

PAPER MACHINE REBUILDS AND SOLUTIONS FOR PROCESS IMPROVEMENT

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1. Introduction

Increasingly global operations and the generic development of technology in all areas place ever-growing pressure on paper machine productivity. A single papermaking line has to remain fit and competitive every day. Carefully selected and perfectly matched rebuild products are one good tool for maintaining and improving the competitiveness of an existing paper machine.

The greater and greater production rates of newly built paper machines place pressure on existing paper machine lines to stay competitive, at least among the so-called standard quality bulk paper grades. History has, however, shown in many contexts that also the small can survive. This is the case in papermaking as well. Smaller paper machines, too, can improve their competitiveness with clever investments. This may require rebuilds designed for both production increase and paper quality improvement.

Rebuilding a paper machine actually means removing or fixing any known bottlenecks to achieve higher productivity and a steeper earnings curve compared to the existing situation. Addressing bottlenecks, together with possible quality enhancements, can produce a steep turn in the cash flow gradient of an old machine. This also improves the overall economics of a paper machine line.

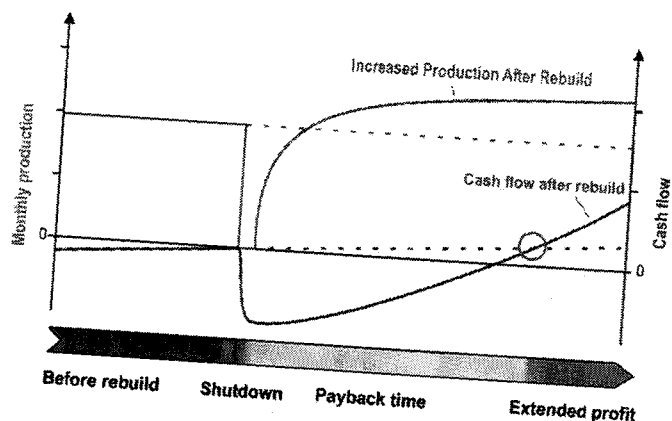


Figure 1.1.1: A targeted rebuild with a steep startup curve offers increased cash flow opportunities with a short investment payback.

A well-executed rebuild is targeted and designed to remove any known paper machine bottlenecks, and it consists of

- analyzing and determining the true bottlenecks of an existing paper 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 are smooth to install
- paying special attention to the startup and supporting it with specific expertise to get a steep startup curve, which enables the fastest investment payback.

Metso Paper is capable of offering a wide variety of rebuild solutions for every paper machine section and application and for a variety of needs. This paper discusses some of the solutions available for improving existing paper machines.

2. Products

2.1 Headbox upgrades for better profiles

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

machine performance. Grade differences and differences in the scale of production and machinery concepts require customized solutions.

Metso Paper has built an extensive headbox product portfolio, or product "family", that covers all customer needs in the papermaking business. This product family can provide the most cost-effective product for any given application. The product family today covers high-end needs for the fastest speeds as well as low-end needs for lower speeds. And, of course, all needs falling between these two extremes.

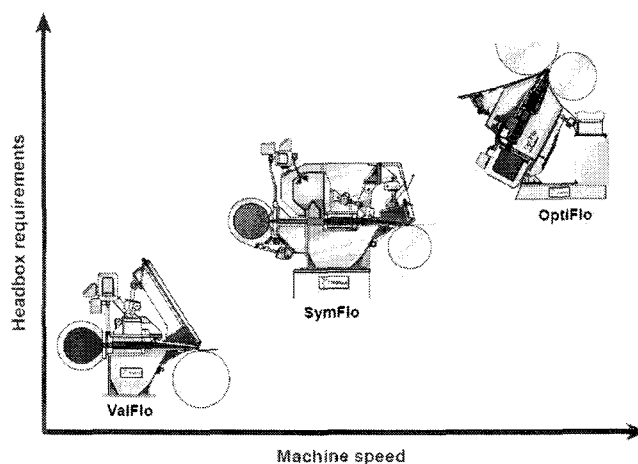


Figure 2.1.1: Metso's headbox portfolio offers solutions for all customer needs.

It is widely accepted that the ability to produce uniform cross-directional profiles (both basis weight and fiber orientation), small residual variation, strength properties, and good formation numerically describe the properties of a good headbox. In addition to these numbers, some non-measurable features, such as sheet uniformity and streakiness, are also used to evaluate headbox technologies and to justify choosing a specific headbox.

Starting at the low end, the most economical headbox is the hydraulic ValFlo single tube bank headbox. ValFlo belongs to Metso's range of Val products that has been developed to address the industry's need for cost-effective and

appropriately sized solutions for rebuilds and new installations. The light and compact construction of a ValFlo headbox ensures fast and easy installation, which makes ValFlo a perfect fit for lower-speed rebuilds. ValFlo is made of solid stainless steel, built with the same pride and care as bigger Metso Paper headboxes.

