-shaped frame for symmetrical force transmission **(Fig. 5)**.

The Ecosoft™ U design enables convenient removal of the bottom roll on a retraction rail, without having to remove the top roll.

Although a good idea, the U-frame arrangement may not be possible in some machine rooms due to the relatively wide aisle space required. This is where the latest development in the Ecosoft™ series comes into its own:

Ecosoft™ Delta

Based on the successfully established Janus™ MK 2 concept and well-tried Ecosoft™ family, a new frame type has been developed to round off this soft-calender range – the Delta frame.

This machine layout originated from the Janus™ MK 2 concept, and transferring the clearly proven advantages of this layout to the Ecosoft™ calender was only a matter of time.

Several Janus™ MK 2 installations allow single-nip operating mode in the bottom nip **(Fig. 6)**.

By singling out this nip from the Janus MK 2, the concept of the Delta frame is now easy to understand **(Fig. 7)**. In fact the layout of a 2 x 2-roll Ecosoft™ calender is simply the mirror image of its roll pairing **(Fig. 8)**.

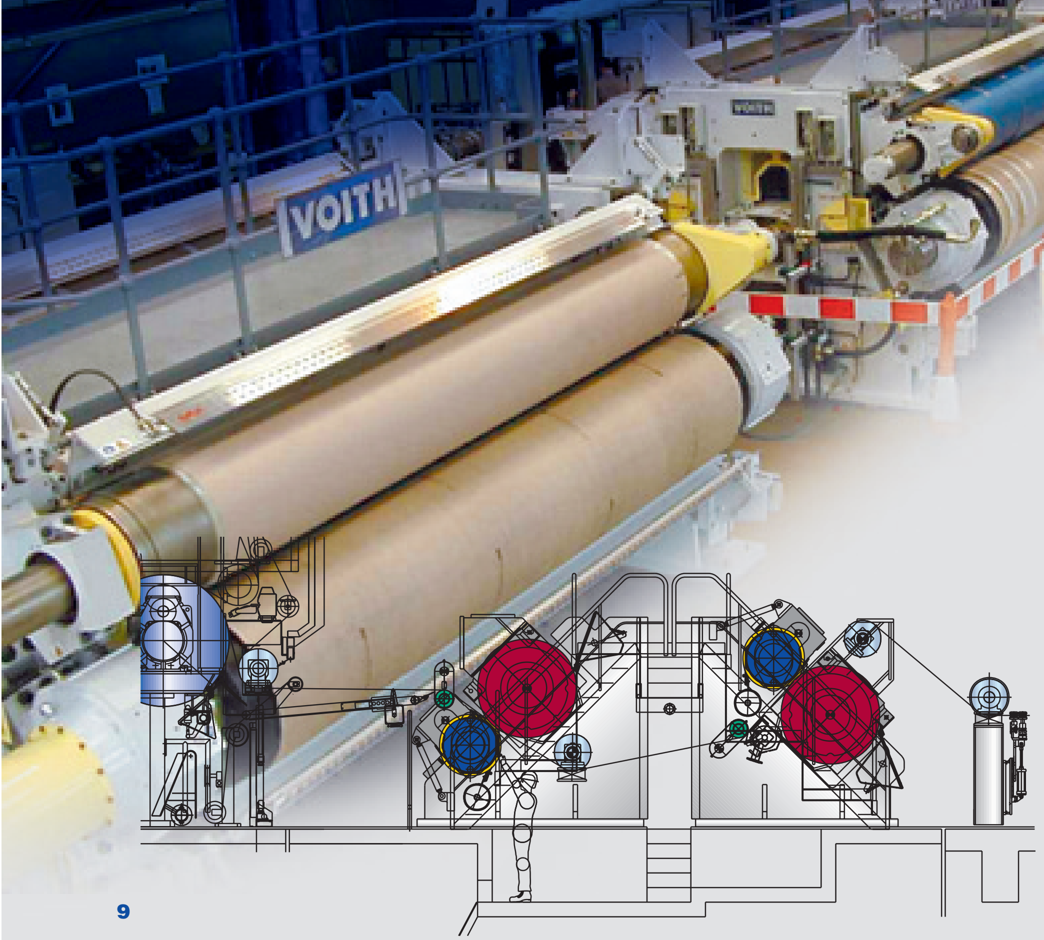

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Fig. 5: *Ecosoft™ U layout, 2 x 2 rolls.*

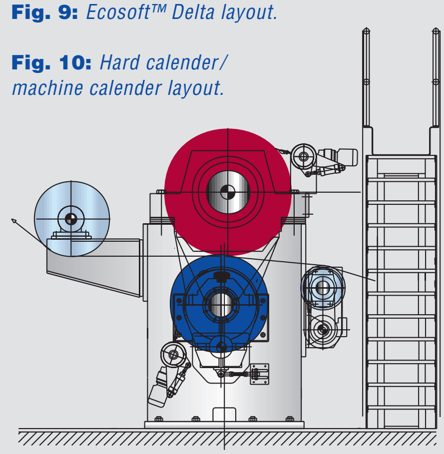
Fig. 6: *Janus™ layout, single nip bottom.*

Fig. 7: *Arrangement of Ecosoft™ Delta – 1 x 2.*

Fig. 8: *Arrangement of Ecosoft™ Delta – 2 x 2.*

Fig. 9: *Ecosoft™ Delta layout.*

Fig. 10: *Hard calender/ machine calender layout.*



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The key feature of the Ecosoft™ Delta layout is, therefore, the 45° arrangement of the calender rolls, as in the Janus™ MK 2 **(Fig. 9)**. Due to this layout, some of the biggest advantages of the Janus™ have been integrated in the Ecosoft™ Delta series:

- All components are well proven in practice
- Vibration-free frame design (wide foundation, low center of gravity of rolls)
- Increased correction potential (deflection due to roll mass is not in the nip direction)
- Easier roll change from the top
- Maintenance-friendly access
- Compact dimensions both in the machine and cross-machine directions.

Customer recognition of these benefits in practice has already been demonstrated by the first sale of such a unit, with the following operating data:

Web width:	6,490 mm
Speed:	1,800 m/min
Paper grade:	Newsprint.

Hardnip calenders/ machine calenders

One of the many applications for machine calenders is the online caliper profiling of LWC base paper.

Fig. 10 shows the typical layout of a hardnip calender, with the following features:

Based on a V-frame design, the nip is formed by two hard rolls.

The bottom roll is an Econip™, Nipco™ or Nipcorect™ roll with deflection compensation, while at the top is a Flexitherm™ chilled-cast iron heated roll. The Nipco™ roll not only maintains a constant nip, but also, to a certain extent, corrects long-wave caliper deviations. Finer caliper profiling is done by a Nipcorect™ roll.

Equipped in this way, the calender can efficiently optimize caliper profile in the cross-machine direction. Each roll has a separate drive. The tail is fed through the open nip, and the nip is then closed at full web width.

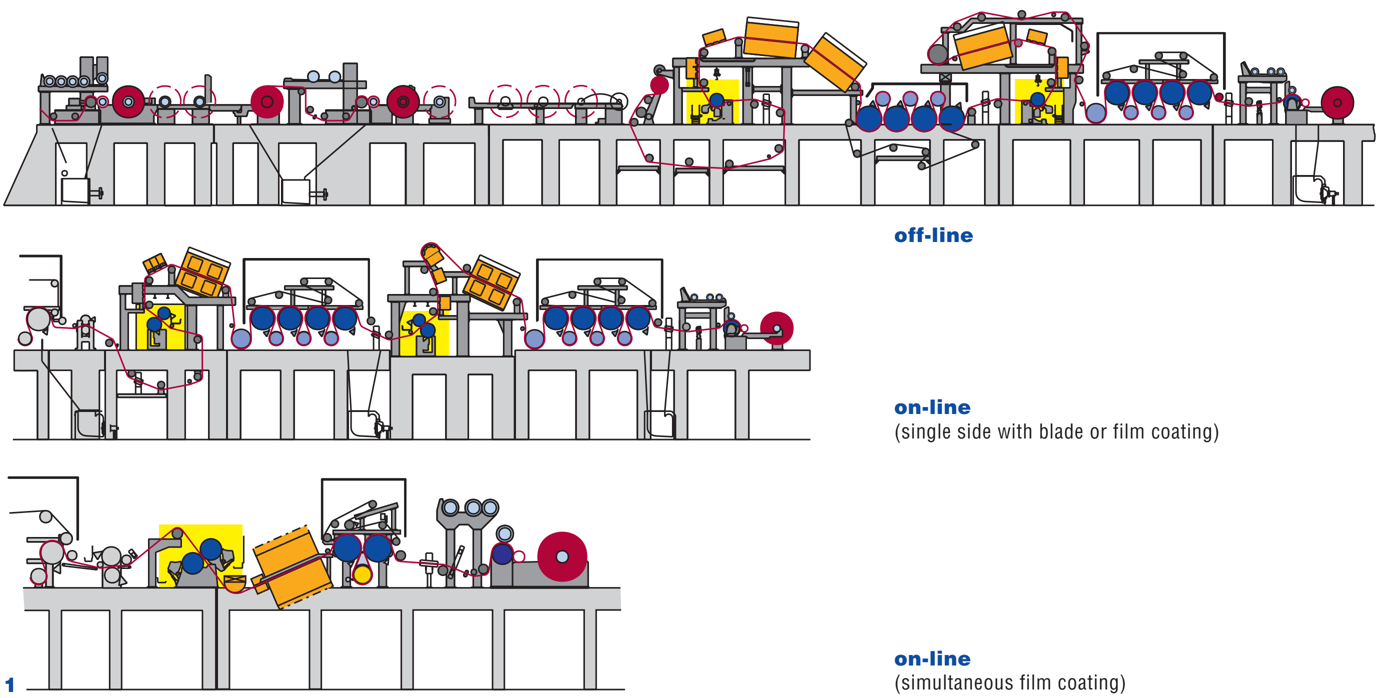
Both rolls are generally fitted with continuously operating doctors.

