Paper Machine Rebuilds and Solutions for Process Improvement

초지기 개조 및 공정개선 방안

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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.

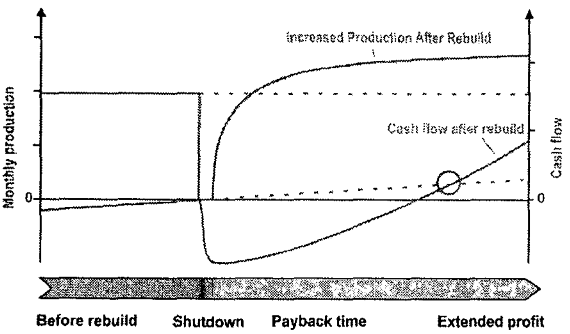

Figure 1.1.1: A targeted rebuild with a steep startup curve offers increased cash flow opportunities with a short investment payback.

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삭제됨: REMOVING PAPER MACHINE BOTTLENECKS WITH TARGETED REBUILDS

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삭제됨: Petteri Halme

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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.

삭제됨:

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.

삭제됨: PRODUCTS

2 SOLUTIONS

2.1 Headbox upgrades for better profiles and paper quality

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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.

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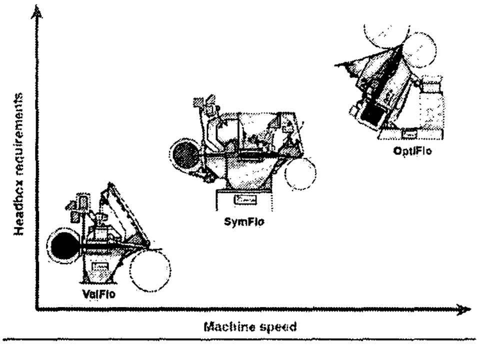

Figure 2.1.1: Metso's headbox portfolio offers solutions for all customer needs.

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

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records in speed and production provide the best proof of OptiFlo's performance capabilities.

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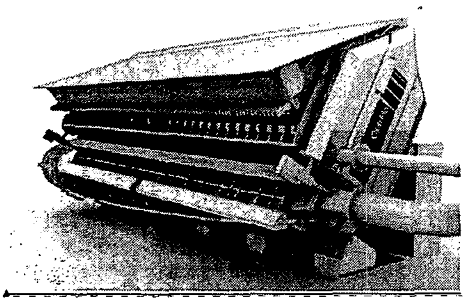

Figure 2.1.2: The OptiFlo headbox includes all features necessary for high-speed paper production.

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.

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 resulting better flatness, tensile ratio and formation.

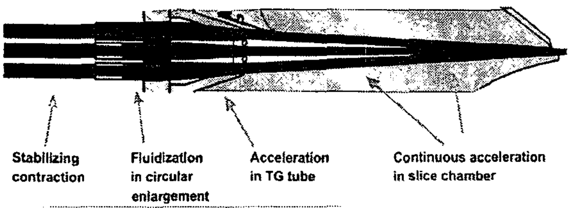

Figure 2.1.3: An OptiFlo II turbulence generator followed by wedges

삭제됨: [a&b]

삭제됨: creates a uniform sheet.

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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.

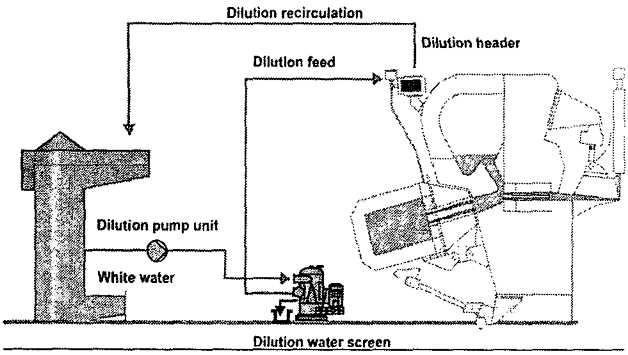

Figure 2.1.4: RetroDilu is an interesting alternative for many existing headboxes for improving web basis weight and orientation profiles.

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. Low dilution ratio of approx. 9% used in all ValFlo, SymFlo and OptiFlo headboxes reduce the effect of dilution water consistendy variation compared to higher dilution ration. In practice the key for this is design of the dilution water feeding which ensures excellent mixing to the stock.

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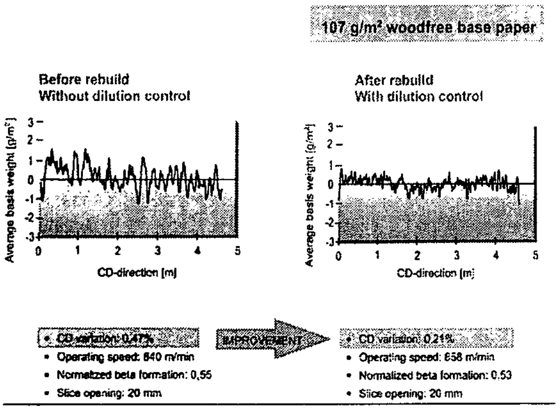

Figure 2.1.5: CD profiles will improve remarkably with dilution control.

2.2 Forming section rebuilds for improved sheet quality

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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.