SymFlo headboxes are intended for Fourdrinier and hybrid formers. SymFlo pays special attention to process stability in terms of both CD and MD profiles. This means that all important features, such as a shape-optimized header, integrated dilution system, edge feeds, two tube bank design, air pad attenuation and thermal compensation, are always included. The design and case-specific dimensioning of the turbulence generator, along with the forming section, delivers the targeted qualitative properties of paper even in the most demanding applications. The most common applications for SymFlo headboxes are fine paper machines producing high-quality uncoated and coated papers.

At the high end of the headbox family, the OptiFlo headbox is targeted at the highest operating speeds without compromising paper quality. Sturdy mechanical structures, together with well-established and robust hydraulics, are the most prominent features of this headbox.

Its excellent references have made the OptiFlo headbox the state-of-the-art headbox for gap forming machines producing top quality printing paper worldwide. Numerous world records in speed and production provide the best proof of OptiFlo's performance capabilities.

OptiFlo includes all of the headbox features required for high-speed papermaking, such as a two tube bank design, advanced dilution system, shape-optimized header, edge feeds and thermal compensation. These contribute to the optimization of paper quality at high levels.

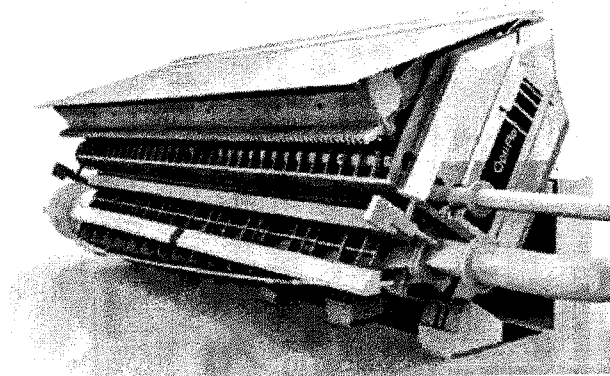


Figure 2.1.2: The OptiFlo headbox includes all features necessary for high-speed paper production.

Further development of high-speed headboxes has created the new OptiFlo II headbox. OptiFlo II technology is based on the excellent and well-established features of the classic OptiFlo, combined with a new philosophy for the production of the optimal slice jet. Thorough fluid dynamic research was carried out on fluid flow and fiber flocculation interactions to optimize headbox hydraulics. OptiFlo II headboxes include wedge technology to restrict the scale and intensity of turbulence and to continuously accelerate the flow after fluidization in the turbulence generator. These characteristics make paper more uniform compared to headboxes with conventional hydraulics.

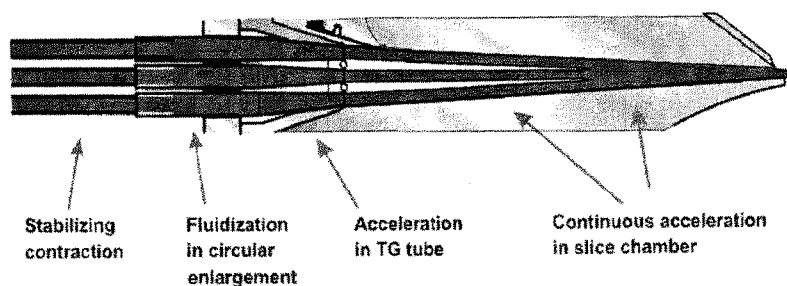


Figure 2.1.3 : An OptiFlo II turbulence generator followed by wedges

When machine speed is increased, the old headbox may become too small or, even if the headbox would be able to operate at higher speeds, the CD profile may get too unstable. New headboxes are usually equipped with dilution water CD control to enable good sheet uniformity. It is not, however, necessary to replace the whole headbox to make improvements. A retrofit kit named RetroDilu has been developed for existing headboxes whereby a dilution bank can be installed on an existing headbox.

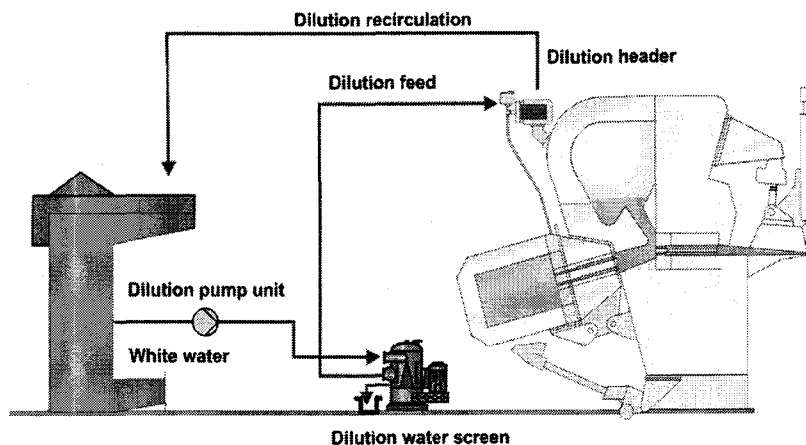


Figure 2.1.4: RetroDilu is an interesting alternative for many existing headboxes for improving web basis weight and orientation profiles.

It is suitable for all paper machines equipped with rectifier roll or SymFlo type headboxes with slice lip control. The benefits of dilution profiling are indisputable: end-product quality will be improved thanks to very uniform basis weight and fiber orientation profiles, which can be controlled independent of each other contrary to slice lip control. They also contribute to fewer web breaks and reduced broke, thereby improving machine runnability.