In the latest machine concepts, further components can be added according to requirements such as:

- Steam moisturizers to control curl
- Tail transfer systems for threading at the highest operating speeds
- Ionization systems to neutralize electrostatic charges after calendering.

For optimal caliper profile, the heated roll in these calenders operates at the web temperature, typically 60-120 °C, depending on application.

With the Ecosoft™ calender line, Voith Paper now covers all requirements for soft calendering, including customized machines for special applications. In our continued commitment for perfection, detailed development work will of course continue.



1

New concepts
for coated mechanical papers


Dr. Michael Trefz
Voith Paper
Heidenheim, Germany

Low paper prices and competition from improved supercalendered and coated woodfree paper are threatening the market position of coated mechanical grades (lightweight coated paper). Producers are under pressure to reduce their production costs while maintaining or improving the paper quality. This situation is the background for the development of new on-line concepts that provide maximum efficiency with greatly reduced costs for equipment. These concepts and their potential will be discussed in this paper.

Lightweight coated papers are best characterized by their basis weight range and quality figures. In general, they are produced from stone groundwood or TMP and include between 15% and 50% kraft fiber. They are used for offset and rotogravure printing, and the different print processes require certain differences in paper-making and finishing. The following table gives a survey of the typical product characteristics.

Machine concepts

Traditionally LWC papers are blade coated and supercalendered. Many of todays major production lines were installed in the 1980's and include a paper machine, an off-machine coater, re-reelers and two or three supercalenders.

Later in the 1980's, large machines with on-line coaters were built. It became at-

Fig. 1: *Development of coater concepts.*

Table 1: *Typical properties of LWC paper.*

Table 2: *Comparison of machine concepts.*

T1

Property	Unit	Offset	Roto
Basis weight	g/m^2	48-70	48-70
Gloss 75°	%	45-60	45-65
PPS-10S	µm	1.1-1.6	0.8-1.2
Bulk	cm^3/g	0.8-1.1	0.78-1.0
Brightness	%	66-72	66-72
Opacity	%	88-94	90-96

T2

	Concept A	Concept B	Concept C
Max. Speed (m/min)	1,700-1,800	1,600-1,800	1,600-1,800
Line Efficiency	75-85 %	73-84 %	75-85 %
Investment cost	100 %	70-75 %	60-64 %
Manpower req.	4	2	2
Quality aspects	Offset & Roto No limitations	Offset & Roto with blade Offset only with film	Offset only 10 g/m^2 max. coat weight

tractive to save all the investment and space for the re-reelers and the off-machine coater. As a trade-off, the overall efficiency of such a machine with online coaters was slightly reduced.

In the early 1990's, improvements in the application of hot soft calendering made it possible to develop the first LWC machines with both coating and calendering on-line. Another reduction of investment (no supercalenders) and an even more operational challenge came along. Machines like Port Alberni PM 5 and Ortviken PM 4 started in early 1996.

In the late 1990's, another milestone in calendering technique made it possible to consider multinip-calenders with polymer covers on-line. An even better quality can be produced with this new concept.

Fig. 1 and Table 2 show a general comparison of available machine concepts for coated mechanical grades.

Concept A is the conventional off-line blade coater with a re-reeler between paper machine and coater. Concept B is the on-line coating section within the paper machine. Concept C is also an on-line coating section, but with only one coater station for simultaneous coating of both sides of the paper. The coating section for concept A (off-line) requires roughly double the space as concept B (on-line). Most of the additional space is needed for reel transport from the PM to the re-reeler, the re-reeler itself and the unwind for the off-line coater. The significant difference in price is mainly influenced by the additional equipment such as three reels instead of one, continuous unwind with flying splice, more reel spools, parent reel transportation carts.

The difference between concepts B and C is the number of coating stations. In concept C, the coating is applied simultaneously to both sides of the sheet with a premetered film coater. Having only one coater station instead of two provides another reduction of investment costs. The efficiency is in the same range as with concept B. However, there are certain trade-offs coming with the film coating technique as well as with the simultaneous application that will be discussed in the next chapter. The comparison of the concepts A to C is summarized in **Table 2**.

It is shown in **Table 2**, that the significant differences are the investment costs and the number of operators needed.

Concept C with only one coater station on-line is the most economical production line for coated mechanical grades as long as only offset paper is produced. It is still not possible to produce the smooth surface needed for rotogravure printing with the film coating technique. The advantages and limitations of film coating are discussed in the following chapter.

Potential and limitations of the new concept

A major breakthrough for coated mechanical paper was the rapid development of the film coating technique in the early 1990's. Advances in equipment and – more important in coating color formulations – made it possible to produce film coated LWC paper for offset printing with a quality according to **Table 1**.

The driving force for this development was the fact that film coating imposes much less stress on the paper during the coating process. While the blade is a perfect digital hole detector – each hole causes a break – film coaters promise a greatly increased efficiency. The reduced paper stress allows also to reduce the

Fig. 2: *Principle difference between film and blade coating.*

Fig. 3: *Max. possible speeds and coat weights for film and blade coating.*

Fig. 4: *Gloss and roughness values for coated mechanical gardes.*

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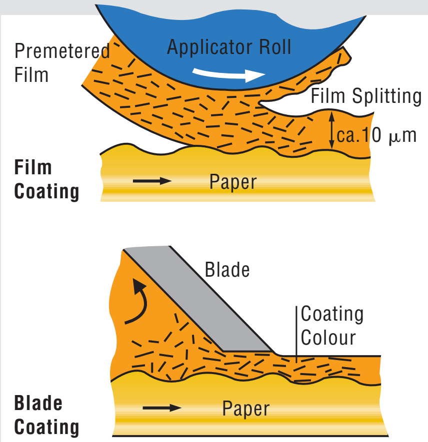

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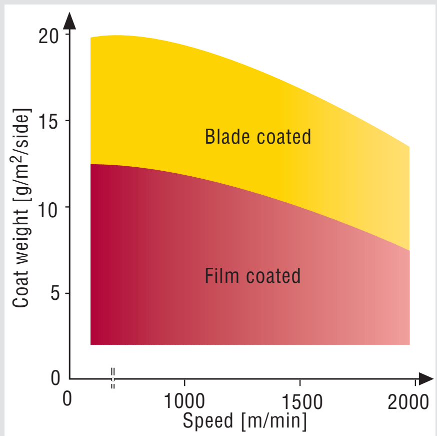

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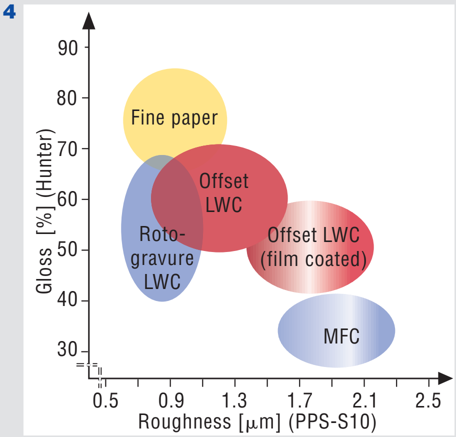

amount of kraft fiber from a level between 40% to 50% down to somewhere around 20% and below. This fundamental difference is also a major contribution to any return-on-investment calculation.

The advantage, however, comes at a certain price. With maximum possible paper machine speeds reaching 2,000 m/min, film coating requires careful optimization of both the base paper properties and the coating color formulation. The reason is shown in **Fig. 2**: While the blade more or less levels the surface topography of the sheet, film coating applies a film of color with a constant thickness of 10 to 15 microns onto the paper. It is obvious that a rough base paper will be rough after coating. Also the two-sidedness is much more difficult to compensate with film coating and should be avoided as much as possible by carefully designing the wetend of the paper machine.

