twogether

Hans Müller,
President and CEO,
Voith Sulzer Papiertechnik GmbH

Dear Customers, Dear Readers,

“By the way, congratulations on your new customer magazine – quite a source of information. But what else could we expect from the ‘twogether company’?”. This comment by a reputed customer in the USA reflects the overwhelming response to our first edition of “twogether” magazine. Not only the paper industry, but also professional associations, academic institutes and the trade journals were unanimous in this acclaim. Bearing in mind today’s flood of printed media and pressure of time, we were delighted with such a positive response. And it is nice to be called a “twogether company” – a sign of acceptance as partner in the paper industry.

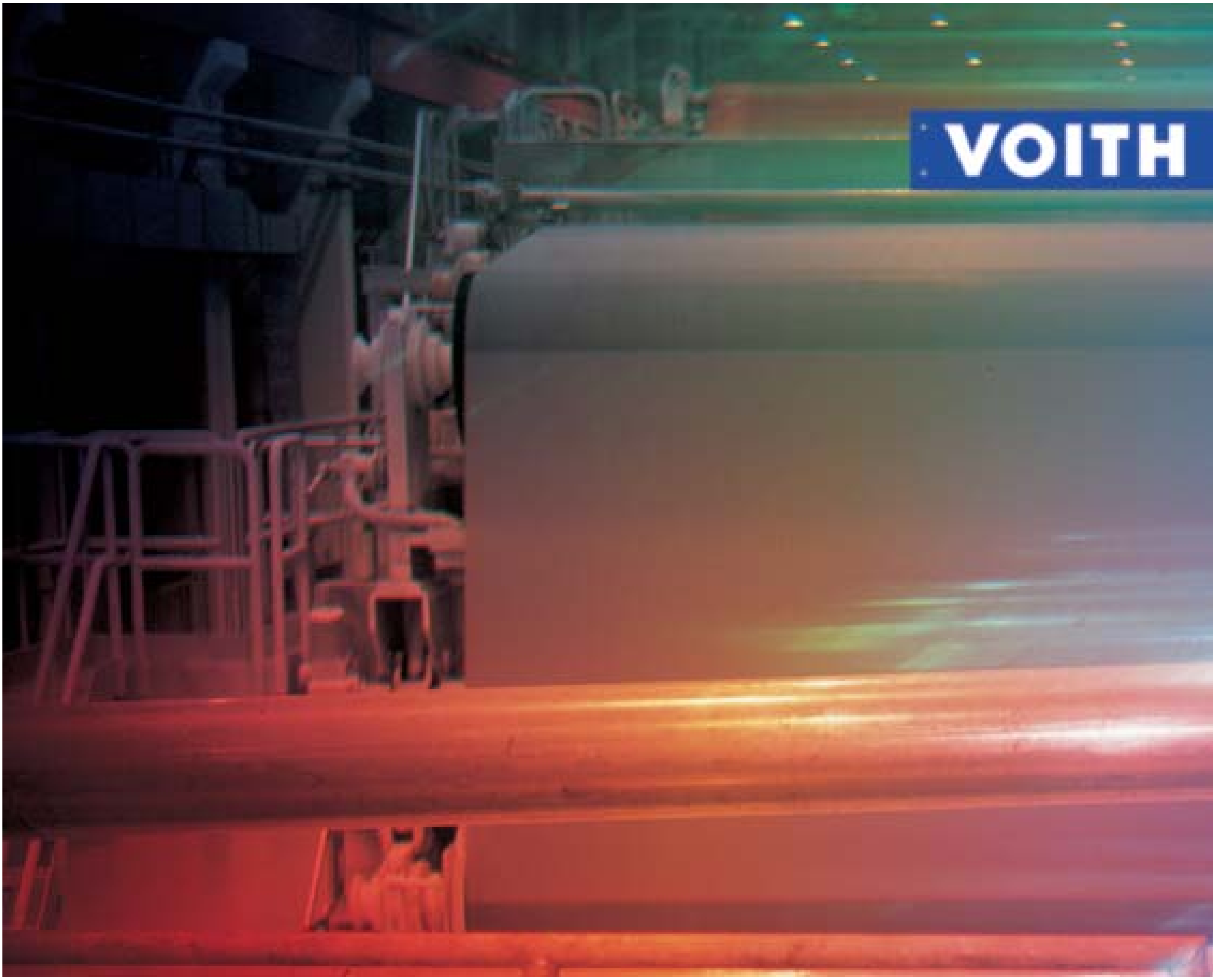
Keeping you up to date in this way is another step in our strategy of closer customer contact. What are the next steps? How will the situation of papermakers and machinery manufacturers develop in the context of increasingly rapid global market changes? A dependable way of foretelling the future would certainly be the dream of all investors.

Some weeks ago we received an interesting paper on this theme by Riccardo E. Moeschlin, an expert not unknown in the paper industry. How valid are such forecasts? Since no recipe exists for reliable prognoses, and as human beings we are all prone to error, this theory based on repetitive economic cycles seems particularly interesting. Read on and judge for yourself!

One again, we trust that “twogether” No. 2 brings you interesting reading and some useful technical information.

Sincerely

Hans Müller


VOITH


SULZER

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HIGHLIGHTS

STARTUPS, ORDERS ON HAND

The tables below show main startups from October 1, 1994 to September 30, 1995 and prime orders on hand.

STARTUPS

Stock preparation

Waste paper processing systems and subsystems for printings and writings
945,000 tonnes p.a.

ANM Albury, Australia
Stora Feldmühle, Langerbrugge, Belgium
Utzenstorf Paper Mills, Switzerland
Hann. Paper Mills, Alfeld, Germany
Stora Feldmühle, Kabel, Germany
MD Paper, Germany
SCA Aylesford, Great Britain
Georgia Pacific, Kalamazoo, USA

Waste paper processing systems and subsystems for board and packaging papers
550,000 tonnes p.a.

Visy Paper, Australia
Lenk Paper Mills, Kappelrodeck, Germany
Townsend & Hook Ltd, Snodland, Great Britain
P.T. Indah Kiat, Indonesia
Board AB, Fiskeby, Sweden
Hansol Paper, South Korea
Shin Poong, South Korea
Visy Paper, Conyers, USA

Waste paper processing systems and subsystems for tissue papers
148,000 tonnes p.a.

Thrace, Greece
Apizaco, Mexico
AS Sunland Eker Paper Mills, Sweden
Pope and Talbot, Wisconsin, USA
Scott, Owensboro, USA

Waste paper processing systems and subsystems for other types of paper
110,000 tonnes p.a.

Kemsley, UK Paper, Great Britain
Auburn VPS, USA

Chemical pulp processing systems
MD Paper, Dachau, Germany
Stora Billerud, Baienfurt, Germany
Weißenborn Paper Mills, Germany

Paper machines

264,000 tonnes p.a.

Printings and writings
Tamil Nadu Newsprint and Papers Ltd, Madras, India

Board and packaging papers
Visy Paper, Australia
Willamette Ind. Inc., USA
Hansol Paper Co. Ltd, Korea

Rebuilds
Visy Paper Conyers, USA
Haindl Paper GmbH, Walsum, Germany
Cartiere Burgo SpA, Italy
Stora Billerud GmbH, Germany
Holmen Paper AB, Sweden
Haindl Paper GmbH, Schongau, Germany
MD Paper GmbH, Germany
PWA Graphical Papers GmbH, Germany
Albbruck Paper Mills, Germany
Kanzan Spezialpapiere AG, Germany
Smurfit Newsprint Co., USA
Stora Grycksbo AB, Sweden
Stora Langerbrugge N.V., Belgium
Steinbeis Temming, Germany
Norske Hönefoss, Norway
Stora Feldmühle, Hillegossen, Germany
Stora Forest Industries, Canada

Coating technology
Votorantim Celulose e Papel Simao Jacarei, Brazil
Kanzan Spezialpapiere GmbH, Germany
International Paper, Poland
Consolidated Papers Inc., Biron Mill, USA
MD Paper, Germany
Albbruck Paper Mills, Germany
Zaklady Celulozowa Papiernicze S.A., Poland
Saica Zaragoza, Spain
Ripasa S.A. Celulose e Papel, Limeira, S.P., Brazil
Kostryznsie Zaklady Papiernicze S.A., Poland
Scheufelen Paper Mills, Germany

Winding technology
- Duoreel
Haindl Paper GmbH, Walsum, Germany
- Winders
Tamil Nadu Newsprint and Papers Ltd., Madras, India
Haindl Paper GmbH, Schongau, Germany
Smurfit Newsprint Corp., USA
Visy Paper, Australia
Visy Paper Conyers, USA
Kostryznsie Zaklady Papiernicze S.A., Poland

Finishing

Supercalenders
Burgo Ardennes, Belgium
PTS, Germany
Jiangnan Paper Mill, China

Soft calenders
Henry Cooke Makin, Great Britain
Pap. de Gascogne, France
NN, Germany
Jang Chun, Korea
Georgia Pacific, USA
Portals, Great Britain
Shandong, China
Hannover Paper, Germany
Pap. Calparsoro, Spain
Longview Fibre, USA
Inland Empire Spokane, USA
Visy Board, Australia
Tai Shan, China
Zhu Hai, China
Sappi Specialities, Great Britain

Papelera De Castilla Duenas, Spain
Sam Poong, Korea
Suzano, Brazil
Perlen paper Mills, Switzerland
SNIA f. Krasnokamsk, Russia
Long You Paper, China

Machine calenders
Crown Packaging, Canada
Australian Paper Botany Mill, Australia
Zhu Hai, China
Crane Byron Mill, USA
Weyerhaeuser, USA

Rebuilds
Arjo Wiggins, France
Koehler, Germany
Pudumjee, India

Roll transport systems
Bruckmann, Germany
Maul Belser, Germany
Burgo Ardennes, Belgium
KNP Leykam, Netherlands

ORDERS ON HAND

Stock preparation

Waste paper processing systems and subsystems for printings and writings
1,466,000 tonnes p.a.

Hermes Paper Mills, Germany
Parenco B.V, Netherlands
Trust International Paper Corp., Philippines
Holmen Paper Mill, Braviken, Sweden
Australian Newsprint Mills, Australia
Jiangmen, China
Stora Kabel GmbH, Germany
Paper Industries Corp., Philippines
Halla Engineering & Heavy Industries Ltd, South Korea
Hansol Paper Co. Ltd, South Korea
Georgia Pacific, USA
Dae Han Paper, South Korea
Genting Newsprint Sdn. Bhd., Malaysia

Waste paper processing systems and subsystems for board and packaging papers
2,479,000 tonnes p.a.

Ningbo Zhonghua Paper, China
CMPC Procart, Chile
Zülpich Paper GmbH & Co. KG, Germany
SCA De Hoop, Netherlands
VSDN Cape Kraft, South Africa
Cheng Loong Co. Ltd., Taiwan
Thai Kraft Paper Industries Co. Ltd., Thailand
Georgia Pacific, USA
Port Townsend, USA
PT Indah Kiat, Indonesia

Waste paper processing systems and subsystems for tissue papers
93,000 tonnes p.a.

A/S Sunland Eker/Papirfabrikken, Norway
Crisoba Industrial, Mexico

Waste paper processing systems and subsystems for other types of paper
478,000 tonnes p.a.

Australian Paper Manufacturers, Fairfield Mill, Australia
St. Petersburg Carton Combine, CIS
Corenso United Ltd, Finland

Chemical pulp processing systems
597,000 tonnes p.a.

Neidenfels/Blue Star, Germany/China
Tronchetti, Italy
Hiang Seng, Thailand

Pulper feed systems
Stora Feldmühle, Belgium
VPK Oudegem, Belgium
Ningbo Zhonghua Paper, China
St. Petersburg Carton Combine, CIS
Corenso United Ltd, Finland

Paper machines

3,198,000 tonnes p.a.

Printings and writings
Consolidated Papers, Stevens Point, USA
Holmen Paper Mill, Braviken, Sweden
SCA Ortviken AB, Sweden
Sinar Mas Pulp & Paper Ltd, India
Halla Paper Co. Ltd, Korea
Mazandaran Wood and Paper Industries, Iran

Board and packaging papers
Visy Paper, USA
Zülpich Paper GmbH & Co. KG, Germany
Victorgo Industries Guangzhou, China
VPK Oudegem, Belgium
Ningbo Zhonghua Paper Co. Ltd, China
Thai Kraft Paper Industry Co. Ltd, Thailand
Visy Paper, Brisbane, Australia
Mazandaran Wood and Paper Industries, Iran
P.T. Indah Kiat, Pulp & Paper Corp., Indonesia
CMPC-Cia. Manufacturera de Papeles y Cartones S.A., Chile

Tissue
Bacraft, Brazil
Al Keena Hygienic Papermill Co. Ltd, Jordan
Tien Long Paper Mill, Taiwan
Industria Cartaria Tronchetti Burgo a Mozzano, Italy

Rebuilds
Visy Paper, Australia
Bataan Pulp and Paper Mills Inc., Philippines
CMPC, Santiago, Chile
Thomas Tait & Sons Ltd, Great Britain
Tentok paper Co. Ltd, Japan
Davidson & Sons, Great Britain
United Paper Mills Ltd, Finland
Federal Paperboard Co., USA
Consolidated Paper Inc., USA
Rigesa Celulose, Papel e Embalagens Ltda, Brazil
Assidoman Kraftliner, Sweden
Westvaco Corporation, USA
Stone Container Corporation, USA

Coating technology
Nippon Paper, Japan
Koehler Paper Mills GmbH, Germany
Federal Paperboard Comp. Inc., USA
SCA Ortviken AB, Sweden
Hansol Paper Co. Ltd, Korea
Halla Paper Co. Ltd, Korea
Hong Won Paper, Korea
Consolidated Paper Inc. Stevens Point, USA
Kymi Paper Mill, Finland

Winding technology
- Duoreel
SCA Ortviken AB, Sweden
Koehler Paper Mills GmbH, Germany
Holmen Paper AB, Sweden
Industria de Papel Arapoti SA, Brazil
- Winders
Halla Engineering & Heavy Industries Ltd, Korea
Papeles Bio Bio SA, Chile
Holmen Paper AB, Sweden
Genting Newsprint Sdn. Bhd., Malaysia
Fabricadora de Papel de Celulose S.A., Brazil
Townsend & Hook Ltd, Great Britain
Guangzhou Victorgo Industries Co. Ltd, China
Companhia Suzano de Papel e Celulose, Brazil
International Tendering Company CNTIC, China

Finishing

Supercalenders
KNP Leykam, Netherlands
Yuen Foong Yu, Taiwan
Bosso, Italy
UPM Tervasaari, Finland
Marubeni for Daishowa, Japan
Hansol Paper, Korea

Soft calenders
Genting Newsprint, Malaysia
CMPC Procart, Chile
Ballarshah, India
Siam Paper, Thailand
Pap. del Aralar, Spain
Miliani f., Hungary
Assi Domän, Sweden
Kymmene Wisaforest, Finland
Simao, Brazil
Henry Cooke Makin, Great Britain
IP Kwidzyn, Poland
J.R. Crompton, Great Britain
Portals, Great Britain
Ningbo PM 3, China
Ningbo PM 2, China
Halla Paper, Korea
Holmen Paper, Braviken Mill, Sweden
SCA Ortviken, Sweden

Machine calenders
Australian Paper, Australia
Ningbo, China
Townsend & Hook Ltd, Great Britain
Crown Packaging, Canada
SCA Ortviken, Sweden

Rebuilds
Stora Kabel, Germany
Stora Reisholz, Germany
Cart. Toscolano, Italy

Roll transport systems
KNP Leykam, Netherlands
Scheufelen Paper Mills, Germany
NDI, Netherlands
Halla Paper, Korea
Genting Newsprint, Malaysia

NEW PLANTS AND SYSTEMS

Stock Preparation Division:
The first waste paper recycling line at MD Papier GmbH, Plattling

This recycling line with its trend-setting technology recently went into service after more than two years of fruitful collaboration with MD Papier GmbH. To meet specific requirements, conventional recycling technologies were further developed and adapted accordingly. Capacity of the new Plattling recycling line is 72,000 t.p.a. of waste paper furnish. Design services and machinery were supplied by a consortium mainly comprising Voith Sulzer Stock Preparation GmbH, Ravensburg, B+G Fördertechnik GmbH, Euskirchen, and Maschinenfabrik Andritz, Graz/Austria.

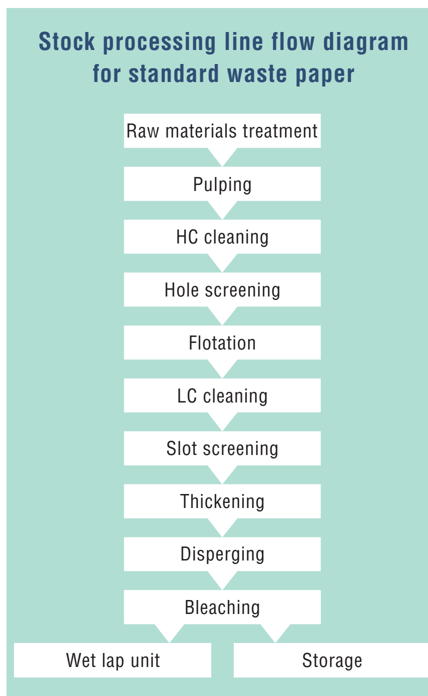
MD Papier GmbH has invested 53 million DM here in a recycling line with almost entirely closed-circuit water loop layout. This represents a significant contribution toward increasing the waste paper recycling quota in Germany, a self-imposed obligation of paper producers and publishers which was agreed in autumn 1994. Primary design criteria for this recycling line were environmental compatibility and consistently high product quality. Thanks to completely new technological developments, it is now possible for the first time to use old labels from reutilized beer and beverage bottles as furnish for making high grade printing papers. This is done by efficient removal of inks, stickies and wet-strength additives.

Previously, old labels of this kind were disposed of in landfills or used as filler material in the tile and brick industry, thus wasting the high-grade kraft pulp of which they were made.

The so-called eco-agreement signed by MD Papier together with several breweries creates the logistical conditions required for label recycling. As a result, some 60,000 tonnes of bottle labels circulating every year in Germany can now be used as furnish for high grade products.

The new recycling line – the first of its kind – makes this technically feasible by allowing the use of high wet-strength labels and punchings (special-grade waste paper) as well as higher-grade standard furnish such as printing waste, returns and department store catalogues.

Depending on processing mode (special or standard grade waste paper), the correct machine sequence can be run accordingly. The goal of this line concept was dual utilization of as many aggre-



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, PRODUCT DEVELOPMENTS

Fig. 1:
Stock processing line flow diagram for standard waste paper.

Fig. 2:
Waste paper charging system with automated bale dewiring, designed and built by B+G Fördertechnik GmbH, Euskirchen, an associated company of Voith Sulzer Paper Technology Group.

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gates as possible in both modes. Daily capacity is up to 220 tonnes of waste paper.

Raw materials handling

Waste paper is delivered loose or in bales. The bales are automatically dewired with a B+G Fördertechnik machine, and fall as loose material on the slat conveyor pulper feed belt supplied by the same company.

The integral weighing system stops the conveyor automatically as soon as a predetermined waste paper charge has been fed to the pulper.

Pulping and HC cleaning

The waste paper is pulped at a stock consistency of 15-17% in an intermittent high-consistency pulper. This is designed for maximum fibre retention and efficient deinking.

All deinking additives are fed to the pulper together with each charge.

The pulper is drained via a PreClean system, which minimizes dumping time while at the same time ensuring consistent mixing of dilution water during dumping. It also ensures efficient junk removal.

The 2-stage PreClean system comprises a Fiberizer with special rotor/screen combination, a buffer tank and drum screen. Coarse rejects are removed at an early stage by the Fiberizer hole-screen plate. Any fibres contained in the coarse rejects are recovered in the drum screen before

Fig. 3:
Hole screening in the Fibersorter.

Fig. 4:
Compact flotation cell.

they are dewatered and compacted in the rejects screw press.