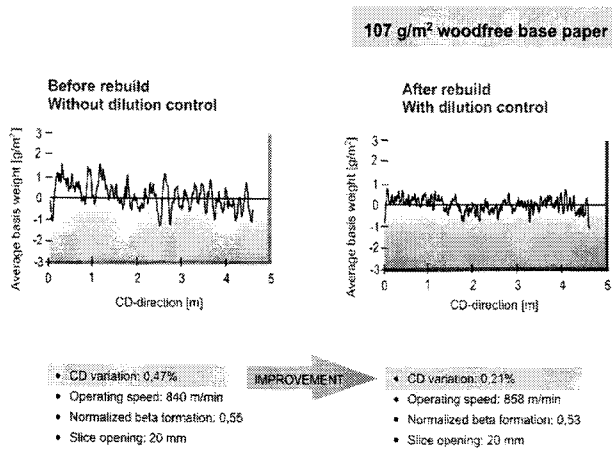


Figure 2.1.5: CD profiles will improve remarkably with dilution control.

2.2 Forming section rebuilds for improved sheet quality

Formation is considered to be one of the most important sheet properties. Paper formation originates at the forming section, and the performance of the forming section therefore plays an important role. Another fact is that about 97%98% of total paper machine drainage takes place at the forming section, which means that the former has to be able to handle large amounts of water.

SymFormer MB is a hybrid former with a top former unit capable of adjusting forming parameters with the help of pressure generated by loadable blades. Because water is removed both up and down on the forming section it provides increased drainage capacity and a more symmetric sheet compared to a Fourdrinier section.

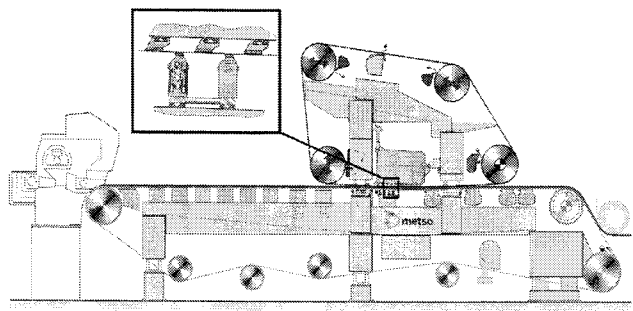
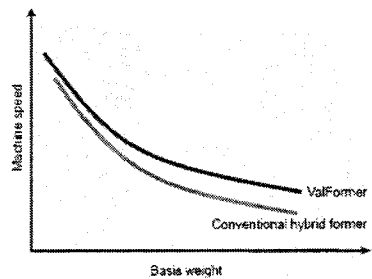
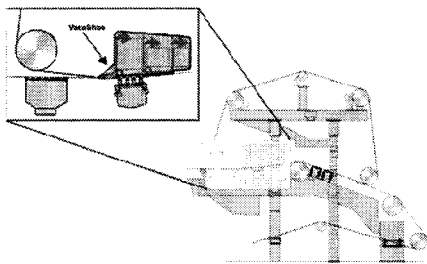


Figure 2.2.1: SymFormer MB is a hybrid former with a top forming unit.

SymFormer MB hybrids are used worldwide for various paper grades. It has been very common to install these top forming units on top of an existing Fourdrinier. They work well with all paper grades.

However, a hybrid former is subject to quality and capacity limits that vary depending on the paper grade. The new ValFormer is designed to stretch the operating window of hybrid formers and thus facilitate production increases without the need for excessive investments in the existing construction. The main drivers behind ValFormer development have been improved hybrid former capacity, speed potential, runnability and sheet quality. So far ValFormers are suited to newsprint and multigrade use with fine papers within the 40300 g/m² basis weight range.

At the heart of a ValFormer lies Metso Paper's ingenious VacuShoe technology. VacuShoe is a curved, vacuum assisted dewatering element that is mounted on the top side of the sheet. It replaces the doctoring foils of SymFormer MB but retains best of other proven SymFormer MB features. With VacuShoe papermakers can produce paper at greater speeds or greater basis weights without running into capacity limits.



Formation has improved by 15-20 %

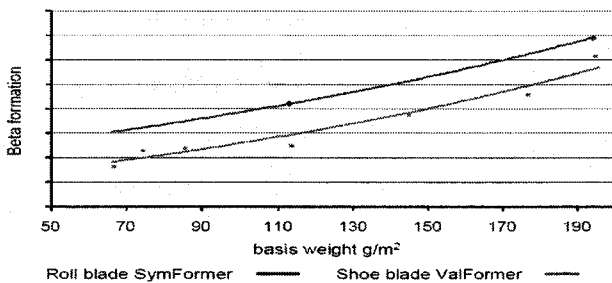


Figure 2.2.2 : ValFormer is based on VacuShoe technology and it provides tools that facilitate a step forward from conventional hybrid formers.