The major challenge for the quality is the film splitting effect. The elongational forces at the nip opening cause a disturbance in the alignement of the mineral pigments on the sheet surface. This is the reason why it is generally more difficult to reach similar gloss and smoothness levels as with blade coating. This problem is solved by using very glossy clay pigments and also some plastic pigment to enhance the final sheet quality.

Another aspect to be considered is the misting of color droplets created in the outgoing side of the nip at high speeds and high coat weights. These effects limit the film coating technique today to the areas shown in **Fig. 3**. There should not be a problem for coat weights of 8 g/m^2 and speeds up to 1,800 m/min. But beyond that, careful optimization and adaption of the coating color to the base paper is mandatory.

Finally, the use of film coating for lightweight coated paper was made possible by new calendering techniques. While conventional blade coated paper produced with machines from the 1980's is finished with supercalenders, newer machines are equiped with hot soft calenders or multinip calenders with polymer covers that allow high surface temperatures. The changes in the calendering technique, which is primarily an increase in steel roll temperature, new polymer covers, and the development of heat sensitive coating color components such as plastic pigment made it much easier to reach satisfactory gloss levels.

A more detailed analysis of the quality potential is shown in **Fig. 4**.

Film coated LWC can be produced with surface roughness between 1.3 µm and 2.0 µm PPS, depending on the base paper roughness and the calender configuration. As it is shown in **Fig. 4**, blade coated and film coated LWC qualities overlap in the area around 1.3 to 1.6 µm PPS. Gloss levels are almost equal.

A medium quality blade coated paper is as good as a premium film coated one. This requires a coat weight of 10 g/m^2 per side. Although film coating has some of the above discussed limitations with regard to speed, coat weigths around 8 g/m^2 are possible at 1,800 m/min.

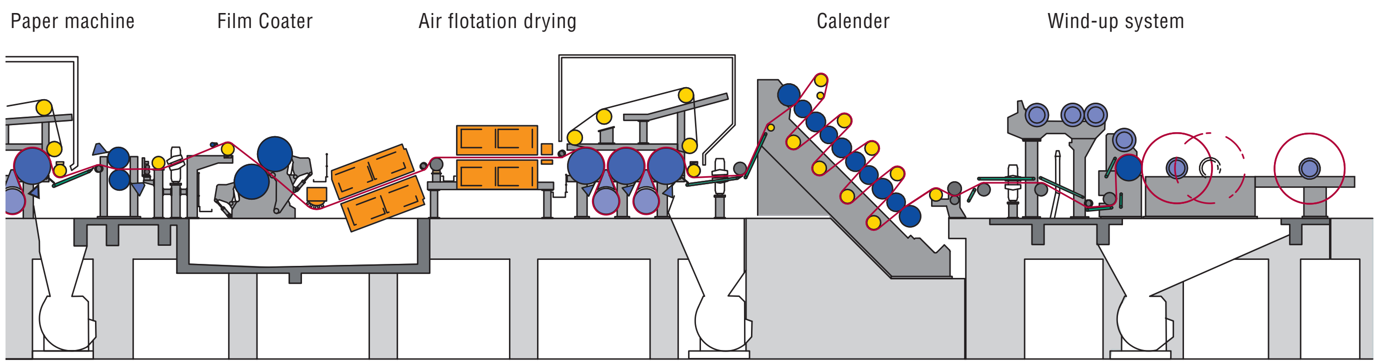

Fig. 5: *Modern machine layout for light-weight coated grades with simultaneous film coating and online calender, design speed 1,800 m/min.*

Practical aspects

Film coated LWC with on-line calendering is produced since 1996. The first two machines are using two separate film coating stations and hot soft calenders.

Main reasons to go for this concept was the advantage of independent control of coat weight, coat weight profile and sheet release with single-sided application.

The investment costs for the coating section, however, is about 30% higher compared with only one film coater for simultaneous application. This was one motivation to further develop the most economic machine layout as it is shown in **Fig. 5**.

In this layout, the coating color is applied simultaneously with a film coating station. As the sheet is coated with 8 to 10 g/m^2 per side, a contactless sheet run into a drying section is required. The first contact of the sheet with a roll surface should be at a point where the color is dryed beyond the immobilization point.

Otherwise color build-up on guide rolls would damage the sheet surface. The standard element for a contactless drying section is an air turn to guide the sheet into the required direction. The air turn is typically followed by an air flotation dryer to evaporate the water. Since there is only little danger of print mottle with lightweight coated grades (and coat weights below 10 g/m^2), the evaporation rates can be chosen higher than in fine paper coating.

Other than in earlier installations, there are no more hot soft calenders used. They are being replaced by new developed multinip calenders with polymer covers and steel roll temperatures between 120° and 140°C.

The lower temperature is a major operational advantage over the hot soft calender, and technologically it is compensated by the number of nips that produce the critical surface roughness. Spacewise there is no significant difference between both calender concepts.

By middle of 2000, the first machines with this concept started up in Germany and Switzerland. Compared to the conventional concept with the off-machine coater and the supercalenders, the investment costs are dramatically reduced (about 36% to 40% less, according to **Table 2**).

On the other hand, a very high degree in automation is required to keep the line efficiency around the 80% value.

The quality will fit into the typical range for light weight coated offset papers. A good example how development of new techniques such as film coating and multinip calendering dramatically decreases the investment costs while the quality is maintained. The new concept is a suitable upgrade for older newsprint or uncoated mechanical machines.

The new PM 4 at Perlen Papier in Switzerland to a similar concept as shown in **Fig. 5** is a perfect example for that. The completely new machine that replaces an old newsprint machine started up in the summer of 2000.

1

The DF coater –
Coating technology of the new generation

Hirofumi Morita
Voith IHI Paper Technology Co., Ltd., Tokyo, Japan

This article introduces the DF (Direct Fountain) curtain coater developed by Voith IHI Paper Technology. The DF coater is a relatively uncomplicated coating system with many advantages such as user friendliness, high quality of coated surface and high production efficiency. Twenty DF coaters are already in service worldwide, with widths up to 5 m and operating speeds up to 1,200 m/min, which corresponds to a maximum design speed of 1,500 m/min. The maximum design and production width currently possible is 10 m. A maximum speed of 1,800 m/min was successfully attained with the pilot coater. Voith IHI is convinced that the DF coater will be used much more for producing various coated paper grades in the near future.

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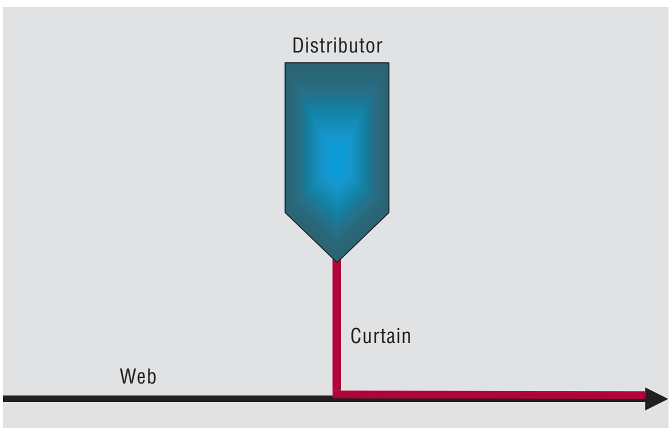

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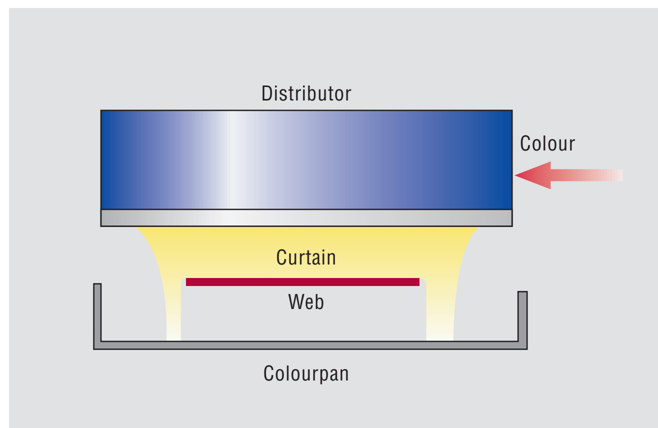

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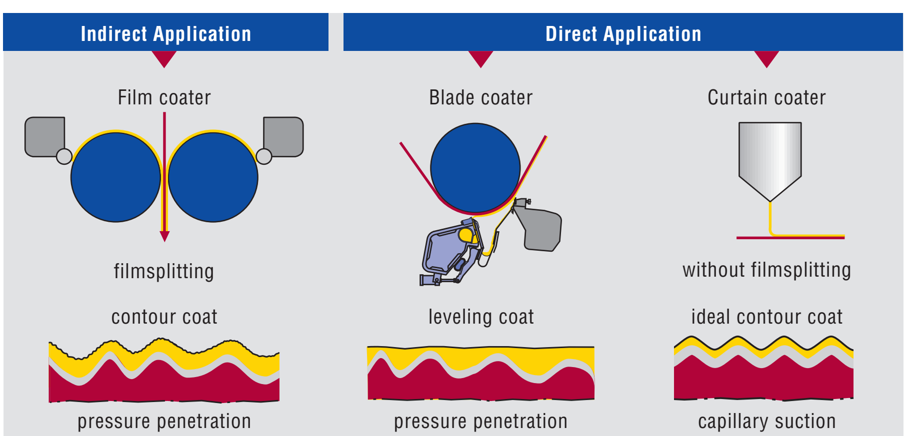


Fig. 1: *Curtain coater.*

Fig. 2: *DF coating system.*

Fig. 3: *Cross-sectional view of the DF coating process.*

Fig. 4: *Basic coating technology.*

Curtain coating **(Figs. 1 and 2)** is a relatively new process with very high efficiency, good coating quality, easy operation, cleanliness, etc. So far, this type of coater was hardly used in paper production, because of difficulties in controlling the air boundary layer on the web, coating color deaeration and curtain stability.