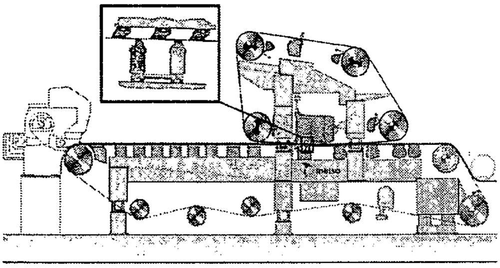

Figure 2.2.1: SymFormer MB is a hybrid former with a top forming unit.

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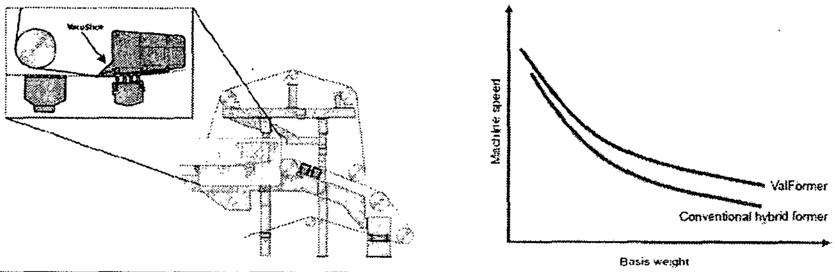
SymFormer MB hybrids are used worldwide for various paper grades. It has been very common to install these top forming units on top of an existing Fourdrinier. They work well with all paper grades.

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 40...300 g/m^2 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.



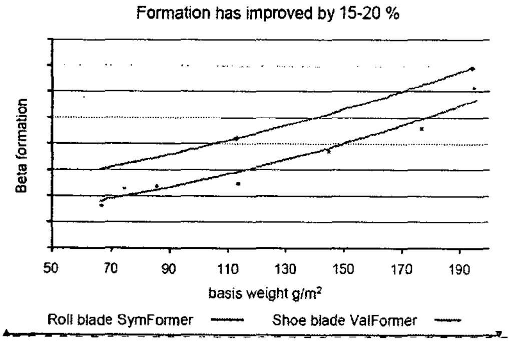


Figure 2.2.2 : ValFormer is based on VacuShoe technology and it provides tools that facilitate a step forward from conventional hybrid formers.

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삭제됨: *Figure 2.2.2 [a&b]: 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

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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".

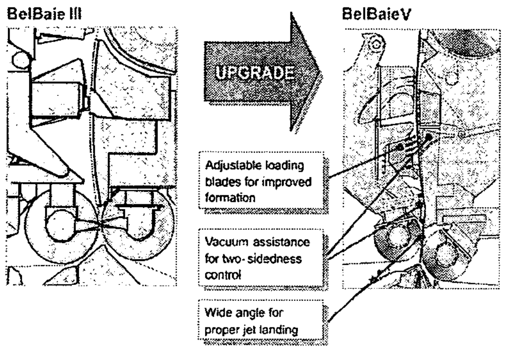

Figure 2.2.3: BelBaie V is the latest upgrade for existing BelBaie gap formers.

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

삭제됨: *Figure 2.2.3 [a&b]: A ValFormer offers an extended production window and improved formation.*

삭제됨: with

삭제됨: pilot-scale

삭제됨: trial runs

삭제됨: Another outcome of VacuShoe technology is the "zero-length-table" former. Its design resembles a roll and blade gap former arrangement, but the roll is replaced with a VacuShoe. *Figure 2.2.4: VacuShoe technology added to a horizontal gap former.*

삭제됨: .5

삭제됨:

삭제됨: For existing roll and blade formers the right upgrade is typically an OptiFormer. An OptiFormer rebuild is a good example of a product where both capacity and quality benefits can be achieved at the same time. With an OptiFormer rebuild the existing gap former will gain greater drainage capacity and better formation. The forming zone of the old former will be rebuilt and loadable blades will be added in the rebuild. These blades will contribute to improved sheet formation, together with higher ... [1]

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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.

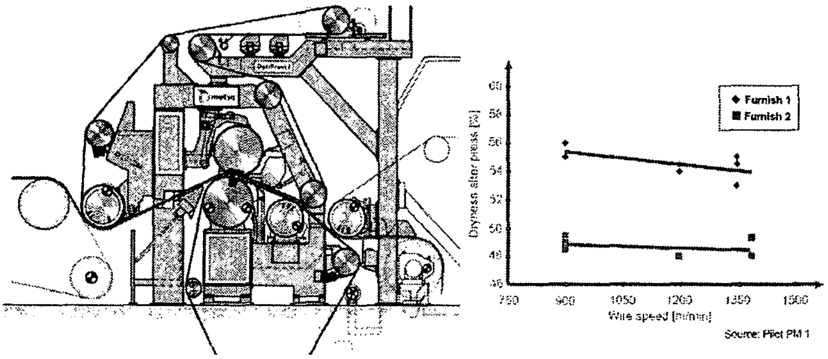

Figure 2.3.1: OptiPress I is a single-nip shoe press and it has been proven to yield outstandingly high dryness after the press section.

삭제됨: [a&b]

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.