Thanks to its geometry and capacity, the design of VacuShoe enables lower headbox and inlet consistencies compared to earlier solutions. VacuShoe provides better controllability and capacity without creating excessive turbulence. The web top surface can thus be formed in a controlled manner. Controlled dewatering at the first stage essentially helps in optimizing the loading blade area, which has a significant effect on the various quality variables of paper.

In traditional hybrid formers the front edge position is sensitive to basis weight changes. Depending upon the basis weight range produced with the machine, the front edge position is adjusted based on the main grade. The advantage of the VacuShoe design is that there is practically no need to make any changes in the front edge position as the inlet consistency changes.

The ability of ValFormer to work with a lower inlet consistency will improve sheet formation potential compared to traditional hybrid formers. This has been verified from actual references.

A specific application of VacuShoe technology is the upgrading of old Beloit BelBaie forming sections. An existing BelBaie former can be rebuilt to a BelBaie V type by upgrading the jet landing and forming zone equipment. This type of a rebuild case is presented later in this article under "Practical examples".

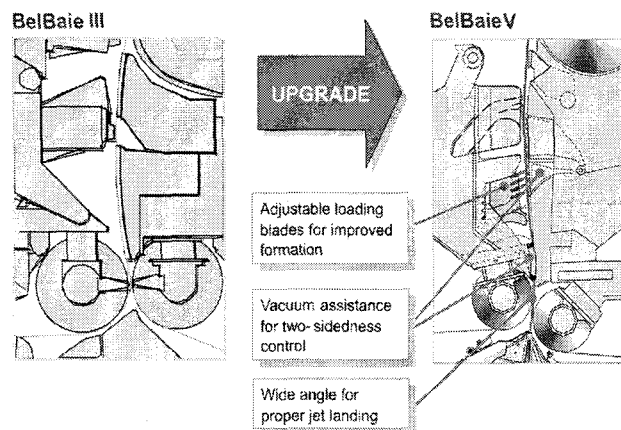


Figure 2.2.3: BelBaie V is the latest upgrade for existing BelBaie gap formers.

2.3 Shoe press rebuilds for capacity increase

Web dryness after press is a very important characteristic for paper machines that want to reach high operating speeds, operating efficiency and higher production rates. A shoe press has proven to be a very viable tool for this purpose. A shoe press will greatly increase press exit dryness compared to a roll press. This improvement can be in the range of 2%–8% units depending on the application. This enables higher production rates for dryer capacity restricted machines and improved runnability at the start of the dryer section. A dryer web is stronger and less prone to stick on the cylinder surfaces.

After their introduction for printing and writing papers some 10 years ago, shoe presses have found their way into a variety of configurations. As an extreme example, a modern shoe press is capable of operating alone without the assistance of other presses. OptiPress I is a single-nip shoe press that can be a very interesting choice when looking for a dramatic dryness increase with modest investment and operating costs.

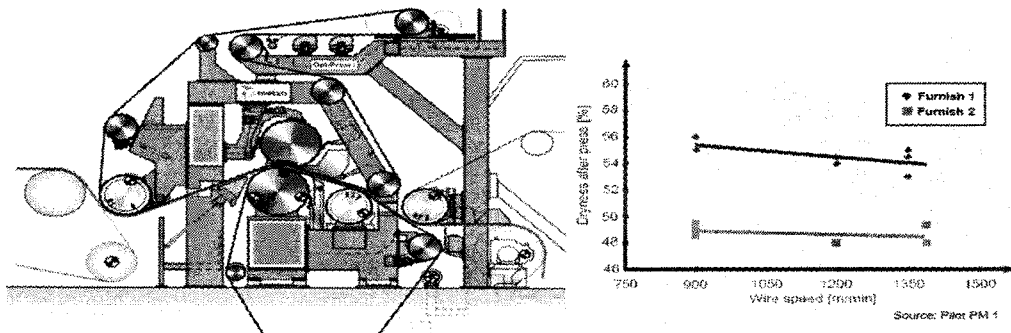


Figure 2.3.1 : OptiPress I is a single-nip shoe press and it has been proven to yield outstandingly high dryness after the press section.

OptiPress I needs only two felts and produces a symmetric web after the press section with very good dryness. This concept is applicable for uncoated fine papers.

Often the easiest and most cost-effective way to install a shoe press at an existing press section is to simply replace one roll press with a shoe. The most

typical way to do this is to rebuild press 3 of an old SymPress II into a shoe press. This type of rebuild is very common for all paper grades, and it is actually the best selling shoe press configuration. This configuration combines a proven three-nip arrangement with the dryness boost of shoe press.