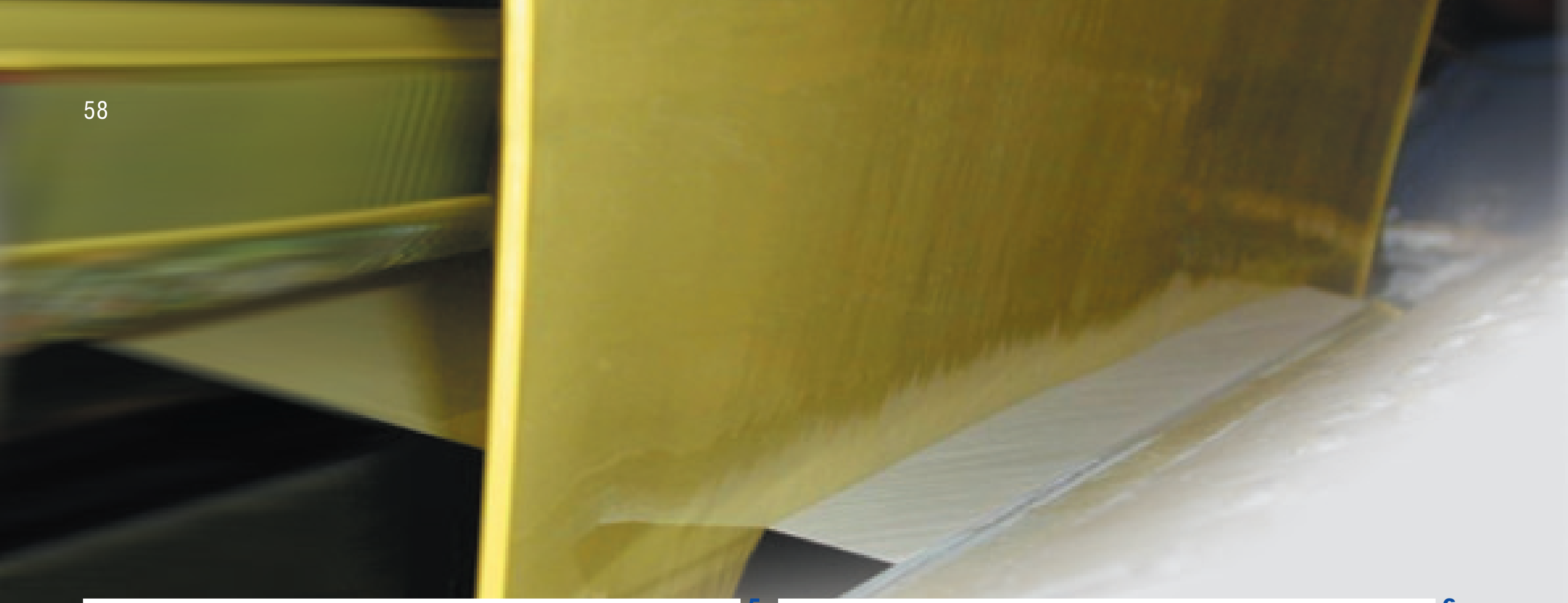
Voith IHI has solved these issues and made curtain coating market-ready. This is reflected by the excellent operation and dependability of the 20 DF coaters now in operation around the world.

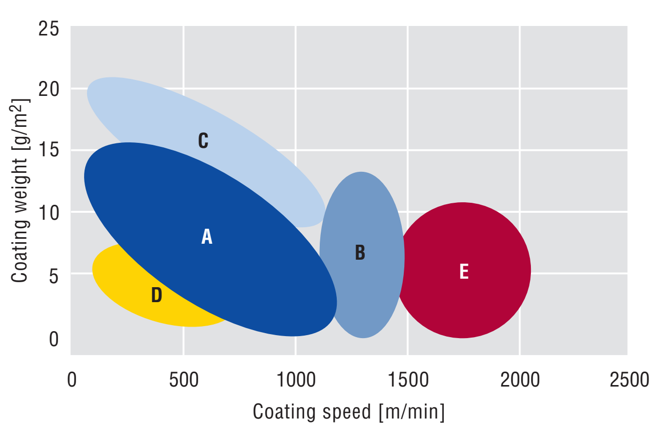
The DF coating process

(Fig. 3)

The deaerated coating color, supplied to the distributor (curtain head), flows smoothly downward to the nozzle, where it is evenly applied to the moving web. The velocity of the curtain film flowing out of the nozzle slot is accelerated due to gravity. When it impinges on the web, the curtain film is further accelerated and stretched. As a result, ideal coating quality is attained.

With this coating method no metering element is required after application, thus enabling a very even coating profile and uniform coat weight and very stable coat weight adjustment.





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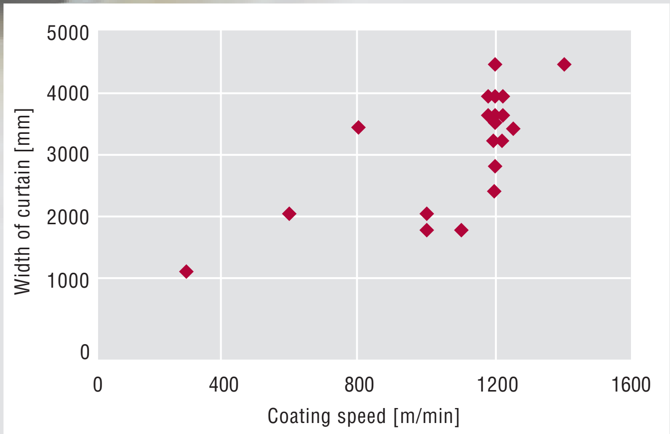

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Coating method comparison

Fig. 4 shows a comparison with the main coating methods currently used, i.e. blade coating and film coating.

Curtain coating and film coating are premetering processes, where coating color dosage is defined prior to application.

With the blade coating method, the coating color is not metered until after application.

Since curtain coating is a pre-metering method, a very even coated surface can be achieved irrespective of web surface condition.

In the case of blade coating, penetration of coating color into the web is caused by blade load and the large amount of color during dwell time.

With film coating, penetration is also high due to the nip pressure applied by the rolls. In a comparison with other coating methods, curtain coating results in a more even thickness of coating film, and much less color penetration since only capillary action is involved. This is why the curtain method results in ideal contour coating.

Operating requirements and limits for the Direct Fountain Coater

For stable operation of the DF coater, the following conditions are required.

- Stable curtain film from the distributor
- Suitable coating color which spreads out evenly after impinging on the web.

These requirements are met by appropriate mechanical performance and rheological characteristics of the coating color.

- Mechanical condition: optimal shape of distributor, stable color supply system, efficient boundary air layer removal device
- Coating color: spreadable coating color, no air bubbles, appropriate viscosity range.

The operating windows **(Fig. 5)** of the DF coater are significantly influenced by the rheological characteristics of the coating color, however, the general limits are as shown below:

- Window A: most suitable range
- Window B: potential range depending on rheological characteristics
- Window C: potential range with changing coating parameters
- Window D: potential range in case of relatively low solid content of coating color.
- Window E: potential range requiring mechanical improvement and coating color enhancement.