The pulp is pumped into one of three 200 m^3 dumping towers in order to ensure adequate fibre swelling and chemical reaction of the deinking additives. Pulp leaving the dumping tower then passes through a high-consistency cleaner.

Hole-screening

Basic principle of the 3-stage hole-screening system is early removal of screenable rejects, with systematic forward feed of accepts.

The first and second screening stages comprise two Omnisorters for standard waste paper, or two Fibersorters for special-grade WP. Coarse rejects are removed in the third stage, which comprises a Rejectsorter.

Flotation

In the flotation stage all the ink particles and finely disperged impurities are removed. This gives a consistently high quality recycled product which meets all requirements for manufacturing printing papers.

The flotation aggregate comprises five primary deinking cells and one secondary cell. These closed-circuit cells are arranged in pairs, one above the other. Flotation air is injected into the stock suspension through independently operating step diffusors. Thanks to the high air content (up to 60%) and wide bubble spectrum, all ink particles from 10 to 500 µm in size are removed. The closed-loop


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Fig. 5:
Stock thickening in the double wire press.

Fig. 6:
Disperger with heating screw.

flotation air circuit prevents polution of the atmosphere.

In the secondary cell any fibres still usable are recovered. The sludge remaining is dewatered as far as possible in the prescreener before treatment in the sludge handling unit (supplied by Maschinenfabrik Andritz).

Low consistency cleaning and slotted screening

The small heavies, sand and plastic particles are removed in a 4-stage heavies cleaner.

Rejects are treated with the sludge, while the accepts are processed for light weight contrary removal.

In a 3-stage slotted screen system the suspension is fine-screened again to remove mainly all the cubic rejects and stickies.

Thickening, disperging and bleaching

The clean suspension is now passed through a disk filter and afterwards dewatered in a double wire press (supplied by Maschinenfabrik Andritz). This thickened stock is then conveyed by a screw system comprising shredder, elevator, feed and steam-heating screws to a disperger with cast fillings. The disperging effect is based on the principle of intensive friction between fibres. This homogenizes the stock and drastically reduces visible dirt specks. In order to increase brightness, the stock is processed in a bleaching disperger with reductive additives.


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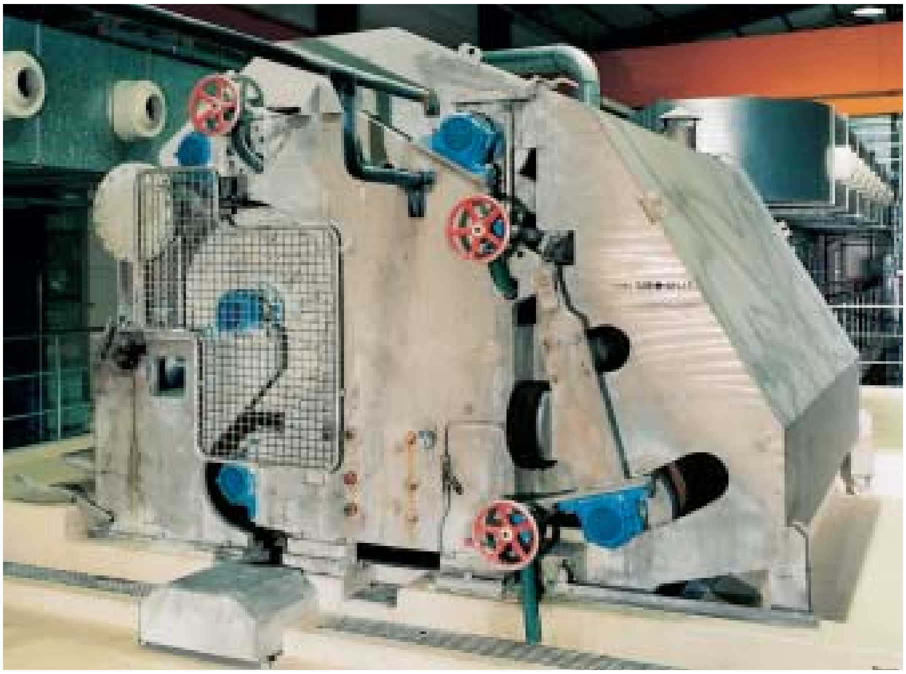
Fig. 7:
Washing in the VarioSplit.

Fig. 8:
View of storage tower.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Washing and wet lap system

For processing special-grade waste paper furnish, the stock is washed in a Vario Split after low consistency slotted screening. It is then processed in a wet lap unit and paletted ready for dispatch.

Storage

After medium consistency bleach dis-perging, standard waste paper stock is pumped to a storage tower.

Water loops

The water loops in this stock preparation line are almost entirely closed-circuit. Except for added dilution water and sealing water, no fresh water is used. The sludge dewatering filtrates are purified by microflotation in a Purgomat, and returned to the stock preparation process water loop. The VarioSplit filtrate is likewise cleaned by microflotation.

Rejects compacting

Coarse rejects from the PreClean dumping system and hole screening are dewatered and compacted in a rejects screw press.

Rejects from the high and low consistency cleaners are transported by container for landfill disposal together with compacted rejects from the screw press.

Fig. 9:
Water purification by Purgomat.


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Stock Preparation Division:
The C-bar screen basket – a high-tech product

According to an old saying: "paper is made in the Holländer". Despite the common opinion that paper mills only contain paper machines, this still holds true – as long as "Holländer" is replaced with "stock preparation".

The task of stock preparation – the "factory" feeding the paper machine – is to process basic papermaking materials according to the required product grade and quality. Screening has always been an important part of stock preparation, and since the rise of waste paper as a basic material, it has become even more important.

The author: R. Rienecker, Product Group Screening

With traditional primary furnish such as groundwood and chemical pulp, the components to be screened largely comprise solid particles such as splinters. With greater use of recycled paper, the main requirement now is to remove softer components such as stickies, foils, styropor and other rejects. This is much more difficult than screening out solid particles.

The main importance of screening technology lies not so much in the finished paper quality, but in the cost-effectiveness of the paper production and finishing process as a whole – in other words what goes into the paper machine at one end, and how it is processed after it reaches the other end.

Screening machines today generally operate under pressure, and the pulp has to be pumped into them *(see Fig. 1)*. Inside the screen housing is a rotor and a fixed cylindrical screen basket. This is perforated either with holes or with slots.

Whether the screen basket has holes or slots depends on the kind of rejects to be removed. The rule of thumb here is to use holes for flat materials (such as foils) and a slotted screen for cubic particles (e.g. styropor). The idea is that the stock fibres should pass through the screen and the unwanted materials should remain for subsequent removal.

It is easy to see that apart from other parameters, the main aspect here is the size of screen hole or slot.

To meet today's demands for clean stock despite more use of dirty waste paper, very small screen holes or slots have to be used – and the trend is more and more toward fine slots.

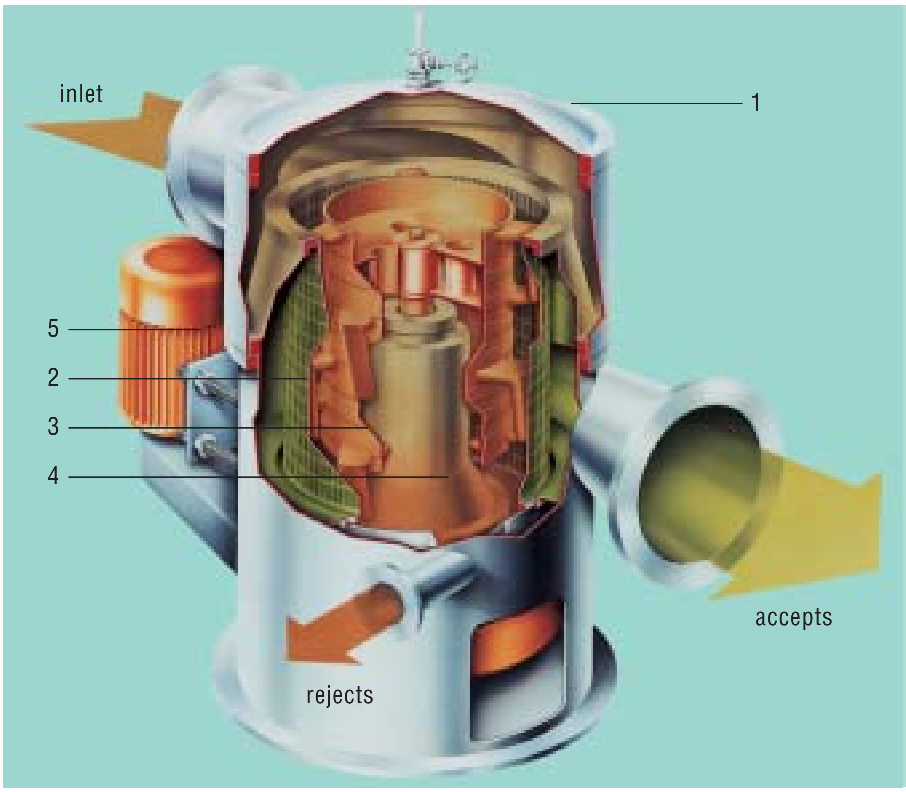
Slotted screens are nothing new, but ever since the screen was invented they have played a secondary role. Slotted screens in the past comprised flat plates in which slots were cut painstakingly *(Fig. 2)*. These were generally ≥0.8 mm wide, but for special applications slots as small as 0.45 mm were used.

The limits of slotted screens were dictated by manufacturing processes, which allowed a relatively small amount of free screening area, and by the low rotor efficiency due to the smooth surface. Both these factors reduced throughput, so that slotted screens were relatively uneconomical.

During the second half of the seventies, papermakers called more and more for greater use of slotted screens and at the same time for smaller slots. Screen manufacturing methods at that time did not allow either for modifying screen flow conditions or for increasing the free screening area. The only possibility remaining was to increase turbulence, and hence throughput, by adding bars to the rotor side of the screener basket.

As a further development of these high-turbulence screener baskets, a wide variety of surface profiles were proposed. One example is the so-called VV basket *(Fig. 4)*, comprising a large number of "minibars" generated by milled grooves in the basket surface. The principle here was that the depth of these grooves influences screening efficiency to a certain extent. In simple terms, a very rough surface increases throughput, while a smoother surface increases screening efficiency.

All these screener basket versions had



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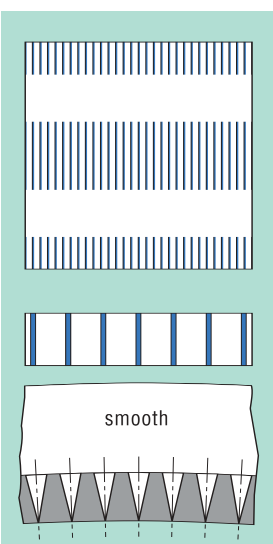

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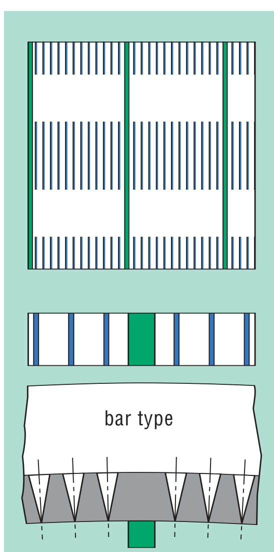

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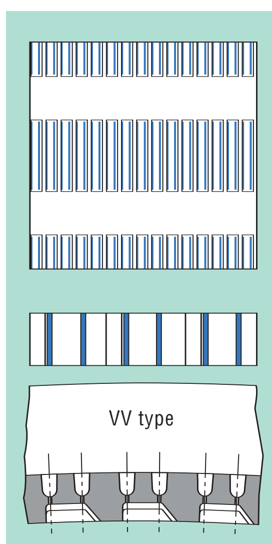

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Fig. 1:
Schematic arrangement of a screen:
1 housing, 2 screen basket,
3 rotor, 4 bearings, 5 drive.

Figs 2, 3, 4:
Slotted screen basket patterns.

three drawbacks in common, however: the relatively small free screen area due to manufacturing restrictions, the poor flow characteristics due to sharp slot edges, and last but not least the high manufacturing cost.

Back in the nineteen-seventies Voith therefore started developing smooth or bar type screener baskets, for which several patents were taken out *(see Fig. 5)*. This development represented a quantum leap in screening technology at that time.

These baskets no longer had milled slots with milled surfacing. Instead they have profile bars with an approximately triangular cross-section, spot-welded to strips which later form the stiffening rings on the finished basket.

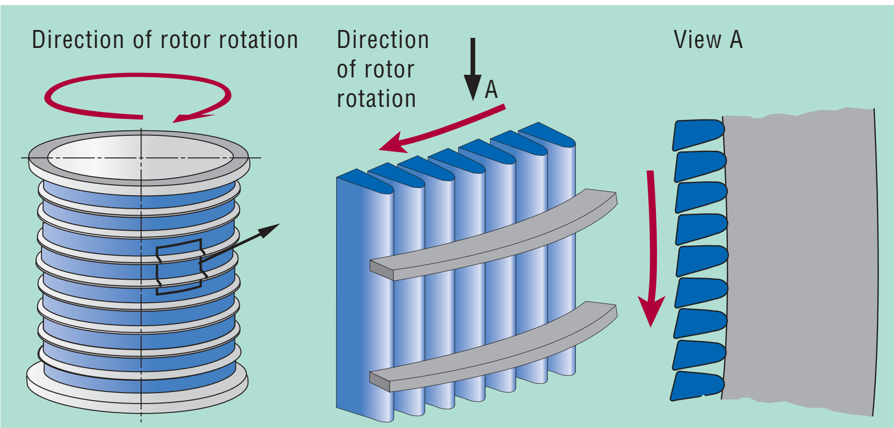
The slot width is defined by the bar spacing, while the bar angle generates the surface profile. These flat screens are then rolled into cylindrical form and welded together into a finished screen basket.

In many respects these screen baskets are far superior to their machined predecessors. This superiority can be summarized as follows:

- Higher screening efficiency for the same slot width
- No sharp edges
- Large free screening area
- Lower screening energy consumption

Fig. 5:
Principle of the conventional bar-type basket.

Fig. 6:
Principle of the C-bar screen basket.



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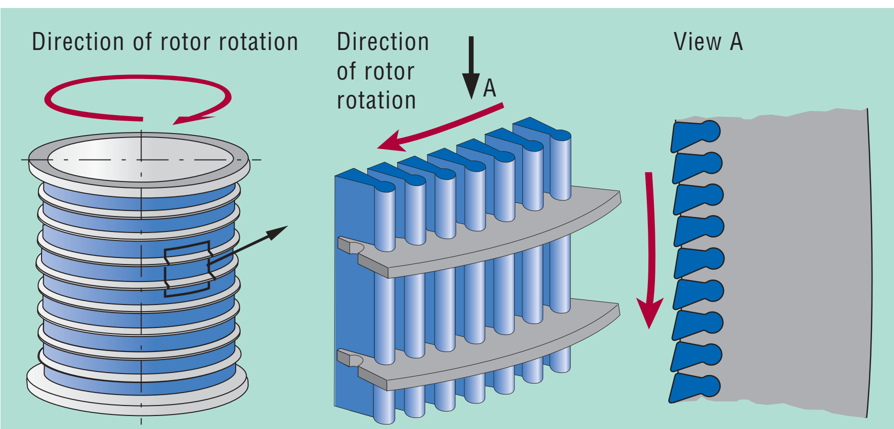

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- Low-cost manufacturing

These fabricated screen baskets also have their manufacturing limits, however:

- Relatively wide scatter in slot width
- Smallest slot size limited to about 0.2 mm since narrower slots require thinner bars and reduce basket stability.

While retaining the bar-screen principle, these deficiencies were then completely eliminated by developing and patenting an innovative manufacturing process.

All problems were solved through close cooperation between manufacturing specialists and stock preparation experts, and the result is a mature screen basket meeting all market requirements.

It is not easy for the layman to imagine how many problems were involved in developing what seems at first sight to be a plain and simple product.
In order to comply with flow patterns, a screen basket is a highly filigrane structure. On the other hand it has to withstand extremely high dynamic loads for long periods in the screening machine, and is often exposed to abrasive attack as well.

By its very nature, the basket has a very large number of interconnecting points, which from the stress point of view have the same effect as notches.

On top of this, the use of chrome-nickel stainless steel turns the development of such a screener basket into an engineering challenge of the first magnitude.

The manufacturing process involves the following main steps:

- Precise cutting of the clamping profile in the bars by laser technique
- Production of a flat screen by fitting specially drawn profiled bars on a newly developed welding machine
- Rolling the flat screen into a cylinder and welding the ring ends together
- Machining the end flange and welding it to the cylindrical screen
- Finish-machining the entire screen basket.

Each of these manufacturing steps – particularly welding and rolling – not only demands precise work planning but high-

Figs. 7 and 8:
Slot width scatter of the C-bar screen basket compared with a conventional bar-type basket. The patented C-bar basket manufacturing technology guarantees width tolerances below 0.01 mm for 80% of slots.

ly trained machinists.
The final result of all these trials is the C-bar screen basket – a high-precision product which is almost a work of art.
Fig. 7 shows the slot width scatter of the C-bar basket. Our patented manufacturing technololgy guarantees that 80% of the slots deviate in width only by ≤0.01 mm and the other 20% by ≤0.02 mm. In most cases the measured scatter is significantly less *(Fig. 8).*

The problem of weld faults at the connections between profile bars and stiffening rings does not apply to the C-bar manufacturing process, because the bars are clamped into the rings and not welded.

The advantages of the C-bar screener basket, in the meantime patented worldwide, are listed follows:

- Bar-type basket without welding points in the screen structure
- Rings and bars shaped to clamp together
- Extremely close slot width tolerances
- High uniformity and stability of slots in the longitudinal direction due to closely spaced stiffening rings
- High surface quality (cold-drawn bars without welding)
- 0.1 mm slot width easily reproducible
- Large free screening area
- Optimally variable profiling (no manufacturing limits).

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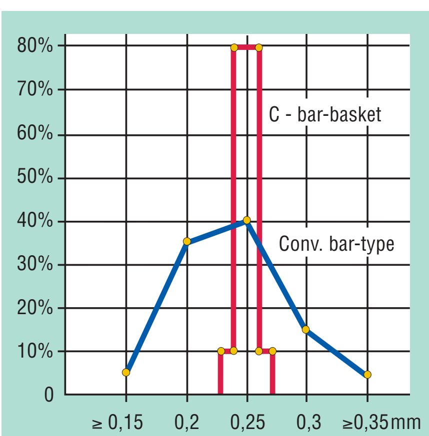

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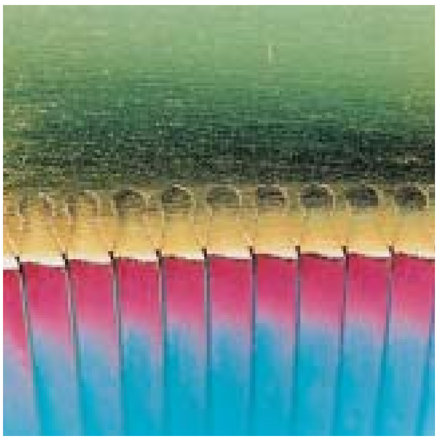
Customer appreciation of these advantages is shown by the fact that within a short space of time about 700 C-bar screen baskets of various sizes (see *Fig. 10)* are now in service worldwide. And this trend is growing, since at the present time 6 fine screens in deinking plants are entirely equipped with 0.15 mm C-bar baskets, all with excellent results in stickies removal.

Equally successful is the installation of a 0.15 mm C-bar screen basket in the approach flow section of a photographic

Fig. 9:
Macro-view of the C-bar screen basket.

Fig. 10:
Nothing succeeds like success: more than 700 C-bar baskets in various sizes have gone into service in a short space of time.

