Tangible Rebuild and Upgrade Solutions for Improved Quality, Output and Resource-Efficiency

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ABSTRACT

In India, the paper industry has grown an average of 6 to 7 per cent over the last few years. India is the fastest growing market for paper globally and paper consumption is expected to follow the rate of the economic growth. The paper sector in India is dominated by small and medium size units. There is a growing need to modernize Indian mills, improve productivity and build new facilities.

This paper will present tangible solutions for boosting up productivity. These solutions comprise modern technology that has proven its capability in numerous references by means of improved production output, higher end product quality and better resource and energy efficiency.

Introduction

Paper industry in India is fragmented, with a large number of small-capacity mills. The growth in demand for paper is strong, and the question is whether the demand will be met by increased imports or by developing a stronger domestic industry. A highly developed domestic industry would create economical and ecological health, mostly in the rural areas.

Easy availability of raw materials would increase the competitiveness of the Indian industry, and give it a better position in standing against the heavy import. But there is also a clear need to modernize the mills, improve productivity and build new capacities, with new efficient and environmentally sound technologies. With smart investments, also smaller paper machines can improve their competitiveness.

A well-executed rebuild consists of

- analyzing and determining the true bottlenecks of an existing machine line
- selecting the best-fit products and means for removing the bottlenecks
- carefully planning and designing machinery and auxiliaries that are a perfect fit for the existing equipment and can be installed smoothly
- paying special attention to the start-up and supporting with specific expertise to get a steep start-up curve, which enables the fastest payback.

This paper discusses concepts that can be applied as larger rebuilds and as separate machine section upgrades, depending on the targets set for the production line. A Fourdrinier-equipped fine paper machine, with running speed target of around 1,000 m/min, has been selected as the base concept for a rebuild (Fig. 1). A case study with non-wood grades (pilot trials, wheat straw) is also presented.

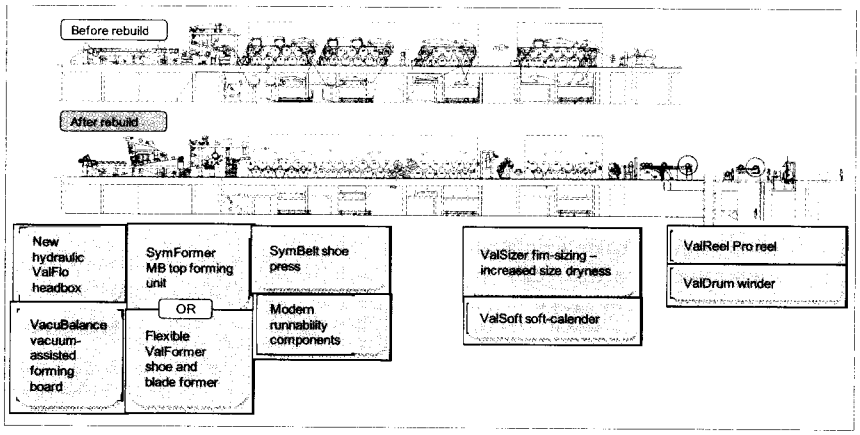

Figure 1. The different machine section concepts and equipment can be applied as larger rebuilds and as separate machine section upgrades, depending on the targets set for the rebuilt line.

ValFlo headbox for excellent profiles

A stable and even flow of stock out of the headbox is important when aiming for good paper quality and machine performance.

ValFlo is an ideal headbox for medium-capacity Fourdrinier and hybrid former applications up to 1,200 m/min machine speeds (Fig. 2). ValFlo headbox is designed for new lines and rebuilds, and it is especially well-suited for cases where the layout adaptability to the mill environment and processes is challenging.

The robust and proven design of ValFlo headbox maximizes the machine's profitability and lifetime. It helps to increase production capacity and improve end product quality in cases where the existing headbox is outdated and cannot fulfill the new targets..

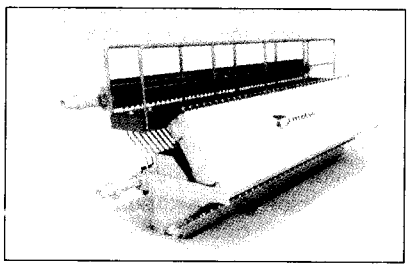

Figure 2. ValFlo headbox

Excellent basis weight and fiber orientation profiles are essential in the production of high quality paper and ensure excellent machine runnability. Basis weight profile control by ValFlo headbox is implemented using either dilution or slice lip control. On production machines ValFlo headboxes equipped with dilution profiling have given outstanding results (Fig. 3 and 4).

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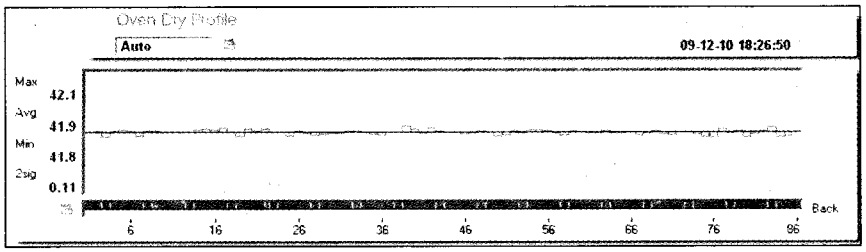


Figure 3. Even ValFlo basis weight CD-profile (production machine results).