Fig. 5: *Operating limits of the DF coater.*

Fig. 6: *DF coater references at the present time. Maximum width currently: 5,000 mm. Total units in service: 20.*

Fig. 7: *Double coating by single DF in tandem.*

Fig. 8: *Double coating by twin DF.*

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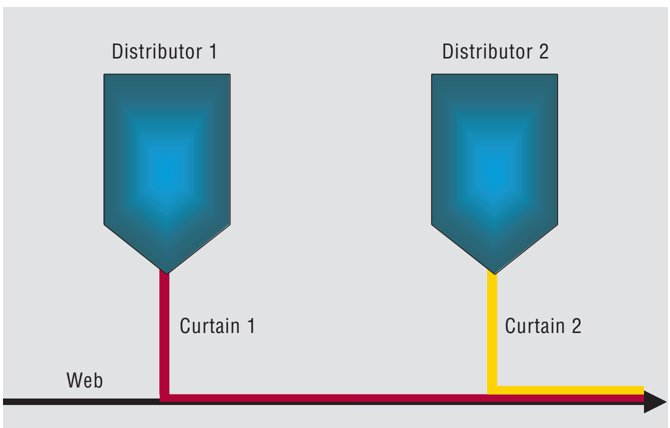

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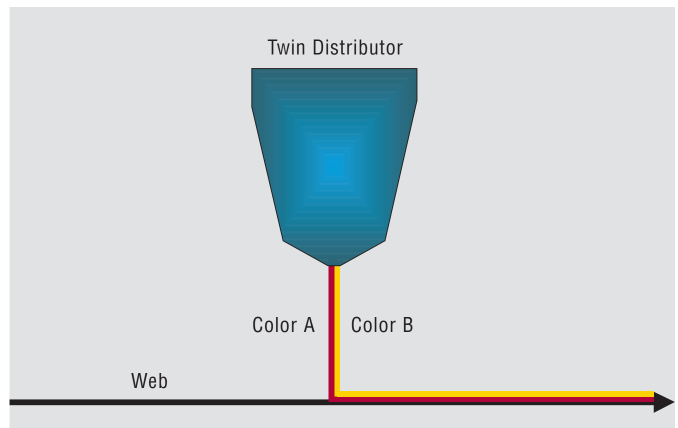


In the pilot trials, the possibility of coating with the DF coater in window E was confirmed.

Advantages of the DF coater

The many advantages of DF coaters compared with conventional coaters are set out below. These are mainly due to the very simple coating mechanism and ideal contour coating.

High coating quality

- Improved CD and MD profiles
- No scratches, no streaks, no film splitting
- Good opacity and coverage (ideal contour coating).

Easy operation

- No splashing, no misting
- No metering element, no blade or rod change
- No applicator roll change
- Easy adjustment of coat weight.

Low operation costs and high productivity

- Coating color savings
- Compact coating color supply and recirculation system
- No wear parts
- No down time needed for changing blades, rods, or rolls
- Less down time due to web breaks.

DF coater references at the present time

Twenty DF coaters are now in service worldwide **(Fig. 6)**, including Japan, Asia, Europe and the USA. The working width of these curtain coaters is mostly 3 to 4 m, with coating speeds from 1,000 to 1,200 m/min. The maximum design speed is currently 1,500 m/min. The maximum design and production width currently possible is 10 m. A maximum coating speed of 1,800 m/min was successfully attained with the pilot coater.

Future development of DF coaters

The ongoing improvement of coating colors for curtain coating will also enable pigment coatings with high solid content for graphic papers in the future. Particularly in the case of woodcontaining LWC paper with very low wet strength, the DF coater may be very effective.

Due to contamination and noise, it will become increasingly necessary in the future to replace existing air knife coaters with DF coaters for board production. In the near future double coating – wet on wet – will be possible using two DF coaters in tandem, or a twin distributor **(Figs. 7 and 8)**.

Masahiro Murakami

Director/Mill manager, Nippon Paper Industries Co., Ltd., Nakoso Mill

We are pleasantly surprised by the excellent performance of Voith IHI's DF Coater Head installed on the No.4 Coater in our Nakoso mill since 2001.

We trust that the DF Coater Head will enhance our reputation and competitiveness to fully comply with our operation and quality requirement for customer satisfaction.

Shinichi Suzuki

General Manager, Production Dept., Mitsubishi Paper Mills Ltd., Takasago Mill

Takasago 12 CM (Mitsubishi Paper Mills) was designed as a high-speed coating machine for carbonless copying paper. It started operation with coating color on October 16, 1998 and soon after started commercial operation without any problems.

We already had experience with DF coating operations in the medium speed range (700 m/min), but it was a first challenge for us to handle a higher-speed (1,200 m/min) and wider machine (1.7 m - 2.6 m). We therefore carefully investigated the technical issues using the pilot coater in Voith IHI several times and established the most suitable air deflecting system and color preparation, which we succeeded in, starting up without any problems.

We soon reached a normal commercial operating speed of 1,200 m/min at an early stage after start-up and, furthermore, we achieved a DF coating design speed of 1,500 m/min. Now we are able to produce carbonless capsule paper with one of the highest efficiencies in the world.

The DF Coater gives us higher performance than other coaters both in terms of quality and productivity when producing information papers in our mill. And especially from the operational point of view, we are sure that this method of DF coating is much superior to other coating methods because there is less noise, less mist and the machine is therefore easier to operate.

Michael Boschert

Head of Division, Production SD and Production Manager for Thermal and Carbonless Copying Papers at August Koehler AG

August Koehler AG, headquartered in Oberkirch/Germany, was founded in 1807. The family-owned company is today one of the world's leading manufacturers of specialty graphic papers. The Koehler Group manufactures not only decor papers but mainly also coated papers like carbonless copying and thermal paper. Our company has long been associated, in a spirit of partnership, with Voith AG as the process supplier for our systems.
In the field of coating we have again implemented pioneering innovations together with Voith. Since the highest demands are made on the functional coat in terms of functionality and uniformity in machine and cross directions in the thermal paper market segment, we decided to place our full trust in the new development "Curtain Coating". As a first step, our CM1 was re-equipped for this method and simultaneously the new CM 2 designed with a DF Coater (Direct Fountain) and ordered from Voith.
Following preliminary trials at Voith IHI in Japan, it soon became clear to us that only the DF Coater can meet our high demands on thermal paper coating. What looked so simple on the pilot coating

machine then had to be implemented in the production systems.

DF Coaters are today in use on our two coating machines and a new era has begun for us here at Koehler. In our opinion, the constancy of quality reached up to now is not achievable with other coating technologies.

On all our coating units we have, in the past, had to battle to obtain a constant coating color. With the DF Coater, on the other hand, we have now achieved something that had previously been inconceivable to us. We start off with one coating color formulation and no longer need to make any corrections to this up to the end of production. Thanks to this constancy, we now have to ask ourselves: "Do we still need a quality test on the finished paper?"

As the DF Coater operates without contact, there are no longer any sheet breaks at the applicator. And because no wear parts, such as blades or rods, are used for Curtain Coating, these no longer have to be replaced.

After over six months of use, we are highly satisfied with this new and innovative coating technology and have decisively improved the quality of our papers. I am sure that Curtain Coating has a great future lying ahead of it. We at Koehler have only made the decisive beginning with specialty papers. I can well imagine that this technology could also be used for mass-produced papers such as LWC.

1

Krieger completes the product range of Voith Paper – Infrared drying, integrated drying systems and means for contact free web-handling

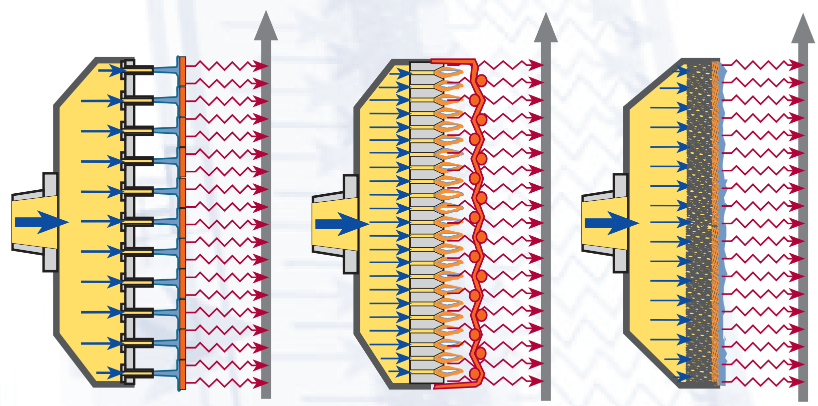
Jan Eberhard
Krieger GmbH & Co. KG
Mönchengladbach, Germany

With the beginning of the year 2002, Krieger GmbH & Co. KG has become a member of the Voith Group of Companies. Both companies have a long history of working successfully together which makes the integration of Krieger equipment into Voith Paper's One Platform Concept a rather natural process.

When it comes to finishing, drying the coating color in a fast, energy efficient and quality preserving or rather quality establishing way, constitutes a challenge which can only be met with the appropriate, state of the art equipment and a lot of experience. In almost all cases, infrared drying (IR drying) has proven to be the method of choice for this purpose. Whilst Krieger has several installations operational with its Infraelectric system in places where natural gas as well as liquid petroleum gas are hard to get, gas fired infrared is favored in almost all cases because of obvious economical advantages.

Fig. 1: *CB-Turn™ for non-contact web turn and IR emitter.*

Fig. 2: *Gas fired IR emitter principles used in the paper industry.*



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Krieger is not only the expert with the most experience in this field but also the only manufacturer of gas fired infrared emitters who can provide all different types of design principles for such emitters presently known **(Fig. 1)**.