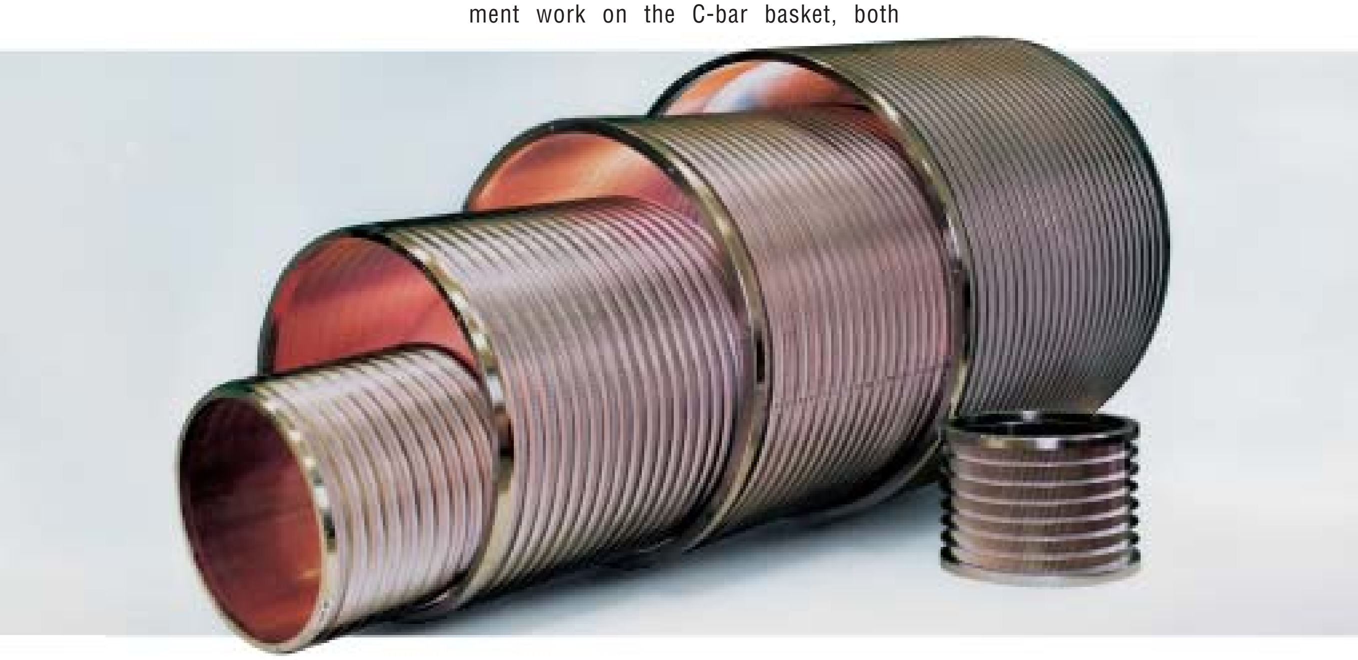
9 

paper machine – a particularly demanding application. Likewise 0.1 mm C-bar baskets are now in service successfully, for example in an American waste paper stock preparation line and in an SC paper mill, where the extremely fine slots and suitable profiling has brought unsurpassed splinter removal efficiency.

An important point is that in many cases existing screens cannot simply be upgraded with C-bar baskets. The operating parameters have to be taken into consideration as well as the kind of screen and the system layout, etc. Above all when extremely fine slots are required, screen and system behaviour deviates from experience with previous basket types.

C-bar baskets are currently in service for LC screening on waste paper stock preparation lines, for screening woody pulp and in approach-flow screening systems. They are soon to be used for medium consistency screening, and trials are already underway.

New applications and the associated problems demand continuous development work on the C-bar basket, both from the design point of view and with regard to manufacturing. By entering this high-tech field at an early date, Voith Sulzer has acquired not only considerable know-how in manufacturing C-bar baskets, but also wide background knowledge on their applications in the paper industry. This allows fast reaction to new demands.

10 

Stock Preparation Division:
The EcoCell, an example of synergy effects in flotation cell development

The new EcoCell combines the advantages of both existing Voith-Sulzer flotation cells – the E-cell and the Compact Flotation cell. These comprise on one hand the design features of the E-cell (simple control strategy, practically unlimited scale-up and inside aeration element), and on the other the technological benefits of the CF-cell (excellent efficiency in reducing a wide ink particle size range).

The authors: T. Martin and H. Britz, product group Flotation

This has been achieved by applying the CF-cell aeration principle to the E-cell aeration element. Initial tests on a pilot plant have confirmed the outstanding efficiency of the new Voith Sulzer EcoCell, and these will now be followed by operational trials in a paper mill.

After Sulzer Papertec and Voith joined forces in paper technology, one question was, which type of flotation cell should be followed up as a joint Voith-Sulzer product – the E-cell or the Compact Flotation cell *(see Figs. 1 and 2).*

Close comparison of the two types with regard to technology, design and operating principle brought the following findings:

The design advantages of the E-cell lie in the cell unit and periphery *(Fig. 1)*:

- Uncomplicated scale-up on a linear basis
- No scale-up limitations (except possible pumping limits)
- Simple level control by compensation between cells, i.e. only one level control loop per stage
- Interior aeration element, particularly advantageous with closed-circuit process air loops.

On the other hand, the CF-cell also has technological advantages due to its more sophisticated injector design *(Fig. 3).* This results in an excellent efficiency in reducing a wide ink particle size range, particularly including large dirt specks.

Comparative testing on the Ravensburg pilot plant showed that for relatively easily deinked waste papers (newspapers/magazines), both types of cell give equally good technological results in their standard layouts.

For waste papers which are difficult to deink, such as mixed office waste, laserprint and multiprint, the CF-cell removes large ink particles (200-400 µm) considerably better than the E-cell *(see Fig. 4).* Based on these findings, it was decided to use the E-cell for easily deinked waste papers (newspapers/magazines) due to its design advantages in this respect, while for difficult waste papers such as laser and multiprint, the more complex technology of the CF-cell was justifiable because of its technological benefits.

The next step was obviously to try and combine the advantages of both types. A valuable basis for this was the thorough research work carried out by Sulzer Papertec on further development of the compact flotation cell. It was found that greater efficiency particularly in dirt speck removal could be reached mainly by modifying the hydraulics of the air injection element.

In this way the principle of the CF aeration element was transferred to the mixing-bundle injector of the E-Cell. None of the existing design advantages of the E-cell were lost in this connection, in fact they were improved. The air suction hole of the E-cell injector was replaced by intake slots leaving almost the entire injector periphery free, thus reducing the possibility of air intake blockage.

As shown in *Fig. 5*, the comparative tests carried out on the new aeration element prove the technological superiority of the EcoCell both for easily deinked waste papers (newspapers/magazines) and difficult grades such as laser and multiprint.

As a next step, these positive results will be confirmed by practical trials on a flotation unit.

Fig. 1:
Principle design of the Voith Sulzer E-cell.

Fig. 2:
Principle design of the Voith Sulzer Compact Flotation cell (CF).

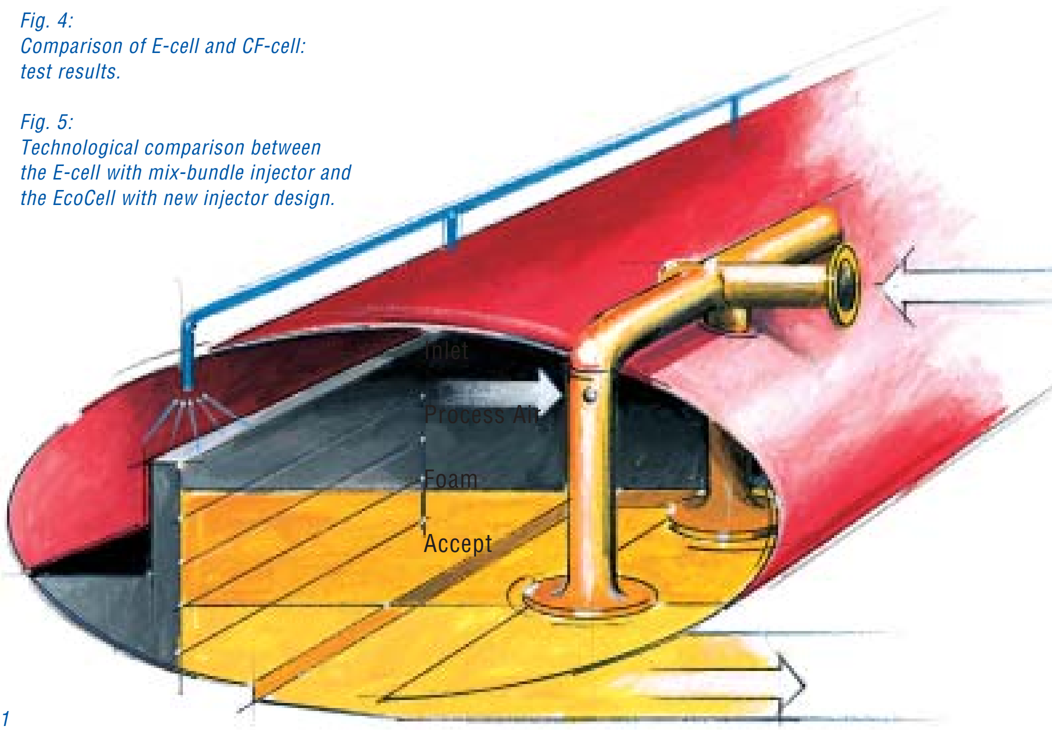
Fig. 3:
Design of the aeration element of the Voith Sulzer CF-cell.

Fig. 4:
Comparison of E-cell and CF-cell: test results.

Fig. 5:
Technological comparison between the E-cell with mix-bundle injector and the EcoCell with new injector design.

With the EcoCell, a flotation cell will be available in future which optimally combines the advantages of both existing types.

Apart from further tests on the EcoCell, upgrading kits are being developed at the present time which will enable existing flotation units of (...) to benefit from the new aeration technique (multi-injector tube cells or E-cells).



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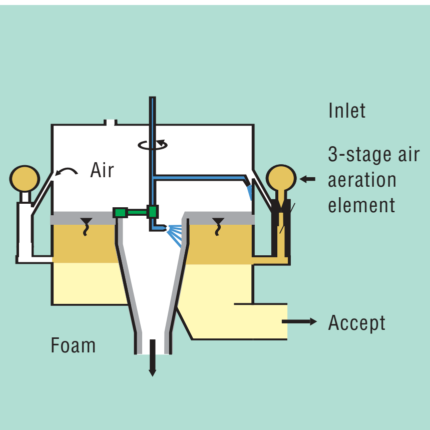

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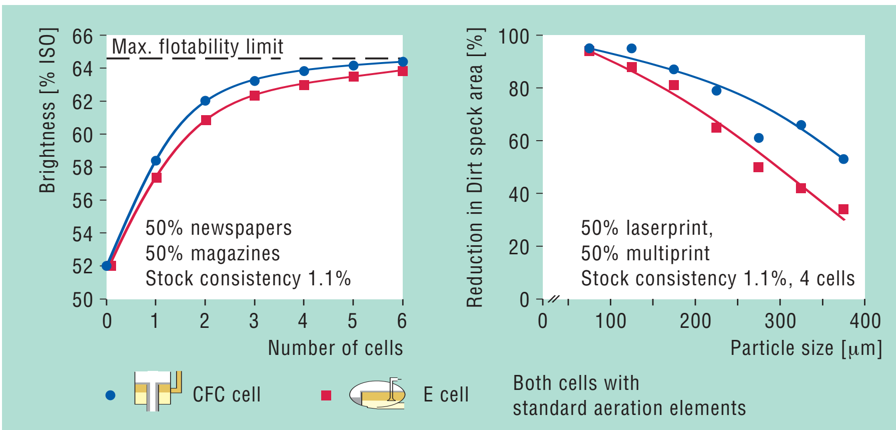

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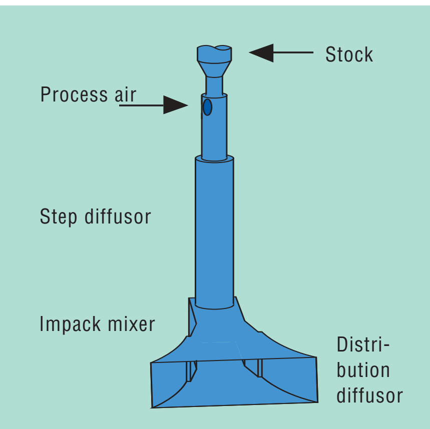

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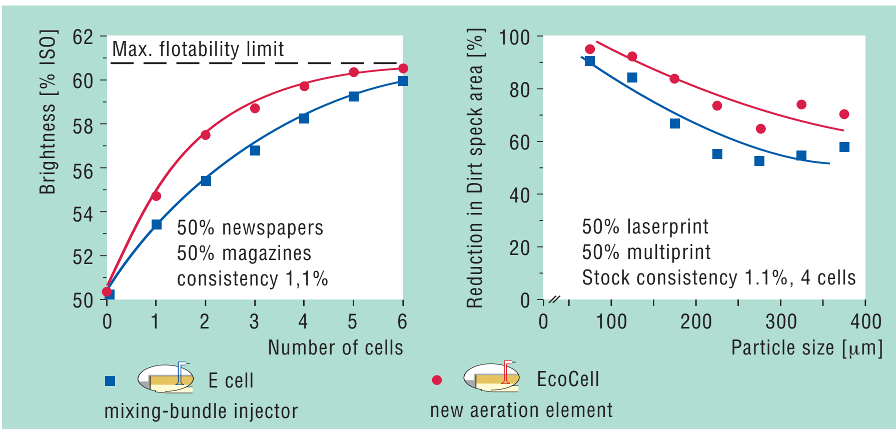

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Paper Machines Division:
NipcoFlex shoe press – the new product symbiosis

In 1984 the world's first closed shoe press went into service: the Voith Flexonip press. Two years later followed the Sulzer Escher Wyss equivalent: the Intensa-S shoe press. Thanks to their high efficiency and outstanding technological results, both systems soon became well-established *(see Fig. 1)*. A total of 26 Flexonip and 28 Intensa presses are now in operation, mainly for brown paper and paperboard production. Since Voith Sulzer Paper Technology was founded, orders have been booked for another 15 Flexonip and Intensa shoe presses.

The author:
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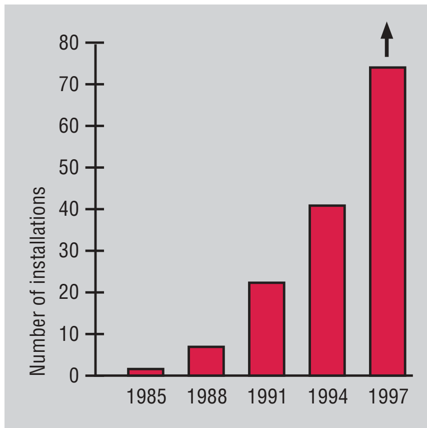
NipcoFlex Technology

The joint venture between Voith and Sulzer in paper technology has brought a symbiosis of the best products from both sides. Based on more than 200 years of accumulated operating experience with closed shoe presses, the greater patent freedom now applying has been exploited to unite the advantages of both concepts in a single product: the NipcoFlex press. This symbiosis is not limited to the roll and shoe alone, but also includes the backup roll – in other words, the entire press system *(see Fig. 2)*. Since the market launching of this concept, ten NipcoFlex presses have already been sold.

The new NipcoFlex roll shown in *Fig. 3* combines the shoe design of the Flexonip press with the pressing system of the Intensa press. Pressed against the roll by individual elements, the shoe is made up of an top and a bottom part which are thermally insulated from each other. As a result, thermal deformations are largely avoided. The shoe is asymmetrical to the pressing direction, displaced toward the ingoing nip. The flexible roll sleeve is likewise asymmetrical to the pressing direction, thus allowing a more favourable sleeve intake geometry. Lubrication between the press shoe and roll sleeve is purely hydrodynamic. To this purpose a lubricating oil distribution pipe spreads cool oil uniformly over the sleeve immediately after the press nip, thus ensuring freedom from wear. An added benefit of this single-source system is the above-average life of the yarn reinforced QualiFlex press sleeves, a patented product of Voith Sulzer Paper Technology.



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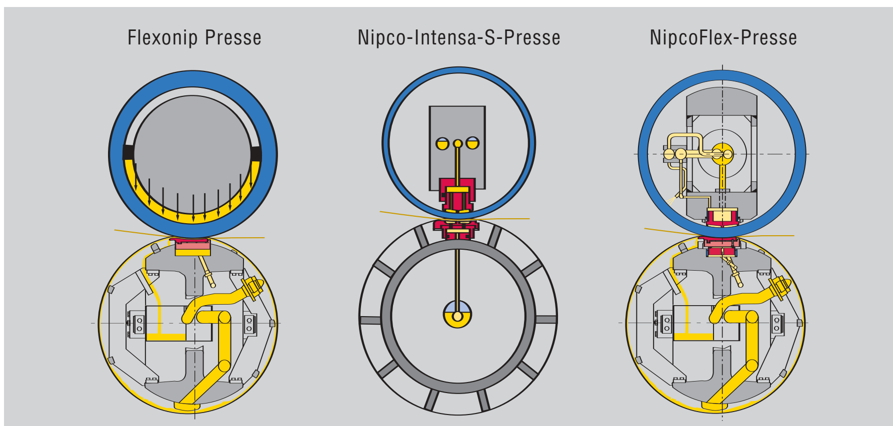

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As shown in *Fig. 4,* the shoe generates a pressure profile with three characteristic zones. In zone 1 the pressure rise is relatively steep until the beginning of the dewatering phase (zone 2), during which pressure rises more gradually to ensure uniform compacting. In zone 3 the pressure falls off steeply to prevent rewetting. This kind of pressure characteristic is indispensable for gentle dewatering and a uniform sheet structure with greatest possible volume retention. Apart from this, pressure profiles with moderate gradients and low maxima also give longer felt and sleeve life.

As backup to the NipcoFlex roll, the Nipco-P roll shown schematically in *Fig. 5* combines the advantages of the

Fig. 1: (page 21)
Sales development of Voith and Sulzer shoe presses.

Fig. 2: (page 21)
The symbiosis of Voith Sulzer shoe presses.

Fig. 3:
Cross-section through an inverted NipcoFlex roll: 1. Support structure, 2. Sleeve guides, 3. Press roll sleeve, 4. Lubricating and cooling oil, 5. Oil return, 6. Hydrostatic oil, 7. Lubricating oil distributor, 8. Pressing element, 9. Press shoe.

Fig. 4:
Ideal pressure profile.

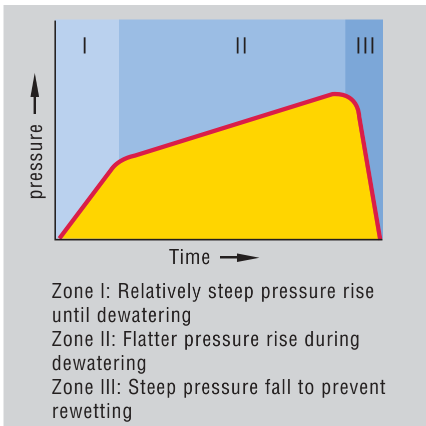
Fig. 5:
Longitudinal section through a Nipco-P roll: 1. Bearing housing, 2. Roll sleeve, 3. Support structure, 4. Pressure oil, 5. Pressing element, 6. Oil return, 7. Drive.

classical Nipco roll with the stable bearing positioning of the profile roll. In fact the designation Nipco-P stands for “position-stable”. The roll bearings are spaced directly opposite the main roll bearings, and therefore unaffected by the inevitable beam deflection. This brings some important advantages with regard to press operation. According to the well-proven Nipco principle, the roll shell run on internal hydrostatic support elements. As shown in *Fig. 6*, these operate on identical bearing surface areas in both rolls and are supplied with hydrostatic oil from a common feed pipe. This allows extremely simple and reliable control, only one valve being required, and neither the roll bearings nor roll shell can be damaged under any circumstances. Only at the edges are small compensation elements required for pressure relief in case the web width is changed.