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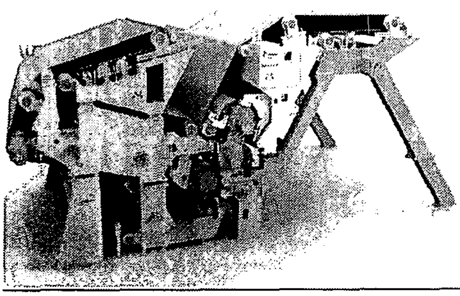

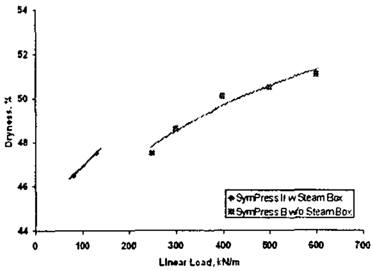

Figure 2.3.2: A SymPress B rebuild is the optimal way to improve existing three-nip press performance and it is therefore the bestseller of shoe press rebuild concepts.

삭제됨: *[a&b]*

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Latest steambox technology, such as IQSteamPro steamboxes, (fig. 2.3.3) introduces design applying details developed in impingement drying. The nozzle geometry and steamflow control enables more efficient steam application to the web. IQSteamPro has proven to be very efficient solution in many cases to increase the dryness at the press section making it attractive complement to existing press or even together with shoe press installation.

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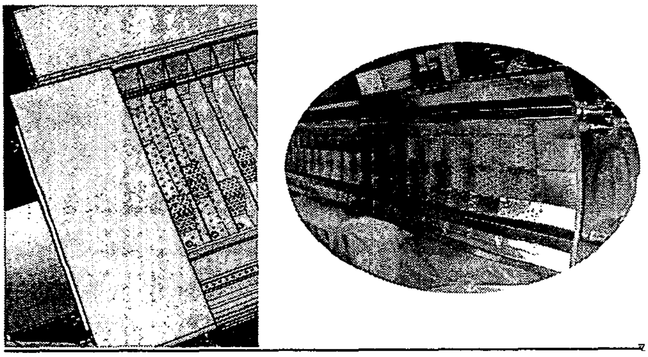

Figure 2.3.3: IQSteamPro steambox and nozzle design

In addition the actuators are unique and reliable electro-mechanical type, which require significantly less maintenance compared to traditional pneumatic actuators. Furthermore, if the delivery includes steam system, it comes with accurate desuperheating valve, which ensures that steam is converted to correct temperature before introducing it to the paper. All these features lead to superb results:

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- >1.5 % -units higher dryness after press section
- >50% improvement on CD moisture profile (measures steamprofiler on/off)
- better runnability after center roll and in the beginning of the drying section

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The results of IQSteampro installation on WFC paper machine are introduced in figure 2.3.4 results of installation of IQSteamPro.

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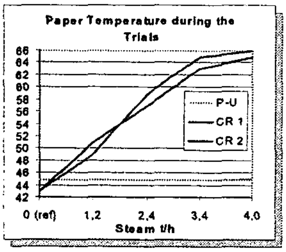

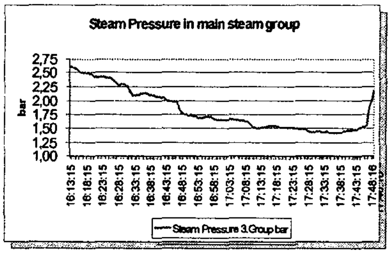

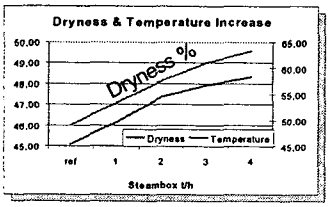

Superior results

- Steam pressure reduction in main steam group 40%
- Temperature increased by 23 degree C at press section, 14 degree C at the beginning of dryer section
- Dryness increased by 3,5 %-unit
- 2-sigma improvement 80%

Figure 2.3.4: IQSteamPro installation results at the WFC machine

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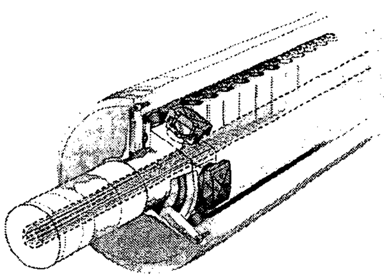

- **Self -loading with hydraulic loading element**
- **Better running characteristics**
  - Better control at edges
  - Better damping characteristics at roll ends
  - Higher profiling ability
- **Excellent running features**
  - High running accuracy
  - No speed limitations
  - Reliable operation at all loads
  - Silent running
- **Minimum service required**
  - Reliable hydrostatic bearing arrangement
  - Simple and easy main structure
  - Thick oil film in all conditions

Figure 2.3.5: SymZS self loading roll

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One possibility to improve dryness after press section, if bulk allows, is to increase the nip loads at the press section: Self-loading SymZS rolls (fig. 2.3.5). The design and loading method where only the shell is loaded by internal hydraulic loading elements instead of traditional loading arms provides vibration free operation even with high speeds and nip loads. In figure 2.3.6 we can see some case results of increased nip loads and dryness.