In all cases, the heat of combustion must be transferred to a solid body, since the flame itself emits virtually no IR radiation. In Krieger's **Metal emitter** the gas-air mixture flows through an array of nozzles at high speed and burns at the exit of the nozzles. This design, based on the principles of impingement jet flow guarantees particularly good heat transfer. Besides, the emitter plates located in front of rather large nozzles makes this emitter very resistant to both, contamination from inside and outside and to air flows.

Likewise, this feature produces a relative thermal inertia, making the metal emitter suitable for stepless (0%-100%) power setting for CD moisture profiling.

The **Ceramic emitter** has a perforated ceramic plate through which the gas-air mixture flows before subsequently burning on its surface. Since the convective heat transfer to the ceramic plate takes place at the root of the flame only, this emitter principle has a marginally lower efficiency by comparison. To compensate for this limitation, a metallic screen is installed as a secondary emitter in front of the ceramic plate. Nevertheless, since ceramic as a material permits higher temperatures than metallic heating alloys, higher input power is possible with this type of emitter than with metal emitters.

Consequently, the radiated power on the whole is somewhat higher. Given the lower thermal inertia (less metallic mass), faster heat-up and cool-down times are evident besides the higher specific energy density, which can be important for some applications in paper machines and coating lines as well as for pilot coaters.

In the **Fibre emitter**, the perforated ceramic plate has been replaced by a metallic fibre plate. Since the same materials as for the metal emitter are in use here, though in the form of very thin fibres (~100 µm), the operating temperature is restricted to levels even below those possible with the metal emitter.

For the same reasons as on the ceramic emitter, the heat transfer in this case is significantly poorer than with the metal emitter. Moreover, the fibre material is even more critical in terms of its sensitivity to contamination and the risk of air flows causing dark spots than the ceramic emitter. This explains why this type of emitter is only used in cases where these criteria are of a certain importance.

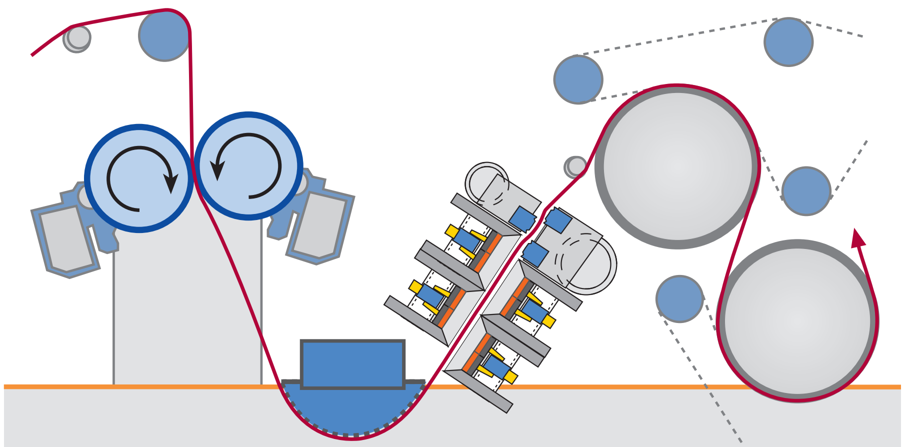
Fig. 3: *Typical integrated dryer™ installation following a film press.*

Fig. 4: *CB-Turn™ for non-contact web turn.*

Fig. 5: *CB-Float™ nozzle in operation.*

Fig. 6: *Krieger Integrated Dryer™.*

Fig. 7: *InfraFloat™ concept – the air dryer is heated exclusively with exhaust heat from the IR dryers.*



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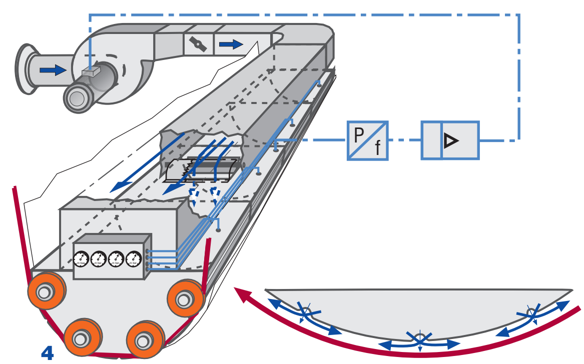

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Apart from providing the right emitter for each individual application, Krieger has specialized in fitting complete drying/web handling systems into very limited space. On the one hand, in these systems energy efficiency is increased by making use of the energy contained in the exhaust gases of the IR emitters by means of a circulation air system and additional air-hoods **(Integrated Dryer™)**, on the other hand space limitations in existing machines can frequently be dealt with by using a **CB-Turn™** for contact free web turn in connection with an integrated system **(Figs. 1, 3, 6 and 7)**. This ensures that the coating color is dried to such an extent that coating deposits on the following drying cylinders and guide rolls are prevented.

Krieger's **CB-Turn™** **(Figs. 1 and 4)** has proven its excellent runability not only for double sided coated LWC paper in installations following a filmpress (mill in the US) but also for cigarette paper (Feuerstein/Austria), coated fine paper (Arjo Wiggins Besse/F, Grycksbro/S) as well as for heavy board (FS-Karton/GER, Iggesund Workington/GB, Buchmann/GER).

Besides the **CB-Turn™**, Krieger can also provide a solution to replace guide rolls for very small angles of wrap: The **CB-Float™** nozzle **(Fig. 5)** comes in handy whenever a slight polygonal sheet run is preferable to long, straight free draws.

The **InfraFloat™** concept **(Fig. 7)**, uniquely available from Krieger, achieves an even higher utilization of the heat contained in the exhaust gases applying an optimized relation between the air-hood length and the volume of exhaust heat from the installed IR-hood(s). Nevertheless, this system depends upon a relatively undifferentiated product range with respect to the required drying energy, since the high efficiencies (72-75%) can only be achieved if all IR emitter rows installed are operational. If not, the burner shown in the functional diagram must also run as a "backup burner". Usually, this burner chamber is only used for fast system heat-up.

The sophisticated system of dampers and pipes makes it possible to regulate the blowing air temperatures in the IR dryer (max. 120 °C) independently of the temperature in the hot-air dryer (max. 160 °C), in order to ensure maximum energy efficiency as well as quality.

Despite its exceptionally high efficiency, the relatively large amount of space required and higher investment costs of this system by comparison with the integrated dryer makes a careful expert analysis of possible applications necessary.

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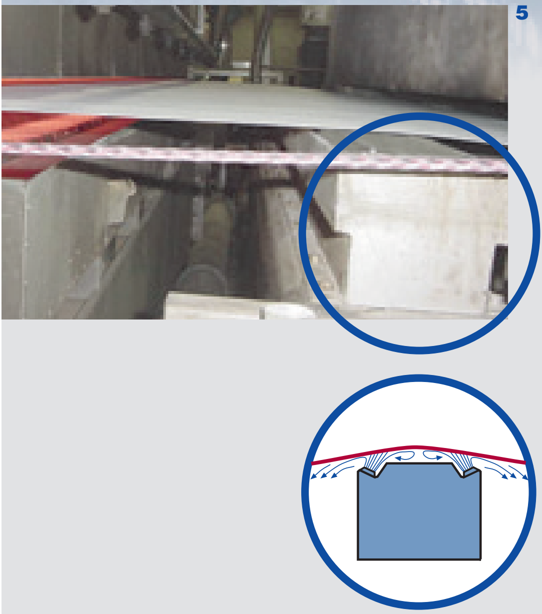

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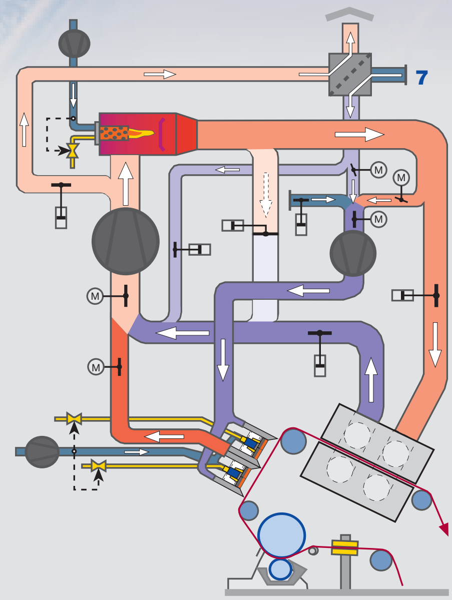
The air-hood shown in **Fig. 7** features nozzles specially designed for the paper industry and can, in connection with an air heating device, be used as a stand alone system (CB-Dryer) for LWC grades (3 recent installations in the US), high quality coated paper (Propal/Columbia) as well as for virtually all other paper grades as has been proven many times in the pilot coater of the PTS in Munich.

Taken all in all, through its flexibility and the wide range of drying systems (IR and air), Krieger will prove to be a most valuable addition to the Voith family.