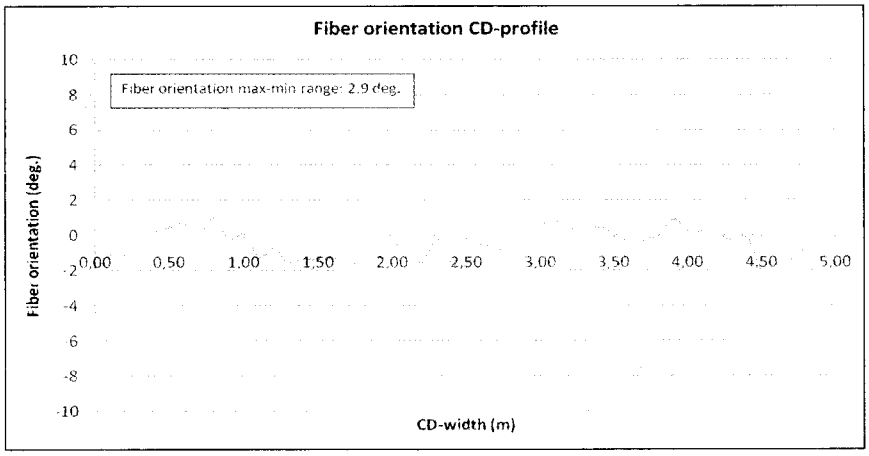


Figure 4. Even ValFlo fiber orientation CD-profile (production machine results).

With dilution profiling basis weight and fiber orientation profiles can be controlled independent of each other, in contrast to slice lip control. Shape optimized inlet header and edge feeds complete the ValFlo CD-profiling tool package.

Hydraulics is the heart of a headbox and it strongly contributes to paper and board quality (formation, strength properties, residual variation, visual appearance, etc.). The experience gained from the design and case-specific dimensioning of over 1,000 headboxes is applied in ValFlo hydraulics. The two sudden expansion steps in the headbox turbulence generator together with slice channel vane technology possibilities give the turbulence the right scale and intensity to break up fiber flocs and thus obtain high end product quality.

It is possible to adjust the headbox flow rate operating window by the changeable plastic inserts of different sizes during only a few hour shutdown. This brings the flexibility to possible production changes in the future.

Good preventive cleaning (electropolishing of flow surfaces, cleaning showers etc.) and rapid corrective cleaning during shutdowns (easy access to headbox interior, functional cleaning equipment etc.) result in high operation efficiency. It is further enhanced by quick grade changes and a speedy start-up after shutdown, thanks to the quickly reacting automation and heat compensation system of this headbox design.

The mechanical design of ValFlo headbox requires fewer spare parts, provides easier operation and reduces the need for maintenance.

Forming section rebuild for improved web quality

About 97% to 98% of total paper machine dewatering takes place at the forming section which means that the former has to be able to handle large amounts of water. The structural properties of the web, such as formation, materials distribution and fiber orientation, are also affected. How these properties change depends on the former's operating principle.

Hybrid former is the most cost-efficient forming concept for the production of fine paper within the speed range of 800 to 1,200 m/min (Fig. 5).

Compared to a Fourdrinier, the key

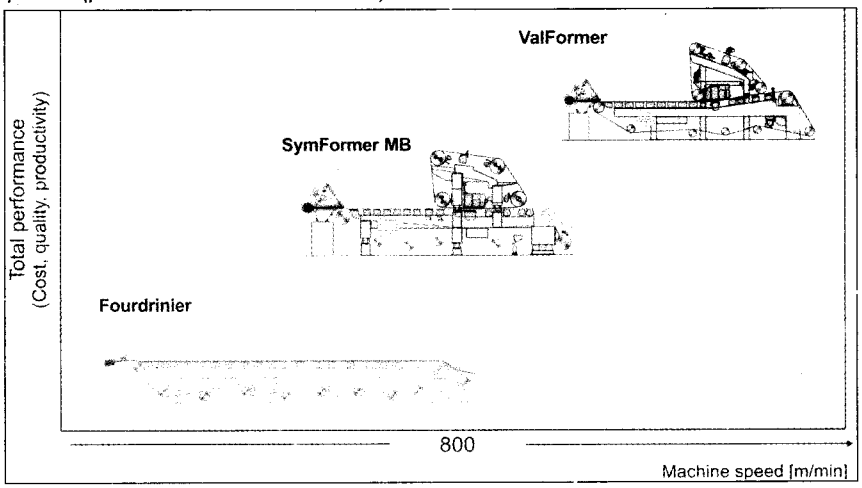


Figure 5. Metso forming section concepts for medium-capacity machines.

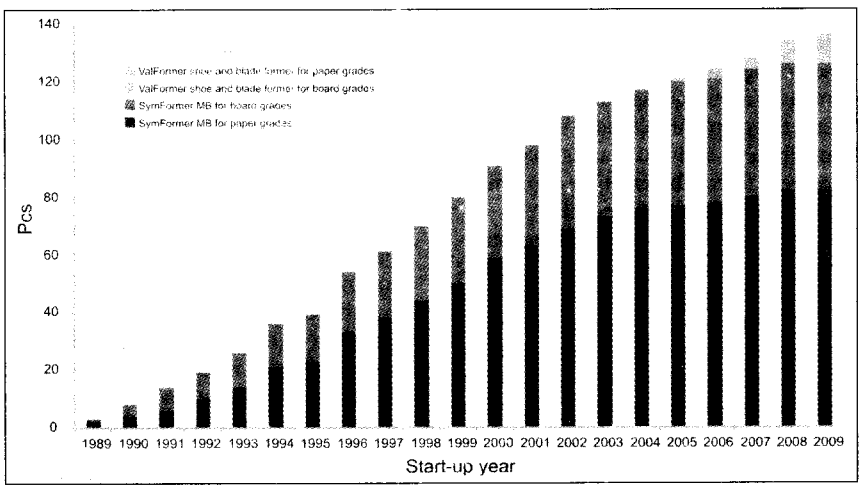


Figure 6. Metso hybrid forming technology is used worldwide for various paper and board grades.

advantage of a hybrid former is its two-sided dewatering and increased drainage capacity.