One of the main reasons for the versatility of the NipcoFlex press is its compact bearing frames *(see Fig. 7)*. Thanks to patented link elements, mechanical forces are transmitted directly from roll to roll without the need for massive supports. This allows simple press design with good accessibility, as well as fast felt and sleeve changing.

So far shoe presses have mainly been used on paperboard and packaging paper machines, and only now are they coming into use for manufacturing wood containing and wood-free printing papers. Operating experience with the world’s first shoe press on a newsprint machine has shown that in this field as well, there is enormous potential for improving dry content, output and product quality. By using a shoe press instead of a conventional third press, dry content was increased by 5% to 49-50% – despite a 200 m/min speed rise to nearly 1200 m/min – thanks to the sixfold increase in line force *(see Fig. 8)*. This brought a productivity rise of more than 16% without any reduction in specific volume, which was even increased slightly. Sheet smoothness and 2-sided uniformity after soft calendering were improved at the same time. The technological results and cost-effectiveness of this concept have complied with all expectations.

For extremely high operating speeds, shoe press concepts with closed-loop web runs are available. In mid-1996 the world’s first 4-roll press with integral shoe press in the third nip is due to go on line in a 9.6 m wide newsprint machine operating at 1800 m/min. Compared with existing concepts, the design of this Duo-Zentri NipcoFlex press *(see Fig. 9)* represents a real quantum jump. With dry content reaching 48% or more



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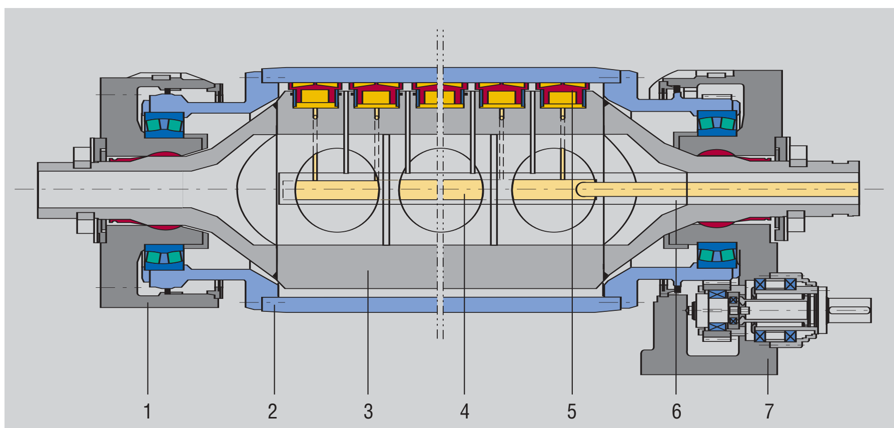

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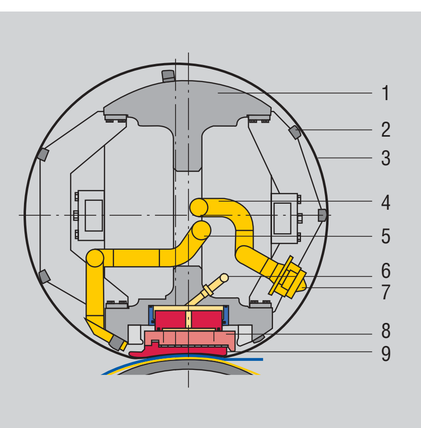

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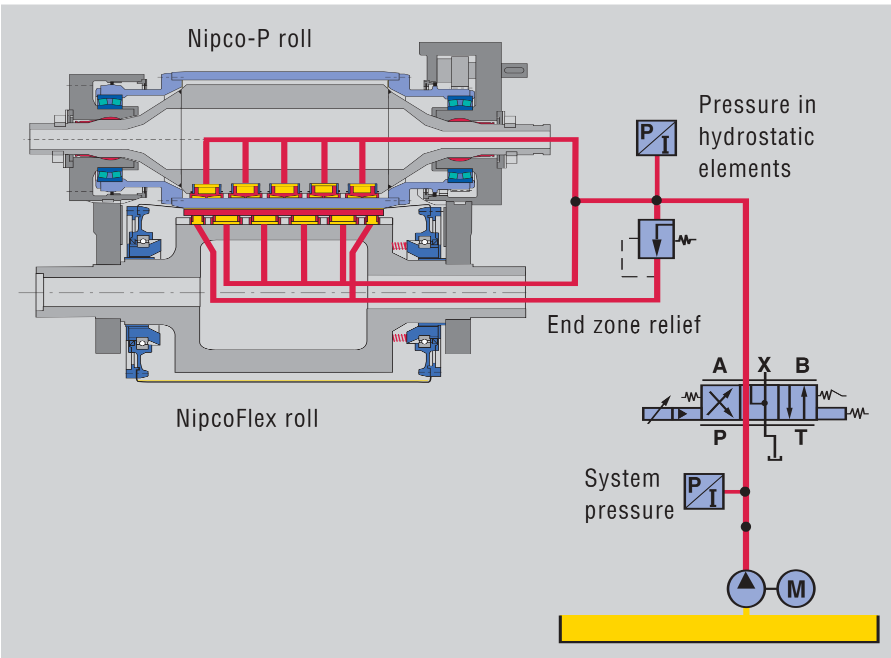
Fig. 6:
Pressurizing system of a NipcoFlex press.

Fig. 7:
Mechanical force transmission:
Conventional shoe press (left)
Compact NipcoFlex press (right).



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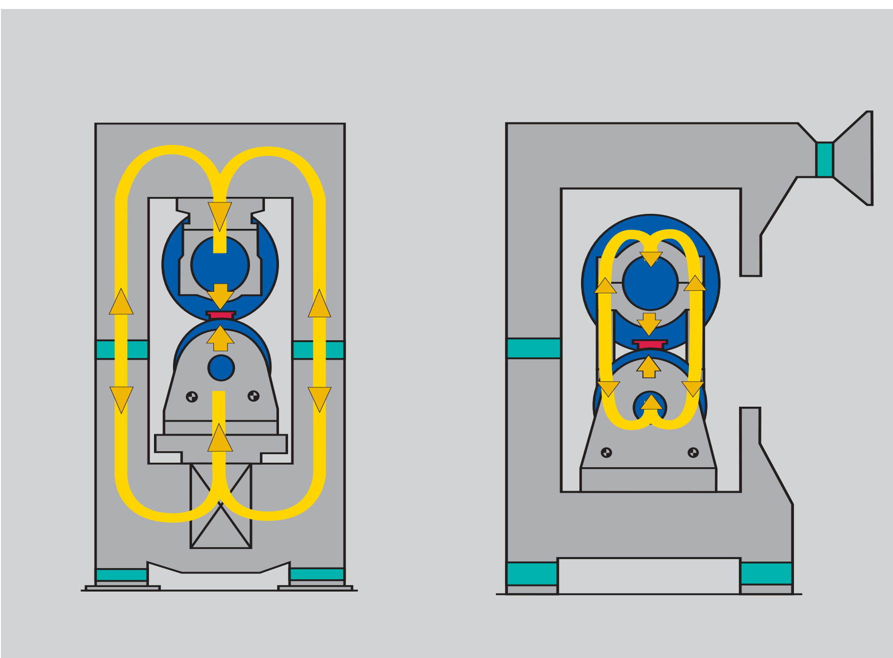

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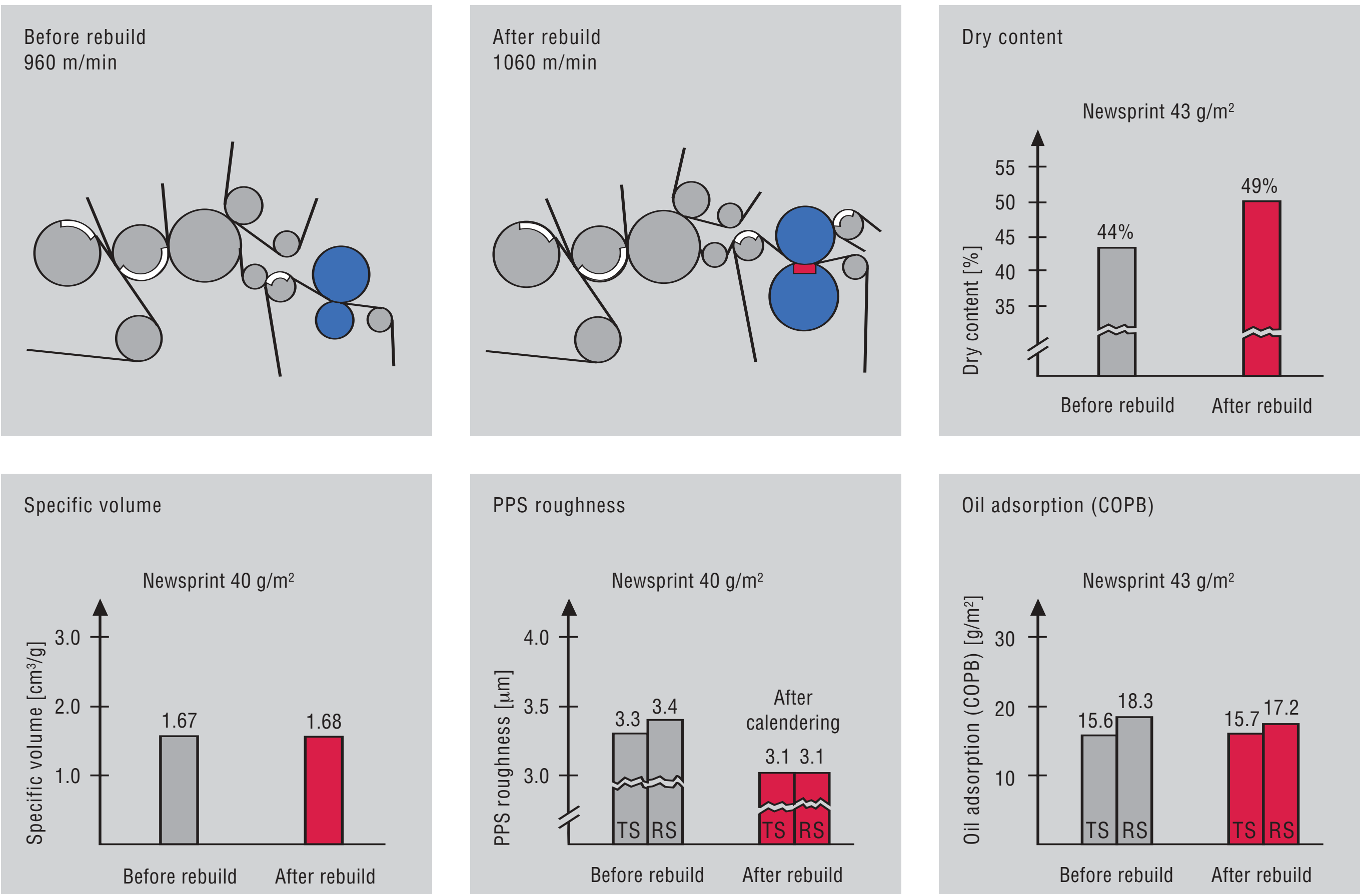
immediately after the press at an operating speed of 1700 m/min, and a basis weight of 42 g/m^2, productivity expectations on this machine are high indeed. Another decisive advantage over conventional 4-roll presses is of course the high volume retention during dewatering in the last nip.

Before shoe presses come into general use for wood-free writing and printing papers, a good deal of testing and operating experience is still required. The trend is clear, however: not only do shoe presses bring the decisive advantages of higher dry content and greater productivity, but in particular they also improve product quality. For these reasons shoe presses will soon be state-of-the-art for printing and writing papers as well as board and packaging products.

Fig. 8:
Technological results after conversion to NipcoFlex (Perlen No. 5 newsprint machine).

Fig. 9:
Example of a Duo-Zentri NipcoFlex press.



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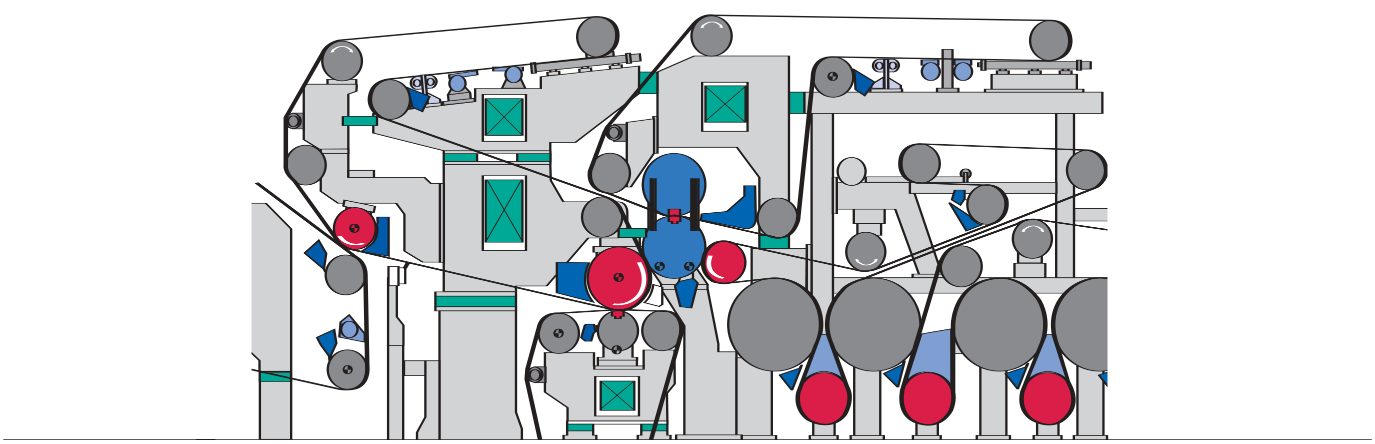
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Paper Machines Division:
Top DuoRun – a new dryer concept for high-speed paper machines

Summary

Machine operating speeds at the present time for producing printing paper are just over 1500 m/min on average, and new machines are now being designed for speeds up to 1800 m/min. Main requirements on the drying section of these fast-running paper machines are high availability and high specific evaporation capacity, with minimum energy outlay for the product grade in question. The Top DuoRun with its overhead dryer aggregates and DuoStabilizers meets all these requirements. The web is supported throughout the entire drying process, and in case of a break waste material falls on a conveyor belt which feeds it to the pulper. Thanks to short dryer groups at the beginning and end of the drying section, longitudinal web stretch and lateral shrinkage are compensated so that folds and breaks are eliminated. The combination of DuoStabilizers and drilled guide-rolls fixes the web on the dryer fabric, which not only stabilizes operation in the dryer section but also makes for lower operating costs. The ropeless tail transfer system ensures safe and reliable transfer through the dryer section, and an intermediate floor underneath allows better space utilization. The DuoCleaner keeps the dryer fabric clean at all times, thus ensuring good evaporation and reducing dirt content in the paper. In the V-Top DuoRun, the dryer section is arranged as a single line in vee-form, thus shortening it by about 20%.

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Drying Technology

Introduction

During the course of dryer section development, the bottom cylinder of a slalom drying group was replaced by grooved guide rolls for the dryer fabric. This was the beginning of single-tier paper drying. In front of the run-in gusset between the grooved roll and dryer fabric, a stabilizer had to be installed to prevent web lift due to air inclusions. This led to problems in the edge zones of the web, where air inflow prevented fixing to the dryer fabric.

For high operating speeds, the grooved rolls were replaced with suction guide-rolls. These fix the web over its entire width to the dryer fabric and counteract centrifugal force. The pre-suction zone of the roll, where the entrained air is sucked away, replaces the web stabilizer.

Combi DuoRun

The Voith Sulzer Combi DuoRun is a combination of single-tier dryer group in the first part, and double-tier dryer group in the second part of the dryer section. In modern paper machines this concept operates successfully at speeds up to 1500 m/min. With rising speeds, the number of double-tier drying groups and the number of cylinders per group has been reduced since problems were caused by the damp web in the open draw of the double-tier dryer group. The dryer section of paper machine 11 in the Schwedt mills *(Fig. 1)* has six Top DuoRun groups, and at the end of the dryer section a double-tier group with six cylinders. This was the first paper machine in the world to have only one double-tier drying group. The start up was in 1993 and now operates at more than 1500 m/min.

Top DuoRun

The latest generation of printing paper machinery is designed for operating speeds up to 1800 m/min. These high speeds and much higher investment costs place more stringent requirements on the drying section:

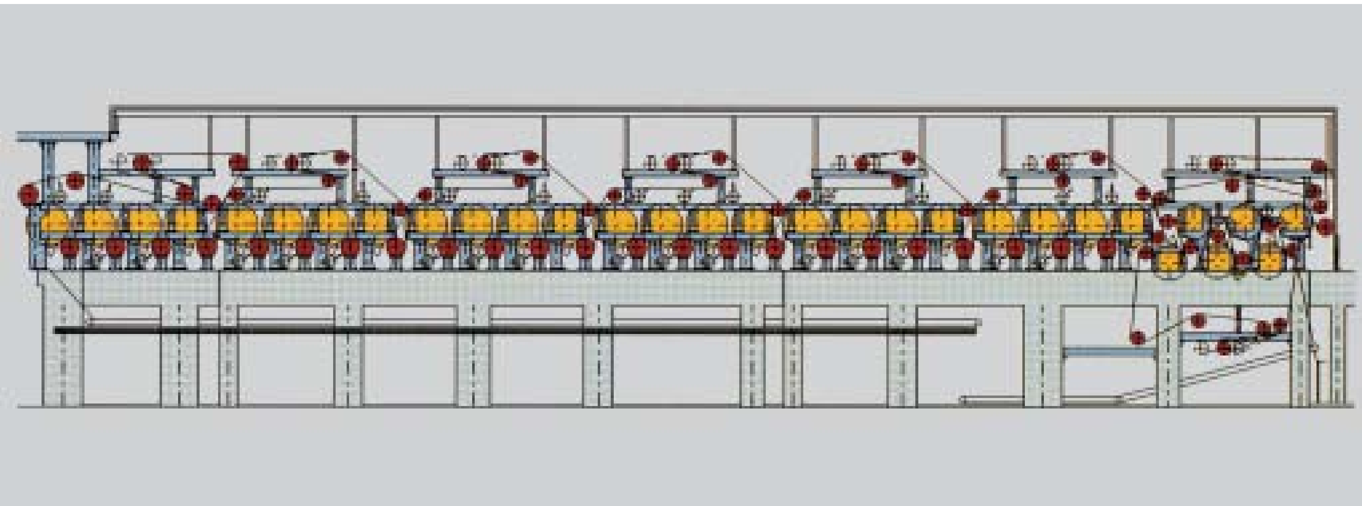
- High runnability
- High specific evaporation
- Low energy consumption
- High paper quality
- Lowest possible investment costs

In order to meet all these requirements at such high operating speeds, Voith Sulzer developed the Top DuoRun dryer section concept described in the following.

The Top DuoRun *(see Fig. 2)* comprises a single-tier dryer group with overhead drying cylinders. Under the cylinders are drilled guide-rolls, together with Duo-Stabilizers. Compact short dryer groups are installed at the beginning and end of the drying section.

Fig. 1:
Combi DuoRun.

Fig. 2:
Top DuoRun.