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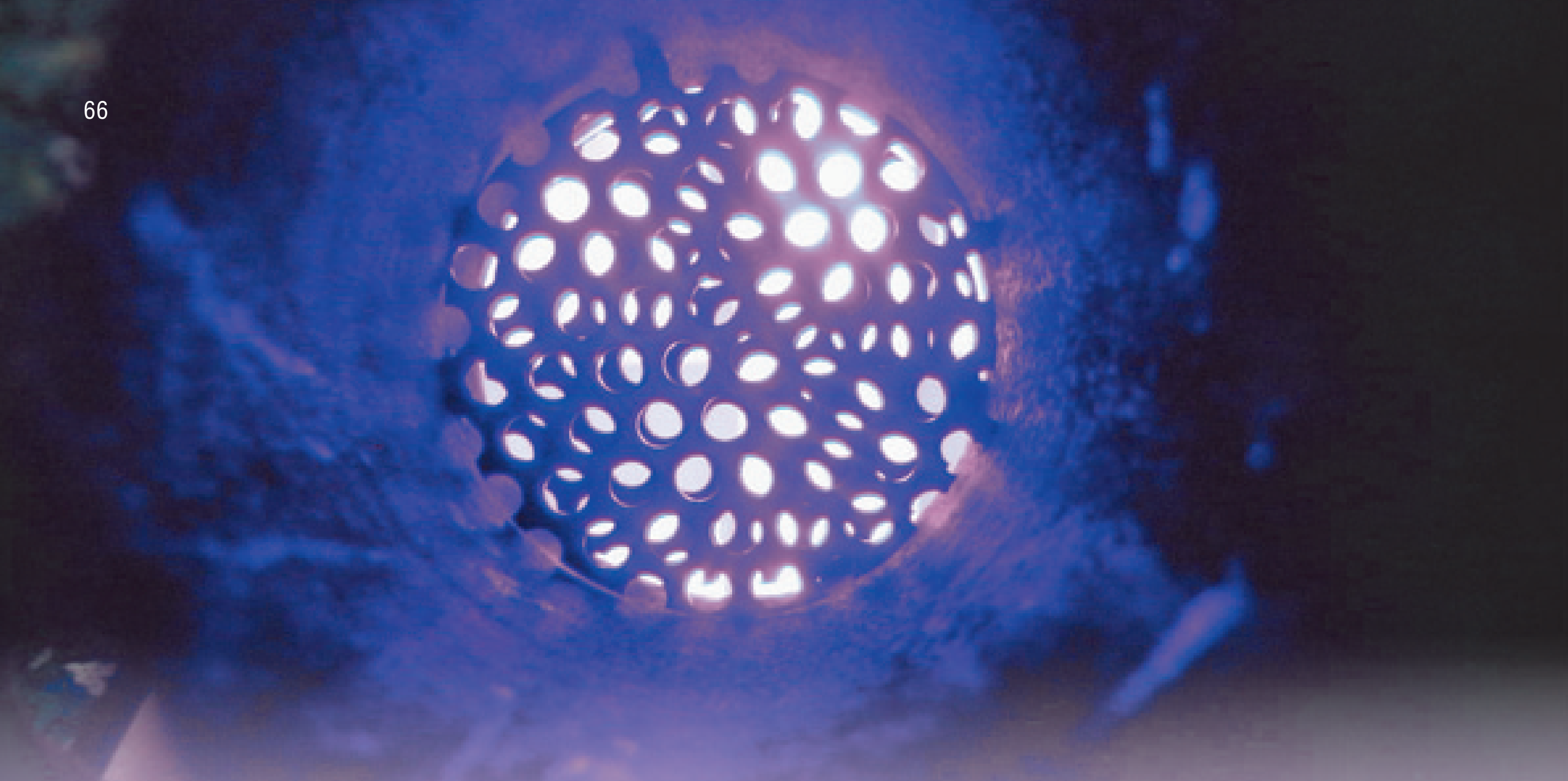

1

Innovative BLUE SOLID treatment of wearing parts materials – not only for the paper industry

The BLUE SOLID Centre, formely belonging to Jagenberg Papiertechnik GmbH, is meanwhile an integral part of Voith Paper.

Michael Hoffmann

Voith Paper
Krefeld, Germany

In 1997 the former Jagenberg Papiertechnik launched a research project to investigate the effects of ion implantation in metallic wearing surfaces in paper machinery. The paper industry is particularly prone to wearing parts, whose ongoing replacement or even failure involves high costs or production losses which can be critical in view of today's tough cost competition. By extending component life, failures can be minimized and production losses reduced accordingly.

This project has been continued by a small team of seven specialists, using the BLUE SOLID plasma process for ion implantation mainly on paper industry tools and wearing parts which are successfully marketed worldwide. In the meantime several patents and proprietary brand names have been registered.

The BLUE SOLID materials treatment process

Material properties can be systematically influenced by the BLUE SOLID process. For example, relatively low grade materials can be imparted with characteristics only found otherwise in expensive high grade materials.

For wearing parts and cutting tools, the main properties positively influenced by this process are as follows:
- Resistance to wear and abrasion
- Reverse bending fatigue strength
- Emergency and dry running properties.

The following material characteristics are also improved:
- Tensile and compressive strength
- Torsional fatigue strength
- Resistance to corrosion and erosion.

2

3

The BLUE SOLID process is most effective with the following materials:

- Chromium steels, high-speed steels (HSS), sintered steels
- Tool steels
- Stainless steels
- Chromium plating
- Chromium alloy cast steels.

The principle of plasma ion implantation is to impart component materials with the properties of target materials such as molybdenum, titanium, chromium, etc. Ions from the target materials are implanted and anchored thereby in the workpiece material. Thanks to the unusually low temperature level of this treatment, the microstructure can be systematically changed still maintaining material strength. And since the dimensional precision of the workpiece remains unaffected, this process can be used as the final finishing stage in component manufacturing. High-temperature treatment exceeding the annealing temperature of the respective material would cause uncontrollable and/or undesirable structural changes negatively affecting tenacity – not to speak of workpiece deformation.

For treatment by the BLUE SOLID process, workpieces are suspended in a vacuum chamber. An electrostatic potential difference is generated between the workpiece and the chamber wall. In the presence of reactive gases at constant vacuum, ions separate out of the target material and are accelerated between the poles. They impact the workpiece equally distributed over its surface, and become anchored in the molecular structure. Since the ions penetrate relatively deeply into the microstructure due to the electrostatic charge, this is not merely a superficial coating process. The depth to which the ions penetrate mainly depends on the duration of treatment. By this means, the metal structure can be imparted with new properties to improve the material characteristics.

Anchored to a depth of several tenths of a millimeter in the microstructure, the implanted ions remain effective on a long-term basis. This process, therefore, considerably extends the service life of wearing parts such as cutting tools, doctor blades, refiner plates, screen baskets, deflakers, etc.

Apart from extending service life, the BLUE SOLID process also offers several other advantages:
By influencing surface tension and/or smoothness, the reliability of a good many papermaking process stages can be improved.

Furthermore, costs can be optimized by selecting less expensive component materials – which also opens up new design possibilities.

Two different vacuum chamber sizes are currently used for the BLUE SOLID process: 11,000 x 400 x 400 mm, and 3,150 x 650 x 750 mm. With such large dimensions, even the biggest components can be treated.

The product offers range from BLUE SLIT cutting tools for nearly all makes of paper roll slitter and guillotine to BLUE ROD doctor blades for various coaters (Filmpress, Speedsizer, Speedcoater, Symziser and Metering Blade Sizepress).

A wide spectrum of services is offered by the BLUE SOLID centre:

- Plasma-treated wearing parts
- BLUE SOLID treatment to customer order
- Practical and theoretical training courses in cutting technology
- Cutting system consulting service for modernization/optimization projects
- Cutting system rebuilds
- Cutting system optimization
- Troubleshooting analysis of wearing parts and cutting samples
- CNC grinding service etc ...