SymFormer MB blade hybrid former

SymFormer MB (previously Alform-MB) was introduced in the late 1980's. The basic advantage of this former compared to conventional hybrid formers at the time was the use of adjustable forming pressure with loadable blades. This feature enabled a wide operating range in addition to the former's higher dewatering capacity and better end product properties, such as excellent paper formation and web symmetry.

Since the early 1990s, SymFormer MB hybrids have been used worldwide for various paper grades (Fig. 6), and different basis weights.

The SymFormer MB is a blade-type hybrid former consisting of a top former unit, which can be easily installed on existing Fourdriniers (Fig. 7). The rigid frame of the former is designed to withstand all types of static and dynamic forces to ensure trouble-free operation even at high running speeds. For quick and easy fabric changes, the entire former structure can be cantilevered.

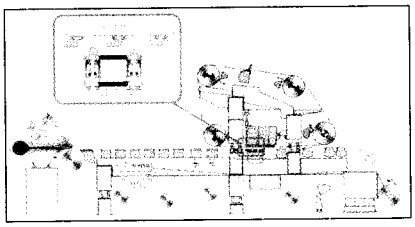


Fig. 7. The SymFormer MB is a blade-type hybrid former consisting of a top former unit, which can be easy installed on existing Fourdrinier.

Enhanced capacity with ValFormer shoe and blade hybrid former

In recent years the focus of development has been on increasing the capacity of hybrid formers, and in 2005 Metso introduced ValFormer, shoe and blade hybrid former that incorporates vacuum shoe technology (VacuShoe; figure 8).

VacuShoe is a perforated, curved dewatering element that is operated under a low vacuum. It is the first topside dewatering element and marks the start of upward dewatering. The dewatering pressure is effectively pulsation-free. The shoe vacuum impacts the virtually unfiltered top surface of the web enabling high dewatering capacity.

After the vacuum shoe dewatering phase, the whole web is more symmetrical in terms of web consistency, and thus more tolerant of the shearing effects of subsequent forming elements. It is now possible to use higher headbox flows than before, and to fully utilize the formation improvement capabilities of top former unit as well as the fluidization capabilities of the headbox.

The quality and filtration properties of nonwood grades, such as of straw or bagasse, may vary largely according to season and degrading degree. This further emphasizes the importance of a flexible forming concept in terms of speed, dewatering and quality.Thanks to the huge dewatering capacity of ValFormer the top former unit can be placed also close to headbox without extending the Fourdrinier table.

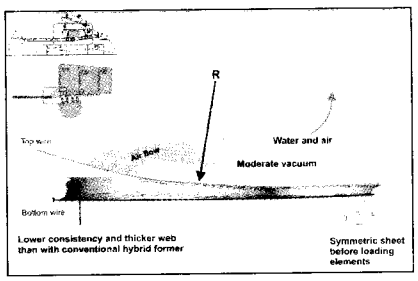


Figure 8. Dewatering on a shoe blade hybrid former.

ValFormer forming concept offers a solution for improving the capacity range of Fourdriniers and conventional hybrid formers, both as a rebuild or a new forming section, for both paper and board grades. A shoe blade hybrid former also works on high-speed machines exceeding conventional hybrid former speed limits, with excellent runnability.

ValFormer-equipped reference machines have exceeded previous quality and production rates on a wide basis weight range. Post-rebuild beta formation values are among the best on the market also at higher production rates.

Stabilized initial dewatering with VacuBalance

In addition to dewatering capacity limitations headbox jet landing on forming board is the second bottleneck of conventional hybrid forming. Excessive table activity on the forming board so-called stock jump limits both machine speed and the slice opening when conventional forming board designs are used. Table activity is directly proportional to jet impact energy, which is directly proportional to both the machine speed and slice opening.

The VacuBalance forming board is a new vacuum-assisted forming board design that efficiently absorbs the slice jet's impact energy and enables fast non-pulsating drainage through a large open area (Fig. 9).

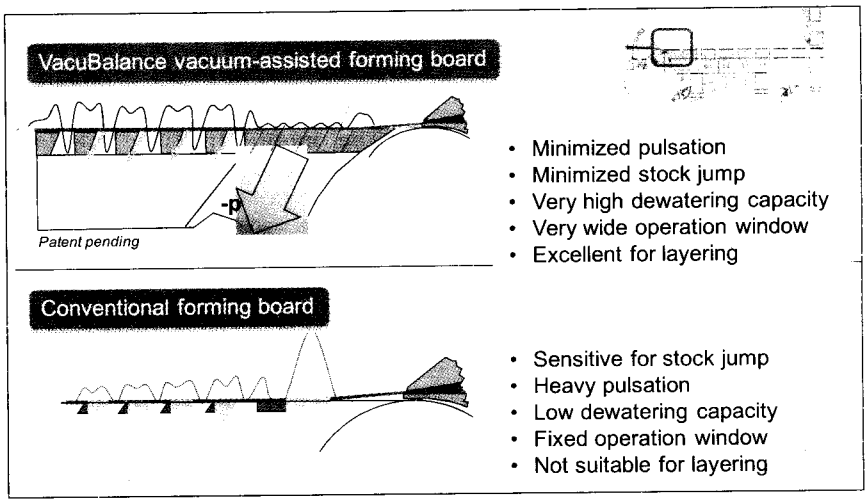


Figure 9. VacuBalance vacuum-assisted forming board efficiently absorbs the slice jet's impact energy and enables fast non-pulsating drainage through a large open area.