	NIP LOADS (kN/m)						
	1	2	3	4	Dryness (%)	Speed (m/min)	Remarks
NSI Skogn PM1							Twinver press
- before rebuild	65	80	80		41.5-42.2	930	
- after rebuild	70	110	120		44-44.8	1120	
StoraEnso Summa PM2							Twinver press
- before rebuild	70	79	80		40-42	1000	
- after rebuild	80	90	120		46-46.5	1120	with steambox
NSI Follum PM2							Twinver press
- before rebuild	70	80	80		-	1050	
- after rebuild	70	86	93		44-44.5	1160	
Daehan Paper PM3							Trivent+4th press
- before rebuild	75	90	120	130	45	1420	vibration problems solved
- after rebuild	75	95	130	140	47	1490	rubber cover changed to G-band
Other replacements with SymZS rolls:							
Skogn PM2							SymPressII, 3rd press
Skogn PM3							SymPressII, 3rd press
UPM Kaukas PM2							
UPM Kaukas PM1							
UPM Voikkaa PM11							
Myllykoski PM7							Twinver, 3rd press
Madison PM3							SymPress II, 4th press, SC
Laakirchen PM10							SymPress II, 4th press, SC

Figure 2.3.6: Results of SymZS roll installations

In addition of improved dryness and runnability we have found out that press felt lifetimes have been longer and power consumption can also been reduced (depending on the existing roll type).

2.4 Improved runnability and drying capacity through new technology

Increased quality expectations even at very high paper machine speeds have set new demands for paper machine manufacturers. In years past, the level of draw between the press and dryer section was dictated by runnability: the higher the machine speed, the higher the draw. This led to a situation where paper quality weakened in the case of many machines due to increased speed.

Both OptiDry Vertical and Twin uses natural gas instead of steam. Energy use and economic comparisons are presented between conventional dryer sections and the new solution.

Metso's solution for modern printing paper machine dryer sections is called SymRun (Fig. 2.4.1). It consists of a grooved and drilled VacRoll and a runnability component integrated

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삭제됨: *Press sections are famous for the fact that the paper machines in existence around the world employ lots of different designs. A shoe press can be added at many different positions. One typical application for smaller and lower-speed machines is a SymPress Combi B. It has no double-felted presses and the sheet will face smooth roll treatment from both sides, which makes this configuration very interesting for high-quality fine papers.*
Figure 2.3.3: SymPress Combi B has no double-felted presses and treats both sides of the she [... [2]]

삭제됨: **Dryer modifications for runnability and capacity**

삭제됨: When increasing speed, web runnability at the dryer section mu [... [3]]

삭제됨:
Figure 2.4.1: As speed is increased, more and [... [4]]

삭제됨:
A HiRun system provides many benefits, prove [... [5]]

삭제됨:

삭제됨: [... [6]]

삭제됨: *2 [a&b]*

삭제됨: *: A HiRun system provides increased web support that facilitate* [... [7]]

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to work together with the roll. There are many types of runnability boxes, the most common being SymRun HS blowboxes and HiRun blow/suction boxes. HiRun runnability components are used at the beginning of the dryer section and HS boxes at the middle and dry part of the dryer section. PressRun blowboxes are used to transfer the sheet from the press section.

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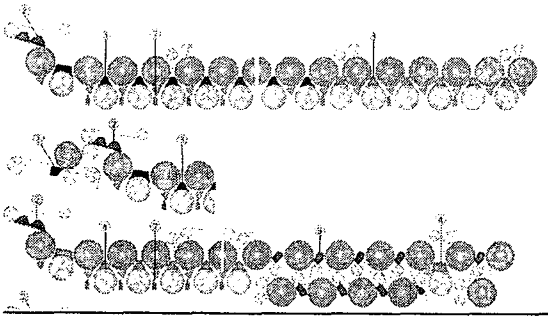

Figure 2.4.1: Typical conventional SymRun drying section

삭제됨:

The paper web is transferred from the press section in two different ways: by open draw, which is the case with SymPress concepts, or by closed draw, which appears in OptiPress concepts. In both concepts, a speed difference between the press and dryer section is needed. This speed difference is called draw, and its amount has a huge impact on paper quality. Draw effects on porosity, oil absorption and Scott Bond are presented in previously published articles (see references). However, the draw difference between the press and dryer section also affects the strength properties of paper and the breaking tendency of the sheet at a printing house.

삭제됨:

Under the SymRun concept draw is optimized by controlling web detachment from the dryer cylinder. The opening dryer cylinder gap is the most critical point in runnability and tail threading because an intense negative pressure zone is built up at this location. This detrimental negative pressure is eliminated by means of runnability components, the development of which has concentrated lately on decreasing energy consumption and on high negative pressure designs.

An appropriate stretch value is important in finished paper because paper is under tension at many stages after the paper machine. The following test was conducted on a pilot machine. Paper (LWC base) was dried to 8% moisture. The pilot machine dryer section was followed by a piece of equipment capable of breaking the sheet dynamically online. Paper strength properties were calculated from these breaking values. From this data it was possible to determine the effect of draw on the online stretch value, and to also estimate sheet breaking tendency at a production machine (Fig. 2.4.2). Based on Figure 2.4.2 we can conclude that an increase in draw makes paper break more easily. After higher draw from the press section, paper will not withstand high draw on finishing or printing machines (low stretch ability). Change starts to occur immediately after draw is increased, although the biggest gradient is between the 2% and 3% draw levels.