Fig. 1: *View inside a BLUE SOLID vacuum chamber.*

Fig. 2: *Plasma-treated cutting tools, for example: BLUE SLIT disc knife.*

Fig. 3: *Vacuum chamber.*

Fig. 4: *BLUE SOLID products.*

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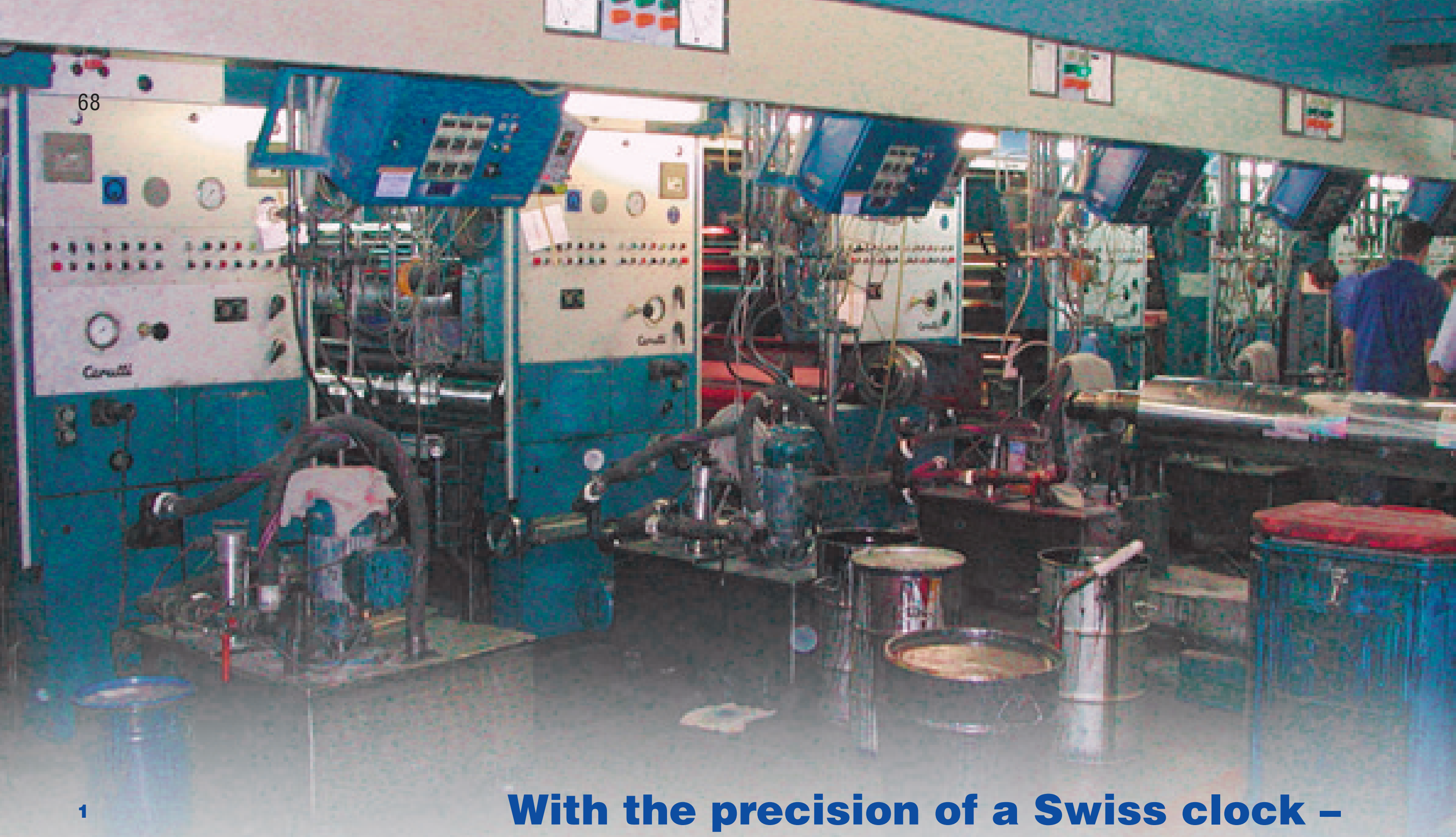


1

With the precision of a Swiss clock – VPT Walztechnik AG Zürich, a Voith Paper Group company, converts a printing press at Burda/Offenburg to Nipco™ Print Rolls

Eugen Schnyder

Voith Paper
Krefeld, Germany

It is well known that Nipco™ Rolls are state-of-the-art in the paper industry. Probably not so well known is the fact that they are also very successfully used in other industrial sectors. In rotogravure printing, for example, they play a decisive role, as the following report confirms.

Burda in Offenburg ranks among the leading companies in the European printing industry. It equipped two modern, 3,280-mm-wide Cerutti rotogravure units with the Nipco™ Print System more than six years ago. Because of the very good experience gained with the Nipco™ System, Burda placed an order with VPT Walztechnik AG Zürich (VPWZ) last autumn for the conversion of a 15-year-old, 2,450-mm-wide Cerutti rotogravure printing press to the Nipco™ Print System. Every week, among other publications, parts of "Focus", a magazine that is impatiently awaited every Monday by a broad readership, are printed on this rotogravure printing press no. 14 in Offenburg. On time delivery of the printed product is therefore an absolute "must".

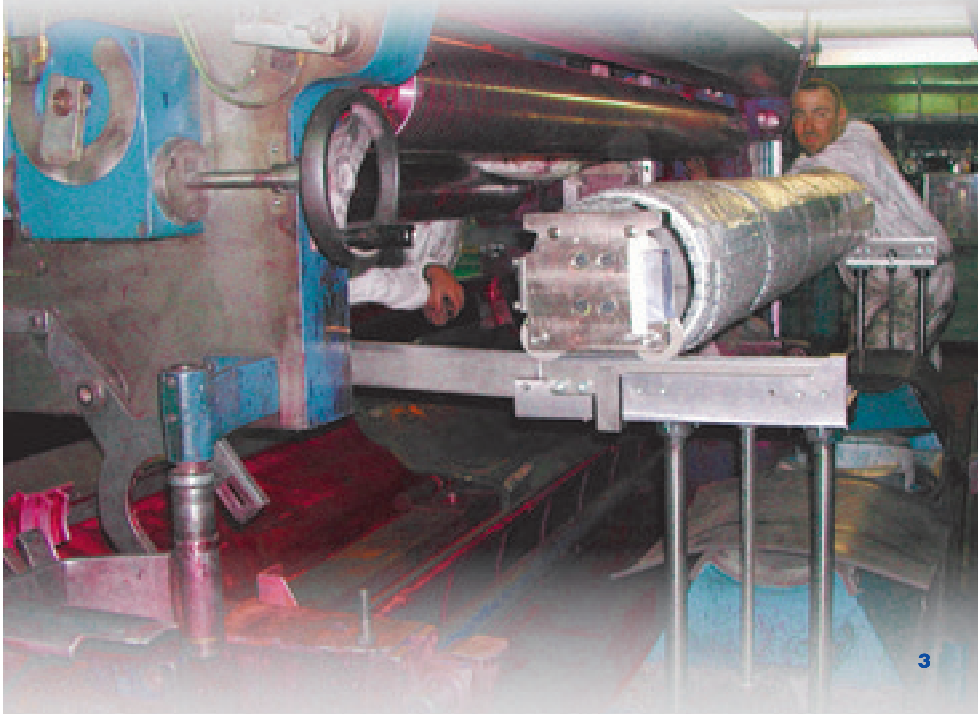
In other words: the rotogravure press really must keep "rotating"; downtime is unacceptable. Taking all this into consideration, it becomes clear what it means to convert a rotogravure printing press: everything really has to "go like clockwork".

This is the task that VPT Walztechnik AG, Zürich faced recently. After a period of only 6 months of application engineering, planning and manufacturing, rotogravure press no. 14 had to be rebuilt. The scope of supply included:

Fig. 1: *Rotogravure printing press.*

Fig. 2: *Commissioning team.*

Fig. 3: *Mounting of Nipco™ print roll.*



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- 10 Nipco™ Print Rolls (two of which as spares)
- 1 complete new hydraulic system, including controls
- 8 hydraulic control blocks
- Linking of the Nipco™ System controls to the machine controls
- Various mechanical adaptations and modifications on the machine.

It was planned to stop the printing press on April 15, 2002, a Monday morning, at 6.00 a.m. Official takeover was set for the following Saturday morning. This date had to be met – come what may.

The machine was stopped punctually, so that the rebuild work could be started on schedule. VPWZ had prepared all of the rebuild activities “with military precision”: every single dismantling/reinstallation step had been exactly determined in advance in very small time intervals.

The pictures convey an impression of the situation on site. At many points several activities were done at the same time and very close to each other. The color of the commissioning engineers overalls shows in which printing press they were currently working. Besides the experts from Zürich and Krefeld, there were 2 outside teams assigned to mechanical tasks and the laying of electrical lines and hydraulic pipes. Only very limited space was available in the machine, so the coordination of activities was of prime importance. Cooperation between all those involved went off so smoothly, and the parts were so precisely manufactured, pre-assembled and pre-tested, that the VPWZ’s project manager, Marco Dell’Ava, reported to the mill management in Offenburg as early as Friday morning – that is a full day earlier than planned! – that everything had been completed.

2

The highly satisfied reaction of the customer: “That went off like clockwork.”

But that was not all: the results of the rebuilt printing press met the expectations that Burda had placed in the modernization right from the start. Properly reproducible setting values, a perfect web run, optimal register and smooth press operation even at very high printing speeds make a significant contribution to the good performance and perfect print execution of the modernized printing press.

The readers, who purchased their “Focus” on Monday, enjoyed its beautiful appearance. Of course they had not the faintest idea of the stress and efforts behind the scene that were required to enable them to get “their” Focus in their hands as usual. And that is a good thing.

It is sufficient for Burda to know: VPWZ and Voith Paper are partners on whom they can rely.

twogether

Paper Technology Journal

Newsmagazine for the
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partners and friends of
Voith Paper

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