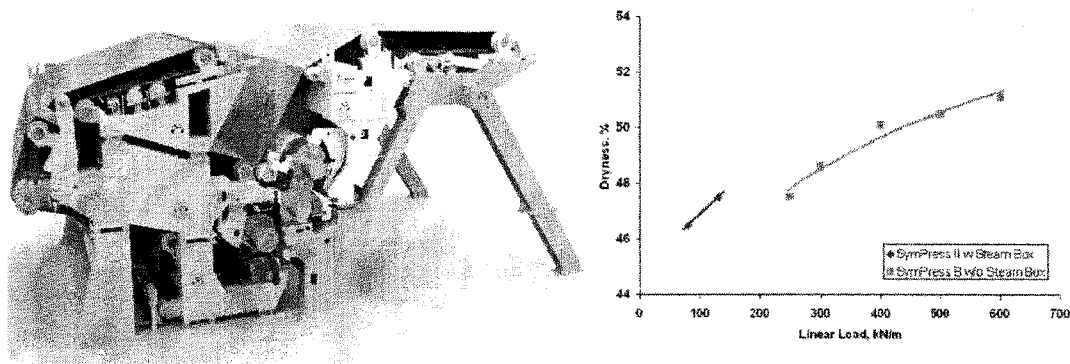


Figure 2.3.2 : A SymPress B rebuild is the optimal way to improve existing three-nip press performance and it is therefore the bestseller of shoe press rebuild concepts.

2.4 Dryer modifications for runnability and capacity

When increasing speed, web runnability at the dryer section must always be taken into account. The most problematic arrangements from a runnability perspective are double-felted dryer groups due to open draws between the cylinders. Sheet flutter is a typical ailment for these groups already at moderately low speeds. It is therefore quite common to modify double-tier groups into single-tiers.

Aerodynamic forces start to make the sheet unstable at higher speeds even in single-tier areas causing bubbles and/or wrinkles, and thus severely increasing the probability of web breaks. These disturbances are typically fixed by increasing web tension (draw) but this method involves many negative aspects, such as lower strain in dry paper and higher porosity.

Metso has long been the pathfinder in dryer runnability components. Thanks to

extensive development work over the years, Metso can offer a blowbox portfolio where a suitable blowbox application can be found for any particular need.

Runnability systems are designed to stabilize the web at the dryer section. In single-tier dryers the runnability system consists of a blowbox, vacuum roll and an auxiliary blower system. These components generate a negative pressure zone covering the entire length of web travel between cylinders.

Special nozzles built inside the blowbox enable it to create a vacuum effect that improves contact between the sheet and dryer fabric. As speed increases, higher and higher vacuums are needed to offset the aerodynamic forces created at cylinder gaps. Stable web travel at the dryer section facilitates higher operating speeds under minimum draw conditions.

A HiRun system provides many benefits, proven in production situations. It enables higher speeds, helps tail threading, and improves machine productivity. The main benefit of a HiRun system is that it facilitates control over web draws in order to optimize paper properties.

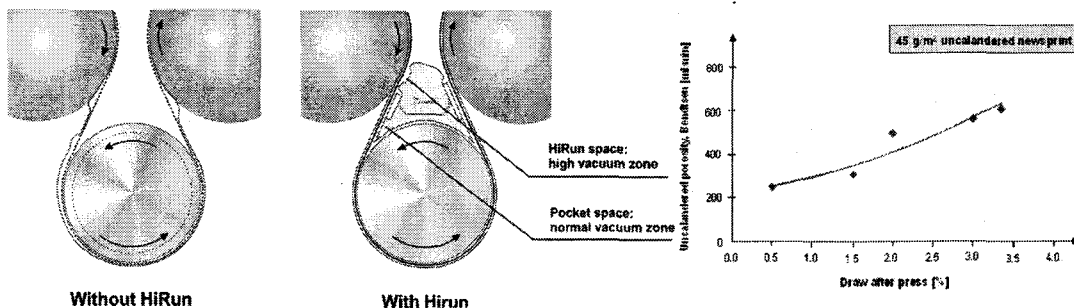


Figure 2.4.1 : A HiRun system provides increased web support that facilitates higher speeds, lower draws and improved paper properties.

In addition to HiRun blowboxes Metso can also offer a SymRun HS blowbox designed for moderate machine speeds.

Another dryer section-related bottleneck is drying capacity. Increasing the number of dryer cylinders is typically not a favorable option because it usually requires major changes at the whole dry end of the paper machine. Impingement

drying is a well-established drying technology for drying paper. Air dryers are widely used in coated paper drying, and now Metso Paper has introduced an air drying technology that works with all printing paper grades. It can be installed on single-tier or double-tier dryer sections without any loss of existing drying capacity.

This new technology advancement remarkably increases drying capacity without adding machine length and with minimal building and machine frame modifications. This makes it very attractive for rebuilds targeting production increases of 10%...15%. The long impingement drying phase means enhanced drying capacity, higher speeds and increased production. Impingement air velocity adjusts drying capacity rapidly and speeds up grade changes. Fast dry content increase also means better runnability. An additional benefit is the ability to use ropeless tail threading. Paper quality also improves as moisture and tension profiles become very uniform.