The new vacuum-assisted forming board has one or more vacuum zones for efficient operation. The headbox slice jet lands at the 1st zone equipped with a non-pulsating perforated cover. The forming board features a rigid, vibration-free construction with a stainless steel frame and a durable perforated cover.

The VacuBalance forming board provides minimal pulsation at the forming board for improved paper properties and runnability. In Fourdrinier rebuilds, it enables higher

running speeds and high dewatering capacity with a very wide operating window. Compared to conventional forming boards, stock jump effects are minimized.

Perforated suction box cover: high dry content with minimized vacuum and drive power load

The third limitation of conventional hybrid forming is the excessively low dry content after the former. Nonwood furnish like wheat straw or bagasse have both a high water resistance (WRV) and a high dewatering resistance (SR) value and the dry content remains at a low level.

Sufficiently high dry content secures web transfer on to the press section and good press section runnability. Dry content is typically increased by using various kinds of vacuum-assisted elements such as suction boxes and suction rolls. There are several factors affecting dry content and its development in the former. These include element type and vacuums, dwell time, rewetting, furnish, temperature and fabrics.

Dewatering takes place under a vacuum and is influenced by the vacuum level, open area and dwell time, which are governed by the element length and machine speed. Rewetting is a phenomenon which takes place after a certain web dry content level. The web acts like a sponge and tends to absorb water back from the fabric when vacuum is released (Fig. 10).

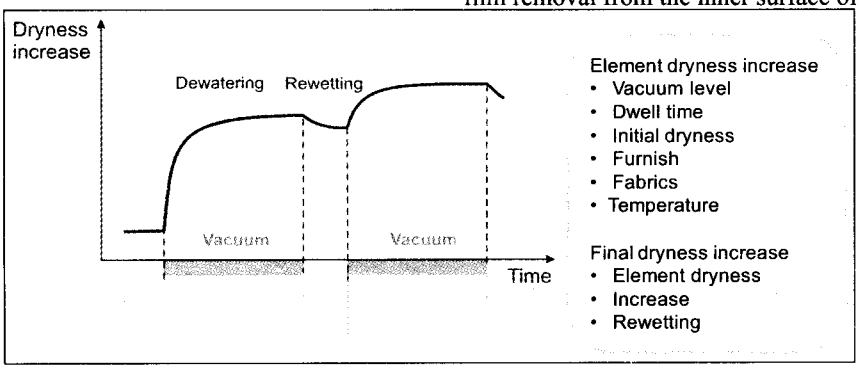


Figure 10. Dewatering and rewetting.

Typically a suction box uses considerably less vacuum energy than a suction roll, but generates a friction force that needs to be overcome by the drives. By optimizing the usage and design of different vacuum-assisted elements, energy consumption can be minimized and dry content production maximized.

Slotted ceramic covers have been used as a standard solution for suction boxes for years. In a systematic study of new energy-efficient dewatering processes Metso has developed a special perforated cover that clearly improves dewatering. Additionally, the new cover reduces specific energy consumption in comparison to slotted covers (Fig. 11).

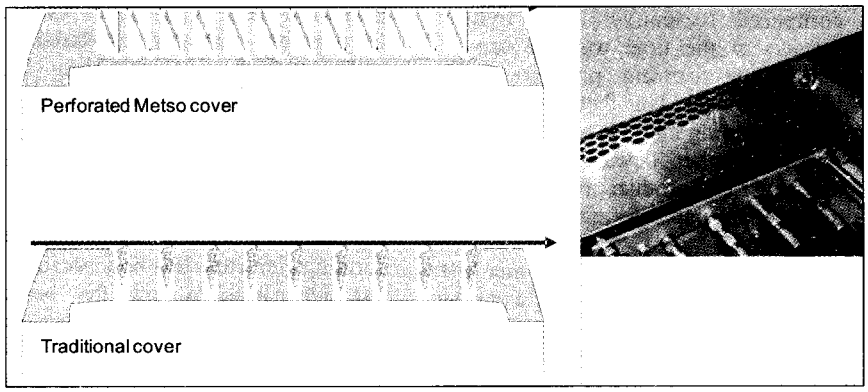


Figure 11. The perforated suction box cover with inclined drilling reduces flow resistance. In pilot trials and on production machine this design has improved dry content at moderate vacuum levels and reduced drive power demand.

Table 1. Pilot machine trials with different suction box covers

Table 3. Pilot machine trials with different suction box covers	Cover used	Dry content [%]	Vacuum level [kPa]	Drive power demand reduction
Lightweight FINE	Perforated	19-20	-30 - -40	5-20% (various grades)
Lightweight FINE	Slotted	19-20	- 65 - -80	

The more effective dewatering performance of a perforated cover stems from its large open area and more uniform vacuum effect. The special surface geometry of the perforation pattern dramatically improves water film removal from the inner surface of fabrics and thus minimizes web rewetting after the suction box.