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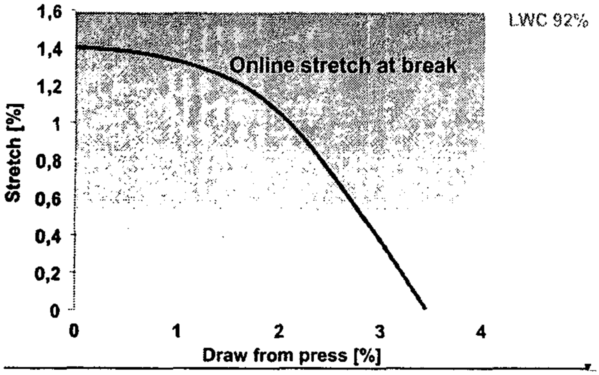

Figure 2.4.2: Effect of draw on on-line stretch value

삭제됨:

Web breaking tendency was determined based on the pilot machine tests described above, and the following result was obtained (Fig. 2.4.3). It seems clear that the draw between the press and dryer section is the most powerful factor affecting the runnability of paper after the paper machine. Figure 3 shows this in numbers: a draw level under 2% is quite safe, but draw increase from 2% to 3% makes web breaking tendency increase dramatically. Almost three times as may breaks will occur at a draw level of 3% than at 1%.

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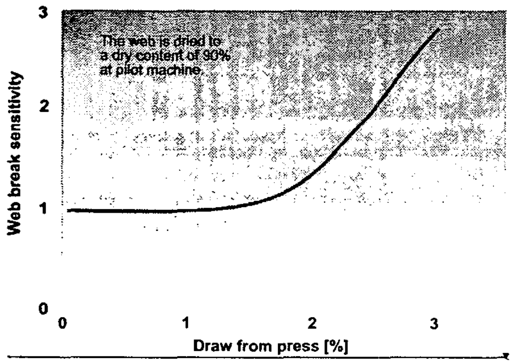

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Figure 2.4.3: Press draw affecting dry web break sensitivity

삭제됨:

The findings from numerous pilot machine trials presented above show very clearly that draw optimization between the press and dryer section is the most important tool for

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reaching optimal runnability of the dry paper web. Today, a draw decrease can be implemented utilizing effective runnability components. Metso's HiRun runnability components play a key role in this development. Well-working runnability components facilitate the optimization of draw differences without compromising the runnability of paper after the paper machine.

OptiDry, with its big vacuum roll, was originally developed in the 1990s. One machine making fine paper was rebuilt using the OptiDry concept. This machine has been running since 1999. Based on production machine experiences we can say that impingement drying is a good choice for drying printing papers. Hot (even 400°C blowing air temperature) air has no negative effect on paper quality, and when the blowing width control works properly, fabrics will last a normal replacement interval. However, there were some aspects that reduced the interest of paper makers in this technology: a lot of changes to the existing dryer section were needed, which means a long shutdown, and the limitations of a big vacuum roll, which limits the impingement length and is also difficult to manufacture and install. Put concisely, this concept with a big vacuum roll did not provide paper makers acceptably short payback times. That's why new development work was started at the beginning of this century. The target was to develop a new concept that would utilize impingement drying without a big vacuum roll.

The basis of this new development work was that the new concept would not have a big vacuum roll. Many ideas were studied, and finally a simple design utilizing normal diameter rolls and blowboxes was chosen as the new concept. This new concept has a number of blow boxes and supporting rolls instead of one big vacuum roll. This unit is also located just under the existing dryer section so that changes required at the existing dryer section will be minimal, if any. The new concept looked good, but would it work? How is the paper staying on the fabric surface? Does tail threading work? These items needed to be answered and pilot machine tests were required, once again.

Tests with supporting rolls were first run on VTT's (Technical Research Centre of Finland) dynamic pilot machine and pilot #1 at Rautpohja. These preliminary tests were so promising that the decision was made to run OptiDry Vertical on pilot #2 at Rautpohja. Test trials were run during 2004 and 2005.

The new impingement drying concept provides several benefits for rebuilds. It differs from the earlier concept in the sense that it lacks the big vacuum roll supporting the fabric and the web. Instead, there are a number of smaller lead rolls on which the fabric and paper web travel. The sheet is held on the fabric surface by blowboxes located under the fabric. The new concept suits all paper grades and it can be used with different dryer section layouts.

The long impingement drying phase means enhanced drying capacity, higher speed, and increased production. Since the sheet dry content increases very rapidly in the impingement area, higher than normal steam pressure can be used at an early drying stage. The fast dry content increase at the beginning of the dryer section also means better runnability. Impingement air velocity adjusts drying capacity rapidly and speeds up grade changes. A grade change automation solution has also been studied together with Metso Automation in recent years.

The concept is also suitable for double-tier dryer sections as it uses standard components. The rebuild is easy and fast, and only minimal building and machine frame modifications

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are needed. An additional benefit is the ability to use ropeless tail threading as there are blowboxes under the paper web. The air system is integrated, which means that circulation air blowers and burners are connected to the hoods. That is why no big diameter rolls are needed (Fig. 2.4.4).

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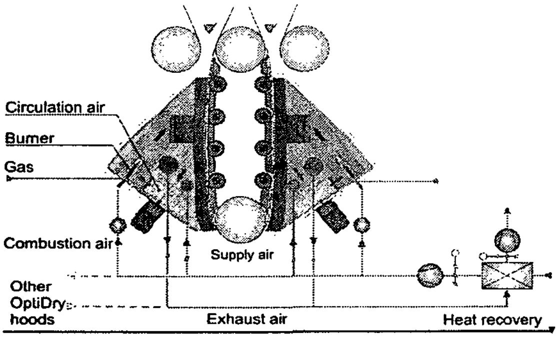

Figure 2.4.4: OptiDry Vertical with air system

삭제됨:

Most of the air is circulated inside the hoods. Moist air is naturally exhausted from the hoods, and the exhaust air is led through a heat recovery unit and used to heat incoming supply air. No leakages to surrounding air are allowed, which is why the concept is designed so that it works independently of the machine hood. Hoods are well insulated for minimal heat loss and safety.