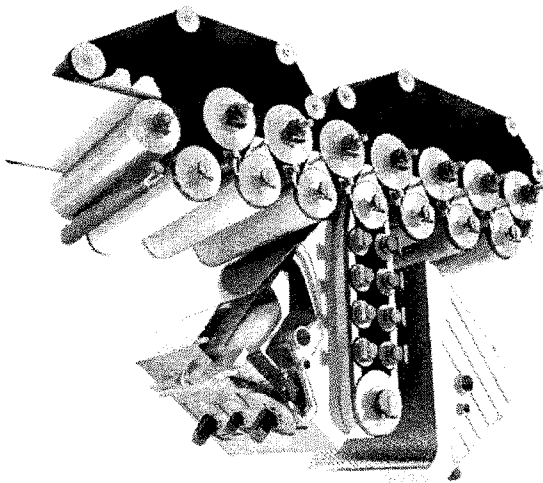


Figure 2.4.2: OptiDry Vertical consists of two hoods that blow hot air directly onto the web. The air is heated by gas burners. Air circulation fans and gas burners are integrated into the hoods, minimizing the need for outside equipment space.

No speed limit is known at the moment and runnability tests at pilot facilities have proven successful up to speeds of 2,400 m/min. This is possible because the

concept is equipped with vacuum rolls and blowboxes that eliminate the harmful airflows and pressure peaks often disturbing regular high-speed runnability.

2.5 Calender rebuilds smart move to ensure optimal sheet quality

The final appearance of the sheet is created at the calender. A calender treats paper in a way that achieves the desired qualitative properties, such as gloss, smoothness, density etc. Although a calender is often regarded as a quality-related tool, it can also bring some production benefits.

Calendering and wet pressing have a similar effect on the paper web, 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 is getting more and more popular worldwide because of its smoothness symmetry control capabilities. By putting the rougher sheet surface against a hot smooth roll (and bottom side against soft cover) the sheet can be gently calendered to produce a onesided end product. Thanks to the gentle calendering process paper strength properties do not deteriorate much in soft calendering.

ValSoft is the new soft nip calender to meet the calendering needs of small and medium-sized papermaking lines. The benefits of ValSoft include reliable and easy operation and maintenance due to an open-frame design with easy access and good visibility to the stack, as well as easy control and monitoring. Furthermore, roll replacement is efficient due to optimal roll stack design. Thanks to its modular design and workshop pre-testing, ValSoft is fast to install and start up. ValSoft has all of the tools needed to produce uniform high-quality paper.

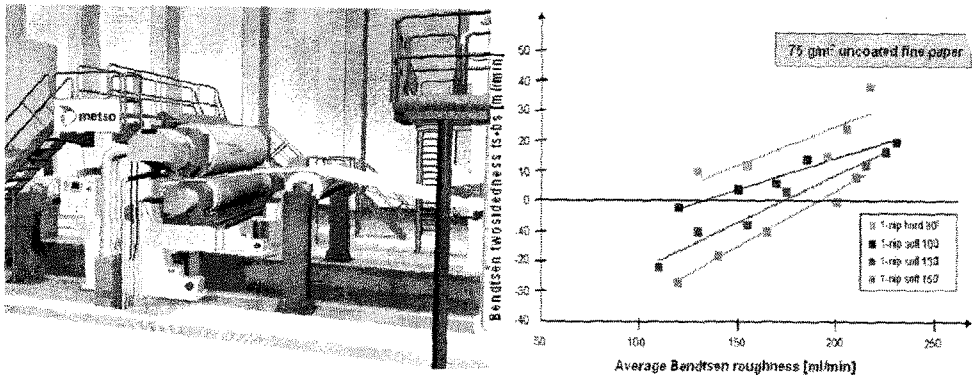


Figure 2.5.1: : A ValSoft calender offers tools for roughness symmetry control.

OptiSoft is the right choice for more demanding applications. It has all of the tools, including narrow-zone CD profiling, needed to produce the highest quality paper. This makes external profiling devices unnecessary. The integrated automation concept gives versatile tools for optimizing paper quality and machine running parameters.

Improving paper quality and possibly stepping into a new, higher quality paper grade can be a good choice for improving the economics of an existing paper machine. Metso Paper has products available for this purpose as well. OptiLoad calenders can be added (offline or online) to an existing paper machine line to provide improved smoothness and gloss. Paper machines producing newsprint can be upgraded to produce SC papers, or coated papers if coating equipment is also provided.

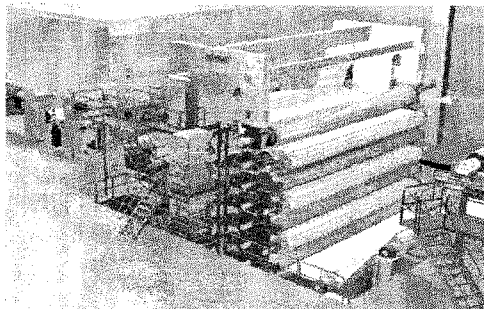


Figure 2.5.2: An OptiLoad multinip calender can be added to an existing paper machine online or offline.

OptiLoad is a multipurpose calender for optimum paper quality and capacity with a unique full roll weight relieving principle. Its efficient design features reduced maintenance needs with easy access to all maintenance points. OptiLoad's operation is stable also at high speeds, which is facilitated by the utilization of SymCD rolls with hydrostatic slide bearing technology. Extensive R&D work has produced consistent tail threading that has been proven through scores of references.