Pilot machine trials show that high dry content (19% to 20%) can be achieved with relatively low vacuums (-30...-40 kPa) compared to a conventional high-vacuum suction box (-65 ... -80 kPa). The cover provides stable support for the forming fabric, thereby keeping it from "detaching" at the slots. These facts serve to reduce vacuum capacity needs, friction levels and drive power requirements.

A European paper mill needed to increase web dry content after the forming section in response to challenges with runnability and high press to dryer draw. Drying capacity was also limited. Metso suggested testing the new perforated cover.

On this production machine the perforated cover yielded a dry content increase of as much as 2 to 3.5 percentage points, whereas the slotted cover added only 1 to 1.5 percentage points. This dry content improvement slightly reduced draw at the center roll (3.92% > 3.55%). At the dryer section the steam pressure of the main dryer group was 10 to15 percent lower than with a slotted cover. All quality

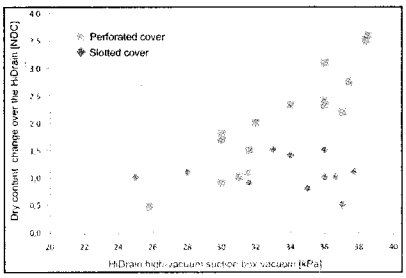


Figure 12. Dry content increase over the suction box as a function of the suction box vacuum level in a production machine. (SpeedFormer HHS-MB, HS fabroc, 950-1200 m/min, no fillers, RET. 88-95 %, dry weight 52-70 g/m2, various pulps/grades).

requirements of the various paper grades were fulfilled with the new perforated cover. The mill in question is pleased with the results gained (Fig. 12).

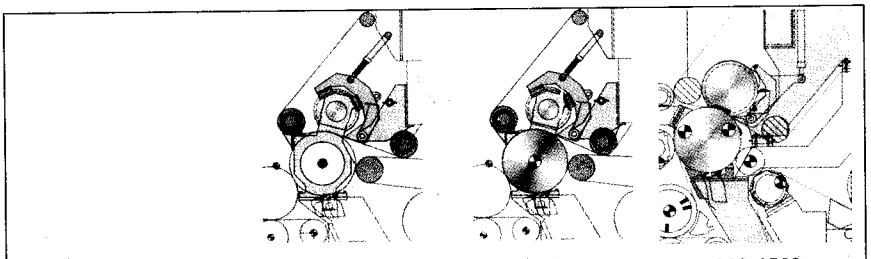
Shoe press rebuilds for increased speed and operating efficiency

The main task of the press section is to remove as much water as possible from the web without impairing the quality of the paper. The result of the pressing depends on the pressure in the press nip and on the nip length.

A shoe press greatly increases press exit dry content compared to a roll press. This improvement can be in the range of 3 ... 8 % depending on the application. This translates into 18 ... 32% higher production for dryer capacity restricted machines, and improves runnability at the start of the dryer section. A dryer web is stronger and less prone to stick on the cylinder surfaces.

A shoe press has been a real game changer in pressing technology. It all started in 1980 in Oregon, USA where the first shoe press ever was installed in a linerboard machine. Until today, more than 400 Metso shoe presses have started up around the world in various installations, both in paper and board production.

Often the easiest and most cost-effective way to install a shoe press on an existing press section is to simply replace one roll press with a shoe. The most typical way to do this is to place the shoe press roll in an overhead position in the 3rd nip of an old center roll-based press section (Fig. 13). This type of rebuild is very common for all paper grades.

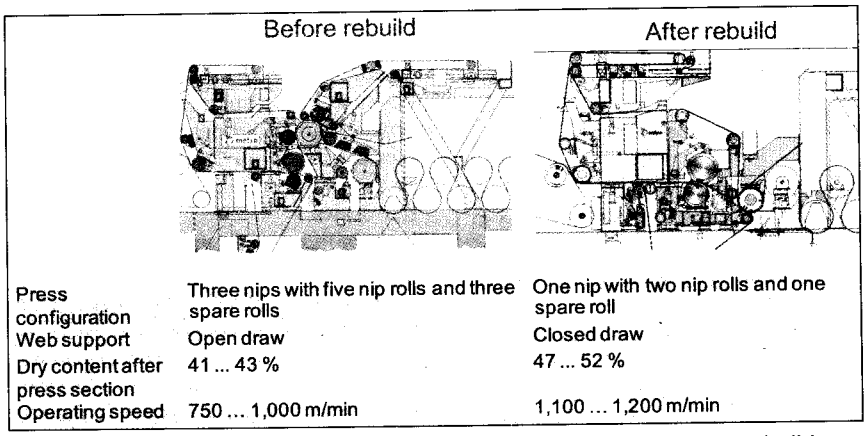


Linear load (kN/m)	350 kN/m	Up to 600 kN/m	600-1500
Dry content increase	Approx 2 %	Approx. 2 – 3 %	Approx. 3 - 6 %
Production increase or steam cons decrease	6 – 8 %	8 – 12 %	12 – 24 %
Press / Shoe press roll diameter	1095	1095	1250-1595
Counter roll	Existing (new bearing housing, new drive)	New SolidL roll	New SymZLC roll package

Figure 13. Center roll-based press section shoe press rebuild alternatives.

A single-nip closed-draw press is designed especially for uncoated fine paper grades (Fig. 14). The concept produces a symmetric web with high dry content. The single-nip closed-draw press is equipped with two felts that are responsible for removing water, and transferring the web throughout the press section at the same time. The web is fully supported to the 1st dryer group. Within the single-nip press configuration felts are an important tool helping to reach the desired quality and production efficiency.