삭제됨:

The target of this project was to develop a concept that is easy to install and delivers a short payback time for our customers. Finally, the new concept is presented in Figure 2.4.5 at a single-felted dryer section. Figure 2.4.5 shows that no major changes are needed to the existing machine when OptiDry Vertical is used in rebuilds. If sufficient room exists in the basement, hoods, rolls and blowboxes can be installed from the basement side and the existing machine layout remains unchanged.

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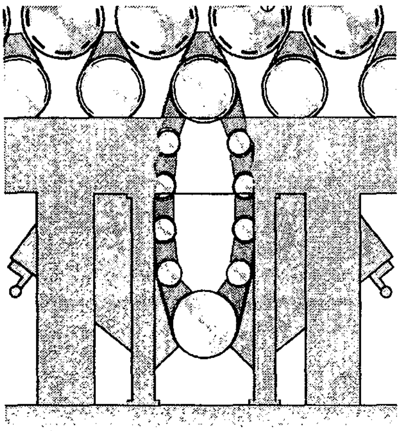

Figure 2.4.5: OptiDry Vertical layout

삭제됨:

Machine speed is the most critical item determining the choice of runnability components under the new solution. Flat-surfaced rolls are sufficient at low machine speeds. Grooved or vacuum rolls are used at higher speeds. The need for grooved rolls, and even vacuum rolls, stems from moving air that travels on fabric and roll surfaces into the closing roll gap creating a pressure pocket in the gap. Unless eliminated, this positive pressure tends to detach the sheet from the fabric surface.

The runnability of the new concept has been tested on pilot machines at machine speeds ranging from 600 m/min to 2,400 m/min. Runnability is excellent due to the runnability components used, namely blowboxes and vacuum rolls. Blowboxes are designed so that paper is held on the fabric surface at every part of the fabric loop. At higher speeds VacRolls help to eliminate the flow of air into the closing roll gap; no pressure is built up in the gap and web detachment does not occur.

Successful pilot machine performance made it possible to take OptiDry Vertical to a production machine. The first installation was a paper machine making fine papers. The machine speed is 600 m/min at its maximum. OptiDry Vertical was installed at the first dryer group, which was based on a single-felted concept. This implementation can be seen in Figure 2.4.6.

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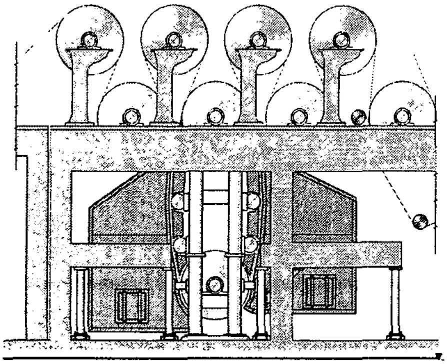

Figure 2.4.6: First OptiDry Vertical installation

삭제됨:

The first OptiDry Vertical has now been running for 1.5 years. Performance has been good. Machine speed has been increased by about 10% with dryer-limited grades. Tail threading is based on ropes and it works well. Runnability has been as expected: blowboxes between the supporting rolls hold the sheet on the fabric surface during drying.

삭제됨:

The first OptiDry Vertical was implemented on a narrow machine and the basement height was also small, which made it possible to construct the air system without integrating it with the dryer hoods. In this project the air system was executed using outside air equipment. The second installation of OptiDry Vertical involved a machine with a high basement and also a wide machine. That is why it was implemented with integrated hoods, which means that circulation air fans and gas burners were located in the hoods. This installation is presented in Figure 2.4.7.

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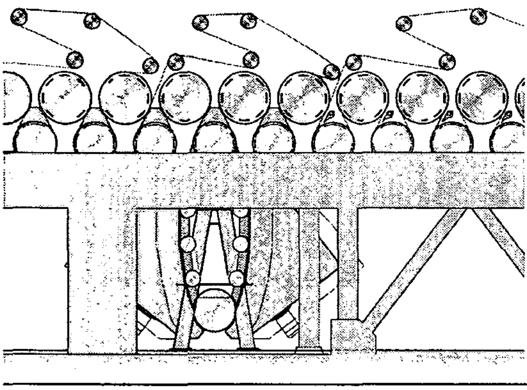

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Figure 2.4.7: Second OptiDry Vertical installation with integrated air system

The machine started up in February 2006. Shortly after startup we can state that it has fulfilled all expectations: drying effectiveness is good and runnability is excellent. The ropeless tail threading works without difficulties. Machine speed has increased due to a dryer section rebuild.

OptiDry Vertical is designed for the rebuilding of machines needing more drying capacity without any other major changes to the existing machine or machine hall. OptiDry Vertical is good for this purpose, but it does not help alone if machine speed increase is limited by the dryer section just after the press section. As was presented above, HiRuns help in this, but their capacity may also be too low when optimal speed and top quality are needed.

As noted earlier in this presentation, the opening cylinder gap is the main reason for runnability problems at the beginning of the dryer section. A wet and cold web tends to attach to cylinder surfaces and speed increases strengthen this phenomenon. Furthermore, as speed increases, the web dry content tends to drop after the press section, which means that the web is weak and its tension is low. The only way to avoid these detrimental phenomena is to increase the dry content of paper before it arrives at the first steam-heated cylinder. Metso's answer to this is a new solution called OptiDry Twin.