2.6 Latest reeling technology for maximized line efficiency

Paper mills and machinery suppliers normally focus on getting the web efficiently through the paper machine with as limited losses as possible. But it is also important to realize that huge potential for efficiency improvement exists in the finishing area as well. The following graph shows how the reduction of reeling-related waste has affected line efficiency during the last two decades.

Reeling technology has four major effects on the profitability of a papermaking line:

- greater material efficiency in terms of reduced spool and surface waste
- better throughput in the finishing area by maximizing parent roll diameter
- shorter payback time when changing grades, improving quality, or speeding up the machine
- reduced number of turn-up breaks

The latest reeling technology minimizes the amount of waste paper and enables the winding of larger diameter parent rolls. The largest potential for waste paper reduction lies in the minimization of bottom waste, i.e. paper that needs to be left on the spool in the next unwind. Actions focusing on reeling technology (new reel + new spools + bigger parent roll) result in a 3% efficiency improvement. A 3% increase corresponds to an additional ten production days in a year and an additional 6,000 metric tons of production on a 200,000 tpy line.

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 results in a several percentage point gain in material efficiency and provides plenty of extra capacity for removing existing bottlenecks in the finishing area, for example.

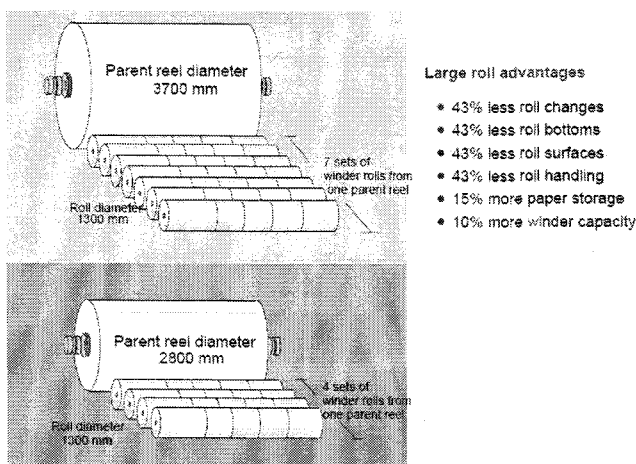


Figure 2.6.1: The effect of parent roll diameter on line efficiency and capacity.

All Metso Paper reels provide accurate control of reeling parameters, correctly sized reel spools, optimized roll properties (spreader roll, reel spools & reel drum) and high turn-up efficiency. Metso Paper's reel family consists of the following reels: ValReel, ValReel Plus, OptiReel and OptiReel Plus.

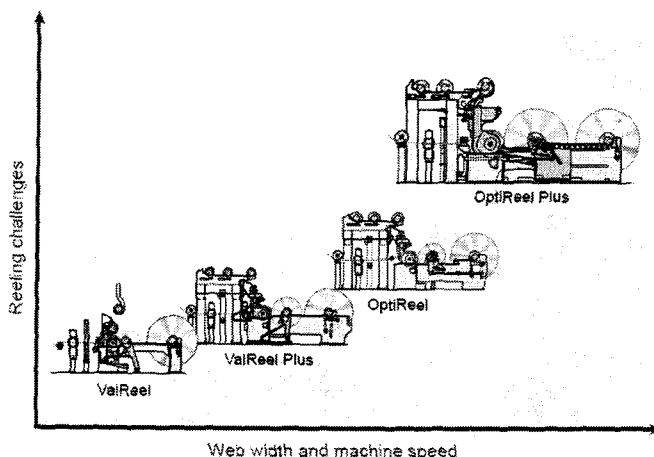


Figure 2.6.2: The Metso Paper reel family.

ValReel is a conventional pope type reel and it provides just the right level of reeling technology required by grades and operations with less demanding reeling conditions.

ValReel Plus is also a conventional pope type reel with an attractive feature that allows it to be converted to a center driven OptiReel. This conversion capability supports investments that need to be carried out in stages and provides security for future major rebuilds.

A center driven reel is the right application for more challenging grades (high smoothness, density or gloss) or high requirements on material efficiency and line capacity. OptiReel is a center driven reel for medium-sized production lines and it provides excellent value for the money. OptiReel Plus is designed for bigger machines. It conquers the most challenging reeling conditions and delivers the best performance available anywhere.

3. Practical Examples

3.1 Top quality newsprint at Daehan Paper PM 3 after a forming section rebuild

Daehan Paper PM 3, situated in Cheongwon, South Korea, started up the first BelBaie V forming section rebuild in November 2003. PM 3, which was started up in 1995 and has a design speed of 1,500 m/min and a wire width of 6,950 mm, produces recycled newsprint from 100% recovered paper (DIP) with an annual capacity of 210,000 metric tons.

In Daehan the existing BelBaie III forming section was rebuilt into a BelBaie V with VacuShoe technology. Two BlowCleaners were installed for both fabrics to reduce fiber carriage and to improve the cleanliness and dryness of the fabrics when entering the gap. Mist was remarkably reduced due to a more closed dewatering area and improved ventilation. The original headbox was relocated, and the bowed rolls were removed. Press section geometry was optimized for better runnability and all felt stretchers were upgraded. The dryer section was modified to a single-felted dryer group including SymRun HS blowboxes and new doctors, targeting better runnability.