The primary advantages of the single-nip concept are its lower operating and investment costs compared to the two-nip press. Also, the single-nip concept is quite easy to fit in an existing paper machine line due its compact design.



	Before rebuild	After rebuild
Press configuration	Three nips with five nip rolls and three spare rolls	One nip with two nip rolls and one spare roll
Web support	Open draw	Closed draw
Dry content after press section	41 ... 43 %	47 ... 52 %
Operating speed	750 ... 1,000 m/min	1,100 ... 1,200 m/min

Figure 14. Closed draw configuration of a single-nip shoe press rebuild. In closed draw concepts the web is fully supported to the 1st dryer group.

Closed draw press sections, both single-nip or double-nip ones, offer possibilities for furnish optimization, such as the use of less expensive raw materials in terms of

- long fiber - short fiber proportions
- kraft wood-containing fiber proportions
- fiber - filler proportions

It has been 11 years since the first modern closed draw press section started up in Kentucky, USA. When writing this the number of closed draw presses in operation is close to 30 and the number is increasing. In conjunction with latest dryer section runnability components, these machines have turned a new leaf in paper machine efficiency and productivity.

Case study with non-wood fibers

Non-wood fibers differ substantially from wood fibers in their morphological, physical and chemical characteristics and behave differently in the paper making process. A pilot machine test was performed to compare the performance of the vacuum-assisted forming board and the shoe blade hybrid former with a short table length using wheat straw based furnish and eucalyptus based furnish. The applied press concept was a single-nip shoe press with a closed draw.

The most significant difference between wheat straw based furnishes and eucalyptus furnish detected in the pilot trials was in the dewatering properties. Wheat straw furnish has much slower water removal, which results in lower dry solids content. Runnability of wheat straw in the paper machine finishing areas was otherwise good and paper properties are competitive with those of eucalyptus based paper.

When wheat straw furnish was mixed with eucalyptus furnish, it became more difficult to achieve good formation, but after tuning the shoe blade hybrid former parametres good formation was maintained (Fig. 15).

With wheat straw mixtures bulk preservation became important which again could be tackled with the shoe press concept. On the other hand,wheat

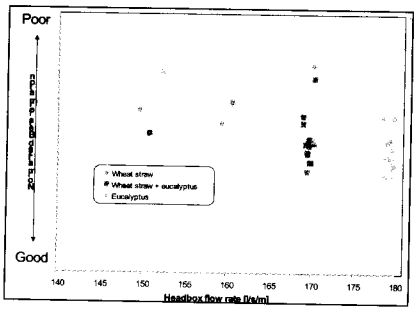


Figure 15. Development of formation when the headbox flow rate changed. Pilot trial with a shoe blade hybrid former with a vacuum-assisted forming board and a single-nip shoe press, machine speed 1,200 m/ min. Furnish mixutres wheat straw/SW (80 / 20 %), wheat straw/eucalyptus/ SW (40 / 40 / 20 %), and eucalyptus/ SW (85 / 15 %). Filler content target 20 %, ground calcium carbonate).

straw increased sheet strength.

Formation of wheat straw and eucalyptus furnishes developed differently as the headbox flow rate was changed.

In this trial, the single-nip shoe press section with closed draw provided a more than 50% solids dry content after the press together with excellent runnability with a furnish combination of wheat straw/eucalyptus/SW (furnish ratio 40/40/20). With a furnish combination of eucalyptus/SW (furnish ratio 85/15) the single-nip press produced an up to 56% solids dry content (Fig. 16).

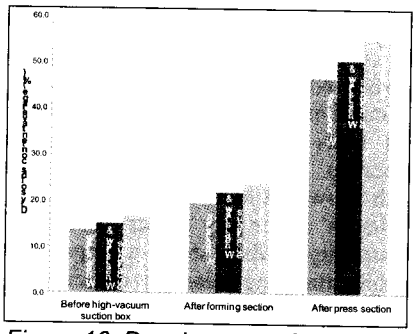


Figure 16. Development of solids dry content with different furnishes. Pilot trial with a shoe blade hybrid former with vacuum-assisted forming board and single-nip shoe press, machine speed 1,200 m/min.. Furnish mixutres wheat straw/ SW (80 / 20 %), wheat straw/ eucalyptus/SW (40 / 40 / 20 %), and eucalyptus/SW (85 / 15 %). Filler content target 20 %, ground calcium carbonate).

Due to different fiber morphology, especially the higher fines content, wheat straw pulp has slower dewatering, and thus lower dry contents were measured both after forming section and after press section.
Consequently, it is important to select forming and press section concepts with sufficiently high dewatering capacity and flexibility.

Web runnability onto the dryer section

The critical areas from a runnability perspective in dryer section are the free draws between the press and dryer section and double-felted dryer groups, due to open draws between the cylinders. Web flutter typically occurs at moderately low speeds.
Runnability in the press-to-dryers can be improved through PressRun blow boxes which hold paper tightly on the fabric surface on its way to the first dryer cylinder. This also minimizes the free draws.
In rebuilds, it is quite common to modify the double-tier groups into single-tier ones. By applying runnability system components the web can be stabilized, by neutralizing the opening nip vacuum and adhesion forces and keeping the paper in transit to the next cylinder
In single-tier sections SymRun Plus blow box guarantees good runnability. It utilizes specially designed blow nozzles on both sides of the pocket. The boxes can be installed very close to the fabric, thanks to which the vacuum level needed for a stable web run is reached with a small amount of air (Fig. 17).