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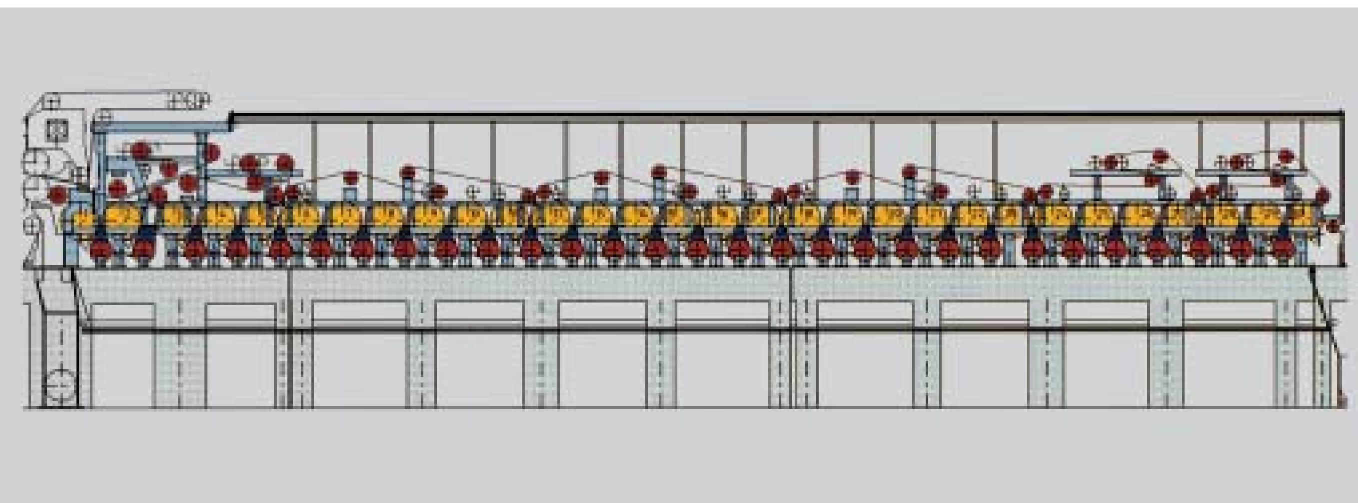

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Due to the overhead tensioning of the dryer fabrics, the space under the single-tier dryer group is free. As shown in *Fig. 1*, this was already utilized in Schwedt by installing an intermediate floor for the waste conveyor belt. The additional basement space can be used as roll and clothing store or for secondary aggregates. Not only is the cellar enclosure smaller and less expensive, but better use is made of available space.

Main components of the Top DuoRun

Rising demands on paper quality make machine cleanliness very important these days. For this reason all the drying cylinders are equipped with fold-out doctors to allow easy cleaning of the surfaces. The fabrics in the first dryer groups are cleaned continuously by DuoCleaners during operation.

All drying cylinders are dewatered by a stationary suction siphon. The suction siphon is ideal for fast-running machines since it works independently of operating speed.

The ropeless tail transfer system is reliable and trouble-free. Tail removal from the cylinder surface and attachment to the dryer fabric is assisted by air blow nozzles. Transfer in the drying section via the DuoStabilizer transfer zone and drilled roll is likewise assisted by air blowers. This system is simple and maintenance-friendly, and due to the short intermittent blower cycles air consumption is low. At the end of the dryer section the web is supported on the last drying cylinder, and cut by a water jet.

Together with the drilled guide roll, the DuoStabilizer sucks the web on to the dryer fabric and keeps it free of creases to allow reliable transport from roll to roll. The vacuum in the gap between outgoing fabric and box and in the fabric guide roll is provided by the DuoStabilizer, which is connected to a vacuum system. The gap is sealed at the top of the DuoStabilizer by a felt seal across the web and by air-jets at the sides. The felt seal folds away to allow changing of the dryer fabrics. On the operator side a transfer zone 500 mm long is incorporated in the DuoStabilizer and drilled roll. During the transfer procedure vacuum is applied to the transfer zone only. The amount of air to be sucked out in the DuoStabilizer is relatively small compared with the suction guide-roll, since the felt seal keeps out the air entrained with the fabric. Furthermore, the DuoStabilizer vacuum connection is not limited by the bearing diameter as in the suction-roll, so that it can be designed for low pressure losses. For these reasons smaller, lower-cost fans can be used.

Comparison of electrical energy consumption shows that the DuoStabilizer/drilled roll combination uses about 70% less energy than a suction roll, and about 60% less than the web stabilizer/grooved guide roll combination. Vacuum measurements on DuoStabilizers in production machines gave the following results:

In gap between outgoing wire and box	70-250 Pa
In dryer wire suction guide roll	250-700 Pa
In gap between incoming wire and box	10-30 Pa

The use of DuoStabilizers allows the evaporation distance between cylinders to be extended by up to 30%, without changing the roll diameter.

The DuoCleaner *(Fig. 4)* is a fabric cleaning device operated by water under high pressure. Dirt is removed mechanically, and the vacuum zone around the water nozzle sucks away the water and dirt particles rebounding from the fabric.

The DuoCleaner operates at a pressure of 200 to 300 bar and uses very little water (about 0.7 litres/min). This means that it can be used continuously throughout production. Even at low basis weights, there is no visible interference in the web. At the present time the DuoCleaner is used very successfully for basis weights between 35 and 160 g/m^2. It keeps the dryer fabric clean and thus helps to improve water evaporation on the side of the web away from the cylinder. This increases drying capacity and reduces web curling. Installed on a testliner machine, it was found that the DuoCleaner rapidly increased the air permeability of the dryer fabric from 270 to 375 cfm (new condition: 400 cfm).

Since shutdowns are not required for fabric cleaning, machine runability is improved and these components soon pay for themselves.

Fig. 3: Duostabilizer.

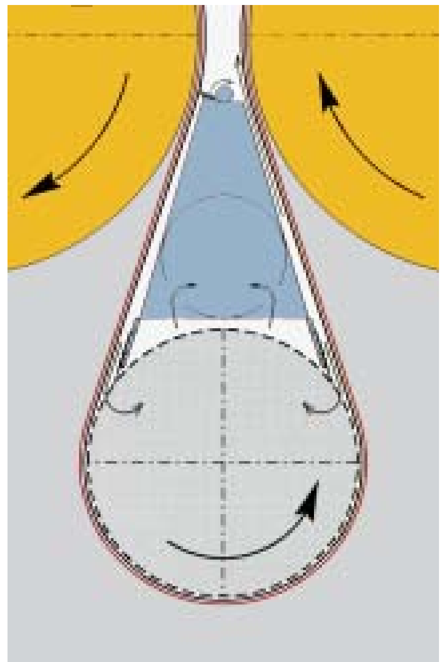

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Fig. 4:
DuoCleaner fabric cleaning device.

Features of the Top DuoRun

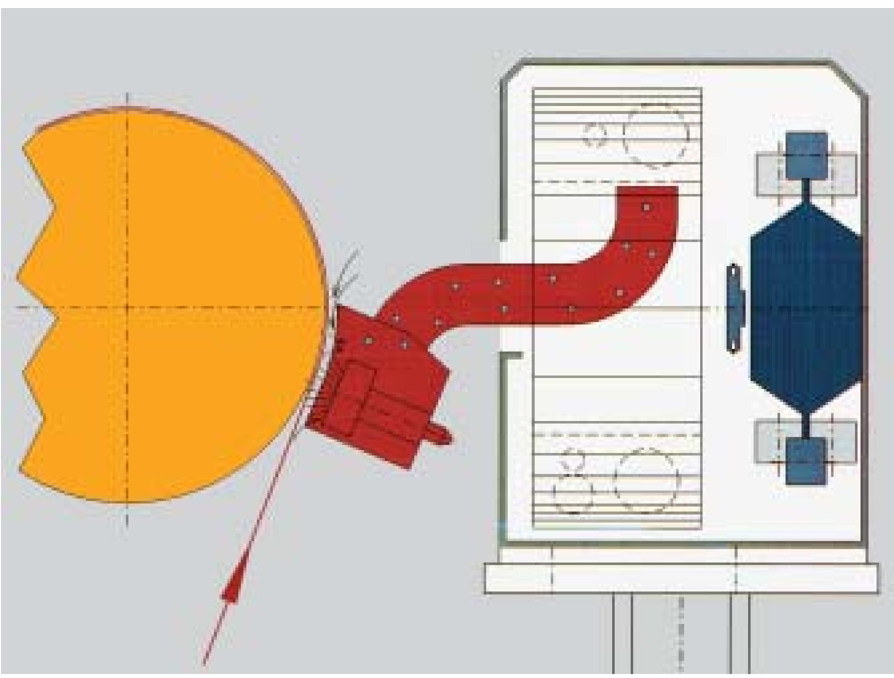
Stable running

After leaving the last press nip, the web is sucked on to the fabric of the first dryer group and fixed. It is then supported on the fabrics right through the dryer section, thus ensuring stable running and reducing the risk of a break rupture to a minimum. The combination of DuoStabilizers and dryer fabric drilled guide roll transports the web reliably from cylinder to cylinder.

At the cylinder runout point the DuoStabilizer fixes the web by suction on the dryer fabric. The vacuum balances out the centrifugal force around the drilled guide roll and thus keeps the web fixed to the dryer fabric.

High specific evaporation

Thanks to the high specific evaporation, dryer sections are shorter and investment costs lower. To increase the heat transfer from steam to web, all cylinders are fitted with spoiler bars. In order to reach such a high evaporation capacity, the heated web must be able to dry out sufficiently after leaving the cylinder. To this purpose the DuoStabilizer provides a long evaporation distance. Since most of the evaporation takes place below the cylinder in the Top DuoRun, hot air blow pipes are installed at this point. These blow pipes are dimensioned so that more fresh air is blown into the centre of the machine. The moist air then flows equally toward the operator and drive sides of the machine, thus removing the water vapour on both sides to ensure a uniform humidity profile.



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High availability

The Top DuoRun ensures high availability, with short down times and consistently high paper quality. Its stable running characteristics reduce web break frequency to a minimum. A significant advantage of this cylinder arrangement is the short tear-off time required. Waste material falls on to the conveyor belt below and is transportet automatically to the pulper. As a result, time-consuming removal of waste from the drying section is no longer necessary. The ropeless edge strip transfer system ensures fast and reliable transfer, without any time wastage due to rope wear or breakage.

Controlled paper shrinkage

Due to the rising web temperatures at the beginning of the dryer section, the initial wet strength falls off and web extension increases. When the web is tensioned, it extends in the longitudinal direction and its width shrinks.

The DuoStabilizer fixes the web to the dryer fabric by suction at the cylinder take-off point. Relatively small forces are required to remove the web from the cylinder surface, so that longitudinal extension and lateral shrinkage are low. Thanks to the small dryer groups, extension in the wet part of the web can be compensated by speed adjustment, thus preventing folds.

In single-tier dryer sections, the web is firmly fixed to the dryer fabric and prevented from shrinking. This generates web stresses which can cause tearing. By

Fig. 5:
V-Top DuoRun.

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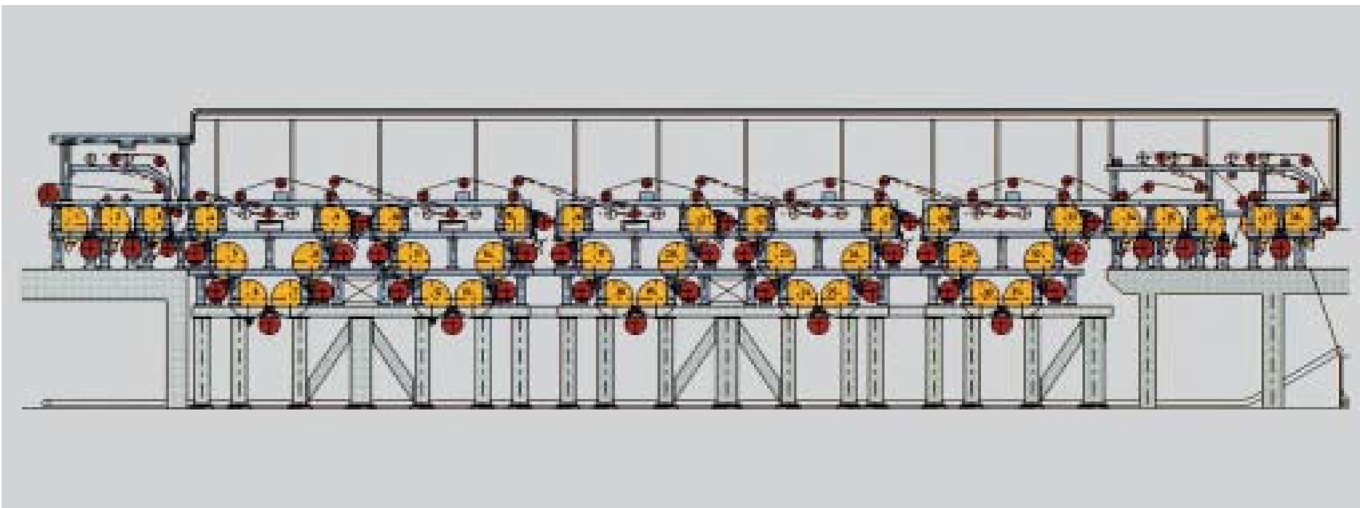


means of short dryer groups at the end of the dryer section, allowance can be made by speed adjustments for web shrinkage, thus preventing breaks.

Prevention of curling

One-sided drying makes the web tend to curl. This curling tendency is caused in the dryer section by unequal water distribution between the top and reverse sides of the web, which therefore curls toward the most recently dried side. Tests on paper machines in practice have shown that curling can be controlled quite precisely by adjusting side-to-side humidity distribution. This can either be done in the drying section or afterwards. According to these tests, one-sided drying has no effects on other paper characteristics.

The first Top DuoRun will start up in Sweden early in 1996 on a newsprint machine designed for an operating speed of 1800 m/min.

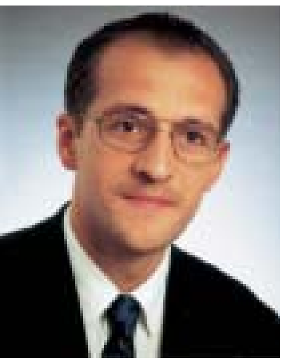
V-Top DuoRun

The V-Top DuoRun *(see Fig. 5)* was developed in order to minimize paper machine investment costs. It likewise comprises a single-tier dryer section, but arranged in vee-form. At the beginning and end of the dryer section short horizontal dryer groups can be installed. The vee-configuration is more compact than the horizontal arrangement, and allows more effective utilization of space below the drying section.

The V-Top DuoRun is accessible from several servicing levels. In case of web break, the waste material falls on to a conveyor belt below the machine. With the Vee configuration, drying capacity can be increased without sacrificing space, thus making it ideal for rebuilds. For the same number of drying cylinders, the vee configuration is about 20% shorter than the horizontal configuration.

Paper Machines Division:
Coating with the JetFlow F

JetFlow F is the name of our new blade-coater generation. The new Voith Sulzer blade-coater was developed to maturity in only three years, and is now well-proven in practice. With enormous potential for output and product quality, the JetFlow F sets new standards in the paper industry. If we were to adopt Olympics terminology, we could say that the JetFlow goes faster, higher, further and cleaner – in other words:



The author:
Bernhard Kohl,
Application engineering coaters

- This coating machine runs faster (better runnability)
- Coating quality is higher than with other types
- It has wider applications than other types
- It uses jet-sizing – the cleanest way to coat paper.

This article summarizes the development and technology of the JetFlow F. As shown by experience, the success of this new blade-coater is due to a complete understanding of the principles and interrelationships involved.

1. Basic principle

In the early 1990s, a well-known USA paper producer had a good idea – to develop a free jet coater for a predetermined coating thickness, evened out by a blade. This idea was not new, but it took considerable brain-storming between customers and engineers to make it feasible. In order to put the idea down on paper – literally – we converted our pilot machine in Heidenheim accordingly.

2. Development

After innumerable tests, rebuilds and optimizations, the JetFlow F was finally born. Parameters such as jet angle, length, velocity and consistency for the right coating quantity and pressure were worked out. A significant feature is the curved outflow lip (patented) resulting from this development work. At the same time a coating deaerator was developed for this system which likewise improves all other free jet coaters.

3. Trials

In May 1993 the first two JetFlow F coaters were installed in the USA. Right from the outset, they met all quality demands for fine papers – although the coating formulations used here had been developed and optimized over some decades for roll-type coaters.

This was where the customer contribution to development work really started. If the JetFlow F could meet roll-type coating quality with these formulations, what quality levels might it reach with formulations optimized for jet-sizing? – Better ones!

4. Results

Many paper producers are interested in the JetFlow F because they have problems with their existing coaters. Exhaustive tests on the Heidenheim pilot coating machine have proved the versatility of the JetFlow F, and market acceptance is shown by the following reference list *(Tab. 1)*.

Tab. 1: JetFlow F Reference list

Customer	Coating system	width mm	speed m/min	Paper grades
Rapids 64 USA	2 JetFlow F Off-CM	3680	1070	80-200 g/m^2 single and double coating
Biron PM 24 USA	1 JetFlow F On-CM	3680	762	LWC 60-80 g/m^2
Plattling SM 11 Germany	2 JetFlow F Off-CM	7610	1550	LWC 35-70 g/m^2
Gratkorn SM 9 Austria	2 JetFlow F Off-CM	6450	1250	80-240 g/m^2 single and double coating
Kuusankoski PM 7 Finland	2 JetFlow F On-CM	4660	900	60-150 g/m^2 Precoating with Speedsizer
N.N. Finland	2 JetFlow F On-CM	7680	1400	LWC + MWC 6-16 g/m^2
N.N. (LOI) Brazil	2 JetFlow F On-CM	7560	1500	LWC 40-70 g/m^2

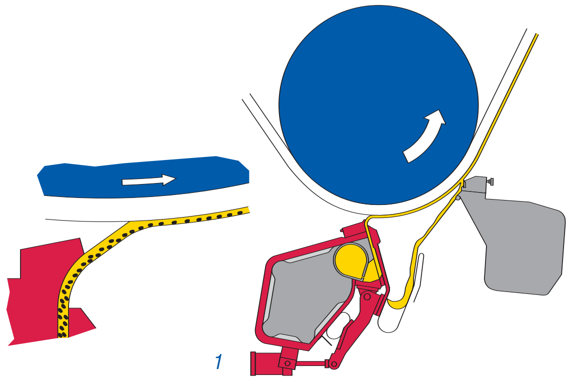


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Fig. 1:
Schematic arrangement of the JetFlow F.

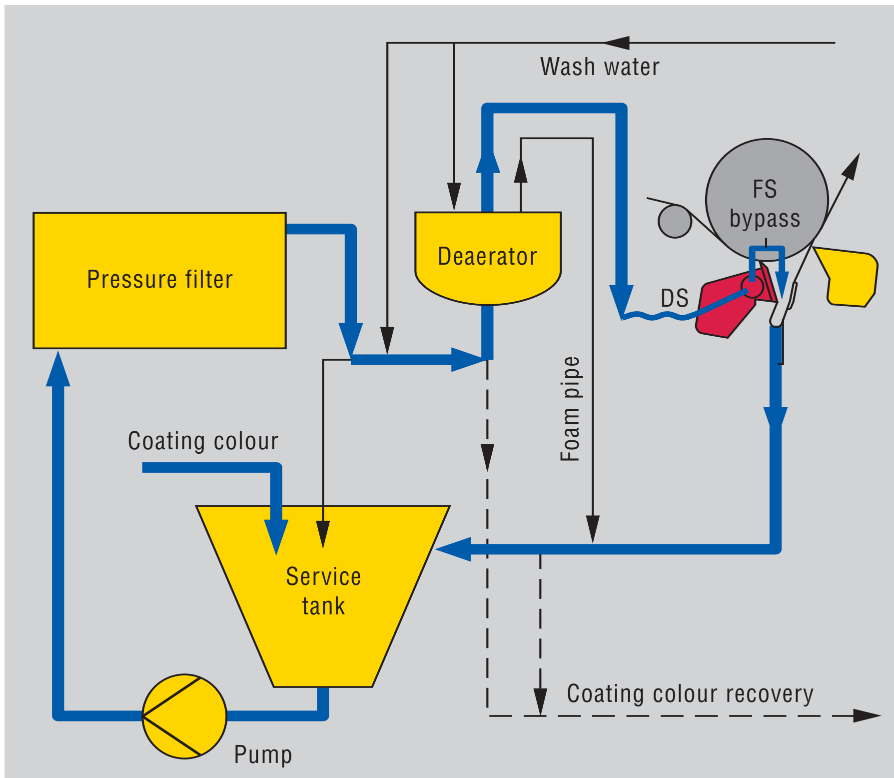
Fig. 2:
JetFlow F coating principle.