As a result, such paper properties as formation, printability and oil absorption symmetry were noticeably improved. After the rebuild Daehan Paper has been considered the reference standard for print quality in the South Korean market a standard that all others are trying to reach.

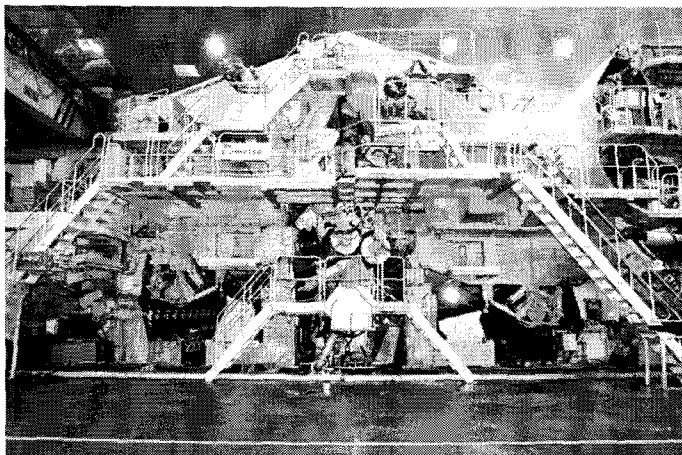


Figure: The original BelBaie III former was upgraded to a BelBaie V, which extends the former's life to match the latest modern machines.

3.2 More capacity with extensive rebuilds at Thai Paper PM 4 & PM 5

Thai Paper Co., Ltd., which specializes in coated and uncoated fine paper, started up its rebuilt PM 4 and PM 5 fine paper machines in the fall of 2004 in Banpong, Thailand. The comprehensive rebuilds, supplied by Metso Paper, included equipment upgrades starting from stock preparation and the forming section all the way through to the calendering section. The target for both rebuilds was to increase the speed and production capacity of the machines.

Thai Paper PM 4, installed in 1994, produces 60-120 g/m² uncoated woodfree paper and PM 5, which was built in 1997, produces 55-120 g/m² base paper for coated fine paper grades. Both machines have wire widths of 3,900 mm and use eucalyptus pulp as well as broke from both machines as their raw material.

Capacity increases were made possible by replacing the 4th press with an additional group of drying cylinders to improve runnability. To ensure optimized sheet symmetry, single hard nip calenders were modified to soft nip ones. Existing grooved rolls were converted to vacuum rolls, and broke handling in stock preparation was upgraded to improve the cleanliness of coated broke. Automation, tail threading and air systems were also upgraded on both machines. Fabric cleaning equipment was added to the PM 4 forming section and a steambox was installed on the PM 5 press section.

The production capacity and runnability of both machines was improved as a result. Within two months of startup the production lines had increased their production speeds to 1,050 m/min and 1,180 m/min, respectively. Base paper sheet symmetry and moisture profiles improved as well.

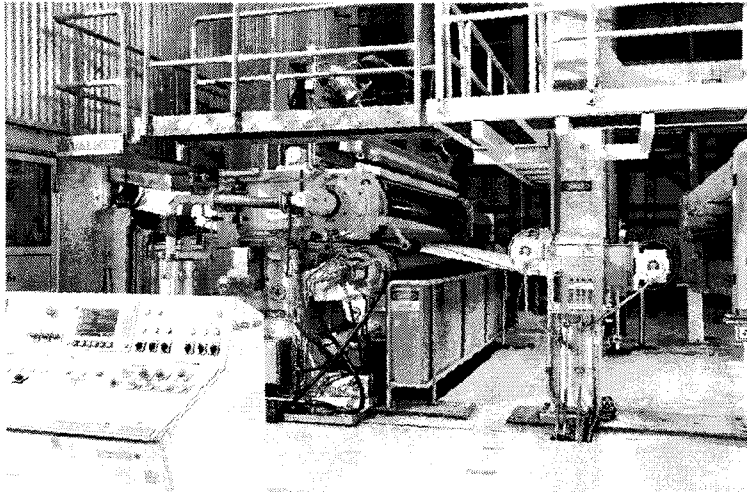


Figure: Thai Paper started up its rebuilt PM 4 and PM 5 fine paper machines in the fall of 2004 in Thailand. The targets set for both rebuilds - increased speed and production capacity were achieved shortly after startup on both machines

4.SUMMARY

Rebuilding an existing paper machine is often a very profitable way for papermakers to increase the cash flow created by an older paper machine. Metso Paper has placed particular emphasis in recent years on developing concepts and products specifically for rebuild needs. The outcome of this work can now be seen as a wide selection of products offering quite possibly the best coverage of all time of specific improvement targets. Different needs can be addressed through truly different solutions. Selecting the best-fit alternatives will offer great upgrade options for all paper machines and paper grades.

Metso Paper's long experience with high-speed paper machines has been put to good use to create more cost-effective small and mid-sized solutions with the reliability and quality of bigger and faster paper machines. This paper has discussed some of the most interesting and latest configurations available today for paper machine and finishing area rebuilds.