OptiDry Twin is developed on the basis of OptiDry Vertical, and it is an excellent solution for the beginning of the dryer section. OptiDry Twin consists of two drying units: a horizontal part and a vertical part (Fig. 2.4.8). At the horizontal part of OptiDry Twin, paper is heated and dried from the top side. After the horizontal part paper is transferred to a vertical part, where drying continues from the bottom side of the web. When paper comes to the first drying cylinder, its dry content has increased by several percentage points and, also very importantly, its temperature is usually 70…75 degrees Celsius, which means that adhesion to the dryer cylinder is not as bad as with a cold web just after the press section.

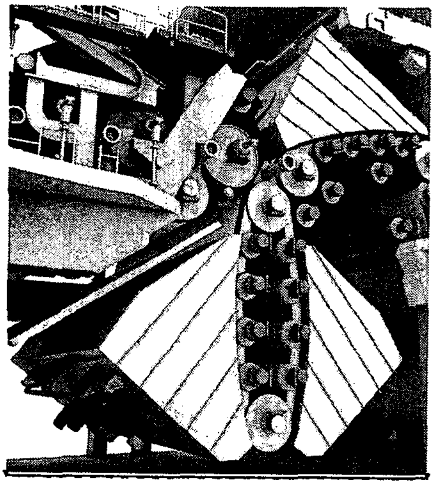

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Figure 2.4.8: OptiDry Twin

삭제됨:

OptiDry Twin has one feature that makes it superior in drying efficiency: both horizontal and vertical parts can be dimensioned to facilitate maximal dry content increase. Roll diameter does not limit impingement length, as was the case with Metso's former "big roll" OptiDry. Space utilization is also excellent in this new solution, as can be seen in Figure 2.4.8 above.

Drying efficiency can be estimated by measuring the sheet dry content before and after impingement drying. Pilot machine tests show an average evaporation rate of 90 to 110 kg/m^{2}h. This high evaporation rate means that an 8...10% dry content increase can be obtained with OptiDry Twin on a high-speed newsprint or LWC machine. This means that the sheet dry content is about 56...60% at the first cylinder depending on the press configuration (Fig. 2.4.9).

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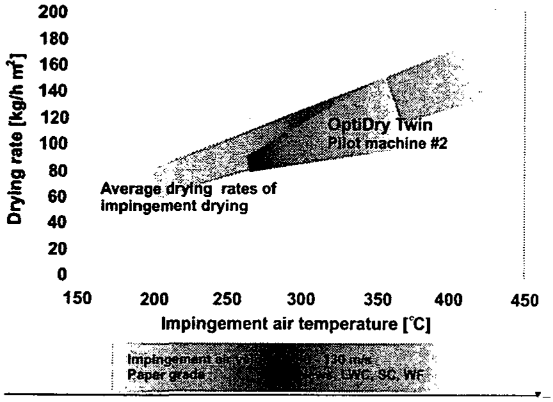

Figure 2.4.9: OptiDry Twin drying rate

삭제됨:

The early part of this article addressed the importance of the draw difference with respect to paper quality and runnability. OptiDry Twin involves three different draw locations before the first dryer cylinder, whereas OptiPress (or SymPress) + SymRun has only one transfer point before the first cylinder.

One main target in the development of OptiDry Twin has been draw control without speed limits. While the increase of draw from the press section is a key tool in conventional cylinder drying, OptiDry Twin needs only enough web tension for the web to stay attached to the dryer fabric on its way from supporting roll to supporting roll. OptiDry Twin lacks a smooth and hot cylinder surface where cold paper would attach to the cylinder. This is why it was assumed that OptiDry Twin draw would be moderate. This phenomenon was proven shortly after pilot machine startup. A test was conducted with fine paper increasing speed

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from 1,450 m/min to 1,800 m/min while optimizing the speed difference at OptiDry Twin. Related results can be seen in Figure 2.4.10.

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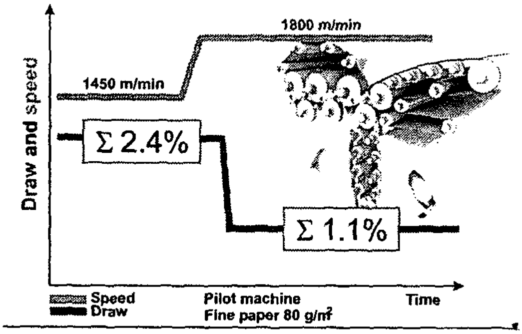

Figure 2.4.10: OptiDry Twin - optimization of press to dryer draw

삭제됨:

As shown in Figure 2.4.10, the pilot machine speed was 1,450 m/min at the beginning of the test. Total draw at the three draw points of OptiDry Twin was 2.4%. At this draw level machine speed was accelerated to 1,800 m/min. At this speed draws were optimized and the result was amazing: total draw was decreased to 1.1% and the sheet ran continuously to the reel and no wrinkles or edge flipping were seen at the dryer section.

Successful tail threading is the main issue in the evaluation of paper machine efficiency. At the pilot machine OptiDry Twin, the paper web is threaded to the first cylinder from the forming section. Web threading has been so trouble-free that we can talk of 100% success.