5. Operating principle

A thin coating film is applied in the form of a jet at a defined angle *(Fig. 1)*. Air entrainment is prevented by the vertical force component. Since the paper web moves faster than the jet, the application area is greatly extended. This makes the film much thinner and more uniform than in conventional coaters, with the following benefits:

- Better cross-profile
- Lower blade loading
- Smaller recirculation flow

In order to eliminate the air entrainment problem applying to all other types of coater, the coating jet is preceded by a deaeration unit *(Fig. 3)*. In addition, the curved outlet lip ensures centrifugal mixing of the coating material, so that by the time it reaches the web it is completely free of air.



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6. Technology

The JetFlow F induces no pressure penetration as in conventional coaters, but dewatering during the dwell time is unrestricted and therefore more uniform. Furthermore, the coating material is more liquid when it reaches the blade. After equalizing, the coating structure is thus better.

7. Clean operation

The JetFlow F is a closed system, and coat reaches the paper without film splitting. As a result, coating takes place cleanly without any spray, mist or deposits. Between the nozzle, blade and return flow plate of an LWC coater, for example, a mirror-finish film without any stripes can be seen over a distance of 7 m through the machine at 1500 mpm. The range of applications tested so far on the pilot machine is very wide *(Tab. 2)*. Practical experience is not sufficient as yet to assess overall potential, but based on test results so far we are confident of meeting all market challenges.

Tab. 2: JetFlow F Applications successfully tested

Raw paper:		
– wood-free	50 - 140	g/m²
– wood-containing	28 - 290	g/m²
Coat weight	4.5 - 17	g/m²
Speed range	330 - 1800	m/min
Solids content	(4)50 - 70	%
Viscosity range *(100 rpm Brookfield)*	(140)1200 - 2400	mPa·s

Finishing Division:

The Janus Concept – the future of paper finishing

For a number of uncoated and coated paper grades, softcalenders installed online and offline are also currently being used with success for calendering in addition to the proven supercalenders. The essential challenges for the future will be improvement of the efficiency of the manufacturing process with simultaneously increasing quality requirements. The experience available for both processes results in the necessity of developing completely new calendering concepts to meet these market requirements.

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The following provides a summary of the arguments decisive for the development of new calendering concepts. The technical and technological possibilities of the new Janus Concept to be installed online and offline are presented. In comparison to the classic supercalender, the exceptional advantages lie in online integration for each production speed, the lower number of rolls in conjunction with the use of plastic covers, the distinctly lower calendering temperature compared with the softcalender and the considerably lower energy requirement achieved as a result.

Laboratory results will be discussed with respect to a comparison between the Janus Concept and supercalender for highly compressed paper applications, i.e. LWC-Roto and SC-A, which show that the gloss and smoothness values and printability for such papers are comparable with the current SC-finish, also for PM and SM speed.

Introduction

Until the beginning of the 1980's, calendering was carried out exclusively by means of supercalenders and machine calenders. While the supercalender is distinguished by its technological advantages due to the use of elastic rolls, the advantages of the machine calender lie in its efficient operation, whereby the uniting of these two positive arguments were the basis for the development of the softcalender, which in meantime has established itself on the market.

Before dealing with the developments of the Janus Concept, a completely new calendering technology, it is meaningful to take stock between the supercalender and the softcalender in order to clearly show the arguments decisive for the new process.

Table 1 initially shows the calender types which could currently be considered for a wide variety of papers, whereby the main difference here lies in the higher number of nips of 8-13 in the case of the supercalender, compared with 1-4 individually controllable nips of the softcalender. If these criteria are transferred to the calendering process, the supercalender is accordingly provided with considerably more nips for densification the paper via

Table 1: Comparison between supercalender and softcalender

	Supercalender	**Softcalender**
No. of nips	8 - 13	1 - 4
Cover material	native fibre/plastic	plastic
Cover hardness	85 - 91° ShD	85 - 94° ShD
Max. line load	350 N/mm	350 N/mm
Max. specific pressure	39 - 50 N/mm^2	31 - 40 N/mm^2
Max. surface temperature	100°C	200°C
Roll diameters	smaller	bigger
Load changes	2/revolution	1/revolution
Speed	450 - 900 m/min	PM/SM speed

pressure and temperature, while in the softcalender, a distinctly higher amount of energy has to be supplied for web densification per nip for a comparable calendering result.

Furthermore, it is important to show, on the basis of *Table 1*, to what extent the two calendering processes additionally differ from each other (1).

The table clearly shows why higher calendering temperatures are necessary for the softcalendering process. The larger roll dimensions are effecting a wider contact zone, which results in a lower compressive stress being produced based on a comparable line load compared with the supercalender.

For a conversion energy comparable with the supercalendering process, considerably higher surface temperatures are accordingly necessary in the case of the softcalender.

An important point is the energy to be installed for both calendering processes. Based on a 8 metre wide plant, energy has to be installed for a four-nip online calender with about 50% more in comparison to two offline 12-roll supercalenders.

A further difference lies in the fact that covers made of cotton or a composition of cotton and wool are still used to a large extent in the supercalender, in contrast to the softcalender, where only plastic covered rolls are provided. The advantages of the plastic covers are given by their higher mark resistance and a better wear resistance, which finally serve to ensure a long life time. Cotton rolls by contrast are subject to a higher mechanical load because of the double load change per revolution in the supercalender, compared with the plastic covers in the softcalender. The previously lower loading capacity of the plastic covered rolls is an argument which is currently

Table 2: supercalender advantages/disadvantages

Advantages	**Disadvantages**
Many nips with high degree of coverage	Limited speed range
Good distribution of calendering work between load and temperature	Online installation not possible
Process technically and technologically wellknown for decades	Limited temperature range
All paper grades can be finished at high quality	Small influence onto two-sidedness
Low amount of energy to be installed	Low efficiency because of roll and reel change downtime
	Dependence of line load from top to bottom nip
	High space requirement with additional

Table 3: Softcalender advantages/disadvantages

Advantages	**Disadvantages**
Online installation possible	Not suitable for all paper grades
Individual controllable single nips	High amount of energy to be installed
Minimisation of two-sidedness	Compression lines problem can occur
Wide load and temperature range	Only few nips
High efficiency because of less roll changes	
For online installations low space requirement without add. personnel	

still responsible for the main use of cotton covers in supercalenders. However, one cannot fail to notice that plastic covers are increasingly being used in supercalenders, whereby their installation positions are mainly in the upper calender area. In this connection, a technological aspect resulting from moving to plastic covers should not remain unnoticed. As a consequence of the internal friction, on account of their larger hysteresis, the cotton covers are subject to a higher temperature development, which is simultaneously a component of the conversion energy. In the case of plastic covers by contrast, a clearly lower temperature development is noticed. A supercalender equipped with such rolls produces lower gloss and smoothness values under comparable calendering conditions as a result.

For the purpose of further clarification, the advantages and disadvantages of both calendering processes are shown in the *Tables 2 and 3 (2)*.

The list essentially shows that the supercalender cannot follow the current speeds of modern paper and coating machines. The capacity of the standard two supercalenders is frequently exceeded today. A second or third supercalender involves higher investment costs for buildings and also add. personnel costs. The main features of the softcalender are summarised in *Table 3*.

Summarised, the main advantages of the softcalender are its high efficiency and flexibility, whereby the latter mentioned feature refers to minimisation of the two-sidedness, due to individually controllable single nips and the wide temperature and line load range.

It should be mentioned that the successful use of the softcalender in the case of specific paper grades, e.g. high gloss qualities, was initially made possible by engineering advances and the additionally created preconditions from the papermakers. The latter mentioned includes, in addition to levelling the cd-profiles, a coating formulation which has been consistently adjusted to the changed conditions of the softcalender.

The necessity to reconsider current calendering possibilities is also underlined by the results of extensive tests carried out for a highly compressed SC-A paper (3). The core statement here was that the printability of a SC-A paper, supercalendered with eleven nips, can also be achieved with only four nips of a softcalender when the temperatures of the chilled iron rolls reach minimum 160°C and the compressive stresses of all nips are in a range, as are present in the bottom nip of a supercalender loaded with 350 N/mm. However, this applies only to a speed range of about 500-700 m/min, i.e. the calendering speed of the supercalender usual for this type of paper.

The Janus Concept

Decisive for the development of a new calender concept was the requirement for an online installation for any conceivable production speed in conjunction with a finish being produced which is comparable to or better than a supercalender.

The task basically represents the total synergy between the supercalender and the softcalender. Because of this double task, the concept was given the name of the ancient god with two faces: the Janus Concept. One face reflects tradition, the supercalender and the softcalender, the other looks ahead towards new calender technology.

Table 4 Janus Concept requirements.

- Finish of all paper grades at high quality
- online and offline installation possible
- High efficiency including less roll changes
- Low space requirement without add. personnel
- Low amount of energy to be installed
- Less energy loss during operation
- Minimisation of two-sidedness
- Wide load and temperature range

The core principle of the Janus Concept is that only the number of nips necessary for calendering a specific paper quality is used. Missing nips, which are to be equated with mechanical conversion energy, are not replaced by thermal energy only. Based on the results of numerous analyses which showed that the high number of nips as used in the supercalender is unnecessary for the actual calendering process, a maximum of eight rolls resulted for the Janus Concept.

Fig. 1:
Janus Concept with 2 x 5 rolls.

Fig. 2:
Janus Concept with 1 x 8 rolls.

Fig. 3:
Janus Concept: Formula.

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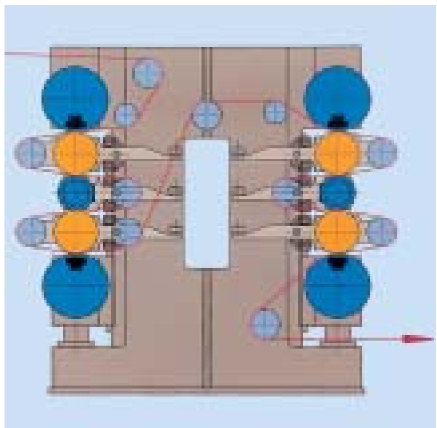

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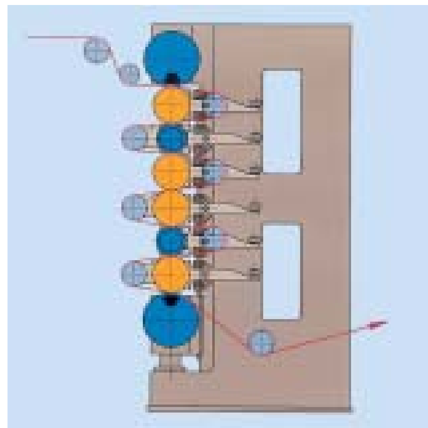

An initial precondition for online integration of the Janus Concept is controllability of paper web threading at full PM or SM speed. Several years of intensive tests on a pilot plant, developed specifically for this purpose, showed that web threading can take place successfully by a combination of aerodynamic elements with ropes and belts.

The most significant difficulties did not occur at the beginning as actually expected with web guidance within the calender, but rather with web transfer to the calender. The control of problem-free web threading also assumes the drive of all rolls installed in the calender.

Against the background of the finish, comparable with the supercalender in conjunction with minimum two-sidedness, one solution could be the division of the supercalendering process into two processes, represented by the two stacks, consisting of 5 rolls respectively. Additionally it was examined how a single stage solution with 6-8 rolls could meet all requirements. Like the supercalender, a roll reversing nip must also be provided for two-sided calendering. The two-sidedness can be controlled by influencing the increase of line load nip by nip, using different roll materials and precalculated nip widths.

The question naturally arises as to how the energy plus of the Janus Concept is achieved compared with the supercalender, since the same result is to be achieved with less nips at a considerably higher calendering speed.

From the wide range of information acquired from available supercalenders, a mathematical description of the distribution of the calendering work in the nips of a calender could be found with the aid of extensive analyses.

Figure 3 shows the calendering range of the Janus Concept in three-dimensional form. Illustrated in this case for the 8-roll version, for example, is the bulk of a SC-A paper, applied to the Y-axis, as a function of the dwell time, applied to the X-axis and compressive stress, applied to the Z-axis. As curved surfaces in space the bulk at 100 and 150°C surface temperature can be seen.

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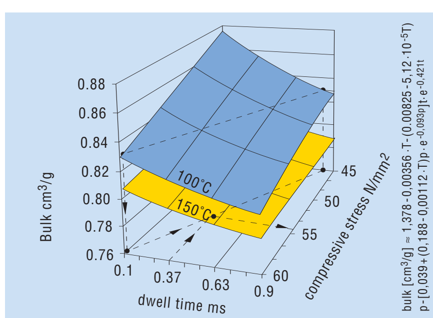


This spatial representation is based on the equation shown below which makes it possible to predetermine the necessary calendering temperature and compressive stress as a function of speed or dwell time for any number of nips. In principle, this equation describes nothing else than the influence of these parameters on, e.g. the bulk of a paper. Equations can naturally also be used in a similar form for specific gloss or smoothness values for the respective customer product, i.e. for the respective paper quality.

These calculations result, particularly in the case of papers to be highly compressed, in necessary nip numbers which a softcalender can normally not provide.

In order to make this “multi-nip online calendering process” possible, a whole series of technical elements are necessary. The most important features of the Janus Concept are accordingly listed in *Table 5*.

Due to the considerably smaller rolls and high line loads compared with the softcalender, compressive stresses up to 60 N/mm^2 can be realised in the Janus Concept, whereby the development of suitable plastic covered rolls took place at the same time. The new roll generation withstands the high mechanical and thermal loads whilst maintaining the familiar advantages of low sensitivity to marks and high wear resistance, which ensures a long life time.

Table 6: Energy balance Janus Concept – softcalender – supercalender

	4-Nip Softcalender		**2 Supercalender**		**Janus Concept**	
	installed	consumed	installed	consumed	installed	consumed
Heating capacity	4320 KW	3140 KW	1950 KW	1300 KW	1860 KW	1430 KW
Drive power	3300 KW	2100 KW	2600 KW	1600 KW	2480 KW	1580 KW
Power for units	520 KW	400 KW	950 KW	440 KW	260 KW	140 KW
Power for winder	0 KW	0 KW	720 KW	360 KW	0 KW	0 KW
Total kW	8140 KW	5640 KW	6220 KW	3700 KW	4600 KW	3150 KW

Table 5: Janus Concept – Features

- High-speed open-nip threading system
- All rolls driven
- New generation of plastic covered rolls
- Midrange-heated intermediate rolls with new type of surface treatment
- Heated top and bottom roll
- Individual temperature control of all thermo-rolls
- Lever-type calender with overhanging load compensation

In addition to increasing the mechanical conversion energy, the proportion of thermal energy also had to be adapted to the new concept. By using new types of heat rolls, surface temperatures of about 150°C with minimum cd-profile deviations are achieved. Each roll is allocated a separate temperature control loop. The oil-heated deflection compensation rolls in the top and bottom position permit surface temperatures of about 130°C, whereby each roll is similarly allocated its own control loop. Thus, a total of four control elements are available for thermal reduction of two-sidedness.

The Janus Concept accordingly moves in a temperature level above the supercalender, however, distinctly below the temperatures necessary for the softcalender. In conjunction with the considerably smaller roll diameters compared with the softcalender and utilization of thermal energy of a heating roll in two nips, the heating capacity to be installed is drastically reduced and the heat losses to the atmosphere are considerably reduced as well. Table 6 shows the capacities to be installed, as well as the energy consumption of the Janus Concept in comparison to an online 4-nip softcalender or two 12-roll offline supercalenders for an assumed machine width of 8 m.

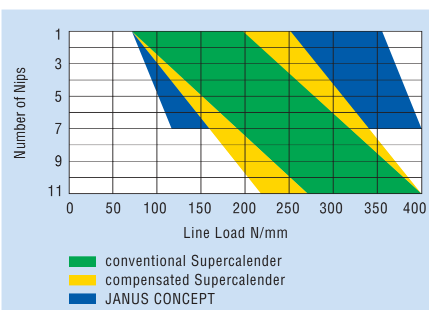
For the two calenders to be installed online, the Janus Concept and softcalender, an operating speed of 1200 m/min at a design speed of 1400 m/min was taken as a basis. For the supercalender an operating speed of 800 m/min respectively at a design speed of 1000 m/min was taken as a basis.

Assumed as maximum surface temperatures were 85°C for the supercalender, 150°C for the Janus Concept and 200°C for the softcalender. The maximum line loads are about 400 N/mm for the supercalender, about 550 N/mm for the Janus Concept and about 370 N/mm for the softcalender.

The table clearly shows that the Janus Concept has an approximately 15% lower energy requirement compared to two supercalenders, and an approximately 44% lower energy requirement compared to the softcalender. The Janus Concept also has significant advantages for the energies to be installed: 26% less than the supercalender and 45% less than the softcalender.

Further essential features of the Janus Concept are in the consistent realisation of the constructive functional units of the new lever-type calender generation with overhanging load compensation, which considerably improves the quality of line load distribution in the individual nips.

In conjunction with the achieved weight reduction of 50% for the elastic rolls, the weight compensation distinctly increases the operating capacity of the Janus Concept. With comparable line load in the bottom nip, the overhanging load compensation and reduction of the roll weights as such enables a distinctly higher line load in the above located nips, i.e. the line load characteristic from bottom to top becomes steeper. *Figure 4* shows the line load range of each individual nip of the Janus Concept in comparison to a



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conventional calender or a compensated calender.

The steeper the line load characteristic, the less the line load differences are between the bottom and top nip, which has a positive effect on the reduction of the two-sidedness (4). Clearly distinguishable is also the enormous line load range of the Janus Concept compared to the relatively limited range of the supercalender.

The available high compressive stress, the steep line load characteristic, as well as the temperature range up to 150°C when using seven nips, create the precondition for calendering virtually all paper grades at the respective PM and SM speed, based on the Janus Concept.

The test results achieved according to the Janus Concept with SC-A paper and LWC paper for rotogravure printing are discussed in the following. A laboratory calender with all features of the Janus Concept will be commissioned in the summer of this year and will be available for customer tests from autumn onwards.

Calendering of SC-A paper acc. to the Janus Concept

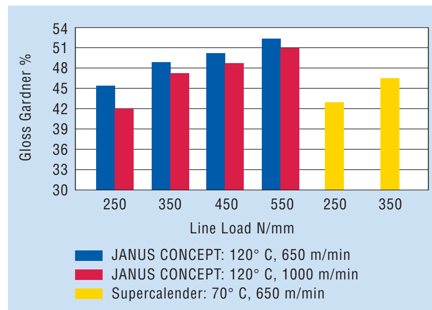
The tests were carried out with a European standard SC-A paper. The basis weight was about 56 g/m^2, the ash content was about 31%. These papers are currently being calendered with the addition of steam on two 12-roll supercalenders at 250-280 N/mm line load and about 70°C surface temperature at 650 m/min.

The following results show a comparison of the standard supercalendering process to the Janus Concept, whereby in the case of the Janus Concept, both the current calendering speed of 650 m/min as well as the PM speed of 1000 m/min are taken into account. *Figure 5* initially shows the paper gloss according to Gardner as a function of line load.

Fig. 4:
Line load characteristic of the Janus Concept in comparison to a conventional or compensated calender.

Fig. 5:
SC-A grade 56 g/m^2, gloss vs. line load.

Fig. 6:
SC-A grade 56 g/m^2, printgloss vs. line load.