Film sizing for excellent sheet surfaces

Sizing and coating always involve tradeoffs with sheet quality and runnability. From a quality point of view size or coating color should cover the surface of the paper uniformly and fully. From a runnability perspective all excessive rewetting of the paper should be avoided to prevent high draws and sheet breaks.
ValSizer film sizer features technology for resolving process bottlenecks in sizing and coating, both in rebuilds and new installations. Existing pond sizers can also be rebuilt using ValSizer technology and reusing existing rolls.
The sealing blade also prevents skipping by eliminating harmful flow disturbances and air even at higher speeds. The precision applicator beam ensures a uniform cross-directional film profile (Fig. 18).

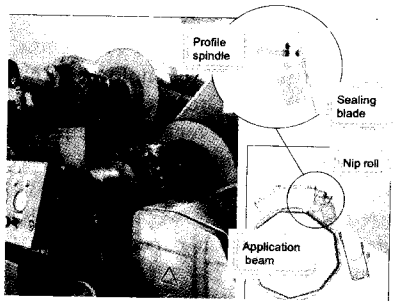


Figure 18. ValSizer film sizing technology is based on 560 delivered sizing /coating units. Existing pond sizers can be rebuilt using ValSizer technology and reusing existing rolls.

ValSizer's application head uses the unique perforated sealing blade principle patented by Metso. This ensures the ideal and even application of size and coating color. Replacing an

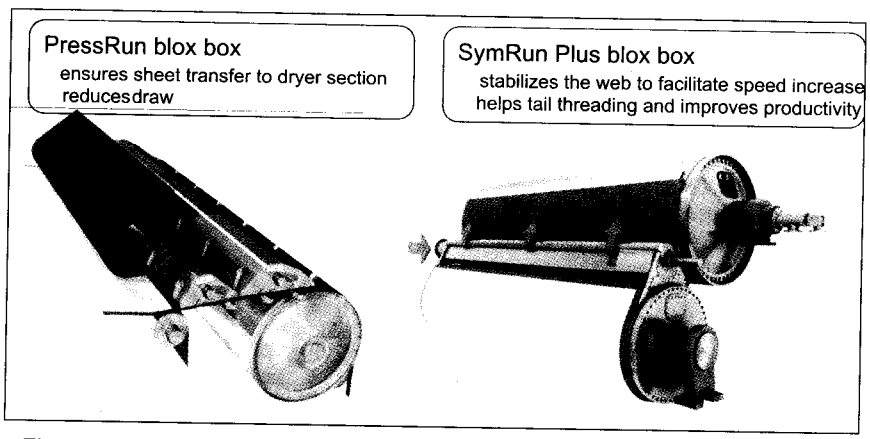


Figure 17. Metso runnability systems are used in numerous paper and board machines all over the world.

existing pond sizer with a ValSizer will erase any existing speed limitations.
Compared to pond sizing, ValSizer helps to increase the size dryness, which means that the sheet is dryer and overall moisture profiles will improve. This contributes to fewer sheet breaks and excellent runnability. Moreover, the improved size dryness helps to reduce drying energy consumption in the after dryer section (Fig. 19).

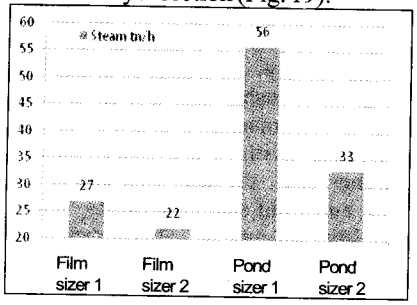


Figure 19. Film sizing reduces steam consumption is after dryer section considerably compared to pond sizing. Data simulation.

The fundamental design of ValSizer provides easy operation with integrated controls and reduces maintenance. Thanks to minimized field cabling and piping, ValSizer is fast to install and start-up, which ensures short payback time and return-on-investment.

Calender rebuilds

The final appearance of the sheet is created at the calender. A calender gives the desired qualitative properties, such as gloss, smoothness, density, etc. In addition to quality, calender can also bring production benefits.
Calendering and wet pressing have a similar effect on the paper sheet, namely smoothening the surface and adjusting sheet density. That is why the best-fit calender concept always takes into account the press configuration. For example, using a soft calender on a paper machine line allows one to increase press section efficiency by removing the 4th press and possibly also installing a shoe press in the 3rd press position without sacrificing the smoothness symmetry of the sheet.
Soft calendering offers effective smoothness symmetry control capabilities. By pushing the rougher sheet surface against a smooth roll (and bottom side against soft cover) the sheet can be gently calendered to produce one-sided end product. Thanks to the gentle calendering process paper strength properties do not deteriorate in soft calendering.
ValSoft is a soft nip calender for small and medium-capacity paper making lines. It is reliable, easy to operate and maintain thanks to its open-frame design with easy access and good visibility to the stack. Workshop pre-testing ensures fast installation and start-up (Fig. 20).