Sheet runnability at OptiDry Twin has been excellent. Because there are no opening cylinder gaps, the paper sheet can be held on the fabric surface with very moderate negative pressure in the runnability components. This means lower energy usage.

OptiDry Twin has now been in use at the pilot machine for more than a year. Speed tests have shown that paper machine speeds can be set to a new level in the future. Far over 2,000 m/min can be run, and most promising of all is that the reliability of the new dryer section is excellent.

삭제됨:

OptiDry Twin represents a good option for producing copy paper at top quality and efficiency. The primary copy paper quality demand is a good bulk/roughness ratio at the highest possible production speed. This normally means that the sheet dry content after the press section must be as high as possible for good runnability at the beginning of the dryer section. High press loads are good for paper dry content but not so good for bulk, which will drop at high press loads. If press loads are decreased, runnability will drop and the machine speed must probably be lowered, which is an unwanted situation. The sheet dry content must therefore be increased by drying, not by pressing, if the highest possible bulk is wanted. The answer to this requirement is OptiDry Twin.

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2.5 Energy control and paper machine ventilation

Nowadays there is several factors setting new requirements for paper mill energy control that has to be taken into consideration:

- decrease of the production costs
- Kyoto protocol
    - to reduce the greenhouse –gas emissions between 2008 and 2012 to the level of 1990
    - concerns in the beginning mainly CO_2
- environmental legislation
- energy is an important environmental and cost factor
    - energy audits
    - possibilities to improve the energy efficiency
- process control
    - way of operation and training

A typical subprocess energy consumption of newsprint and WFC line is presented In figure 2.5.1. There we can see that regarding steam consumption drying and air system is by far the dominating factor, which has significant effect on the above mentioned factors.

	Newsprint		WFC	
	Steam GJ/t	Elec. kWh/t	Steam GJ/t	Elec. kWh/t
Stock Preparing				
Pulping		50		50
Chemicals			0,20	100
Screening		55		189
Paper Machine				
Approach System		89		98
Drives		150		175
Air system and Drying	4,80	45	8,90	45
Coating and Coat Drying			2,20	173
Calendering and Winding		20	0,10	173
Vacuum System		137		130
Pressurized Air		10		20
Fresh water and water treatment		32		14
Power plant	0,05	7	0,10	15
Building	0,20	18	0,30	45
Others	0,15	5	0,30	7

Figure 2.5.1: Typical energy split between newsprint and WFC line subprocesses

We can see the air systems of paper machine in figure 2.5.2. Their optimal operation is has a great impact on paper machines runnability, drying capacity, energy efficiency and thus environmental impact.

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서식 있음: 글머리 기호 및 번호 매기기

서식 있음: 들여쓰기: 왼쪽: 0.63 cm, 글머리 기호 + 수준:1 + 맞춤 위치: 0 cm + 탭 간격: 0.63 cm + 들여쓰기 위치: 0.63 cm, 탭: 3 글자, 탭 목록 + 1.5 글자(없음)

서식 있음: 글머리 기호 및 번호 매기기

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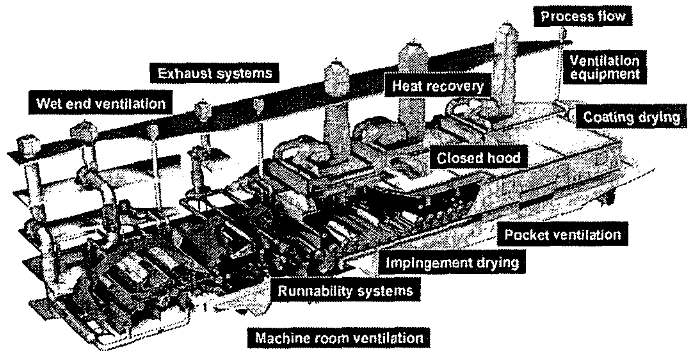

Figure 2.5.2: Air systems in paper and board machines

The energy consuption should be seen by means of overall energy management at the mill with clear actions and objectives in each area. Energy management and its objectives can be split in steps as seen in figure 2.5.3.

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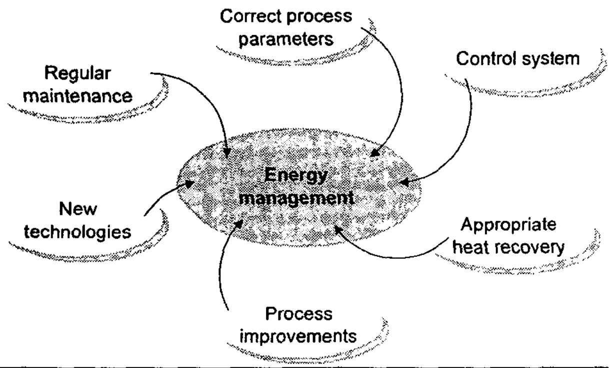

Figure 2.5.3: Important steps leading to overall energy management

Energy management planning and implementation includes scheduled analysis and measurements, preventive maintenance and repairs of the existing systems to enable their optimal and designed operation. In addition new technolgies, such as impingement drying, improved off-machine coater air dryers etc., can be then easily evaluated and implemented to increase the productivity of the paper making line. Drying is one of the most energy consuming areas of papermaking and it should be paid proper and consistent attention

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together with the air system which is handling much of the energy flows in and out of the machine.

3 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. In Metso Paper we have 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 rebuilds.

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