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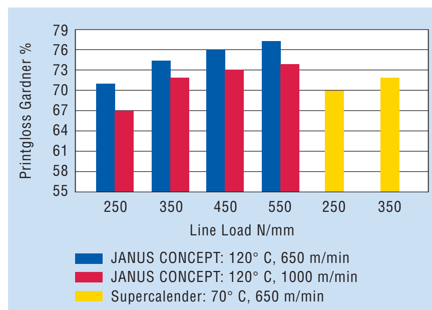

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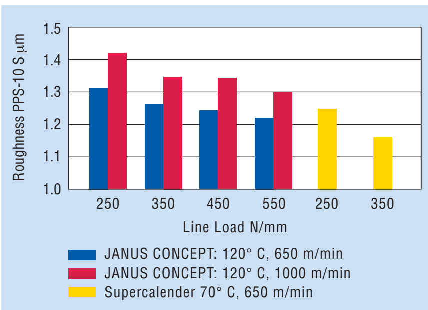
One can see that the gloss of the paper supercalendered at 650 m/min is exceeded by the Janus Concept even at a PM speed of 1000 m/min at 120°C surface temperature and line loads of about 350 N/mm. The calendering temperature which is 50°C higher compared to the supercalendering process, has a strongly positive effect on the gloss result in this case. Figure 6 appropriately shows the print gloss of samples printed by the rotogravure process.

For the print gloss, virtually the same correlations can be seen as previously discussed for the paper gloss. At 350 N/mm line load, the print gloss of paper supercalendered at 650 m/min can be exceeded, even at a PM speed of 1000 m/min. *Figure 7* shows the roughness PPS-10 S over the line load.

Fig. 7:
SC-A grade 56 g/m², roughness vs. line load.

Fig. 8:
SC-A grade 56 g/m², bulk vs. line load.

Fig. 9:
SC-A grade 56 g/m², blackening vs. line load.



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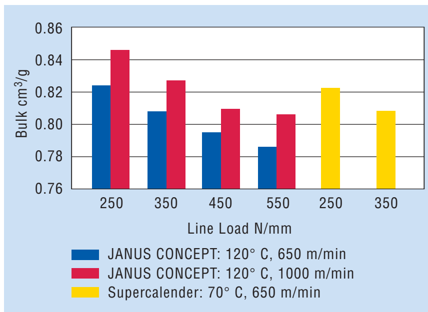

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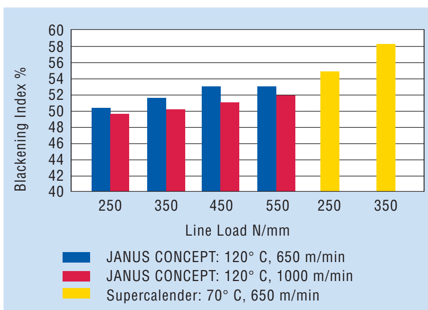

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The diagram clearly shows that the roughness of the supercalendered comparison paper by means of the Janus Concept could be achieved at a comparable calendering speed of 650 m/min at line loads of about 450 N/mm. However, due to the surface temperature of only 120°C in this case, this was not completely possible at a PM speed of 1000 m/min. Figure 8 shows the densification or bulk as a function of line load.

One can see that the compression of the supercalendered paper by the Janus Concept at 450 N/mm line load is also achieved at a PM speed of 1000 m/min. Based on knowledge from earlier tests that the printability of such paper was less correlated with smoothness or roughness rather than with densification, a comparable printability was also to be expected in this case (5).

The respective rotogravure tests carried out confirmed this in all respects. Both from a visual assessment aspect and also from the number of counted missing-dots in the quarter-tone range, no differences of the supercalendered paper to the Janus Concept calendered samples were to be seen.

A further important criterion, particularly in the case of SC-A papers, is the so-called blackening. Blackening occurs with high densification of the papers due to collapsing of the fibres. These fibres then appear transparent in transmitted light and black in reflected light.With the aid of an image analysis system developed at the Technical University in Darmstadt, it was possible to measure the blackening in the form of a blackening-index, whereby the larger percentage figure indicates more blackening. The respective results are summarised in *Figure 9*.

One can clearly see that the blackening index is lower in the case of papers calendered according to the Janus Concept. This means that the Janus Concept enables paper to be calendered with a printability comparable to that of SC paper with less blackening.

Summarised, this test shows that the Janus Concept is capable of producing with only seven nips at maximum 450 N/mm line load, even at PM speed, a paper with a printability comparable to that of the supercalender with less blackening and a simultaneously higher print gloss.

Calendering of LWC-rotogravure paper according to the Janus Concept

The tests were carried out with a European standard LWC rotogravure paper. The basis weight was about 58 g/m² the coating weight was about 9 g/m² per side. The papers are currently being calendered on two 12-roll supercalenders at 270-300 N/mm line load and about 65°C surface temperature at 700 m/min.

The following results show a comparison of the standard supercalendering process to the Janus Concept, whereby in the case of the Janus Concept, both the current calendering speed of 700 m/min as well as the coater speed of 1400 m/min are taken into account. *Figure 10* initially shows the paper gloss Gardner as a function of line load. One can see that the gloss of the paper supercalendered at 700 m/min is exceeded by the Janus Concept also at an SM speed of 1400 m/min, 135°C surface temperature and 350 N/mm line load.

Figure 11 appropriately shows the smoothness Bekk. The diagram clearly shows that the Bekk smoothness of the supercalendered paper by the Janus Concept at double the speed of 1400 m/min at 135°C surface temperature and 350 N/mm line load is virtually reached and already exceeded at 450 N/mm line load.

Figure 12 shows for the sake of completeness also the roughness. Measured according to PPS-10 S, the roughness of the paper supercalendered at 700 m/min by the Janus Concept at 1400 m/min and 135°C surface temperature is already exceeded at line loads of 350 N/mm.

Figure 13 finally shows the densification or bulk as a function of line load. The diagram clearly shows that the bulk of the paper supercalendered at 700 m/min corresponds to the sample calendered according to the Janus Concept at 1400 m/min, 135°C surface temperature and

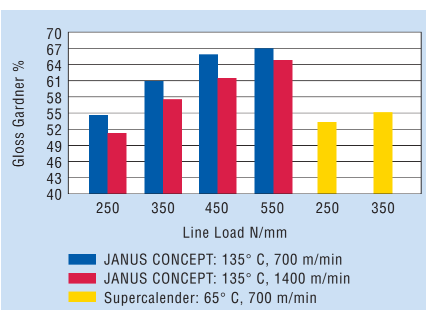

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Fig. 10:
LWC-roto 58 g/m², gloss vs. line load.

350 N/mm line load, i.e. calendering conditions under which more favourable gloss and roughness values could be achieved by the Janus Concept.

The rotogravure printing tests carried out for this comparison showed, as was already to be expectedfrom the calendering results, no differences in the printability of the samples supercalendered at 700 m/min to the samples calendered according to the Janus Concept at 1400 m/min, whereby the latter were characterised by a higher print gloss due to the higher calendering temperature.

Summarised, this test also shows that the Janus Concept is capable of producing with only seven nips but double the speed at 350-450 N/mm and 135°C surface temperature, a paper which is absolutely comparable with the supercalendering process. Both these tests based on the example of the highly densified paper grades, SC-A and LWC rotogravure, impressively show the enormous potential of the Janus Concept.

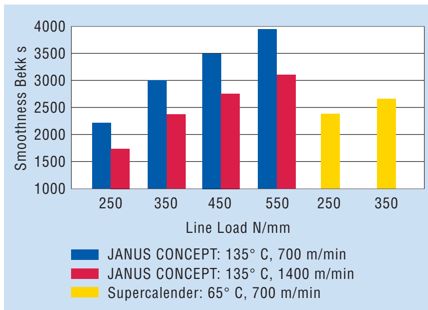

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Fig. 11:
LWC-roto 58 g/m², smoothness vs. line load.

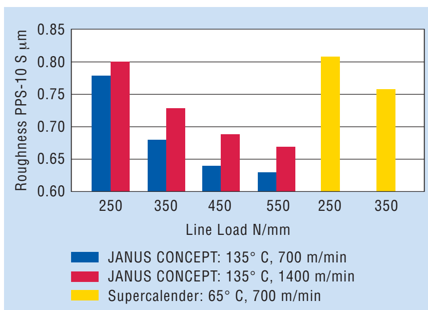

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Fig. 12:
LWC-roto 58 g/m², roughness vs. line load.

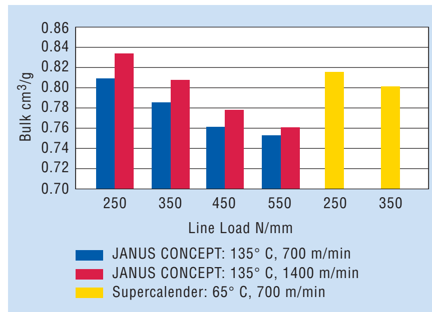

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Fig. 13:
LWC-roto 58 g/m², bulk vs. line load.

With this new calendering technology, papermakers are provided with an instrument which fully meets the initially mentioned requirements for calendering high quality papers in "supercalender quality" also at PM or SM speed with high efficiency and distinctly reduced energy consumption.

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Service-Division:
Paper machine condition analysis

Paper machines are designed for specific product types and defined output capacities. They are also optimized for a defined mechanical loading, both static and dynamic. There is a growing demand among operators for modernizing old paper machines as far as possible. The goal is to achieve better product quality and greater output through higher operating speeds. However, before finalizing the new production parameters a machine condition analysis survey should be carried out. By establishing the detailed condition of the paper machine and its environment, conclusions can be drawn as to how far existing components can meet the new requirements.

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Measuring and
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Ravensburg

Who is better suited to carry out this task than reputed manufacturers of paper machinery? Not only are they familiar with the needs of papermakers, they also know all about the machine itself.

Against the background of worldwide references, and together with the technical departments of the product divisions the engineers of the Voith Sulzer Paper Technology Service Division carry out condition analyses on all kind of paper machines, for example in connection with project feasibility studies.

1. Condition analysis by means of measurements

Before an old machine can be upgraded for higher output, mechanical loading limits have to be analysed above all. Even for establishing new production parameters and modifying the operating range of individual components – which can now be done by computer methods – basic data is still essential. Extensive measurements are often required in order to analyse existing operating conditions and possible improvement potential without excessive modifications.

1.1 Approach flow section analysis

The starting point for condition analysis is generally the approach flow section. To ensure faultless product quality, the stock suspension and so the fibres flowing out of the headbox have to be distributed as uniformly as possible on the wire. Pressure pulsations originating among other sources from rotating machines in the approach flow section play a decisive role in this. These pressure pulsations are therefore measured at several points between the cleaners and headbox, using special sensors inserted in the piping. A frequency analysis may then be carried out to detect the main disturbances generated by the fan pumps or screeners.

If various products with different basis weights are manufactured on the machine, these measurements are normally repeated for each product. The resultant data and absolute pressure measurements are used for assessing the approach flow layout. In addition, various paper samples are taken in order to analyse the effect of pressure pulsations on longitudinal and cross-machine profiles.

1.2 Mechanical vibration analysis

A significant proportion of condition analysis investigations involves measuring mechanical vibrations on the paper machine itself. Measurements are first carried out at highest possible operating speed on the headbox, wire and press sections and reel winder to assess vibrations occurring during production. These basic readings initially indicate any disturbances originating from shaker systems, drives, misaligned rolls or design deficiencies which might affect product quality or roll runnability. This kind of investigation can also be carried out at any time to check and optimize machines for which no rebuild plans have yet been made.

One of the main goals of condition analysis is to predict mechanical behaviour at higher operating speeds. This means locating critical operating points or resonance conditions in the rolls, transmission and gear systems, framing and foundations. The mechanical behaviour of all machine sections is therefore analyzed at different speeds. Ideally, each group is accelerated to full speed several times in succession in order to record dynamic characteristics over the entire speed

Fig. 1:
Up to 16 sensors can be connected simultaneously to the multi-channel measuring system for data recording and analysis.

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range. This can only be done by using a computerized multi-channel measuring system *(Fig. 1)* capable of reading data from up to 16 sensors at the same time.

It goes without saying that such measurements cannot be carried out during normal operation, but have to be scheduled for long shut down periods. Carrying out this kind of vibrational analysis on an entire Fourdrinier machine, from headbox to the last drying section on both the drive and front sides, needs about 100 measuring points *(Fig. 2)* with a time outlay of 15 to 20 hours. The frequency spectra thus measured are displayed for each point as a function of machine speed in the form of waterfall diagrams *(Fig. 3)*. These indicate not only the location of critical conditions, but also any out of balance conditions in rolls, etc. By carrying out a trend analysis on amplitudes, the highest permissible operating speed from the mechanical stress point of view can be determined. If necessary, these measurements are complemented with numerical computer simulations.

In addition to this, vibrational analyses are carried out on the guide rolls in the wire, press and drying sections. Representative rolls are selected in each section and tested for resonance behaviour using a special impact hammer *(Fig. 4)*. Based on these findings, the critical speeds of these slender rolls can be determined. In contrast to numerical analysis, this experimental method establish the vibrational behaviour of guide rolls under the installed condition. This

Fig. 2:
Vibration measurements:
An average of 100 measuring points are required for machine analysis from headbox to drying section on both front and drive sides.

Fig. 3:
The measured frequency spectra are displayed in the form of waterfall diagrams as a function of machine operating speed.

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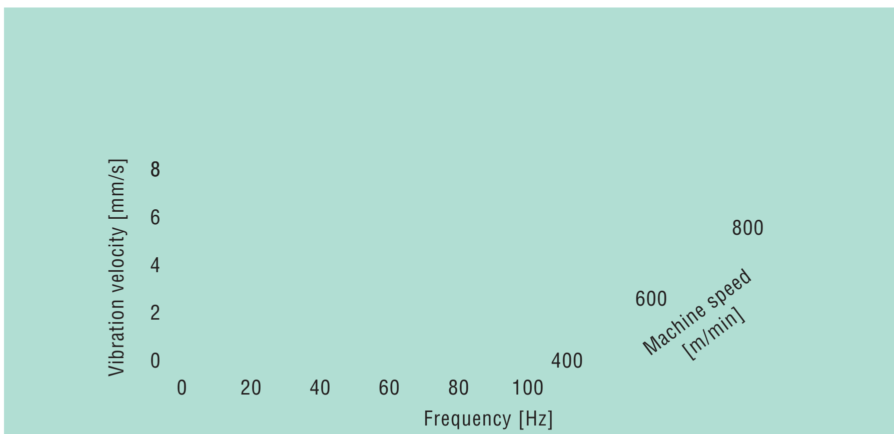

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indicates whether larger rolls are required at certain positions to allow for higher operating speeds.

1.3 Other analytical measurements

Old machines often incorporate lever-type presses, whose actual pressing force is not usually known exactly. This data deficiency is remedied by using load cells which measure the pressing forces transmitted via the supports. By recording a loading and unloading characteristic, the hysteresis component can be determined and hence the friction in the loading system. For example, by this kind of measurement it was possible to locate a defective hydraulic cylinder. Additional nip impressions are also evaluated at various line force settings, in order to assess line force profile uniformity as well.

With modern computerized measuring techniques, the temperature profile over the web width can be determined using special infra-red cameras. These thermographical tests are mainly of interest in the drying section, but also in the press section, for assessing the web drying process. Usually damp zones are cooler than dry zones, so humidity profiles can be measured on the press felts but also on finished paper reels to assess uniformity of drying over machine width *(Fig. 5)*. Here again, these measurements can be used for process optimization as well as condition analysis.

1.4 Air system analysis

Air system measurements are carried out on supply and exhaust air in the drying section, in order to assess air and water balances. For this purpose sensor pockets have to be installed in the piping, upstream or downstream of the various branching points, for determining water and dry air flows. Likewise in the steam and condensate system, extensive measurements have to be carried out for assessing steam quantities, temperatures, pressures and flow velocities. Based on this comprehensive data, conclusions can be drawn for optimizing piping layout and energy consumption.

2. Mechanical inspection

Apart from pure measurements, a complete condition analysis also includes visual inspection of the machine with regard to the bearing design of press rolls, guide-rolls and drying cylinders *(Fig. 6)*. By also measuring bearing temperatures and oil flows, the existing lubrication system can be assessed with regard to

Fig. 4:
Selected rolls are tested for eigenfrequency behaviour using a special impact hammer.

Fig. 5:
Thermographical measurements:
Even the finished paper reel can be checked for uniform drying over the entire web width.

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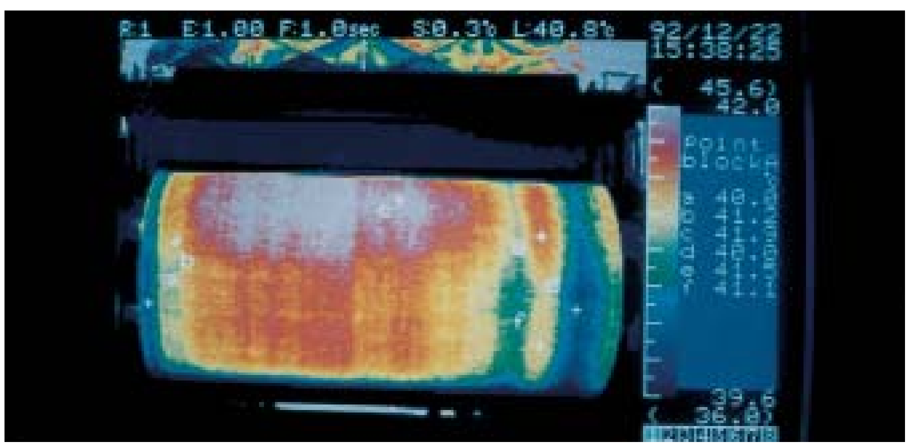

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Figs 6, 7 and 8:
Three important points for mechanical inspection: roll bearings, doctor moving systems and corrosion on all structural components.

higher operating speeds. If a substantial speed increase is planned, grease lubrication may have to be replaced with an oil lubrication system, or high-temperature grease must be used at least for the guide rolls in the drying section.

At this point our experts also assess the viability of existing pressing systems and doctor moving systems *(Fig. 7)*. Finally, a rebuilt machine must be able to stand up to higher output without reducing runnability.

At higher speeds long press levers are a disadvantage since they are prone to vibrate, for example, and fixed doctors are also unsuitable. Depending on the drive concept, gearwheels must be carefully checked particularly in the drying section. Data in relation to this is available from the vibration measurements carried out previously, since worn or damaged gear tooth flanks generate a special kind of vibration pattern. A visual check is still carried out on individual gearwheels, however, and the clearance between mating gear teeth is measured. Furthermore open gearing makes more noise at higher speeds, which may not be tolerable.

Older plants must also be checked for corrosion, particularly in the wet section (wires and presses) where the wall thickness of structural components such as frames and levers may be seriously affected *(see Fig. 8)*. For this reason the residual wall thickness at critical points must be carefully measured. These

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measurements are usually carried out by ultrasonic methods.

3. Electric motors and drives

Speed increases on old machines are often limited by existing drive and transmission concepts. Even if individual drives are already installed, it may not be possible to increase motor capacity. Initially this can be checked by measuring the motor current consumptions, speeds and temperatures during normal operation, and comparing them with design data. In case where motor speed is the limitation, the problem can usually be solved by using different gear ratios to keep the motor speeds within the design range while increasing the speed of the rolls. In cases of doubt Voith Sulzer may also consult the drive manufacturer.

4. Vacuum system analysis

Increasing the machine output generally means that vacuum requirements will be higher for the suction rolls and devices in the wire and press sections. Here again, Voith Sulzer takes comprehensive measurements of all vacua and flows involved in order to analyze the vacuum system concept. The most important aspect here is to check vacuum pump capacities versus design characteristics. This shows whether the higher capacity can be met by existing equipment or if new pumps are required. Conclusions are also drawn with regard to the design of felt suction units (number and width of slots) and the interconnection of individual components.

5. Summary

Condition analysis serves not only for optimizing paper machinery, but also gives indispensable information on the possibility of capacity increases, which normally mean higher operating speeds. Based on comprehensive measurements and technically well-founded prognoses, upgrading potential is assessed and any critical components or weak points are located. Machine condition analyses are nearly always a combination of extensive measurements and visual inspection. The most important criterion are the mechanical loading limits on the various components in each section of the machine. These are mainly assessed by vibration measurements, which are therefore an indispensable part of the analysis procedure.