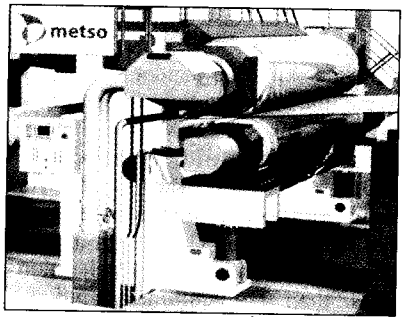


Figure 20. ValSoft calender offers tools for roughness symmetry control.

results in a gain of several percentage points in material efficiency and provides plenty of extra capacity for removing existing bottlenecks in the finishing area, for example (Fig. 21).
ValReel Pro stands for latest reeling technology in a compact package for medium-capacity paper making lines (Fig. 22). The one-level reeling concept gives significant benefits in terms of operating and maintenance. The lower crane lifting height and simplified controls for example, the elimination of hydraulics contribute to lower investment costs.
High material efficiency is ensured by well controlled reeling parameters. Parent roll structure and high turn-up efficiency are ensured by nip force control during turn-up. This concept gives plenty of time for primary winding as sequence limits have been eliminated.

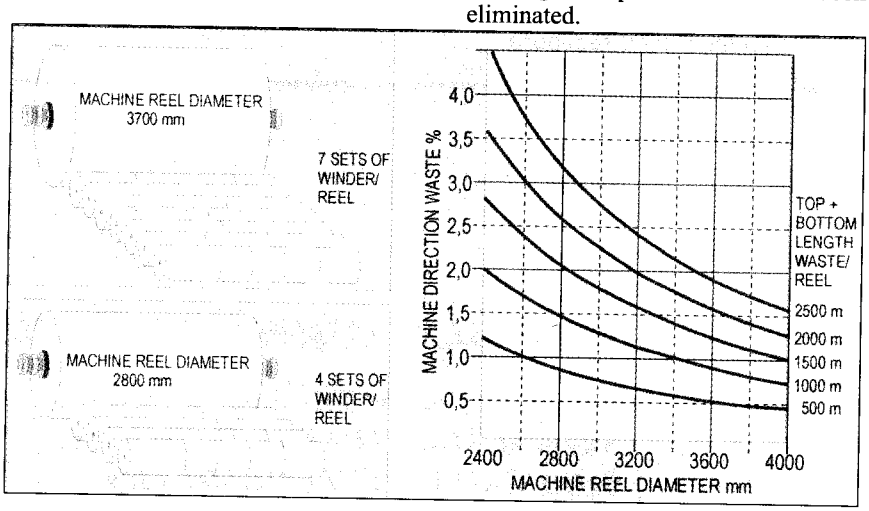


Figure 21. The effect of parent roll diameter on line efficiency and capacity.

One-level reeling on solids rails

Reeling technology contributes to profitability of a paper making line by creating greater material efficiency and capacity in terms of reduced spool and surface waste and better throughput in the finishing area by maximizing parent roll diameters.
The efficiency of an existing line can be improved in two stages. Firstly, a new reel is installed to minimize bottom waste. In stage two, when more winder capacity is needed, new spools are added to increase the parent roll diameter.
Parent roll size has a remarkable effect on overall material efficiency and capacity in the finishing area. A fairly typical 2.8 m parent roll will yield four sets of 1.3 m shipping rolls. Bringing the parent roll diameter to 3.7 m will increase the number of shipping roll sets to seven from each parent roll. This

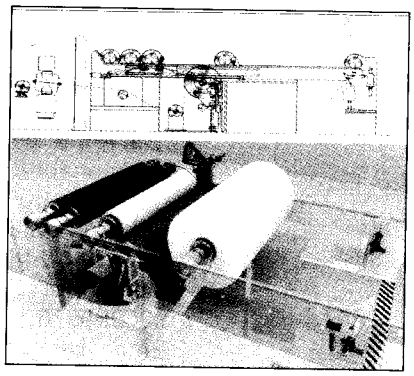


Figure 22. One-level reeling on solid rails enables lower crane lifting height. Optimized controls, with no hydraulics, ensure easy operating and maintenance.

ValReel Pro can easily be fitted into existing production lines; the installation takes only a few days.

High-capacity ValDrum winder manages large parent rolls

The larger parent roll diameters and increased machine speed are a challenge in winding. The winder has to be able to produce tight and uniform customer rolls with very good efficiency.

ValDrum winder (Fig. 23) is a high-performance winder for medium-capacity paper making lines. Its design combines the experience gained from several hundred winder deliveries in the form of sturdy mechanics, robust solutions and overall reliability of the winder. The winder is easy and safe to operate and maintain. Workshop pre-testing ensures fast installation and start-up.

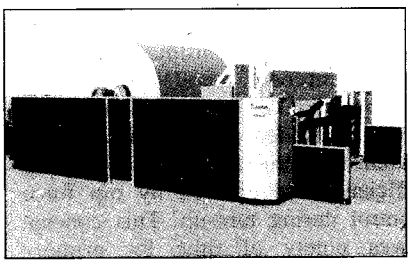


Figure 23. ValDrum winder has huge capacity potential, thanks to its automated short sequence times and drive optimization

By having only one winder in a paper making line brings savings in operating costs and investment payback time. This is possible with high-capacity ValDrum winder, thanks to its automated short sequence times and drive optimization. The design allows higher acceleration and deceleration values than conventional winders, without increasing the size of drives.

Summary

The rapidly growing demand in the Indian market calls for more efficient production lines, both in pulp and paper production. New production lines are being built but there is a strong need to rebuild the existing machinery. Healthy growth in the paper market can only be guaranteed by making high-quality paper and board more efficiently.

Rebuilding an existing paper machine with best-fit solutions is often a very profitable way for papermakers to increase the cash flow created by an older paper machine. Metso's long experience with paper and board machines has created cost-effective small and mid-sized solutions with reliability and quality. This paper has discussed some of the latest optimal and viable technologies for paper machine and finishing area rebuilds.