These fundamental analyses are complemented by further investigations with a view to process optimization. Apart from purely mechanical inspection and measurements, Voith Sulzer, as an experienced plant manufacturer, is also in the position to assess the entire papermaking process. Apart from the approach flow section layout this covers the dimensioning of the vacuum system as well as of electrical and mechanical drives. A comprehensive single-source service is thus available which not only reveals weak points but above all indicates possibilities for optimizing machine runnability and improving productivity.

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Research and Development:
The Voith Sulzer Paper Technology R & D centres

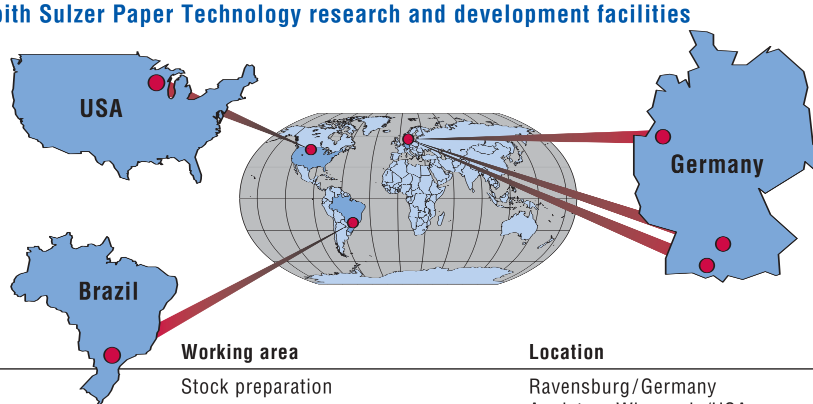
Since the founding of Voith Sulzer Paper Technology in 1994, group R&D capacities have been extended with additional facilities at various locations. According to the specialization of VSPT divisions, the working areas at each research centre were likewise re-defined. Parallel work at different locations has now been eliminated, and the capacities thus freed are now concentrated on specific research activities. As a result, customers now have specialists at their disposal for solving problems in every area of paper technology, together with the necessary test facilities and measuring systems.

The author: A. Meinecke, Research and Development Heidenheim

The primary goal of all VSPT R&D centres is to serve our customers. All our new developments and improvements in paper technology are directed at higher product quality, greater productivity and more cost-effective paper machinery.

This article presents the VSPT R&D centres and describes their work. In a later edition of “twogether” we shall be reporting on research projects of particular interest (see table for summary of R&D facilities).

Voith Sulzer Paper Technology research and development facilities



Working area	Location
Stock preparation	Ravensburg/Germany Appleton, Wisconsin/USA
Paper Machines – Writings and printings – Board and packaging – Tissue	 Heidenheim/Germany Ravensburg/Germany São Paulo/Brazil
Coating Technology	Heidenheim/Germany
Finishing	Krefeld/Germany Manchester/Great Britain
Winder Technology	Heidenheim/Germany

Heidenheim

At the Heidenheim research centre, development work is concentrated on paper production, ranging from headbox to sheet processing. This centre is also responsible for research and development in printing and writing paper production. Detailed development work is carried out on special facilities for each component, such as headboxes, sheet formation and drying systems. The following facilities are available for interrelated process stage testing:

- For sheet formation and press trials, a total of four test paper machines with various sheet formation and press concept configurations. These cover a speed range of 20 to 2000 m/min, with web widths of 0.5 and 1 m.
- A test coating machine with various coating and equalization processes and a Speedsizer. Working width is up to 0.85 m and maximum speed is currently 2000 m/min.
- A trial roll cutting machine with variable geometrical configuration, for operation e.g. as two drum or as a one drum winder.

Numerous development laboratories and measuring facilities are likewise available.

Fig. 1: (page 46)
Heidenheim: pilot paper machine for printing and writing grades.

Fig. 2:
Heidenheim: test coating machine.

Fig. 3:
Heidenheim: test roll-cutting machine.

Fig. 4:
Ravensburg: test paper machine for paperboard and packaging papers.

Fig. 5:
Pilot paper machine for packing and board grades.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Ravensburg

Research work in stock preparation is concentrated at this centre. Development of new and improved processes and machines – from pulping to bleaching – is carried out on numerous test facilities. The heart of the R&D facilities here is a stock preparation line which incorporates all the main process stages such as pulping, screening and cleaning, flotation, disperging, refining, bleaching and thickening, including loop water treatment. Various complete stock preparation concepts or sub-processes can be tested here under mill conditions. Likewise customized stock preparation concepts can be studied and optimized. The extensive laboratory facilities ensure rapid evaluation of stock analyses and other measurements in the various process stages.

The Ravensburg test machine is particularly suitable for carrying out production trials on paperboard and packaging papers. Over a wide range of basis weights and operating speeds, single and multilayer or multi-ply papers and boards can be produced. In the press section adjoining the sheet formation section, various press configurations can be built up using the latest NipcoFlex technology. A great advantage is the close proximity of this machine to the stock preparation line, which allows stock made of special raw materials to be supplied under mill conditions for sheet formation trials.

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Fig. 6:
Krefeld: Finishing Division technology centre with soft nip calender.

Fig. 7:
Krefeld: test calender for high surface finishing.

Fig. 8:
Appleton, USA: technology centre mainly for waste paper recycling.

Fig. 9:
Appleton, USA: test deinking plant with flotation cells.

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Krefeld

Here at the headquarters of the Finishing Division, R&D work is carried out on calendering. The main components of calenders are tested on special facilities, some of which are equipped with extremely high-resolution measuring systems. Sophisticated computer simulation programs are coming into general use for replacing or shortening some of the more time-consuming experimental work. For various calendering processes such as soft calendering or supercalendering, comprehensive facilities are available which are fitted with the associated equipment for humidifying, preheating, etc. These allow calendering systems and parameters to be selected and optimized for customized requirements. The latest installation here is for carrying out tests on the Janus concept. Other calendering test facilities are available for customer trials at Hunt & Moscrop in Manchester, England.

Appleton, Wis., USA

The waste paper recycling quota is likewise rising in North America – particularly for manufacturing printing and writing papers. For stock preparation tests, with special emphasis on waste paper, a complete line with all the various process stages is available in Appleton. These range from pulping, screening, cleaning and flotation to disperging, bleaching, thickening and loop water treatment. Tests and optimization trials can thus be carried out under mill conditions on nearly all stock preparation processes. Stock can also be prepared from customers' raw materials according to special

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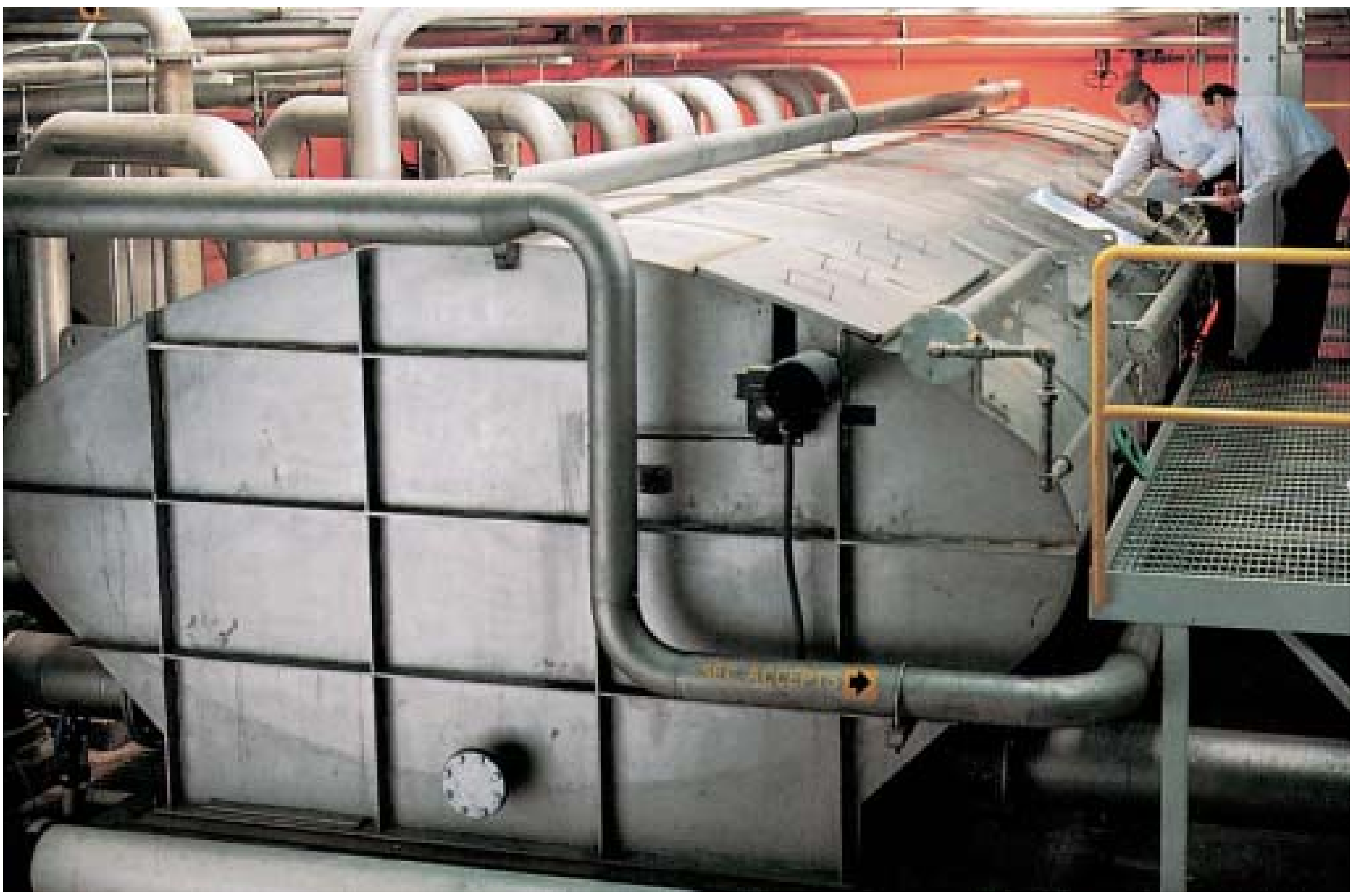

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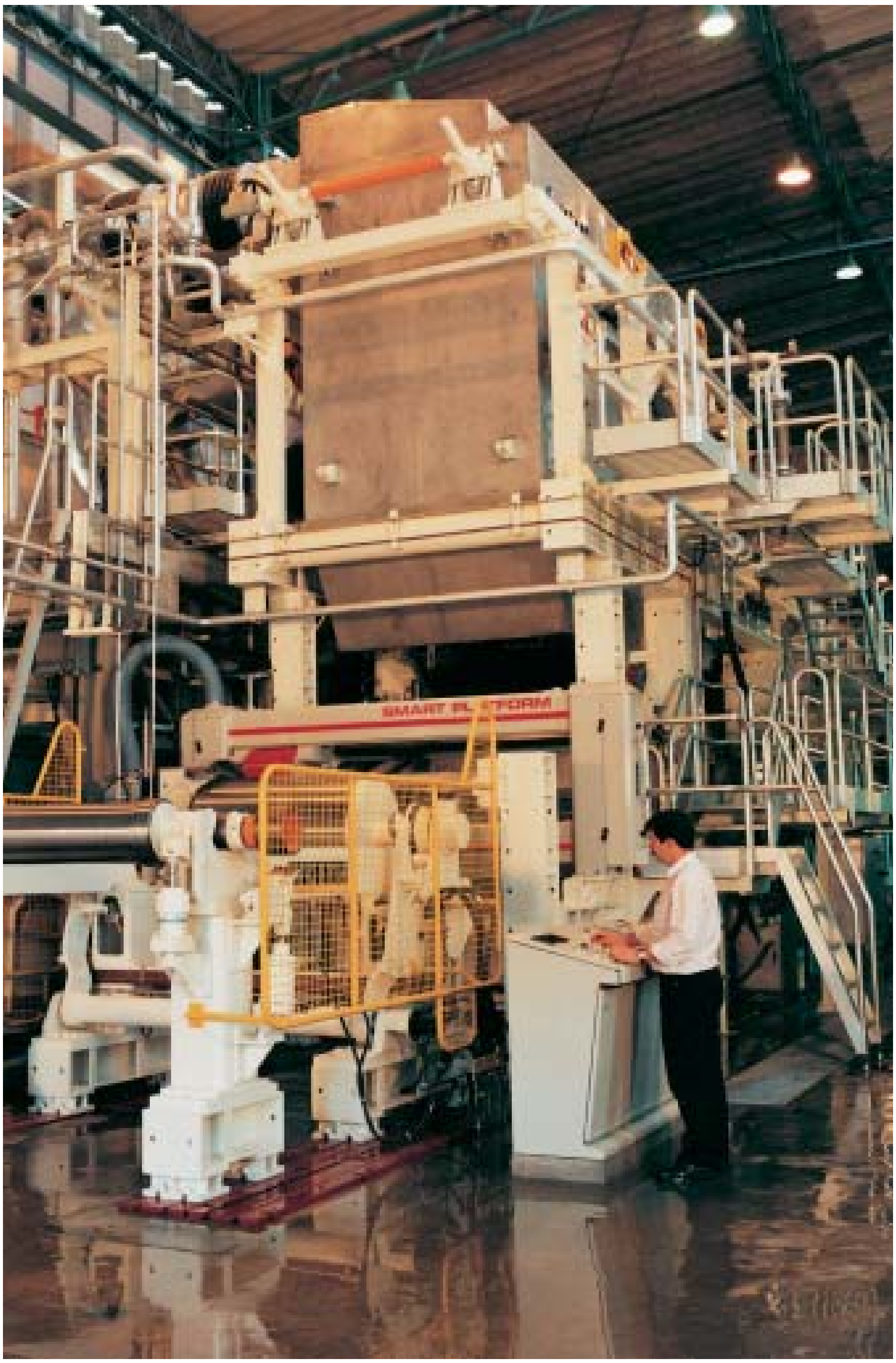
Fig. 10:
São Paulo, Brazil: test paper machine for tissue grades with twin wire forming section and crepe cylinder.



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requirements – in large quantities if necessary – for carrying out tests on production machines. Extensive laboratory facilities are available for evaluating test results.

São Paulo, Brazil

This is the latest VSPT research and development centre, where a trial tissue machine with a working width of 1 m is installed. This machine incorporates the following modules: single or multilayer headbox, various twin wire configurations for sheet formation, a crepe cylinder with presses and reeler. The machine is completed by a stock preparation line so that the effects of special raw materials on tissue quality can be investigated. An ambitious target here is the introduction of new processing stages which will have significant effects on tissue production in future.

PAPER INDUSTRY PRESS CONFERENCE IN HEIDENHEIM

Workshop, symposium and birthday party:

At the end of September 1995, international journalists and German business press leaders met in Heidenheim at the first VSPT paper industry press conference. The motto on this Voith Sulzer

Paper Technology anniversary was “twogether future for paper”.

The conference got off to a ceremonial start with a baroque trumpet concerto in Neresheim Abbey church – part of the Benedictine monastery’s ninth centennial celebrations.

Hans Müller, President and CEO (seen above with Kevin Chang of Paper Asia) had every reason to be content: all the VIPs of international paper industry journalism were present on this memorable occasion. The entire VSPT management were gathered at

the Heidenheim engineering centre to welcome guests from Australia, Singapore, the USA and numerous European countries. “For us the press – and above all the paper industry press – is a very important partner”, said Müller. “As far as technical advances and customer benefit are concerned, information is everything”.

Does this joint venture between former competitors really work? Is the new company accepted on the market? What about the present situation and future goals? The positive answers to all such questions impressed even the most experienced journalists – for the combined forces of this joint venture have brought some notable innovations which are making their mark among customers.

“The Voith Sulzer marriage in paper technology is working fine. The future looks promising. Out of the red straight after take-off. Unexpectedly high order intake”... These are only some of the headlines appearing after the 1995 VSPT press conference. And everyone who attended this fertile round of discussion wants to come back again next time.

BIBLIOPHILI TREASURES

Neresheim Abbey, only a few minutes' drive from Heidenheim, was founded in 1095 and celebrates its ninth centennial this year. This monument to European cultural history houses a library with some twenty thousand medieval and early baroque volumes.

In eastern Baden-Württemberg, at the crossroads between Heidenheim and Nördlingen, Aalen and Dillingen, lies Neresheim – only a few minutes from the Würzburg-Ulm motorway.

Whichever way you approach Neresheim, you will be surprised by an imposing collection of buildings dominating the town from its 582 m.a.s.l. vantage point – the Benedictine abbey. On a clear day the view from here extends to the Alpine peaks. This year Neresheim Abbey celebrates its nine-hundredth anniversary. Founded in 1095 by Graf Hartmann of Dillingen, the abbey has survived all the turmoil of European history.

Already during the first struggle for power between Kaiser and Curia, the abbey was burnt down by Konrad IV, banished son of the Hohenstaufen Kaiser Friedrich II, because its monks were loyal to the Pope. In 1525 the Peasants' War raged over the Härtsfeld, and during the Schmalkaidic War in 1546 Karl V took up residence in Neresheim Abbey. Toward the end of the Thirty Years' War the abbey became headquarters of the Swedish General Lorenz von Hofkirch.

The same fate befell the abbey during the Coalition Wars of 1796 to 1801, when General Moreau set up headquarters for Napoleon's troops in Neresheim. As if for the sake of posterity, he nonchalantly recorded his daily log in the abbey library guest-book.

Two dozen incunabula still remaining

Despite all the losses inflicted by war and secularization, the abbey library still houses many other treasures apart from its notable guest-book. It is one of the very few baroque libraries in South Germany whose form and content has remained more or less intact over the centuries. As a highlight among almost twenty thousand volumes ranging from the fifteenth to early nineteenth centuries 25 incunabula have been preserved here. The relatively extensive collection as it stands today was built up through systematic acquisition and exchange, or thanks to foundations and donations. A number of works were acquired as a kind of “morning gift” from the mother house Beuron and other monasteries when the abbey was newly founded. Prince Albert of Thurn and Taxis and his consort Margaretha of Austria bequeathed the new abbey a valuable collection of volumes, which are particularly interesting from the art history point of view. At the present time the entire collection is housed in the so-called “new library”, where another 85,000 volumes from more recent times can be found.

The baroque wing of the monastery building, where the old library is situated, was in danger of collapse but in the meantime has been saved by restructuring measures. Interior restoration work is still underway, with particular outlay required for the library room with its valuable stucco ceilings. Thanks to generous support from local firms, the Baden-Württemberg authorities and international well-wishers, it is hoped to reopen the library in one or two years as a European centre of learning.

The library is not the only attraction, however. Neresheim Abbey is well worth visiting as one of Europe’s most interesting and best-preserved baroque edifices. Construction of the present buildings started in 1694 and took thirty years to complete, interrupted by wars and lack of funds.

The crowning glory is the abbey church designed by Germany’s most famous architect of the day, Balthasar Neumann of Würzburg who was also an artillery colonel.

Most important baroque church north of the Alps

When Balthasar Neumann, born in 1687 of an Eger clothmaker, was approached by Abbot Aurelius of Neresheim, he was already reputed to be the greatest architect between Cologne and Constance. His creative intuition was combined with an enormous capacity for hard work and a genial talent for organization. In his position as senior architect to the Archbishop of Würzburg, he was responsible for construction works throughout the land as well as for the building materials and glass manufacturing plants which he himself had founded. As artillery colonel he was responsible for military defence and engineering, artillery and fortifications. And as engineer he held an important teaching post in civil and military construction. At times Neumann was in charge of more than 10,000 workers distributed among his various building sites. With no telephone communications or copying facilities and only horse transport, this seems an impossible task today – but as we can see, it was indeed possible.

Neresheim represents the peak of Neumann’s achievements in ecclesiastical architecture. At the height of his creative powers and in his best years, he incorporated in this building all the ideas inspiring his most important work. It is here that Balthasar Neumann expressed his sense of grandiose celebrity with the greatest perfection. The masterpiece of baroque architecture we are privileged to see and admire in Neresheim today is a true statement of timeless nobility.

twogether

VOITH SULZER
PAPIERTECHNIK